Italian National Agency for New Technologies, Energy and the Environment

Systems and Advanced Solutions for eLogistics in the Sustainable City

Edited by G Ambrosino, M Boero, J D Nelson , M Romanazzo

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ENEA, the Italian National Agency for New Technologies, Energy and the Environment, is a public undertaking operating in the fields of energy, the environment and new technologies to support competitiveness and sustainable development. ENEA is mainly called upon:

- *to promote and carry out basic and applied research and innovation technology activities;*
- *to disseminate and transfer technologies;*
- *to provide high-tech services, studies, tests and evaluations to both public and private bodies and enterprises.*

(IST-2001-34241) eDRUL - eCommerce Enabled Demand Responsive Urban Logistics – is a three year European project for the development of e-solutions for City Logistics Services. It ended on February 2005 and this book is the eDRUL FINAL REPORT. All eDRUL partners have been involved in the realisation of this document which is focused on the main project results and on City Logistics Agency concept.

eDRUL project has been undertaken in the EU's fifth Framework Programme for Research and Technology Development, Information Society Technologies (IST) thematic programme.

The Interreg III B Medocc Programme supports projects aimed at transnational co-operation between national, regional and local authorities in the field of territorial development of Western Mediterranean countries. The primary objective of the Programme is to increase the territorial competitiveness of Southern Europe in order to create an economic integration zone of world-wide importance, as well as supporting the contribution of the Barcelona Process to greater integration between the European regions of the MEDOCC and Third Countries of the Mediterranean zone.

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Direzione Generale dello Sviluppo Economico - Area di Coordinamento Politiche Industriali, Innovazione e Ricerca, Artigianato - Settore delle Politiche Regionali dell'Innovazione e della Ricerca
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"eLogistics services for a city development
based on technology, talent and tolerance"

Giorgio Ambrosino, Italy

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Preface

Freight transport and distribution is one of the primary components of the economic and social welfare of our cities, playing a major role in many key socio-economic sectors and activities. On the other hand, as a main component of urban traffic and mobility, it has important effects on the quality of the environment and life in urban areas, as heavily congested roads are significantly affecting the life of citizens.

Evaluations of CEMT (the European Council of Transport Ministers) show that urban freight transport is responsible for 34% of total goods transport, for20% of traffic network occupation and 60% of whole polluting gas emissions. In Italy traffic for goods distribution is about 20-25 % of overall road urban traffic and contributes to a considerable increase of congestion and generally of internal and external transport costs.

The way freight transport is organised, managed and regulated influences and depends upon urban planning, production and consumption networks, social relationships. Therefore, actions to improve freight distribution in urban areas imply policies and integrated measures that deeply change the previous unregulated distribution systems. Such a change is a challenge for the European cities and has a potential to offer new work opportunities. However, it also requires a governing process clearly orientated towards continuous improvement in transport efficiency, supported by dynamic long term, strategic policies.

Urban freight transport policies assume more than others a transverse role, since they operate within complex interdependencies at urban levels. Trade flow structures are mainly influenced by SMEs (that represent 70% of the total EU company turnover) that are involved mainly with short-distance procurement and distribution often in a context where there is a lack of culture of transport optimization techniques of dispatching, scheduling and optimisation of distribution flows. Appropriate use of advanced ICT solutions for the management of fleets of vehicles should considerables reduce the number of empty trips or trips made with small loads increasing the overall economic efficiency.

Growing attention has been recently paid to the search for new approaches and innovative models and solutions for city logistics, taking advantage from a number of enabling technologies and ICT tools. Local Authorities are increasingly engaged on these issues and sustainable freight transport is the objective to be achieved. This becomes particularly true when considering the specific, complex environment of 'old' urban centres and historical cities, a particular type of urban context which is common in virtually all European countries. So city logistics represents the nervous texture of a city production and economic life that should be qualified and preserved to ensure the liveliness and attractiveness of our historical centres.

ENEA, the Italian National Agency for New Technologies, Energy and the Environment, has been involved for many years in research projects concerning rational and sustainable use of energy both in passengers and freight transport. ENEA, conscious of the importance of goods transport from an economic, energy and environmental point of view therefore, starting from 1998, promoted research activities concerning freight transport and logistics by means of "Consortium TRAIN", an organization that besides ENEA includes railway national companies (Trenitalia and RFI), universities and private companies. The main competences of the consortium are: organisation of transport services, advanced technology for intermodal transport through the development of integrated design techniques, development of planning tools, development of intermodal dedicated carriers, intermodality with fast ships, urban passengers and freight mobility, study and application of innovative technologies for faster freight loading and unloading operations in freight terminals.

Interesting pilot projects of city logistics have been carried out in recent years that could be followed in many European towns. ENEA believes that it is a good opportunity to publish this book that not only provides a comprehensive, up-to-date overview of the latest developments in the domain of sustainable city logistics, but also contributes to dissemination of that innovation culture in a sector that is very important for the future of our economies.

This book addresses results achieved in research and innovations initiatives recently carried out in Italy, particularly the Tadiram project (part-funded by the Italian Ministry of Scientific Research) and in Europe, particularly the eDRUL IST project and MEROPE Interreg IIIB MEDOCC projects, involving a relevant number of cities and towns. These initiatives have been designed and implemented to investigate and experiment innovative solutions to city logistics, addressing a range of aspects, from service schemes and organisational models, to enabling and supporting ICT solutions, to institutional measures and policies.

The Tadiram Project is aimed at demonstrating all the elements of an innovative logistic concept for freight distribution in urban areas: new organization and logistics based on innovative vehicle (tram), use of freight HUB, telematics systems for gate procedures and for service management, integration of value added economic activities, new loading units specifically designed for the application.

Part-funded by the European Commission, Directorate General Information Society Technologies (DG-INFSO) in the context of the 5th Framework Programme eDRUL - eCommerce Enabled Demand Responsive Urban Logistics - was a pilot project designed and carried out taking into account this multi-faceted context. eDRUL pilot sites – Siena, Aalborg, Eindhoven and Lisbon – all have an advanced urban environment, well instrumented at physical and ICT levels, controlled by a defined set of normative and administrative rules and operating ICT systems. Based on this, eDRUL allowed the investigation, realisation and experimentation of innovative concepts and solutions for city logistics, throughout nearly three years of activities, between April 2002 and January 2005.

The demonstrations and evaluation undertaken in the eDRUL sites, as well as the experiences gained with similar schemes and complementary elements and solutions in MEROPE cities, have shown the effectiveness of the approach and the relevant role that a City e-Logistics Agency and regulated city logistics schemes can play as fundamental tools to implement and control sustainable solutions for urban goods distribution.

Maurizio Romanazzo

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CHAPTER 1

Context and contents of the book

G Ambrosino, M Boero, J D Nelson, M Romanazzo

1.1 An introduction to e-logistics in urban areas

In today's Information Society the impact of the Internet continues to profoundly change the established business logic. Boundaries between markets, industries, companies, products and services, sellers and buyers, and so on, are disappearing. Internet applications can be divided into three major stages; e-presence, e-commerce, and e-business.

- e-Presence. e-presence often starts with one-way information about the company, its products and services. The Internet is primarily used to publish information. Suppliers can deliver product and service information directly to customers in a cost efficient way.
- e-Commerce. In the second stage – e-commerce - opportunities are opened for transactions. A transaction consists of two major parts; transaction creation and transaction fulfilment. In the digital economy, transaction creation is achieved over the Internet (e-creation), which usually leads to reduced transaction costs. When it comes to digitally transferable services and products, such as bank services, computer software and music, transaction fulfilment can also be achieved over the Net (e-fulfilment). For physical products, however, fulfilment has to be supported by physical movement (e-logistics). E-commerce can be divided into two separate areas: Business to Consumer (B2C) and Business to Business (B2B) with different e-logistics requirements. Logistics costs can account for more than 40% of total costs in e-trade. This means

that e-logistics, e.g. in terms of cross-docking, and payment are the critical factors for profitability. Since e-commerce transactions put heavy stress on effective and efficient logistics operations the e-logistics concept is of great help. E-logistics companies can act as advanced 3PL partners and add value in a very profitable way – for all parties involved.
- E-business. The third phase – e-business – involves transformation of processes and systems to increase integration and automation in order to take advantage of all the possibilities created by the Internet.

1.1.1 Recent developments in e-logistics

The e-logistics concept is adapted to the digital economy in which the Internet is a major backbone. The information flow is the starting point and the enabler – not the physical resources. Physical resources for moving and storing products do not have to be owned by the e-logistics company.

The e-logistics concept is defined by the interaction and integration taking place at the interfaces between traditional logistics, Information and Communication Technology (ICT) and process management. In summary:

- ICT provides the methods, systems, and techniques necessary. Database technology and data mining techniques are major enablers in the implementation of the e-logistics concept. The gap between those who know enough about ICT and those who know enough about the application area of logistics has to be bridged.
- Logistics provides the frame of reference, the concepts, and the models for management of cross-functional and inter-organisational flows and processes. Logistics is, in many ways, the cradle for process orientation. Virtual integration offers the solutions for inter-organisational co-ordination and co-operation, and also for the shift from supply chain to demand chain thinking.
- Process management helps in creating the necessary conditions for renewal. Most of the effective and efficient relationships in the networks of the digital economy are process driven. The concept of e-logistics focuses on integration and improvement of interaction in the interfaces between these processes.

E-logistics delivers total solutions that are built on virtual rather than ownership based integration. ICT enables the creation of an intelligent value web in which individual activities are optimized based on the creation of value to the customer. E-logistics is one of the cornerstones for successful e-commerce, but it is also a key factor in e-business and the rethinking of traditional industrial enterprises.

A clear understanding of the developments in e-logistics is necessary in order to understand the applicability of these concepts in urban logistics in general and has been fundamental to the EC-funded eDRUL project in particular. The core objective and focus of the eDRUL project has been the integration of e-Commerce/e-Business services with advanced city logistics management architecture (see Chapter 4) and (crucially) the formulation of concepts relating to the development of a business case for an e-logistics platform (see Chapter 7).

1.1.2 A basic understanding of freight distribution in urban areas

Logistics entails the management of the goods flow through a logistics chain; that is, the sequence of consecutive actions that must be performed to enable the production of and then delivery of a product to the end-user. Although the focus is mainly on the final distribution of consumer goods in urban areas (physical distribution), insight in related logistics processes (materials management) is also important to understanding and optimising the physical goods distribution processes for urban areas.

Multiple actors are involved in logistics operations, including producers, logistics service providers, retailers, transport companies, and consumers. In terms of transport, actors can play roles as shippers, receivers, and transporters. Actors can optimise the specific basic logistics activity they control via the normal business-economic optimising strategies (by balancing the inputs of capital, man-power, and capital goods). In business logistics, total chain optimisation can result in some efficient solutions. One can propose concepts that aim to optimise distribution processes on a supra-company level. Optimisation of the trade-offs between multiple basic logistics activities (of multiple firms) means that for the sake of total efficiency, some partial inefficiency may occur and must be accepted. This is clearly the case in just-in-time strategies where inventory cost reductions can only be achieved by allowing less efficient transport.

Public policy usually aims at certain sectors and tries to optimise processes such as production or transport, for instance, to limit the production of waste materials. Public policy actors do not control basic logistics activities and can only impose measures to guide decisions that should lead to societal optimisation. To achieve an overall societal, transport system optimisation, inefficiencies may be introduced for individual actors. In advanced public policy optimisation, sectoral optimisation is still the main goal, but all relevant processes in the logistics chain are taken into account. This includes both vertical optimisation (within a single logistics chain) and horizontal optimisation (between different firms). In Western society, governments are reluctant to interfere directly with business operations; therefore regulations, market forces (specific taxes, subsidies, etc) and facilitating policies are used to reach the objective.

The six basic physical urban distribution concepts are:

1. Direct distribution originating from the suppliers
2. Round-trip distribution originating from the suppliers
3. Urban distribution with direct distribution from a local transfer point
4. Urban distribution with round-trip distribution from a local transfer point

5. Network distribution with direct distribution from a regional transfer point
6. Network distribution with round-trip distribution from a regional transfer point

1.2 Institutional aspects of urban logistics

The institutional framework identifies the public and private actors within the field of urban distribution and defines their roles. In the operation of the transport system for urban goods distribution, many actors and regulators (public and private) are involved (see Figure 1.1). Governments have limited control over the system.

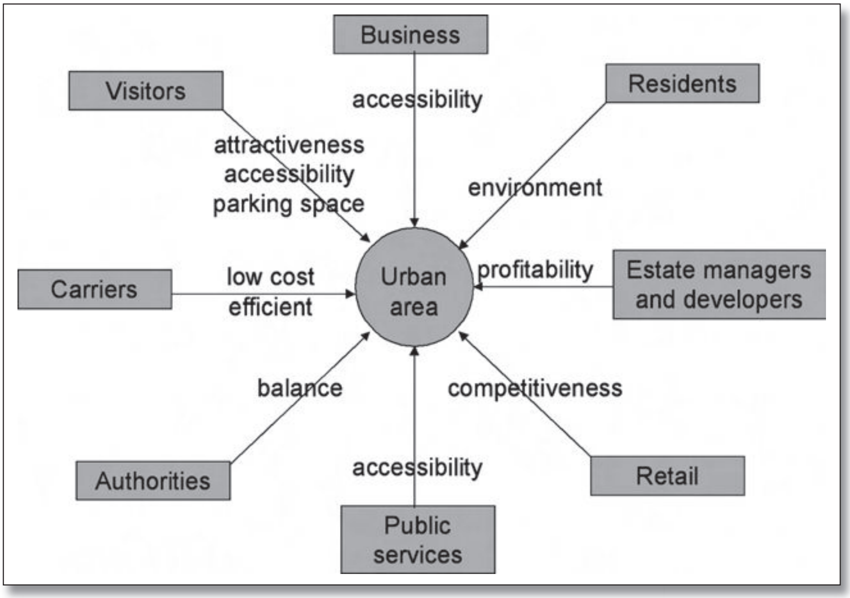


Figure 1.1: **Actors and their interests**

Source: Binsbergen and Visser, 2001

Policymakers focus on urban logistics in order to:

- reduce congestion;
- reduce pollution and noise;
- improve road safety;
- safeguard accessibility of important economic areas; and
- increase the attractiveness of city centres.

Figure 1.2 describes the policy relevance of urban logistics, starting from the objective of contributing to sustainable development.

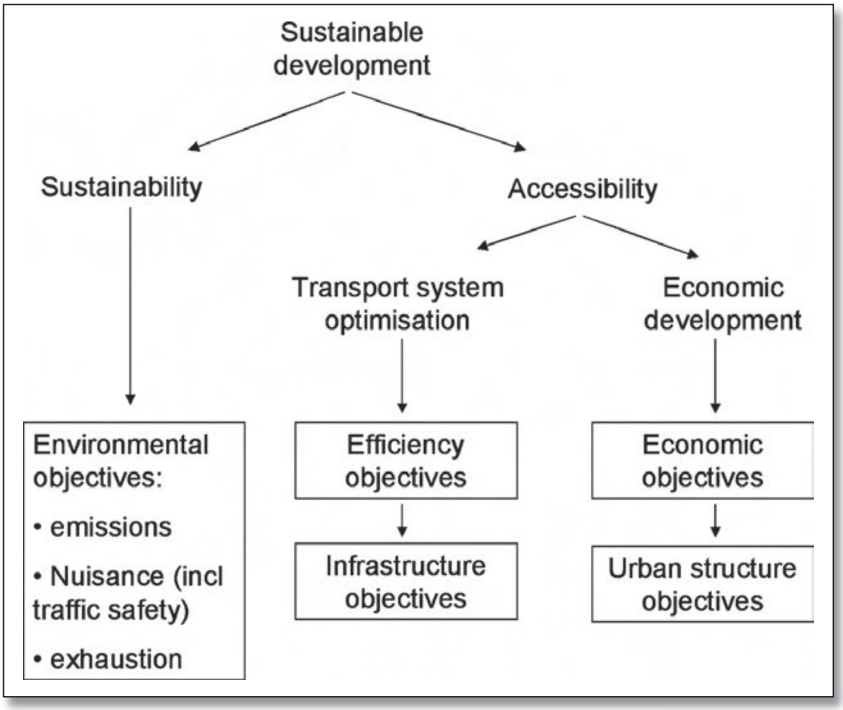


Figure 1.2: **The policy relevance of urban logistics**

Source: Binsbergen and Visser, 2001

Planning styles are a key element of the policy-making process. The following typology of planning styles can be distinguished:

- Traditional planning, in which governments act as doctors: they try to control processes and try to solve problems with public measures (top-down approach).
- Progressive planning, in which governments act as educators: they provide information to the relevant actors and try to let them solve the problems (bottom-up approach).
- Consultative planning, in which governments act as facilitators: they present a window of opportunity and encourage public participation (combined bottom-up and top-down approach).

eDRUL (2005) note that guidelines for the planning process are essential for a successful implementation of policies:

- Policy-making is a rational process. Decisions are the result of a series of identifiable steps.
- One can speak of a poly-actor model. Policy-making and implementation occur by many public actors with their own values, interests, responsibilities and rationalities. However, during the policy-making process, it is necessary to engage with a multitude

of actors with overlapping and/or unclear authorisation and responsibility, but limited numbers of representatives.
- The policy-making must be well structured; offering space and a framework for policy enforcement and adjustment.
- Objectives should be defined clearly and should be made operational for evaluation purposes.
- Consensus on policy objectives and instruments is not, by definition, necessary.
- The policy itself must be supported by sufficient means to realise the objectives.
- The policy making process requires optimal communication and information processes.
- Evaluation of policies should be possible during the policy-making and implementation (effectiveness, efficiency and coherence).
- Involvement and commitment of the relevant actors is required during implementation.

The extremely important role of institutional issues in influencing the development of e-logistics services is discussed in Chapter 10.

There are a variety of instruments that a government is entitled to use in order to carry out a policy. The following typology of policy instruments is proposed by eDRUL (2005):
- Active involvement as a:
  - Developer: public sector can develop infrastructure or technology
  - Provider: public sector can provide financial means
  - Operator: public sector can operate the systems
- Planning instruments concerning:
  - Infrastructure planning
  - Spatial planning
- Financial instruments dealing with:
  - Taxes and pricing (e.g. time and location dependent road-user charging systems);
  - Financial support (financing, subsidies, credit loans, financing guarantor)
- Legislative instruments (licensing and regulation)
- Communication and consultation instruments
- Agreements and covenants (these instruments allow both public and private sector to commit to change)

Regulation as a legislative instrument can appear in several types of traffic and vehicle regulation (the subject of Chapter 3):
- **Time windows** (a period during which one may enter a particular zone). Time windows serve primarily to keep designated streets or areas completely free of freight traffic during specific periods. Outside the time window the inconvenience does not

exist but during the window times there is a concentration of traffic. Experience with time windows shows that time windows that are too tight, or cover too broad an area, can cause accessibility problems and extra traffic during peak periods. This shows the importance of co-ordinated time windows.

- **Dimensions and/or surface areas of vehicles**. These restrictions are primarily intended to limit the physical hindrance of freight traffic. Smaller vehicles are easier to manoeuvre in the urban environment, and the driver's control of the vehicle is usually better. In many municipalities, the maximum length used is ten metres.
- **Axle load and/or vehicle weight.** These restrictions are meant to limit the physical damage that freight vehicles inflict on the infrastructure and its surroundings.
- **Emissions.** Emission restrictions are aimed at improving the air quality.
- **Noise**. Noise restrictions are also aimed at improving the local living environment in the city. Traffic is often the main source of noise pollution, and freight traffic plays a significant role here.
- **Target group and/or urgency.** Admission rules based on the criteria of 'target group' and 'urgency' is another form of restrictive policy. For instance, it is possible to aim for a higher degree of loading by providing only a limited number of concessions (as in Amsterdam for example).
- **Load factor.** The load factor can be used as a restriction criterion because it is an indicator for an efficient use of vehicles.
- Any **combination** of the above. A new development in regulation is the certification of transport companies in combination with the introduction of permits. Certification results in receiving a permit; with this permit the company can make use of certain routes (dedicated bus lanes), may enter certain areas or may use certain public unload facilities.

Enforcement is always an important issue in the application of regulation. Experience shows that a lack of control can make a policy less effective. In recent years, all kinds of tools have been developed to support the enforcement of regulations, including the use of electronic identification, automatic (video-) cameras, and non-permanent roadblocks (such as rising pyramids, rising steps or bollards).

1.3 e-Logistics in urban distribution

e-Logistics in urban distribution is mainly focusing on supporting operational processes to fulfil the distribution of goods in urban areas by advanced ICT tools. A number of tools are available to contribute to improved enforcement, like electronic identification, automatic (video-) cameras, and non-permanent roadblocks (such as rising pyramids, rising steps or bollards). Collaborative planning tools and web-based transport planning services help in realising an efficient and effective urban distribution system. Further supportive tools are available in the form of communication services between the different partner organisations in the supply chain, but also between the planner and vehicle driver. Finally, a last cluster of tools to support e-logistics is the group of interfaces connecting different systems, all necessary for an effective and efficient distribution of goods in urban areas.

These kinds of tools, services and applications have been subject to the integration of e-Commerce/e-Business services with advanced city logistics management architecture, as has been developed within eDRUL and further validated within projects such as MEROPE and AGATA. The extensive experiences of key applications in Europe, many employing e-logistics applications are documented in Chapter 8.

1.4 Structure of the book

This book assembles recent research relating to the concept of e-logistics and its contribution to the goal of sustainable freight distribution.

Chapter 2 introduces an essential prerequisite to a greater understanding of urban freight management, namely an appreciation of the requirements and needs of users. All "users" from local authorities, to transport service providers and private actors like consumers, must be regarded as an important part of the overall organisation of freight management.

Chapter 3 focuses on the process of goods distribution in urban areas. The chapter gives examples of solutions adopted for the regulation and monitoring of goods distribution in sensitive areas and also considers alternative forms of goods delivery for private customers.

The concept of a city logistics Agency based on e-Business services is developed in Chapter 4. An IT platform for the support of the logistics Agency as a virtual organisation ensuring interoperation and co-ordination of different service providers in a multi-organisation context is proposed based on the experience of the EC-funded eDRUL project. In Chapter 5 the software techniques required to support the implementation of a platform like eDRUL are explored in detail. Relevant communication and integration technologies are discussed and the eDRUL architecture is described showing the technologies used. The chapter also provides a focus on fleet management and in-vehicle technologies. Chapter 6 continues the discussion of software techniques required for modelling the design and evaluation of city logistics projects. City logistics requires the availability of appropriate models for the location of city logistics centres, routing and scheduling of fleets and the generation of performance indicators for evaluation. Practical experience with the AIMSIM simulator is described.

In Chapter 7 the emphasis turns to practical experience of urban logistics schemes with an introduction to evaluation methodologies. It is emphasised that without the use of a proper evaluation process, all efforts of the development, testing and demonstration of useful applications may be worthless. The evaluation of a wide variety of experiences with sustainable freight distribution in urban areas from across Europe is provided in Chapter 8. Experience is documented in detail from sites in Italy, Denmark, Spain, The Netherlands, Portugal and the Czech Republic drawing from the results of high-profile EC-funded projects like eDRUL and MEROPE as well as many nationally funded projects.

The capture of European experience of various aspects of freight distribution continues in the chapters which follow. Chapter 9 reports the lessons learned from the BESTUFS project which has identified and disseminated best practice with respect to urban freight transport via an open network of experts, user groups / associations, projects, cities and demonstrations. Institutional, regulatory and political aspects of e-logistics applications are discussed in Chapter 10 with a specific proposal for the creation of a Management Authority to support the development of e-logistics services.

Chapters 11 - 14 report the strategic experience of a number of European-level research and demonstration projects. Chapter 11 describes the approach of the MOSCA project which has developed a decision-support system for integrated door-to-door delivery. Four test sites have been selected to test the MOSCA modules. Additionally, the design allows for future valued added services (e.g. on-line routing) to be added. Chapter 12 describes the 14 cities of the MEROPE project. The objective of MEROPE is to investigate and develop evaluation models and telematics instruments to manage and control goods distribution in urban areas. The project is actively promoting ICT and services in the field of urban logistics and mobility planning and focuses on the MEDOCC (Western Mediterranean) region. The CITY PORTS project is presented in Chapter 13. CITY PORTS is concerned with developing solutions of urban logistics through development of a methodology which is context-based, integrated and economically sustainable. A network of 19 cities from 4 countries has been established. The main objective of the project was to carry out a comprehensive analysis of urban freight effects for different cities and situations in Europe. The project carried out analysis of selected supply chain schemes and undertook evaluations of their impacts in an urban context, making use of a common measurement methodology; the material is thus complementary to Chapter 7.

Chapters 15 and 16 highlight relevant aspects of recent developments in flexible transport services for the movement of passengers. Chapter 15 provides an introduction to AGATA which is demonstrating a multi-services Agency for the integration and co-ordination of mobility and access to transport services. This project focuses on the MEDOCC (Western Mediterranean) region. Chapter 16 describes the CONNECT project, an expert network established to promote the concept of flexible transport services for passengers and small goods. A principal output of CONNECT is a virtual library to gather and manage information on on-going research, the state-of-the-art and good practice in flexible transport and its supporting technologies.

The final contribution stimulates the important debate surrounding the emerging business case for e-logistics services. Drawing on the experience of the eDRUL project Chapter 17 identifies the complex issues associated with decision-making and the need to balance socio-economic policy with the commercial business case.

CHAPTER 2

Requirements and User Needs

R Macário, G Caiado

Urban freight management has been systematically banished to a secondary level of priority within urban transport policies, despite being responsible for a significant fraction of pollutant and noise emissions (European Commission, 1998). Even the solutions which aim to cope with urban logistics problems are most frequently isolated measures disregarding the fact that this type of transport takes place in the same mobility system as passenger transport.

The main reason behind this lack of focus is related to the fact that the problems associated with the urban logistics field are extremely complex and involve a high level of interdisciplinary engagement. In fact, acting in the urban logistics domain implies intervening in different aspects of urban mobility management, particularly institutional, regulatory, social, infrastructural and technological, therefore requiring the joint and co-ordinated action of the different stakeholders in the urban logistics arena.

Although this is an area only few authors have exploited in terms of solutions and experiences, especially when compared with other fields of transport policy, there are some attempts to optimise the urban freight distribution process. However, these attempts are mainly operational measures, aiming at regulating the access of freight vehicles to the urban environment (for example vehicle weight limits, time windows restrictions, etc.). The implementation of such measures is not always supported with a reasonable knowledge of basic features of the urban freight transport system, resulting in unexpected impacts.

A clear example of such phenomenon is the introduction of different freight vehicle weight restrictions in some European cities, sometimes even within the same country. This situation puts an extra burden on the operation of transport and commercial operators managing distribution fleets. Another disadvantage associated with this type of restriction has to do with the increasing number of freight vehicle trips due to capacity reduction.

One of the main urban freight challenges for the next decade is precisely the recognition that it is not enough to invest in infrastructure or in the introduction of extremely limiting vehicle access regulations. Rather it is necessary to ensure an holistic overview of the different interests and prior to operational measures, strategic orientations should be developed in order to optimise the social and environmental parameters, namely by considering the location of specific functions in order to reduce the number and length of the freight trips.

Moreover, the role of land-use policies should not be disregarded in urban freight policies. In fact, this is one of the areas with higher potential to increase the efficiency within the urban freight system. Actions in this area have been mainly limited to the introduction of urban freight distribution centres in order to limit freight vehicle movements.

Nevertheless, it is crucial to emphasise that such initiatives should be framed through a top-down approach, in which the location, capacity and function of these distribution centres should be consistently equated, in order to optimise the whole system instead of isolated elements (geographical areas or certain actors of the logistic chain). Furthermore, it is also important to consider functions already settled through a bottom-up approach. Therefore, the effectiveness of any urban freight policy will largely depend upon the intersection of these two approaches.

The gap between the operational measures that are already widespread and the missing, though extremely indispensable, strategic orientations represent an excellent opportunity for the application of IT tools to urban freight management. These opportunities will reveal themselves in the years to come in two major areas: i) increasing efficiency enforcement; and ii) collecting data to continuously monitor and adapt the existing system parameters to the dynamic user needs.

Urban freight transport is extremely complex and heterogeneous and especially when compared with passenger transport the diversity of mobility patterns is much higher. In this sense, it is very difficult to identify common characteristics in the requirements of the different agents involved in this process. In addition, for each type of product there is a huge variety of requirements, which will result in different decisions regarding transport (for example vehicle type and dimensions, pick-up and delivery times, etc.). Simple aspects such as supplier selection may imply different requirements, even for the same product category.

This heterogeneity and diversity of requirements leads to a multiplicity of perceptions from the different types of problems, resulting in different concerns to the several actors involved in the urban freight distribution process. For instance, the private vehicle drivers feel prejudiced when a freight vehicle delays them by reducing road capacity when performing a loading or unloading operation. However, these drivers are precisely some of the clients for the transported products. On the other hand, retailers value the products that their suppliers deliver but regret the fact that a potential parking space for their clients is dedicated to loading and unloading operations. In the same way investors in shopping centres see the space they are forced to provide for loading and unloading operations as non-profitable space. Finally, urban planners often face problems related to space provision for freight vehicles operations. All these examples confirm that the vast set of activities associated with urban logistics lead to an enormous variety of conflicts and problems, which obviously raise difficulties to any attempt of systematisation. Each actor of the urban freight distribution system has its own perception of the different problems, resulting in conflicts between the different users of the urban space.

The benefits of freight distribution are not so visible for the end consumers when compared with the disadvantages. In fact, drivers of private vehicles are more indulgent to congestion generated by other private drivers than to capacity reduction due to freight vehicle operations. But if it is accepted that freight distribution is as important as passenger transport for the functioning of cities, it is also true that there is a major potential for optimising certain steps of this process.

In this context it is obvious that the starting point for the application of IT tools to the urban freight field is to develop a deep and clear understanding of the different user needs and requirements. This will allow the search for equilibrium between the different interests, reaching minimum satisfaction levels for each of the private actors involved, therefore promoting economic efficiency in a private perspective. On the other hand, it should also decrease the impacts in the external dimensions of the freight system, aiming at protecting society from the negative impacts of freight distribution, therefore promoting the economic efficiency in a collective perspective. The movement of urban goods raises a fundamental problem in urban living conditions that is to find an acceptable balance between these conflicting interests (Ogden, 1992).

To achieve this balance a complex functional structure is needed to provide services to both business agents and private users (eDRUL, 2002), with co-ordination of logistics services and co-operation between different logistics operators. The main focus is on business user categories, and on ways to improve efficiency of the logistics system in the framework of urban mobility policies. However, private actors like consumers and the customers of goods have to be regarded as an important node of the overall business process organization. This is the function of the e-Logistics Agency which is introduced in Chapter 4.

2.1 Local Authorities

Urban freight distribution represents an essential activity for the economic and social development of urban centres by sustaining the actual living styles and the retail activities. An efficient distribution system may significantly contribute to regional economic prosperity, not only through the optimisation of the transport costs and other logistics activities, but also by revenue and employment generation, crucial factors to the competitiveness and wealth of metropolitan areas.

Any policy conceived to cope with the urban freight distribution problems should address not only the economic aspects, but also environmental and social issues, including the reduction of the conflicts between urban space users.

It is precisely because of its complex nature, involving a large number of interests and issues, that the resolution of urban freight problems has been so difficult and in some cases systematically postponed.

If the urban freight distribution market was free of any type of operational restrictions, it is certain that all private companies would plan and execute their operations in such a way that the costs associated with these operations would be minimised, that is, they would only consider the specific parameters of their business (for example transport, warehousing, handling, etc.), however ignoring any environmental and social issues. For this reason it is essential to ensure the role of entities responsible for managing the public space and planning the private spaces, namely by adopting policies, regulations and enforcement methods which aim at establishing and effectively implementing rules that try to internalise all or part of the external costs generated by freight distribution.

However, these interventions should also seek for a trade-off between these external costs and the associated interference in the private companies' activities, as the market should still make the operational decisions, in order to ensure an efficient production. Nevertheless, it is likely that certain problems will not be solved if left to the market self regulation, therefore local authorities and central governments should intervene in a steering role, that is through regulation and monitoring of market behaviour and performance.

As already stated, the ideal performance of the authorities, when it comes to urban freight distribution would be to try to internalise most of the external costs, transferring them to the entity responsible for its generation, therefore protecting the public in general from these negative impacts. As an example of this type of internalisation process one could refer to the case of safety or noise emission reduction devices, in which the additional costs imposed are in reality an internalisation of external costs. This principle can be extended to other aspects of urban policies, namely the ones related with land-use planning and access regulation of distribution vehicles.

In fact, due to its nature, the private sector planning and financial objectives are extremely limited to the concerns directly related with its operations. On the other hand, private agents tend to accept the inefficiencies of the transport system, thus avoiding resource consumption in its eventual minimisation, because they believe that this will not have a proportional return in terms of profits. For these reasons, the decisions seen as optimal from a private perspective may not be so if seen from a wider perspective. How far government intervention should go in these types of systems will continue to be an issue of debate, however, it is already clear that central and local authorities should attempt to change private companies selfish objectives, inducing behaviours that internalize certain external costs.

As the institutional entities responsible for the planning and control of urban mobility policies, Local Authorities are also one of the system users. For instance, it is important that these entities have direct access to information regarding the logistics system in order to be able to follow policy implementation as regards urban logistics processes, and to perform adaptation and re-planning.

The overall objectives of local authorities and service providers show many similarities in various cities. Since the local authorities deal with a wide diversity of stakeholders their objective is focused on the functionality and long-term sustainable development of the city. eDRUL (2002) suggest that in general they can be summarized in the following common objectives:

- To alleviate traffic congestion and reduce the number of heavy trucks in the city;
- to foster sustainable economic development;
- to maintain accessibility of the (historical) town centres;
- to maintain the attractiveness of the city for residents, tourists and commercial organizations; and
- to encourage optimal use of urban spaces, with a special emphasis on loading and unloading spaces and parking spaces.

2.2 Freight Transport Service Providers

This group of stakeholders is responsible for the transport operation itself and therefore, is obviously the main user group addressed although they can be divided into two distinct markets, long haul transport or urban distribution transport. For further purposes, freight transport providers are hereinafter distinguished between transport operators and urban delivery service providers. The former may include private or public organizations providing various forms of goods transport services on a long/mid distance scale. These include, for instance, forwarders and courier services. The latter, includes transport companies typically operating with vans and small trucks, specifically dedicated to transport operations and deliveries within the boundaries of the urban area.

At the time of writing, the companies which have transport services as their core business dedicate themselves to other complementary activities in order to offer a more competitive service, such as: load consolidation, packaging, warehousing, documentation processing, etc.

The transformation of raw materials implies many production processes to which transport connections may be associated. In many sectors, companies have dedicated themselves to the core activities of production, sub-contracting the complementary tasks, in which transport is included. This process of vertical disintegration may increase the amount of transport connections to the supply chain and requires a higher degree of co-ordination and communication between the different agents involved in the chain.

The trends for these types of actors in the short and medium term will involve the establishment of some type of co-operative relations, especially to small and medium operators, so that they can reach economies of scale. These changes will obviously imply some loss of business-related independency and will be based upon the willingness to co-operate with competitors, and are therefore strongly dependent upon human factors and business strategic games.

In this context the objectives of fleet and transport service providers can be summarized in the following aspects (eDRUL, 2002):

- To lower transport costs / maximize profit;
- to provide high quality services and maintain relationship with clients;
- to expand activities;
- to relieve traffic congestion and reduce traffic pollution; and
- to minimize trips of large trucks at low loading level.

2.3 Retailers

Commercial operators represent the second main type of business actors and include shops, regarded as the commercial activities located or operating services in the city centre (e.g. shops, shopping centres and malls, retail points, etc.). This user category also includes the suppliers (e.g. wholesale dealers, distribution centres of large retail networks, etc.) directly supplying goods to shops.

Retailers are the last link in the supply chain, providing final consumers with products. Generally, they sell small quantities to customers and not to other businesses. Because they are precisely the last link in the chain, they are able to have a more clear view of the consumers' preferences and even influence their choice.

These types of actors may carry out their functions in different types of establishments: i) small independent stores, ii) groups of small stores under the same name and selling the same products, iii) neighbourhood supermarkets, and iv) large supermarkets usually belonging to huge enterprises and selling an enormous variety of goods.

In the last ten to fifteen years, the retail sector has been in the first line of logistics innovation in many countries, mainly by recognising the importance of supply chain management in order to satisfy the different and demanding needs of the final consumers. Just to mention some examples, the biggest retailer at global level, the Wal-Mart chain, has always been in the forefront of logistics innovation mainly by its communication and information systems as well as its centralised distribution systems. The Benetton chain is also a good example of innovation and success due to its totally automatic stock management systems and by using EDI (Electronic Data Interchange) to perform data transmission related with supply requests. Its management strategy has contributed to reach the fastest production cycles ever accomplished by the clothes industry.

One of the main interests of the retailers is to reach high efficiency levels within its operation, mainly by reducing operational costs (for example transport, warehousing, etc.). On the other hand, they also wish to increase the sales volumes, leading not only to an increase in the profit margin, but also the product flows requested to its suppliers. In fact, many retailers, after reaching the break-even (coverage of operational costs by the sales income) dedicate their operation until the end of that month to maximise sales volumes, manly through discounts to its clients.

The objectives of the commercial operators naturally focus on optimizing their business operations (eDRUL, 2002) and may be summarized as:

- To minimize delivery costs / maximize profits;
- to expand retail / core activity;
- to gather new clients;
- to reduce stocks; and
- to increase service towards clients.

2.4 Consumers

Consumer demand has become extremely sophisticated, with a continuous need for introduction of new innovative products that are themselves the drivers of new needs. Trends follow one after the other causing the reduction of the product life cycle. Producers are forced to produce and distribute more quickly, not only to decrease the risk of surplus stock, but also because their competitors do the same.

Facing the increasing expectations of consumers, both producers and retailers adopt a more flexible and agile attitude. Companies introduce production methods which allow a high level of product diversity through modular and flexible processes. One of the consequences of such phenomenon is precisely the freight distribution of smaller quantities, though more frequently.

The introduction and growth of eCommerce has also brought deep impacts into the urban distribution system. In this type of commerce the shop is suppressed and the direct delivery implies strong demands from a logistics perspective (the "last mile" problem) (OECD, 2003). Most eCommerce operators do not have their own vehicle fleet, therefore they rely upon the postal services transport or express carriers' services. It is certain that the continuous growth of the sales volumes will, in the short or medium term, lead to the insufficiency of such distributions channels to satisfy the demands.

The objectives of the consumer reflect both objectives regarding delivery of goods, tourism and urban environment (eDRUL, 2002) and may be summarized as:

- To reduce traffic congestion, noise, air pollution and accidents;
- to upgrade availability of the city centre for visitors and tourist; and
- to protect consumer's rights and interests.

CHAPTER 3

Freight Distribution Schemes and Business Models in urban areas

K Markworth, G Zomer, H Jess Jensen

3.1 Introduction

Freight distribution is becoming more and more important in modern life. Customers expect a wide and growing variety of services in the local area e.g. shopping and leisure facilities and recreational areas. However, most of these functions need some sort of goods distribution in order to provide the necessary services for the customers. This means a steady supply of goods to the commercial operators and thus a growing freight distribution in these areas which can cause severe annoyance to inhabitants and the users in terms of air pollution, noise, vibration, congestion and the visual environment.

At the same time some areas are more sensitive than others to heavy goods distribution e.g. pedestrian areas or older parts of cities. At the same time these are often the areas that have most traffic by goods vehicles due to their status as both shopping and leisure centres. To keep a steady supply of goods to the commercial operators and keep the areas attractive and at the same time to minimise the environmental effect of goods distribution in these areas new solutions are to be developed.

This chapter gives examples of solutions for regulations and monitoring of goods distribution in sensitive areas, e.g. historic town pedestrian areas, in terms of traffic restrictions in Traffic Limited Areas (TLA). Alternative forms for goods delivery for private customers and how to co-ordinate goods distribution among the actors within the city logistics area is also considered.

3.2 City distribution in Traffic Limited Areas under access restriction

Access restriction is a common solution used to regulate traffic in certain part of cities e.g. TLA (Traffic Limited Areas) and can be implemented in numerous ways involving various actors. Traffic restrictions in cities are however often related to goods distribution due to the impact to the surrounding areas and the citizens.

The most important element is to define the area in which access restriction is necessary. The primary reason to use access restriction is to secure:

- an improvement in quality of life;
- elimination of unnecessary congestion;
- efficiency in goods distribution; and
- environmental improvements.

Preserving quality of life in a city can be one of the reasons to implement access restrictions. Unique elements could for example be old parts of cities, traffic through recreational areas, pedestrian areas etc. The unique parts of a city are often some of the most frequented parts by citizens and tourists. As a consequence heavy goods traffic in these parts of the cities causes problems.

In certain areas goods transport is often the reason for severe congestion. The goods vehicles are typically slow moving due to several stops along a delivery route. At the same time goods deliveries in urban areas often take place in confined streets, which adds to the problem.

Environmental improvements are however often the most logical motivation to implement access restriction due to the fact that environmental improvements will be the positive outcome of the restrictions. Less traffic equals less impact on the surrounding areas.

The most common access restrictions are:

- related to the goods vehicle;
- related to time; and
- related to place.

3.2.1 Access restriction related to the goods vehicle

A rather new phenomenon in European cities is areas where specifications for freight vehicles determine access. The restrictions to enter the environmental zones are based on the vehicles specifications at the present time and could be manifested in several types for example:

- age of vehicle;
- type of engine;
- load factor; and
- maximum tonnage.

It is mainly up to the local authorities to define which types to use when establishing access restrictions. The optimal use of the restriction types are built into the local conditions and the objectives of implementing access restriction. Some are thus more suitable in some cases than in others. At the same time the local authority also defines the degree of the restrictions e.g. the maximum age or maximum total tonnage of the vehicles entering the zone.

To implement access restriction based on vehicle types it is necessary to have extensive knowledge of the vehicle fleet in order to secure a steady supply of goods to the commercial operators in the restricted area.

Access restrictions based on vehicle data can however be difficult to control for the authorities. For example it is not possible for the enforcement agencies on sight to control how old the vehicles are or type of engine in each vehicle entering the area. These problems can be solved to some extent but there will always be exemptions. Stockholm, Gothenburg, Malmo, Lund and Copenhagen have already implemented a scheme for access restriction formed as an environmental zone.

3.2.2 Time access restriction

Access restriction based on time windows (time intervals when it is legal to enter the area/zone) are primarily used to keep goods traffic away during rush hours to secure pedestrian mobility in the pedestrian streets during "shopping hours" (see Figure 3.1). "Pedestrian Street" is written at the top of the sign. The text below allows daily (and Saturday) goods distribution between 05:00-11:00.

Time access restriction is relative easy to control because outside the time window goods vehicles are not allowed to enter the TLA. Time restriction can in some sense be very inflexible. The restriction does not leave room for commercial operators who either open late or have late opening hours. In order to service these commercial operators the local authority has to grant them permission.

Figure 3.1:
Time restriction sign for pedestrian areas in Denmark

3.2.3 Access restriction related to space

The last type of access restriction mentioned in this chapter is related to space. This type of access restriction can be introduced through parking restrictions. The parking restrictions can be used as an element to regulate goods traffic through other corridors to the commercial operators and to use alternative drop off points for example using backdoors to drop off when available.

Loading and unloading zones can be established alongside parking restrictions in the traffic restricted area. In this scenario strategic locations in the area are identified as focal points for goods deliveries. As with time restrictions access restrictions related to space are easy to control for the local enforcement agencies.

3.2.4 Conclusions

In order to secure lively and attractive city centres goods distribution is a necessity. By using access restriction it is possible to reduce the negative effects of goods distribution in Traffic Limited Areas. Traffic restrictions can basically be built on three elements:

- time;
- the vehicle; and
- use of space.

Which type to use depends on the local conditions and the objectives of implementing access restriction. At the same time it is necessary to keep a strong law enforcement strategy in order to secure the restriction functions as planned.

3.3 Customer-driven goods delivery services through the use of special infrastructure

The concept of customer-driven goods delivery services through the use of special infrastructure is another business scheme in urban logistics. This scheme is based on the concept of goods delivery to the end user at an intermediate easily accessible collection location (possibly indicated by the customers from a list of available collection points) instead of the traditional door-to-door delivery. Several concepts will be discussed in this section and some conclusions will be drawn. These concepts are goods delivery via attended collection points, goods delivery via unattended collection points, and the park-and-buy concept. The first two concepts are both alternatives for home delivery in the distant selling market; the park-and-buy concept involves a service that makes shopping and sightseeing more convenient.

3.3.1 Distant selling turnover

The distant selling market in Europe represents a sales figure of over 50 billion Euros per annum and an average sales per capita of some 130 Euros. This trade sector employs roughly 400, 000 people, of which 200, 000 are directly in the mail-order companies and at least another 200, 000 are in ancillary jobs (post offices, telecoms, printing etc).

When defining distant selling, the element of "distance" and the fact that consumer and company do not meet "face to face" is fundamental. The information concerning the range of goods and services is given by way of a multitude of commercial communications: catalogues, mailings and such printed documents, telephone, call centres, television, the Internet etc. Also essential is the "right to return" the goods or to cancel the order within a period of at least 7 working days. The products offered can be distinguished as follows:

- a large range of goods, comparing with any high street store, including textiles, clothing, electrical goods, furniture etc.;
- a specialized range of goods, such as books, compact discs, computer hardware and software, cosmetics, wines, plants and bulbs; and
- services like insurance cover, holidays, correspondence courses, financial services and consumer credit.

The distant selling market in Europe is still smaller than the US market (88 billion Euros in 2001). In 2002, total turnover of the countries represented in the European Mail Order and Distance Selling Trade Association (EMOTA) was 54 billion Euros. In 1990, this was only 33 billion Euros, which means that the market grew on average with 3.2% each year. Figure 3.2 (below) shows the market development since 1990.

The growing penetration of e-commerce needs careful fulfilment of the orders received and the delivery of parcels. Therefore, the need to enable reliable, affordable and market-oriented postal services is and remains of the utmost importance. Postal administrations and other dedicated service providers should therefore listen carefully and respond adequately and creatively to the needs and wishes of this sector with respect to the market and the customers. Customers demand low rates, high quality of service, reliability, accountability and flexibility. For a growing group of customers, an important user need is that they do not want to stay at home in order to receive the parcel. Postal offices have begun to develop new and dedicated services for this market. But not only postal offices develop such concepts; dedicated service providers like Kiala have also developed services for flexible fulfilment of distant selling orders. The concept of collection points, either attended or unattended, provides for those needs.

3.3.2 Customer driven goods delivery via attended collection points

One of the providers of dedicated services for delivery of distant selling goods using attended collection points is Kiala. Kiala has set up a network of take-out stores (Kiala Points), allowing customers to pick up, pay and return their parcels quickly, where and when it suits them best. The Kiala points network consists of nearby stores (grocery stores, newspaper stands, gas-stations, etc.), which allow easy access, long opening hours - even during the weekend - quality service and secured storage space. As a consequence, the customer can optimise his time by picking up his/her parcels at a place of his/her own choice.

The network is supported by a unique technology platform that automates most of the activities involved in the transportation and delivery of parcels, thus raising productivity and lowering costs to the minimum. The heavy administrative tasks and sources of errors disappear from the delivery process. The application also manages the numerous and complex data flows going from and to end-customers, direct selling companies, 'delivery points' and transportation partners. As a consequence, the customer can track and trace his/her parcel on the Kiala Internet site and he/she is immediately notified of the arrival or of the delay of his/her parcel on his/her home telephone, mobile phone or by e-mail.

Currently (beginning 2004), Kiala delivers more than 30, 000 parcels each day in Europe, using a network of 4, 200 pick up points in France (3, 500), Belgium (300) and The Netherlands (400). In Belgium, the network is almost operating at full capacity, delivering about 25 parcels per pick up point each day. France has also shown a remarkable growth. Hardly one year after starting the operations in France, France is now responsible for 70% of the consolidated volume.

Since Kiala began at the end of 2001, the consolidated volume of parcels has grown each quarter on average by 47%, as can be seen in Figure 3.2.

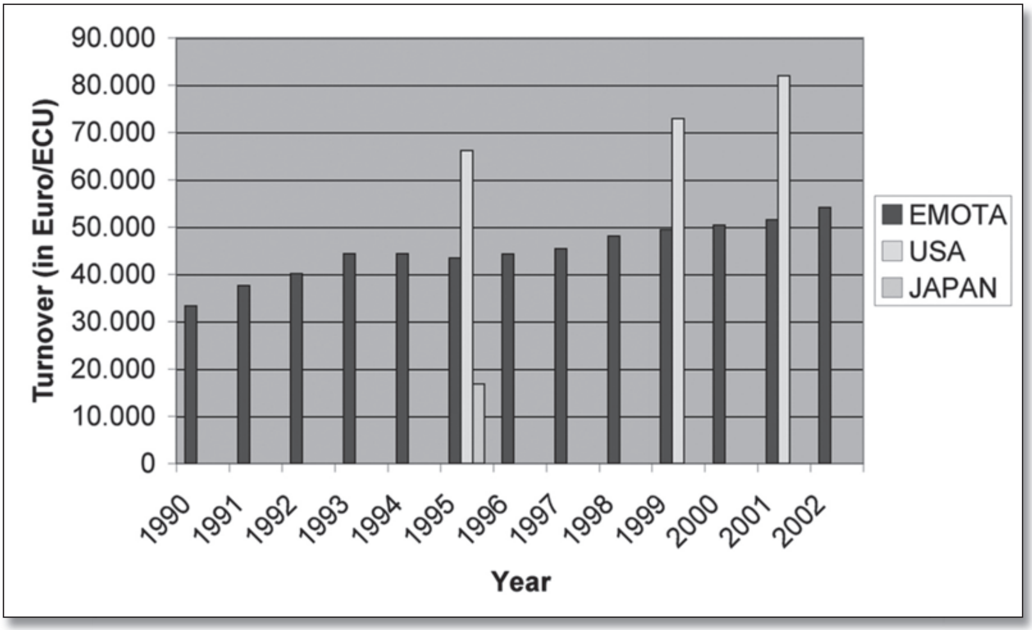


Figure 3.2: **Distant selling turnover**

Pakje Gemak

TPG Post started in August 2002 with a new concept for distant selling deliveries, called 'Pakje Gemak'. Consumers can choose to have the parcel delivered to one of the 500 pick-up-points (supermarkets, bookstores, etc). The consumer can choose a suitable moment to pick up the parcel (on the way home after work for example). Partners like Kijkshop.nl offer this service to their customers.

Afhaalpost – Postkantoren BV

Postkantoren BV is a joint venture of ING (50%) and TPG (50%), who have started the concept of 'Afhaalpost'. The concept has similarities with the PakjeGemak concept, but differs in some crucial aspects. The pick-up-point network consists of 800 post offices or post service points. The concept includes a payment service, which makes it interesting for an additional group of retailers. The retailer does not take the risk of doubtful debtors, while the consumer can choose a suitable moment to pick up the goods. Afhaalpost is a logical extension of the current practice of handling of packages and shipments (reliable, good back office). Afhaalpost started offering their service to Bruna.nl (books, DVD's etc) which is also a 100% subsidiary of Postkantoren BV. Currently, the Afhaalpost-service is no longer offered at the website of Bruna.nl.

3.3.3 Customer driven goods delivery via unmanned collect points

Packstation – Van Gend and Loos Euro Express

Packstation is a concept from DHL (Deutsche Post) using unattended collection points (see Figure 3.3). Packstation offers customers in commercial and consumer markets the opportunity to collect their parcels from locker points 24 hours a day, at a time that suits them. The locker system has special access codes for customers and is currently provided free of charge.

Figure 3.3: **Packstation from DHL**

Packstation is a new service that meets the needs of the consumer (B2C) and business user (B2B). It is an 'end-to-end' logistic process that gives users maximum freedom in choosing the moment to receive the goods. For people often on the road - like service engineers and sales representatives - it offers easy access to the materials they need. They can collect these from a Packstation immediately after receiving a SMS message that the package has arrived. Packstation is also ideal for customers or mail order companies and Internet businesses because they can order when they like and decide for themselves when they will collect the package.

In the current situation the B2C market implies home deliveries. This means that the consumer needs to be at home to receive the package. The courier has to call the consumer on average 2.5 times in order to deliver the package. For the consumer this means inconvenience and a decrease in speed of delivery. For the freight operators it means increased costs of delivery (the “last-mile problem”). Packstation is able to offer a solution to this problem.

A trial has been carried out at 15 places in Amsterdam and Eindhoven (McDonald’s restaurants, BP stations and public areas). As part of the pilot, several branches of Selektvracht, one of Van Gend and Loos Euro Express’s business units have also been designated as attended Packstations.

Experiences with the Packstations in The Netherlands pointed out that the volumes were not large enough to expand the concept in The Netherlands. An important conclusion was that the concept of unattended pick up points did not satisfy customer’s demands in the B2C market. These customers appreciate the human aspect (opportunity to give feedback or complaints) in attended pick up points. On the other hand, the concept of unattended pick up points suits the market for B2B deliveries very well (sales representatives, agents, maintenance servicemen). Deutsche Post did not continue the pilot in The Netherlands, but the Packstations are a huge success in Germany. On the heels of the successful pilot project in Dortmund, Mainz, Frankfurt am Main, Offenbach and Bad Vilbel, Packstation is being expanded: from the spring of 2004 the service is available in cities like Munich, Cologne, Berlin, Hamburg, Wiesbaden and Darmstadt.

Figure 3.4: **Planned Via Collect points in Rotterdam**

Via Collect

Via Collect takes the challenge for delivering 'the last mile'. The goods are not delivered directly to the customer's premises, but to Via Collect collection points, which are situated at strategic locations near the main motorway network (like Park and Ride sites). Customers collect their goods themselves at these collection points and do not even have to leave their car.

The first Via Collect points have been set up in the region of Rotterdam, where the very first location was running from the beginning of 2002. Via Collect is supported by the European TELLUS project.

The project was not successful and was terminated in 2003 because of the very low volumes. The low volumes were mainly caused by the high price for the service.

3.3.4 Park and Buy

This service allows "hands free shopping" to customers purchasing heavy or bulky goods during shopping or sightseeing and having the problem of carrying their purchases to the car parked outside a limited access zone or to the hotel where they're lodging. An example of this park-and-buy concept is being implemented in Siena within the eDRUL project. This section describes the main characteristics of the workflow.

The customer is offered this service by the shops and, in case he/she is interested, he/she indicates the time within and the place where the goods have to be delivered. After paying a small fee he/she gets a receipt for collection. When the customer accepts this service the shop operator contacts a Logistics Agency (via dedicated web services or a call centre) and provides information about the pick-up place, the delivery place, and the expected delivery time.

When the shop operator has sent his request, the Logistics Agency calculates and optimizes the load and the route of some local delivery truck and provides the shop operator with some choices about the calculated trips' delivery schedule. When the user confirms one of the solutions proposed by the Logistics Agency, the new route will be uploaded to the urban delivery van using wireless technology and hand held computer.

At the given time the urban delivery van driver will pick up the goods from the shop and will deliver them to the selected place. When the parcel has been delivered the operator, using its own hand held computer, will communicate with the Logistics Agency. The Logistics Agency could transfer this information to the end customer, (if that suits him), in order to notify that his parcel has been delivered by sending an SMS message. Finally the customer presents the receipt when paying for the parking (or when entering the hotel) and collects the goods. The Via Collect concept in Rotterdam was a good example of this flow. Experience with Via Collect shows that price setting is crucial to the success of the concept.

3.3.5 *Conclusion*

The concept of offering alternatives for home delivery undoubtedly has a great potential. Nevertheless, the concept can only be implemented successfully when offering a full nationwide coverage and enough volume. This requires support from the large mail-ordering companies. Only a few concepts will succeed in generating enough critical scale to become commercially viable. Kiala and Packstation seem to have good prospects of becoming one of the few successful European service providers.

Cities with many shopping tourists like Siena in Italy may also develop successful local solutions for hands free shopping using pick up points.

3.4 Delivery through co-operation of network transport providers

There are many ways to improve goods distribution in cities. It can be done either by access restrictions as described above, co-operation between the actors in the city logistics chain or a mix of both. This part focuses on the co-operation between the city logistics actors in the City of Aalborg, Denmark.

The City of Aalborg participated in the national project "Sustainable City Logistics Solutions". It was a tri-city co-operation between Copenhagen, Aarhus and Aalborg supported by the Danish Ministry of Transport (described further in Section 8.4). The objective of the project was to improve goods distribution in urban areas by developing and implementing new ideas of city logistics solutions. Different approaches were used in the cities. The key factor in Aalborg was however voluntary co-operation between the members of the city-logistic actors.

The overall principle in the Aalborg trial was voluntary participation among the actors in the city-logistisc area. A local forum with representatives from goods distributors, the commercial operators, shopkeepers, local authorities and the police was formed in order to develop new solutions for goods distributions based on local conditions in Aalborg.

The voluntary participation in this forum secured a high motivation among the participants in order to achieve results that everybody could gain from. A bottom up approach was chosen to identify problems and create new solutions among the actors. The working forum strengthened open discussion among the participants before implementation and created a joint project identity among the participants. This meant that the participant more openly agreed to change internal routines and administration in order to meet the project objectives due to the fact that co-operation would create more synergy in the city logistics area for the benefit of all participants. At the same time it opened up new working relations between the members creating future partnerships.

The pedestrian area in the city centre was identified as the target area (see Figure 3.1). It is a well defined area consisting of more than 220 shops and several leisure facilities and most of the city shopping and leisure activities are confined to this area.

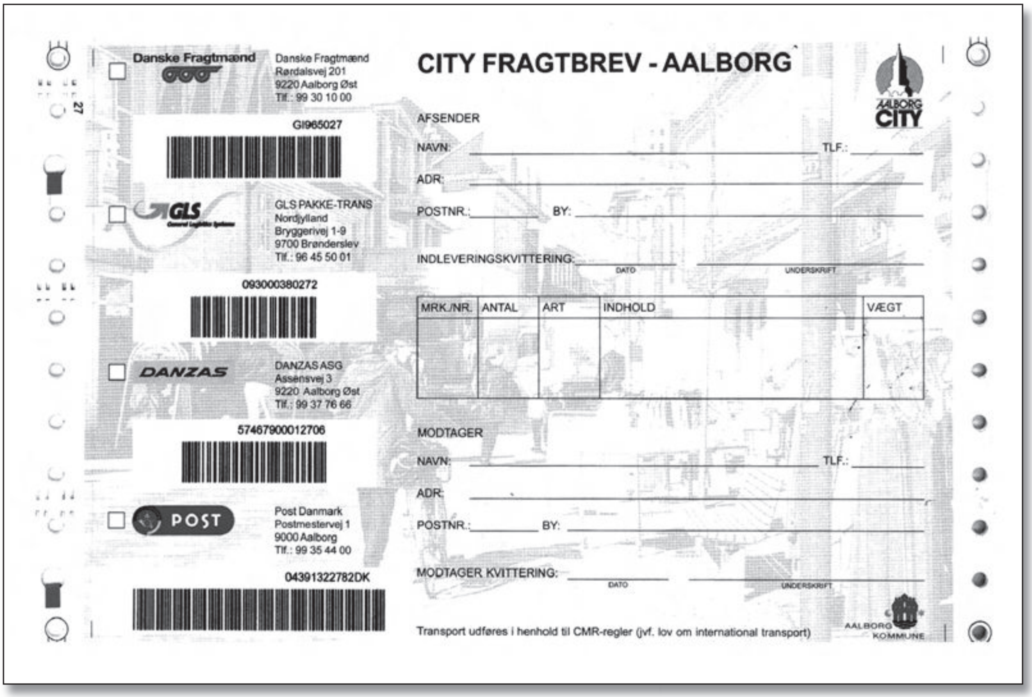
3.4.1 Examples of co-operation

During forum meetings several solutions were agreed. The solutions agreed were a mix of both physical solutions and changes in routines and creation of new co-operation as shown in Table 3.1.

Solution	Implementation
A change in driving direction	A change in driving direction was implemented to secure overall logical and optimal goods delivering routes for the goods distributors.
Creation of loading and unloading zones	Loading and unloading zones were created to reduce the congestion in the target area. The loading and unloading zones were established in connection to the drive-by-zones, see below.
Creation of drive by zones	Goods distribution in pedestrianised streets often causes congestion. By establishing drive by zones, the congestion has been reduced and the flow for goods distribution has been more efficient. The drive-by-zones were established in a dialogue between the shopkeepers, transport companies, police and local authorities.
Time access restriction	A general access restriction was set up in the time between 05:00-11:00. This meant that the goods distributors should leave the pedestrianised streets before 11:00. To smooth the delivery process the shopkeepers agreed upon not putting merchandise into the streets until after 11:00. This meant more available space for the goods distributors to manoeuvre the vehicle and make optimal use of the
"Pick-up-shop"	The shops in the target area open at different hours. Normally this means that it is necessary for the goods distributors to enter the pedestrian zone more than once each day. The drop zone made it possible to drop goods at one shop to be "picked-up" later by a shopkeeper next door or nearby.
Two persons in each vehicle	Two persons in a vehicle were part of a trial in order to speed up the deliveries in the pedestrian zone. The persons in the vehicles were not necessarily from the same goods delivery company. The result of this solution was that it was not attractive in economic terms
Creation of a consign-ment note	A consignment note was designed by the fourth largest goods distributors of goods in the pedestrian area. The idea of the consignment note was to encourage the goods distributors to co-operate in delivering goods in the target area in order to reduce the number of trips and vehicles to the area. The consignment note made it possible for one goods company to hand over parcels to another goods company who was going to the target area anyway instead of creating another trip to the area. There were no complications or extra expenses for the receivers of the parcels. The result was fewer long distance service providers in the pedestrian zone because they had to deliver their parcels at a nearby terminal for the city distributor to deliver. The consignment note is shown in Figure 3.5.

Table 3.1: **Examples of co-operation between members in the logistic area in the Aalborg trial.**

Table 3.1 shows some examples of co-operation between the actors in the logistics area in the Aalborg trial. The examples are primarily interactions between the distributors and the shopkeepers. The co-operation between the municipality and the police was however very important. The local authority had a role as facilitator of the trial and function as the co-ordinator of the trial. The law enforcement agencies had to secure no rules was broken by the measures in the trial. By creating the forum for logistic solutions all members of the logistic area were represented which resulted in a short decision process due to the fact that all the necessary actors were present to take direct action.


Danske Fragtmænd
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Rørdalsvej 201
9220 Aalborg Øst
Tlf.: 99 30 10 00
GI965027
GLS
GLS PAKKE-TRANS
Nordjylland
Bryggerivej 1-9
9700 Brønderslev
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093000380272
DANZAS
DANZAS ASG
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Tlf.: 99 37 76 66
57467900012706
POST
Post Danmark
Postmestervej 1
9000 Aalborg
Tlf.: 99 35 44 00
04391322782DK

CITY FRAGTBREV - AALBORG

AALBORG CITY

AFSENDER
NAVN: ______ TLF.: ______
ADR: ______
POSTNR.: ______ BY: ______
INDLEVERINGSKVITTERING: ______ DATO ______ UNDERSKRIFT

MRK./NR.	ANTAL	ART	INDHOLD	VÆGT

MODTAGER
NAVN: ______ TLF.: ______
ADR: ______
POSTNR.: ______ BY: ______
MODTAGER KVITTERING: ______ DATO ______ UNDERSKRIFT

Transport udføres i henhold til CMR-regler (jvf. lov om international transport)
AALBORG KOMMUNE

Figure 3.5: **Consignment note between the fourth largest goods distributors in the Aalborg trial**

3.4.2 Results

In addition to the co-operation between the city logistics actors access restriction for goods distribution was implemented in the TLA. Through the evaluation several significant results were obtained. The most important results were:

- an average 5 minutes time reduction in delivering goods in the pedestrian area per vehicle;
- improved working conditions among the drivers of the vehicles e.g. they were working for the same objectives;

- delivery on time to the shopkeepers; and
- a 1½-3% reduction in emissions in the TLA due to more efficient goods distribution.

3.4.3 Conclusion

In this section some examples of co-operation between actors of the logistics area during the Aalborg trial have been discussed. However numerous examples can be found where a co-operation between the actors of the city logistics area is achieved. The Aalborg trial showed that it is possible to establish co-operation where all the participants benefit from it. Furthermore the Aalborg trial showed high motivation as a success factor, this was due to the fact that all the participants engaged in the trial participated on a voluntary basis and in dialogue.

CHAPTER 4

City Logistics Agency Concepts: B2B and B2C services

M Boero, G Ambrosino, A Saffron

4.1 Basic concepts

The objective of the integration of e-Commerce/e-Business services with the goods distribution management IT platform to support operation of City Logistics Agency relates to:

- integration of different actors of the city logistics chain through a multi-service, web-based e-Business platform supporting on-line collaboration among logistics parties and operation of a City Logistics Agency;
- decision support and aid to operation of logistics resources enabling integrated, flexible demand-responsive goods distribution schemes integrated in the ITS urban scenario;
- provision of a number of networked services enabling easy interface of end-customers of the logistics system.

Figure 4.1 provides a schematic illustration of the basic e-Business services for a City Logistics Agency.

The Logistics Agency acts as a virtual organisation ensuring interoperation and coordination of different logistics service providers in a multi-organisation context. Despite the physical location of the operators and the goods terminals, the different types of fleet and the different booking systems and shop keepers requests, the IT platform of the Logistics Agency must ensure the management of the entire goods distribution service chain (from customer booking to service planning, monitoring and control) as a unique entity.

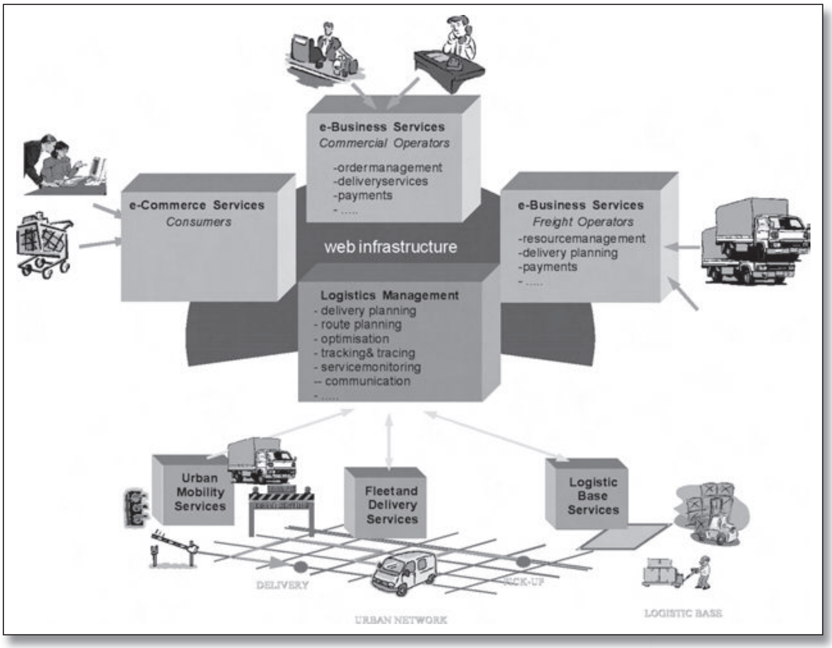

Fig.4.1: **B2B/B2C e-Business basic concepts**

Specifically, it is supposed that the Logistics Agency platform should be able to provide and integrate the macro-operations/functions shown in Figure 4.2 below.

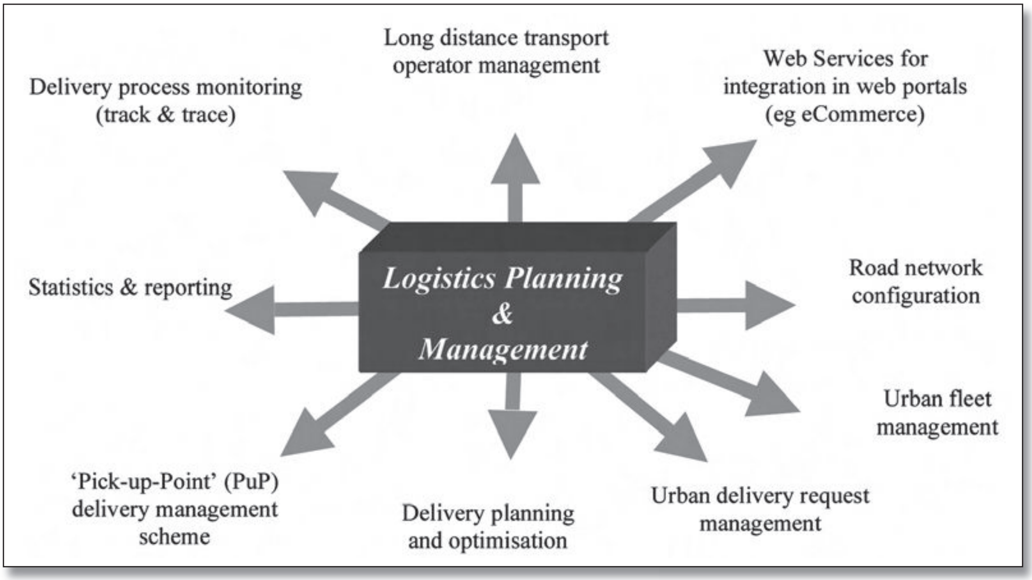

Fig.4.2: **Main functions and services for Logistics Agency scheme**

These functionalities have to focus on the optimisation of the goods distribution chain and should represent the fundamental core of the Logistics Agency service schemes with the aim to coordinate and monitor the overall goods delivery/pickup process, independently from the different freight distribution reference models operationally designed for coordinating and integrating the urban logistics service.

4.2 A reference for city distribution services

Most European cities and urban areas have to face similar problems with freight distribution: increasing urban congestion; increasing pollution and deterioration of the urban environment; increasing number, duration and costs of goods delivery trips; insufficient service quality for both the different actors of the logistics chain and for the consumers. In order to meet these problems, three main logistics scenarios can be identified; each scenario matches different problems that can be addressed in European cities.

In summary, we can find:

- **Scenario-1:** addressing the city distribution in traffic-limited areas (TLAs) under access restrictions. In this case the city has got a restricted traffic zone which makes it possible to enter into town only if the freight transport service provider agrees with the city access rules. In such a scenario, the purpose related IT platform is to offer entrance, slots booking, load optimisation and route planning services to the different carriers accessing the TLA for deliveries on the basis of load factor and emissions requirements in specific time windows.
- **Scenario-2:** addressing the consumer-driven goods delivery services through the use of dedicated infrastructures. In this scenario the goods are not delivered to the end customer but to dedicated infrastructures (e.g. pickup points or take away stations), avoiding the "last mile problem".
- **Scenario-3:** addressing delivery through cooperation of networked transport providers focuses on load consolidation operations. This is relevant in situations where goods distribution services are operated by different freight transport service providers who agree on sharing resources (i.e., load capacity, logistics bases, etc.).

Figure 4.3 provides a schematic view of service **Scenario-1**.

Scenario-1 addresses freight distribution in city protected areas (Traffic Limited Areas, TLA) i.e. areas where access limitations to traffic is applied according to specific policies. In city distribution **Scenario-1**, it is supposed that access to a TLA for inner deliveries is allowed only to certain kinds of freight vehicles: i.e long-/mid-range freight vehicles meeting some predefined conditions or authorised fleets dedicated to goods distribution in urban areas. The former type of vehicles will only get permission to access the city centre by booking through the Logistics Agency. Booking is done via a call centre

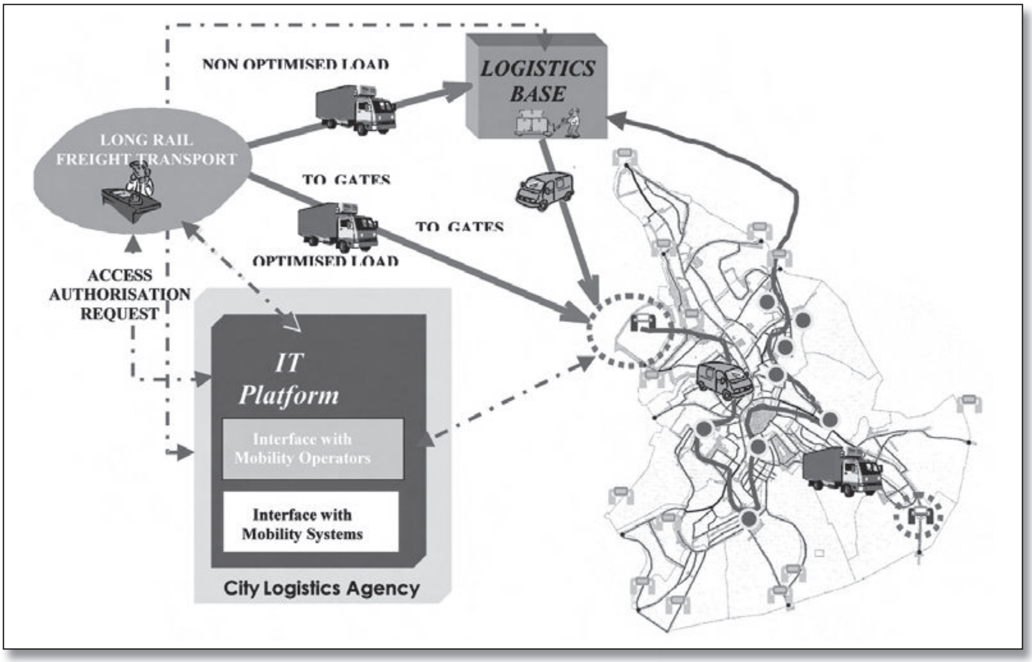

Fig.4.3: **Overall reference scenario-1 city goods distribution**

or the Agency Portal and the corresponding permits are released only in case the access conditions are met.

When the access is granted, the corresponding permit (certificate) provides the specification of allowed operations, including: the date and time band allowed for deliveries, the entry/exit gate, the route and sequence of consignees. Freight operators may also book "unloading spaces", in case they need a time for deliveries longer than the granted time band. The access and delivery booking can be related to different subscribing modalities: long-term, regular access subscription (e.g. yearly, monthly, etc.); non-regular access subscription (e.g. for a given day); subscription "on-the-fly", by direct presentation at the access gate.

For those vehicles that do not meet the access regulation restrictions, the delivery will be only possible through transhipment at the logistics base and consignment to final destinations by urban fleet operators. This will be the case also for those freight operators willing to hand over the "last mile" operation to the urban delivery fleet. In such cases, the Logistics Agency, besides booking services for long distance freight forwarders, will provide support services for planning and managing the operations of the urban delivery fleets: delivery planning, route planning, tracking and tracing, communication with vehicle drivers through PDAs, etc

4.3 eDRUL reference architecture

Figure 4.4 below presents a schematic view of the overall reference conceptual architecture for the Logistics Services Agency. Different implementation of the architecture based on local functional, technical and operational requirements can be identified.

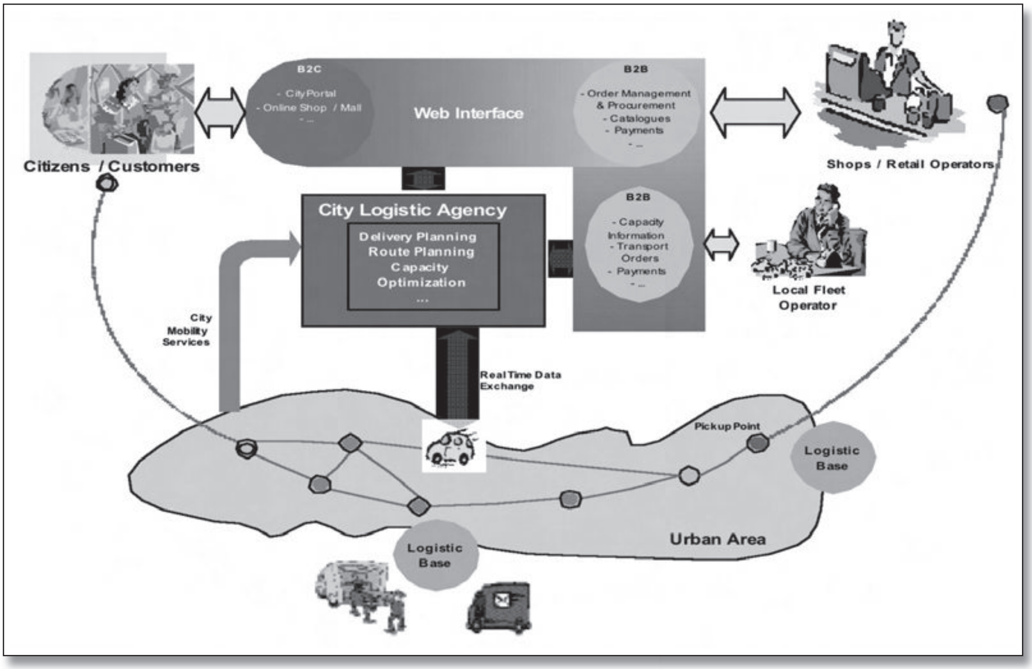

Fig. 4.4: **Reference architecture of the Logistics Services IT platform**

Overall, the architecture includes the following main functional and service components:

- a number of tools and services in the ***City Logistics Agency*** for planning and management of the goods delivery system, including support to the operators in managing system information, data and geographical information related to the logistics network, algorithms for distribution planning and optimization, etc.;
- the ***Web Interface*** which provides functionalities to Private Users (B2C) as well as Business Users (B2B) like:
  - the front-end of e-Commerce services enabling the interfacing between the end-customers and the goods retail/delivery system;
  - e-Business services accessible for the integration between the management centre and the parties involved in the logistics chain (traders and sale points, wholesalers and goods distribution centres, transport operators). It involves the functionalities

for information exchange among the participating parties, the access and interaction through the network of distributed services;

- both fixed and wireless communication infrastructures to support the flows of information among the logistics operators and between the end-customers and the logistics system;
- mobile terminals to ensure the exchange of information among the logistics planning and operation services of the platform and the goods delivery fleet (using ***Real-Time Data Exchange***). These include on-board terminals in the vans and hand-held devices (palm tops, cell phones) for operators involved in the deliveries.

Specifically, the Logistics Services Agency platform allows logistics operators to manage the following (macro) operations:

Classification	Description
Logistics Agency Back Office	Trip planning and management for goods collection and distribution
	Management of available transport resources (vehicle capacities), particularly if vectors belonging to different operators are used within the distribution system
	Management of the economic costs related to the goods distribution services, particularly concerning the allocation of costs/revenues to the different vectors integrated within the system
B2B	Reception of purchase orders
	Communication with the producers and the goods collection points (e.g. notification of collection time, changes or anomalies in the service, etc.)
B2C	Communication of information to the customers (e.g. planned time of goods delivery)
Communication / Infrastructure	Management of communication with the vehicles for routine operations of goods collection and delivery
	Management of communication and exchange of on-line and real-time information with the different vectors within the distribution system

Table 4.1: **Overview of main services supported by the Logistics Agency IT platform**

These functionalities optimise the goods distribution chain and provide the fundamental core for coordinating and monitoring the overall goods delivery/pickup process, independently from the different freight distribution reference models operationally designed for coordinating and integrating the urban logistics service.

Figure 4.5 shows the physical architecture of the generic Logistics Services Agency system.

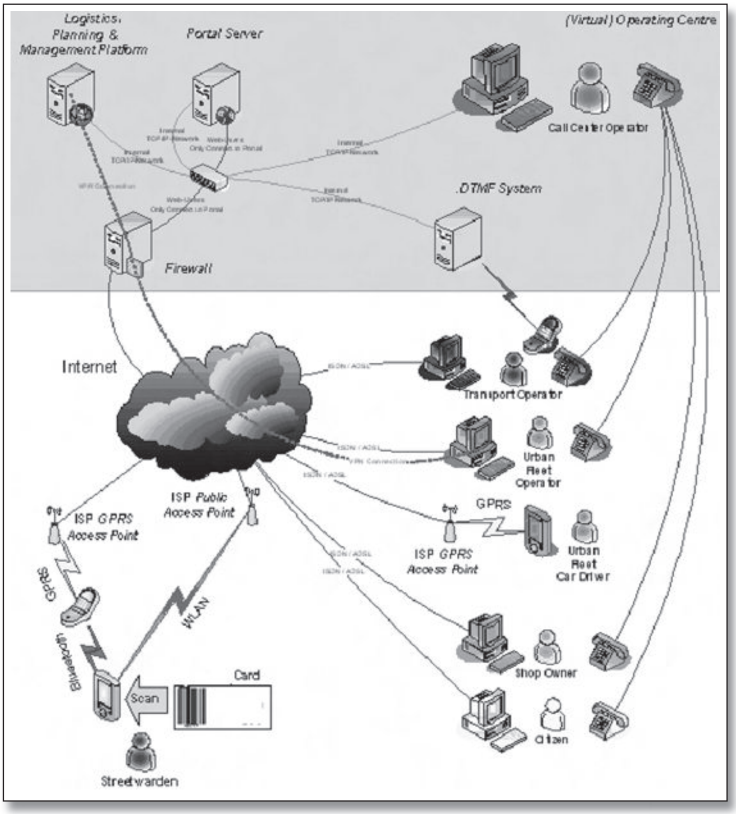

Fig. 4.5: **The physical architecture of the generic Logistics Services Agency system**

At a general level, the main components of the general Logistics Services Agency physical architecture can be described as follows:

- The (Virtual) **Operating Centre** (VOC): The VOC hosts the Server Platforms of Logistics Agency (Portal Server, Logistics Planning & Management Platform Server, Firewall and DTMF-System Server), the required network connectivity and provides the working environment for the Call Centre Agent of the system.

  The Server platforms can be described as follows:

- The **Portal Server**: the Portal Server implements and provides the e-Commerce and e-Business functionalities (B2B as well B2C) to the users, who access the systems through the Internet using ASDL, ISDN, GPRS, …..
- The **Logistics Planning & Management Platform**: This component implements the planning and management module logistics processes of the Logistics Agency.

This platform can also be accessed by the operators of the urban fleet using a Virtual Private Network (VPN) connection directly through the internet.

- The **interface** between the portal and the IT Logistics Planning & Management Platform are described in detail in Section 4.4 (and also in Figure 4.6). It uses TXP/IP and SOAP communication for the data exchange.
- The **DTMF-System (added service)**: This system can be used to provide the drivers of transport operators a simple way to apply a drive-in or -out for the Traffic Restricted Zone and for the registration of the use of loading and unloading spaces.

4.4 Enabling technologies

Different technologies, methodologies and components can be evaluated for their possible use in the Logistics Agency implementation. We will therefore give an overview of one of these approaches: from our point of view one of the most profitable in the current scenario. Indeed in the last years, the market and solutions available for all the basic techniques panned for use within the Logistics Agency system have experienced rapid expansion and evolution.

This approach is based on an open architecture approach and use of current and emerging standards and guarantees the longevity of the developed ITS architecture over the next years. Accordingly, one requirement of any component and basic service of this architecture was to be modular and as loosely coupled as possible in order to allow a fast integration of new available solutions and elements.

The main technological areas that can be related to the Logistics Agency development include:

- *Web Applications and Services.* Web-enabled information and services are used for both B2B elements – e.g. information exchange, resource sharing for logistics operators, etc. – and for B2C elements – e.g. booking and information on delivery services for consumers and goods customers. Standard Opensource can be used as:
  - Cocoon Open Source Portal Software
  - MySQL Database
  - Java Server Pages / Servlets
  - Tomcat Servlet Engine
  - Apache Web Server
- *Order Management, Goods Dispatching and Trip Planning*. This provides the basis of logistics planning, management and control services. Various tools and products were available on the market, addressing different steps and phases of logistics operations (e.g. order managers, demand-supply managers, vehicle assignment models, route planners, load optimizers, etc.) but on the other hand the development of a completely new product should be more profitable.

- *Communications, notification and personal delivery of information.* The interaction with the Logistics Agency implies exchange of information of various types between the Agency and the different users, both business actors (B2B) and consumers (B2C). These include, for instance: mobile phones, using GSM/SMS or GPRS technologies; e-mail; specific web services accessible via WAP or GPRS. The overall approach was to support "anytime and everywhere" access to information for users.
  The communications services are implemented in the Communication Gateway. The logistics platform communicates with the fleet and with other users through the gateway. The communication services must be used either from the vehicle/user terminal or from the platform. With the communications module and on-board-units, such as combination of mobile phone and PDA or an integrated device, it must be possible to send the delivery schedules to the drivers. From the practical point of view the main idea has been to provide the freight operators with modern and cost-effective tools, and more importantly, these are standard devices using existing public mobile communication networks. Thus, in general, no design or build-up of specific hardware or dedicated physical communication structures has been needed.
- *In-vehicle and Mobile Units*. Delivery operations is supported during trip execution by both in-vehicle units and hand-held devices (palmtops, PDAs, new generation mobile phones based on WAP and GPRS) in such a way that vehicle drivers and goods delivery personnel can access dedicated services during, e.g., goods collect or consignment.
- *Long-range, wireless communication.* Wireless communication is instrumental to support interactions and information exchange between the Logistics Agency and the different actors. GPRS channels and UMTS (less tested up to this time at the experimentation site) are available for this objective.

It is important to stress that a number of reference methodologies and standard alternatives can be evaluated during design and development, particularly as regards interfacing of architectural components, service interoperability and communications. At different architectural levels it is possible to find:

- **Interface Layer**: W3C software standards like XML, XSL, RDF, SSL and B2B extensions like ECML and TranXML, EDI, EDIFACT;
- **Network Layer**: all standard protocols such as e.g. TCP/IP, HTTP, HTTPS, WAP, SMS, GPS, GSM/GPRS/UMTS;
- **Implementation / Application Layer:** object-oriented languages (e.g. JAVA, EJB 2.0, …), service support standards (e.g. JINI, WSDL, UDDI), standards for semantic interoperability of components (e.g. DAML, KIF, KQML, OIL, UML).

Finally, the following methodologies and technologies were selected and used during the implementation described further in Chapter 5:

- **Interface Layer**: W3C software standards like XML, XSL, RDF, SSL and B2B extensions like ECML and also for the implementation of the interface SOAP;
- **Network Layer**: all standard protocols such as TCP/IP, HTTP, HTTPS, WAP, SMS, GPS, GSM/GPRS;
- **Implementation / Application Layer**:
  - object-oriented languages: JAVA, EJB 2.0, C#
  - service support standards: WSDL, UDDI
  - for semantic interoperability of components: UML 2.0.

Figure 4.6 below presents a schematic view of the overall software architecture and the use of some of the technologies and components.

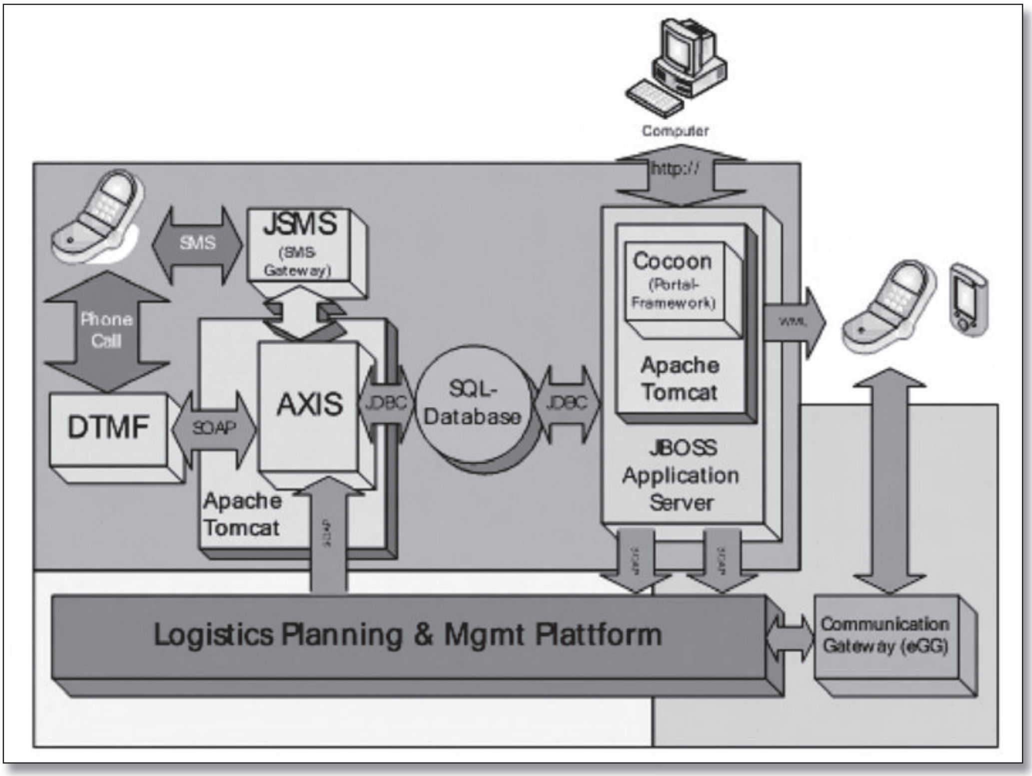

Fig. 4.6: **Schematic view of the overall software architecture of the Logistics Services Agency**

CHAPTER 5

eBusiness and eCommerce sw techniques

B Wild, A Saffran, L Vosilla, P Eloranta

5.1 Introduction

eDRUL – eCommerce Enabled Demand Responsive Urban Logistics – (IST-2001-34241) is a 30 month project initiated under the EU Research and Technological Development programme Information Society Technologies (IST). The aim of the project is to investigate, develop and validate innovative IST platform and e-commerce-based service models for improved management of freight distribution and logistics processes in urban areas.

The general concept of the system developed in the eDRUL project draws on the application of the system components using modern communication techniques like the Internet. Therefore most parts of the system have to be available via what technicians call a "portal". Thus the portal will be used as a starting point of the description of Information and Communications Technologies for Freight Distribution Systems.

Starting from a general introduction of the important and modern information technologies used to-day in the implementation of a portal architecture like in eDRUL, this chapter decribes the communication and integration technologies required to publish information services from sub-systems.

Where appropriate, examples of the techniques used in the eDRUL project are presented. Next the architecture of eDRUL is described, showing the technologies used. Then, the results are summarized and an outlook on further developments is offered. Finally, recent advances in fleet management and in-vehicle technologies are highlighted.

5.2 Information Technologies

5.2.1 Portal Technologies

A “portal” (Web Portal) offers a broad range of resources and services, such as e-mail, forums, search engines, on-line shopping malls and a *“… portal combines different information from the Web, corporate databases and applications into a single point of access using Web browsers and search technology”* (Computer World, 1999).

The main qualities which can be identified for portals are:

1. Navigation
2. Data Integration
3. Personalization
4. Notification
5. Knowledge Management
6. Application Integration
7. Infrastructure Services

For the implementation of these qualities, several techniques are used and necessary. The principles of the main techniques are introduced below, concentrating on the techniques used in the eDRUL project.

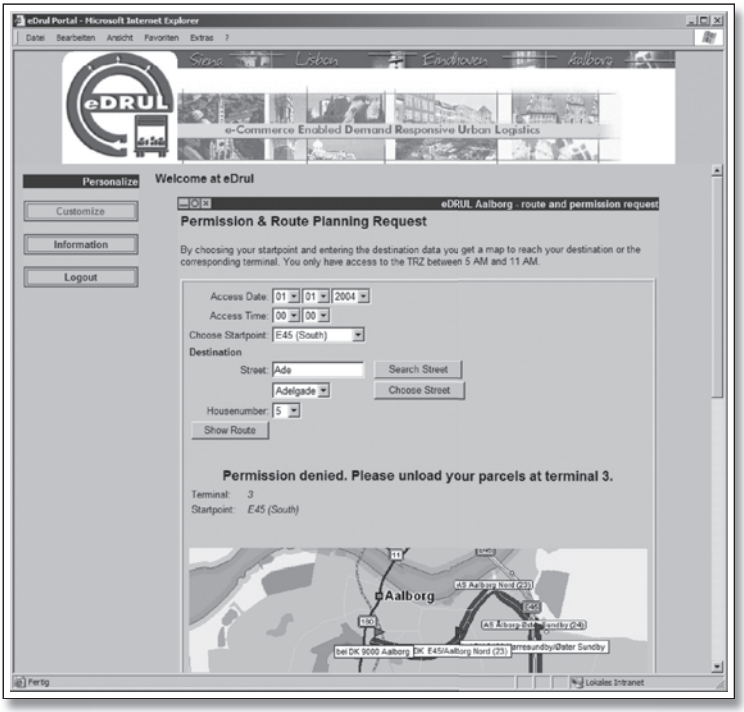

Figure 5.1:
The eDRUL Portal

J2EE

J2EE is a platform independent, Java centric environment from Sun for developing, building and deploying Web-based enterprise applications on-line. The J2EE platform consists of a set of services, APIs, and protocols that provide the functionality for developing multi-tier, Web-based applications.

Some of the key features and services of J2EE:

- At the client tier, J2EE supports pure HTML, as well as Java applets or applications. It relies on Java Server Pages and servlet code to create HTML or other formatted data for the client.
- Enterprise JavaBeans (EJBs) provide another layer where the platform's logic is stored. An EJB server provides functions such as threading, concurrency, security and memory management. These services are transparent to the author.
- Java Database Connectivity (JDBC), which is the Java equivalent to ODBC, is the standard interface for Java databases.
- The Java servlet API enhances consistency for developers without requiring a graphical user interface.

JSP

Java Server Pages are an (server-side) extension to the Java servlet technology developed by Sun. JSPs have dynamic scripting capability that works in tandem with HTML code, separating the page logic from the static elements – the actual design and display of the page – to help make the HTML more functional (i.e. dynamic database queries). A JSP is translated into Java servlet before being run, and it processes HTTP requests and generates responses like any servlet. However, JSP technology provides a more convenient way to code a servlet. Translation occurs the first time the application is run. A JSP translator is triggered by the jsp file name extension in a URL. JSPs are fully interoperable with servlets. You can include output from a servlet or forward the output to a servlet, and a servlet can include output from a JSP or forward output to a JSP.

JSPs are not restricted to any specific platform or server. It was originally created as an alternative to Microsoft's ASPs (Active Server Pages). Recently, however, Microsoft has countered JSP technology with its own ASP.NET, part of the.NET initiative.

XML

XML (Extensible Markup Language) is a simple, very flexible so called markup language. The development of this language started in 1996, the first W3C recommendation was published in February 1998[1]. XML was originally developed to overcome the limita-

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[1] For further information and more background to XML see Fowler et al (2002); http://www.w3c.org/XML/; http://www.computer.org/internet/xml/xml.tutorial.pdf

tions of HTML. One main purpose was to develop a language which supports dynamic contents on web pages. HTML is quite good for presenting static data but has some limitation in showing dynamic data. If dynamic changes of a web page are required, and for usage of HTML it is necessary, the content has to be generated each time on request. So, XML was originally designed to be used in large-scale electronic publishing but is now the pro-forma standard for exchanging data (not only in the World Wide Web). Using XML, it is possible to define any number of elements that associate meaning with data.

Basically, an XML document is very similar to HTML. If we are discussing XML documents, we speak about well-formed XML-documents; they start with prolog and contain exactly one element.

```
<company>
                <companyname region='US'>
                        Fast and Furious Transport Ltd.
                </companyname>
                <street>
                        Fast Street
                </street>
                <city>
                        Lisbon
                </city>
                <type>
                Long Distance Service Provider
        </type>
        </company>
```

Figure 5.2: **Example for XML**

Webservices

A Webservice is a XML-based application which provides functionality in the form of programs, objects, databases or business functions. For this purpose, the calling program sends a XML-document in the form of a message through any kind of network (Local Area Network, Internet, …) to the Webservice. The Webservice may reply, also sending a XML-document[2].

In the eDRUL project, the general concept described above is used in different stages. Due to the large distance of the software partners and due to the different experiences and preferences of the partners concerning the development systems (mainly Microsoft.Net and Sun Java), an early decision was taken to use Webservices for the implementation

[2] To make this communication easier, Webservices provide the definition of the messages, of the interface, in a Webservice Description, provided in the Webservice Description Language.

of the interfaces between the different parts of the eDRUL system. Another important point for the decision was the fact that it was possible to divide the system to be developed into modular parts, with differentiated functionality.

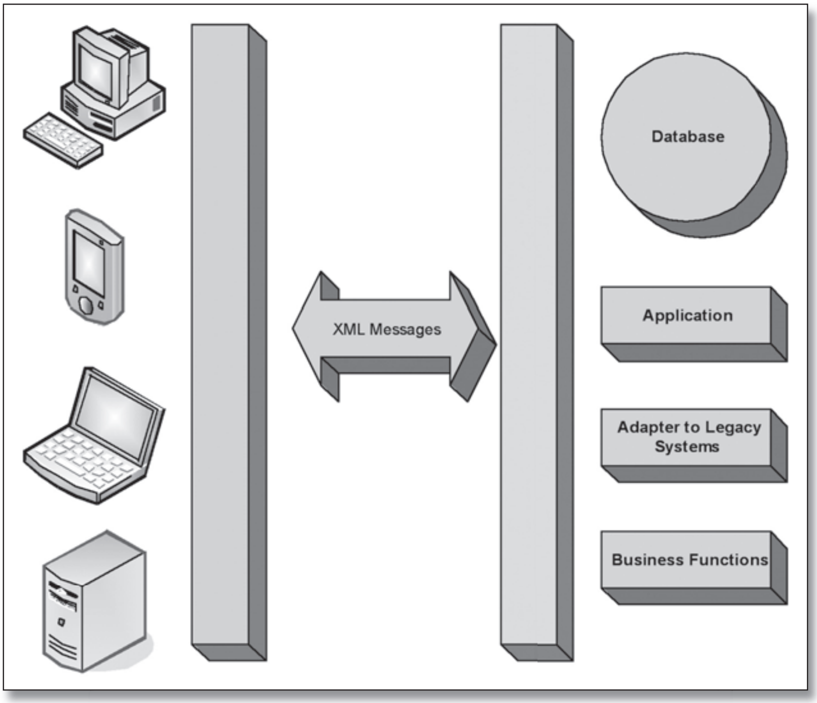

Figure 5.3: **General Concept of Webservice Interfaces**

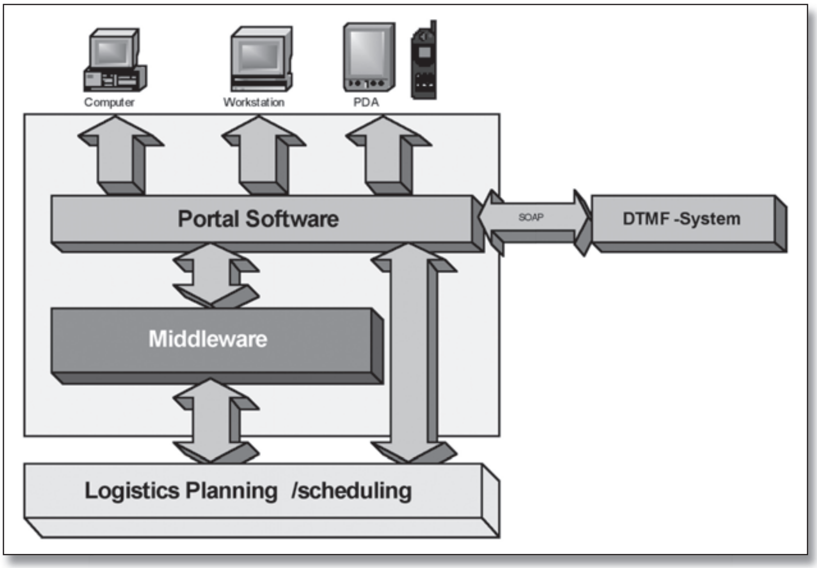

Figure 5.4: **Use of SOAP in eDRUL**

WSDL

The Web Services Description Language (WSDL)[3] is a XML-based language used to describe the capabilities of a Webservice. In the WSDL file of a Webservice, one will find all information such as the definition of the interfaces, the data and message types, the interaction patterns and the protocol mappings.

```
POST /eWebFunctions/WebLdtomgm.asmx HTTP/1.1
Host: edrul-develop.softeco.it
Content-Type: text/xml; charset=utf-8
Content-Length: length
SOAPAction: "http://edrul-develop.softeco.it/eWebfunctions/WemLdtoMgm.asmx/AddTruckToFleet"
<?xml version="1.0" encoding="utf-8"?>
<soap:Envelope xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xsd="http://www.w3.org/2001/XMLSchema"
xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/">
  <soap:Body>
    <AddTruckToFleet xmlns="http://edrul-develop.softeco.it/eWebfunctions/WemLdtoMgm.asmx">
      <iLdtoId>
        <mLaUserId xmlns="http://edrul-develop.softeco.it">long</mLaUserId>
        <mPoUserId xmlns="http://edrul-develop.softeco.it">long</mPoUserId>
      </iLdtoId>
      <iTheTruck>
        <mPTruckId xmlns="http://edrul-develop.softeco.it">long</mPTruckId>
        <mLTruckId xmlns="http://edrul-develop.softeco.it">long</mLTruckId>
        <mTypology xmlns="http://edrul-develop.softeco.it">
          <TypologyName>string</TypologyName>
          <Version>long</Version>
          <Width>long</Width>
          <Height>long</Height>
          <Length>long</Length>
          <mTypologyId>long</mTypologyId>
          <mTranspVolume>long</mTranspVolume>
          <mTranspWeight>long</mTranspWeight>
          <mPollutionLevel>string</mPollutionLevel>
        </mTypology>
        <mHandyNumber xmlns="http://edrul-develop.softeco.it">long</mHandyNumber>
        <mNumberPlate xmlns="http://edrul-develop.softeco.it">string</mNumberPlate>
      </iTheTruck>
    </AddTruckToFleet>
  </soap:Body>
</soap:Envelope>
```

Figure 5.5: **Example of a WSDL (clipping)**

[3] WSDL is very often mentioned in connection with UDDI (Universal Description, Discovery and Integration). UDDI is a Webservice discovery mechanism which is used for storing and categorizing business information and retrieving pointers to Web services interfaces. So, for example, it is possible to get the description of a Websevice (in the form of the WSDL) from the UDDI.

Figure 5.5 shows part of a WSDL file. This WSDL implements a Webservice for adding a truck to a fleet. This service is provided by the "Logistics Planning/scheduling" component of the eDRUL system. In this description the following information can be found:

- the name of the function: AddTruckToFleet
- the parameters needed:
  - the typology information
    - width
    - height
    - length
    - transport volume (mTranspVolume)
    - transport weight (mTranspWeight)
    - pollution level
  - additional information
    - mobile number (mHandyNumber)
    - license plate (mNumberPlate)

UML

The Unified Modeling Language (UML) is a general-purpose mainly graphical notation (language) specifying and visualizing complex software, especially large, object-oriented projects. UML is consequently the successor of the wave of object-oriented development concepts that appeared in the late '80s and early '90s. UML went through a standardization process with OMG (Object Management Group) and is now standardized in the version 2.0.

Extract: Object Oriented Design & Programming

The Object Oriented Design is a software design method that models the characteristics of abstract or real objects using classes and objects. Objects are key to understanding object-oriented technology. You can look around you now and see many examples of real-world objects: your dog, your desk, your television set, your bicycle.

These real-world objects share two characteristics: They all have state and behaviour. For example, dogs have state (name, colour, breed, hungry) and behaviour (barking, fetching, and wagging tail). Bicycles have state (current gear, current pedal cadence, two wheels, number of gears) and behaviour (braking, accelerating, slowing down, changing gears).

Software objects are modelled after real-world objects in that they have state and behaviour, too. A software object maintains its state in one or more variables. A variable is an item of data named by an identifier. A software object implements its behaviour with methods. A method is a function (subroutine) associated with an object.[4]

Figure 5.6: **Object Oriented Design and Programming**

[4] Extract from http://java.sun.com/docs/books/tutorial/java/concepts/object.html

With UML, the model of the application to be developed can be described. This description is mainly based on four different kinds of diagrams:

(a) Class Diagrams

Class diagrams are the central part of the UML. "A class diagram describes the types of objects in the system and the various kinds of relationships that exist among them" (Fowler and Scott, 2000). Mainly we can distinguish between two different kinds of these relationships:

- Associations:

Example: one ("1") long distance service provider may own a number ("n") of vehicles.

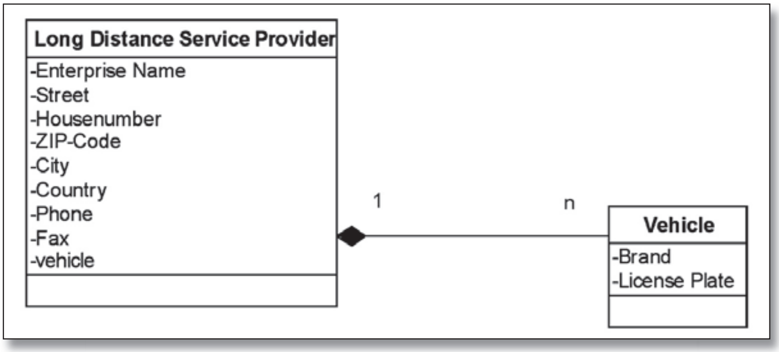

Figure 5.7: **Example of an association**

- Sub-types:

Example: a lorry is a sub-type of a vehicle.

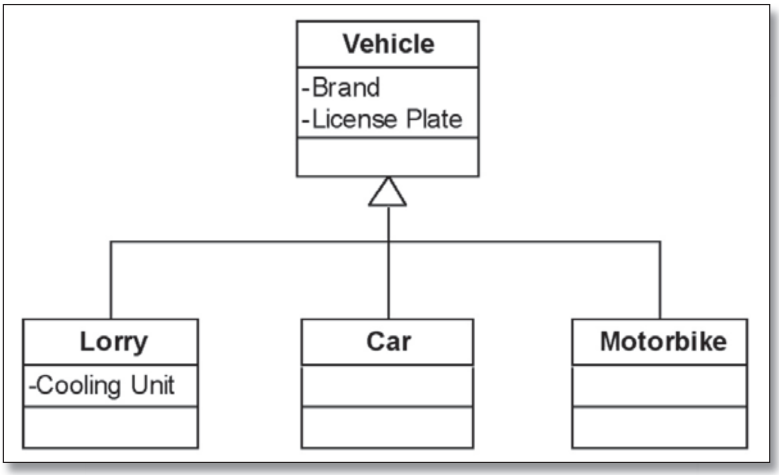

Figure 5.8: **Example of a sub-type**

(b) Interaction Diagrams:

An interaction diagram defines how objects co-operate with each other. Typically, you will find in one interaction diagram the co-operation of these objects in one use case. The co-operation is described in defining the messages to be sent between the objects.

(c) Use-Case-Diagram

UML Use Case Diagrams (UCD) can be used to describe the functionality of a system in a horizontal way. That is, rather than merely representing the details of individual features of the system, UCDs can be used to show all of its available functionality. It is important to note, though, that UCDs are fundamentally different from sequence diagrams or flow charts because they do not make any attempt to represent the order or number of times that the systems actions and sub-actions should be executed. UCDs have only 4 major elements: The actors that the system you are describing interacts with, the system itself, the use cases, or services, that the system knows how to perform, and the lines that represent relationships between these elements.

(d) Activity Diagrams

In the following picture the whole business process to be build one eDRUL e-Commerce e-Business interface is shown.

The service “Submit delivery Booking Request / Modification” is presented here. It is used by transport operators willing to deliver their goods to destinations in an historical centre and restricted traffic zone. Delivery bookings may be submitted: (a) via the internet (eDRUL portal), or (b) via phone call to eDRUL Logistics Agency operators. In both cases, the information supplied is basically the same.

This service is the starting point of the entire chain of:

- delivery booking;
- negotiation of “load combination”;
- confirmation of accepted booking; and
- issuing of a delivery order by the eDRUL Logistic Agency.

In this phase, all relevant information is specified by the booking transport operator and acknowledgement of receipt is issued by the eDRUL agency. The user may also specify the preferred channel to get booking confirmation and delivery order back from the eDRUL agency (e.g. web service, e-mail, SMS, fax).

If a modification is needed, the call centre operator will use the service “Search booking request”. If not, a new request will be opened. The operator will now ask for the required data, as a base for the decision about the request.

- Preferred time and date
- Destinations
- Type and volume of goods
- Type of car used
- Load percentage of the car
- Willingness of the consignor for an acceptance of load from a third party using the load negotiation process

- Finally, the willingness of the consignor for an acceptance to deliver the load to a third party using the load negotiation process

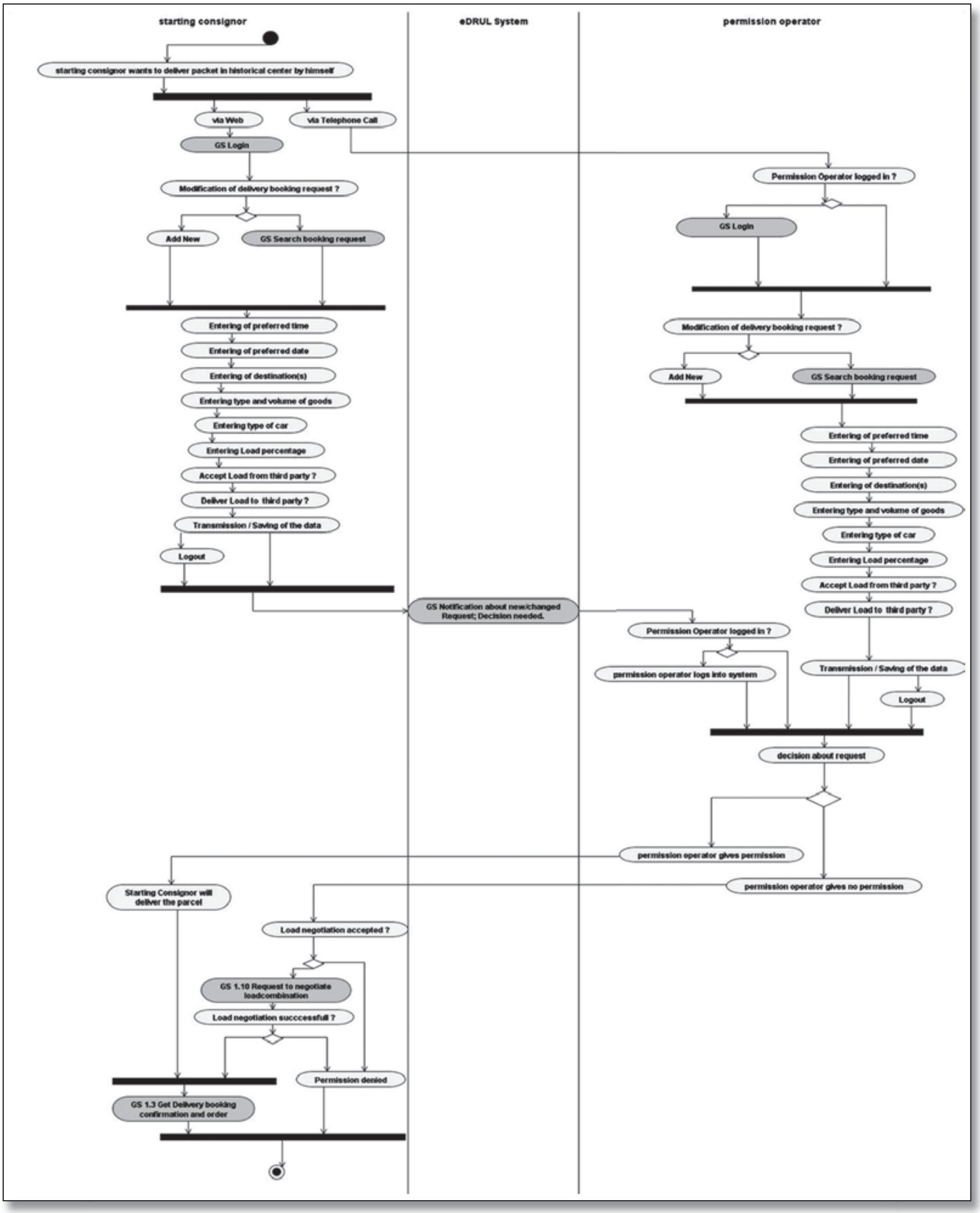

 Figure 5.9: **Example of an UML sequence diagram**

All the data entered has to be saved and transferred to the system. After this data collection a decision about the permission of the request will be possible.

Case I: Permission accorded

In this case, the consignor has the possibility to deliver the parcel.

Case II: Permission denied at first

Case IIa: Acceptance of Transhipment

In the case where the permission is denied and the consignor would accept any kind of transhipment (to another or from another party), another service called GS 1.10 "Request to negotiate load combination" will be used. If a compatible load combination / transhipment can be found permission will be given.

Case IIb: Refusing of Transhipment

In the case where the permission is denied and the consignor refused any kind of transhipment (to another or from another party), the permission will be denied completely.

The case where the consignor will use the Internet to submit a delivery-booking request is now described. In this case, to enter the data, the consignor will use virtually the same interface used for the delivery request. After entering the data the permission operator will get a notification about the new request in order to analyse if the access permission has to be raised or not. Now the further processing is the same as described above.

Web Content Management System (CMS)

A Web Content Management System (CMS) is a system which provides users without deep computer knowledge the possibility to add information in the form of articles, pictures, statistics, etc to a web site. Such systems span a wide variety of needs, from small systems with almost no workflow for small user-groups and such, to large database-based systems for running large, very active web sites such as those for a newspaper. One of the main features of a CMS is the strong differentiation between content and layout. The user has only to take care of the content, not of the layout. CMSs very often contain some kind of work flow: standard users add the article, after some review a second person publishes the article on the Internet.

Web Content Management Systems are at the first view not so important for the urban freight transport process. At the second view, during the installation of a new urban freight transport system or concept, these systems can be used by the responsible authorities of the city, local authority, the political tree of a project, to promote the activities, the objectives, etc to the respective user groups. In the eDRUL project, the Open Source Content Management System "OpenCMS" was used. The following will give some impressions about the usage and the layout of this system for eDRUL.

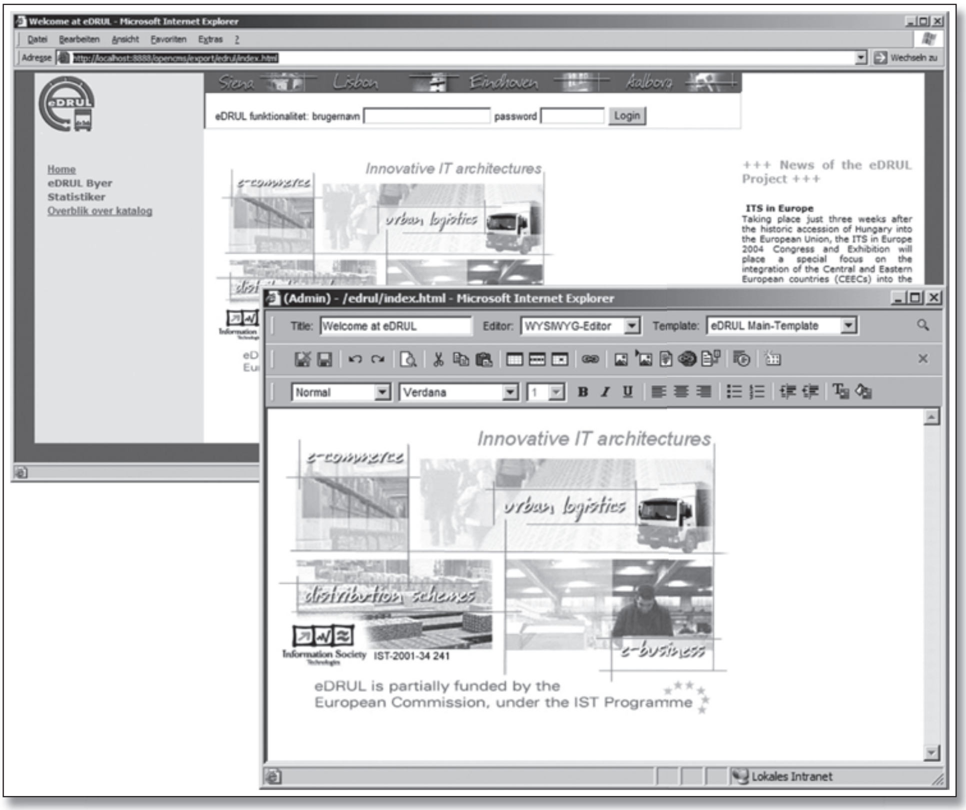

Figure 5.10: **The eDRUL Information Portal / CMS**

Cocoon

Cocoon is an XML Publishing Framework. The main functionalities of Cocoon are to manage XML data streams, processing and transforming them in different formats (e.g. PDF, HTML, WML[5]). The main objective of Cocoon is to enable the simple implementation of a portal. Here the strict separation of the following responsibilities was given priority: data, logic and layout. So, the person responsible for the layout doesn't have to take care about the data and the developer of the business logic will not take a close look at the layout. This concept is one of the main differences of Cocoon compared with other technologies like Active Server Pages (ASP) or Java Server Pages (JSP). What all these concepts have in common is the dynamic generation of the HTML-pages during runtime. The main difference of Cocoon to the other concepts is the constant use of XML in Cocoon.

[5] Wireless Markup Language is the primary content format for devices that implement the WAP (Wireless Application Protocol) specification based on XML. WAP is mainly used by PDAs and Mobile Phones.

All the main qualities, which were described at the beginning of this chapter, can be covered when using Cocoon. A very short introduction to how Cocoon works is given below[6].

Using the so-called "Sitemap" (a XML-document, which defines the procedure to be done for an URI) for each document an "XML-Pipeline" will be established. The XML-Pipeline is a functional unit, built from a combination of different components. Each pipeline starts with a generator, which supplies a XML data stream. This data stream is processed by the other components of the pipeline. The source for a generator may not be mandatory XML; a generator may also transform other data formats into XML.

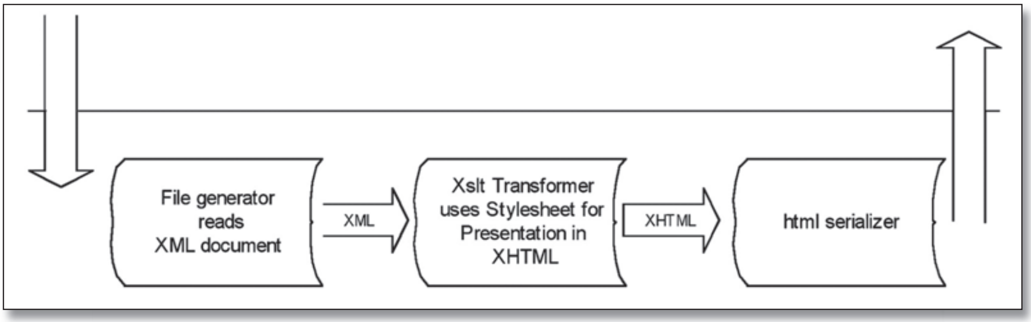

Figure 5.11: **e-Commerce/e-Business processing pipeline**

This transformation is a very important point for the eDRUL Project, since within the eDRUL website a multitude of generators will be developed to attach the sub-systems of eDRUL (e.g. traffic management systems, traffic control systems, access control systems). As described above either this mechanism or the Middleware component for complex transformations will be used.

After the file generation the data is available in XML format. Now another transformer may be (optionally) applied. This transformer may change the data. Additional XML-elements may be included (from other data sources) or existing elements may be deleted. Furthermore the structure of the XML element may be changed or information of the XML data set may be changed.

At the eDRUL project website an XSLT transformer is used. This transformer will add layout data http://www.neurauter.at. (XSLT stylesheet) to convert the data for a proper presentation.

The last component typically used in a pipeline is a so called "serializer". This component transforms the XML data, now in the desired data format, the proper output format, sets MIME-characters for the client and lastly generates the final document.

[6] For further details please refer to Langmall and Ziegler (2003); http://cocoon.apache.org; http://jakarta.apache.org/tomcat

Some examples for this final serializer are an HTML-serializer or a PDF-serializer. The usage of this pipeline in the whole Portal Software internal architecture is shown in Figure 5.12.

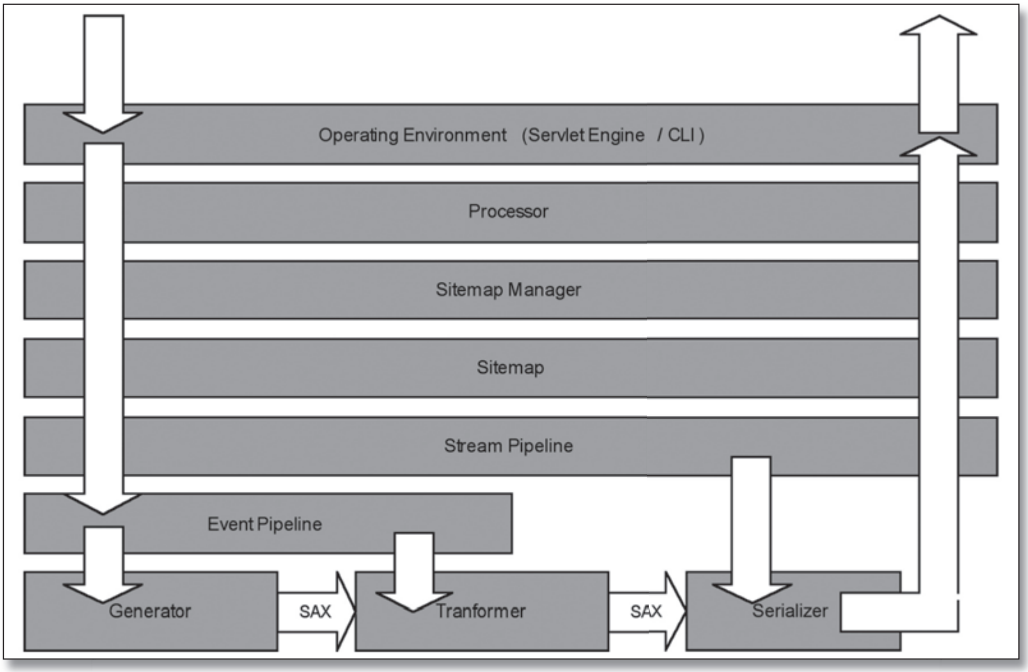

Figure 5.12: **Portal Software internal architecture**

Web Application Server

Also called an appserver, this is a program that handles all application operations between users and an organization's backend business applications or databases. Application servers are typically used for complex transaction-based applications. To support high-end needs, an application server has to have built-in redundancy, monitors for high-availability, high-performance distributed application services and support for complex database access.

5.2.2 Electronic Marketplaces

Introduction[7]

Between companies and public organisations, a hierarchically organized form of coordination is widely appreciated, whereas the marketplace dominates the majority of interactions among companies and between companies and consumers.

[7] This section draws on http://www.neurauter.at.

A marketplace in the sense of an electronic ("virtual") marketplace is in general not reduced to geographic boundaries (a later example will show that due to the regional concept of eDRUL, the usage of the marketplaces implemented in the eDRUL system will be local).

This extension is based on the loss of former limitations like distances as they lose their weight due to global networks (e.g. the Internet). An electronic marketplace may therefore include classical local and global markets.

A marketplace is institutionally a medium:

- that assigns roles to a community of agents. Besides the necessary ones of the sellers and the buyers - others can be defined, e.g. those of intermediaries, authorities…
- in which protocols and processes that regulate interaction of the agents are defined;
- that offers a common speech area which enables communication;
- which has a channel system, (i.e. a communications and transport system in store) that enables the exchange physically.

It consists socially of a community of agents that:

- are within a certain state that includes the components knowledge, intentions, contracts (assets and liabilities) and shopping cart;
- makes use of certain roles with their corresponding rights and obligations;
- by means of transactions, i.e. exchange or communications channels via the market medium, seek for change of their state corresponding to their intentions.

It is economically identified by:

- the vector of the shopping carts of the agents within a certain moment;
- the supplies and demands of the agents at this moment and their summation, i.e. the aggregated supplies and the aggregated demands;
- the contracts that are signed during a certain period;
- the exchange relations that exist for the contracts to a specific type of good, i.e. the prices.

This leads to the insight that although companies have been connected to each other using EDI and value-added networks for quite some time, these classical ways of utilizing electronic business were done on proprietary standards tightly bound to existing systems. The new electronic marketplaces represent a paradigm shift in how companies could potentially be doing business. The electronic marketplace model can enable real-time or close to real-time communication and collaboration.

Below the general term "electronic marketplace'' a more detailed typology can be layed out, as suggested by Timmers (2000). His first priority is the diversion of global vs. local markets, which results in the following classification:

- Intrinsically global electronic marketplaces: They deal with global products, customers and suppliers, e.g. MRO or automotive.
- Globally replicated local marketplaces:
  e.g. auctions or perishable products
- Local markets with a global infrastructure:
  e.g. location-dependent mobile commerce
- electronic Ports:
  products are exported globally by a collaboration of producers

Another diversification can be made according to the business models implemented (Bauknecth et al, 2000):
- electronic auctions:
  Auctions can be applied in any situation where there is fluctuation of demand or supply.
- collaboration platforms:
  They fit the wider definition of e-Commerce, namely that it is "about doing business electronically including collaborative work"; e.g. collaborative design or construction, consultancy, etc.

The different participants who decide to use a virtual marketplace may have different reasons to do so. The main benefits offered by a "virtual" marketplace compared to a traditional one according to Timmers (2000) are:
- Improved process efficiencies:
  Higher transparency at inter-organizational processes using telecommunications and computer technologies.
- Improved supply chain efficiencies:
  reduction in cycle time, reduced inventories and better collaborative planning capabilities.
- Better control over the process:
  Intra-organizational re-design of processes is a consequence of the integration of electronic marketplace processes into existing business processes. Therefore the insight into the processes is increased.
- Speed-up of processes and reduced media breaks
- Access to additional suppliers/buyers:

Marketplaces in eDRUL

According to the concepts described, various marketplaces were developed for the eDRUL system and the different requirements of the sites were implemented (see Figure 5.13).

Figure 5.13: **First version of a virtual marketplace in eDRUL**

5.3 Architecture of eDRUL

5.3.1 The eDRUL Datamodel

User Model

The eDRUL e-Logistics Agency represents a complex organisational structure providing services to a high number of users. The actor identification exercise and the description of their respective relationships have been carried out in the project. Starting from user categories and needs analysis conducted at site level, the underlying concepts have been generalised to address the urban logistics scenario.

In the following, a brief overview of the different actors categories addressed by eDRUL is provided, with the aim of illustrating the several user categories involved in

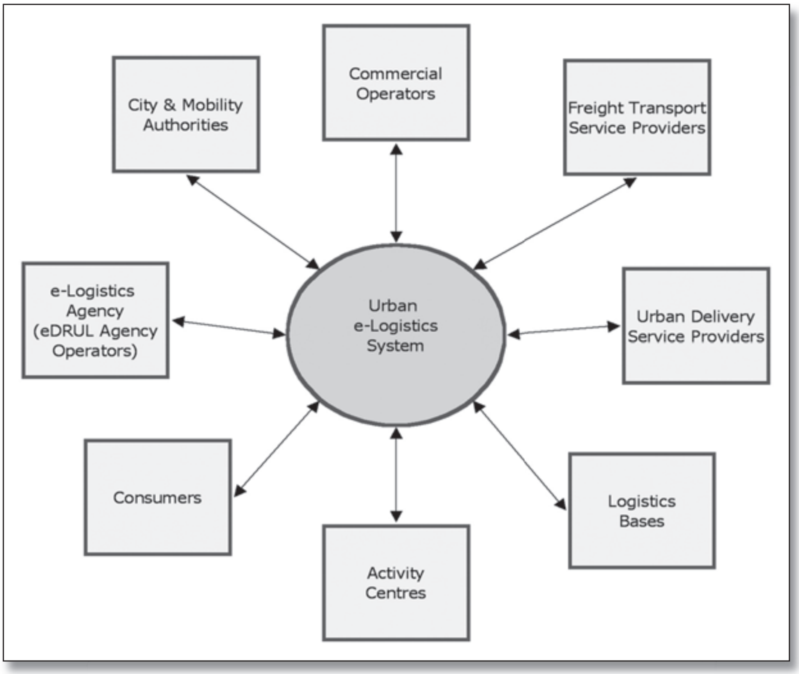

Figure 5.14: **User categories in eDRUL**

the system's scenarios. Finally, this section describes how this concept was transformed into an object oriented data model.

The eDRUL e-Business/e-Commerce Logistics framework has to provide services to both business actors and private users addressing co-ordination of logistics services and co-operation between different logistics operators. The main focus is on business user categories, and on ways to improve efficiency of the logistics system in the framework of urban mobility policies. A private actor like consumers and customers of goods are regarded as highly as an important node of the overall business process organisation eDRUL is looking at. Figure 5.14 provides an overall summary of the business actors involved in the eDRUL platform's scenarios. The next section gives an example of the data model implemented in the eDRUL system and project for the user class "transport operator".

Among business actors, Freight Transport Service Providers are one of the major user groups involved within the eDRUL architecture. For the purpose of eDRUL this may include private or public organisations providing various forms of goods transport services on a long/mid-distance scale, including for instance forwarders and courier services (DHL, FedEX). Chapter 3 described the different ways to regulate access into the town, including the booked, non-booked and several booked access subscriptions. The information related to the actors can be addressed in different ways.

Transport operators as previously stated can be considered the overall category (or base ancestor referring to Figure 5.15 below) of this group of actors. This actor identifies the company that owns the truck (or the truck fleet). In this user category one may also include private or public organisations. At the same level of the transport operators one can find the actor that represents the user category of the *external citizens*. This refers to private citizens not living in the Traffic Limited Area of the town but that need to enter the town occasionally in order to transport their own items.

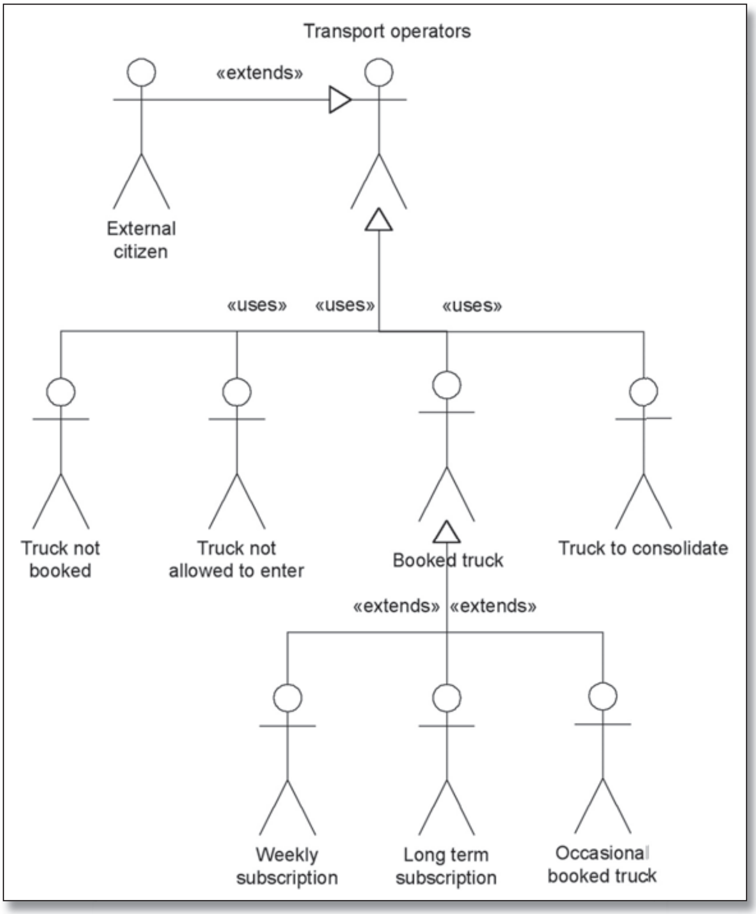

Figure 5.15: **Transport operator hierarchy**

Focusing on business user categories, the *transport operators* will need some conveyance in order to perform the delivery. As it is possible to guess within the overall conveyance category several kinds on trucks depending on the actions they want to perform can be found. Recalling the operative procedures previously introduced (and looking at Figure 5.15) the trucks' category managed by the eDRUL platform will comprise:

- *Booked truck.* This actor represents all the users that get the requirements to enter into town including the trucks that have been consolidated before reaching the city's access gate. This category is further expanded into other actors described later on.
- *Truck not allowed to enter.* This actor identifies the truck that hasn't the rights to enter into town.
- *Truck not booked.* This actor identifies a truck that directly goes to the city's access evaluation point without a previous booking action.
- *Truck to be consolidated.* This actor identifies a truck that hasn't the right to enter into town but complies with the requirements that allow the load consolidation so this actor identifies a truck that has requested use of the consolidation service and it has been added to the consolidation list.

As Figure 5.15 shows, the category of booked truck can be further sub-divided into several sub-items:

- Long-term subscription: This user category summarises the trucks that need to enter into town frequently and don't want to get diverted by the standard access procedures because they need a more streamlined one. This user category (as reported in detail within Chapter 3) will get an access subscription and infrequently will interface with the eDRUL platform. In order to get the access permission the transport operator will specify characteristics of the access permission required such as:
  A. in which days,
  B. which time windows,
  C. specific vehicles,
  D. …
- Occasional booked truck: This user category summarises the trucks that need to enter into town infrequently and in order to gain the access have booked their own delivery trip.
- Weekly subscription: This user category summarises the trucks that need to enter into town consecutively for the whole week.

Operational context

The operational context represents the bond existing between the user category and the services provided by the e-Commerce/e-Business platform. This information however is difficult to manage, due to the great number of actors involved and also to the fact that within the delivery chain the same actors can be involved in different actions, . In order to face these issues the concept of role has been introduced.

A role can be defined as a collection of functions that are logically linked together and could be performed by a certain actor within a business chain. For each actor all possible roles were identified. By analysing each actor-role pair of the eDRUL architecture and integrating that with the service list introduced, all the services provided by the platform have been obtained.

In the following the description of the services every actor-role pair can be involved in will be provided (Figure 5.16). Each actor-role pair has been related to the Generic Service, which is a generalization and synopsis of specialized services provided by the platform. For each Actor-role-Generic Service relationship a short description of the activities pursued is provided. For example, the actor "Transport operator" playing the role of "Performance evaluator" uses the Generic Service "Statistical data" when statistical data of the usage of the eDRUL system is requested.

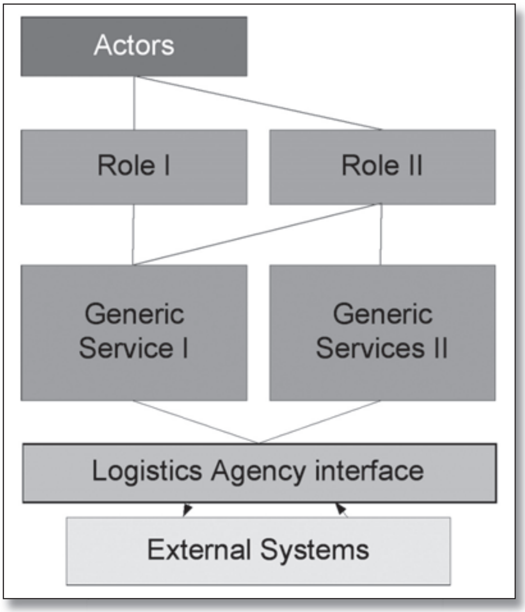

Figure 5.16: **Actors – role relationships**

Role	Description
Performance evaluator	The actor "Transport operators" plays the role of Performance evaluator when some information and statistics about the e-Commerce/e-Business platform is needed. This business is executed in each scenario.
Temporary consignee	The actor "Transport operators" plays the role of temporary consignee when it gets the goods to be delivered. This actor can play this role when he requests to consolidate his own load in the scenario of delivery through co-operation of networked transport service providers. In this scenario when the transhipment occurs the truck can be considered the temporary consignee of the goods.
Temporary consignor	The "Transport operator" can play the role of temporary consignor in each business that requires some delivery. This is executed in each scenario where some delivery is required.

Table 5.1: **Examples of actor-role relationships**

5.3.2 The eDRUL Communication Gateway

The eDRUL Communication Gateway (CG) is the architectural component that implements all the communications services. The platform communicates with the vehicles through CG, (the platform never communicates directly with the vehicle, always through CG). The communication services can be used either from the vehicle or from the platform, but only a few individual services have any meaning in both directions, most of them are meant to be used only from one of the two communicating parties.

The use of the wireless communications module makes it possible for the Logistics Agency to monitor the real-time state of the local delivery fleet at an individual van level, e.g. the last delivery that the van operator has executed. This enables full-scale utilisation and implementation of track and trace services. The communication module, moreover, will also support the possibility to provide such functionality as sending SMS to consumers' mobile phones. This again would mean some value added services, e.g. such that a carrier operator would receive on his own mobile phone the confirmation of the booking process or a tourist sightseeing the city would receive on his own mobile phone the delivery notification that his purchased goods have been delivered to a defined drop-off point (i.e. pick-up point from the customer point of view), etc.

Demonstration of the functionalities that other eDRUL modules provided for the management of the local delivery fleet would require some PDAs and GPRS based mobile phones (see Section 5.4). There are also competitively priced integrated devices on the markets. Use of these devices would enable demonstration of functionalities such as:

- Sending a message to the local van in order to communicate the route to be followed during the delivery trip. This route can also be updated on the fly by a new message.
- Sending messages from the local delivery van driver to the Agency that provides the Logistics Agency with information that a new good has been loaded to the truck (pick-up notification) or that some good has been delivered (drop-off notification). It should be noted that the terms pick-up and drop-off are always mentioned from the eDRUL system point of view. An eDRUL drop-off point is a pick-up point from the individual customer perspective.

5.3.3 Overall Architecture

For the implementation of the e-Commerce e-Business services the XML-Framework "Cocoon" will be used. Figure 5.17 shows the basic architecture implementation.

In general, a portal is well suited to building a middleware solution that shields clients from the backend-systems. Figure 5.17 shows how the portal software can access data from a variety of systems and then manage it for presentation in the required output format. The use of such architecture allows the platform, and therefore the project, to merge different data to give the client a single presentation format that hides the source of the data and its original format from the viewer.

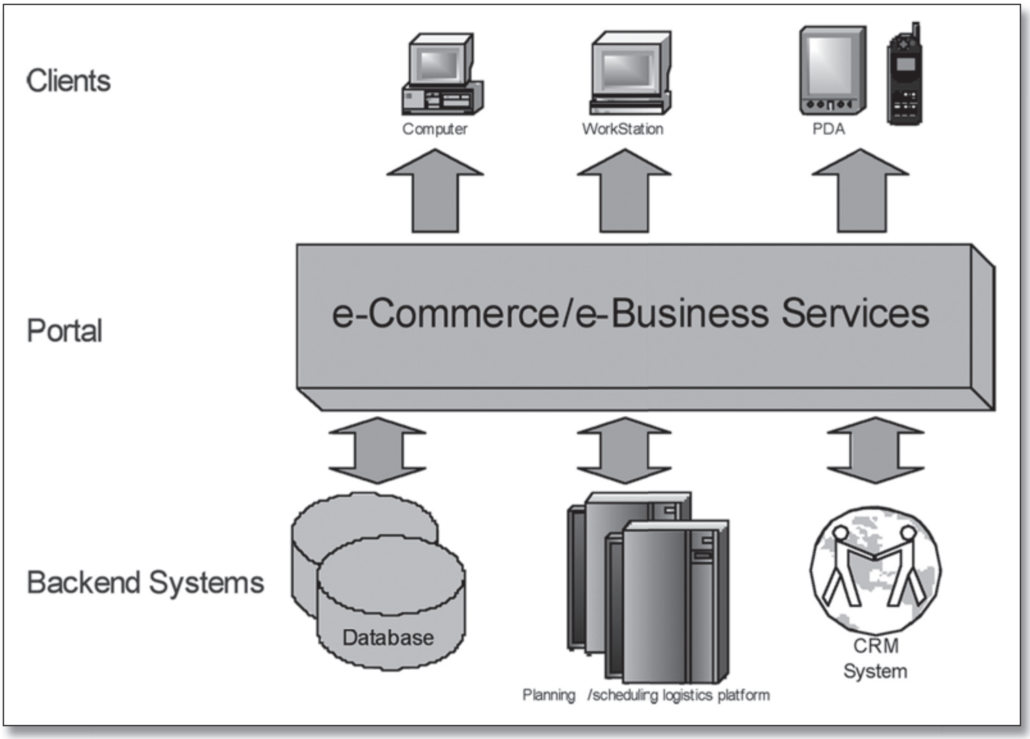

Figure 5.17: **Overall architecture**

This general architecture will be adapted to the specific requirements of the project. Depending on the final specification of the Logistic Agency interface as well as the interfaces to the traffic management systems additional Middleware software will be used. This software has to provide a wide variety of standard input interfaces (e.g. csv, XML, http, neutral) as well as output interfaces (e.g. XML, PDF; csv, FDF). The usage of this software enables the project team to develop rapidly the necessary interfaces for the system.

Figure 5.18 shows the enlargement of Figure 5.17 using an additional middleware component and the interface modules to be developed for the implementation of the e-Commerce/e-Business services. Input Modules (IM) will be developed either for the Middleware or for the Portal Software. Each system, which has to be integrated in or will deliver data to the eDRUL portal, has to send the data for the Portal Software in XML-format; if not an eDRUL Import Module for this system will be developed. Depending on the complexity, on the need for data transformation, and on the kind of the import (real-time data or batch) it will be decided, if a direct import in the Portal will be done or the components of the Middleware will be used.

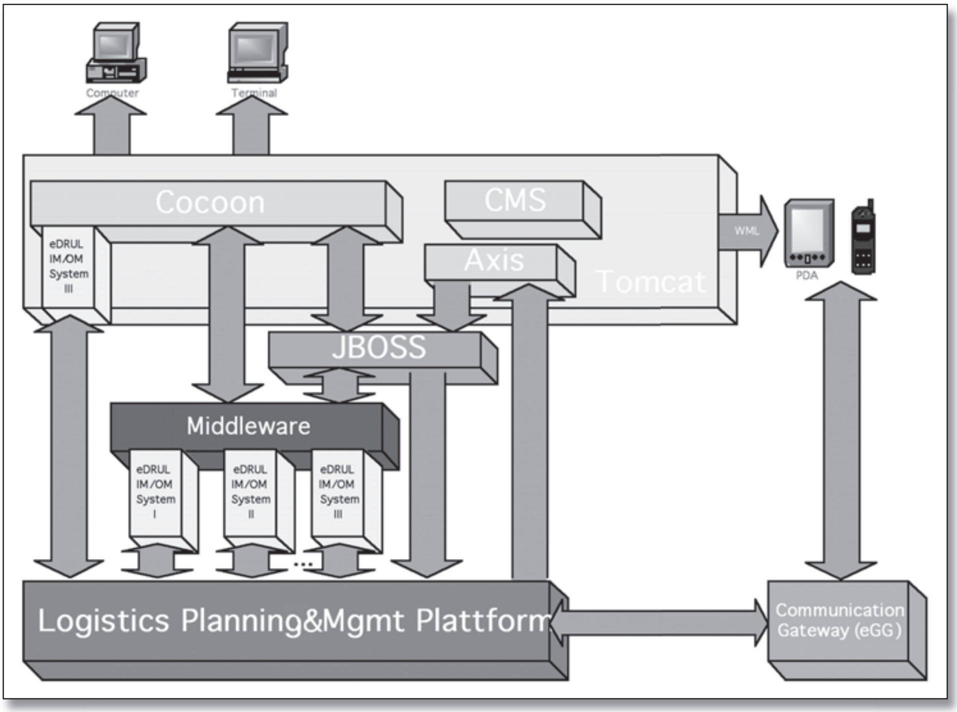

Figure 5.18: **Overall architecture in detail**

5.4 Case Study: Fleet management and in-vehicle technologies for goods distribution

The new GSM/GPRS based automated vehicle dispatching systems for improving the service levels of different transport companies by increasing both the speed and reliability of dispatching and fleet management have developed rapidly during recent years. These kinds of advanced telematics systems have shown that they can increase dramatically the efficiency and operational areas of the fleet management and monitoring systems and make it possible for the drivers to be contacted, helped and instructed. This is also possible when drivers are not sitting in their vehicles if they are using mobile vehicle terminals that are portable.

The new fleet management systems are based on the possibilities offered by the new and emerging technologies. They can relay incoming resource and service requests from the fleet management and dispatching centre to the optimal vehicle to satisfy the customer needs and requests.

Because these new fleet management systems are data transfer path- and terminal-independent, they can be used with various transfer technologies, such as private radio networks and GSM/GPRS networks. Requests are transferred as data to the chosen vehicle terminals. The drivers confirm the target addresses on their vehicle terminals. When this confirmation takes place the orders are automatically recorded as accepted. The drivers can see their position and the target address on the map which can be shown on the vehicle terminal display. The new systems can provide the driver with easy to use route guidance.

When it comes to the vehicle fleet they can use any standard on-board unit with the fleet management and dispatching systems (Windows, Windows CE and Series 60 equipment). This makes it possible for each driver/taxi company to find the best technological alternative to meet their needs and financial resources. The Series 60 alternative is using the state-of-the-art technologies providing a location independent, flexible, low-cost system for the taxi industry. For the mobile phone operators there is an opportunity for highly profitable business in global markets through the fleet management and dispatching systems for Series 60.

The fleet management and dispatching systems can be operated by the transport companies/dispatch centres themselves, which is the most common solution, but also by the telecom operators or as an Application Service Provision (ASP). The fleet management and dispatching systems are normally rather easy to use and yet very advanced. However, proper training and good user manuals are also needed.

Only recently the systems utilising GPRS for communications between the dispatch centre and the drivers have been implemented. Today the drivers can either use the in-vehicle terminals or simply their own mobile phones to receive orders and instructions and to communicate with the dispatch centre.

So far the fleet management and dispatching systems have often been regarded as expensive and not so user friendly. The next generation fleet management and dispatching systems have changed the situation. When, for instance, using the fleet management and dispatching systems and Series 60 mobile devices there is no need to invest in other in-vehicle equipment. This solution offers transport companies an easy and cost effective way to utilise the latest advantages in fleet management, scheduling and communication technology.

As mentioned the GSM/GPRS based fleet management and dispatching systems have just emerged and bring intelligent transport systems to the reach of small transport companies. The increasing need for better use of resources is not the only justification for new generation fleet management and dispatching systems. Using GPS (in the future Galileo) positioning in the fleet management and dispatching makes it possible to see the location of each vehicle all the time everywhere. One can say that the safety and security issues can be dramatically increased because of the new fleet management and dispatching systems.

There are cases where serious and dangerous situations have been quickly solved with the help of advanced telematics systems. Indeed in real life situations the fleet management and dispatching systems have even helped to save drivers lives. There are also cases where the violently attacked driver has been able to call for help and get it before the situation has become too threatening. If the alarm button is pressed, the position of the vehicle can be shown on the map, not only to the dispatchers but to all the other drivers of the fleet too. Thus rapid reaction and quick help is assured. The feedback from the drivers has been extremely positive.

The Windows-based environment and highly advanced technological features ensure that the advanced fleet management and dispatching systems are normally also easy to use. GPS positioning lets the dispatchers know the exact location and status of each vehicle in the fleet. This functionality also eliminates the driver's need to constantly report his location and movements by manually keying in his position.

If several vehicles in the vicinity are available, the fleet management and dispatching systems can offer the order and service requests to the vehicles that for instance have been idle for the longest period of time. This maximises the utilization of the vehicles on duty, enabling the fair and equal treatment of all drivers.

The fleet management and dispatching systems enable a single dispatcher to manage several dispatching areas, if needed, a feature that is particularly valuable when one dispatch centre is responsible for several operational areas or services. The system cuts costs and ensures the most suitable vehicle reaches and serves the customer quickly. This increases customer satisfaction - and enables the transport companies to build a reputation for speed and reliability.

The fleet management and dispatching systems are widely available throughout Europe and they are generally considered as reliable and powerful tools. The systems are also becoming easier to use. The potential market of these kind of fleet management systems is global.

The fleet management and dispatching systems improve service by making the dispatcher's work easier and faster. The systems normally have at least the following key features:

- Automatic dispatching (search of best service alternative)
- Digital maps
- Regular order management
- Advance orders
- Vehicle's properties and equipment management
- Automated positioning (GPS)
- Database reports
- Several language options
- SMS, WAP and WWW-ordering
- Emergency messages
- Connection to other systems of the transport company

The fleet management and dispatching systems are normally an open architecture. This means that they enable different bearers and vehicle terminals to be used even within the same dispatching centre. For instance fleet management and dispatching in an urban area could be handled using an existing private radio network or GPRS network, while fleet management and dispatching in a rural area would use GPRS network. Thus the use of bearers can be optimised and costs kept reasonable. The fleet management and dispatching systems also make it possible to have some of the vehicles use voice radio dispatching while the rest of the fleet simultaneously use automated fleet management and dispatching.

The vehicle terminals can be advanced and powerful vehicle computers such as Sunit d-series (with Pentium III processor 500 MHz and Windows 2000), vehicle computers with Windows CE (Infowave Waveon 728), PDAs with Windows CE (Compaq iPAQ with Nokia 6310i mobile phone and a GPS receiver) or any Series 60 GSM equipment. This gives transport companies alternatives. Since no special equipment is needed to run the cost effectiveness and savings are huge compared to the old "conventional" fleet management and dispatching systems.

Fleet management and dispatching systems scenarios that can be presented include:

1. Fleet management and dispatching systems for bigger transport companies

The transport companies buy (or lease) vehicle terminals, servers and software. The fleet management data needed can be sent via private radio network or GPRS network. The software licenses and hardware are owned by the transport companies, and the fleet management and dispatching is done by the companies themselves. New management and dispatch areas can join the existing system very easily, so the company can provide dispatching services for other areas, no matter where located. Investment costs naturally depend on many issues. Costs depend always on the project, and they consist of issues such as:

- Hardware in the dispatching centre: servers and workstations (costs vary)
- Software licenses of the dispatching software
- Vehicle terminals (from 300 to 5.000 euros each, VAT excluded)
- Communication media (GPRS/PRN etc.) and the amount of data sent
- Map coverage
- Fleet size (software licenses)
- Software and map data maintenance charges

2. Fleet management and dispatching systems for small transport companies

Transport companies buy vehicle software licenses and buy or lease vehicle terminals but purchase everything else from an Application Service Provider (ASP). Local partners are required to provide a vehicle terminal service.

In this scenario small transport companies get the benefits of a modern and powerful dispatch system without investing in their own dispatch centre software and server hardware. The dispatching can be done by the transport company itself (normal case) or the service can be bought from a third party. The transport companies can choose whether they want to invest in PDAs or in more developed vehicle terminals. It is also possible to use different vehicle terminals within one company.

Vehicle terminals can even be Series 60 mobile phones (for example in rural areas). Almost all the system features and advantages are available, but instead of vehicle terminals ordinary GSM phones are used. This way the drivers avoid the cost of separate vehicle terminals. In cases like this the costs depend mainly on the vehicle terminals used and also the pricing of ASP’s services. Costs usually consist of:

- Vehicle terminals (from 300 to 5, 000 euros each, VAT excluded)
- Communication media (GPRS/PRN etc.) and amount of data sent
- The pricing of ASP's services, which can include:
  - Maps
  - Vehicle software licenses
  - Software license (central system)
  - Hardware in the dispatching centre: servers and workstations
  - Software licenses of the dispatching software
  - Software and map data maintenance charges
- Dispatching service (if bought from a third party)

In the course of recent years the dispatching systems have been under continuous development. The breakthrough of GPRS made it possible to develop extremely sophisticated and at the same time low-cost solutions that are location independent, effective and easy to use.

The low-cost terminal is around €300, whereas the most expensive on-board-units may cost up to €5, 000. This offers a wide range of alternatives to the user. The software and hardware cost depends on what kind of contract the customer wants to have. The costs consist of hardware (servers and workstations), software licenses of the dispatching software, vehicle terminals, communication media, data sent, maps, fleet and maintenance. There is a possibility to use an Application Service Provider.

The following figures illustrate the new existing fleet management and dispatching technologies. Figure 5.19 provides an example of the dispatcher user interface with map and windows for order entry and fleet management/dispatching. Figure 5.20 displays the user interface of a fixed on-board unit with Windows 2000.

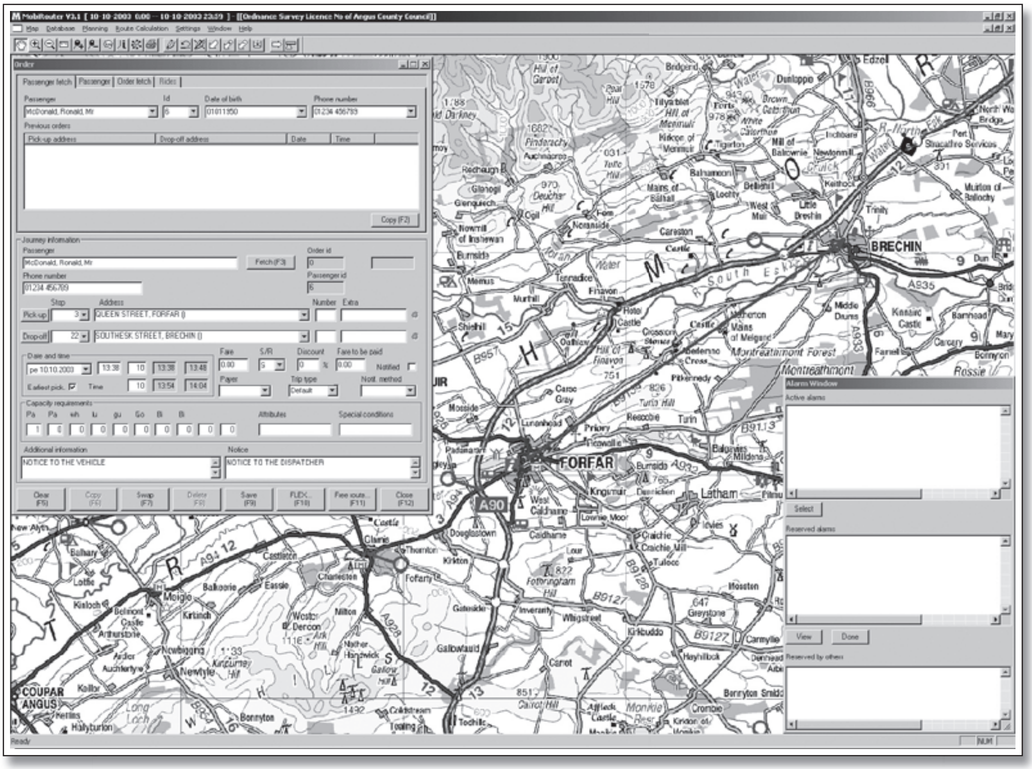

Figure 5.19: **Dispatcher user interface**

Figure 5.20: **On-board unit user interface**

CHAPTER 6

An overview of models to design City Logistics projects

J Barceló

6.1 Introduction

Logistics, as defined by the Council of Logistics Management (CLM, 2001), is that part of the supply chain process that plans, implements, and controls the efficient, effective flow and storage of goods, services, and related information from the point of origin to the point of consumption in order to meet customers' requirements. However, when logistics activities take place in urban areas they show unique characteristics making them different from the general logistics activities, which is the reason why freight transport in urban areas, and specifically the freight flows associated to the supply of city centres with goods, is usually referred to as "city logistics".

Taniguchi *et al*. (2001) define City Logistics as "the process of totally optimising the logistics and transport activities by private companies in urban areas while considering the traffic environment, traffic congestion and energy consumption within the framework of a market economy".

Among the special characteristics of urban freight transport there are two of particular relevance: its contribution to the traffic flows, and the subsequent environmental impacts. According to Koriath and Thetrich (1998) from the total traffic within urban areas, freight transport (lorries > 3.5 tonnes) has an average share of about 10%. If vans and cars, which are currently becoming more important, are included this share would be considerably higher.

The importance of urban freight transport can also be shown by the cost distribution within the freight transport chain. The share of pick-up and delivery operations, which often take place in urban areas, on the total door-to-door cost is about 40% in combined transport[1]. The weight of these costs is further increased by the reduction of stocks, the smaller size of consignments and the increase in their number.

From a systems approach City Logistics systems have many components usually related to the stakeholders playing a role in the system (such as those identified in Chapter 2), who's relationships can be described in the following terms:

1. Shippers, as for example manufacturers, wholesalers, retailers, etc. operating from Warehouses and/or City Logistics Centres, whose location should be appropriately determined when looking for optimal operations.
2. Freight Carriers, i.e. transporters, warehouse companies, operating the fleets supplying the customer's demand, whose optimal operation requires the appropriate decisions on fleet sizes, types of vehicles, vehicle routes, and scheduling, dispatching and monitoring systems.
3. Residents, consumers and clients, in the urban area, located at specific points in the urban area, whose demands have to be supplied in time.
4. Administrators, at city levels in this context, who define the operational traffic and supply policies in the operational area.

The involvement of such a variety of stakeholders and applications means that the objectives of City Logistics Applications and the objectives of the various stakeholders are multiple and possibly conflicting. Public stakeholders will usually be interested in achieving social, economic, environmental or energy objectives. Private stakeholders namely private shippers and freight carriers aim to reduce their freight costs and to optimise their traffic flows in accordance to their specific needs, which do not conform to the objectives of an overall optimisation.

Taniguchi *et al.* (2001) propose a methodology for the design of a City Logistics System which implies that:

- **Problems must be identified and defined**: these can, primarily, be of:
  - Fleet planning and management
  - Environmental impacts
  - Traffic congestion
- **Evaluation criteria must be set up according to the objectives** of the City Logistics Applications that can be primarily:
  1. Social: i.e. reductions in traffic congestion by a more efficient pick-up/delivery system that reduces the size of the fleets and maximize the load factor

[1] "Inner Urban Freight Transport and City Logistics", http://www.eu-portal.net, 2003.

2. Economic: derived from the reductions in fixed and operational costs
3. Environmental: as a consequence of the reduction of the emissions and noise
4. Energy consumption: derived from the reductions in fuel consumption or the resort to alternative energies.

Therefore the evaluation criteria should be based on the suitable models for each purpose which should be multiple and usually conflicting since there are numerous stakeholders involved, and take into account that, since there are a number of evaluation criteria for each stakeholder, it is difficult to determine a single evaluation measure for City Logistics Applications. This means that multi-objective evaluation techniques must be used to compare the performance of alternative schemes (see Chapter 7 for further details).

According to these criteria the design and evaluation of City Logistics Systems requires the availability of proper models for the location of the logistics centres, routing and scheduling of the fleets of service vehicles, and to measure the performance indices for the various evaluation criteria.

6.2 Location and Vehicle Routing problems in the context of City Logistics

Taniguchi *et al.* (2001) point out the many problems arising within urban areas as a consequence of the distribution of goods based on road services. Contributions to traffic congestion and environmental impacts along with high logistics costs, among others, are examples of such problems. One of the main reasons is the fact that most of the actors involved in urban goods distribution, industrial firms, shippers, freight carriers, and so on, have been individually established to meet consumer demands looking to maximize the company effectiveness and as a consequence, from a social point of view, the resulting logistics system is inefficient from the point of view of the social costs and environmental impacts.

A potential solution from the City Logistics approach, that could improve the efficiency of the logistics system in an urban area, is to operate from common logistics terminals or City Logistics Centres. Location Theory provides the models and algorithms to find the optimal solution to this problem.

Mathematical Location Models are designed to address a number of key questions (Daskin, 1995), for more details see Mirhandani and Francis (1990), including:

1. How many facilities should be open?
2. At which sites should each facility be located?
3. How large should the capacity of each open facility be?
4. How should demand for the facilities' services be allocated to the facilities?

The answers to these questions depend on the context in which the location problem is stated and on the objectives underlying the location problem. According with these criteria a taxonomy of Location Problems has been proposed. Following Daskin (1995), one of the most common criterion classifies Location Problems on the basis of the topography and the way in which demands on candidate facility locations are represented in:

- Planar versus discrete location models
  - In Planar Location Models demands occur anywhere in the plane and facilities can be located anywhere on the plane.
  - In Discrete Location Models demands and candidate sites for facilities can occur anywhere in the plane with arbitrary distances between them and no underlying structure.
- In Network Location Problems demands and travel between demand sites and facilities are assumed to occur only on a network or graph composed of nodes and links. Depending on the network structure we can have:
  - Problems that arise in trees, and
  - Problems that must be formulated on a general graph that we will assume is fully connected.

  In most Network Location Problems often we assume that demands occur only at the nodes of the network, although in some cases demands are permitted to occur anywhere on the links of the network. Facilities can be located only on the nodes or on the links of the network.

In the context of City Logistics Systems it is clear that travel between demand sites, shop retailers, businesses, etc., and facilities, that is the City Logistics Centres, occur only on the street network or, equivalently in terms of the model, on the graph representation of the street network, therefore Network Location Models appear as the most natural to model these systems.

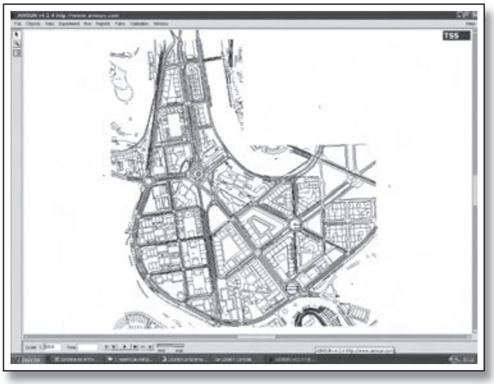

Figure: **6.1a**

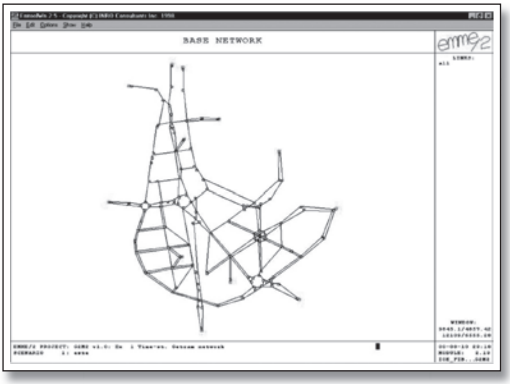

Figure: **6.1b**

Figure 6.1 depicts an example of a digital map of a borough of a city and its representation in terms of a directed graph accounting for the directions of the streets, the turning movements at intersections, banned turns, etc.

For a general discussion on Location Models see any of the references above. The Optimization Group at the Department of Mathematics of the Kaiserslautern University and the Fraunhofer Institut für Techno- und Wirtschaftsmathematik have conducted research reported in Hamacher and Nickel (1996). After classifying the Location Models they have developed a public library, LOLA, accessible at http://www.mathematik.uni.kl.de/~lola, where the models and their algorithms are available. To illustrate the concept we will discuss here two general cases of Network Location. (In what follows we will assume that our problems are uncapacitated, that is we are not going to take into account limitations on the capacities of the facilities, assuming implicitly that it will be enough to satisfy the demands of all nodes assigned to each open facility):

- Vertex Centre Problems: in which facilities can be located only on the nodes of the network and deal with placement of P facilities to minimize the maximum distance from any facility to the demand point it assigned to serve, and
- Median Problems: dealing with placement of P facilities in P locations, to minimize a cost criterion.

Vertex Centre Problems

Vertex Centre Problems can be formulated mathematically in the following terms (Daskin, 1995): where I={1, 2, …, n} is the set of demand sites or customers, J={1, …, m} is the set of candidate sites for the facilities, d_{ij} is the distance from demand node i to candidate facility site j; h_i is the demand at node i; P is the number of facilities to locate; x_j=1 if a facility is located at candidate site j, and x_j=0 otherwise; and y_{ij} is the fraction of the demand of node i that is satisfied by facility at node j.

$$\text{MIN} \quad W \tag{6.1}$$

$$\text{s.t.} \quad \sum_{j \in J} y_{ij} = 1, \quad \forall i \in I \tag{6.2}$$

$$\sum_{j \in J} x_j = P \tag{6.3}$$

$$y_{ij} \le x_j \tag{6.4}$$

$$W \ge \sum_{j \in J} d_{ij} y_{ij}, \ \forall i \in I \tag{6.5}$$

$$x_j \in \{0,1\}, \quad \forall j \in J \tag{6.6}$$

$$y_{ij} \ge 0, \qquad \forall i \in I, j \in J \tag{6.7}$$

The objective function (6.1) minimizes the maximum distance W between a demand node and the closest facility to the node; constraints (6.2) state that the demand of each node i is satisfied from some facility j; constraint (6.3) stipulates that exactly P facilities will be located; constraints (6.4) ensure that the demand of a node i cannot be satisfied from a facility which has not been located at node j; constraints (6.5) state that the maximum distance W between a demand node and the nearest facility to that node must be greater than the distance between any demand node i and the facility j to which it is assigned. Finally constraints (6.6) and (6.7) are the integrality and non-negativity constraints respectively.

P-Centre Problems

P-centre problems are well known Combinatorial Optimization problems for which a wide variety of algorithms exist (see Hamacher and Nickel, 1996 and Francis *et al.*, 1992), but for most of them acceptably efficient heuristics have been found. An example of such heuristics for the Unweighted Vertex P-Centre Problem in a General Graph, when demands and facilities are located at nodes, and demands h_i are not explicitly taken into account, works as follows (Daskin, 1995). All link distances are assumed to be integer, not a restrictive assumption since continuous distances can be acceptably approximated to an integer multiplying them by a sufficiently large number. The heuristic searches over the range of coverage distances looking for the smallest coverage distance that allows all nodes to be covered. The search procedure works as follows:

- Selects initial lower and upper bounds on the value of the P-Centre objective function
- Solves a set covering problem (Daskin, 1995; Francis *et al.*, 1992) using as coverage distance the average of the lower and upper bounds on the objective function.
  - If the number of facilities needed to cover all nodes with that distance is less than or equal to P, reset the upper bound on the value of the P-Centre objective function to the used coverage distance.
  - If the number of facilities needed is greater than P, reset the lower bound to the used coverage distance plus 1.
  - If the lower and upper bounds are equal then stop, a solution has been found. Otherwise repeat with the new coverage distance set equal to the average of the upper and lower bounds.

The heuristic algorithm can be formally stated as follows: let us define P*(x) as the optimal value of the set covering problem when the coverage distance is x, and W_C^L and W_C^U as lower and upper bounds on the value of the P-Centre objective function W.

Step 0: (Initialization)

Set W_C^U to a suitable large number (For example: $W_C^U = (n-1)\underset{i,j}{MAX}\{d_{ij}\}$ where n is the number of nodes in the graph and d_{ij} is the length of link (i, j))

Set $W_C^L = 0$

This ensures an estimate of the coverage distance sufficiently large, because a path between any two nodes will have at most n-1 links, and $\underset{i,j}{MAX}\{d_{ij}\}$ is the length of the longest link. Therefore $(n-1)\underset{i,j}{MAX}\{d_{ij}\}$ is an upper bound on the distance between any pair of nodes in the network.

Step 1: (Update Coverage Distance)

Set $D_C = \left\lfloor \left(W_C^U + W_C^L\right)/2 \right\rfloor$ (Where $\lfloor x \rfloor$ is the largest integer less than or equal to x)

Step 2: Solve a set covering problem with a coverage distance Dc:

$$\begin{aligned} &\text{MIN} \sum_{j \in J} x_j \\ &\text{s.t.} \quad \sum_{j \in J} a_{ij} x_j \geq 1, \forall i \in I \\ &\qquad x_j \in \{0,1\}, \forall j \in J \end{aligned}$$

coefficients aij are defined as: $a_{ij}\begin{cases} = 1 & \text{if candidate site j can cover demands at node i} \\ = 0 & \text{otherwise} \end{cases}$ in terms of the distance between a demand node i and the candidate facility j. If DC is the coverage distance then $a_{ij} = 1$ if $d_{i\varphi} \leq DC$.

And $x_j \begin{cases} = 1 & \text{if a facility is located at candidate site j} \\ = 0 & \text{otherwise} \end{cases}$

Let the solution be $P^*(D_C)$.

Step 3: (Update upper or lower bounds)

f $P^*(D_C) \leq P$ reset W_C^U to D_C, otherwise reset W_C^L to $D_C + 1$

Step 4: If $W_C^L \neq W_C^U$ repeat from Step 1, otherwise stop. $W_C^L = W_C^U$ is the optimal value of the P-Centre objective function W, and the corresponding locations optimal for the P-Centre.

This algorithm can be extended to solve the Weighed Vertex P-Centre Problem on General Graphs, that is the case when demands h_i are explicitly taken into account. For that:

- The initial upper bound W_C^U is redefined to account for the demands in the network. A solution is to multiply the upper bound used in the unweighted case by the largest demand:

$$W_C^U = (n-1)\left[\underset{i,j}{MAX}\left\{d_{ij}\right\}\right]\left[\underset{i}{MAX}\, h_i\right]$$

- In solving the set covering problem, a candidate site j will be able to cover demand node i if $d_{ij}h_i \leq DC$.

Median Problems

In solving the P-Centre above we assume that the demand at a node is satisfied from a facility if it is within the coverage distance otherwise it is not satisfied. In many cases, however, the benefits (costs) associated with satisfying a demand from a facility decreases (increases) with the distance to the nearest facility. An example, suitable to many City Logistics problems, is the case when servicing a retail establishment from a warehouse which depends on the time the driver must spend in travelling from the warehouse to the retail store. This is the type of problem addressed by median problem when costs are assumed to be linear.

The P-Median problem is to find the location of P facilities on a network so that the total cost is minimized, assuming that the cost of serving demands at node i is given by the product of the demand at node i and the distance between demand node i and the nearest facility to node i. The P-Median problem can be formulated as a mathematical programming problem as:

$$\text{MIN}\sum_{i\in I}\sum_{j\in J} h_i d_{ij} y_{ij} \tag{6.8}$$

$$\text{s.t.} \quad \sum_{j\in J} y_{ij} = 1 \qquad \forall i \in I \tag{6.9}$$

$$\sum_{j\in J} x_j = P \tag{6.10}$$

$$y_{ij} - x_j \le 0 \qquad \forall i \in I, \forall j \in J \tag{6.11}$$

$$x_j \in \{0,1\} \qquad \forall j \in J \tag{6.12}$$

$$y_{ij} \in \{0,1\} \qquad \forall i \in I, \forall j \in J \tag{6.13}$$

The objective function (6.8) minimizes the total cost expressed in terms of a weighted distance between each demand node and the nearest open facility. Constraint (6.9) requires each demand node i to be assigned only to one facility, and constraint (6.10) states that exactly P facilities are open among the |J| candidate sites. Constraints (6.11) link location variables x_j with allocation variables y_{ij}, stating that demand at node i can only by assigned to a facility j that is open. Constraints (6.12) and (6.13) are the integrality conditions, the allocation variable y_{ij} is equal to 1 if demand at node i is served by a facility located at node j, and 0 otherwise.

P-Median Problems are well known Combinatorial Optimization problems for which a variety of algorithms exist (see Daskin, 1995; Mirhandani and Francis, 1990; Francis *et al.*, 1992), for the purpose of these comments we will illustrate them with an example of heuristic algorithm following the approach in Daskin (1995).

As for other Combinatorial Optimization problems heuristics for the P-Median Problem can be classified in two broad classes:

- Construction, or primal, heuristics, whose purpose is to discover an acceptable solution to the problem at a cheap computational cost.
  - Greedy algorithms are standard construction algorithms which attempt to build a good solution from scratch
- Improvement, or dual heuristics, that starting from an already existing feasible solution try to find a better one.
  - Exchange and neighbourhood algorithms are examples of improvement heuristics.

A greedy algorithm for the P-Median Problem

As usual in greedy algorithms the basic assumptions rely on some intuitive facts or straightforward reasoning on the main features of the problem to be solved. In the case of P-Median problems a quite natural assumption could be the following. If we were to locate only a single facility on a network the optimal solution could be found by enumerating all possible locations and choosing the best. Taking into account that the solution to P-Median Problems on a network consists of locating facilities only at nodes, we could evaluate the objective function for this 1-Median Problem as:

$$Z_j = \sum_{i \in I} h_i d_{ij} \tag{6.14}$$

if we locate the unique facility at node j. Calculating Z_j for each demand node we could then choose as solution to the problem the location resulting in the smallest value of Z_j.

Suppose now that we are given the location of P-1 facilities. Let X_{P-1} denote the locations of these P-1 facilities, and $d(i, X_{P-1})$ the shortest distance between demand node i and the closest node in the set X_{P-1}. Similarly we let $d(i, j \cup X_{P-1})$ be the shortest distance between demand node i and the closest facility in the set X_{P-1} augmented by candidate location j. A similar reasoning leads us to think that the best place to locate a single new facility, given that the first P-1 facilities are located at the sites in X_{P-1}, is at the location j that minimizes:

$$Z_j = \sum_{i \in I} h_i d\left(i, j \cup X_{P-1}\right) \tag{6.15}$$

This approach leads to the following greedy algorithm:

Step 0: (Initialization)
Set k:=0 (Counter of the number of facilities located so far) and $X_k := \emptyset$ (X_k will give the location of the k facilities located at iteration k of the algorithm)

Step 1: (Iteration counter)
Set k:=k+1

Step 2: Compute $Z_j^k = \sum_{i \in I} h_i d(i, j \cup X_{k-1})$ for each node j which is not in X_{k-1} (Cost of locating the k-th facility at node j given that k-1 facilities have been located at nodes in X_{k-1})

Step 3: Find the node j*(k) that minimizes Z_j^k, that is $j^*(k) = \text{argmin}\{Z_j^k\}$
This is the best location for the k-th facility given the location of the first k-1 facility.

Step 4: If k=P stop, the P facilities have been located and X_P is the solution. Otherwise repeat from 2.

An improvement to this solution could be found by a neighbourhood algorithm based on the consideration that we should expect that given the locations of some facilities the allocations of demand nodes should be assigned to the nearest facility since the facilities are uncapacitated (that is we are not taking into account the capacities of the facilities assuming implicitly that each one has enough capacity to satisfy the demands of the nodes assigned to it), and we are trying to minimize the demand-weighted total distance. That allows the creation of a set of nodes or neighbourhood of each facility, all of them assigned to that facility. If we assume that within each neighbourhood the median should be located optimally, we can generate a set of P 1-median problems whose solutions could improve the greedy solution.

6.3 Some comments on the concept of distance and location problems in City Logistics applications

A common feature of all location models and the corresponding algorithms is that they are based on the idea of minimizing a distance or a weighted distance between demands and facilities. In the case of Network Location we assume that this is the distance between nodes, the key question then is, how these distances are calculated? Usually these distances are calculated in terms of shortest paths between nodes in the network but shortest path algorithms calculate the solution in terms of link costs, therefore the question should then be restated as, which is the concept of link cost that is relevant for the City Logistics application of interest?

A variety of cost concepts could be used ranging from geometric link lengths, to link travel times under certain traffic conditions or a combination of both. When link travel times are taken into account then traffic assignment models are among the candidate models to estimate average link or path travel times. Taniguchi *et al.* (2001) propose the formulation of the location and traffic assignment as a joint problem. This could be the most appropriate approach in some cases while in others, either because not all the required information for such models is available, or because the relative contribution of the urban freight transport lies within the limits mentioned in the introduction, traffic assignment and location can be treated separately in a sequential scheme in which traffic assignment provides the average travel times used to calculate the link costs on which the distances for the location algorithm will be based.

User equilibrium models for traffic assignment

The main traffic models to estimate the distribution of traffic flows on a road network are based on mathematical models of route choice, that is, the modelling of how users select their routes under the prevailing traffic conditions. The concept of equilibrium plays a central role in this model building process. Wardrop (1952) stated the two principles that formalised this concept of equilibrium and introduced the behavioural postulate of the minimisation of total costs that along with the principles are the fundamental modelling hypothesis. Traffic equilibrium models are descriptive models aimed at predicting link flows and travel times that result from the way in which users choose routes from their origins to their destinations in a transportation network (see Florian, 1986; Florian and Hearn, 1995; Sheffi, 1985; or Patriksson, 1994).

The first principle states that "The journey times on all routes actually used are equal to or less than those which would be experienced by a single vehicle on any unused route".

The traffic flows that satisfy this principle are usually referred to as "user optimised flows", since each user chooses the route that he perceives the best. "System optimised flows" are characterised by Wardrop's second principle which states that "the total travel time is minimum". Static Traffic Assignment Models built according to these principles and the postulate of minimisation of total cost consider a given period of time for which the demand characteristics have been determined and estimate the flow patterns that result from the interaction of the demand and the congestion characteristics of the transport infrastructure available. The road network is modelled in terms of a graph, whose nodes $n \in N$ represent origins, destinations, and intersections of links, and links, $a \in A$, represent the transportation infrastructure. The flow of trips on a link a is given by v_a, and the cost of travelling on a link is given by a user cost function $s_a(v)$ where v is the vector of link flows over the entire network. As these functions model the time delay for a journey on arc a they are called volume/delay functions. An example of volume delay functions widely used in practice is the Bureau of Public Roads, or BPR functions, of the form:

$$s_a(v_a) = t_0 \left[1 + \alpha \left(\frac{v_a}{c_a} \right)^{\beta} \right]$$

Where t_0 is the free-flow time, c_a is the capacity of link a, va the flow on the link and α and β calibration parameters. Demand characteristics are represented in terms of trip or Origin to Destination matrices, origins and destinations are coupled in pair and g_i, $i \in I$, where I is the set of origin/destination pairs, is the number of trips between the I-th O/D pair, for a given time period and a trip purpose. Trips between an O/D pair may use directed paths k, $k \in K_i$, where K_i is the set of paths for O/D pair i. The flows on paths k, h_k, satisfy flow conservation and non-negativity conditions:

$$\begin{aligned} &\sum_{k \in K_i} h_k = g_i, \forall i \in I \\ &h_k \geq 0, k \in K_i, \forall i \in I \end{aligned} \qquad (6.17)$$

The corresponding link flows va are given by:

$$v_a = \sum_{i \in I} \sum_{k \in K_i} \delta_{ak} h_k, \forall a \in A \quad \text{where: } \delta_{ak} = \begin{cases} 1 & \text{if link a belongs to path } k \\ 0 & \text{otherwise} \end{cases} \qquad (6.18)$$

$$s_k = \sum_{a \in A} \delta_{ak} s_a(v), \forall k \in K_i, \forall i \in I \,)$$

The cost of each path s_k is the sum of user costs of the links on path k:

$$u_i = Min\left\{ s_k \mid k \in K_i \right\} \quad \forall i \in I$$

Let ui be the cost of the least cost path for any O/D pair i:

The network equilibrium model is formulated by supposing that for every O/D pair Wardrop's user optimal principle is satisfied, or in other words, that all the used directed paths are of equal cost, that is:

$$s_k^* - u_i^* = \begin{cases} = 0 & if \quad h_k^* \geq 0 \quad k \in K_i, i \in I \\ \geq 0 & if \quad h_k^* = 0 \end{cases} \qquad (6.19)$$

Over the feasible set (6.17)-(6.18).

When the user cost functions are separable, that is, they depend only on the flow in the link: $s_a(v)=s_a(v_a)$ $a \in A$, and demands gi are considered constant, independent of travel costs, the assignment model is equivalent to the following convex optimisation problem (Florian and Hearn, 1995; Patriksson, 1994):

$$\begin{aligned} &Min \sum_{a \in A} \int_0^{v_a} s_a(x)dx \\ &s.t. \ \sum_{k \in K_i} h_k = g_i, \forall i \in I \\ &h_k \geq 0, k \in K_i, i \in I \end{aligned} \qquad (6.20)$$

and the definitional constraint of v_a (6.18). Efficient algorithms to solve the model have been proposed (Florian and Hearn, 1995; Patriksson, 1994), and some of them are implemented in commercial transport planning software packages, such as EMME/2 for example. These are the typical algorithms implemented in most transport planning packages based on this approach, for example EMME/2 (INRO, 1998).

An example of the proposed use of the traffic assignment to provide the distances d_{ij} for locational studies is depicted in Figure 6.2. The figure depicts the graph of the street network of Barcelona in which (ZAL) identifies the potential location of a City Logistics Centre, encircled are the locations of some of the demand nodes, where the customers are located, and the shortest paths from the facility to the demand nodes are identified. These shortest paths are calculated in terms of the average path u_i travel times estimated by the assignment.

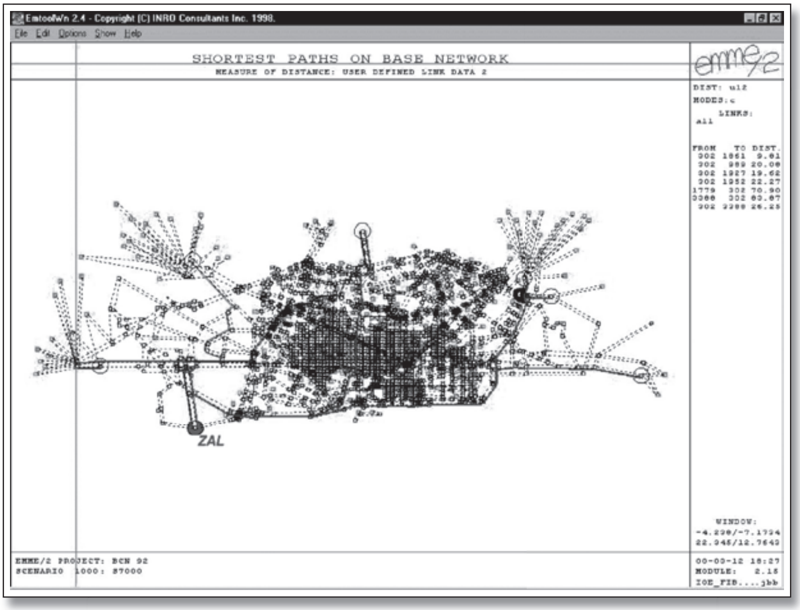

Figure 6.2: **Shortest path analysis after a traffic assignment on the urban network of Barcelona**

6.4 Vehicle Routing and Scheduling Models

According to Taniguchi *et al.* (2001) Vehicle Routing and Scheduling Models provide the core techniques for modelling City Logistics. Once the facilities, or the City Logistics Centres have been located, and the demand nodes have been allocated to each facility the next step is to decide the efficient use of the fleet of vehicles that must make a number of stops to pick up and/or deliver passengers or products. The problem requires the specification of which customers should be serviced by each vehicle and in what order so as to minimize the total cost subject to a variety of constraints such as vehicle capacities, delivery time restrictions, etc. For a complete State-of-the-Art of Vehicle Routing and Scheduling Models see Toth and Vigo (2002).

To illustrate the concepts we will restrict our exposition to a few simple cases of Capacitated Vehicle Routing Problem (CVRP) and Vehicle Routing problem with Time Windows (VRPWT).

A Simple Case of CVRP (Fisher, 1995)

This is the case when there is a fleet of identical vehicles making deliveries to customers from a unique central depot. Let K be the number of vehicles in the fleet, n the number of customers to be served, b the capacity of each vehicle, ai the demand of customer i measured in the same units as vehicle capacity, and $c_{ij} \geq 0$ the cost of travelling between points i and j. For convenience customers are indexed 1 to n, and index 0 denotes the central depot, that is the City Logistics Centre in our case. A basic assumption in simple models is that travel costs are symmetric, that is $c_{ij}=c_{ji}$ This is not a very restrictive hypothesis for Vehicle Routing Problems at a regional level but could lead to unacceptable solutions in urban networks.

The CVRP is to determine K vehicle routes where a route is a tour beginning and ending at the depot and visiting a subset of customers in a specified sequence. Each customer must be assigned to exactly one of the K vehicles and the total amount of the demand to be serviced by a vehicle must not exceed the vehicle capacity b. The routes should be chosen to minimize the total cost.

CVRP is also a well know case of a hard Combinatorial Optimization Problem (see Toth and Vigo, 2002, for details) for which exact and heuristic algorithms have been proposed. One of the earliest heuristics, still widely used in practice, due to Clarke and Wright (1964), works as follows:

- Assuming a graph G=(N, A), with a set of nodes N={0, 1, …, n}, with the central depot at node 0, and customers or demand nodes at 1, …n; and a set of arcs A=NxN. Begin with an infeasible solution in which every customer is supplied individually by a separate vehicle.
- Combine any two of these single customer routes to use one less vehicle and reduce cost:
  - The cost of servicing customers i and j individually by two vehicles is

$$c_{0i}+c_{i0}+c_{0j}+c_{j0}$$

  - The cost of one vehicle serving i and j on the same route is

$$c_{0i}+c_{ij}+c_{j0}$$

  - Combining i and j results in cost saving of

$$s_{ij}= c_{i0}+c_{0j}-c_{ij}$$

- Select the arc (i, j) with maximum saving s_{ij} subject to the requirement that the combined route is feasible (i.e. does not exceed vehicle capacity).

- Repeat the process until the number of routes is reduced to $K = \left\lceil \frac{\sum_{i=1}^{n} a_i}{b} \right\rceil$

Since the seminal work of Clarke and Fisher many other algorithmic approaches have been proposed. The Vehicle Routing Problem is still a fertile field of research as Toth and Vigo (2002) show. The various approaches can be roughly classified in two groups:
- Cluster first and route after
- Allocate and route the vehicles simultaneously

One of the better known heuristics of the first group is the Fisher and Jaikumar heuristic (Fisher, 1995), in which customers are first clustered and assigned to vehicles and then a sequence of routes for each vehicle visiting customers in each cluster are defined. Figure 6.3 depicts an example.

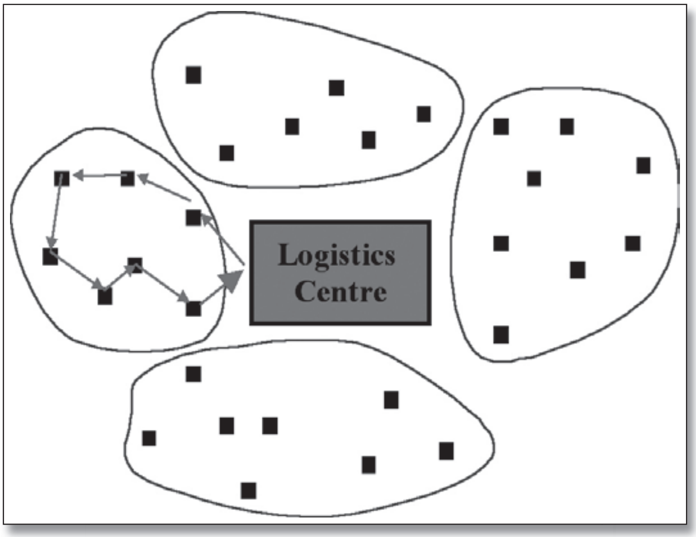

Figure 6.3: **Example of cluster first and sequence routes after**

Customers are first clustered and each cluster is assigned to a vehicle and a route for visiting customers in a specific order is determined for each cluster.

The Fisher and Jaikumar heuristic:
1. Solves a Generalized Assignment Problem approximation of the VRP to determine an assignment of customers to vehicles.
2. Sequences the visits of each vehicle to the assigned customers solving a Travelling Salesman Problem (TSP) in the cluster.

The VRP can be formulated in terms of the following non-linear assignment problem:

Let y_{ik} be

$$y_{ik} = \begin{cases} 1, \text{ if customer i is visited by vehicle k} \\ 0, \text{ otherwise} \end{cases} \qquad y_{ik} = \left(y_{0k}, y_{1k}, \ldots, y_{nk}\right)$$

$$\text{MIN} \sum_k f(y_k) \qquad (6.21)$$

s.t.

$$\sum_i a_i y_{ik} \le b, \quad k = 1, \quad ,K \qquad (6.22) \qquad \text{(GA-1)}$$

$$\sum_k y_{ik} = \begin{cases} K, & i = 0 \\ 1, & i = 1, \quad ,n \end{cases} \qquad (6.23)$$

$$y_{ik} = \{0,1\}, \quad i = 0, \quad ,n, \; k = 1, \quad ,K \qquad (6.24)$$

where $f(y_k)$ is the cost of an optimal Travelling Salesman Tour of the points:

$$N(y_k)=\{i \in N \mid y_{ik}=1\}$$

The exact value of $f(y_k)$ would be given by the solution to the problem:

$$f(y_k) = \text{MIN} \sum_{i,j} c_{ij} x_{ijk} \qquad (6.25)$$

$$\text{s.t.} \qquad \sum_i x_{ijk} = y_{jk} \qquad j = 0, 1, \ldots, n \qquad (6.26)$$

$$\sum_j x_{ijk} = y_{ik} \qquad i = 0, 1, \ldots, n \qquad (6.27)$$

$$\sum_{i,j \in S} x_{ijk} \le |S| - 1 \qquad S \subseteq N\left(y_k\right), \; 2 \le |S| \le n \qquad (6.28)$$

$$x_{ijk} \in \{0,1\} \qquad i,j = 0, 1, \ldots, n \qquad (6.29)$$

which is a hard problem (namely taking into account that it could be an exponential number of constraints (6.28)). To overcome this difficulty the heuristics of Fisher and Jaikumar propose to replace $f(y_k)$ by the linear approximation $\sum_i d_{ik} y_{ik}$, problem (GA-1) then becomes:

$$\text{MIN} \sum_k \sum_i d_{ik} y_{ik} \quad (6.30)$$

s.t.

$$\sum_i a_i y_{ik} \le b, \quad k = 1, \ \ ,K \quad (6.22) \qquad \text{(GA-2)}$$

$$\sum_k y_{ik} = \begin{cases} K, & i = 0 \\ 1, & i = 1, \ \ ,n \end{cases} \quad (6.23)$$

$$y_{ik} = \{0,1\}, \quad i = 0, \ \ ,n, k = 1, \ \ ,K \quad (6.24)$$

The coefficients dik of the linear approximation are estimated by the following heuristic procedure:

1. Specify K "seed" customers, i_1, …, i_K, that are assigned one to each vehicle. The quality of the "seed" strongly affects the quality of the solution, and therefore various procedures to specify this seed have been proposed (see Fisher, 1995, for details).
2. Assume customer i_k is assigned to vehicle k, k = 1, …, K, then set coefficient dik to the cost of inserting customer i into the route on which vehicle k travels from the depot to customer i_k and back: $d_{ik} = c_{0i} + c_{ii_k} - c_{oi_k}$

The solution to (GA-2) provides the assignment of customers to vehicles in terms of y_k, a TSP problem is then solved to determine the optimal route of each vehicle to visit its customers. A state-of-the-art for TSP problems can be found in Lawler *et al.* (1995); Reinelt (1994); Gutin and Punnen (2002).

A drawback of this approach in the context of City Logistics, as pointed out above, is the assumption on the symmetry of the costs $c_{ij}=c_{ji}$. A more realistic approach for City Logistics applications would be to obtain travel distances by applying a shortest route algorithm to a computerized model of the road network system, namely when travel times become the relevant data instead of distances.

A similar approach to that proposed for Network Location Problems could be used here, but then, as Figure 6.4 illustrates the costs are no longer symmetric, that is costs are now asymmetric $c_{ij} \neq c_{ji}$. In the example shown in Figure 6.4 the digital map of a part of the city of Barcelona is depicted. To travel from node A , to node B , the shortest time travel path is highlighted in grey, while to travel from B to A under the same conditions the vehicle should follow the green route, sections in black correspond to the links were the two routes overlap.

This is due to the fact that in an urban environment routes using the streets have to account for one way streets, issues related to penalties at intersections, signalized as well as unsignalized, banned turning movements and/or U-turns, etc. This is the reason why some authors make a distinction between Routing Problems and Street Routing Problems (see Bodin *et al.*, 1993, 1999; Golden *et al.*, 2002). Consequently we shall

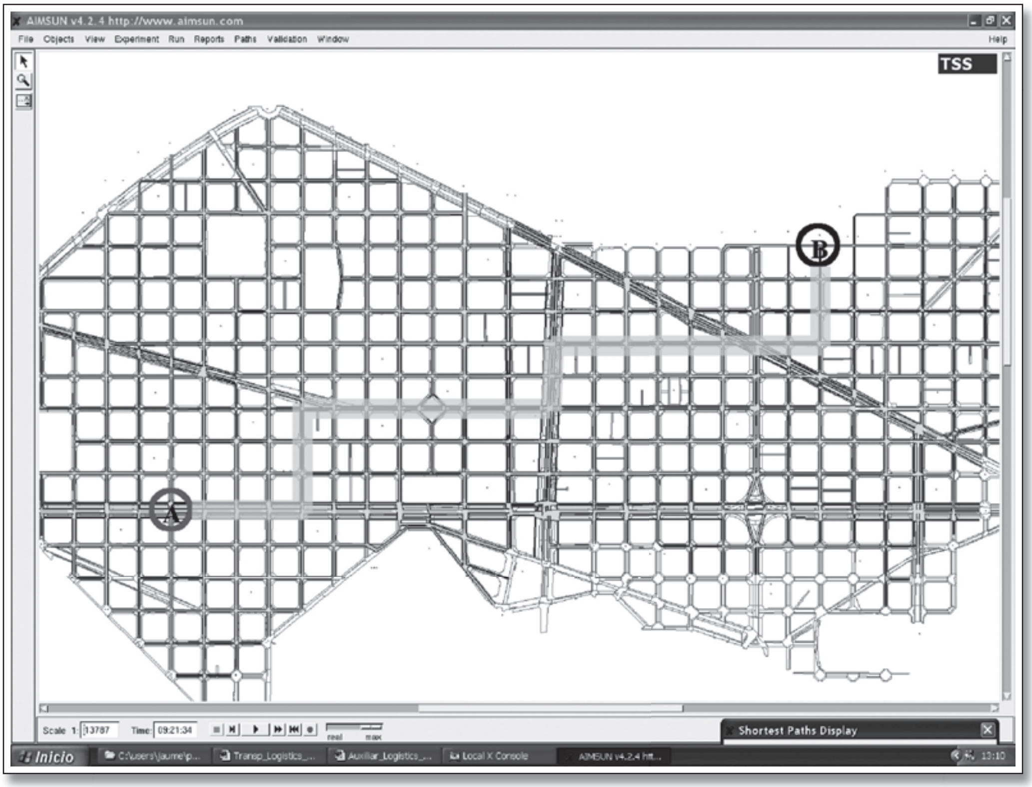

Figure 6.4: **Asymmetry of the travel costs in a urban network**

draw our attention towards the models that deal explicitly with the asymmetry in the travel costs, as the most appropriate for urban routing problems.

An Overview on Asymmetric Capacitated Vehicle Routing Problems (ACVRP)

Toth and Vigo (2002) classify the formulation of these problems in vehicle flow and commodity flow models. A typical integer programming formulation for the ACVRP is based on a two-index flow model that uses binary variables x to indicate if a vehicle traverses an arc in the optimal solution:

$$x_{ij} = \begin{cases} 1 & \text{if arc } (i,j) \in A \text{ belongs to the optimal solution} \\ 0 & \text{otherwise} \end{cases}$$

The ACVRP consist of finding a collection of K simple circuits, one for each vehicle, servicing the customers in such way that each customer is serviced by exactly one vehicle and the total cost is minimum. According to Toth and Vigo (2002) the two index flow ACVRP model is:

$$\text{MIN}\sum_{i\in N}\sum_{j\in N}c_{ij}x_{ij} \tag{6.31}$$

$$\text{s.t.}\quad \sum_{i\in N}x_{ij}=1 \qquad \forall j\in N\text{-}\{0\} \tag{6.32}$$

$$\sum_{j\in N}x_{ij}=1 \qquad \forall i\in N\text{-}\{0\} \tag{6.33}$$

$$\sum_{i\in N}x_{i0}=K \tag{6.34}$$

$$\sum_{j\in N}x_{oj}=K \tag{6.35}$$

$$\sum_{i\notin S}\sum_{j\in S}x_{ij}\geq r(S) \qquad \forall S\subseteq N\text{-}\{0\},S\neq\varnothing \tag{6.36}$$

$$x_{ij}\in\{0,1\} \qquad \forall i,j\in N \tag{6.37}$$

Where in-degree and out-degree constraints (6.32) and (6.33) impose that exactly one arc enters and leaves each vertex associated with a customer. Constraints (6.34) and (6.35) impose that K vehicles arrive and leave the depot at vertex 0. The capacity cut constraints (6.36) play a twofold role imposing both the connectivity and vehicle capacity requirements.

They impose that each cut (N-S, S) defined by a customer set S is crossed by a number of arcs that cannot be smaller that the minimum number of vehicles r(S) needed to serve customers in S. Assuming that the K vehicles are identical, each with capacity b, and that each customer has a demand $a_i \leq b$, then the demand d(S) of customer in set S is $d(S)=\sum_{i\in S}a_i$ then r(S) in constraints (6.36) can be replaced by the trivial lower bound $\left\lceil \frac{d(S)}{b} \right\rceil$. Alternative formulation can be found transforming (6.36) by means of the degree constraints (6.32) and (6.33) into generalized sub-tour elimination constraints:

$$\sum_{i\in S}\sum_{j\in S}x_{ij}\leq |S|-r(S) \qquad \forall S\subseteq N\text{-}\{0\},S\neq\varnothing \tag{6.38}$$

which impose that at least r(S) arcs leave the customer set S. The main difficulty with constraints (6.36) or its alternates (6.38) is that they have a cardinality growing exponentially with n, this has led some authors to propose alternative formulations of polynomial cardinality considering the sub-tour elimination constraints proposed for the TSP (for details see Toth and Vigo, 2002):

$$u_i-u_j+bx_{ij}\leq b-a_j \qquad \forall i,j\in N\text{-}\{0\},i\neq j,\ \text{such that}\ a_i+a_j\leq b \tag{6.39}$$

$$a_i\leq u_i\leq b \qquad \forall i\in N\text{-}\{0\} \tag{6.40}$$

where u_i is an additional continuous variable whose value represents the load of the vehicle after visiting customer i, these constraints also impose the capacity and the connectivity requirements for ACVRP. When $x_{ij}=1$ they impose that $u_j \geq u_i+a_j$ that also eliminates isolated sub-tours.

A way to partially overcome some of the drawbacks associated with the two-index models is to explicitly identify the vehicle that traverses an arc including in this way additional constraints on the routes.

This formulation uses binary variables x_{ijk} counting whether vehicle k traverses arc $(i, j) \in A$ in the optimal solution and additional binary variables y_{ik} to identify whether customer i is served by vehicle k in the optimal solution ($y_{ik}=1$) or not ($y_{ik}=0$). The alternative model is now:

$$\text{MIN} \sum_{i \in N} \sum_{j \in N} c_{ij} \sum_{k=1}^{K} x_{ijk} \tag{6.41}$$

$$\text{s.t.} \qquad \sum_{k=1}^{K} y_{ik} = 1, \qquad \forall i \in N\text{-}\{0\} \tag{6.42}$$

$$\sum_{k=1}^{K} y_{0k} = K \tag{6.43}$$

$$\sum_{j \in N} x_{ijk} = \sum_{j \in N} x_{jik} = y_{ik}, \quad \forall i \in N, k = 1,2,\ldots,K \tag{6.44}$$

$$\sum_{i \in N} a_i y_{ik} \leq b, \qquad k = 1,\ldots\ldots,K \tag{6.45}$$

$$\sum_{i \in S} \sum_{j \notin S} x_{ijk} \geq y_{hk} \qquad \forall S \subseteq N\text{-}\{0\}, h \in S, k = 1,\ldots.K \tag{6.46}$$

$$y_{ik} \in \{0,1\}, \qquad \forall i \in N,\ k = 1,\ldots.,K \tag{6.47}$$

$$x_{ijk} \in \{0,1\} \qquad \forall i,j \in N,\ k = 1,\ldots\ldots,K \tag{6.48}$$

where constraints (6.42), (6.43), (6.44) imposed that the demand of each customer is served by only one vehicle, that K vehicles leave the depot and that the same vehicle enters and leaves a given demand node. Constraint (6.45) ensures the capacity of each vehicle is not violated, whereas constraint (6.46) imposes the connectivity of the route of vehicle k. As in the other model these constraints can be replaced by ad hoc sub-tour elimination constraints, and in particular the adapted formulation of (6.39), (6.49):

$$u_{ik} - u_{jk} + bx_{ijk} \leq b - a_j \quad \forall i,j \in N\text{-}\{0\}, i \neq j, \text{ such that } a_i + a_j \leq b,\ k = 1,\ldots.,K \tag{6.49}$$

$$a_i \leq u_{ik} \leq b \qquad \forall i \in N\text{-}\{0\},\ k = 1,\ldots K \tag{6.50}$$

A third alternative formulation based on modelling commodity flows has been proposed by Baldacci *et al.* (1999), according to Bodin *et al.* (1999); this is a formulation specially well suited for street routing problems, and therefore for City Logistics applications. According to Toth and Vigo (2002) the formulation requires an extended graph G'=(N', A') obtained from G by adding vertex n+1 which is a copy of the depot node. N':=N∪{n+1, …, n+K-1} contains K-1 additional copies of vertex 0, and the cost c'_{ij} of each arc in A' is defined as follows:

$$c'_{ij} = \begin{cases} c_{ij} & \text{for } i,j \in N\text{-}\{0\} \\ c_{i0} & \text{for } i \in N\text{-}\{0\}, j \in W \\ c_{oj} & \text{for } i \in W, j \in N\text{-}\{0\} \\ \lambda & \text{for } i,j \in W \end{cases}$$

where W:={0}∪{n+1, …., n+K-1} is the set of the K additional vertices of G' associated with the depot, and λ is a proper value.

Routes are now paths from vertex 0 to vertex n+1. Two non-negative flow variables, y_{ij} and y_{ji} are associated with each edge (i, j)∈A'. If a vehicle travels from i to j, then y_{ij} and y_{ji} give the vehicle load and the vehicle residual capacity, respectively, along the edge, i.e. y_{ji}=b- y_{ij}.

The roles are reversed if the vehicle travels from j to i. Therefore the equation $y_{ij}+y_{ji}=b$ holds for each edge (i, j)∈A'. For any route of a feasible solution, the flow variables define two directed paths, one from vertex 0 to n+1, whose variables represent the vehicle load, and another from n+1 to vertex 0, whose variables represent the residual capacity on the vehicle. The resulting model is formulated as follows:

$$\text{MIN} \sum_{(i,j)\in A'} c_{ij} x_{ij} \qquad (6.51)$$

$$\text{s.t.} \quad \sum_{j\in N'} \left(y_{ji} - y_{ij} \right) = 2a_i \qquad \forall i \in N'\text{-}\{0, n+1\} \qquad (6.52)$$

$$\sum_{j\in N'\text{-}\{0,n+1\}} y_{0j} = d(S), \qquad S = N'\text{-}\{0, n+1\} \qquad (6.53)$$

$$\sum_{j\in N'\text{-}\{0,n+1\}} y_{j0} = Kb - d(S) \qquad S = N'\text{-}\{0, n+1\} \qquad (6.54)$$

$$\sum_{j\in N'\text{-}\{0,n+1\}} y_{n+1,j} = Kb \qquad (6.55)$$

$$y_{ij} + y_{ji} = bx_{ij} \qquad \forall (i,j) \in A' \qquad (6.56)$$

$$\sum_{j\in N'} \left(x_{ij} + x_{ji} \right) = 2 \qquad \forall i \in N' - \{0, n+1\} \qquad (6.57)$$

$$y_{ij} \geq 0 \qquad \forall (i,j) \in A' \qquad (6.58)$$

$$x_{ij} \in \{0,1\} \qquad \forall (i,j) \in A' \qquad (6.59)$$

Conservation constraints (6.52) impose that the difference between the sum of the commodity flow variables associated with arcs entering and leaving each vertex i is equal to twice the demand of i. Constraints (6.53-6.55) impose the correct values for the commodity flow variables incident into the depot vertices. Constraints (6.56-6.57) impose the relation between vehicle flow and commodity flow variables and the vertex degree respectively, and constraints 6.58-6.59) are the non-negativity and integrality constraints respectively.

A wide variety of algorithms from exact based on branch and bound, branch and cut, lagrangean relaxations, to heuristics and specially metaheuristics based on genetic, tabu search, scatter search, simulated annealing or ant colonies, have been proposed for ACRP.

To conclude this summary overview of VRP models which could be of special interest in the context of City Logistics applications we should mention the Vehicle Routing Problem with Time Windows (VRPTW), an extension of CVRP where the service at each customer must start within an associated time window and the service has a duration.

As for the other models the problem is formulated on a graph, G=(N;A), where customers with known demands ai, i=1, …, n are located at the nodes, with the depot located at node 0, cij is the cost of travelling from node i to j. In the case of a City Logistics application we will assume that graph G corresponds to the street network, and travel costs to travel cost between nodes of the street network.

The Vehicle Routing Problem with Time Windows is a CVRP in which each customer i is associated a non-negative demand di, a non-negative service duration si and a time window [ai, bi] representing the earliest and latest time, respectively, at which the customer can be serviced. The VRPTW consists of assigning K vehicle routes on G such that:

i. Every route starts and ends at the depot
ii. Every customer belongs to exactly one route
iii. The total load and duration of route k do not exceed E_k and L_k respectively
iv. The service at customer i begins in the interval $[e_i, l_i]$, and every vehicle leaves the depot and returns to the depot in the interval $[e_0, l_0]$; and
v. The total travel time (cost) of all vehicles is minimized

A formulation of the (VRPTW) as a multi-commodity network flow model with time windows and capacity constraints, Toth and Vigo (2002), is the following:

$$\text{MIN} \sum_{k \in K} \sum_{(i,j) \in A} c_{ij} x_{ijk} \tag{6.60}$$

$$\text{s.t.} \quad \sum_{k \in K} \sum_{j \in \ {}^{+}(i)} x_{ijk} = 1, \qquad \forall i \in N \tag{6.61}$$

$$\sum_{j \in \ {}^{+}(0)} x_{0jk} = 1, \qquad \forall k \in K \tag{6.62}$$

$$\sum_{i \in \ {}^{-}(j)} x_{ijk} - \sum_{i \in \ {}^{+}(j)} x_{jik} = 0, \qquad \forall k \in K, j \in N, \tag{6.63}$$

$$\sum_{i \in \ {}^{-}(n+1)} x_{i,n+1,k} = 1, \qquad \forall k \in K \tag{6.64}$$

$$x_{ijk}\left(w_{ik} + s_i + t_{ij} - w_{jk}\right) \le 0, \qquad \forall k \in K, (i,j) \in A \tag{6.65}$$

$$e_i \sum_{j \in \ {}^{+}(i)} x_{ijk} \le w_{ik} \le l_i \sum_{j \in \ {}^{+}(i)} x_{ijk} \qquad \forall k \in K, i \in N \tag{6.66}$$

$$E \le w_{ik} \le L \qquad \forall k \in K, i \in \{0, n+1\} \tag{6.67}$$

$$\sum_{i \in N} d_i \sum_{j \in \ {}^{+}(i)} x_{ijk} \le b, \qquad \forall k \in K \tag{6.68}$$

$$x_{ijk} \in \{0,1\}, \qquad \forall k \in K, (i,j) \in A \tag{6.69}$$

The VRPTW is defined in network G=(V, A) where the depot is represented by the two nodes 0, and n+1. All feasible routes correspond to paths in G that start from node 0 and end at node n+1.

Nodes 0 and n+1 have associated a time window $[e_0, l_0]=[e_{n+1}, l_{n+1}]=[E, L]$ representing the earliest possible departure from the depot and the latest possible arrival to the depot respectively, and feasible solutions exist only if:

$$e_0 = E \le \underset{i \in V-\{0\}}{\text{MIN}}\left[l_i - t_{0i}\right] \ \text{ and } \ l_{n+1} = L \ge \underset{i \in V-\{0\}}{\text{MIN}}\left[e_i + s_i + t_{i0}\right] \tag{6.70}$$

An arc (i, j) ∈ A can be eliminated due to temporal considerations if $e_i+s_i+t_{ij}>l_j$, or to capacity limitations if $d_i+d_j>b$. The variable x_{ijk}, (i, j)∈A, k∈K, is equal to 1 if arc (i, j) is used by vehicle k, and 0 otherwise, and N=V\{0, n+1} is the set of customers.

In this model constraints (6.61) ensure that each customer is assigned to exactly one vehicle route; constraints (6.62) to (6.64) characterize the flow on the path of vehicle k and constraints (6.65), (6.67) and (6.68) ensure the feasibility in terms of time and capacity. For a given vehicle k constraints (6.66) force $w_{ik}=0$ whenever customer i is not visited by vehicle k, and time variables w_{ik}, i∈V, and k∈K specify the start of service at customer i by vehicle k.

This formulation allows lower bounds to be obtained from various relaxations to be used by exact algorithms. A typical case is the network lower bound obtained by relaxing time and capacity constraints (6.65) to (6.68), and solving the resulting network flow problem. Another example is the linear programming lower bound obtained by replacing constraints (6.65) by

$$w_{ik} + s_i + t_{ij} - w_{jk} \leq \left(1 - x_{ijk}\right) M_{ij} \quad \forall k \in K, (i, j) \in A \qquad (6.71)$$

where M_{ij} can be replaced by MAX{l_i+s_i+t_{ij}-e_j, 0}, ∀(i, j)∈A, but it needs only be enforced for arcs ∀(i, j)∈A such that M_{ij}>0 (otherwise the constraints are satisfied for all values of w_{ik}, w_{kj} and x_{ijk}) and constraints (6.69) by $x_{ijk} \geq 0$ ∀k∈K, (i, j)∈A, and solving the resulting linear programming problem.

Efficient algorithms based on metaheuristics exists for the VRPWT, Cordeau *et al.* (2001) based on a tabu search extension of a previous heuristic for the TSP with time windows (Gendreau *et al.*, 1998). For more general references see Toth and Vigo (2002). The unified tabu search heuristic for VRPTW proposed by Cordeau *et al.* (2001) is a local search meta-heuristic that explores the solution space by moving at each iteration from the current solution s to the best solution in its neighbourhood N(s), including anti-cycling rules to prevent deterioration of the solution. This allows exploration of infeasible solutions during the search and uses diversification mechanisms to help the search process to explore a broad portion of the solution space. A summary description of the heuristic is the following:

Let S denote the set of solutions that satisfy constraints (i) and (ii):

- A solution s∈S is a set of K routes such that every customer belongs to exactly one route
- This solution may violate:
  - The maximum load and duration constraints
  - The time windows constraints associated with the customers and the depot
    The time window constraint at customer i is violated if the arrival time ai of the vehicle is larger than the time window upper bound li
    Arrival before ei is allowed and the vehicle then has to wait the time wi=ei-ai
- For a solution s∈S let
  - c(s) be the total travel time (cost) of route s
  - q(s) be the total violation of load
  - d(s) be the total violation of the duration constraints
  - w(s) be the total violation of the time windows constraints
- Solutions are evaluated using an objective function

  $$f(s) = c(s) + \alpha\, q(s) + \beta\, d(s) + \gamma\, w(s)$$

  where α, β and γ are positive parameters whose values are dynamically adjusted to facilitate the exploration of the search space.
- With each solution s∈S an attribute set is associated
  B(s) = {(i, k): customer i is visited by vehicle k}

- The neighbourhood N(s) of a solution s is defined by applying a simple operator that removes an attribute (i, k) from B(s) and replaces it with an attribute (i, k'), where $k \neq k'$.
- When customer i is removed from route k, the route is simply reconnected by linking the predecessor and successor vertices
- Insertion in route k' is performed between two consecutive vertices so as to minimize the value of f(s).
- When customer i is removed from route k, its reinsertion in that route is forbidden for the next θ iterations by assigning a tabu status to the attribute (i, k)
- The tabu status can be revoked if that would allow the search process to reach a solution of smaller cost than that of the best solution identified having that attribute.
- To diversify the search, any solution $\bar{s} \in N(s)$ such that $f(\bar{s}) \geq f(s)$ is penalized by a factor that is proportional to the addition frequency of its attributes and a scaling factor:

$$p(\bar{s}) = \lambda c(\bar{s})\sqrt{nK} \sum_{(i,k)\in B(\bar{s})} \rho_{ik} \qquad (6.72)$$

  where ρ_{ik} counts the number of times attribute (i, k) has been added to the solution during the search process. The scaling factor $c(\bar{s})\sqrt{nK}$ introduces a correction to adjust the penalties with respect to the solution cost and the size of the problem in terms of the upper bound on the number of possible attributes. The parameter λ controls the intensity of the diversification.

The heuristic has two main components: a constructive phase that constructs at most K routes as follows:

1. Randomly choose a customer $j \in \{1, \ldots, n\}$
2. Set k:=1
3. Using the sequence of customers j, j+1, …, n, 1, …, j-1, perform the following steps for every customer i:
   i. If the insertion of customer i into route k would result in the violation of load or duration constraints, set k:=MIN{k+1, K}
   ii. Insert customer i into route k so as to minimize the increase in the total travel time (cost) of route k

Taking into account that the insertion of customer i can only be performed between successive customers j_1 and j_2 if $e_{j_1} \leq e_i \leq e_{j_2}$, otherwise customer i is inserted at the end of the route. At the end of the procedure routes 1, …, K-1 satisfy load and duration constraints, and route K may violate any of the three types of constraints.

And an improvement phase, in which the tabu search starts from the solution of the construction phase and chooses at each iteration the best non-tabu solution in N(s), and after each iteration modifies the values of parameters α, β and γ accordingly. This process is repeated for η iterations and the best feasible solution s* identified during the search is post-optimized by applying to each individual route a specialized heuristic for the Travelling Salesman with Time Windows

Procedure:

1. Set α:=1, β:=1 and γ:=1
   If s is feasible set s*:=s and c(s*) = c(s)
   Otherwise set c(s*) = ∞
2. For κ = 1, …, η, do
   a. Choose a solution $\bar{s} \in N(s)$ that minimizes $f(\bar{s})+p(\bar{s})$ and is not tabu or satisfies its aspiration criteria
   b. If solution $\bar{s}$ is feasible, and $c(\bar{s})<c(s^*)$, set $s^* := \bar{s}$, and $c(s^*) := c(\bar{s})$
   c. Compute $q(\bar{s}), d(\bar{s})$ and $w(\bar{s})$ and update α, β and γ accordingly
   d. Set $s := \bar{s}$
3. Apply post-optimization heuristic to each route of s*

6.5 City Logistics and ICT

The advent of ICT adds a new dimension to City Logistics applications, namely with respect to information systems and e-commerce which appear to offer great potential. Nevertheless one must take into account that:

- The changes implied by e-commerce (B2B, B2C) on City Logistics may or may not contribute to alleviating traffic congestion and improve environment
- Organizational changes arise from the concentration of logistics centres in Public Logistic terminals whose location will require the use of the appropriate models. In other words realistic Network Location models become even more necessary.
- From the operational point of view models for routing and scheduling vehicles, etc., should be available. Vehicle Routing and Scheduling provide the core techniques for modelling City Logistics, as described in the previous section but, two cases of particular relevance to ICT applications are:
  - When customers specify a time-window to be visited by the pick-up/delivery trucks
  - When the vehicle routing and scheduling has to be dynamic based on real-time information. The information changes whilst vehicles are distributing goods and a sequential updating of routes should occur when new information is received. The types of real-time information could be:
    - On system performance: Travel time (congestion, incidents and breakdowns), Service times, Waiting times
    - On customer demand: Location, Time window, Amount of goods, Priority
    - About the vehicle: Location, Load status

Therefore models to account for this new dimension of City Logistics must be models that not only include the main components of City Logistics applications but

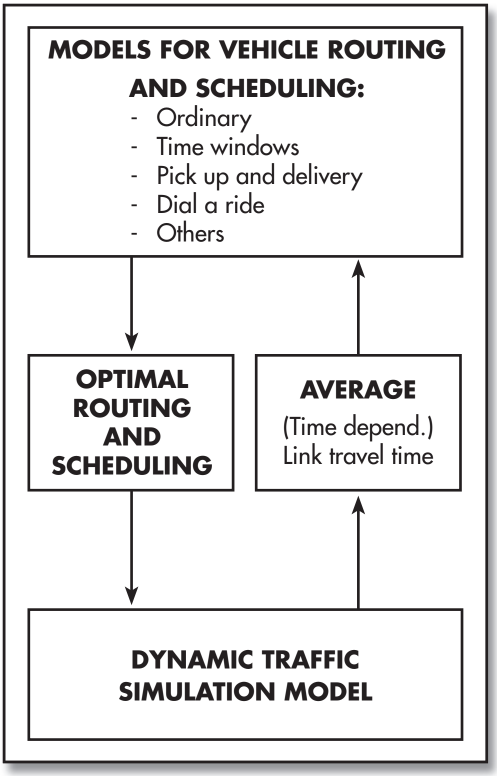

Figure 6.5: **Conceptual diagram of an integrated "Routing-Simulation "approach for modelling "City Logistics" schemes in the presence of ICT**

should also be able to include the dynamic aspects required to model ICT applications. Methodological proposals of this type have been formulated by Taniguchi *et al.* (2001), Taniguchi *et al.* (2000), and Kohler (1997).Figure 6.5 summarizes the conceptual scheme of the methodology proposed by Taniguchi. The dynamic traffic simulation models emulate the actual traffic conditions providing at each time interval the estimates of the current travel times, queues, etc. on each link of the road network. This will be the information used by the logistics model (i.e. a fleet management system identifying in real-time the positions of each vehicle in the fleet) and its operational conditions – type of load, available capacity, etc. – determines the optimal routing and scheduling of the vehicle.

A further step is the case of dynamic fleet management systems in which carrier fleet operators should be able to respond to changes in demand, driver and vehicle availability while also taking into account the time changes in traffic network conditions. These systems are essential to take advantage of real-time information made possible by technological advances in location, communication and geographic information systems. To properly model this new dimension brought to City Logistics by ICT dynamic simulation models become a key component of the system. As Reagan *et al.* (1998) point out such conditions can be represented effectively in a computer simulation modelling framework, which provides the requisite flexibility of strategy representation and complex process emulation for the evaluation of dynamic fleet management systems. The proposed approach, Reagan *et al.* (1997), is complementary to that of Taniguchi and includes an approach for generating a set of initial vehicle assignments that would take known and predicted future demands into account and incorporate strategies for reacting to changes as they occur. The conceptual scheme of the modelling framework, adapted from the one proposed in Reagan *et al.* (1997), is depicted in Figure 6.6.

In both approaches the core models for the evaluation of a generic City Logistics application, as well as for the evaluation of real-time fleet management applications, are

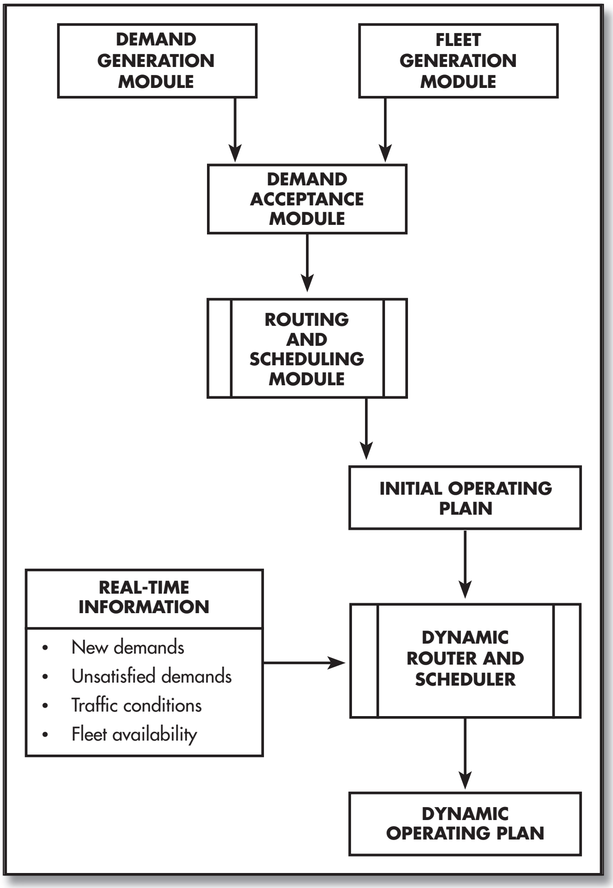

Figure 6.6: **Conceptual scheme for the evaluation of real-time fleet management systems**

Vehicle Routing Models able to interact with dynamic simulation models. This raises the question of which is the most appropriate simulation approach for these applications. Our proposal is that for City Logistics applications dealing with goods distribution in urban areas, involving a fleet management aspect based on the ability of a real-time tracking and dispatching of the vehicles, the simulation models should be of a microscopic type to allow the tracking of the individual vehicles. The evaluation platform should then integrate the vehicular traffic simulation with the models for vehicle routing and scheduling, as depicted in the conceptual diagram in Figure 6.6, which in the case of the real-time fleet management applications would became one of the components of the dynamic router and scheduler.

The simulator that we propose is AIMSUN (Advanced Interactive Microscopic Simulator for Urban and Non-Urban Networks), a well proven traffic simulator implementing a microscopic simulation approach based on emulating individual vehicles according to sophisticated car-following, lane-changing, gap acceptance and other behavioural models which have been calibrated in a wide variety of circumstances. AIMSUN can capture in great detail the time variability of traffic conditions accepting as input time sliced Origin/Destination trip matrices. At each time slice the corresponding number of vehicles start their trip from their origins to their destinations along the available paths on the network. The paths can be fixed or traffic condition dependent, and thus recomputed, according to a variety of user controlled design factors. At each time slice vehicles are assigned to the available paths according to route choice models. AIMSUN can also account in a very detailed way for junction modelling and the control logic governing the traffic lights at junctions, fixed control plans as well as adaptive real-time control, or pre-emptive signals giving priority to public transport.

AIMSUN distinguishes between vehicle classes, and vehicle types within each class; time sliced Origin/Destination matrices can be defined by vehicle types provided such detailed information is available. The routes, fixed or time dependent, and the route choice models can also be vehicle type dependent. Two extreme examples could be the public transport vehicles and the dynamically guided vehicles. Public transport vehicles travel along fixed routes (bus lines) on the network, according to an Origin/Destination matrix defined according to the bus schedules for each line, and stopping at bus stops for variable amounts of time depending on the public transport demand. Dynamically guided vehicles can be allowed to dynamically change the route en route according to the available information.

Being based on emulating the movement of individual vehicles through the network a natural function of a proper traffic microscopic simulator is that of tracking individual vehicles, emulating in this way the monitoring of fleet vehicles in a real-time fleet management system. Figure 6.7 depicts an example of following a vehicle during the simulation and gathering dynamic data (i.e. current position, previous position, current speed, previous speed, etc.) while following the vehicle, in a similar way as the data that in real life an equipped vehicle could provide.

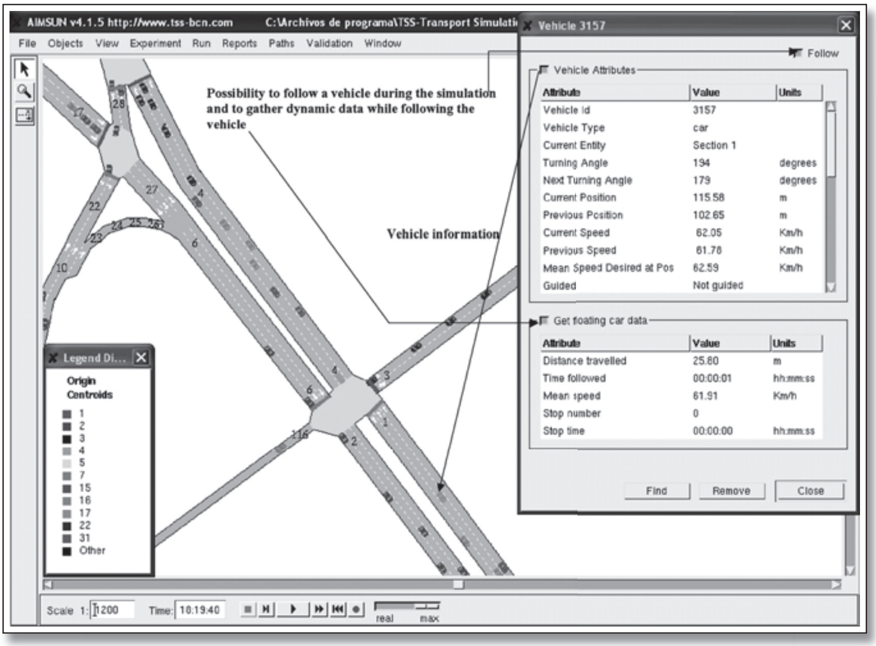

Figure 6.7: **Emulating the monitoring of an equipped vehicle in microscopic traffic simulation**

Figure 6.8 depicts an example of how the conceptual process described in Figure 6.6 could be simulated on the basis of the proposed microscopic simulation approach. The various lines identify the initially assigned routes to a set of 5 vehicles and the order in which customers will be served according to the initial schedule. At time t after the trips have started a new customer calls for an unscheduled service. The simulation process emulates the real-time vehicle monitoring and therefore the positions and availabilities of the fleet vehicles are known. This is the information required by the "Dynamic Router and Scheduler" in the logic diagram in Figure 6.6, to determine which vehicle will be assigned to the new service (vehicles 1 and 2 would be the potential candidates in our example) and which will be the new route for the selected vehicle.

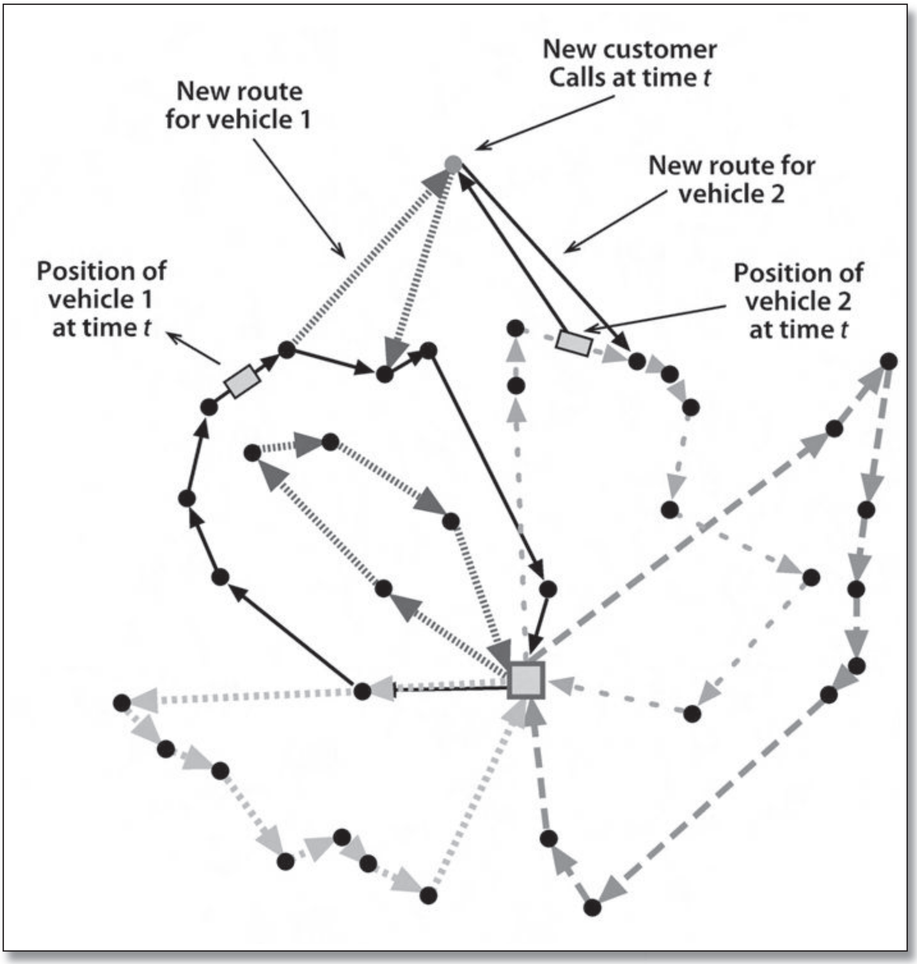

Figure 6.8: **Dynamic vehicle rerouting in a real-time fleet management**

6.6 Conceptual approach to a decision support system for the design and evaluation of city logistics applications

One of the tasks developed in the context of the MEROPE project of the INTERREG III Programme has been the proposal of a methodology for the evaluation of City Logistics applications and the development of a software system to implement such a methodology (see Chapter 12). The system has been conceived as a Decision Support System whose conceptual approach is based on the combination of an Operations Research approach and a Computer Science approach. This methodology has been based on the results of the SADERYL project, founded by the Spanish DGICYT. Methodologically Operations Research works with models that formally represent the systems on which the decision have to be made. Valid models of systems provide the support to answer "what if" questions on the intended system. The main models behind the what if questions that City Logistic Applications have to afford belong to the domain of the Operations Research (i.e. plan location problems to determine the optimal design of the Public Logistic Terminals – number of Public Transport Terminals to operate in a given city, sizes, etc - determination of the fleet sizes, routing and scheduling of the vehicles, and so on) therefore it is quite natural to adopt this point of view to address the design of the intended decision support system.

A key question for an efficient use of the Operations Research models concerns the computing environment into which they are embedded, and the friendliness to build the model and determine and apply which is the most appropriate algorithm to find the solutions to the model, solutions that will provide the answers to the what if questions. This means that it is not only a problem of an efficient computational implementation of the algorithm but also of implementing the algorithm as part of a software structure conceived as a Computer Decision Support System (Turban, 1993). The core architecture for the proposed system has been based on an adaptation of the conceptual structure proposed by Schrague and Watson (1986). This structure, depicted in Figure 6.9, consists of the following main components:

- A Data Base to store all the data required by the implied models: locations of logistics centres and customers, capacities of warehouses and depots, transportation costs, operational costs, fleet data, etc.
- A Data Base Management System for the updating of the information stored in the data base
- A Model Base containing the family of models and algorithms to solve the related problems, discrete location, network location, vehicle routing, scheduling, etc.
- A Model Base Management System to update, modify, add or delete models from the Model Base.

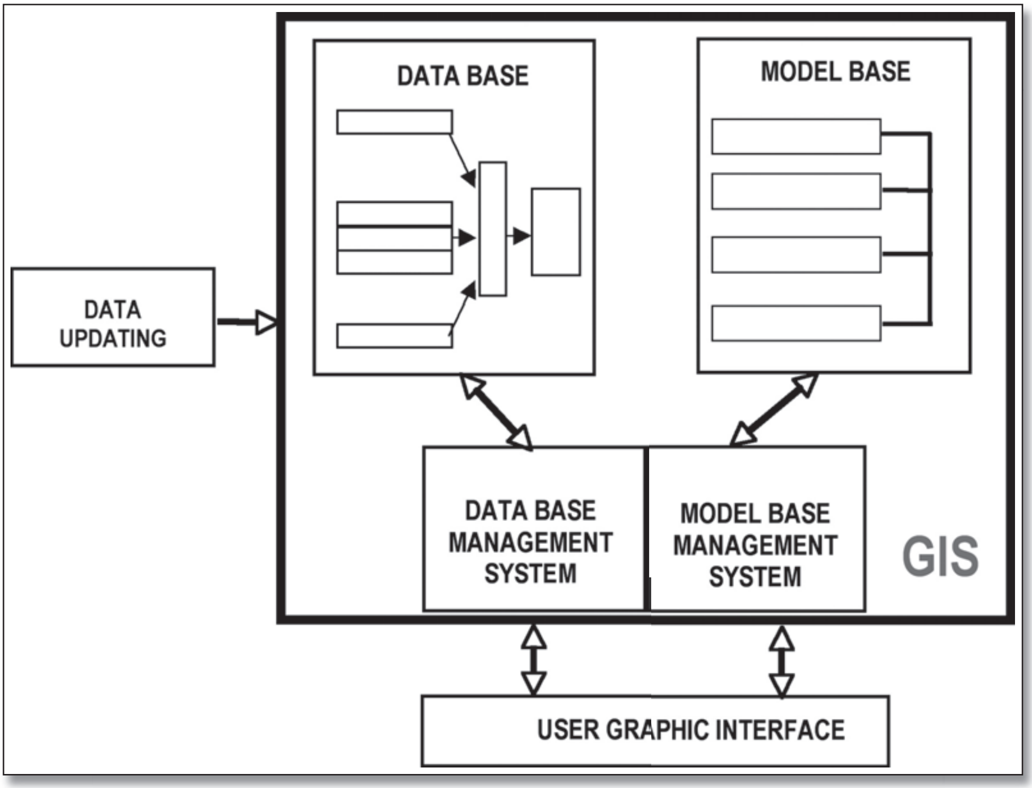

Figure 6.9: **Conceptual Structure of a Quantitative Decision Support System**

- A Graphic User Interface (GUI) supporting the windows-based dialogues to define and update data, select the model suited to the intended problem, apply the corresponding algorithm, visualize the problem and the results, etc.

Taking into account the nature of the problems addressed in a City Logistics Application, and their underlying geographic reality, it seems quite natural that the framework in which the GUI should be embedded is that of a Geographic Information System (GIS) or a software platform with the main GIS functions required to support transport applications. The integrated approach Routing-Simulation, proposed by Taniguchi *et al.* (2001) for the City Logistics Applications, as depicted in the conceptual diagram in Figure 6.5 and its adaptation to real-time fleet management depicted in Figure 6.6, implies that further to the traditional Operations Research models mentioned so far, other models are also necessary:

- Traffic Assignment models, like EMME/2, for example, INRO (1998), and

• Microscopic traffic simulation models, like AIMSUN[2].

The logics of the decision process supported by the software environment works as follows:

• To reproduce the underlying geographic reality as closely as possible the system imports digital maps (as dxf or bitmaps files, for instance), or shape files. As depicted in Figures 6.10 and 6.11 where an AUTOCAD file and shape file have been imported into the working area of the screen respectively.

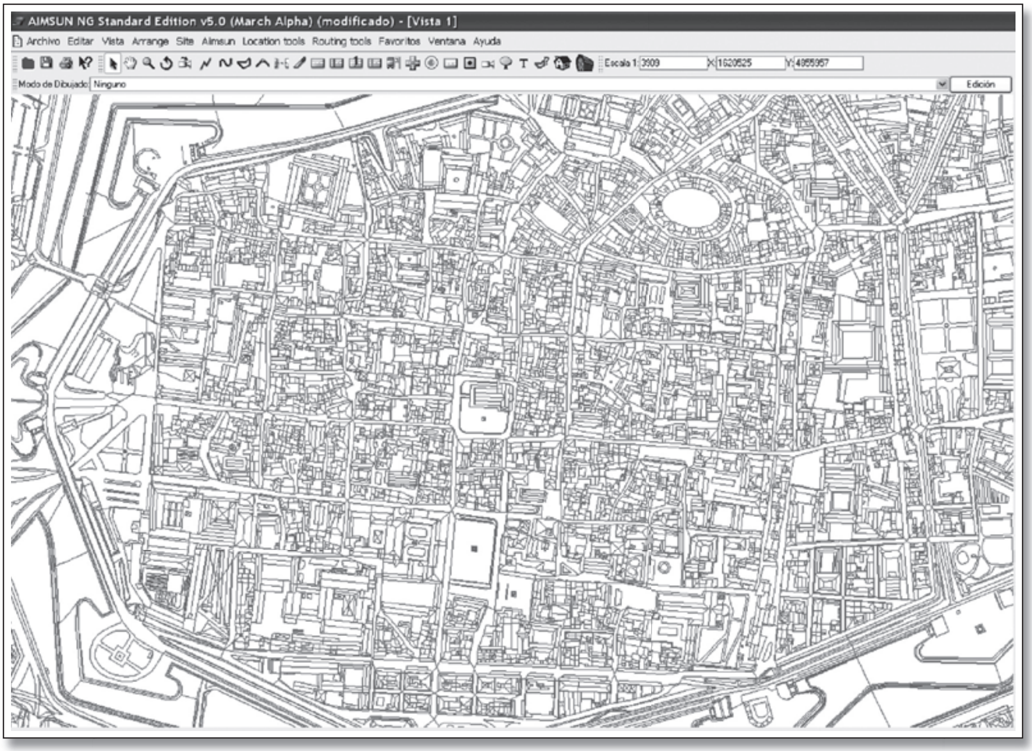

Figure 6.10: **Importing the digital map of a city as a.dwg file**

• The graph of the corresponding road map is automatically built. This is a requirement for the Network Location and Vehicle Routing models.
• On the top of the graph or the digital map the analyst opens a windows dialogue to define the type of model for the problem and input interactively the corresponding data.

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[2] SS – Transport Simulation Systems, GETRAM/AIMSUN, Version 4.2, User's Manuals, November 2003, http://www.aimsun.com.

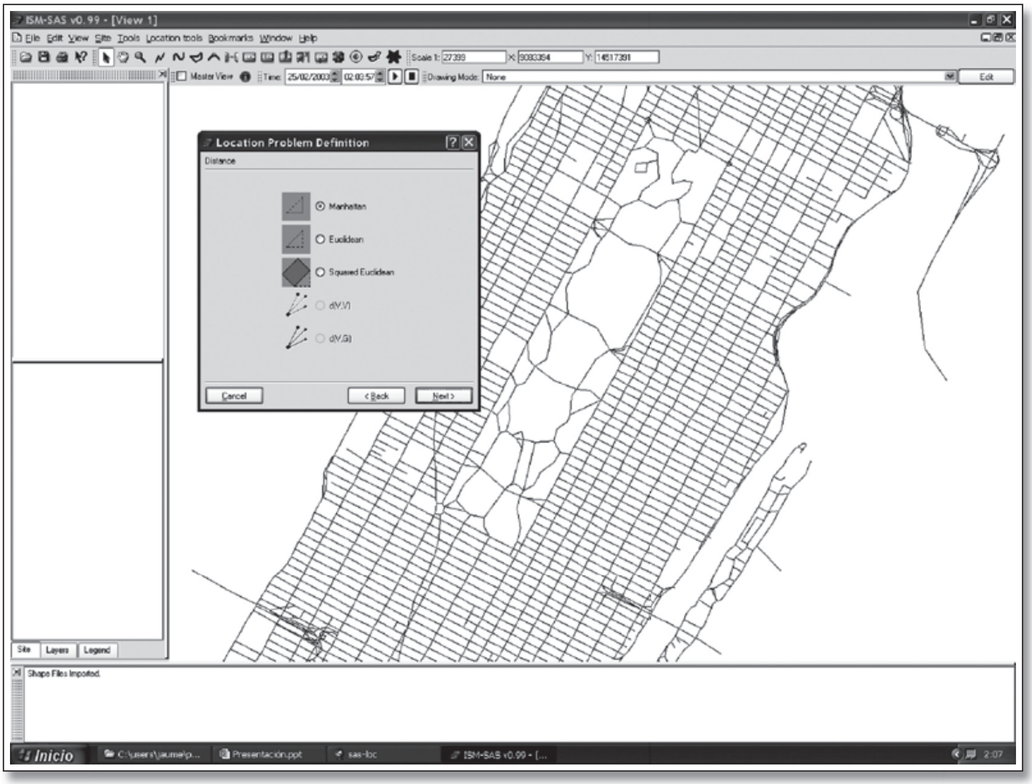

Figure 6.11: **Importing a shape file and defining a Plant Location Problem**

- Figure 6.11 also depicts the dialogue to define a plant location problem on the top of the imported shape file.
- Once the data model is defined the analyst selects the algorithm to solve the model, this is also done interactively through the corresponding windows dialogue.
- Once the solution is found it can be displayed graphically as shown in Figure 6.12.

In the case of the Vehicle Routing models combined with dynamic simulation the GUI has not only to be capable of visualizing how the customers have been clustered to be allocated to the vehicles, and which is the route assigned to a particular vehicle, but also to provide the way to analyse the paths used, get travel times, distances, etc. as depicted in Figure 6.13.

Acknowledgements

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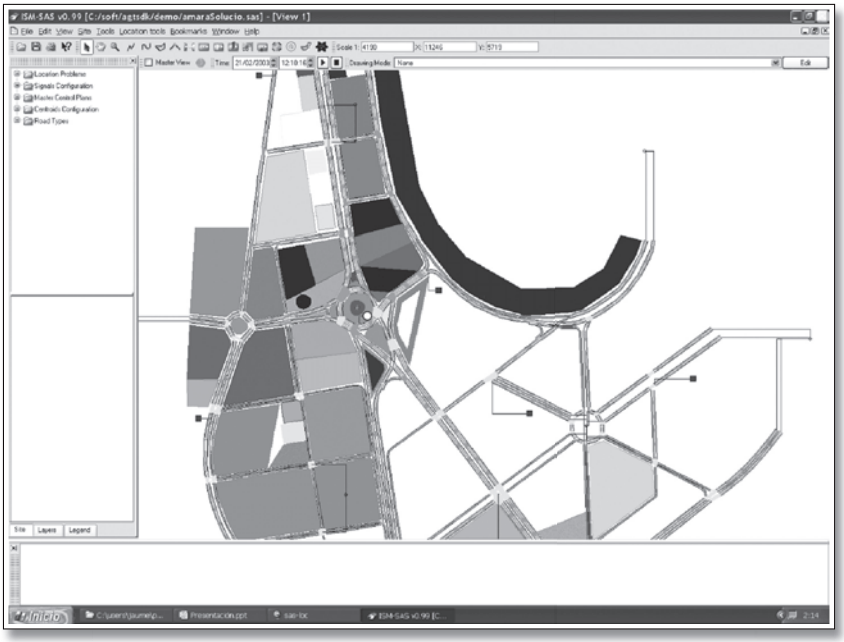

Figure 6.12: **Solution to the Urban Location of a Logistics Centre (in grey squares customers, in white circle logistic centre)**

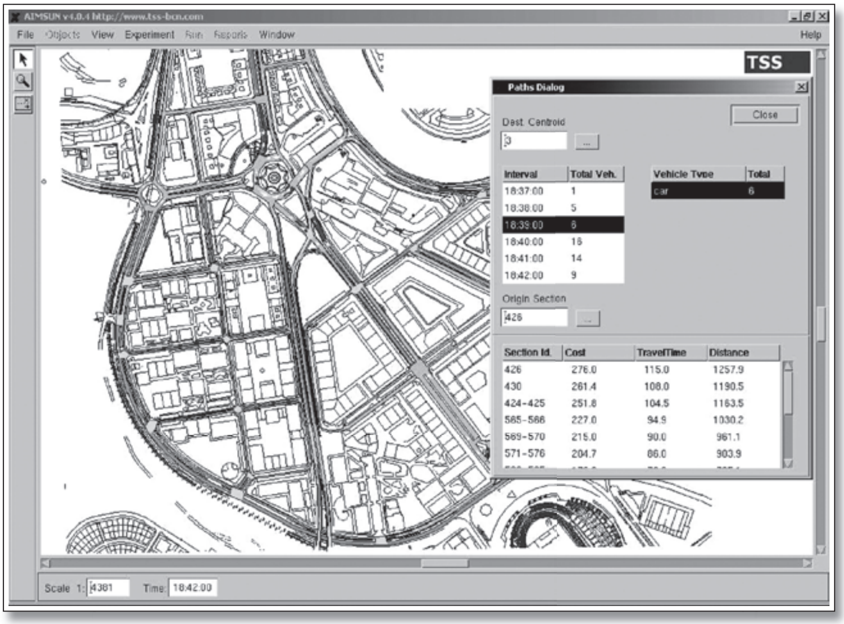

Figure 6.13: **Path analysis: path identification and related attributes (path length, travel time, path cost, etc.)** 125

CHAPTER 7

Evaluation Methodologies for Urban Logistics Schemes

G Zomer, D Nieuwkerk

7.1 Evaluation, assessment and validation

Assessment and validation is a key step in the development and implementation process of telematics applications. Any decision on the development or implementation of applications and services for urban logistics schemes, for instance: (a) whether the design or functionality of an application should be changed; or (b) whether and how an application (a system or a service) should be implemented, should be made on the basis of sound knowledge about the performance and impacts of the application.

What do we mean by the terms "assessment" and "validation"? Assessment is the process of determining the performance and/or impacts of a candidate application, usually in comparison to a reference case (existing situation or alternative applications), and usually including an experimental process based on real-life or other trials, often involving users. Validation is a term introduced within the European Commission's 4th Framework Programme and is the process of verifying that an application performs as expected, often based on assessment results.

In this sense, validation is usually considered as an extension to the assessment process. Nevertheless, validation has a more technical focus, while assessment also includes impact assessment on socio-economic aspects. Therefore we make a distinction between technical and non-technical validation. The complete assessment of both technical and non-technical aspects is called evaluation.

7.2 Overview of the assessment process

In accordance with the CONVERGE guidelines (CONVERGE, 1998), seven key stages have been identified which constitute a generic evaluation process:

1. Definition of User Needs
2. Zero State Analysis (Pre-Assessment of Expected Impacts)
3. Describing Applications
4. Defining Evaluation Objectives
5. Evaluation Methods
6. Data Analysis
7. Reporting Results

Each of these stages will be discussed separately.

7.2.1 Definition of User Needs

Obtaining a sound understanding of the requirements of users for urban logistics telematics applications is the essential first step in the evaluation process. Identification of user needs is essential for both system design and system assessment. For system design the question is, "How can the system/application be designed to best meet the users' needs?", while the system assessment asks, "Does the system as applied/tested perform as intended and meet the users' needs in practice?". User needs can be categorized based on the different stakeholders. User needs can also be categorized based on the type of impact that may be expected. A commonly used categorization for this kind of analysis is:

- Technical aspects
- Operational aspects
- Commercial aspects
- Socio-economic aspects

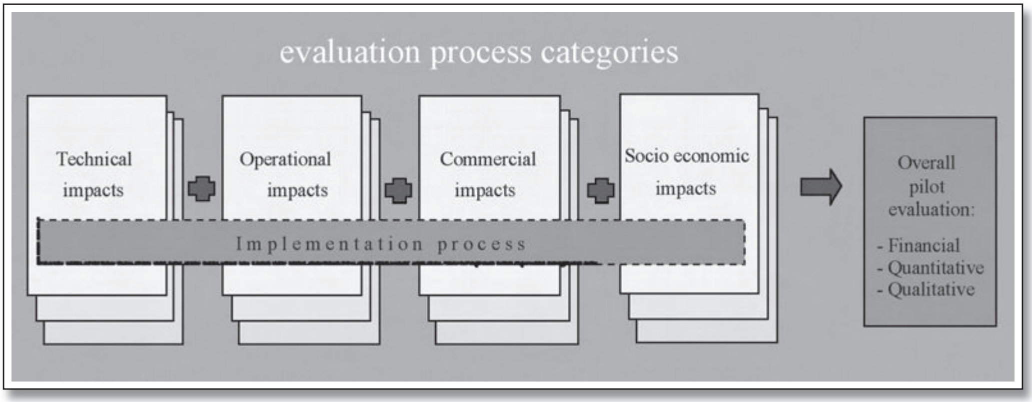

 Figure 7.1: **Categories in an evaluation process**

Sometimes a fifth category including political aspects can be added. This category not only reflects the attitude of policy makers but can also be useful in projects and types of applications that require enough support from the different stakeholders (see Figure 7.1).

A detailed description of user needs analysis has been presented in Chapter 2.

7.2.2 Zero State Analysis (Pre-Assessment of Expected Impacts)

In the evaluation process, before a study can assess the impacts of a telematics application it should first "pre-assess" those impacts on the main groups of users (or non-users) likely to be affected. In that way the impacts to be actually assessed or focused on can be determined.

Any project must have objectives, leading to intended impacts - those which the telematics application should produce. The assessment should verify these expected impacts. In fact, the project cannot be properly designed without a good idea of the nature and scale of likely impacts.

For example, if a reduction of travel time of 5% is likely, that would demand a certain measurement sample size in order to verify the expected impact. If the system would affect certain categories of users or non-users, this would suggest the groups to be targeted in any measurements or data collection.

Therefore it is necessary to identify system impacts expected in principle and assess their approximate magnitude and target groups before deciding which impacts should be assessed in the project. Where it is neither necessary nor reasonable to assess all possible system impacts such a process can help focus the evaluation activities on the most important issues. For this purpose, it is useful to prepare a table indicating the impacts expected and their magnitudes. The expected impacts can be either qualitative or quantitative.

7.2.3 Describing the applications

A precondition for an effective evaluation or validation plan must be a clear and concise description of the key characteristics of the urban logistics telematics applications to be validated. In many cases a project is carrying out assessment and validation activities at several sites, in different countries, and where various telematics applications will be validated. It is recommended that the project summarize the key characteristics of these applications in a table, including at least following information:

- application name or type;
- major technologies (e.g. GSM, GPRS, SOAP, .NET etc.) whose application is going to be validated;
- functionality or service offered; and
- verification and demonstration site.

7.2.4 The evaluation objectives

The identification and definition of assessment objectives primarily needs to be based upon the definition of user needs (stage 1 of the assessment process). What are the key questions to which the users, decision makers and other stakeholders concerned in the project must have answers? These questions comprise the requirement for information which should then be fed into the next stages of the assessment process.

Assessment objectives should correspond to the criteria for making judgements and choices. There is usually a hierarchy from a general to a more specific level. For instance, "improving mobility" leads to "improve transport efficiency", then to "reduce the frequency and severity of congestion". In that way, a set of assessment objectives can be defined against which the applications should be judged.

The assessment objectives are not necessarily the same as the application design objectives, those set by designers and manufacturers for developing the system. The assessment objectives should relate closely to the implementation and use of the application. For this reason, in many cases additional requirements must be taken into account. Although, for instance, a route guidance application may be developed to help drivers avoid congestion, the safety impacts or institutional aspects may also need to be assessed. Generally speaking, assessment objectives should incorporate all application design objectives, as well as those related to needs and requirements of public authorities, operators and end-users.

7.2.5 Evaluation methods

There are different types or categories of evaluation, under which more specific and similar types of evaluation objectives can be grouped. Examples of evaluation categories are:

- Technical assessment (system performance, reliability);
- Impact assessment (safety, environment, transport efficiency, user behaviour, modal split etc.);
- User acceptance assessment (users' opinions, preferences, willingness to pay);
- Socio-economic evaluation (benefits and costs of system implementation);
- Market assessment (demand and supply); and
- Financial assessment (initial and running costs, rate of return, payback period).

Different assessment categories may be inter-related: for instance, to perform a socio-economic evaluation requires the results of an impact assessment, while results of a user acceptance assessment would be an important input to a market assessment.

Moreover, it is necessary for any assessment to use experimental tools, e.g. field trials, user surveys, simulation and modelling, data collection and measurement of indicators. These different evaluation methods will be discussed in detail in Section 7.3.

7.2.6 Data analysis

The first step for the analysis of any variable is to examine the distribution of data values. This may follow a more statistical approach.

The following statistical techniques can be used in data analysis:

1. Techniques for interval data ('hard' measures)
   - T-tests: the 't' test is appropriate for comparing the mean values from two samples.
   - F-tests: the 'f' test is appropriate for comparing the mean values from more than two samples.
   - One-way analysis of variance: In 'one-way' analysis of variance only one factor which may define many groups) is considered.
   - Many-way analysis of variance: This technique is appropriate if there are several factors of interest, e.g. alternative transport telematics applications and also different times of day.
2. Techniques for categorical data ('soft' measures)
   - Chi-squared: The chi-squared test is appropriate for analysing count data.
   - Proportions: Sometimes the impact measure of interest is a proportion of occurrences, for example the proportion of transport operators who think that city access has serious limitations.
   - Log linear modelling: The technique of log-linear models is appropriate to analyze inter-relationships between categorical variables. In many respects it can be regarded as an extension to the chi-squared test, but with interaction terms specifiable and to include as many variables as required.
   - Meta-analysis: Meta-analysis generally refers to the statistical integration of the results from independent studies. Essentially it is the statistical analysis of the summary findings of many empirical studies. Meta-analysis is thus important where it is necessary to combine results from studies carried out at different sites and where different transport telematics applications have been trialled.

An important step in data analysis is the interpretation of results. For the results to be believable the basic assumptions underlying the analytical technique must not have been significantly violated. Perhaps the expected changes due to the transport telematics implementation have not been realised. Were there other changes during the study period that might have reduced the impact? Should other variables be checked for change, such as traffic flow rates, the weather, etc.? This is the time to check that the study design and analysis were not compromised, or confounded by other effects.

7.2.7 Reporting results

It is recognised that there will be different audiences for the assessment results. Whilst traffic managers and engineers require a detailed and technical presentation of all project results, the "end clients" who are usually not specialists in the field, require more of an overview of the key results. Results should be expressed in clear and simple language, all conditions or provisos important for their interpretation should be made transparent, and statistical analysis should be used to assess the significance of the results. Hence, it is recommended that the following structure is used for project validation results deliverable(s):

- Part I Key validation results at project level
- Part II Detailed validation results
- Part III Comparison of validation results across trials or sites

Part I should be a summary of Parts II and III.

7.3 Examples of evaluation methods

Each of the following evaluation methods has its particular characteristics, which makes the use of it worthwhile, depending on the focus[1].

7.3.1 Technical assessment

A technical assessment aims to determine how far a system meets technical requirements and expected objectives. It may be a process for comparing a candidate system with alternative(s). In this case, the purpose of a technical evaluation is to identify which solution can best achieve technical requirements and intended objectives. It would not, however, address the impacts of the system beyond its own boundaries.

Results of laboratory or field trials or other experiments may be used as input for a technical assessment. The results from a technical assessment may affect decisions on whether the system under consideration merits further assessment, e.g. impact assessment, market assessment or socio-economic evaluation.

7.3.2 Impact assessment

Impact assessment is the measurement or estimation of the impacts (effects) of an application, e.g. those on safety, environmental conditions or transport efficiency, for the particular target groups (drivers, system operators, society etc.) likely to be affected. This means determining how the indicators of assessment may have changed, which implies a comparison: either a "before-and-after" measurement, or a comparison between alternative(s).

An impact assessment may be based on the results of field trials, of other experiments, of calculations, e.g. modelling or simulation, and/or of a technical assessment. An impact assessment may provide input, for example, for a related socio-economic evaluation or may support the decision process directly.

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[1] Descriptions have been used from both the CONVERGE guidelines and the SURFF Validation and evaluation guidelines (SURFF, 1996).

7.3.3 User acceptance assessment

User acceptance assessment aims to estimate users' attitudes to and perception of application(s) investigated, usually based on questionnaire surveys, interviews, etc. Here the users may be the operators who implement and operate the systems, the people using the service, or the drivers who buy and use in-vehicle equipment for the service.

For drivers, the user acceptance is often estimated in terms of perceived benefits, e.g. improvement in safety, reduction of vehicle operating costs, saving in travel time, improvement in driving comfort, HMI friendliness, etc. "Willingness-to-pay" is of special interest to manufacturers of equipment or services to be purchased by individual travellers. Although difficult to assess when not based on real purchasing decisions, users' valuation of specific equipment or services can be estimated using specialized methods.

7.3.4 SWOT-analysis

SWOT-analysis is an evaluation methodology for strategic assessment, analyzing Strengths and Weaknesses (SW) of pilots and Opportunities and Threats (OT) that can affect their results. This analysis is mostly of a qualitative nature and will elaborate on the possible influence the new telematics applications could have on the total transport market and, ultimately, on the society as a whole.

7.3.5 Socio-economic evaluation

Socio-economic assessment aims to estimate the "social" gains or losses (the economic gains and losses for all members of society) as the result of implementing an application in comparison with the existing situation.

It is usually appropriate to use socio-economic assessment in the public sector, where a government authority is required to take into account not only the direct, perhaps financial costs and benefits of a scheme, but has to consider also the wider effects on the whole community, non-users included. Indeed, a form of socio-economic assessment is often a requirement for major public-sector schemes. However, there is no agreed framework for socio-economic assessment valid across Europe. In socio-economic assessment, time-savings are usually assigned a monetary equivalent through the "value of time".

Socio-economic assessment usually rests, therefore, on methods that mix actual measurements with calculations based on modelling or even assumption of certain key parameters. This can give an internal consistency to the process, so that a comparison of different alternatives may be reasonably reliable, but it makes a comparison with schemes or projects assessed using a different evaluation framework quite unreliable.

The evaluation of transport telematics applications is even more problematic than that of more conventional transport infrastructure. This is because the benefits often include increased traveller satisfaction or comfort, improved availability or quality of information, or reduced accident risk; benefits like these cannot easily be measured or quantified. Furthermore, there is often little evidence for the mechanism by which benefits are created from the application of telematics technologies.

Depending on the technical approach, there are two principal types of socio-economic evaluation methods: cost-benefit analysis and multi-criteria analysis. A third one is cost-effectiveness analysis.

Cost-benefit analysis

Cost-benefit analysis (CBA), developed from the basis of welfare theory, is used to estimate the ratio (or difference) of the benefits to the costs of an application. The analysis would consider a specific time horizon (e.g. 20 years) and spatial dimension (e.g. a motorway corridor or a city). Both benefits and costs incurred in future years should be "discounted" by an appropriate discount rate; future benefits are less certain than those of today, hence are attributed a lower value. Cost-benefit analysis uses money as the only unit of account. That means that both cost and benefit must be measured or converted into a monetary unit, e.g. Euros, to enable a direct comparison of costs and benefits related to a proposed implementation. Values for key indicators must be agreed as they affect directly the outcome of the analysis.

The relevant costs and impacts should be defined with respect to different target groups, e.g. system operators and drivers. Particular care should be taken to avoid double counting of a cost or benefit item or of neglecting to assess all items that may be significant.

Welfare approach		**Within geographic scope (EU or particular country)**				**Outside geographical scope**
		Priced effects		Non-priced effects		
Causal approach		Redistribution	Efficiency	Efficiency	Redistribution	
Direct	Operator	Operating profit		Uninsured risks		
Effects	Users	Cheaper transport		Travel time savings, safety		Travel time savings
	Third parties			Emissions, noise		Emissions
Indirect		Effects on other modalities		Congestion		Congestion
Effects		Strategic effects		Regional imparity		Exchange rate effects

Source: CPB/NEI, 2000, *Leidraad voor kosten-batenanalyse*, SDU, Den Haag

Table 7.1: **Typology of project effects**

Table 7.1 presents a typology of project effects. In general three types of effects are defined in a social-economic CBA:

1. Direct effects: the direct costs and revenues of the project. This includes both financial costs and benefits for users in the urban logistics and distribution world.

2. Indirect effects on non-users; this item includes aspects like redistribution or creation of employment and business activities that are started as a consequence of the project
3. External effects; these are environmental effects (noise nuisance, emissions) and social aspects (safety, congestion). As far as possible these effects have to be quantified in monetary terms. If this is not possible, they are usually included in CBA results as 'PM' and treated qualitatively in the underlying report.

Multi-criteria analysis

In contrast to cost-benefit analysis, multi-criteria analysis (MCA) can also deal with discretionary or intangible impacts that cannot reasonably be expressed in monetary units. Like cost-benefit analysis, MCA also aims to assess and evaluate the impacts of an application by comparing it with a reference case or with alternatives before a large-scale implementation of the application.

Different criteria included in a MCA can be combined to determine a single deciding value (as in cost-effectiveness analysis), or treated separately without aggregation (as in compatibility analysis). For each alternative the effectiveness should be determined and will be used, together with the respective cost determined, as the basis for making a decision on which alternative should be selected for implementation.

The main difference between a utility analysis and a cost-effectiveness analysis is that within a utility analysis the cost is determined as a negative effectiveness and thus for each alternative only a single utility value is determined. The utility value is used as the basis for comparison and final selection of the preferred application. The approach for a utility analysis in determining the effectiveness is the same as that for a cost-effectiveness analysis. The same precautions apply in MCA as for cost-benefit analysis.

Cost-effectiveness analysis

This methodology is used in the final stage of an evaluation in which all impact categories are used: those that can be directly expressed in monetary terms, as well as those that can only be indirectly expressed in monetary terms (e.g. through expert opinions), and purely qualitative impact categories.

Positive and negative monetary expressed impacts are weighted against the positive and negative non-monetary expressed results. Cost effectiveness analysis focuses on one particular direct effect, whereas cost-benefit analysis also includes indirect and external effects. Another difference is that costs and effectiveness are compared using a ratio (relative comparison), whereas cost-benefit analysis uses net present value of both costs and benefits (absolute comparison). Without the use of a proper evaluation process, all the efforts of the development, testing and demonstration of useful applications may be worthless, because the evaluation results have to convince other actors to disseminate and build further upon these ideas on a wider scale. The next chapter presents the evaluation of a wide variety of experiences with sustainable freight distribution from across Europe.

CHAPTER 8

Experiences and applications in Europe

M Boero, G Ambrosino

8.1 Introduction

This chapter presents results from the evaluation of a wide variety of experiences with sustainable freight distribution in urban areas from across Europe. Experience is documented in detail from sites in Italy, Denmark, Spain, The Netherlands, Portugal and the Czech Republic drawing from the results of high-profile EC-funded projects like eDRUL and MEROPE as well as many nationally funded projects. Overall, the experience tends to fall into two distinct categories, those that arise from a regulative or indirect policy framework (e.g. Copenhagen, Milan) and those that arise where a structural or direct policy framework is permitted (e.g. Leiden, Aalborg, Genoa or Siena). A summary of relevant experience (not restricted to the case-studies in this chapter) in terms of type of intervention, stakeholders involved and results is given in following tables.

Experiences promoting a regulative or indirect policy framework (1)			
City	**Type of intervention**	**Stakeholders involved**	**Results**
Amsterdam (NL)	Regulation of the access based on capacity, length, loading factor and emissions of the vehicle. In the city centre the access to the TLZ is forbidden to vehicles that are over 7,5 tonnes, larger than 9 metres, not Euro2 emission or with a loading factor less than 80% to be delivered or picked up. This regulation was introduced after a referendum that took place in 1993.	Municipality in collaboration with Chamber of Commerce and local haulers	50% of inhabitants have tested a decrease of the traffic congestion due to heavy vehicles 100% of interviewed hope to see a further application of access restriction in the city centre

Experiences promoting a regulative or indirect policy framework (1)			
City	**Type of intervention**	**Stakeholders involved**	**Results**
Copenhagen (DK)	Regulation of the loading/unloading areas based on the loading factor of the vehicles (60% of the capacity). In 2002 an experimental phase lasting 21 months was launched in which the mandatory scheme states that vehicles over than 2,5 tonnes should buy a certificate to be able to stop in the city centre	Municipality promoted an agreement with local transport and logistics operators, unions and the University in 1998	Participation of 80 companies for a total of 300 vehicles 86% of the haulers agreed on the introduction of the mandatory scheme Assigned about 4,000 certificates (180,000 Euro)

Table 8A: **Experience promoting a regulative or indirect policy framework (1)**

Experiences promoting a regulative or indirect policy framework (2)	
City	**Strategy**
Milan (IT)	No logistics platform for freight urban distribution has been installed. Release of permissions (paid or free) allows commercial vehicles to circulate and park in the restricted zones.

Table 8B: **Experience promoting a regulative or indirect policy framework (2)**

Experiences promoting a structural or direct policy framework			
City	**Type of intervention**	**Stakeholders involved**	**Objectives/Results**
Amsterdam (NL)	Regulation of the urban distribution through a system of permits and licenses, according to specific environmental standards and logistics efficiency. The pilot started in 1996: in the periphery 9 logistics platforms have been identified in existing platforms of the haulers who provide the "final mile" service.	Private initiative of the haulers in partnership with the Chamber of Commerce and the Municipality. Investment has been sustained by Municipality for the implementation of the project and for new traffic signs. The membership is optional.	The project aimed at handling 20% of the total amount of freight and to decrease the total number of vehicles entering the inner centre.

Experiences promoting a structural or direct policy framework			
City	**Type of intervention**	**Stakeholders involved**	**Objectives/Results**
Leiden (NL)	Municipality established an urban distribution system based on the release of permissions and linked to a Urban Distribution Centre (UDC). Access hours for freight distribution in the centre were different for the haulers who don't support the UDC.	The management company of UDC comprised the municipality, Mostert company (making available its own existing platform) and a former company controlled by Municipality with the task to provide the necessary manpower. The licensing issued by Municipality was a function of several criteria: vehicle load, number of deliveries per day, etc.	Initiative started in 1997 but was suspended in 2000 as no financial profitability was achieved and the haulers were against the policy of the Public Authority to create a monopoly in the urban goods distribution service.
Utrecht (NL)	Municipality established a system of urban distribution based on the release of permissions and the realisation of three distribution centres. Permissions are awarded to haulers matching conditions on load, number of deliveries per day and using the system. Access for haulers using the system was wider.	No public funding. The two companies that obtained the license have merged into a company.	Initiative started in 1994 and ended in 1996 because of the low number of companies passing their own deliveries on to the authorized company.
Malaga (SP)	The initiative was launched in 2002. The historical centre is almost included in pedestrian area and specific loading/uploading areas have been reserved.	Public funds are provided. The participation is voluntary.	In the future the logistics platform will carry out some added value services as: storage, packaging disposal, integration of IT tools for the receipt of the requests and the localisation of the vehicles.
Aalborg (DK)	Urban goods distribution centre carried out by different operators. Unified planning and information provided by the management company of the Centre.	Aalborg Municipality, NTC (Nordic TransportCentre Ltd.), ACO (Arctic Container Operation Ltd.), Danske Fragmaend (main freight transport operator in Denmark).	The information system on the distribution is underutilized.

Experiences promoting a structural or direct policy framework			
City	**Type of intervention**	**Stakeholders involved**	**Objectives/Results**
Genoa (IT)	The basic structure of MERCI project is the hub where freight are collected to be distributed with ecological (2 methane and 8 electrically propelled) vehicles. This hub is 1.5 Km apart from the motorway and 5 Km from the historical centre. The initiative started on March 2003 with the funding of Sustainable Environment Draft Plan by Italian Environment Ministry and of MEROPE EU project. The hub is built upon an area of 1,400 m 2,700 of which are roofed-over.Road pricing system is also active in Genoa. Cameras based on Telepass technology and covering the whole historical centre perimeter have been installed and a first demonstration phase involving 200 drivers was completed.	The manager company is Genoa-Eco Distribuzione Merci srl, joining together the Chamber of Commerce, Trade Unions and Genoa Municipality.	In a first pilot phase (March 2003 - June 2004), deliveries were made only in a limited area (25,000 m^2 that is 17% of the whole historical centre counting 328 retail points). In a second phase (from June 2003), deliveries were extended to the overall historical centre counting 2,000 retail points. In the pilot phase an average of 150 trips/month were carried out with an average of 5,000 items/ month delivered. In the second phase the amount of deliveries is expected to increase 5-6 times.
Siena (IT)	Creation of two logistics bases as part of the ALIFE project interventions (Ecommerce pilot project of the Ministry of Transport). The project started in 1999. The historical centre of Siena is completely TLZ and each street has an own weight limit for the access of vehicles.Municipality of Siena established a set of traffic restriction measures inside TLZ area based on the subdivision of goods category (from 6:00 to 10:00 and from 14:30 to 19:30 for pharmaceutical products and fresh groceries, from 6:00 to 10:00 and from 15:30 to 17:00 for other goods) and automatic access control system based on Telepass technology	Local Administration, public private partnership, transport operators and ENEA (Italian Energy Authority). A Ltd company of Logistics and Services was constituted to manage and coordinate different aspects related to service.	37% reduction of the freight vehicles travelling in the historical centre (from 450 to 280) with the aim of reaching 60% of the total amount of carried goods.

 Table 8C: **Experience promoting a structural or direct policy framework**

8.2 The Experience of Siena in Italy

A Flori, A Liberato, W Manni

8.2.1 Background

As a world renowned tourist site the City of Siena is one of the most prominent Italian historical towns. In addition to a population of about 60,000 inhabitants, 13,000 commuters/day and 17,000 University students, Siena and its surroundings are visited by more than 5,000,000 tourists every year. The city is characterised by a wide historical area surrounded by ancient walls and gates, a network with narrow streets and relevant gradient. More than 750 shops are located in the inner city centre and freight traffic amounts to some 450 delivery trips/day with more than 160 tons/day of goods being consigned. In addition, the city distribution system as a whole appears (as in many European urban areas and cities) to be largely inefficient, with more than 70% of freight vehicles using less than 50% of their available load capacity.

Although Siena presents one of the higher levels of city life quality in the Italian and European context the figures described above impact on the urban environment in various ways:

- high pressure of tourists;
- high number of daily commuters; and
- high level of freight flows in the inner city.

The current Municipality regulation only allows transport operators with vehicles under 6 tons to enter the historical city centre (the area inside the walls) and in specific time windows based on a typology of transported goods. These access restrictions, however, have not solved the traffic congestion problem and the related issues of noise level and air pollution (made more severe by the narrow streets). Due to this city distribution operators have to face several difficulties. Freight carriers are expected to provide higher levels of service within time windows and route restriction with lower operating costs. Meanwhile, congestion levels on city centre roads have been constantly raising due to the growth of pedestrian flows (tourist) mixed with freight vehicles.

To deal appropriately with these aspects, a Traffic Limited Area (TLA) for pedestrians, one of the first TLAs realised in Europe, is operated in the historical centre in accordance with a specific access regulation policy admitting only few user and service categories: residents, freight vehicles for delivery services, tourists direct to the hotels, public authority cars and public transport vehicles. Furthermore, the city has been gradually well equipped with different infrastructure and ITS systems, including Integrated Parking Management, Automated Access control with some 20 main enter/exit network gates, and on-line traffic data collection. Complementary to this, the Municipality has adopted an advanced Urban Logistics Master Plan to address not only the environmental and energy aspects, but also to improve the conditions and sustain the small and medium-sized enterprises operating in the historical centre.

The Siena Logistics Master Plan aims to realize logistic schemes and measures, based on an innovative urban goods distribution co-ordinated service supported by innovative technologies (new freight vehicles and clean fuels, automated access control, advanced freight distribution platform, ...) and integrated with the general city policy of reducing the level of gases emissions giving a relevant added value to the goods delivery process and enhancing the overall progress towards the Urban Logistics Agency concept.

The key measure of the Siena Logistic Master Plan project, is the Logistics Agency centre for co-ordinating and managing the goods delivery in the overall urban area. This measure is supported from one side by light technological infrastructures (advanced distribution platform, automated access control) and from the other side by a clean freight van fleet with low emission.

From the application and workplan point of view the Logistics Master Plan was carried out in two main realization phases in order to put in practice the Logistics Agency in the medium term and, at the same time, to make a "soft" approach to the goods transport operators, shopkeepers and citizens of the planned measures, and to have the possibility of monitoring the results of each step developed.

The kernel measure of the Master Plan, the Urban Logistics Agency, was designed as an innovative B2B/B2C architecture/ICT platform for improving the freight/parcels distribution and supporting logistic processes in urban/city area. The concepts of Agency, and the related IT platform, were developed in the eDRUL project (see Chapter 5), a relevant European Project founded by the FP5 IST R&D Programme, started in April 2002 and due for completion in 2005 and co-ordinated by Siena Parcheggi SpA, the Siena parking company, partially owned by the Siena Municipality. The eDRUL project therefore, with its current demonstration phase, is the base for testing not only the IT platform for the Agency but also the new concepts, rules and services defined in the Master Plan.

In the following sub-sections the approach of the Siena Logistics Master Plan is provided from the operational and city point of view describing the actions, measures, initiatives developed and realised both under the umbrella of the eDRUL Project and under the local efforts and resources.

8.2.2 The operational scenario

The current scenario of city logistics in Siena in response to the different issues/aspects of freight city distribution and the answers indicated in the Siena Logistics Master Plan by the realization of the planned measures and concepts' (including the Logistic Agency developed under the eDRUL project) is described below:

Competition aspects

The logistics service situation in Siena, as in other European cities, is of free competition among different freight transport providers. Several long-range, mid-range and city logistics organisations are currently operating and have access to the historical city centre for delivery purposes. However, this situation is gradually changing according to, and as a consequence of, the city logistics regulation introduced and under development.

The implementation of the planned restrictions to TLA access and deliveries within the historical centre will have impacts on this free competition scenario. Access to the TLA will still be granted to any freight operator – thus leaving a substantially free competitive environment – but some requirements and operational conditions will alter the current situation. This might be the case for instance of the requirements to use low (or zero) emission vehicles in the inner centre or the operation of city distribution companies acting with a "freight taxi" licence.

The planned eDRUL demonstration in Siena is substantially looking at this – albeit in a "controlled environment", involving selected test groups of operators – to try and derive indications useful for the following phase of large-scale implementation of the new city logistics regulation scenario.

Political aspects

The Logistics Master Plan adopted by Siena Municipality addresses not only the environmental and energy aspects but also improves the social/political conditions and sustains the small and medium-sized enterprises operating in the historical centre. The measures planned are designed to allow optimisation of the freight distribution process, reduction of traffic impacts in the historical centre, environment preservation and reduction of energy consumption and emissions.

The implementation of the Logistics Master Plan will follow a gradual, step-wise approach. Instrumental to this will be the implementation of a large-scale pilot project to assess the impacts in terms of new operation flows and rules for all city logistics actors involved. The eDRUL demonstration is providing a pre-pilot situation, required to test and evaluate some key elements of the organisational and technological and operational measures envisaged in the new city logistics scenario.

Enforcement level

All commercial vehicle restrictions (weight, emissions, size, time window, parking and circulation permits) are monitored by the Siena municipal police. There are some infrastructure which supports enforcement operations, namely weight houses, checkpoints and mobile electronic emission control devices, however the control of the existing restrictions is still manual.

In the mid-term period, the existing Access Control System (ACS) will allow monitoring of time window and circulation permits restrictions. The Municipal Police tolerance to irregular situations is zero (except good sense exceptions) and as surveys conducted by the Municipality have shown, the citizens' willingness to comply with the restrictions is generally high.

During the eDRUL demonstration, the enforcement of the new access regulation for freight carriers will be evaluated (but not applied as a real measure) with a view to obtaining indications for the subsequent large-scale pilot phase.

Co-operation between transport operators

The transport services operators active in the Province of Siena amount to about 800, most of which are small or very small companies usually with only a few (often one) vehicle. This represents the major obstacle to an immediate further growth of a sector which certainly is a remarkable source of income and employment. Although strategic alliances or other co-operative forms could seem a feasible option to overcome the limit mentioned, no relevant consortium is institutionalized.

One of the main aims of the Siena Logistics Master Plan is to test and show in real-life conditions how co-operation between transport operators can be supported. This is being achieved by the eDRUL Agency and its services.

Site-specific regulations

The Siena Logistics Master Plan identified a set of regulations in terms of:

- the constraints and rules for access to the Siena TLA and freight distribution in the area; and
- the workflows for access booking, granting of access permits and "negotiation" of access with the eDRUL agency.

These regulations are embodied in the reference logistics framework developed in Siena in consultation with the commerce and transport categories and citizens associations. The rules have to be taken into account during the build up of the local eDRUL IT architecture and implemented within the technological systems used to plan and manage logistics processes – i.e. the eDRUL portal and logistics planning and management platform.

Integration with Access control system

As already mentioned, Siena city is equipped with an automated Access Control System (ACS) as a main technological tool to control private traffic entering and leaving the Traffic Limited Area, i.e. the inner centre inside historical walls.

This is intended to control access for Siena residents' vehicles, since non-residents' private traffic is not allowed into the TLA. The ACS is fully operational and involves a large number of residents vehicles equipped with a Telepass transponder (see Figure 8.1).

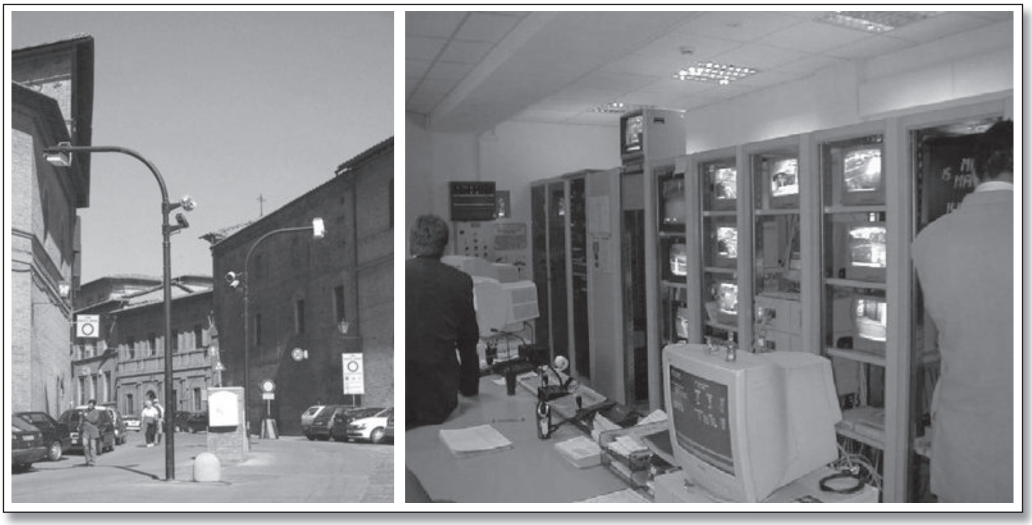


Figure 8.1: **Access Control System in Siena: a Telepass® equipped gate**

Overall, the current characteristics of the operating ACS include:

- 16 access gates (historical gates through the ancient walls) equipped with Telepass check-in technology (beacons and TV cameras): 8 double and 8 single way access gates, with a total of 24 Telepass stations;
- a control room located at the headquarters of Siena Urban Police.

In terms of the planned eDRUL demonstration, given the choice of the area for experimentation one access gate will be of interest for eDRUL operations: the gate located at Porta San Marco. Specifically, the eDRUL platform should be able to send the daily "white list" of freight vehicles entitled by the eDRUL agency to access the TLA to the ACS control room (Siena Municipal Police).

8.2.3 The eDRUL Agency in Siena

During the eDRUL project a major effort was concentrated on investigating and developing an e-logistics platform based on advanced architecture and tools for flexible management of city freight distribution processes and on the relationships and dependencies with the service infrastructure provided by e-Business/e-Commerce networks.

The core objective and focus of the project is the integration of e-Commerce/e-Business services with an advanced city logistics management architecture (see Figure 8.2).

Based on this the main real result of the eDRUL project was the relisation of an innovative and advanced goods distribution IT platform (discussed in Chapter 4) with the following main capabilities:

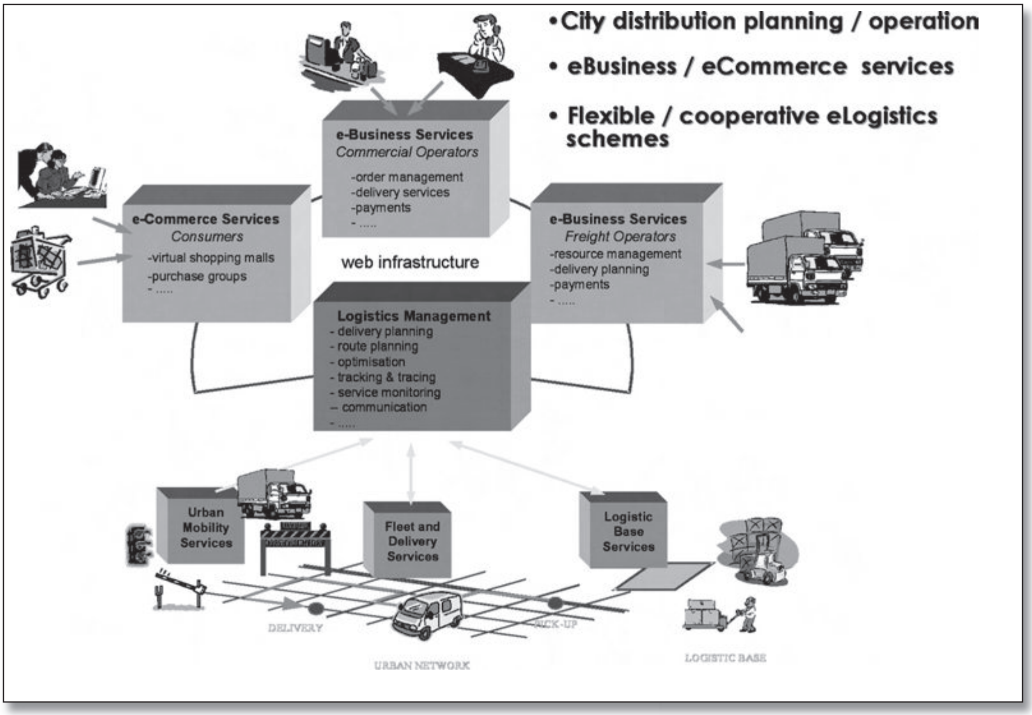


Figure 8.2: **General context of eDRUL**

- integration of different actors of the city logistics chain through a multi-service, web-based e-Business platform supporting on-line collaboration among logistics parties and operation of a City Logistics Agency;
- decision support and aid to operation of logistics resources enabling integrated, demand-responsive goods distribution services;
- provision of a number of e-Commerce services to enable easy interfacing of end-customers of the logistics system.

Supporting the operation of the City Logistics Agency will be a central task of the eDRUL platform. The eDRUL platform is the key element of the Logistics Agency which acts as a virtual enterprise ensuring the work of different logistics operators in a multi-organisation context. Despite the physical location of the operators and the goods terminals, the different types of fleet and the different booking systems and shopkeepers requests, it will manage the entire goods distribution service chain (from customer booking to service planning, monitoring and control) as a unique entity.

These functionalities optimise the goods distribution chain and provide the fundamental core for co-ordinating and monitoring the overall goods delivery/pickup process, independently from the different freight distribution reference models operationally designed for co-ordinating and integrating the urban logistic service. Further details and information about the eDRUL project, Agency concepts and IT platform characteristics are given in Chapters 4 and 5.

The implementation of the eDRUL architecture in Siena involved a number of advanced ICT applications and enabling technologies, including:

- web-enabled information and booking services for the customers (B2C segment), information exchange, resource sharing for e-logistics operators (B2B segment);
- delivery notification and information through mobile phones and SMS;
- goods dispatcher software for trip planning and resource (i.e. vehicle capacity) optimisation;
- in-vehicle display units and hand-held devices (palmtops, PDAs, new generation mobile phones based on WAP and GPRS) to support vehicle drivers and goods delivery operators tasks;
- GPS-based and GSM/GPRS-based vehicle location systems; and
- long-range, wireless communication channels (GSM, GPRS) to support interactions and information exchange among the logistics planning/management platform and vehicles / goods delivery operators.

The IT architecture implemented is illustrated in Figure 8.3.

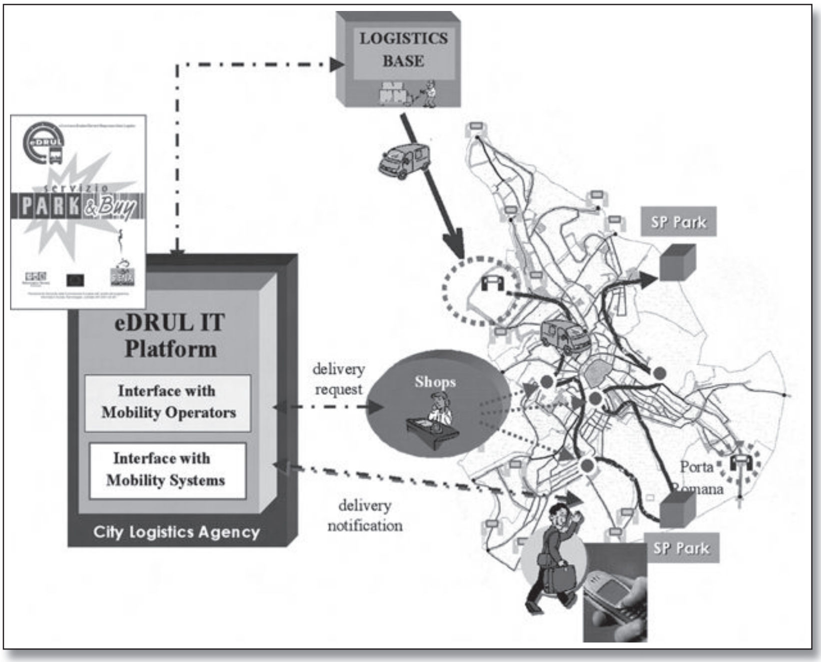


Figure 8.3: **Basic components of the eDRUL platform architecture**

8.2.4 Logistics users and schemes in Siena

The eDRUL Logistics Agency in Siena is carrying out three main types of city logistics services related to the following reference logistics schemes:

1. B2B services for city distribution in the traffic restricted historical centre (TLA) under access restriction regulations and "negotiated access" through the eDRUL Logistics Agency;
2. B2C consumer-driven services for goods deliveries through dedicated collect points (Park-and-Buy service);
3. B2B services for city distribution through co-operation between transport service providers (long-distance freight forwarders, city distribution operators) and use of logistics bases for transhipment of goods.

These different services have been developed on the base of different user categories and needs. For this purpose, the processes of each business operation involved in urban distribution have been depicted and the definition of role has been addressed. For instance, in cases where the commercial operator manages its own distribution fleet, he will not only have access to services available to the user category "commercial operator" but he will also have access to some services available to the user category "freight transport service provider". The type of actors and users of the eDRUL e-logistics system in Siena are shown in Figure 8.4.

- Site extension: entire historical centre
  - Traffic Restricted Zone (TRZ)
- About 750 shops and retail points
- 1 city distribution operator
  - COTAS
- 1 short-/mid-distance transporter
  - Coop F&T
- 1 long-distance transporter
  - Bartolini Corriere Espresso
- 1 logistics base
  - at COTAS wharehouse
- 1 Parking pick-up point
  - Siena Parcheggi "Il Campo"
- 1 freight access check-point
  - Porta Pispini (COTAS operational area)

Figure 8.4: **Overall context of local users involved in the Siena Logistics demonstration**

Specifically, the following local actors, stakeholders and external systems are taking part in the eDRUL demonstration in Siena:

- Long to Mid Range Freight Transport Service Providers.
  Initially the main actor within this category is Corriere Bartolini, an Italian international freight forwarder operating in the domestic as well as European market.
- City Distribution Service Providers.
  Local distribution within the inner historical centre of Siena (LTA) is initially carried out by three operators:
  - COTAS company with a fleet of city vans. COTAS operates under a "freight taxi" license allowing them to access the TLA without time restrictions. COTAS have their own logistics base located outside but close to the urban area;
  - Cooperativa Facchinaggio & Trasporto (Coop F&T). This is another co-operative freight operator using a fleet of vans for local consignments. F&T are specialized in fresh food transport (fruit and vegetables) and have their own operational base (warehouse) linked to the fruit and vegetables general market;
  - Siena Parcheggi Company with an electric vehicle fleet. The "park and buy" service operated by this company is dedicated to parking users and hotel guests.
- Commercial operators and shops.
- eDRUL Agency located in the Siena Parcheggi headquarters.
- Municipal Police, responsible for the ACS.

Each of the identified scenarios and the role of involved local users are described below.

City distribution under access restrictions and "negotiated access"

Access to the inner Siena TLA for freight deliveries is only allowed for two kinds of freight vehicles:

1 Long to mid-range freight vehicles meeting access conditions; and
2 Authorised urban fleets holding a "freight taxi" licence (COTAS and Coop FT city logistics operators) or special fleets of non-polluting vehicles (e.g. Siena Parcheggi electric vans).

The eDRUL service supporting city distribution through "negotiated access" to the inner historical centre relates to the first type of logistics flows. This service scheme is based on the concept of allowing long to mid-range freight vehicles to access the city centre by booking and "negotiating" access conditions through the eDRUL Logistics Agency. Booking is made via a call centre or the eDRUL Agency Portal and the corresponding permits are released only where the access conditions are met. These include:

(a) total weight < 3500 Kg;
(b) load > 60% of available capacity; and
(c) pre-defined time band to access the inner centre, according to the type of transported goods.

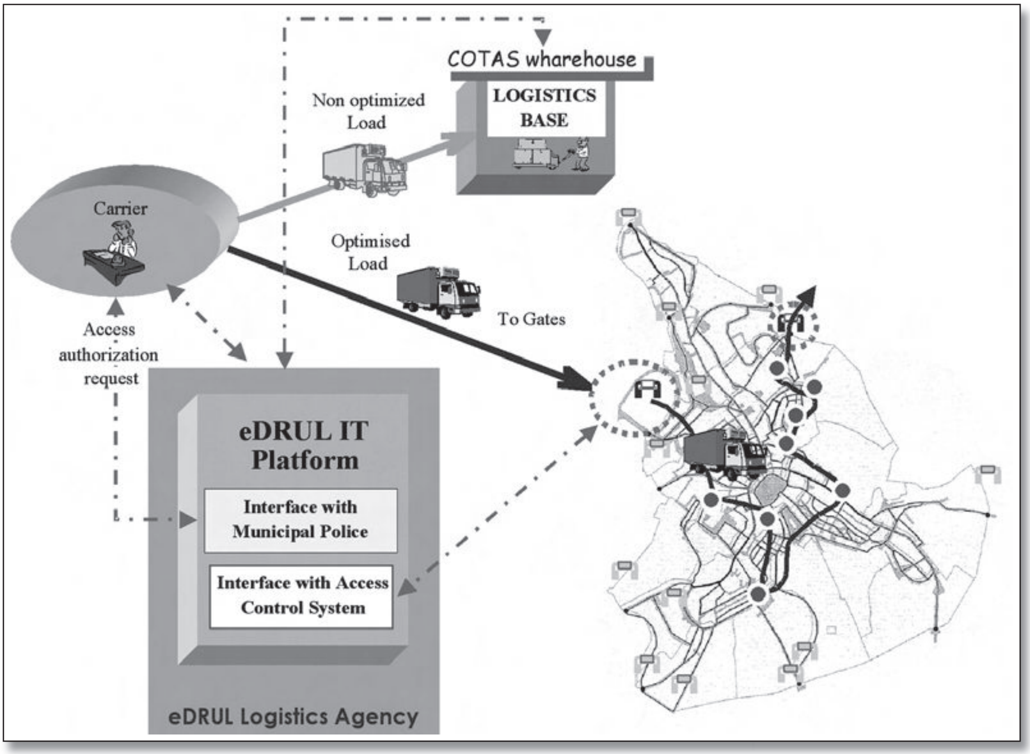


Figure 8.5: **General scheme of city distribution through "negotiated access"**

Further requirements on using low-emission vehicles to access the TLA will be included at a later stage. When access is granted, the corresponding permit (certificate) provides the specification of operations allowed, including: the date and time band allowed for deliveries, the entry/exit gate, the route and sequence of consignees. A specific sequence of consignees can be also requested by the freight operators, in which case the eDRUL Agency provides the routing to carry out the sequence of deliveries. Freight operators may also book "unloading spaces", in case they need extra time for deliveries (i.e. longer than the time band granted).

Access and delivery booking through eDRUL can be related to different subscribing modalities:

1 Long-term, regular access subscription (e.g. yearly, monthly, etc.);
2 occasional access subscription (e.g. for a given day); and
3 subscription "on-the-fly", by direct presentation at the access gate.

In case no access can be granted to the freight operator (i.e. access restrictions are not met) goods deliveries can be only implemented by means of a third party. This co-operation service scheme is described below.

Consumer-driven deliveries through dedicated collection points

This type of logistics scheme will be assessed in Siena by the "Park-and-Buy" (P&B) service, a value-added B2C logistics service providing goods delivery for tourists and visitors in Siena. With a P&B service, visitors to Siena can purchase goods in the pedestrian area and have them delivered at selected parking places or hotels (Figure 8.6). This will help to manage a major flow of goods from the inner centre of the town to the outside.

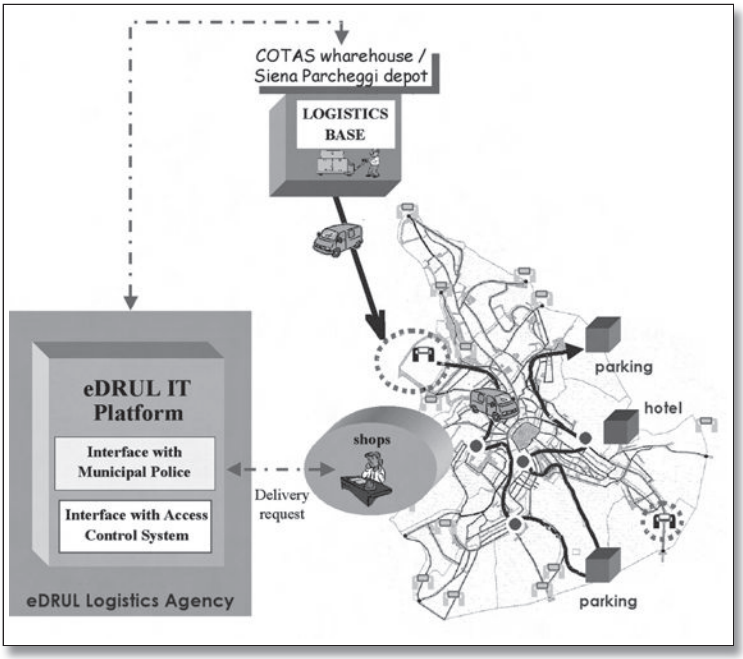


Figure 8.6: **General scheme of customer-driven deliveries through dedicated collect points**

Furthermore, it will also improve the service offer and economy of shops and retail points in the TLA, especially for those shops that are less favorably located with respect to parking places where tourists and visitors have to leave their cars. In the P&B service, goods delivery requests are handled by the eDRUL Logistics Agency through the call centre and/or B2B/B2C portal services. Goods consignment orders are always generated by the shops and retail points, with destination a parking place (or a hotel) and the eDRUL agency providing booking, transportation planning and monitoring services. Feedback to the customers is also provided about the delivery status of the goods through the eDRUL portal or SMS on the customer mobile phone.

The actual delivery services are provided by the urban delivery fleets. Two options are possible: the "freight taxi" operator COTAS, and Siena Parcheggi, with their own fleet of electrical vehicles.

City distribution through co-operation of transport service providers

This scenario encompasses several logistics services:

1 Co-operation between long to mid-range freight operators and city distribution fleets for "last mile" operation;
2 Co-operation between long to mid-range freight operators for load "consolidation" in order to meet access restrictions;
3 Co-operation between local distribution fleets and long to mid-range operators for handling return goods.

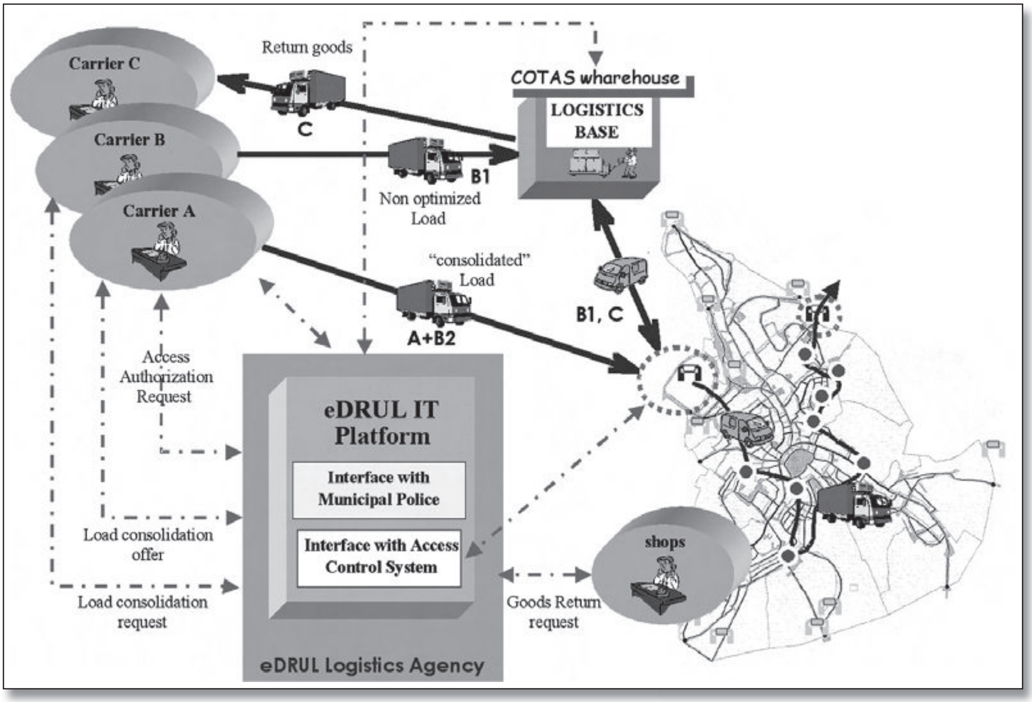


Figure 8.7: **General scheme of city distribution through cooperation of transport service providers (Park & Buy service)**

According to the target Logistics Master Plan for regulation of freight flows in Siena, for freight vehicles that do not meet the access regulation restrictions, delivery operations within the TLA will only be possible through goods transhipment. Within the eDRUL demonstration this will be achieved in two ways (service 1 and 2).

Through the first type of service, the eDRUL Agency will offer long to mid-range freight operators in the above condition the possibility to tranship their load at the logistics base.

Transport and consignment to final destinations will then be carried out by urban fleet operators (COTAS and Coop FT). This type of service will also be of use for those freight operators willing to hand over the "last mile" operation to the urban delivery fleet. Even if meeting the access restriction regulations, long distance freight operators may find it convenient to handle the last segment of transport within the historical centre through co-operation with local operators. In both cases, the eDRUL Agency, besides booking services for long distance freight forwarders (defining the time and place for transhipping, etc.), will provide support services for planning and managing the operations of the urban delivery fleets: delivery planning, route planning, tracking and tracing, communication with vehicle drivers through PDAs, etc.

The second type of service is based on offering long to mid-range freight transport operators a web-based service to exchange information and agree on mutual load consolidation. In such a case, forwarders interested in consolidating their load by transhipment to a third party will be able to post their request through the eDRUL Portal. Likewise, freight forwarders available to take third party goods in order to complete their own load and meet access restrictions will be also able to post their 'offer' on the portal. This will allow bilateral contacts and negotiations to take place, thus enabling the operators carrying the consolidated load to book and get access permission through the "negotiated access" services and process previously described.

The third type of service addresses the workflows and freight processes related to the return of goods from inner centre shops. This is an additional service for the eDRUL agency in Siena which could be experimented during the demonstration phase. The aim of the logistics service is to further reduce the access to the TLA by long to mid-distance forwarders by managing return goods flows by the city distribution operators (COTAS). To avoid having freight vehicles entering the TLA and picking-up the goods to be returned directly at shops in the TLA, goods are collected by the city logistics transport operators and delivered at the logistics base for later transhipment to the relevant long-distance forwarders. Although not the main focus of eDRUL trials in Siena, this type of service is covered by the booking and planning capabilities of the eDRUL IT platform, and could be experimented to some extent by agreement between the participating freight transport operators and the city distribution operators.

8.2.5 The Siena trials

The eDRUL trials in Siena have been conducted in real-life but in a "controlled environment". This means that a test group of logistics operators, commerce and mobility actors have been involved in the trials and the trials themselves heve been implemented in the current city mobility and logistics operational framework (i.e. the Siena Master Plan for access restriction and control in the historical centre which is being gradually implemented and operated in the city) matching the current state of operation.

The overall goal is to test the eDRUL technology and evaluate its capabilities in supporting the implementation and operation of the eDRUL city logistics scenarios. Furthermore, the results of the trials will allow assessment of the viability of eDRUL technologies for a longer-term, permanent implementation of the city distribution schemes tested and e-logistics services.

The local site actors involved in the eDRUL trials in Siena are summarized in Table 8.1.

Role / Facility	Local Site Actor
Logistics Agency	Siena Parcheggi SpA
City distribution transport operator	- COTAS scrl - Coop Facchini & Trasporti - Siena Parcheggi (Park & Buy service, electric vans)
Long to mid-range transport service provider	Bartolini Corriere Espresso
Logistics base	COTAS warehouse
Shops (Park & Buy service)	10-20 shops located in the inner center
B2C goods collect points (Park & Buy service)	Parcheggio "Il Campo" (Siena Parcheggi)
Freight check-in points	One check-in point located close to Porta Pispini (nearby COTAS logistics base)
Access Control (web based access and check of vehicles "white list")	Siena Municipal Police
Technical support for the use of the IT architecture	Softeco Sismat SpA
Local site manager (e.g. organization and local data collection)	Siena Parcheggi supported by MemEx srl

Table 8.1: **Actors involved in the Siena demonstration site**

The eDRUL demonstration in Siena is started in April 2004 and will be completed in November 2004 with the aims not only to validate the B2B architecture, but also to provide indications for normative, regulatory, institutional decisions concerning city logistics processes and follow-up in the adoption of IT solutions. Finally, the Logistics Master Plan of Siena and its realization in terms of Agency concepts and measures represents one of the most relevant pilot actions in Urban Logistics and Sustainable Cities and provides an outstanding opportunity to establish the main guidelines of these types of measures and to test the potential transferability to other European cities.

8.3 Goods Distribution in the City of Genoa, Italy

D Villani, C Gerbaudi

8.3.1 Introduction

From March 2003 a new scheme of goods delivery is in operation in the historical centre of Genoa.

The goods directed to the target area (historical centre) are collected in a hub and then distributed using zero and low-emission vehicles. The service, whose design began in 2001, has been financed by the Ministry of Environment through the Environmental Protection Programme.

Five tenders were necessary to carry out this project:

1. to rent the exchange centre (Hub);
2. to develop the system software;
3. to buy the hardware equipment;
4. to buy the zero emission vehicles; and
5. to choose the company instructed to manage the goods delivery;

To evaluate the challenges met in the design phase and during the realisation of the service it is necessary to analyse the geographical characteristics of the city of Genoa (Figure 8.8).

Figure 8.8: **Genoa**

In particular:

- the area extension (it is 38 km long and only about 8 km wide);

- the urban territory area is 239.55 km^2 and the area of the city centre is about one tenth of all the urban territory, and the historical centre is about 2 km^2;
- 7 highway gates are in the municipality area; and
- approximately 15% of all the goods delivered in the city are addressed to the historical centre;

Due to the particular morphology of the city it was difficult to identify the correct position and extent of the goods exchange centre. After an analysis of the area and a study of the distribution of shops and characteristics the extent of the hub was stated in 1,100 m^2. It is located approximately 5 km from the historical centre and 1.5 Km from the nearest highway gate.

The historical centre has peculiar characteristics to be satisfied by the project:

- the width of the roads (about 2 metres);
- the almost total closing to automotive traffic;
- the quality and type of delivered goods;
- the retail system usually without warehouses; and
- the necessity to reduce the atmospheric and acoustic pollution.

In this trial period, to facilitate the delivery operations and for technical and administrative problems, the distribution service excluded fresh foods, jewellery, pharmacy, newspaper stands, banks and offices. Some of these goods categories will be delivered by the system when the service is extended to some other city areas. In March 2003, when the project started, only a part of the historical centre, as shown in Figure 8.9 below, was served by the system; now the whole historical centre is covered by the service. There are 8 electric and 2 methane vehicles in use and each one covers from 12 to 20 km for each delivery.

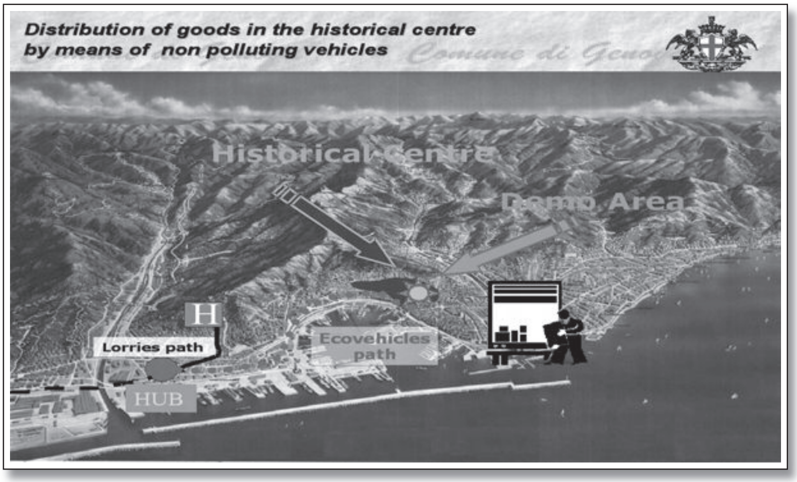


Figure 8.9: **The Genoa demonstration area**

8.3.2 Objective of measures

The project makes use of advanced technologies to optimise the distribution circuit. It is based on a data processing system and a telecommunication infrastructure to manage and track the results. This allows control of every stage of the project. The system uses data processing and TLC technologies to optimise and to control constantly the distribution process, keeping under control each single step of the process. In this way it has been possible to obtain environmental and distributional results, such as:

- Reduction of the environmental impact (atmospheric and acoustic pollution);
- environmental and economic improvement of the area involved;
- improvement of the logistics and definition of services with new added values and new functionalities;
- improvement of the intermodal transportation;
- reduction of the traffic due to goods distribution in the urban area; and
- improvement of the service using innovative TLC systems.

8.3.3 Description of the system

The project is co-ordinated directly by the Municipality of Genoa. The tender for the management of the service was won by a company - "Genova Eco-distribuzione Merci" created expressly for this project and participated in by almost all the couriers and carriers operating in Genoa; this company is in charge of managing all the goods deliveries in the city centre and all the activities inside the hub.

The service in the hub is covered by 12 employees, and everyone has to do a particular job; sometimes when the number of deliveries is particularly high, it's necessary to increase the number of the employees. The sub-division of the job is as follows:

- a person responsible for the warehouse;
- two persons assigned to the insertion of the goods and administrative data;
- two warehousemen; and
- seven persons assigned to the deliveries (drivers of the electrical vehicles).

The system software realization has been subject to tender and assigned after a long phase of design, necessary to plan all the functionalities of the system. The study has produced a technical detailed list used to correctly calibrate the plan, after many meetings with all the actors participating in the system: carriers, couriers, traders and shopkeepers.

The system software is structured in several relevant parts as shown in Figure 8.10:

- management of the warehouse;
- optimisation system;
- interface and development of the PDA (Personal Digital Assistant) applications;
- web applications; and
- firewall system.

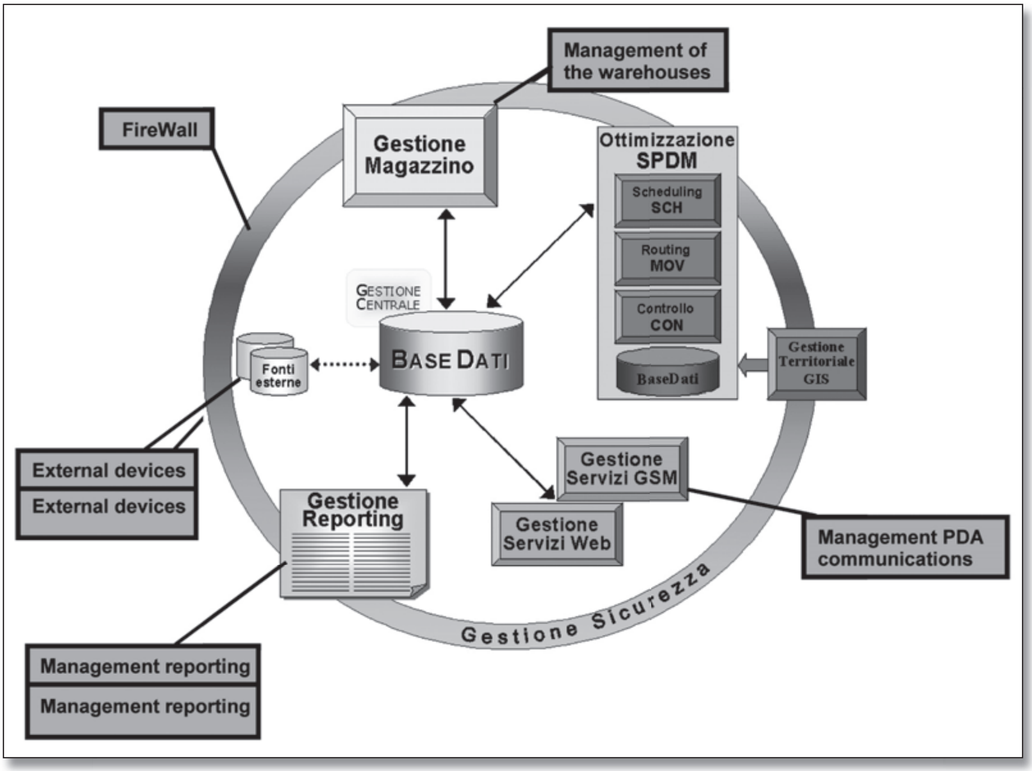


Figure 8.10: **Management SOFTWARE System Architecture**

The system follows these main operative phases. The goods arrive (directly from the carrier centres or from the highway) inside the hub; here they are bar-coded and put into the input/output and storage management system. The bar-code printer creates a new bar-code for each single parcel and makes a link with the previous bar-code data if any. Then the optimisation function makes a choice among the (8) zero emission vehicles (5 with a larger capacity) and the relevant delivery sequence and path. Within 4 hours the goods are forwarded from the hub to the historical centre and delivered to the retailers. For each delivery the operator, through the PDA wireless connection, sends back a GSM message to the hub. In this way the web site and the database are constantly updated.

The Municipality is now planning to upgrade the software, to add a new function inside the system; installation of a Global Position System will make it possible to improve the quality of the service with the management of the real-time position of the vehicles and the change of the paths transmitted via the PDA. Furthermore there is the provision to introduce new added value activities to contribute towards paying for the cost of the service (like collection of goods and packaging from retailers).

The system hardware

The equipment of the system (Figure 8.11) includes:

- two servers, one dedicated to the web applications and the other to the management system;
- some clients inside the hub dedicated to the warehouse management system;
- two barcode printers and two standard printers for all the printing necessities inside the hub;
- two wireless barcode readers to carry out the management operations inside the warehouse;
- 15 PDAs with bar-code readers and wireless communicating capacities, used by the drivers in charge for the deliveries, necessary to manage the system outside the hub.

After the first 9 months of operation the Municipality of Genoa is planning to upgrade the hardware by introducing a GPS system to track the deliveries.

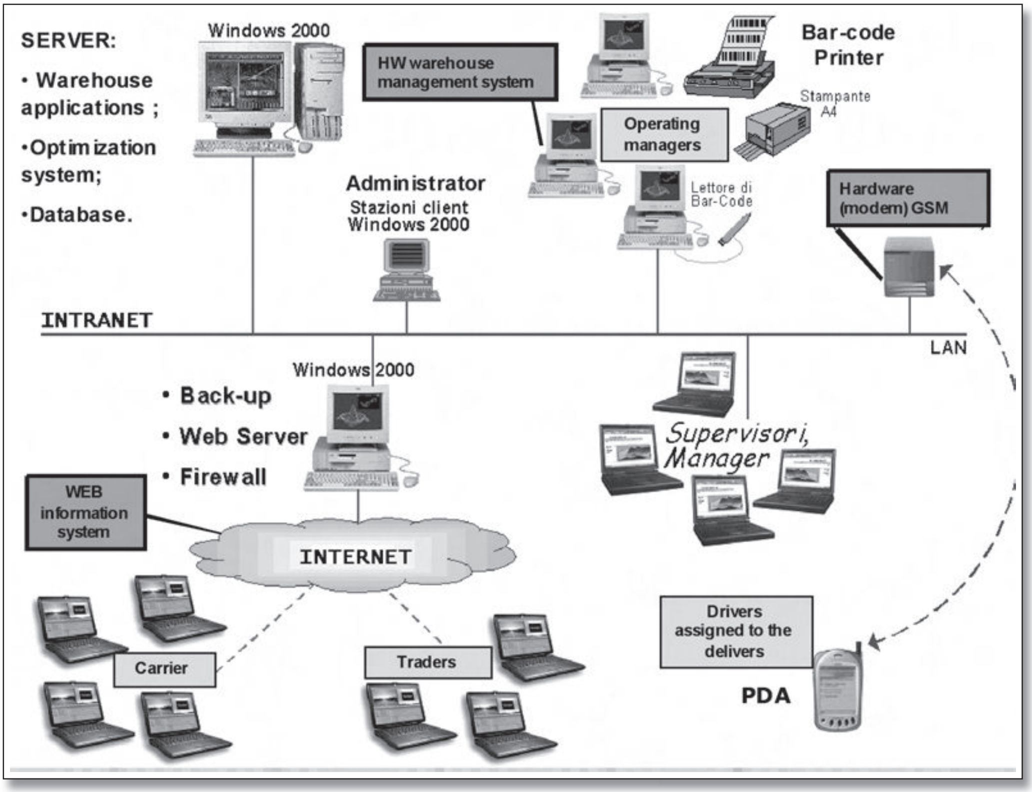


Figure 8.11: **System hardware**

The electric vehicles

Due to the small dimension of the roads inside the historical centre the electric vehicles necessary to deliver the goods had to satisfy this particular constraint. The mechanical and geometrical characteristics of the ZEV (Zero Emission Vehicles) are:

- Work speed to 35 or 55 Km/h (in two different gears);
- Maximum slope at full load: 15%;
- Autonomy with full load battery: 60 km;
- Time of recharging: 6/8 hours;
- Easy replacement of batteries;
- Wheel bending <3.7 m;
- Vehicles width: <1.3 m small e < 1.6 m medium;
- Capacity vehicles: from 5 to 9 cubic metres;
- PTT vehicle: Kg. 3500;
- Height 2.0 m.

Figure 8.12: **An electric vehicle in Genoa**

8.3.4 Preliminary results

The trial period started on the 3rd March 2003. Until the end of June the goods were delivered only in the demonstration area, about one third of the historical centre, and the goods delivered were less than 20% of the quantity foreseen. After some meetings with all the stakeholders in the project (shopkeepers, carriers and technical operators), the delivery area was enlarged to include the rest of the historical centre. After this decision the deliveries increased to about 90% every month (see Table 8.2).

Period (2003)	Work Days	Packages	Weight(Ton)	Note	Carrier	Package/ day
March	20	1425	18,47	36,6	9	71
April	18	2682	29,41	73,2	9	149
May	20	3452	42,65	91,9	12	173
June	20	3656	49,82	75,8	12	183
July	20	5585	85,35	122,5	14	279
August	11	1432	24,55	43,0	8	130
September	22	10121	140,97	265,8	15	460
October	23	12749	185,13	335,2	15	554
November	20	9161	152,54	237,8	14	458
TOTAL	174	50263	728,89	1.281,8	108	289

Table 8.2: **Growth in number of deliveries**

(2003)	July	August	September	October
DELIVERY	1.225	435	2.658	3.352
PACKAGES	5.585	1.432	10.121	12.749
WEIGHT(Kg)	85.353	24.549	140.969	185.011
WEIGHT(Kg)/delivery	69,7	56,4	53,0	55,2
PACKAGES/delivery	4,6	3,3	3,8	3,8
KG.COLLO	15,3	17,1	13,9	14,5
Work day	23	11	22	23
DELIVERY/day	53,3	39,5	120,8	145,7
PACKAGES day	242,8	130,2	460,0	554,3
WEIGHT(Kg)/day	3711,0	2231,7	6407,7	8044,0
Used vehicles	6		7	8
DELIVERY vehicle	8,9		17,3	18,2
PACKAGES vehicle	40,5		65,7	69,3
WEIGHT(Kg)/vehicle	618,5		915,4	1005,5

Table 8.3: **Deliveries following expansion of operation**

Table 8.3 describes how the goods delivered from the hub have increased from July to October, 2003 reaching 8 tons/day for each delivery of October. It is useful to underline that for each step of the delivery it is possible for the carriers or the traders, to track the goods and know if they are in the hub or in delivery or if is just delivered. The service is open to anyone who wants to deliver goods to the historical centre. Everyone (also citizens who usually go inside the historical centre to deliver goods) may, with one simple recording carried out via the website, take advantage of the goods delivery service.

8.4 Experiences of freight distribution in Denmark: Copenhagen and Aalborg

K Markworth, H J Jensen, B Mikelsen

8.4.1 Background

Most European cities and urban centres face the same problems with freight distribution: increasing urban congestion; increasing pollution and deterioration of the urban environment; increasing number of lorries and vans, longer duration and costs of goods delivery trips; insufficient service quality for both the different actors of the logistics chain and for the consumers.

Customers want goods consignment services to be provided at acceptable cost, at convenient times and places and with the flexibility to meet needs, which may vary widely at short notice. Transport and logistics providers want to be able to plan their work with a reasonable degree of certainty and to make the most efficient use of assets. All those who live and do business in urban areas want the environmental and congestion impacts of road freight to be minimised.

However, looking at the environmental aspects of distribution by van or lorry in city centres is a relatively new concept. Basically, everybody wants lively and accessible city centres where we can all move around safely and where trade and culture are flourishing. This requires delivery of goods on a daily basis. So far the distribution of goods has not always been in accordance with our wishes regarding the city's space and environment. Sustainable city logistics solutions could be one of the solutions to the problems in city centres.

In this discussion the following definition of City Logistics is offered:

- The transport must be geographically concentrated;
- large amounts of volume of parcels or goods; and
- high exploitation of capacity.

If these conditions are fulfilled it should be possible to establish a more efficient transportation of goods. This case-study presents three initiatives to improve the quality of life in city centres by reducing the demand for freight transport. The sites are Copenhagen and Aalborg.

Currently Aalborg participates in the "Sustainable City Logistics Solutions" project, a tri-city co-operation between Copenhagen, Aarhus and Aalborg supported by the Danish Ministry of Transport. The three cities and the Ministry of Transport have created a steering group which has established a joint forum - the Forum for City Logistics - with its own secretariat. The overriding principle behind establishing the Secretariat is a practical, experience-based approach to the problems rather than a theoretical approach. The overall objective of the "Sustainable City Logistics Solutions"- project is to develop and on a trial basis implement new methods to improve the freight distribution in middle-sized cities and thereby reduce the negative environmental effect. The aim is:

- To establish a forum for new ideas and solutions for efficient goods transport;
- to learn by and use experience from other European countries; and
- to share our experience and knowledge with municipalities in Denmark and in other European countries;

Aalborg and Copenhagen used two different approaches to reduce the environmental impact on the cities and these are described below.

8.4.2 Site and service description - Copenhagen

Copenhagen is the capital of Denmark and has approximately 1.5 million inhabitants. The City of Copenhagen consists of very well defined city areas divided by arterial roads. However, some city areas are more sensitive to heavy goods traffic than others and therefore need more traffic regulation than others. On 1st February 2002 Copenhagen implemented the trial scheme "City Goods Ordinance" in the medieval part of Copenhagen. The trial scheme ran until 31th October 2003.

Target area

The target area in Copenhagen is the medieval part of the city, shown in Figure 8.13.

This is the largest pedestrianised area in Denmark and the city's primary shopping, leisure and cultural facilities and it is visited by millions of tourists each year. Due to the intense use there is a lot of traffic in the area, both passing through but also in terms of freight delivery. Especially during rush hours congestion is a common phenomenon in the narrow streets. In the 2 year period the ordinance will have implications for all domestic and foreign vehicles that have a total weight over 2,500 kg.

Measures

In order to meet the overall objective and thereby reduce heavy goods traffic and improve the environmental situation the City of Copenhagen has set up criteria to regulate the freight delivery:

Figure 8.13: **Target area in Copenhagen – the medieval part of the city**

- Better use of the vehicles capacity;
- no stopping; and
- establishing of loading and unloading zones.

To uphold these criteria the City of Copenhagen introduced a certification system for freight delivery vehicles. The three types of certificates used are described below.

Certificate for the Medieval City

From February 2002, all lorries and delivery vans over 2,500 kg were required to have a

Figure 8.14:
No stopping sign in the Medieval City

certificate in order to stop in the heart of Copenhagen centre. The network of streets that comprise this area is from the middle ages; hence the name of the Medieval City. Figure 8.14 shows the no stopping sign in the target area which is placed on all the city streets that fall within the area.

The number of lorries and delivery vans has steadily increased making it difficult to navigate the Medieval City's small winding streets and leading to increasing traffic congestion. For these reasons, the City Council of Copenhagen has decided to implement a two year obligatory trial ordinance – the City Goods Ordinance – with the goal of reducing the number and/or size of the lorries and delivery vans that drive into in the Medieval City.

The Three Types of Certificates

The City Goods Ordinance stipulated that from February 1st 2002, all lorries and delivery vans over 2,500 kg in total weight were subject to a fine of DKK 510 (68 €) if they parked in the Medieval City without a certificate. There were three types of City Goods Certificates:

- The Green Certificate – costs DKK 325 (44 €) and was valid for the entire two-year trial period. In order to be eligible for the green certificate, 60% of the vehicle's cargo carrying capacity should be utilized. Additionally, the vehicle's engine had to be younger than 8 years. The green certificate gave exclusive rights to use 20 special loading zones that were established in connection with the City Goods Ordinance.
- The Yellow Certificate – costs DKK 325 (44 €) and was valid for 6 months. This certificate served as an option for those vehicles that could not meet the Green Certificate's restrictions.
- The Red Certificate – costs DKK 50 (7 €) and was valid for one day. This certificate was meant as a service for those deliveries that only occasionally came into the innermost parts of Copenhagen Centre. The Red Certificate could be bought at the City Goods Secretariat as well as at petrol stations found on the streets that lead into the designated area in Copenhagen.

Application forms for the green or yellow certificate were obtained from the City Goods Secretariat or could be printed out from the Internet. There was no special application form for the red certificate. It could be bought at gas stations along the arterial streets leading to the city.

Even though there was no stopping permitted on the streets in the Medieval City unless the driver had a certificate, there still were private areas where vans and lorries can park without a valid certificate.

The trial-period was split into 5 reporting periods and an evaluation period. If the vehicle owner did not fill in the required report after the three months the certificate was withdrawn. To validate the reports approximate 40 controls was carried out.

8.4.3 Results - Copenhagen

During the first couple of month's trial-period approximately 4,000 certificates were issued and at the end of the trial-period approximately 3,000 certificates were valid. The number of firms involved in the project rose from 2,000 to 2,400 in the trial-period. The general split between Green and Yellow Certificates changed during the trial-period from 25% Green Certificates and 75% Yellow Certificates at project start to 33% Green Certificates and 67% Yellow Certificates at project end.

In 2002 a registration of vehicles weighing more than 2.5 tons stopping on random streets in the Medieval City was conducted. Figure 8.15 shows the results of the registration.

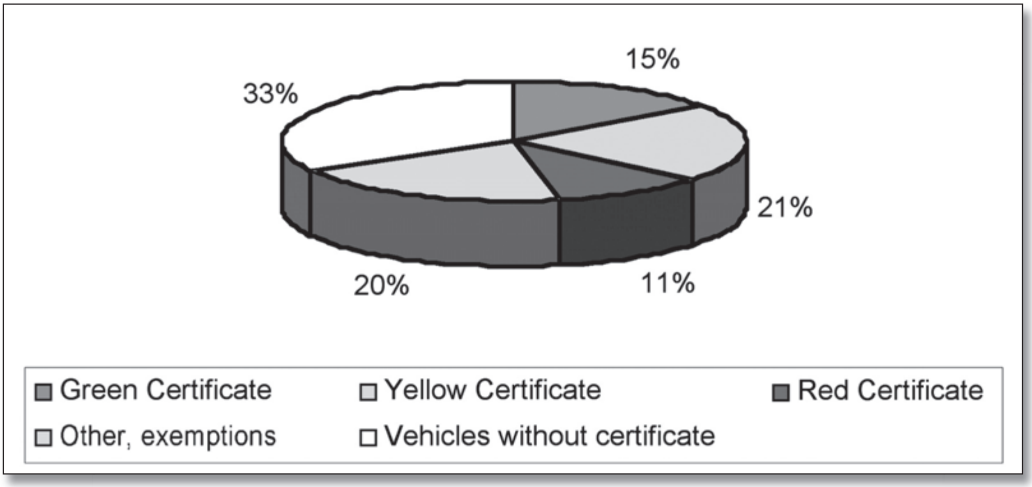


Figure 8.15: **Registration of certificates on random streets in the Medieval City**

A total of 434 vehicles weighing more than 2.5 tons were registered; of these, 67% had a valid Green or Yellow Certificate or other permission to stop in the medieval city, 21% of the registrations had a Yellow Certificate and 15% had a Green Certificate.

Both prior to the project and during the trial period a census of lorries and vans was carried out four times at exit roads from the Medieval City. The purpose was to gain knowledge regarding number of trips and tonnage carried out by the vehicles. The results are shown in Table 8.4.

		Registration date			
	Weight	**November 1999**	**October 2002**	**April 2003**	**August 2003**
Number of trips		6,032	6,236	6,209	5,459
Number of vehicles		3,543	3,503	3,979	3,500
Number of vehicles	> 2 t	3,117	3,155	3,526	3,144
Number of vehicles	>2.5 t	2,456	2,153	2,341	2,185
Tonnage (kg)	> 2 t	12,251,625	11,961,325	13,739,205	12,279,850
Average (kg)	> 2 t	3,930	3,791	3,896	3,905
Tonnage (kg)	> 2.5 t	10,770,100	9,776,200	11,161,325	9,979,375
Average (kg)	> 2.5 t	4,385	4,540	4,767	4,567
Tonnage (kg)	2 < 2.5 t	1,481,525	2,185,125	2,575,380	2,300,475
Average (kg)	2 < 2.5 t	2,237	2,182	2,175	2,174

Table 8.4: **Number of vehicles and tonnage registered**

The minor differences in the four counts are estimated to be in accordance with general statistical uncertainty. The number of trips has been reduced by approximately 10%, however the number of vehicles exiting the Medieval City has be unchanged. The number of vans and lorries over 2.5 tons has not increased in the period November 1999 – August 2003, but the tonnage in total for the weight category has decreased a little in the same period. For vehicles between 2.0 and 2.5 tons, there has been a major increase in both number and tonnage in total.

The number of diesel-powered vehicles shows an increase from 2,283 to 2,524 in the period. The registration also showed that there has been an increase in lighter vehicles powered by diesel which can cause some concerns in regard to the emission of small particles.

As part of the certification the vehicle owner should fill in a report regarding driving in the Medieval City. Based on the registration period from 01.11.02-31.01.2003 the results are shown in Table 8.5.

Total Weight	Number of reports	Number of 0-drives	Number of cars with drives in the city	Number of drives	Drives average	Utiliza-tion	With-drawals
2,501-2,800	28	11	17	1,085	64	66	4
2,801-3,000	15	7	8	328	41	85	0
3,001-3,200	120	46	74	2,108	28	67	21
3,201-3,500	257	75	182	6,169	34	70	35
3,501-6,000	70	27	43	1,957	46	65	3
6,001-12,000	83	29	54	1,485	28	73	8
12,001-18,000	165	56	109	3,154	29	65	8
Total	738	251	487	16,286	38	70	79

Table 8.5: **Reported data from the period 01.11.02-31.01.2003**

The reporting period as shown in Table 8.5 is considered typical for the entire trial-period and the average number of reports for each three months period is approximately 700. Table 8.5 shows a total of 16,000 reported trips to the Medieval City an average of 38 trips per vehicle. For the entire reporting period there has been a 20% increase in the number of registered drives and reported vehicles. However, approximately 70% of the vehicles entering the Medieval town met the demands of a capacity of 60% throughout the entire period. Throughout the entire trial-period approximate by 37,000 Red Certificates were sold, meaning almost 100 certificates per working day. As shown in Figure 8.15, one out of five vehicles stopped with a certificate had a Red Certificate.

Conclusions

The following conclusions were drawn out from the project:

- The majority of the vans and lorries stopping in the medieval area has a Green or Yellow certificate. However, the traffic census carried out four times in the period 1999-2003 shows, that the traffic (stopping and driving) with vehicles between 2.5 and 18 tons has decreased only a little after the start of the trial-period. The limited decrease is probably due to the fact that these cars do not meet the demands of the project, that they are using Red Certificates, and thus are exempted from the rules – a possibility proven by the large-scale sales of Red Certificates;
- approximately half of the haulage contractors were unable to present the required documentation and the most stated reason for the irregularities was misunderstanding of the reporting procedure;

- it is estimated that the project has not contributed essentially to a reduction of the number of vehicles with total weight between 2.5 and 18 tons. Yet, it indicates that the project may have intensified the development in the case of bigger vehicles being replaced by smaller ones;
- it has been very difficult to verify the reports from the vehicle owners especially in case of the demand of a utilization of 60%; and
- the loading and unloading zones are very popular and used a lot.

8.4.4 Site and Service description - Aalborg

Aalborg is the fourth largest city in Denmark and is situated along the banks of Limfjorden in the north-western part of Denmark. Aalborg has around 162,000 inhabitants and being the centre of the county a population of a further 65,000 persons in the metropolitan area forms the part of daily activities in Aalborg – working, shopping, visiting public service facilities or making use of the recreational attractions in the city. Most of the commercial service and office activities are found in the city centre. The Aalborg project started 1st April 2001 and ended 31st December 2003.

Target area

The freight transport in Aalborg City Centre is concentrated around the pedestrian area, primary performed of 4 streets. Approximately 220 shops are located in this area and more or less receive goods everyday, however the quantity and types of goods delivered depends on the size and type of shop. Figure 8.16 shows the target area in Aalborg.

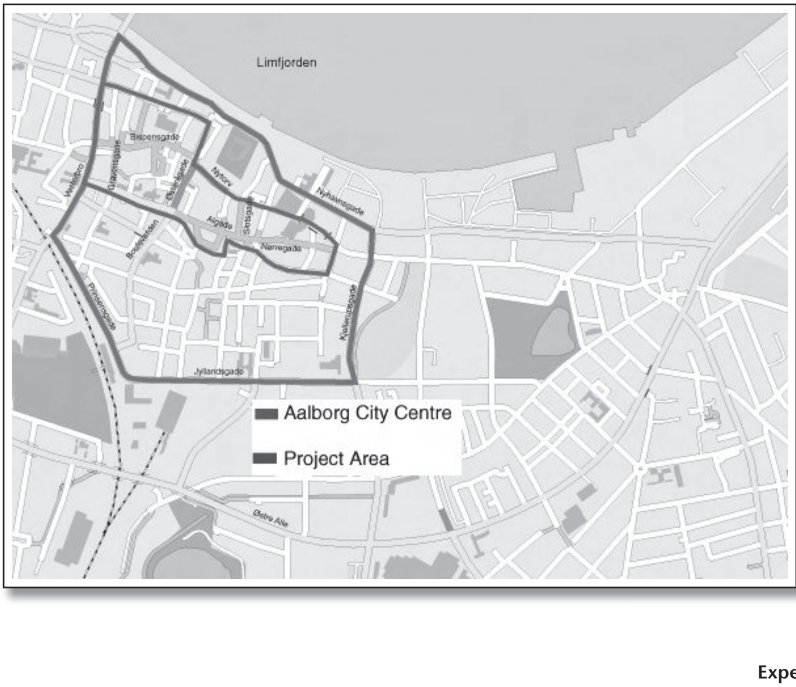


Figure 8.16:
Aalborg Target and project area

Over 80% of the freight delivery in this area is performed by 4 distributors. Earlier the freight delivery was spread over more distributors which often caused congestion on the narrow roads and irritation among the drivers. In order to reduce the annoyance caused by freight delivery to the people living in the area and the visitors/consumers and thereby improve the quality of life Aalborg has initiated several measures to make the freight distribution more efficient.

Purpose and potential

A stop interview survey was carried out in order to find out the purpose of driving in the pedestrian area. Figure 8.17 shows the results of the survey.

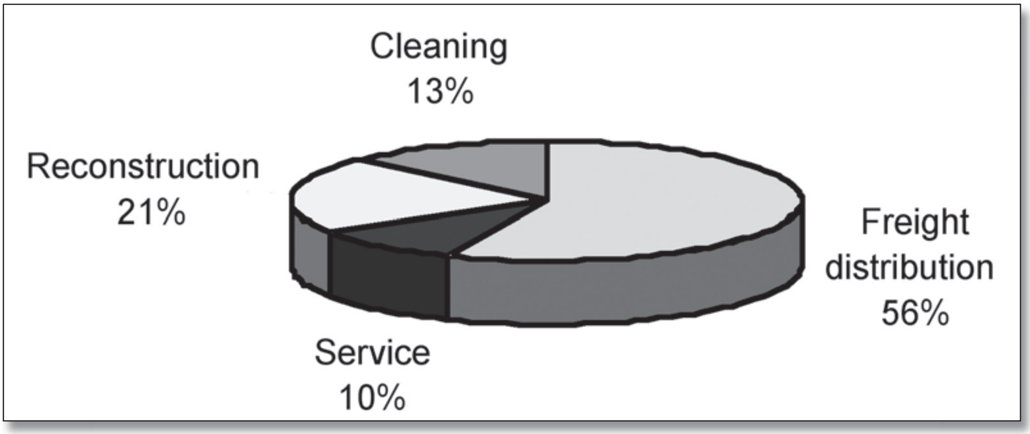


Figure 8.17: **Vehicle purpose in the target area**

Results show that 56% of the driving in the target area was performed by freight distribution. The other 44% was carried out by vehicles performing cleaning, reconstruction and services. This means initially that about half the driving in the target area can be influenced by the measures implemented. The other half can only be influenced due to change of driving direction or other restrictions.

However, not all freight transport can be influenced by the measures implemented. In order to estimate how much of the freight distribution will be influenced by the measures an investigation was carried out to clarify the size of freight transport that potentially could be affected.

Figure 8.18 shows that 41% of the deliveries has a city logistics potential while 31% of the freight deliveries in the pedestrian area could not be affected by the measures implemented due to the nature of the freight delivered e.g. money transport and dangerous or sensitive freight. In total this means that approximately 69% of the driving in the target area can be made more efficient by implementing the measures.

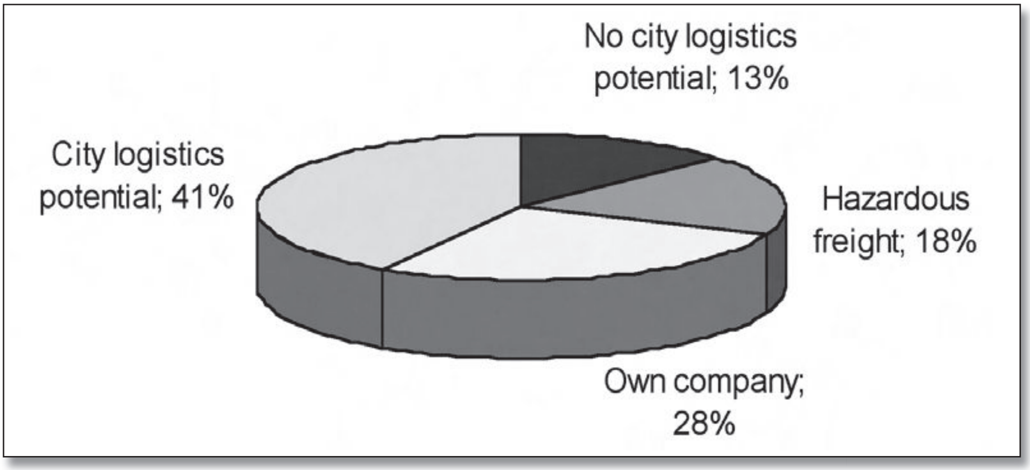


Figure 8.18: **Potential for city logistics solutions in Aalborg**

The stop interview survey also included a registration of type of vehicle and type of fuel used. Figure 8.19 shows that most of the vehicles registered in the target area are younger than 8 years (1995). The vehicles younger than 8 years are mostly driven by diesel engines. More than half the vehicles registered in the target area are vans fuelled with diesel.

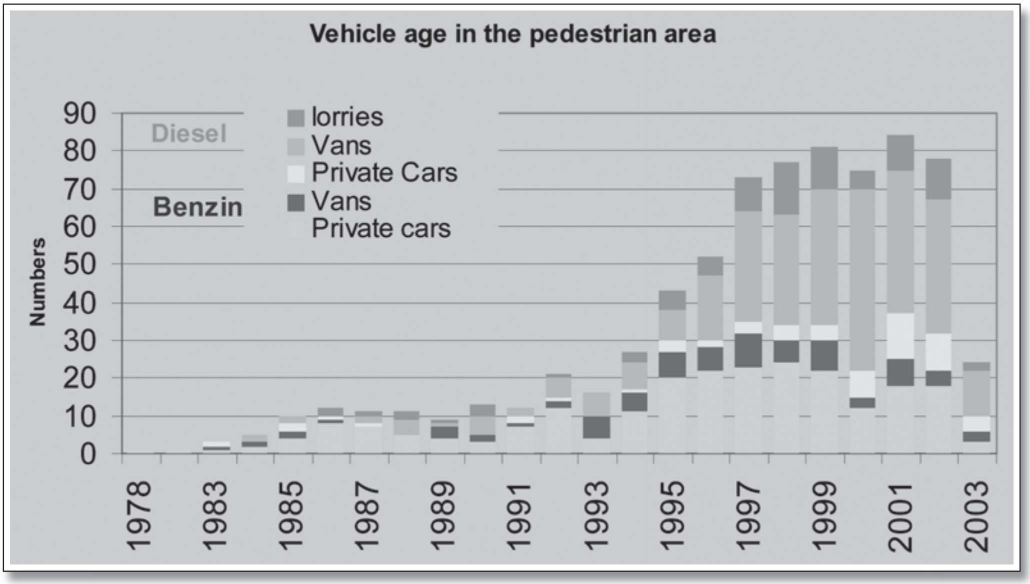


Figure 8.19: **Age, type of vehicle and type of fuel among the vehicles in the target area**

Objectives

The overall objectives for Aalborg in the City Logistics Solutions project are the same as in Copenhagen, to develop and on a trial basis to implement new methods to improve the freight distribution in middle-sized cities and reduce the negative environmental effect. However the approach in Aalborg is different from that in Copenhagen. The principle in Aalborg was based on voluntary participation. This means that the municipality, the commercial service and the freight distributors started a dialogue and defined the measures in order to make freight delivery more efficient in the city centre. The objectives in Aalborg were:

- On time delivery;
- more efficient delivery;
- improved working conditions for freight distributors; and
- reduced numbers of freight vehicles in the city centre.

Measures

Based on the objectives and the physical boundaries in Aalborg City Centre the parties defined a series of measures to be implemented:

- Creation of loading and unloading zones;
- two persons in each vehicle;
- creation of a consignment note among the distributors;
- change of driving direction in pedestrian area;
- a co-ordination of freight delivery among the distributors;
- electric driven vehicles;
- regulation and access restriction in the pedestrian area for freight transport; and
- one shop function as drop zone for freight to other shops nearby.

8.4.5 Results - Aalborg

The evaluation method was a before and after study undertaken in April 2002, (before study) May/November 2002 (after study 1) and in March 2003 (after study 2). The key parameters in the evaluation were:

- Time spent on freight delivery in the pedestrian area; and
- the freight distributors ability to comply with the access restriction;

Other parameters enabled an evaluation and conclusions could be drawn for each of the measures implemented.

In the pedestrian zone the access restriction in general states that freight distribution should be undertaken between 05:00 and 11:00 e.g. before the citizens rush into the area. However, some types of freight delivery need special conditions for delivery e.g. outside the access restriction for which in most cases permission is granted. Figure 8.20 shows in which time slot the freight delivery took place.

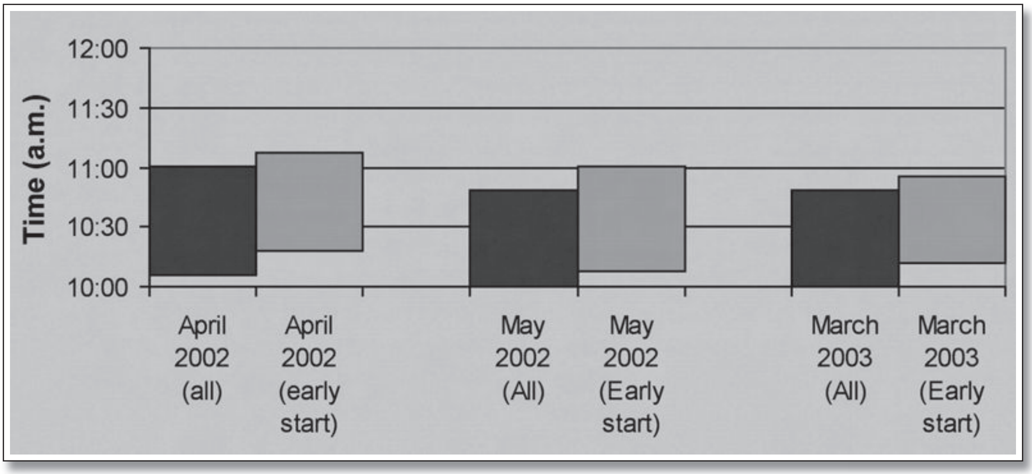


Figure 8.20: **Starting and ending time for delivery**

Figure 8.20 shows that the average starting time for all the monitored vehicles (a total of 6 vehicles) changed from 10:06 in the before registration to 09:57 and 10:00 in the two after registrations. However, one distributor was able to deliver the goods before normal opening hours and thereby influenced the total overall registration and thereby the result. Leaving out that distributor the average starting time was 10:18 in the before registration and 10:08 and 10:12 in the two after registrations.

The average time of leaving the pedestrianised zone changed from 11:00 in the before registration to 10:48 in both after registrations. Leaving out the "early" distributor the ending time changed from 11:07 in the before situation to 11:00 and 10:55 in the two after situations. The result shows that the distributors on average started their distribution 6-10 minutes earlier and left the pedestrianised zone 12 minutes earlier.

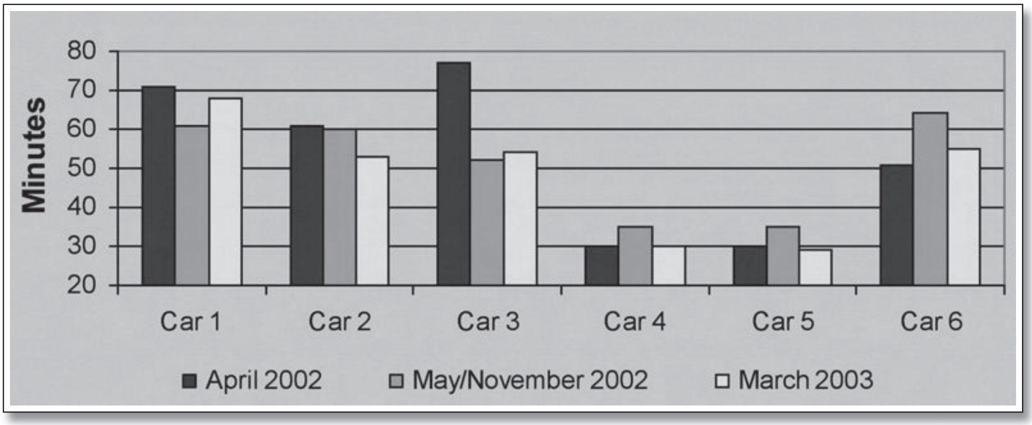


Figure 8.21: **Time spent on delivery per vehicle**

Figure 8.21 shows that all but one vehicle has reduced their delivery time during the entire trial period. For all the vehicles the average spending time on delivery is shown in Figure 8.22.

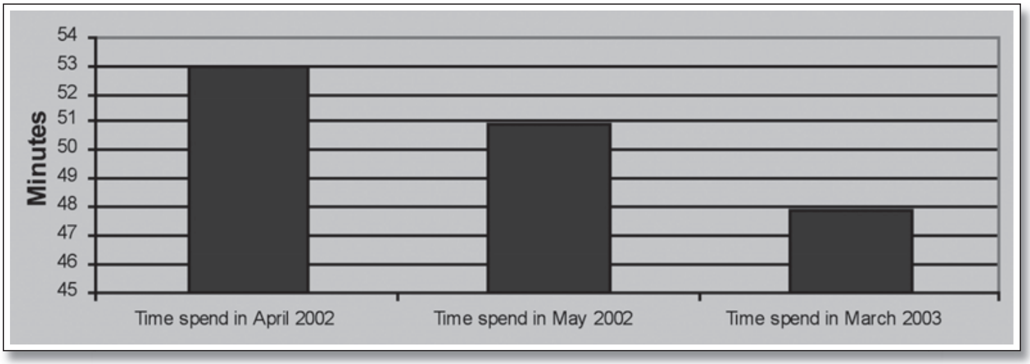


Figure 8.22: **Average time spent on delivery**

The average delivery time was 53 minutes per vehicle in the April 2002 registration. It dropped to 51 minutes in May 2002 registration and finally to 48 minutes in March 2003, an average reduction by 5 minutes or an approximate 10% reduction in time. Although 5 minutes does not seem much, if it is assumed that all vehicles entering the pedestrian area cut 5 minutes of the delivering time it adds up to hours each day with less traffic in the pedestrianised zone. However most important is the fact that the measures implemented are fulfilled. A count survey showed that the number of vans and lorries delivering freight in the pedestrianised zone has not been reduced but that was not the purpose of the initiatives. To give an overview of the experiences gained in the Aalborg project a short description of each measure is given in Table 8.6:

Measure:	Optimization internally by the freight distributors.
Objectives:	Improve delivery time. • Dialogue with the drivers • Pickups by using the backdoors
Experience:	Optimization of time spent on freight delivery. Left the pedestrianised zone earlier.
Measure:	Optimization of the logistics chain.
Objectives:	On time delivery.
Condition:	No delivery to other commercial operators before deliveries in the pedestrianised zone.
Experience:	Optimisation of time spent on freight delivery. Left the pedestrian area earlier.

Measure:	Establishment of loading and unloading zones.
Objectives:	Reduced congestion in the pedestrian area.
Condition:	Loading and unloading zones were located in co-operation with drivers, freight companies, shopkeepers and the municipality.
	An agreement with the shopkeepers regarding putting commerce in the pedestrian area before freight deliveries.
Experience:	Less waiting time for the drivers, leaving the pedestrian area earlier.
Measure:	Delivery and pickup at the same time.
Objectives:	Less delivery vehicles in the afternoon.
Condition:	Agreement between the freight distributors and the shop keepers.
Experience:	Visually improved environment and optimisation for freight companies.
Measure:	Two persons in each vehicle.
Objective:	Faster delivery.
Condition:	Agreement between the freight distributors.
Experience:	Not financially liable.
Measure:	Delivery to shops at late opening hours.
Objective:	Delivery at neighboring shops.
Condition:	Agreement between the shopkeepers and the freight distributors.
Experience:	Less waiting time.
Measure:	Co-ordinated distribution plan among drivers.
Objective:	Less congestion because the drivers starts at different locations in the pedestrian area.
Condition:	Agreement with the freight distributors.
	Necessary with extra car due to new starting points.
Experience:	No trial due to expected high costs.
Measure:	Driving carefully.
Objective:	Improved working condition for the drivers.
Condition:	Agreement with the drivers.
Experience:	Improved working conditions for the drivers.

Table 8.6: **Summary of implementation experience in Aalborg**

8.4.6 Conclusions

During the trial period Aalborg implemented several different measures to reduce the growing demand for goods distribution in the city centre. The two primary objectives were to reduce the time spent on delivering goods in the pedestrian area in the city centre and to improve the goods distributors' ability to respect the time access restriction. Besides these objectives each element implemented was related to a specific goal in order to improve the freight distribution in the city centre.

The main conclusions drawn by the trial in Aalborg were:

- The Aalborg trial was built on voluntary participation. The creation of a local steering group for city logistics solutions where new ideas for freight distribution in urban areas could be discussed openly and with participation of the members of the logistics freight chain e.g. freight distributors, commercial operators, Municipality and the police, resulted in a high motivation among the participants in order to make the trial a success for all.
- The measures implemented during the trial period have lead to an average 5 minutes time reduction in delivering freight in the city centre. The driver's ability to comply with the time access restriction has improved e.g. they are leaving the pedestrianised zone earlier after the implementation of the measures. Individually the measures implemented have lead to improved time spent on freight delivery, visual and environmental improvements for all stakeholders in the area, improved working conditions among the drivers. Some of the measures implemented were not equally successful in meeting the objectives. However, they still gave inspiration to further trials or projects.
- Local conditions e.g. distribution flow and street network play an important role for the measures in meeting the objectives. It is important that the measures are built on local conditions. And most importantly the measures implemented during the Aalborg trial can be transferred to improve freight distribution in other cities.

8.5 The Experience of Spain: Seville

J Muñuzuri, J Larrañeta, N Ibáñez, L Onieva

8.5.1 Background

Sevilla is the largest city in the southern half of Spain. It is located in the middle of the Guadalquivir valley and represents a very important logistics centre with the only inland port in Spain and one of the main airports, and it is the main business centre in the Andalusia region.

Sevilla has a population of 700,000 inhabitants within itself, but it is important to focus also on its metropolitan area. This zone consists of a large number of small and medium-sized towns and residential areas, located within a 20 km. radius from Sevilla, which add an extra 300,000 inhabitants. A high percentage of these people work in Sevilla and most of them use their own car which increases the traffic density around the city, especially during peak-hours. Traffic flows, as in most cities, run from the edges of the city and from the metropolitan areas towards the centre in the mornings, and back in the evenings.

Sevilla is a city whose economy is very much related to services and the tourism industry. It is the centre of a very important agricultural area and has some basic industry (several industrial sites located on the outskirts), but like many other major cities, the service sector is dominant. The type of goods delivered into and around the city basically consists of food and drinks (for supermarkets, bars and restaurants), shop items and construction materials. These deliveries happen to be needed mostly in the morning, which forces truck drivers to compete with private vehicles' peak hours.

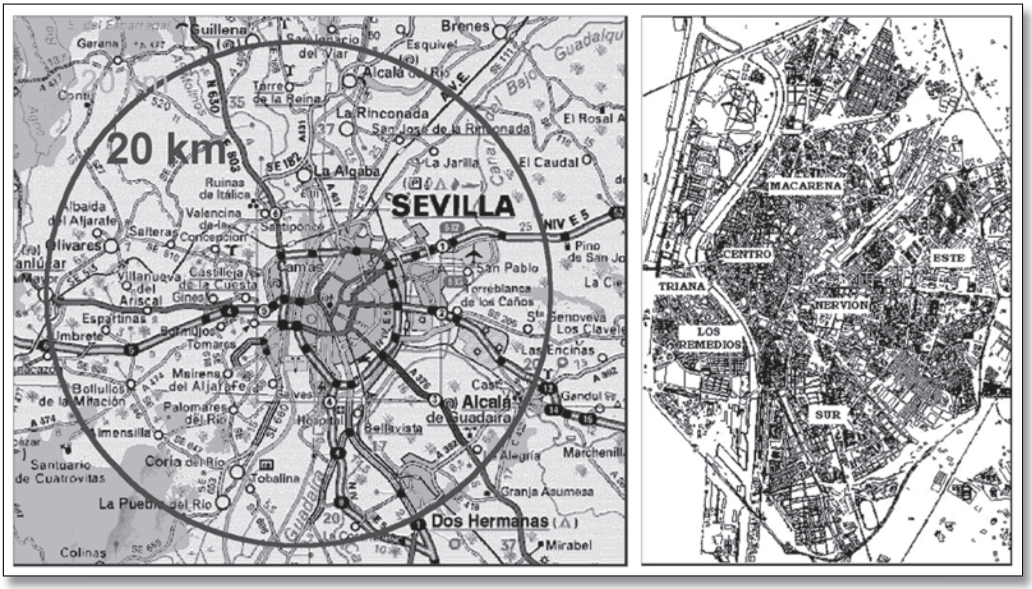


Figure 8.23: **Metropolitan area of Sevilla and main sectors within the city**

The city map shown in Figure 8.23 displays the main areas in which the city can be divided. Among these areas, the highest business and commercial densities can be found in the historical city centre (Centro), Los Remedios and Nervión. These three areas have a strong incidence both of private vehicles and freight every day, which causes high degrees of congestion and load/unload problems. Special mobility plans, including freight transport considerations, are required for each one of these three areas, but nevertheless the most delicate situation appears in the city centre. Tables 8.7 and 8.8 present some relevant information about the city centre of Sevilla.

	Metropolitan Sevilla	City centre
Population	1,000,000	56,000
Surface	700 km2	1.5 km2
Number of person movements per day • Walking • Private vehicle • Bus	2,400,000 1,050,000 910,000 420,000	1,000,000 600,000 185,000 210,000
Number of vehicle trips • Private vehicles • Buses • Freight vehicles	 750,000 4,000 75,000	 150,000 2,300 9,100

Table 8.7: **Relative weight of the city centre within the Sevilla metropolitan region**

Historically, the Sevilla city centre was the heart of the city, and in many ways it still is, but certain problems have arisen which threaten the future of the area. The city centre has a medieval structure, and besides its economic and commercial relevance, it is the main focus of tourist attraction in the city. All this motivates a very intense demand for mobility, including private passenger traffic, public transport and freight deliveries, which the area finds very difficult to absorb. High congestion levels, aggravated by double parking and load/unload activities compete with intense pedestrian displacements in the area.

	Number	Hours
Commercial establishments	500	10:00 to 14:00 and 17:00 to 20.30
Drinks/food	500	08:00/12:00 to 23:00/02:00
Entry streets	7	
Exit streets	8	
Load/unload areas	35	07:00 to 11:00 and 15:00 to 17:00
Surface parking areas	7	
Underground parking areas	7	08:00 to 21:00
Parcel vehicles	400	
Own transport vehicles	250	
Other freight vehicles	350	
Pedestrian areas	2	

Table 8.8: **Relevant data for the centre of Sevilla regarding commercial activity and freight distribution**

Due to the characteristics of narrow pedestrian streets where cars are not allowed, old buildings and high rents, and even insecurity, a lot of residents have been moving out of the city centre into other neighbourhoods of Sevilla and the suburbs of the metropolitan area. The subsequent effect is that many houses are empty, and after the shops close in the evening, the city centre is very deserted. Besides, the difficulty of finding a parking space in the city centre makes many people go shopping to the large department stores in other areas of the city.

However, the intention is to keep the city centre as the commercial, business and residential heart of the city. This means many improvements in:

- New urban plans to enhance the residential attractiveness of the area;
- access and parking spaces for private vehicles;
- good conditions for the retailers of the area, so that they can attract customers;
- performance of the freight delivery system; and
- protection of the architectural and historical values of the city centre.

The remainder of this discussion describes the solutions developed and implemented in pursuit of these improvements. The work described has been achieved in the context of the INTERREG III project MEROPE which is discussed in Chapter 12.

8.5.2 Stakeholder groups involved and their requirements

The conditions described above make it necessary to seek a difficult equilibrium between all the stakeholders involved. Indeed, having trucks driving around the city centre spoils the beauty of the landscape, but reliable freight deliveries are necessary for the commercial activity. Private cars need parking spaces, but more load/unload zones are requested by truck drivers.

Therefore, any logistics initiatives aimed at improving freight transport in the city centre require a consensus between the stakeholders involved in mobility issues within the centre of Sevilla. This is best achieved by a clear understanding of their user requirements (see Chapter 2). The main stakeholder groups related to freight transport in the historical centre of the city are:

- Freight carriers: This includes most companies carrying goods daily in the city, leaving out some specific transport types like construction materials, waste collection, moving companies and dangerous goods. The main types of freight carriers are couriers, companies that carry their own goods (truckload transport) and companies that carry general packages (less than truckload transport).
- Freight receivers: Almost every conceivable activity carried out in a city involves some type of freight movement, but the most frequent and steady receivers of freight are local businesses and commerce. They are embodied in the Chamber of Commerce, but they do not always have a common positioning with respect to freight transport.

- Residents: Persons living in the area will be affected by any urban logistic plan implemented, due to its interaction with general traffic and with the quality of life in the zone.
- Local Administration: The authorities occupied in traffic management in the city, commissioned to select and implement urban logistics plans, seeking the equilibrium between all the other actor groups.
- External actors: This last group comprises all the persons who, due to shopping, work or leisure reasons, access the city centre on a regular basis.

In the morning, congested areas can be found around access points to the main commercial and business areas in the city. This congestion is aggravated by freight delivery activities, which are usually parallel to the morning peak hours. The situation is basically that of a fight for the space, between private vehicles and trucks:

- From the private vehicle's point of view, trucks are too slow, and load/unload operations mean less parking space and often street blocking.
- From the truck's point of view, the traffic congestion caused by private vehicles slows down delivery activities.

The actions to be taken in order to untie this situation, some of which are included in the new Sevilla Strategic Plan for 2010, seek the equilibrium between the different groups of stakeholders involved in the Sevilla city centre.

Regulations and requirements of stakeholder groups

Mobility regulations in the city do not pay significant attention to freight transport. The most relevant regulations are:

- Definition of temporary kerbside load zones, available only from 07:00 to 11:00 and from 15:00 to 17:00 hours.
- Access to the city centre is allowed to freight vehicles only from 07:00 to 11:00, with the obligation to leave before 12:00, and from 15:00 to 17:00, with the obligation to leave before 18:00.

In meetings with the representatives of the freight carriers operating in Sevilla a large number of well defined problems were identified. This list of problems then turned into a series of requirements formulated by this group of actors which they believe would improve the situation (at least their situation) with respect to freight transport in the centre of Sevilla. Some of the main problems identified were:

1. Parking space is scarce and freight vehicles have to compete for it with other types of transport modes (private vehicles, buses, taxis, motorbikes). Load zones are often occupied by private cars, or else by long stays of other freight vehicles that do not allow others to access the load zone.

2. Time windows are too narrow for the access of freight vehicles to the city centre. These windows do not correspond to the hours when shops are open (usually they do not open earlier than 10.00 in the morning or 17.30 in the afternoon).
3. There is not enough logistics infrastructure to perform freight load/unload operations and deliveries in an optimal way.
4. Pedestrian areas do not have an easy access for freight deliveries and on-foot deliveries away from the vehicle are difficult to make if it is illegally parked, for fear of parking tickets.
5. All the problems that have to be faced by freight carriers usually force them to deliver the goods without much regard to complete observation of traffic regulations.

Therefore, two of the main requirements expressed by freight carriers with respect to the centre of Sevilla are:

- An easier access to load zones
- Less restrictive time window regulations

Several types of solutions were contemplated in order to try and fulfil these requirements. The elimination of the access time windows was rejected by the local Administration and the external actors, as was the increase in the number of load zones. Residents and receivers were opposed to night deliveries, and both carriers and receivers refused the introduction of co-operation schemes and joint deliveries. However, the reservation of load zones seemed to generate the agreement of all the stakeholders, and the demonstration of a mini-hub system was also accepted by the local Authorities as a possible solution to the controversial time windows.

8.5.3 Description of the pilot project

According to the requirements of the freight carriers regarding the city centre of Seville, the reservation of load zones have been tested in the city centre within the framework of the MEROPE project. A second different solution, the implementation of a mini-hub system, was also optional for demonstration, depending on the number of carriers interested in the initiative. Both solutions are described next.

The advantage of the solutions selected is the possibility of a gradual implementation. In case the pilot project offered positive results, it would be relatively easy to extend the demonstrations to a larger number of carriers, other areas of the city, etc.

Load zone reservations

This initiative proposes the introduction of a system for optimising the use of load zones, by guaranteeing their exclusive availability for pre-specified freight delivery vehicles. This system would also guarantee the adequate rotation of vehicles in the load zones, avoiding indefinite stays of delivery vehicles in them.

The system, when fully implemented, would consist of:

- A central station (web server) with a software application for load zone reservation processing and data query.
- On-site equipment for controlling vehicle rotation in load zones. In the first stage corresponding to the pilot project, however, the on-site equipment will be discarded due to cost reasons, and the performance monitoring will be manual during the demonstrations.

The objective is to allow the participating freight carriers to reserve, up to a limit, certain load zones located in the centre of Sevilla for their operations. Carriers would thus be guaranteed the availability of the parking space when they require it as long as the time slot has not been previously reserved for that load zone by another carrier. Load zone reservations could then be done on-site, by phone or via the Internet, and the question remains whether carriers would be charged for using the service in case of a definitive implementation of the system, and how much.

Figure 8.24 shows a representation of the web application designed for the management of load zone reservations. Each one of the participating carriers will be assigned a login and password for access to the web, finding then a main menu with the options

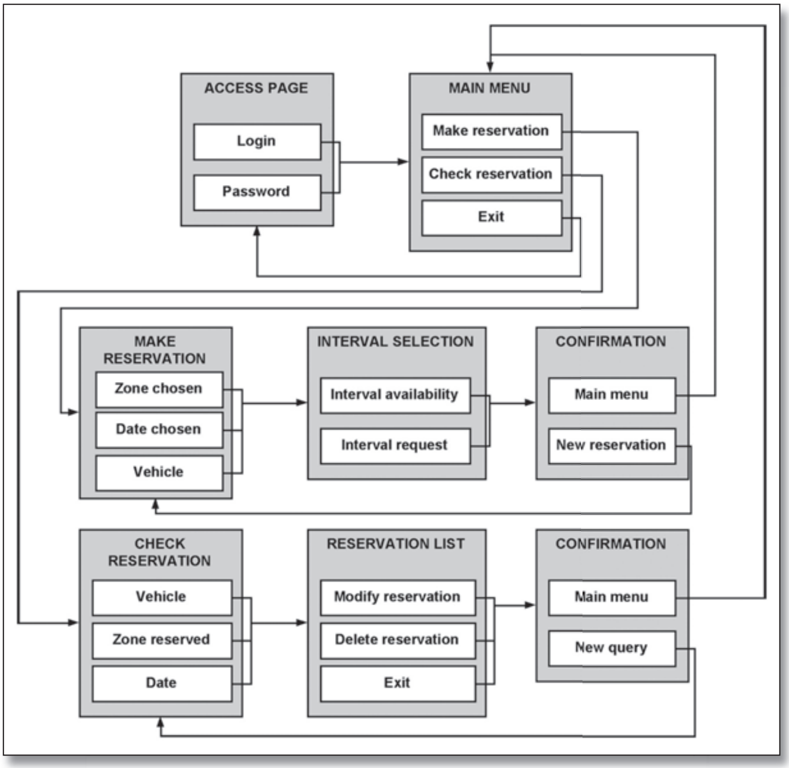


Figure 8.24: **Schematic representation of the web-based application for load zone reservation**

of making a new reservation or editing the existing reservations. If the carrier wants to make a new reservation he should enter the load zone and date and the vehicle licence plate and will then be shown the available time slots for that zone on that specific day. After selecting the desired free slot the reservation is registered in the system. On the other hand, if the carrier wants to check the existing reservations he has already made, he again needs to identify the vehicle, zones and date, and is then shown a list with the existing reservations for that vehicle. These reservations may be modified or deleted and the changes are also registered in the system.

Mini-hub system

This solution consists of the delimitation within the city centre of a number of hub areas which would typically be reserved parking spaces for delivery vehicles. Vehicles may enter the mini-hubs during the time specified by the access time windows but they would then not be forced to leave the mini-hub at the end of the time window interval. Instead, the vehicle may remain parked in the mini-hub while the final deliveries to the end customers are made on foot or using hand-carts or other types of equipment suitable for pedestrian areas.

Figure 8.25 shows a representation of a mini-hub which may also contain small warehousing facilities. These hub areas would be complementary to the current load zones and the adequate rotation of freight vehicles would need to be ensured, perhaps reserving time slots for the different carriers. Entry and exit routes for each mini-hub would also need to be defined.

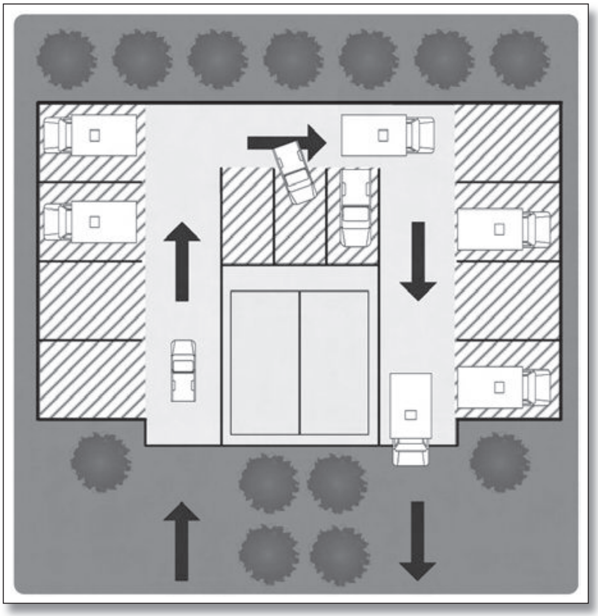


Figure 8.25: **Representation of a mini-hub for urban delivery of goods**

This solution is especially interesting when combined with joint delivery initiatives in order to reduce the number of vehicles accessing the mini-hub locations. In the case of Sevilla, the final demonstration of this solution depends on the number of carriers interested since this system is not suitable for all types of goods. Large items or large loads would not be very appropriate for mini-hub delivery and these are the most habitual types of transport in the centre of Sevilla.

Organisation of the demonstrations

One of the main conditions for the success of such a pilot project is the involvement of all the possible actor groups. In this case, the institutions involved in the project are:

- The traffic division (Delegación de Gobernación) of the Sevilla City Hall
- Emcofeantran and Asatrans: regional associations of transport carriers
- The receivers corresponding to the participating carriers
- AICIA: Sevilla Engineering School[1]
- Proinca: consulting company

Two types of commissions control the progress of this local project:

- The Supervising Commission consisting of representatives of the City Hall, the carriers associations, AICIA and Proinca, meeting once per term, generate progress reports and are responsible for the issuing of the final report of the project.
- The Technical Commission, consisting of representatives of AICIA and Proinca, control the evolution of the project and develop the web application and the evaluation procedure.

The actions to be taken within the pilot project are represented in Table 8.9, together with the responsible institutions in each case.

Phase	Action	Responsible
Phase 1: Preparation	Establishment of a forum with the participating carriers	Proinca
	Explanation of the demonstrations and establishment of a schedule	Proinca, AICIA
	Initial dissemination at a local level: zones designated for the demonstrations and their duration and objectives	Proinca
	Design and development of the web application for load zone reservation	AICIA
	Information to carriers regarding the use of the web application	Proinca

1 The AICIA group for Project MEROPE is composed of the following members: Juan Larrañeta, Jesús Muñuzuri, Nicolás Ibáñez, Luis Onieva, Pablo Cortés and José Guadix.

Phase	Action	Responsible
Phase 2: Development of demonstrations	Load zone demarcation with identification and signalling	Ayuntamiento
	Identification by means of stickers of the vehicles participating in the demonstrations.	Emcofeantran/ Asatrans
	Control of the designated zones to ensure that they are used only by the vehicles participating in the demonstrations.	Ayuntamiento
	Control of the development of the demonstrations: adequate vehicle rotation, observance of the reservations, etc.	AICIA
	Performance of the delivery operations within the framework of the demonstrations.	Emcofeantran/ Asatrans
	Gathering of information related to the demonstrations.	AICIA
Phase 3: Evaluation and diffusion	Design of a questionnaire for evaluation of the demonstrations.	AICIA
	Filling of the questionnaire by members of the carriers and the local Administration.	Ayuntamiento, Emcofeantran/ Asatrans
	Processing of the information obtained in the questionnaires.	AICIA
	Final evaluation using discrete choice models of the solutions tested.	AICIA
	Dissemination of the results obtained	AICIA, Proinca

Table 8.9: **List of the tasks undertaken within the project and responsible institutions in each case**

Figure 8.26 shows the proposed locations for the demonstrations in the centre of the city.

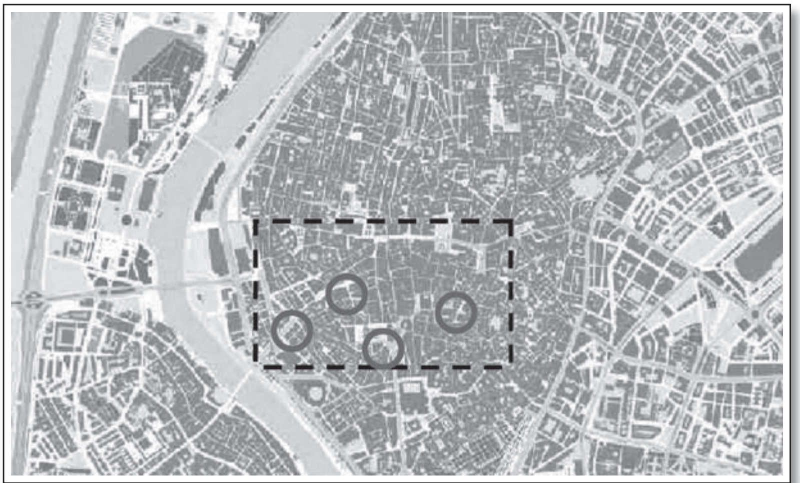


Figure 8.26: **The proposed locations for the demonstrations are marked with circles. The dotted line shows the area within the city centre with the highest commercial density, and therefore with the higher number of deliveries per day**

8.5.4 Evaluation

This being a pilot project its primary objective is to determine the degree of feasibility of the logistics solutions tested. Thus, the opinion of the carriers and the local Administration will be considered with the intention of modifying the solutions, definitely dismissing them, or recommending their full implementation.

Therefore, the analytical tools to be applied in this project are those that allow quantification of the results in order to be able to decide, with the appropriate indicators, whether the tested solutions are adequate or not for the centre of Sevilla. With that objective in mind two widespread tools for similar tasks will be used, namely discrete choice models and multi-criteria analysis.

Discrete choice models represent one of the most powerful tools to assess individual behaviour and preferences. Their application requires information obtained via a questionnaire, where the individuals, in this case the participating carriers, are confronted with pairs of scenarios and forced to choose the one they prefer in each case. Each scenario is defined by different attributes, and the objective is to determine the relative importance assigned by the individuals to those attributes, thus inferring the most preferred scenario for freight delivery in the centre of Sevilla. The design of the questionnaire will be carried out applying efficient techniques in order to obtain the maximum amount of information from the individuals interviewed.

The discrete choice model to be used will be a mixture of two different types of techniques:

- Revealed preferences, where the individuals evaluate scenarios they have experienced during the demonstrations.
- Stated preferences, where the individuals evaluate hypothetical scenarios that have not been experienced by them.

8.5.5 Controversial issues

Finally, there are a number of controversial aspects related to the implementation of a load zone reservation scheme or a mini-hub system in the city of Sevilla.

With respect to the carriers:

- Are they willing to pay for these services? The question of who is going to pay for the implementation, maintenance and control of these logistics solutions is perhaps the most important one to be answered, and carriers might be willing to cover these costs, or at least part of them, if they find they can obtain an added value in return.
- How relevant is the exact location of the reserved load zones or mini-hubs? Or, in other words, how distant from the final destinations can these facilities be located for

them to be useful? This would lead to answering the question of how many of them would be required in the centre of Sevilla.

- Can the acceptance of rules be expected in case of the final implementation of the solutions? The question remains whether carriers are really willing to abandon their current practices of double parking in front of the receiver's premises for an easier delivery. They should be aware of the responsibility they assume when accepting to change to the proposed solutions.
- Would different rules be needed to account for the different types of carriers existing? Should less-than-truckload carriers be allowed to use mini-hubs or reservations in a different way to full truckload carriers? Or should carriers of daily products be allowed to behave differently from furniture carriers?

With respect to the local authorities:

- What should be the maximum width of the time slot a certain carrier may reserve? This should take into account the types of carriers that are willing to use the system, and the time they usually take for delivery of goods.
- How should the observance of the rules be enforced? What types of sanctions should be applied to carriers that do not observe the access time windows but do not operate from a mini-hub either, or to carriers that have a delay in leaving the reserved load zone after their time slot has expired?
- What alternative can be given to the vehicle that, when reaching its reserved load zone on time, finds the preceding freight vehicle still parked in it? Should it then be allowed to double park? Should it come back later?
- What type of actions should be taken if the delay has been caused by unexpected traffic jams, not allowing the carrier to reach the mini-hub or the reserved load zone on time? Should the carrier be to blame, or the traffic congestion instead?
- How will normal-day operations be controlled if the mentioned systems are fully implemented?
  Perhaps the associated introduction of closed-circuit TV cameras for controlling the rotation of vehicles in the reserved load zones or the mini-hubs and the absence of double parking would be an alternative, or the introduction of cameras with an optical character recognition system for reading license plates.
- How will the carriers not participating in the schemes be controlled? Reserved load zones and mini-hubs are meaningful only if double parking and time window infractions are strictly prosecuted, or else illegal operations would be far preferred by carriers.

It is desired to be able to give an answer to all, or most of these issues, after the analysis of the demonstrations and the evaluation process.

8.6 Experiences in The Netherlands

G Zomer, D Niewkerk, D Mans

8.6.1 Background

This section discusses some recent urban logistics experiments, measures and temporary measures in the Netherlands in several cities and summarizes some of the evaluation results. These results can be very useful in the successful implementation of future policy measures and experiments in urban logistics.

Amsterdam is the capital of The Netherlands with 736,000 inhabitants. About 11,000 commercial activities are located in the city centre of Amsterdam. For this reason the number of trucks or vans accessing the city for delivery of goods is very high. In 1996 the Municipality started a new logistics project and related measures in order to rationalize and decrease the freight traffic congestion level without hampering the overall city centre accessibility.

The urban goods distribution project has been conceived and implemented by the Municipality in close collaboration with the Chamber of Commerce and the involvement of relevant stakeholders among which the more proactive have been freight carriers and commercial activities owners.

An efficient access control system based on time windows and a ban of vehicles over 7.5 tons has been established, vehicles with a load factor higher than 80% and some special transport vehicles received an exemption to this ban. In this regard the future trend is toward a narrow regulation granting access rights only to emission free vehicles.

Distribution centres have been realised in the peripheral areas of the city where goods, of which the city centre is the final destination, are optimised in terms of loading capacity and redirected to lighter vehicles.

The effects have been measured in a 'before' and 'after' measurement. Indicators have been developed for the following categories (according to the PSD effect model developed by Platform Stedelijke Distributie):

- ***Attainability:*** number of vehicle kilometres, number of vehicle movements, travel time, number of obstacles (like bridges, small road sections, traffic lights, congestion), and type of vehicle.
- ***Quality of life:*** noise, air emissions, vehicle movements, complaints from citizens, complaints from shopping people, traffic safety.
- ***Transport efficiency:*** average load factor per trip, fuel consumption.
- ***Economic development:*** available sales floor space, visitors shopping area, number of retail shops, turnover/cost/profit figures retail shops, employment.
- ***Bearing surface:*** opinion citizens, opinion shopping audience, opinion transport companies, opinion shops and business, opinion municipality.

The results achieved are satisfying; a positive environmental impact has been assessed. The problems related to the goods supply, acknowledged by some commercial operators, are expected to decrease. The environmental impact will settle at an acceptable level, as the project will progress, in particular when the emission free vehicles stage is attained.

8.6.2 Tilburg

Tilburg is a large city in the southern part of The Netherlands with 200,000 inhabitants. In the City of Tilburg a project entailing the realisation of a Virtual Distribution Centre has been implemented with the aim of rationalising goods distribution and the related impacts in urban areas. It has been developed by the Regional Development Agency in collaboration with the Carrier Consulting Company and involves a telematics platform envisaged at fostering the co-operation among the different transport operators committed to regional and urban goods distribution. The platform enhances and facilitates the communication and message management, the exchange and sharing of order information and data planning among the different transport companies. The platform also performs advanced load capacity co-ordination, in order to accomplish demand / offers of load capacity or delivery specified along customised requisites.

To this end at pilot project level a telematics infrastructure entailing interaction tools for the actors involved in urban logistics activities and process planning / management has been realised, and considering the targeted operators' typology, particular attention has been given to the service access procedures suitable for SMEs. Fruition is unrestricted albeit not all services (i.e. route planning) are public but limited to specific user categories (depending on agreements made between the transport companies and the Platform Managing Authority).

Moreover, in view of the technological interface with the European Traffic Information System a service network of data communication to vehicles has been established. The results achieved are remarkable with regard to the operator message exchange, the loading optimisation service and the delivery and route planning service.

While the latter is operationally centralized and allows the organisation of different carriers' distribution activities matching the common direction routes, likewise for a single operator, the information exchange and load capacity optimisation system fosters a flexible management of the whole system and improved demand/supply harmonization capabilities.

Finally, with respect to the collaboration modalities among the different transport companies, supported by the services and infrastructures implemented, it has been assessed that the informal interaction on a voluntary basis is positively accepted and generally preferred to higher level and structured formal agreements.

8.6.3 Haarlem

DADIRA (Dalurendistributie Randstad) is a Dutch project initiated by the Centraal Bureau Levensmiddelenhandel (CBL) and GOVERA (representative organ of four Randstad provinces on urban logistics policy). The Dadira project started in 1996 and was aimed at distribution of food products to large retail stores in off-peak hours in the Randstad (Western part of the Netherlands). Dadira wants to improve the effectiveness and efficiency in the complete distribution chain (less vehicle kilometres) by realising tight co-operation between supplier, producer, distributor/importer, logistics service provider and large retailer and by following an integral approach of the logistics. Dadira wants to achieve bundling of volumes and tries to realise a change in attitude. Therefore, the project focuses on two aspects:

- Shift the primary distribution (from producer to distribution centre) to off-peak hours with the purpose of relieving the infrastructure as well as the lead time; and
- Realise widening of the distribution time fences in the secondary distribution (from distribution centre to shops).

For several months in 1999 a demonstration project took place in Haarlem for supply of shops in off-peak hours which was defined as before 07:00 in the morning or after 19:00 in the evening. Three grocery chains with shops divided over 5 shopping areas in Haarlem participated in the test. Haarlem is the capital of the Province Noord-Holland and has 150,000 inhabitants.

The test was evaluated (ex-ante and ex-post) according to the PSD effect model on the following aspects:

- Attainability
- Quality of life
- Transport efficiency
- Economic development
- Bearing surface

The size of the project and the duration were too short to draw hard conclusions about the effectiveness and efficiency of off-peak distribution. Nevertheless, the project provided some interesting findings:

- 7% of the (un)loadings took place during off-peak hours in the demonstration period;
- There was a more equal spread within the normal time window during the demonstration period;
- The average transport time of the trips in the early morning were shorter;
- The number of complaints from citizens and shopping audience was also smaller during the demonstration period.

8.6.4 Leiden

Leiden is an historic city with 118,000 inhabitants and with a road infrastructure dating from the middle ages. Leiden has almost 1,500 companies registered in the 'retail and leisure' sector. The inner city of Leiden with its shops, restaurants, museums, cultural institutes and other institutes has been declared as a 'protected area' by the national government and is the economic heart of the city and the region.

The road infrastructure is not designed for modern traffic usage. Congestion, lack of safety, air pollution and noise pollution are the negative consequences of current inner city traffic and threaten the quality of life in the inner city. In order to keep a good quality of life, Leiden has taken measures to decrease the number of cars within the city centre. These measures are:

- Extension of the car free zone;
- restriction of distribution time windows, only between 06.00 and 11.00 in the morning;
- dispensation possibility for vehicles outside time windows if desirable; and
- enforcement of car free zones using moveable bollards and a camera system.

In order to maintain an efficient and effective supply in the inner city the idea of a city distribution centre (CDC) came up as an attractive alternative for transport operators that could not deliver within the time windows or did not want to enter the busy city centre. Also shop owners and other companies could profit from a CDC by outsourcing their warehouse facilities and having the goods delivered on demand from the CDC.

The advantages of a CDC could be:

- Less vehicles within the city centre;
- transport of goods inside and out of the city with environmentally friendly vehicles, with dimensions optimal for inner city distribution in Leiden; and
- transport operators dropping the goods just outside the city borders and therefore gaining transport time advantages.

The local government of Leiden decided in 1994 that a CDC would be realised and it came into operation in 1997. The reasons for the long period between decision and real operation are explained later. The expectations of the CDC were:

- a daily reduction of the daily number of vehicle kilometres from 24,000 towards 5,000;
- a strong reduction of the pollution levels (emissions, bad smell, noise) in the city centre;
- an improved accessibility of the city centre;
- improved traffic safety; and
- a model example for similar cities in The Netherlands and in Europe.

The long-term objective was to have 3,000 daily shipments between the CDC and the rest of Leiden with 40 relatively small clean and environmentally friendly vehicles. At the start in 1997, the forecast for the first year was 500 shipments per day, break even point would be at 600 shipments per day.

The CDC never reached the required volumes for a commercial right to exist and was closed in 2000. There were several reasons for not meeting the expectations:

- Time planning: a disagreement between the three main shareholders led to a discharge of the director and a long juridical battle. The public private partnership construction made it impossible to proceed with operations during this juridical battle.
- The original location of the CDC required a change in the local development plan of the municipality. Juridical procedures from citizens made this impossible. As a consequence, a less suitable location (not directly along the highway) was found and could only become operational in 1997 after new environmental procedures.
- The number of shareholders remained behind expectations. During feasibility studies, large urban transport companies like PTT, Van Gend & Loos and Nederlandse Pakkket Dienst were positive about the concept but in the end gave up. This was a main reason for not generating enough volume.
- The main working area would be the inner city of Leiden. Because transport volume to the centre was too low the working area was expanded to the rest of Leiden and the surroundings of Leiden. Many expected benefits for the society were not, or to a less extent, realised by this expansion of the working area.
- Requirements for urban transport could not be enforced because of changes in the concept. The CDC and the exclusive right of shareholders for urban logistics in Leiden was seen as illegal support of a monopoly position (given the volume restrictions in order to become a shareholder) and it was impossible to enforce city distribution exclusively via the CDC.
- The municipality has financially participated in a company in a highly competitive market. It would have been better if the municipality role was restricted to co-ordination and setting the rules.

Some conclusions can be drawn from this example. There is a major resistance from the transport sector in The Netherlands for transhipment of inner city distribution because:

- Urban logistics is a highly competitive sector with low margins. According to the transport operators additional transhipment causes extra costs, risk and time delay.
- A single focus on inner city distribution does not match demands from transport companies if they want to make use of a CDC. The CDC should also be used for regional distribution. This concept is possible but has other consequences for societal impacts.

- A personal relationship with the receiver of the goods is very important for certain logistic service providers.
- There are many restrictions enforced by law for transhipment of cold and frozen food products.
- Insurance companies do not always allow transhipment of (valuable) goods.
- The CDC had a bad image especially due to the fact that the electrical vehicles hindered other vehicles outside the city centre because of their low speed. The bad image became worse when it became public that the local government invested a lot of money in the concept.

The experiences with a CDC have resulted in a serious blot of city logistics on the political agenda in Leiden. Similar projects in Maastricht, Arnhem and Utrecht have shown that CDC's bring along a series of problems. There are serious investments involved, large shippers usually do not fit into the concept, certain shipments can or may not be consolidated (cold/frozen food products, fresh food products, ..) and shops need to have appropriate storage facilities. The greatest bottlenecks for CDC's are the commercial viability and the compulsory collaboration. Nevertheless, the concept of a CDC seems to operate well in a country like Japan (Ambrosini and Routhiet, 2000).

*8.6.5 '*s-Hertogenbosch**

'*s-Hertogenbosch is the capital of the province Noord-Brabant and has 135,000 inhabitants. The project 'selective access 's-Hertogenbosch' is one of the pilot projects of PSD (just like Amsterdam, Haarlem, Tilburg, Den Haag and Groningen). This pilot project included "ideal time fences" in the priority area. By means of moveable obstacles, so called 'pyramids' or triangular bollards, the inner city can be locked to motorised traffic. The bollards can be operated with the help of a special pass or on request via an intercom system.

The inner city of 's-Hertogenbosch is characterised by a high claim on the use of the available space. Many important functions, like living, working, retail, social and recreational functions are combined in a relatively small area. The streets around the market are relatively small. In the design of the inner city infrastructure a central role was reserved for slow traffic (pedestrians and bicycles), which makes car traffic undesirable. A good attainability of the city centre is nevertheless an important side condition in reducing the traffic volume in the inner city.

At the end of 1997, a zero state analysis has been performed. At the end of 1999, an ex post evaluation has taken place, while the selective access system with bollards came into operation in the beginning of 1999. Around the city centre, the focus is on a quick and efficient traffic circulation; within the city centre the focus is on the quality of life. One of the measures aimed at keeping the inner city attainable and increasing the attractiveness of the inner city for residents and visitors is the implementation of a selective access system. Other important elements of the policy measure package include the parking policy and the policy of public transport and spatial planning and development.

In order to reduce the car traffic in the inner city the city implemented a parking reference system in 1998. This system helps car drivers who want to visit the city centre to search for available parking spaces just near the city centre.

In the parking policy focus is on enlarging the number of parking places for short stay. Parking pressure has been reduced in the city centre and moved to new parking garages just outside the city centre. The parking rate system stimulates the use of these garages by charging higher rates closer to the city centre.

Apart from a good accessibility for cars attention has been paid to the attainability by public transport. The frequency of buses to the city centre has been increased. In addition, the so-called 'piekbus' was introduced in 1998. This bus brings you from several places around the inner city to the city centre for 1 NLG (0.45 Euro). Since the introduction of the 'piekbus' the number of passengers has been increased which required an increase in capacity.

In order to increase the attractiveness of the inner city several streets have been redesigned by making them more attractive for a shopping audience. The starting point in the redesign was to minimise the number of obstacles or conflicts between pedestrians and other traffic participants.

Also parking places for bicycles and permission for events or for pavements were included in the policy measure package.

In order to maintain an efficient supply of retail and shops several new loading and unloading facilities have been created since 1997. This was necessary because the pressure for more loading/unloading facilities was high and resulted in regular situations of double-parking with all its negative consequences.

The measures were evaluated (ex-ante and ex-post) according to the PSD effect model on the following aspects:

- Attainability
- Quality of life
- Transport efficiency
- Economic development
- Bearing surface

The total number of vehicle kilometres times the loading capacity has been decreased which is due to the fact that transport operators try to maximize the bundling potential in order to avoid time losses caused by the selective access system. The measures also caused a shift from large trucks towards delivery vans and smaller trucks, which consequently have a better load factor.

The travel time from the outer city to the first delivery address within the city centre has been increased. Also the number of vehicle kilometres within the city centre has been increased. This is due to the fact that the degree of consolidation of shipments within an inner city trip has been increased. There was also a further concentration of deliveries during the morning time fence.

The shopping audience experienced less hindrance from moving freight transport though hindrance caused by loading and unloading was more concentrated in the morning hours. Traffic intensity in general has been reduced due to the selective access system causing a feeling of improved traffic safety although the number of accidents has not significantly changed during the evaluation period.

Retail turnover has not improved and economic indicators in this sector developed below the national trend. According to the shop owners this was not caused by the selective access system but by the many construction projects that took place in the city centre during this period.

The opinion from the citizens living in the city centre about the selective access system has not changed significantly. Most important for them is to have clear and transparent grounds for granting access and providing passes. In the introduction period, applying for an access pass was relatively easy. The municipality wants to sharpen the grounds for provision of passes in the future because the intensity of passenger cars in the city centre is still quite high. The policy of gradually sharpening the grounds for access passes has resulted in a high acceptance level and bearing surface for the system though the desirable effects of the policy will also appear later in time.

8.6.6 Groningen

Groningen is the capital of the province Groningen and with 177,000 inhabitants is the largest city in the Northern part of the Netherlands. The city centre is divided into four sectors, each with its own access roads. It is not possible to cross the sectors, this possibility is only offered by dedicated bus lanes. The project 'Stedelijke distributie Groningen' is one of the pilot projects of PSD. Within the project the effects have been evaluated of:

- Increased efficiency within the time windows; the intention to increase the efficiency of the supply of the inner city within the time windows by means of allowing co-use of dedicated bus lanes and crossing sector borders during the time window restriction period; and
- implementation of consolidation of supply of urban freight volumes; the structural implementation of consolidated city distribution in order to guarantee the attainability for entrepreneurs in the inner city outside time windows while keeping the quality level of living and shopping in the inner city at an acceptable level.

The measures were evaluated (ex-ante evaluation in 1999 and ex-post evaluation in 2001) according to the PSD effect model on the following aspects:

- Attainability
- Quality of life
- Transport efficiency
- Economic development
- Bearing surface

Increased efficiency within the time windows

Throwing open the dedicated bus lanes and sector borders in the inner city of Groningen for freight transport vehicles with a capacity above 3.5 tons had a positive contribution to the increased efficiency of goods supply within the time fences. The duration of freight vehicles in the inner city has decreased. Throwing open the dedicated bus lanes and sector borders during the time window restriction period opens the possibility for freight transport to enter and exit the city centre in a quick and efficient way. The co-use of bus lanes had no significant impact on the safety whereas buses experienced hardly any hindrance from the increased intensity on the bus lanes.

The time fences in Groningen generate problems for transport operators. This is mainly caused by the tight time fence (07.00-11.00) and the expanded opening hours of shops. Throwing open the bus lanes and sector borders has improved the problem of delivering within the available time window because:

- The average time the vehicles remain in the inner city has been decreased;
- the number of vehicle kilometres times the loading capacity of the vehicles has been decreased (higher loading factor of the fleet); and
- the traffic circulation has been improved due to the possibility of avoiding small and narrow streets. The possibility to cross section borders makes it possible to plan trips avoiding small and narrow streets and results in shorter trip distances.

Nevertheless, many transport operators are still confronted with not having finished the delivery trip before 11.00. An important aspect in the success of the pilot co-use of bus lanes is the bearing surface that has been created with the parties involved, being the Municipality of Groningen, Arriva (the operator of public transport services in the Northern part of the Netherlands) and the Noord-Nederland Division of the Ministry of Transport. All these parties were part of an advisory commission accompanying the complete process.

Implementation of consolidation of supply of urban freight volumes

In order to promote consolidation of supply of urban freight volumes Groningen decided in 1998 to implement a settlement for transport operating companies to perform city distribution outside the time windows. Companies that want approval for the settlement need to apply to certain criteria concerning the number of inner city deliveries and the vehicle characteristics of the operating fleet. Approved companies have a dispensation for the time fence policy.

In 1998 two transport operators became approved city distribution companies. Since 2000 three other companies have gained approval. The settlement for approval has been adjusted in the period between 2000 and 2002 in order to accommodate all freight transport volumes. The need for approval was and is tightly related to the enforcement policy, especially concerning the recognition of the approved vehicles. The enforcement was a major problem during the pilot period. As a consequence many operators made deliveries outside the time windows. This in turn had a negative effect on the advantage potential of approved transport operators. In 2002 the municipality of Groningen in collaboration with Platform Stedelijke Distributie designed a recognizable logo intended for the fleet of vehicles of approved transport operators.

8.6.7 VIFUL (Virtual Infrastructure for Urban Logistics)

An important and useful information source for experience with ICT in urban logistics is a Dutch Research study from 1999 (Bos/Stenfert Jkroese, 1999). In this study the feasibility of a Virtual Infrastructure For Urban Logistics (VIFUL) has been investigated. The focus is on efficient matchmaking between supply and demand, resulting in consolidation and bundling of freight on delivery addresses.

The following 6 steps have been undertaken:

1. Inventory of the market for urban logistics
2. Inventory of the experience with ICT in urban logistics
3. Factors for success and failure of ICT applications in urban logistics
4. Specific needs for ICT applications in urban logistics
5. Opportunities for ICT applications in urban logistics
6. Follow-up activities

In the first step, the analysis has led to three main transport clusters each with particular characteristics, namely:

- Incidental transport
- Professional transport
- Distribution

The transport types can also be divided into regular transport and irregular transport. Regular transport is characterised by a certain form of efficiency which is inherent to its large scale and regular character. Distribution is a type of regular transport. The same parties are involved in transport of goods between fixed locations by the same transport companies on a regular basis. Supply of supermarkets and large shopping malls is a good example of this type of transport. Truckload is often high which makes the need for improvement of efficiency less urgent.

The opportunities for a VIFUL-concept are primarily in the area of irregular urban transport: transport that is generated by incidental irregular demand from the city, with changing consignors and changing delivery addresses.

VIFUL requirements

The following requirements for a VIFUL-concept have been formulated:

Inherent requirements:

1. Build upon irregular transport segments
2. Committed system users
3. Demonstrable advantages for the system users
4. Bundling and consolidation of transport from consignors (from the start)
5. In line with development in urban logistics towards 24-hours and JIT-delivery.
6. Matchmaking of the price within the system
7. An open order entry system

Organisational requirements:

1. Develop enough added value so that the VIFUL organisation can support itself.
2. The functionality of VIFUL has to be at least enough in order to be able to play a substantial role in the unstructured goods transport market within 3 years.
3. Possible extension of transaction and invoicing functionality.

Requirements of the transport sector:

1. The current market situation is a stable situation in which all parties have their place and want to keep that position. This requires a cautious start in a test project.
2. The quality of the physical distribution process has to be high in order to have the concept accepted by consignors.
3. The system has to be open for smaller transport companies, though in general these companies have less developed ICT knowledge and experience. This should not be a hurdle for the smaller parties to participate because those parties are mainly focused on incidental and irregular transport.
4. A system based on information sharing instead of information protection requires a different culture from all parties involved while the parties have some conflicting objectives. The system has to deal with this issue in a constructive way.
5. The system has to be supported also by and through public authorities (policy, regulation).

VIFUL and URBIZZ

The conclusions from the VIFUL study have led to the development of the URBIZZ-concept. The main idea of URBIZZ is consolidation of urban deliveries in a demand-responsive way. The VIFUL research study has shown that demand responsive ICT services with the intention to improve the efficiency of disorganized goods transport in cities does not yet exist, but the potential of such services looks promising. PSD (Platform Stedelijke Distributie) has developed a special simulation model, the URBIZZ simulation model. This simulation model can be applied to demonstrate the possibility of matching demand for goods with supply of transport capacity just in time. The model is able to match various different demand patterns from the city to the different transport companies.

The problem of many concepts for city distribution is that in the short term no insight is available in the available transport capacity. By making use of consolidation of available capacity of transport companies in a smart way the number of vehicle movements in the city can be reduced. By assigning the available capacity in an efficient way the average load factor of trucks can be increased.

The URBIZZ-concept looks very promising but some practical and psychological hurdles have to be taken. These include the following research questions:

- Is the supplier willing to outsource his deliveries to an unknown transport company?
- Related to the above, can the level of quality for the transport be guaranteed and what happens in case of failures in delivery?
- Does an additional linkage in the supply chain of goods transport also result in longer lead times?
- Is it possible to include a payment module in the model in order to include cash-on-delivery (COD)?
- Will the concept really result in consolidation of flows of goods; is there a critical mass required?
- Does the system offer enough efficiency-advantages for the suppliers of transport capacity?
- Is the implementation and management of the model a private or a public task?
- Is the system able to offer a transport guarantee?

Many of these research questions have also been addressed in the eDRUL project which was introduced in Chapter 5.

8.7 The Experience of Portugal: Lisbon

R Macário, G Caiado

8.7.1 Background

The platform designed for the Lisbon site during the eDRUL project (see Chapter 5) did not have a real-life demonstration during the project life-time. Instead, a showcase-oriented format has been developed. This type of demonstration is characterised by the following attributes:

- Laboratory application;
- No real adaptation to site-specific infrastructure via the platform emulation of site-specific sub-systems by time series and parameterization;

- “Shadow” evaluation of business cases;
- No impact on clients at site.

Taking into account the Lisbon context and the user needs identified (eDRUL, 2002) the most relevant opportunities for the Lisbon showcase were the following:

- Demonstrate the potential of IT tools in urban freight management to decision makers;
- Serve as a platform to underpin the definition and specification of the legal and regulatory framework, principles and tools, which will contribute to the definition of an integrated policy in the field of urban logistics distribution;
- Develop new solutions which address specific problems in the area of urban logistics;
- Promote co-operation between the different actors involved in the urban distribution process.

8.7.2 Site and services description

The platform is a tool with the goal of managing urban logistics distribution and will perform its operation in two different areas in Lisbon adapting the same concept to the reality of these two areas (see Figure 8.27).

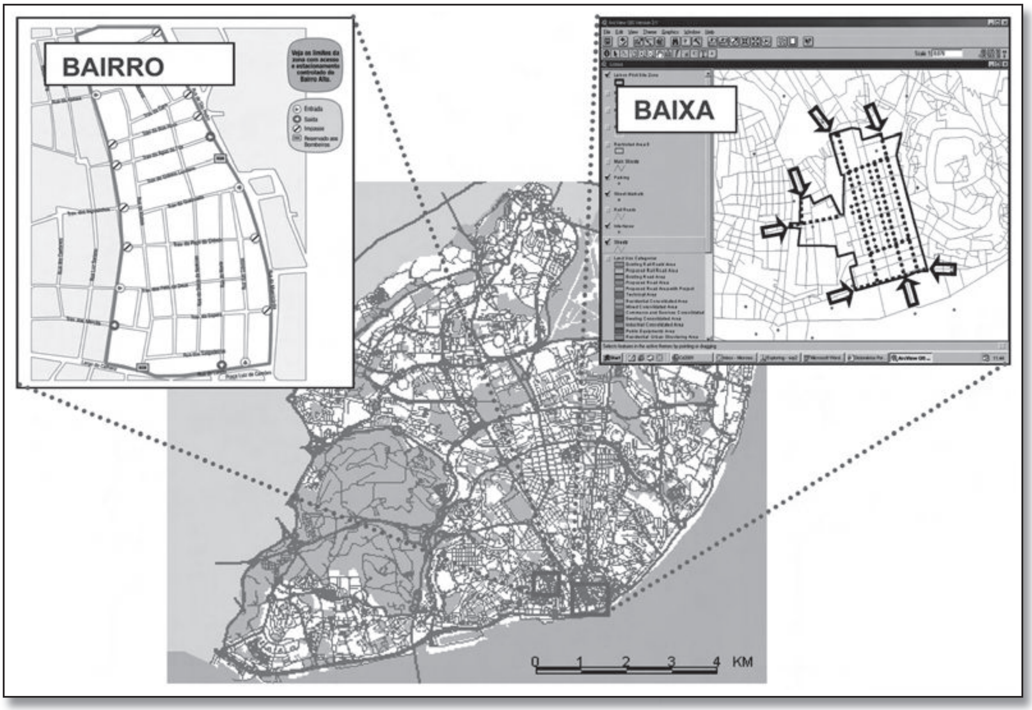


 Figure 8.27: **Geographical Scope of the Lisbon Site Platform**

At the start of the user needs analysis for the platform development only the Baixa area was referred to as being part of the eDRUL test site in Lisbon. Meanwhile, an access restriction system based on retractable bollards and DSRC technology with access cards for different user categories (residents, freight operators, etc.) was implemented in the Bairro Alto area. Taking into consideration the strong role of Access Restriction Systems in the overall concept it represents an opportunity for the Lisbon platform to integrate this system with the services to be provided. Taking these considerations into account two pilot application areas were defined for the Lisbon case study where the several services to be developed will be validated.

The platform will have an essential role in demonstrating the potential of IT tools in managing the urban freight process. For this goal several services for different user categories will be developed and validated. The methodological idea is to develop a first solution that will obviously need to be further adapted in the future through the re-dimensioning of parameters regarding the urban freight management issue (e.g. loading and unloading space provision, delivery time windows, freight vehicles weight limits, etc.).

The solution is to develop a concept in which the loading and unloading operations could be managed but in a more flexible way. For this purpose a new concept based on the use of mobile phones was developed.

Loading and Unloading (L&U) Space Management by using Mobile Phones

This concept is based upon the use of mobile phones in order to increase the efficiency of the delivery processes in urban areas. In this system the driver will have to declare the beginning and ending time of their delivery operation using a mobile phone. The services associated with this concept will allow the implementation of time limits when using loading and unloading (L&U) spaces. Another main goal of this concept is to promote and facilitate enforcement techniques. This concept will be developed for the *Baixa* area.

The goal of this concept is twofold. Firstly, it avoids one of the assumptions in which previous concepts are based upon (travel times of freight vehicles between customers are certain), by providing a more flexible alternative to carriers. Secondly, although it will not take advantage of the a priori information of freight carriers (knowledge of the deliveries that they will carry out in the short term) it will increase the probability of finding an available loading and unloading space by introducing time limits to perform these operations.

This concept is based upon the principle that situations with a high level of demand should be managed through price and not through tickets. After a free time limit is exceeded the commercial operator is charged by using the L&U space. Furthermore, the system will allow the recording of all the information regarding loading and unloading operations (frequency, shops, etc.) which will allow a more efficient management and the ability to incorporate feedback information into the steering function of the system.

The IT solutions envisaged for these two areas (Baixa and Bairro Alto) will be based on the same technology but will be designed under different philosophies. The main purpose of having two different pilot areas in the Lisbon case study is to demonstrate the application of this concept in two different circumstances: with and without an Access Restriction System. With this approach, the eDRUL platform in Lisbon will have a higher transferability potential without requiring an Access Restriction System to be adopted in another European city. This concept, when implemented in a specific city can easily be applied to a much broader area than just the historic centre.

One could say that the eDRUL project for the Lisbon case study had a fundamental role in validating near the business agents and the local authority the concept most viable for their user needs. This showcase will lead to results in terms of expected impacts, upon which the Lisbon Municipality will decide whether or not to conduct a real pilot application or to implement the platform in a full scale.

Lisbon Platform Requirements

The requirements that will have to be addressed by the platform at the Lisbon site can be grouped into the following items:

- Competition issues;
- political aspects;
- enforcement level;
- co-operation between transport operators;
- subsidisation.

Regarding competition issues it must be defined a priori that within the eDRUL Lisbon site, free competition among freight transport operators is to be allowed, thus implying the co-existence of several private operators. From a legal and regulatory perspective it would be a sensitive issue to close certain Lisbon geographical areas to all (or some) of the existing transport operators. A highly unlikely alternative to the system described above would be one where transport services would be performed either by creating a municipal distribution company with permission to operate within the restricted areas, or by making public concessions, or establishing contracts to private operators. In the short-term, none of these two possibilities are viable for the Lisbon Site. Taking into consideration the lack of co-operation between transport service providers it is also difficult to implement a scheme with very strong restrictions (e.g. minimum load factors) or heavy dependence on co-operation between this type of actors (e.g. load negotiation). Therefore, the operational environment and the respective services to be developed for the Lisbon site will be based on an open market with no load factor restrictions.

From a political point of view the introduction of traffic restrictions associated with innovative IT tools within a limited geographical area is a measure which requires strong political will and investment. Therefore, it can only be taken if it is clearly demonstrated that significant improvements are expected. For these reasons the demonstration in the Lisbon site will have to be based on a showcase format. As already stated the main goal of the eDRUL project in the Lisbon site is to demonstrate to decision-makers the potential of the eDRUL platform in urban freight management. This potential will be measured in terms of negative impact reduction, either in the internal agents of the distribution system (e.g. operating costs of transport and commercial operators, etc.), or the external dimensions (traffic and parking conflicts, noise, pollution, etc.).

The enforcement of the existing municipal regulations for the loading, unloading and parking of freight vehicles remains as one of the identified flaws in the Lisbon traffic management process. There is already a common understanding towards the vital importance of such element (enforcement) in the success or failure of introducing innovative measures. Therefore the design of services for the Lisbon application site must be oriented towards the development of innovative enforcement measures and tools. This option corresponds to the Lisbon site's needs, rather than the development of solutions which have a strong need of conventional enforcement means.

The services defined for the Lisbon site application cannot be very demanding in terms of co-operation between transport operators. The existing level of co-operation, not only between private freight transport operators, but also between those and the Lisbon municipality, is still in a quite embryonic phase of development. Therefore, in the short and medium term, the proposed solutions must be designed in order to promote, rather than depend upon, co-operation between transport operators among themselves and between them and the Lisbon municipality.

The level of subsidies necessary both for implementing and operating the eDRUL Lisbon site system is still an open issue. The expected amount of investment and maintenance cost will have to be addressed in the final stage of the project: the Business Case Development and Exploitation. However, the decision concerning the level of subsidies should take into account the definition of the services in order to comply with two requirements:

i) Minimise the investment costs; and
ii) minimise operational costs and search for self-funding alternatives.

A possible solution for the latter requirement, which is being discussed with the Lisbon Municipality, is precisely to charge for the use of the loading and unloading spaces. After a public acceptability phase, the system could begin to charge the above mentioned usage in order to:

i) Optimise freight distribution operations through the reduction of the number of deliveries and therefore the increase of load factors; and
ii) generate revenues in order to minimise the need of subsidies by the local or central administration. The system could allow a certain number of free daily deliveries, according to the supply needs (type of shop) and, for instance, the surface floor area.

The criteria for pricing must be further discussed with the municipality and if possible other stakeholders such as freight transport operators and shop owners/managers, but there must always be a trade-off between public acceptability and operational costs.

Integration of Traffic Management Systems in the eDRUL Platform

As already stated the platform will have a strong interface with the traffic management elements in the Lisbon site. For this purpose, the following sections will develop some considerations concerning integration of existing ITS with the platform.

There is already one Access Control System (ACS) operating in an old part of the city (Bairro Alto), a neighbourhood which had severe traffic problems. More recently another Access Control System based upon similar technology was implemented in another historical area of the Lisbon City (Alfama).

In the Bairro Alto area, the option that was chosen is to forbid circulation into the neighbourhood except for four entries and four exits (see Figure 8.28). Within this area parking fees for non-residents are almost prohibitive. A municipal company (EMEL) is responsible for managing this system. This is the same company responsible for the management of paid parking in Lisbon.

The access is controlled through retractable bollards controlled by an access card. The municipality increased the nearby parking places and Carris (Lisbon bus and tramway

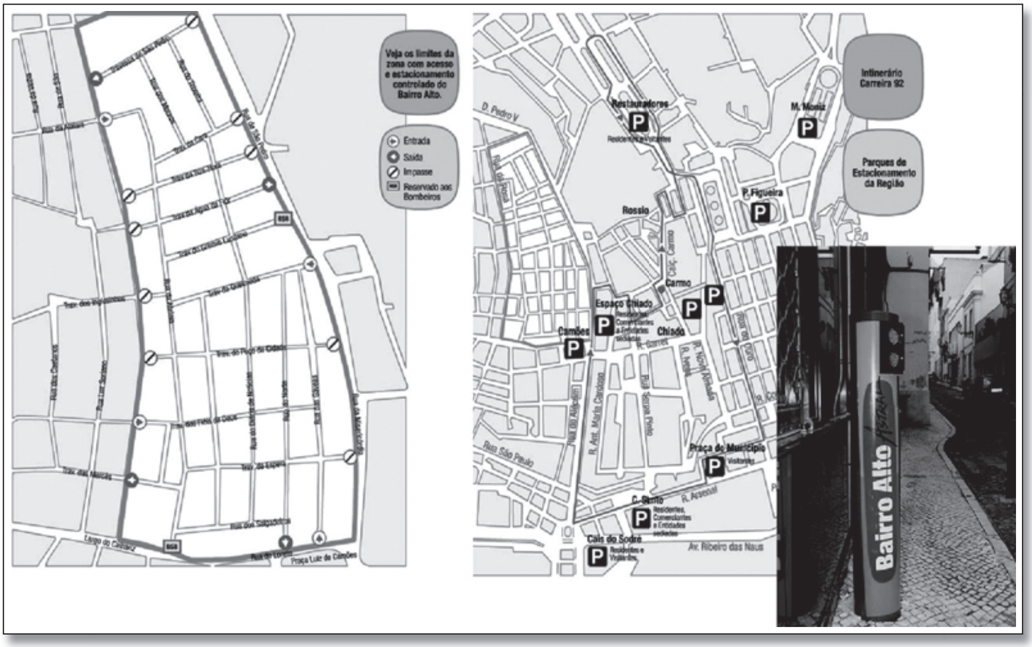


 Figure 8.28: **Bairro Alto Access Control System**

operator) created a new service connecting the neighbourhood with the main interfaces that are located close to Bairro Alto (see below). Freight operators are considered as special users and can only enter the area between 07:00 and 10:00 and again between 15:00 and 17:00. They can only use 1½ hours of free parking space per day and a maximum of 1 hour in each time window.

The interface between the eDRUL platform and the traffic management in the Lisbon site application will be assured by the integration of the platform with the National Road Institute (IEP) Traffic Management and Monitoring System (TMMS).

The National Road Institute's TMMS is currently operating within the Lisbon metropolitan area and monitors highway accesses and some national roads through video surveillance cameras (http://www.iestradas.pt/transito/glx.php) and road sensors connected to VMS (Variable Message Signs), see Figure 8.29. IEP is making efforts to develop the system to allow the use of some of their information by external entities (e.g. integration with the Lisbon municipality traffic management system, etc). A joint service between IEP and a local mobile phone operator is being developed. The mobile phone users will have access to traffic information (pictures and congestion levels) in the monitored links of the road network and will have the possibility to subscribe to an alert service in which an SMS with a picture of the required network link is sent to the user's mobile phone at the requested time. Therefore, it makes sense to build the future Lisbon site platform 'architecture' compatible with the information format of the traffic management and monitoring system of IEP.

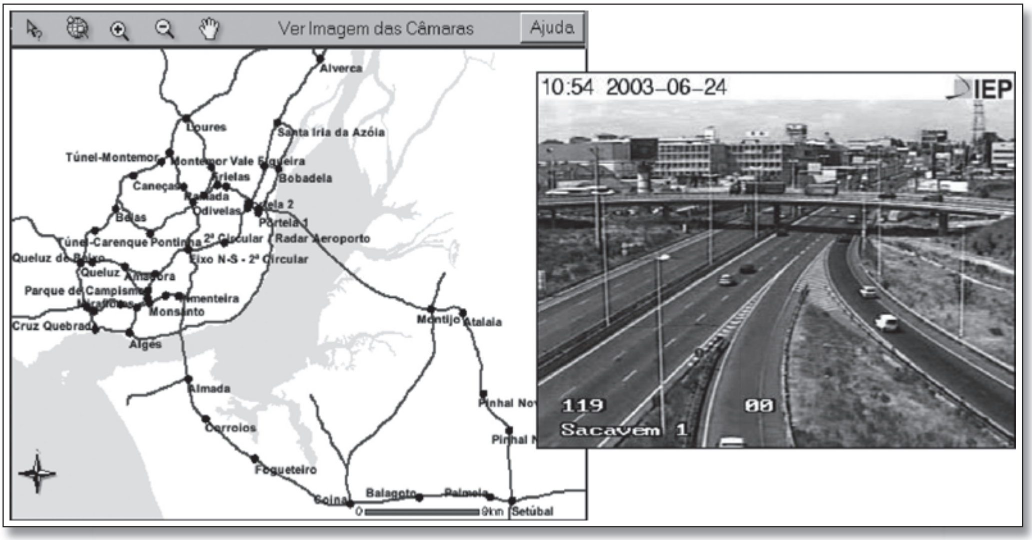


Figure 8.29: **National Road Institute Traffic Monitoring Video Cameras Network**

Planned Services

Based on the requirements described in the previous section the identification of services to be validated in the Lisbon site application are presented in Table 8.10.

User category	Service (s)
Commercial Operators	• LS 1.1 - Submit delivery booking request / modification; • LS 1.2 - Transport service adjudication; • LS 1.3 - Get service information and statistics • LS 1.4 - General information and contents; • LS 1.5 - Communications with eDRUL agency; • LS 1.6 – Vehicle Location and Monitoring • LS 1.7 - Route Planning Request • LS 1.8 - Announce starting of L&U (Baixa area only) • LS 1.9 - Announce ending of L&U operation (Baixa area only) • LS 1.10 – Bollard retraction request – entrance (Bairro Alto area only) • LS 1.11 – Bollard restriction request – exit (Bairro Alto area only)
Freight Transport Service Providers	• LS 2.1 - Transport service proposal; • LS 2.2 - Provide automatic invoicing process; • LS 2.3 - Get service information and statistics; • LS 2.4 - General information and contents; • LS 2.5 - Communication with eDRUL agency; • LS 2.6 - Vehicle location and monitoring; • LS 2.7 - Route Planning Request • LS 2.8 - Announce starting of L&U (Baixa area only) • LS 2.9 - Announce ending of L&U operation (Baixa area only) • LS 2.10 – Bollard retraction request – entrance (Bairro Alto area only) • LS 2.11 – Bollard retraction request – exit (Bairro Alto area only)
eDRUL Agency	• LS 3.1 - Get service information and statistics; • LS 3.2 - New loading and unloading space provision; • LS 3.3 - Loading and unloading space removal; • LS 3.4 – Remote Access to the Delivery Management Dynamic Database
Activity Centres	• LS 4.1 - General information and statistics;

Table 8.10: **Services for validation at the Lisbon site**

8.7.3 Results

In this context, eDRUL in Lisbon has a very important task in the sense of demonstrating the potential of IT tools applied to urban logistics and promoting the necessary political will for a full scale implementation.

Furthermore, for Lisbon the specific objectives of the demonstration are:

- to assess the usefulness of the designed services for each type of user;
- to verify user acceptance of the envisaged services;
- to determine how well each technology performs in comparison to conventional methods;
- to determine the logistical and economic resources needed to operate each service; and
- to produce a verified data set for use in considering the technology for future use in urban logistics schemes.

During the Lisbon Showcase a questionnaire was handed to the participants in order to collect some information concerning the assessment of the services in several dimensions (technical performance, service provision, economic viability, etc.). In response to the question: "Do you expect that the total number of urban goods distribution kilometres driven will be reduced when the proposed solutions are implemented?" 80% answered "probably yes". When asked whether the proposed scheme was likely to reduce environmental impact, 20% replied "absolutely yes", 40% "probably yes" and 20% were neutral. Finally, when asked if implementation would increase enforcement efficiency 80% replied "probably yes".

Although the urban distribution process has only recently reached heavy negative impacts, it is almost as old as the urbanization itself. In fact, also in the ancient city of Rome, measures were implemented in order to control freight distribution vehicles entrances and exits. However, technological developments and the globalization of economic activities, together with consumer behaviour trends, have introduced a new dimension to this problem, by encouraging business practices with heavy demands on the urban distribution system. These demands have been satisfied at the cost of heavy impacts on the society, namely pollutant emissions, noise, urban space and energy consumption, accidents, etc. To-day the urban goods movements issue faces a series of complex challenges, although the opportunities to deal with them have also arisen recently due to the increased awareness by society of the necessity to ensure a sustainable development.

Therefore, it can be anticipated that local authorities in the short and medium term will dedicate their activities essentially to the integration of new solutions and improvement of existing ones, as well as the study of the characteristics of the urban logistics system, especially with respect to the reaction of different elements to the introduction of specific solutions. In this context, the use of recent technologies such as mobile phones, PDAs, surveillance cameras, GPS, etc. will become increasingly common as supporting tools to existing municipal regulations.

In July 2004 the Lisbon Municipality approved new urban freight distribution regulations concerning delivery time windows and vehicle weights. The new rules were based on a proposal developed by TIS.pt which recommended the use of IT technology (GSM).

The influence of the eDRUL solutions for the Lisbon site in the new regulations and supporting technology has surpassed many expectations. In fact, a pioneering and innovative project for freight distribution management is now starting to be implemented in Lisbon, based on DSRC technology. Although the adopted solution is different from the one developed during the eDRUL project the concept behind the new regulations as well as the awareness promoted among decision makers in this process had benefited considerably from the eDRUL research project.

8.8 TADIRAM project: Organisational and technological proposals

G Messina, M P Valentini

8.8.1 Introduction

The current configuration of freight distribution systems in urban areas is reaching unsustainable levels of negative impact on quality of life and economic efficiency.

In the recent past the EC policy has been to direct research towards new strategies, aiming to improve the quality and the efficiency of logistics services and freight transportation in urban areas. Furthermore, research is being directed towards identifying and achieving new technological solutions supporting sustainable freight transportation systems.

The TADIRAM project "Sviluppo di Tecnologie e sistemi Avanzati per la DIstribuzione e RAccolta Merci nella città sostenibile" - Advanced Technologies and Innovative SW Tools for Freight Distribution in the Sustainable City" fits into this area. It proposes a set of research activities aimed at identifying new organizational, technological and computing solutions for the optimization of freight transportation and urban freight distribution processes, while focusing on both the sustainability of the future city (in terms of traffic and air pollution) and on businesses and their needs.

The TADIRAM project is a research project co-funded by MIUR (The Italian Ministry of Research and Universities) for the estimated cost of around 5 million Euro and the TRAIN Consortium (Consortium for RTD on INnovative TRAnsport), which is made up of the following partners: ENEA (Italian National Agency on New Technologies, Energy and Environment) University of Salerno, Uniontrasporti, Trenitalia Spa and RFI Spa, Ansaldo Trasporti Sistemi Ferroviari Spa and AnsaldoBreda Spa, D'Appolonia Spa, Reggiane Cranes and Plants Spa, Bertolotti Spa and Uniontrasporti Service Scarl. The project's most innovative aspect, which is currently in progress and should finish in 2005, consists of a new systemic approach which integrates different organizational, computing and technological aspects, contributing to the freight distribution logistics in urban areas.

In particular the TADIRAM project sets itself the task of developing 3 main activities:

- Identification of innovative logistics models based on the use of the most modern software and telematic systems and new technologies for managing, moving and transporting freight, with the aim of improving distribution service quality and reducing energy and environmental impacts.
- Study and design of innovative solutions and technologies for transporting, moving and storing freight (for example loading unit - LU-) and for automatic and swift management of loading/unloading operations involving road and rail transport.
- Study of the possibility of a rational use of inter-modal transport within freight distribution sectors in urban centres, with potential synergy between collective passenger transport and urban freight distribution transport.

TADIRAM's objective is to identify a new organizational model of the entire logistic system and a framework for innovative technological solutions for movement and transport as well as for software for management and control of the various phases of freight distribution. At the conclusion of the project, a study of application of the new proposals in an Italian southern town will be carried out and technological and computing prototypes will be tested.

8.8.2 Innovative logistics models

Throughout the project, attention has been focused on the distribution of foodstuffs, including fruit and vegetables, as this sector, which covers 63% of the total distribution, seems to be, in the long term, both the most significant and the most delicate.
This is due to convenience and perishable freight so that a daily distribution is required; furthermore, in comparison with other commercial sectors, there is still a net preponderance among suppliers to use their own transport to deliver freight (around 70%). However, distribution of other freight typologies has also been considered in TADIRAM, with the exceptions of newspapers, medicines and temperature controlled freight.

The project has analysed present freight distribution in some Italian cities, Milano, Siena, Genova, studying characteristics of the freight distribution chain of three main freight categories:

Food (fruit and vegetables, not refrigerated);

Dresses;

Small domestic electrical appliances, computers.

The analysis have been carried out by Uniontrasporti and ENEA-Biotec.

The workgroup of Enea-Ene-Tec then has identified new organizational models for small scale distribution in urban areas, distinguishing between fruit and vegetable and other freight (foodstuffs and non-foodstuffs).

In particular, the project has studied two logistics models which seem to offer the most suitable approach for the optimisation of the freight distribution processes in urban areas.

Both the models move towards transport services, the use of telematics technology and innovative equipment for freight handling and finally by the use of ecological vehicles for transportation in the last leg. The two models considered are:

1. model with a physical logistics base (hub),
2. model with a virtual logistics base

A third model has also been examined: the “mixed model”, which proposes a combination of the two base models in a more or less marked manner.

The first operative model moves towards the set up of a hub for receiving and distributing freight, the operation of a centralized vehicle fleet and the use of innovative equipment to move and store freight and telematics technologies and to get a more rational organisation of distribution.

The chosen model proposes that freight to be distributed in the city centre are delivered to the hub by road vehicles, including wide loads, lorries with trailers and articulated vehicles, or by rail, if the hub is situated near to a railway freight delivery point. Within the hub freight are assembled according to their final destination and loaded on special load units, specifically developed during the project in order to simplify loading and delivering operations. The load units are then loaded on vehicles which bring freight to their final destination.

This model could also include a tramway connecting the hub with a set of transit-points located near to commercial areas where freight are transferred from the tram to road vehicles suitable for capillary distribution.

All the activities/operations occurring in this operational model are carried out by an operation centre supported by a software system which manages and controls the movement of freight within the hub and the transit points and plans the vehicles tours for the freight.

Such a model can guarantee a better use of the vehicle’s capacity and thus a fewer number of necessary vehicles and a lower total mileage, with a subsequent reduction in fuel consumption and environmental impact. This will become even more significant as the use of vehicles with no/low environmental impact for the capillary distribution to the point of sale has been proposed.

This new delivery model and its components (hub, transit point, vehicles) have been studied to manage the majority of commercial products (clothing, electronic freight, packaged cargo excluding newspapers and medicines): The analysis considered all dry and fresh food, excluding products which require cold temperatures during transport (frozen freight and ice-cream), fresh meat and fish (due to refrigeration requirements and hygiene regulations)

It has been proposed that cargo trams would be used in the morning for an initial

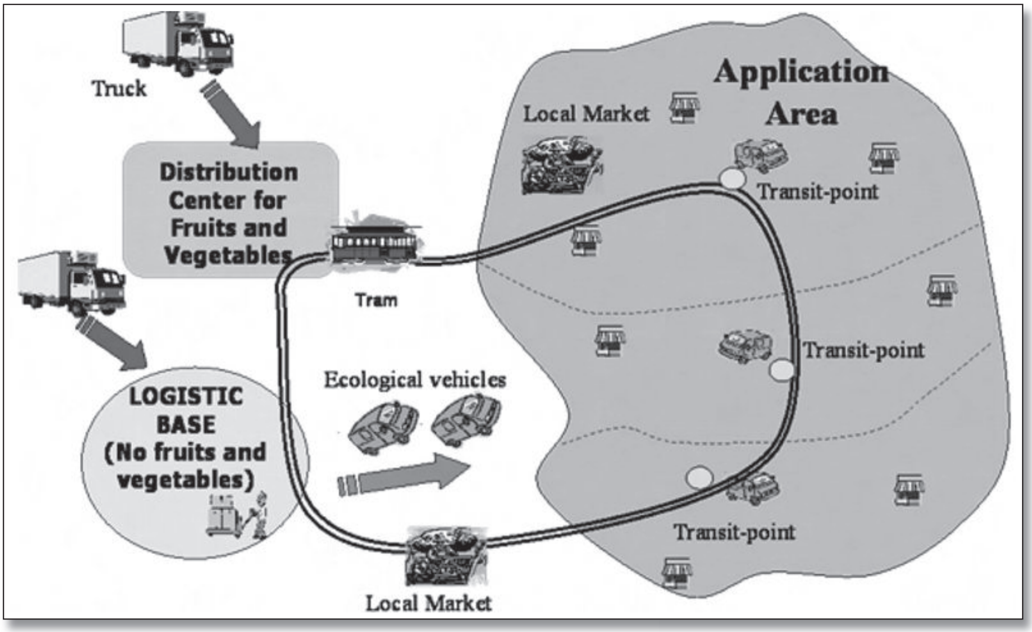


Figure 8.30: **One solution for freight delivery via cargo tram**

journey collecting and delivering fruit and vegetables from the distribution centre for fruits and vegetables outside the city to some local markets in the city centre, then running from the hub to the local transit points to transport foodstuffs in the first instance and later on all the other products for which a distribution service is proposed. During the return journeys the empty LUs and undelivered freight are brought back from the transit points to the hub.

Various operating hypothesis for the hub layout and the cargo tram formation are possible with regard to different context and have to be assessed and modified over time once the application area, the demand and the service that is to be offered have been identified.

The second model with a virtual logistics platform is based on a virtual network in which couriers and carriers exchange freight transport demands and supplies, thus optimising vehicle loads and delivery tours within a determined delivery area.

Unlike the first model, in this case there is no new business entity to carry out the terminal stage of transportation but a number of already existing business entities which pool their personal resources and business aiming to reduce operational costs of transportation and to face possible access regulations; though the target is mainly economic however the result is an optimization in the distribution process, with positive impacts on road circulation and environment.

The critical success factor of such a model is the definition of rules and unequivocal legal parameters which minimise the possibility of legal questions between the participants to the initiatives.

The organization model includes a set of logistics platform offered by the transport operators participating to the cooperative and a central technical platform (hub) who is in charge of optimising loads and tours by collecting (according to the availability to submit or receive) the freight to be delivered.

This solution does not require large initial investments and the monopolisation of the last leg. However, it presents notable organizational difficulties in that it presupposes a reorganisation of transport from the base up, a division of responsibility in managing delivery and a division of relationships between clients and transport companies.

8.8.3 Innovative technologies

Loading Unit and handling equipment

An innovative system for handling pallets and packages has been designed and now is under construction; the new system is based on a specialized loading unit as a support for containing goods during transport and motorized equipment that, connected to the loading unit (LU), permits easy maneuvers and movements inside hub, warehouse and vehicles.

The LU consists of a steel base for the prototype and an aluminum or plastic base, possibly reinforced (polyethylene), for the industrial product, equipped with four running castors.

A frame with three shelves can be mounted on the base in order to carry small parcels without wasting of space.

All the packages arriving at the hub, including pallets, are loaded on the LU; the pallets are put on the base and the small packages on the shelves of the frame.

Bertolotti company has designed the new loading unit and constructed its prototype taking into account all requirements for easy loading, unloading and handling within a logistics system that is self-sufficient and independent from the outside world. Despite this, with the aim of compatibility with existing loading, transportation and handling systems, the LU has been designed with geometric characteristics (width and depth) which allows handling even with standard equipments since the dimensions will correspond with the standard ISO1 (1200x800mm) and ISO2 (1000x1200). According to the typology and characteristics of freight to be transported the height of the LU could vary between 900 and 1800. The maximum weight capacity is 1000kg.

For easy loading and unloading of tram and lorries and short transfers, an "handle" for electrical pushing, pulling, and LU quick handling has been designed and realized as prototype, supplied with batteries, having 4 hours of autonomy. The main characteristics

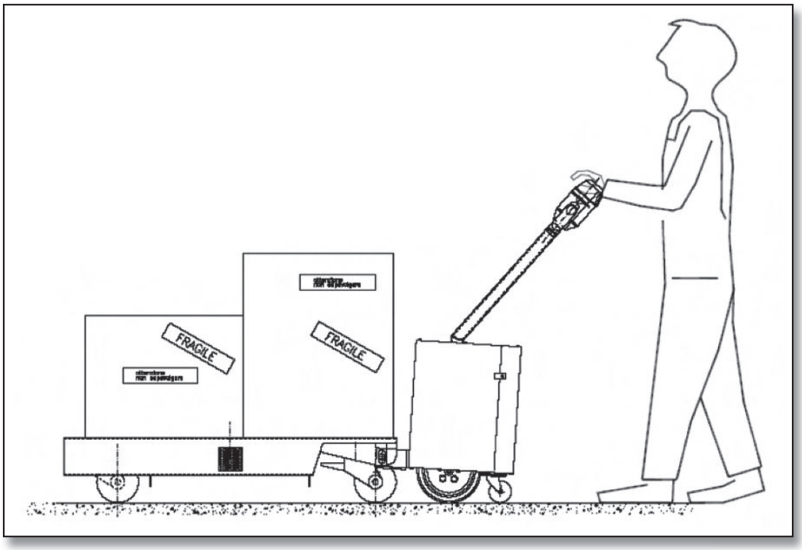


Figure 8.31: **The innovative handling equipment**

Figure 8.32: **The Loading Unit Base**

of the innovative system are: ease handling and maintenance, reduced dimensions and occupancy (1/4 of transpallet), low cost.

In order to move the LU within the hub and for reducing the need for manual handling, the project also considered the possibility to use Automated Guided Vehicles (AGV) managed by an on-board controller and a supervisor computer for real-time information exchange by using transponders (MDS). Moreover, the AGV will be equipped with sensors able to recognize, identify and centre the LU in order to take it and transport it.

The LU's can be equipped with systems of automatic identification, for example RFID (Radio Frequency Identification). These are new generation radio frequencies which enables tracking and control over the entire logistics process with extremely low costs and which are both reusable and re-writable with durability almost unlimited has the load carrying capacity is 1000 kg.

The Cargo Tram

The Tadiram project, as an alternative to road transport, proposes the use of a cargo tram integrated with small trolleys for capillary distribution.

The use of a cargo tram instead of a traditional road vehicles offers the following advantages:

- Less noise and air pollution;
- Possibility to transport amounts of freight in a single trip;
- Possibility to link the inner city directly with ports and airports and other urban centres when circulating not only on urban lines but also on regional railway network.

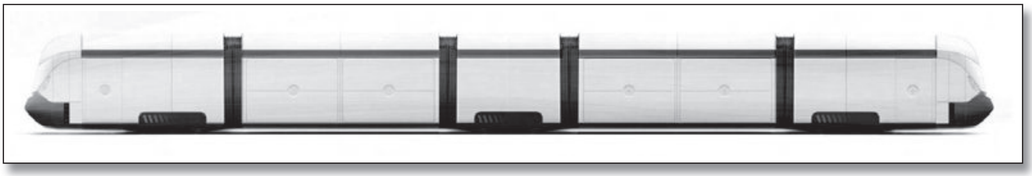


Figure 8.33: **SIRIO Cargo Tram**

So far the AnsaldoBreda Company has analysed the carriageway in order to identify any problems and requirements and has produced some technical solutions.

The SIRIO cargo tram has been derived from those produced by AnsaldoBreda for passenger transportation. Innovative vehicles use bi-directional technology with two driving cabs.

The main characteristics of the SIRIO, which make it particularly suitable for freight transport in an urban context are:

- Fully lowered floor: 350 mm from the top of the rail;
- Overall width between 2.30 - 2.65 m
- Runs on very narrow curves (13 m)
- Track gauge adjustability (950, 1.435, 1.445 mm)
- Axle load ≤10 t
- Good modularity allowing different vehicle configurations from short (3 carbodies) to very long (7 carbodies) simply by varying the number and typology of the modules,
- According to requirements the vehicles can be bi-directional or mono-directional, and can also be run connected to another SIRIO tram for passenger transport,
- Possibility to operate both on railway rails and tram rails

In order to allow vehicles access into areas where security drawbacks (hub and Transit points) and/or environmental impact don't allow the use of overhead wires (historic centres), either an alternative energy supply system (STRAM) or batteries can be used on the tram.

The innovative energy supply system comes directly from the STREAM experiments in Trieste by AnsaldoBreda and it is based on an under system of electrical supply placed at the centre of the carbody and a centrally positioned sliding block below the carriage which is flexibly connected to the supply. Within the TADIRAM project the characteristics of the carbodies of the SIRIO passenger tram (internal dimensions, dimensions and modes of door opening etc) have been reconsidered in order to adapt it to the freight transportation needs. It has already been designed within the project and is now in a suitably modified prototype tram able to transport any packaged loads and dry freight loaded on the Loading Unit.

The new vehicle will have a fully lowered floor, the convoy will be composed of three or more carbodies and may be used for only freight transportation or a combination of the two (convoys with freight wagons and passenger wagons). Furthermore, by simply varying the number of vehicles different formations are possible. The vehicles can also be furnished with a suitable system of air conditioning which allows the transportation of fresh products (fruit and vegetables general foodstuffs); it is designed for ease of maintenance and cleaning operations.

The logistics platform (hub)

The first phase of the TADIRAM project analysed the characteristics, the requirements and the drawbacks of the different typology of goods that are intended to be managed by the logistics system.

This analysis has been taken into account in the successive phase of designing the hub and its various components: means of movement, warehouse etc.

While defining and dimensioning the hub, the project tried to ensure an optimisation of the logistics features like infrastructure, equipment and human resources, intending to a strongly autonomous system.

Bertolotti studied three different possible lay-outs for the hub, aiming to highlight different characteristics which may favour different functional-logistics aspects and satisfy multiple needs. The choice of one layout rather than another depends on the costs, the size of the city, the demand amount and its specific characteristics.

8.8.4 Innovative management sw tools

The innovative distribution system is supported by telematics which can manage the logistics activities in an urban environment: hub operation, optimisation of routes and loads, freight monitoring and information exchange between all the actors of the System (suppliers, hauliers, retailers, logistic operators). The optimisation of the distribution chain is founded on an organizational and functional macro-process which covers the collection, movement and distribution of freight and offers advantages to all the subjects involved: producers, distributors, shopkeepers.

To achieve this goal the telematics architecture has to be structured according to a modular philosophy and will be made up of technological and software components which, integrated between themselves, allows logistics base management, and system planning, control and monitoring

The figure shows the main functionalities supported by the integrated software system which has been implemented by the D'Appolonia company and ENEA.

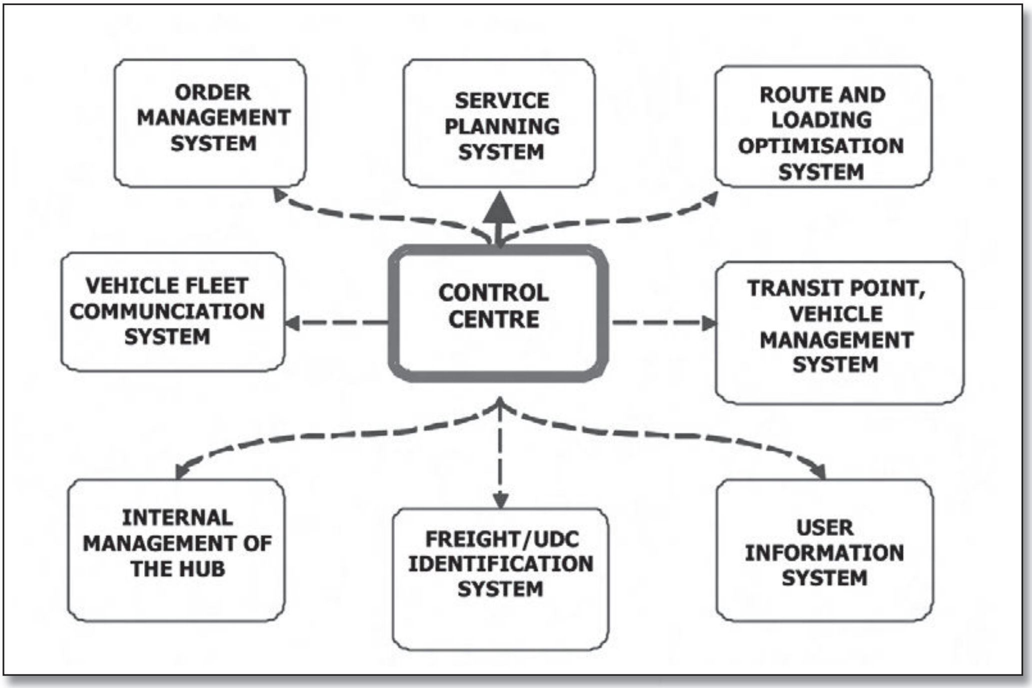


Figure 8.34: **Support and management functionalities**

System database

The integrated software includes an on-line database which will be organised so as to memorize all static and dynamic information necessary for the various software modules and their outputs. This data are useful for monitoring the logistics process, gathering statistics and carrying out analysis for a complete evaluation of operations and services of the hub. The database will include, geo-referential cartography of the area involved in the distribution and collection service as well as data on physical and functional features (layouts of the hub, warehouses and transit points, vehicle fleet, etc).

All key information for a correct management of the activities and the evaluation of the service provided are immediately available to all the subjects involved in the distribution process (internal operators)

Planning system

This module is dedicated to the daily optimization of distribution and pick-up service.

Within it there are various subsystems which allow:

- Receiving and managing freight transportation requests across many communication channels (fax, email, internet, etc.)
- Programming of the urban freight distribution service for each destination area, assigning of deliveries to available vehicles, optimising the loads on vehicles and finally determining the delivery sequence of each road vehicle
- Identify optimal distribution routes from the hub to the destination via transit point on the basis of the capacity of available resources, the transport network configuration and the state of traffic with the aim of reducing times and costs of transport
- tracking of vehicles by transferring information on vehicle location obtained automatically by a GPS/GPRS system.

With a Geographic Information System the defined trips of delivering freight to customers by means of ecological road vehicles are visualized on the territory as well as vehicles tracking and other useful indications for a middle term planning (weekly/monthly) and for an operative short term planning (daily).

Hub e-transit point management software system

This module will permit the following functions to be carried out:

- Optimal management of resources internal to the hub and transit points
- Management of freight movements in the warehouse

Optimised management of the warehouse leads to the implementation of all necessary features for picking-up and warehousing of packages and LUs which will be equipped with a system of automatic identification. The system aims at implementing space and time saving.

On the other hand, features that allow route minimisation using compound cycles of deposit and pick-up have been proposed for the freight movements within the hub.

Control system

This system allows a real-time control of the all operations to be carried out within the logistics base. The system detects and manages each anomaly and technical problem regarding transport and delivery (freight refused, road diversions, vehicles break downs, mistaken deliveries, returns) taking charge of carrying out automatically or semi automatically any eventual corrective actions (assigning an alternative route, registering returns, inserting new data).

It is capable of tracking all operations (the arrival of freight, storage, running of the warehouse area, preparation of loading/unloading platforms, reception of the state of play of the delivery, etc).

Identification systems (SIM) like smart cards, RFID or bar codes are integrated into the control system to identify packages and LU and locate them during each stage of the logistics chain and trace their movements towards the final destination.

Information system

In order to comply with the wishes of the actors involved in the freight distribution process and to surpass the limits which currently exist in data and information exchange, there is a telematics subsystem within the TADIRAM software dedicated to exchange of information within the hub and towards the external world. This system works towards a control over the flow of freight and information activated between freight origins, the hub, and the network of retailers and local markets, aiming at reducing errors in data transfer and smooth operations as much as possible, using technology which has already been consolidated. This allows to reduce costs and increases efficiency of information flows related to freight delivery.

The system will manage demand for the transportation service passed on by the carriers/courier and will provide information in real-time on the state of the delivery process both to the operators in the hub and to the carriers and to commercial operators, using different channels of communication including Internet. The main functionalities of the telematics system are:

- Information exchange hub – service users (transporters, couriers etc)
- Information service to commercial operators (shopkeepers etc) on the state of play on the delivery process.
- Information service dedicated to internal users (hub operators and managers) on the state of freight at each stage of the distribution process, and on the provision of service.
- Data transmission between the hub and the transit points to pass information on the pending arrival of freight (timetable, quantity, number of vehicles to use to forward freight to their final destination).
- Data transmission between the fleet of vehicles and the hub on whether or not the freight have been delivered to the shopkeeper.

8.8.5 Conclusions

This chapter has presented the TADIRAM project which intends to provide a contribution regarding the large problems of today freight distribution in an urban environment by providing an integrated approach of organizational and technological proposals finalised towards a rationalisation of the distribution process.

The project's fundamental target is to improve the efficiency and effectiveness of the system and to reduce environmental impacts according to a management which, as far as possible, plans and automates the different process phases. In particular innovative technology for the transport and movement of freight have been studied and computing models and modules have been developed in order to plan delivery and journeys, and to optimise vehicle loading

The project has also planned and created a data transmission network, formed by an internal and external part. The internal part of the system is aimed at monitoring the various phases of the process (arrival/departure of the freight, operations within the hub) and includes a communication network with the fleet of vehicles used as the capillary transportation for the last phase of the journey from the transit point to the point of sale. The external part is used for the couriers and transporters to take orders and to provide information on the state of play of deliveries, both to the users of the hub and to those to whom the freight are destined.

The new organizational and technical model which has been identified and the innovative technology created as a prototype comprise:

- Loading unit (LU),
- Cargo tram compartments,
- LUs Identification System,
- Planning/management software system
- Telematics system for service orders receiving and management will be verified in an urban study context.

The next stage is to verify the applicability of the proposal by carrying out a feasibility project in the city of Cosenza. According to the volume of freight to be distributed and the characteristics of the demonstration site an innovative logistics scheme will be configured identifying: user base, location of the hub and the transit points, models of running the hub and the cargo tramway route.

The actual situation state of freight distribution will be re-built and compared, using simulations, with the new project both in terms of efficiency and effectiveness of the distribution process and in terms of general energy and environmental impact. Finally, a draft operational costs evolution will be carried out along with an analysis of costs/profits taking external costs into consideration as well.

It is necessary to highlight that the proposed solutions will probably entail infrastructure and logistics overheads that will only in some cases be compensated by the increased efficiency of the entire logistics process. However, we need to advise that a correct evaluation must also consider external environmental and social costs. For government organizations the reduction of external costs obtained via the new distribution model translates into savings in various sectors, for example health (reduction of accidents and pollution), and road maintenance (reduction of traffic).

The public sector could therefore reallocate a part of the funds designated to the sectors mentioned above either by giving incentives to transporters who use the new distribution system or operating the hub directly, financial support for the realization and new service.

8.9 Government strategies for urban and metropolitan haulage: the experience of Milano

D Gattuso, G Goggi

8.9.1 Introduction

In general, the definition of government measures for haulage of goods within the urban and metropolitan areas must aim both at a reduction of the negative impacts on traffic and at a rationalisation of the organisation for the dispatching of goods. In other words the planning of new strategies in order to organise the haulage of goods must target:

- a reduction in inefficiencies in the goods haulage;
- the protection of the urban environment;
- an improvement in the quality of life.

The achievement of these objectives certainly constitutes an interest of the community and in this respect it is fundamental that the public authority (whether local, regional or at a national level) is promoting specific and targeted initiatives. In principle, government policies for haulage of goods must belong to one of those four types (Dablanc and Monticelli, 2000):

a) restrictions, in order to regulate and limit access to the urban centre and stops;
b) incentives, such as fiscal advantages and special rules for the traffic of economic operators who use technologies which are friendly to the environment;
c) policies of communication and dissemination in order to make information available to the interested parties, and a set of rules relating to the haulage of goods; and
d) investment targeting the road infrastructure, the creation and organisation of stopping areas for the delivery and loading of goods, the creation of centres for urban distribution and for the development of the application of telematics in the haulage of goods.

8.9.2 Government policies for goods haulage

Better management of the haulage of goods within urban areas involves a mixture of co-ordination initiatives. The most urgent actions are those that will rationalise the ratio between demand and supply, aiming at an improvement in the behaviour of the operators. In fact such actions, which usually are not expensive, aim at a limitation in negative actions, improve policies friendly to the environment, and improve the knowledge of the users for efficient methods of communication. These can be considered as tactical/operative actions. Other actions of a strategic type must instead be founded upon more important investments in order to increase the supply, and in particular infrastructure and service components such as areas for parking and centres for grouping and dispatching of goods.

Restriction policies

The view towards restriction policies within the urban distribution of goods must not be such to stop the circulation of commercial goods within the urban environment, but rather to regulate access and stops. Purely restrictive actions can in fact significantly compromise the economic and social prosperity of urban centres as they would be strictly related to the circulation of goods (Maggi, 2001). The definition of restriction policies can therefore be based upon the regulation within the urban environment of the access of flows of goods and/or the stopping of commercial vehicles. The regulation of the access of commercial vehicles within the urban environment can be either spatial and/or temporal. Spatial regulation of access must be implemented with the aim of:

a) identifying urban routes or areas within the city (for example, districts with historic or artistic quality) where the haulage of goods could contribute in a significant manner to the limitation of vehicular traffic and the protection of pedestrian flows, and to the limitation of environmental impact;
b) a definition of specific routes within a city to be used by commercial vehicles, removing them from the flows of private vehicles.

This can be operated based upon a number of criteria such as the fully-loaded mass, dimensions of the vehicle (length of area covered), or based upon the emissions produced by the vehicle.

Temporal regulation consists of the identification of a number of timeslots during which commercial vehicles can freely access the city centre in order to load and unload the goods. Those timeslots could be either within or outside the opening hours of the commercial activities.

For the former, it is necessary to discourage the use of timeslots at peak times, thus fostering the circulation of commercial vehicles at off-peak hours; from one point of view this allows a reduction in vehicle congestion, and on from another point of view it increases productivity of commercial vehicles in their activity of dispatching goods. For the latter, night timeslots which are characterised by low intensities in traffic should be used; using timeslots at night allows the spread of loading and unloading of goods over longer periods, allowing faster dispatch thanks to lower traffic flows but creating other problems (Progetrasporti Associati, 2001) such as noise nuisance, dissatisfaction of the recipients who have to stay outside normal working hours, and higher costs for the personnel involved.

Regulation of the stops aims at an improvement in the management of the areas reserved to commercial vehicles for their operations of loading and unloading of goods. In that respect it is possible to foresee areas where stops are only allowed for a very limited time period and areas where stops can be longer.

The policies of incentive

In order to limit the negative by-product of distribution systems within the city it is important that the public administration promotes policies for various types of incentive such as fiscal facilitation, spatial regulation for the traffic, etc.
It is in fact possible to foresee that some form of public support can be used in the conversion of the commercial vehicle fleet, thus fostering the purchase of vehicles with little or no emissions. Such a policy of incentive could also be accompanied by a more favourable system of urban traffic whereby environmentally friendly vehicles could have easier access to the centre. Further forms of incentive could be foreseen in order to make the operations of loading and unloading of goods more efficient by providing the dispatching point with incentives for the creation of parking pays reserved for commercial vehicles.

The policies of information and dissemination

The dissemination of information relating to goods vehicles could be organised (for example through leaflets distributed to transport operators or available at the shops), in order to make the following known to those interested:
- the position of the parking bays for commercial vehicles;
- the transit route specialised for the wider traffic; and
- the regulations regarding vehicles for haulage of specific categories of goods such as refrigerator cars or vehicles to move out.

Investment policies

Investment policies which are there to make the activities of distribution of goods within the urban environment more efficient and directional can be related to:
- the improvement of the road infrastructure;
- the organisation of parking bays for the operations of loading and unloading of goods;
- the creation of specialised platforms for the collection and distribution of goods;
- the development of ITS in goods haulage.

The policies of improvement of the road infrastructure must be based upon the principle that the interventions designed to bring an improvement in urban traffic can also contribute to improved goods haulage, bearing in mind, however, the specific requirements of each category of vehicle.

The improvement policies of the urban road network should relate to a redesign of intersections, an increase in capacity wherever possible of the roads, mostly traffic, a separation of the traffic from different categories of vehicle, and readjustment of the policies of traffic diversion. In many urban environments, the lack of parking areas which are reserved for commercial vehicles in the vicinity of loading and unloading areas can negatively influence the efficiency of the goods haulage, in addition to having negative consequences on the entire traffic (one can think of the slowing down and stops caused by commercial vehicles which are usually parked in lanes which should be reserved for traffic).

It is therefore important to think about reorganisation of parking areas for loading and unloading which could be useful to the wider possible number of commercial activities in the area. Their number and their position must be planned on the basis of the density of destination points for the goods, for example where shops are located, and to the frequency of the dispatching activities, whilst their dimensions must be designed in relation to the main types of vehicles using them.

The construction of these parking bays could become inefficient unless accompanied by careful management by the local administration; this should always monitor use through a policy of continuous and stringent checks of their correct use in order to avoid parking bays being occupied illegally as normal parking areas by vehicles which are outside the distribution process. An important response to the requirement of rationalising the urban haulage of goods could be represented by the creation of so-called centres for urban distribution (CUDs).

A CUD can be defined as a platform for a centralised management system for the collection and dispatching, aiming at organising the distribution of goods within an urban area through the aggregation of flows of goods, the reorganisation of their goods and the optimisation of the routes (Dablanc, 1997). In other words, a CUD constitutes a logistics platform which can be used to collect all the goods directed to and from the city in order to organise them and fulfil their distribution, thus planning the routes in the best possible way and increasing the loading coefficient of vehicles. It appears that the primary objective of the CUD is to reduce the number of movements of commercial vehicles (heavy and light goods vehicles) within the city.

The number of CUDs can depend mainly on the dimensions and the structural characteristics of the urban area which is to be served, as well as possibly from a differentiation of the goods type and by type of users/recipients. Apart from their position within the urban area, CUDs must be accessible and must be efficiently integrated with the other logistics nodes of the city in order to create a network that can contribute to make the territory more competitive. The development of markets applies to the urban haulage of goods, and will allow transport operators to use systems that can better manage orders such as the demand for distribution services, the monitoring of the state and condition of vehicles with the aid of GPS, the optimisation of routes and dispatching with the help of mathematical models and algorithms such as "routing" and "scheduling".

Telematics applications can be considered very important tools for the implementation of efficient logistics schemes within urban environments. They allow the readjustment of loads of goods to be dispatched, a decrease in the mileage travelled by vehicles and the number of vehicles used, and an increase in the average loading factor for the vehicles as well as a reduction in the negative effects of traffic on the environment.

8.9.3 Experiences in some European cities

Different initiatives are being followed in Italy and abroad in order to rationalise the urban distribution of goods. Table 8.11 presents a comparative framework of the most significant European experiences. It can be observed that the majority of actions relate to a limitation in the mobility of heavy goods vehicles within city centres, even though through a varying spectrum of actions. Policies to foster the use of telematics are rather less frequent and often at an experimental state. CUDs are becoming more widespread even though a successful standard does not exist and there are difficulties in the different ways of management.

In terms of limitation in access to certain urban areas (usually in the city centre or in the so-called zones with limited traffic – ZTL in Italy) it can be observed that the most important criterion is based on the mass of the vehicle, even though the threshold varies from city to city (in general it is between 3.5 and 8.5 tons). By contrast Paris uses the area covered by the vehicle, whilst Milan and Stockholm differentiate commercial vehicles according to their length (the limit is 7 metres in Milan and 12 metres in Stockholm). The lack of choice appears interesting because apart from facilitating the checks it also allows unlimited transit to certain categories of vehicles that offer high/low factors despite not covering too much area. There are also cases in which vehicles are differentiated according to how old they are and how much pollution they generate (Euro classes).

The limitations of access and stop are based purely on the area with a prevalence of exclusive protection for city centres. There are also cases however where a differentiation based on the type of infrastructure is used. In the case of Milan, for example, the territory is divided in concentric zones around the city centre.

The other parameters used for discrimination of traffic are the timeslots used for dispatching and the haulage of goods, but also in this case there is a great variety of solutions, ranging from the total closure to traffic and stops for commercial vehicles, to the closure for daily operations and/or the definition of limited timeslots. In the latter case there are two main tendencies even though there are also a range of ideal solutions. There are two hybrid solutions: using timeslots for closure which in general relate to traffic peak times, or the adoption of opening timeslots for the loading/unloading of goods; the times from free access are usually within the opening times of the commercial activities and in general are either in the morning or in the early afternoon (depending though on the local situation those timeslots vary in terms of extension and starting/ending times).

CUD initiatives have started in many cities and many more are under development. However, it is not possible yet to recognise a successful standard that could be used as a reference. The solutions used are different for their dimensions, their management structure, the forms of partnership and the relationships involved. Some of those solutions were not successful initiatives because of management problems.

City	Surface (Km²)	Population	Current regulations and recent initiatives
Bologna (IT)	141 (C)	370,000 (C)	An historic centre into which only authorised vehicles can enter from 07:00 to 08:00 every day. Within the centre there is an area, the so-called T area, in which accessibility limitations are in place everyday for the whole day, and in which commercial vehicles without authorisation can enter only from 06:00 to 09:30 and from 14:30 to 16:30. Furthermore, commercial vehicles with a capacity higher than 8 tons can only go through the historic centre if they have an appropriate authorisation. Within the three-year project (1996-1998) "Sustainable Urban Regional Freight Flows" (S.U.R.F.F.) partly financed by the European Community, the city of Bologna has developed a pilot where telematics solutions for the improvement of the distribution of goods within the city are in place.
Genova (IT)	243 (C)	600,000 (C)	The strategies of regulation of traffic haulage mainly consists in limiting the availability of the possibility to stop in certain commercial streets. From March 2003, a new scheme for the distribution of goods within the historic centre is in operation. Goods which are directed to it are collected in a hub and distributed through electric vehicles.*
Milano (IT)	182 (C)	1,300,000 (C)	The freedom of movement of goods vehicles in the city is limited in relation to position in the network (the territory is divided into four concentric corridors), the time (there are different timetables available) and to the length of the vehicle (there is a limit of 7 metres), with greater restrictions in the central part of the network. Besides, some initiatives are being evolved in order to foster the use of commercial liquefied natural gas (NLG) vehicles and for the organisation of a co-ordinated system of CUD.

City	Surface (Km²)	Population	Current regulations and recent initiatives
Padova (IT)	93 (C)	212,000	From April 2004 a project called "Delivery within the City", financed by the region, municipality, province and the Chamber of Commerce. Seven food vans powered by methane distribute the goods within the centre on behalf of all transport operators belonging to the scheme (in practice, all the companies dealing with urban distribution of goods, with the exception of express couriers and those companies dealing with food). The exchange hub is located within the harbour and occupies a surface of 1,000 square metres. Deliveries can be made at any time of the day by utilising particular lanes and appropriate parking bays that speed up the operations of load/unload. Access is to be by gates which are to be installed. The service is guaranteed even when there are blocks when the traffic is at a standstill, and also when the traffic is stopped because of pollution. The platform contains informatics systems allowing for the complete traceability of the goods by each single transport operator, as well as the personalisation of the so-called delivery receipt with the logo of the companies on the goods.
Roma (IT)	1.285 (C) 5 (ZTL)	2,500,000 (C) 42,000 (ZTL)	An historic centre in which traffic is forbidden every weekday from 06:30 to 18:00 and on Saturday from 14:00 until 18:00. During those times one needs an appropriate permit in order to enter the ZTL. Access is checked during the times when access is forbidden, through an electronic system called "Iris", with a technology which is similar to the motorway telepass (automatic tolling). The following regulations are in place in order for the vehicles to access the ZTL: • Lorries with a capacity higher that 3.5 tons can circulate within the ZTL without a permit and they can wait in parking bays from 20:00 to 07:00 next day; • Lorries for haulage with a fully loaded mass of up to 3.5 tons can circulate within the ZTL and they can wait in the bays for loading/unloading of goods only if they have a permit and only within the following times: from 20:00 to 10:00 and from 14:00 to 16:00; • Specific categories of lorries can access the ZTL without any time limitation and wait in the bays as long as they have a permit.

(C) = data relating to the entire municipality (ZTL) = data relating to the ZTL (Zone with Limited Traffic)

• = see Section 8.3

City	Surface (Km^2)	Population	Current regulations and recent initiatives
Siena (IT)	119 (C)	49,000 (C)	A very detailed set of rules apply for the access of commercial vehicles within the historic centre. The regulation implies that different sets of times are available depending on the type of goods (food etc.): • From 18:00 to 10:00 and 15:30 to 17:00 for express couriers, wholesale dealers and distributors of the goods relating to the food industry; • 06:00 to 10:00 for shops using their own vans for the collection of goods; • 06:00 to 09:00, 11:00 to 13:00, 18:00 to 20:00 for the distributors of fresh produce and catering; • 08:30 to 09:30, 12:00 to 13:00, 16:00 to 17:00, 18:30 to 19:30 for distributors of medicines; • 08:00 to 21:00, 13:00 to 14:00, 18:30 to 19:30 for sellers who already have a permit to occupy public ground of the ZTL. No commercial vehicle can circulate after 10:00 in those streets which are clearly defined within the central part of the city. In February 2000 a new pilot called "Alife" was started with the aim of integrating new technologies and distribution systems whereby a new system for the delivery of goods to shops in the historic centre is dealt with by logistics hubs which are situated outside the city and where the orders arrive via telematics. Goods should be dispatched using vehicles with a low environmental impact controlled by a telematics system at the moment of their access in the city centre through entry gates. *(see Section 8.2)*
Paris (FR)		9,600,000 (AM)	The regulation of haulage is based on the following principles: • regulation of the times of activity of commercial vehicles as a function of the service used (in that respect three categories of commercial vehicles have been identified); • protection of the peak times of private traffic (07:30 to 09:30 and 16:30 to 07:30); • fostering of initiatives carried out at night; and • the exception of the regulation for certain types of commercial vehicle. These restrictive measures are not valid for vehicles carrying specific types of goods.

City	Surface (Km²)	Population	Current regulations and recent initiatives
La Rochelle (FR)		116,000 (AM)	A new project was started in 2001 with a two-year timescale called Elcidis (Electric City Distribution System) that envisages the realisation of a system of urban distribution of goods which is based on electric vehicles. The project, which is partly financed by the European Union, is based on the setting up of an urban hub localised in the city centre in which lorries and vans must unload all the goods; these will then be distributed according to their final destination using electric vehicles.
London (UK)		7,600,000 (AM)	A general regulation does not exist. However, the established use of operations of loading and unloading falls on the road network within diversified time periods for the various boroughs and the function of local requirements. Usually, operations of loading and unloading are forbidden during peak hours of the morning and afternoon with differentiations based upon the capacity of vehicles. It is quite common practice, and gradually growing, for goods to be distributed at night. There is also a specific regulation within the so-called "Red Routes" (privileged routes) along which, despite waiting being forbidden from 07:00 to 19:00, it is possible to stop and carry out loading/unloading of vehicles in purpose-made parking bays from 10:00 to 16:00 with waiting time being limited to 20 minutes. In March 2000 a project called "London Night-time and Lorry Control Scheme" set up limitations to the transit of heavy goods vehicles in certain parts of the city. Each vehicle with a capacity greater than 18 tons requires a special permit in order to access the "Lorry Control Scheme Area" during the following time periods: • Midnight to 19:00 and 19:00 to midnight Monday to Friday; • Midnight to 19:00 and 13:00 to midnight on Saturday; • Midnight to midnight on Sunday.

(C) = data relating to the entire municipality (AM) = data relating to the metropolitan area

City	Surface (Km^2)	Population	Current regulations and recent initiatives
Barcelona (ES)		1,585,000 (AM)	A regulation is in place which is based on the peak time transit. The areas covered by this regulation are: • A small zone in the southern districts of Barcelona where vehicles with a capacity greater than 5 tons can circulate during day and night; • The central zone in which the transit of lorries with a capacity higher than 16 tons is forbidden from 13:30 to 21:30; • The city centre where vehicles with a capacity higher than 3.5 tons can circulate from 12:00 to 14:30 and from 17:00 to 20:00; • A supplementary zone in which the circulation of vehicles with a capacity greater than 5 tons is forbidden from 12:00 to 14:30 and 17:00 to 20:00. A project has begun for the application of several actions: • Organisation of small areas in correspondence to junctions in which the operations of load/unload can be made between 08:00 and 14:00 (in certain cases until 20:00) for a maximum wait time of 30 minutes; • Introduction of "multi-functional street"; these are reserved for long stops at night for the circulation of private vehicles during peak times and to the delivery of goods during the day but outside of peak times; • Identification in the city centre of 5 ZTLs where access is regulated by a central electronic system; • Organisation of 2 logistics hubs where access is regulated through a system of automatic tolling.
Cordova (ES)		180,000 (AM)	Within the LEAN LOGISTICS project (1997-1999) which was partly financed by the European Community, a number of strategic solutions were identified: • Sub-division of the city centre into a number of different zones; • Regulation of the access to the zones by commercial vehicles according to their mass; • Check of the access and itineraries which are authorised for haulage; • Limitation within those zones of the operations of loading/ unloading of goods.

City	Surface (Km²)	Population	Current regulations and recent initiatives
Seville (ES)		1,000,000 (AM)	The most important measures to regulate the haulage are: • Definition of areas which are organised for the loading/unloading of goods and available during 07:00 to 11:00 and 15:00 to 17:00; • Access to the city centre for commercial vehicles only from 07:00 to 11:00 (with the obligation to leave before 12:00) and from 15:00 to 17:00 (with the obligation to leave before 18:00). Within the MEROPE project (2003) two initiatives have been foreseen regarding the urban distribution of goods:* • Introduction of a system for the optimisation of the use of loading/unloading of goods areas with the purpose of guaranteeing the rotation of vehicles within the same zones; • The identification within the city centre of hubs where space is reserved for the waiting of commercial vehicles.
Lisbon (PT)		3,750,000 (AM)	Within the eDRUL (2003) project a platform for the urban distribution of goods has been planned as well as flexible management of the operations of loading/unloading of goods through the use of mobile telephones.**
Freiburg (DE)		600,000 (AM)	Commercial traffic for the dispatching of goods within the city centre, and in particular within the ZTL, has been regulated in this way: dispatching is allowed from 08:00 to 12:00 with the limitation that the mass of the commercial vehicles has to be below 7.5 tons. Within the other pedestrian sectors of the city centre there is the same limitation regarding the mass of the vehicles but the times for the deliveries are different: 05:00 to 10:30 and 19:00 to 10:00 Monday to Friday, and 05:00 to 09:00 and 19:00 to 10:00 Saturday. In 1993 a new project, "Freiburger City-Logistic", was started; this includes a new organisation for the distribution of goods within the city which is the result of a private initiative of the transport operators. The project includes the constitution of four centralised co-operative groups each of which are composed of a number of companies that are aggregated based on the geographical vicinity of their corresponding headquarters. Each group has defined their own organisational model. The project "Freiburger City-Logistic" has been in operation since 1997.

(AM) = data relating to the metropolitan area

* see Section 8.5 - ** see Section 8.7

City	Surface (Km^2)	Population	Current regulations and recent initiatives
Basilea (CH)		560,000 (AM)	The operations of loading and unloading of goods are allowed at particular times of the day which are identified as a function of the PTAC of the vehicles ("Poid Total Autorisé en Charge", i.e. the vehicle capacity) and of the urban areas interested. In more detail: • The PTAC of commercial vehicles cannot be above 28 tons; • Vehicles with more than 3.5 tons of PTAC cannot operate between 22:00 and 06:00; • Goods vehicles can circulate within pedestrian zones only from 06:00 to 10:30 and the PTAC of the commercial vehicles must not exceed 18 tons; • The other zones in the city are not subject to restrictions. In 1994 a new project was launched within the framework of the national plan "Energy 2000" by the "Office Fédéral de l'Energie". This pilot project called "Basel City Logistik" is aimed at rationalisation and optimisation of the haulage which is heading towards the city centre. "Basel City Logistik" provides 5 terminals for delivery. In general terms the system works in the following way: transport operators deliver their goods to one of the five terminals; the companies doing the transport and managing the project deliver the goods to the shops or the city centre using their own vehicles and charge the transport operators directly for their work. The deliveries are done through vehicles with 3.5 tons of capacity, therefore at low environmental impact. The project "Basel City Logistik" works but is not "taking off ", by involving further transport companies because it is not financially advantageous or sustainable.
Amsterdam (NL)		1,120,000 (AM)	In 1996 the city council began a new project for urban haulage. This involved the use of an efficient system to check access which is based on temporal windows and the access prohibition of commercial vehicles with a load higher than 7.5 tons; those vehicles with a "load factor" higher than 80% do not have to abide by this rule, and also those which are devoted to specific categories of goods. In preferred areas of the city a number of centres for the collection and distribution of goods to the urban centre are being set up.
Leida (NL)		115,000 (AM)	The transport operator can access the city centre in order to dispatch their goods between 05:30am and 11:00; in the streets outside the city centre there is no enforcement. In 1997 a new project involving a CUD (centre for distribution) was started. This project was suspended in 2000.

City	Surface (Km^2)	Population	Current regulations and recent initiatives
Utrecht (NL)		540,000 (AM)	The regulation of haulage requires that deliveries within the city centre are done between 06:00 to 11:00 and from 18:00 to 19:00. Due to the presence of caves under the road surface a certain number of restrictions have been imposed based on the weight of vehicles: vehicles in fact cannot weigh more than 2 tons.
Stockholm (SE)		750,000 (AM)	In the city centre the following regulations apply: • Commercial vehicles with a mass greater than 3.5 tons cannot circulate during the night (from 20:00 to 06:00); • Commercial vehicles with a height greater than 12 metres are not authorised to access the city centre; • The circulation of all engine-propelled vehicles is allowed only from 06:00 to 11:00 (except for taxis); • These heavy goods vehicles must not be older than 8 years in order to access the city centre. In 1996 a project was launched involving the definition within the city centre of "environmental zones" in order to protect the environment from the problems caused by traffic. In these zones a certain number of regulations have been defined concerning the circulation of diesel vehicles with a mass higher than 3.5 tons. These cannot access "environmental zones" unless they belong to a specific "environmental category" (which is identified in terms of noise and pollution produced). Exceptions to this rule are possible.
Monaco (MC)		30,000 (PR)	The urban haulage is regulated in a very rigid manner. Lorries with a total mass higher than 8.5 tons are forbidden to travel in the city (except for vehicles moving out or vehicles to move hydrocarbons, or vehicles transporting goods at controlled temperature, etc.) Commercial vehicles with a lower capacity can travel freely except during the following time periods: 07:45 to 08:15, 11:30 to 12:30 and 13:45 to 14:15. The dispatching operation on board are authorised from 08:30 to 11:30 and from 12:30 to 13:45 and from 14:15 to 16:30. During the time periods when the traffic is forbidden, commercial vehicles can however still wait at the parking bays. In 1989 a centre for the urban distribution (CUD) was started which belongs to the Monaco government, and is managed privately.

(AM) = data relating to the metropolitan area - (PR) = data relating to the Principato (Monaco)

 Table 8.11: **A comparison of European experiences**

8.9.4 *The experience of Milan*

Milan has looked into different directions in terms of government policies for goods haulage:

a) a more in-depth study of the transport system of goods haulage within the metropolitan area;
b) the constitution of a framework for discussion between local public authorities and organisations or individuals interested in the regulation policies;
c) the activation of a number of tactical operational initiatives and the preparation for interventions at the strategic level.

The investigation of goods haulage

Between 2000 and 2003 an extensive investigation was carried out by the City of Milan with the help of the Ministry for the Environment, with the aim of identifying a better picture of the requirements in terms of goods haulage in the metropolitan area (see Figure 8.35).

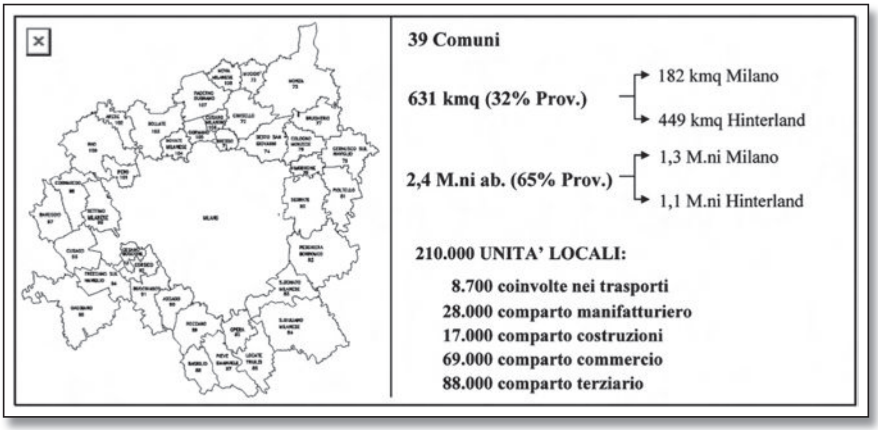


Figure 8.35: **Metropolitan area of Milan**

This analysis, co-ordinated by the Polytechnic of Milan (Da Rios and Gattuso, 2003) has been developed through:

- traffic flow surveys on the road (8 screen lines points at motorway tolls, 53 screen line points within the metropolitan area and 14 within the centre) within a weekday (between 07:00 and 21:00);
- roadside interviews corresponding to the surveys mentioned above;
- stated preference interviews for local operators at shopping points;
- an investigation within a district of the city centre where there is a high demand for commercial activities.

As a result of the above surveys, a wide range of parameters has been identified regarding the haulage of goods (Da Rios and Gattuso, 2003). Table 8.12 shows some of the characteristics gathered on the three concentric screen lines (one on the motorway, one in the metropolitan area and one in the centre) where goods haulage has been observed in terms of 107,000 units (20% of the total traffic), 78,000 units (19%) and 33,000 units (8%) within a normal working day (from 07:00 to 21:00). It can also be observed how the characteristics of the movement of goods change from outside the city towards the centre.

		Motorway	Outside city	City Centre
Typology of vehicles	HGV	28%	7%	2%
	Lorry	43%	38%	24%
	Bus	29%	55%	74%
Regime	Third party	60%	45%	37%
	own	40%	55%	63%
	own - operations	8%	20%	31%
Type of transport	Dispatching	60%	45%	45%
	Operations	8%	20%	31%
	Couriers	15%	18%	10%
More than one destination		20%	30%	40%
Return within the day	Towards Milan	60%		
	Towards periphery	40%		
Load	> 3,5 t	55%	27%	11%
	Empty	14%	20%	33%
% of load for non-empty vehicles		57%	47%	40%

Table 8.12: **Characteristics of haulage of goods within the metropolitan area of Milan. Traffic flows surveyed at 3 screen-lines**

The Consultation Framework

It is important that the ways those objectives are achieved and the initiatives to be taken are shared as much as possible and also agreed upon by stakeholders; in this respect the council has been promoting a number of consultation initiatives with the social actors (shopkeepers, companies, associations) in order to create an environment of co-operation and dialogue.

Private operators have put forward a number of proposals for the setting up of CUDs which are under assessment by the city council whose approach is to foster those initiatives that appear to be more valid within the decision framework based on the interests of the entire community and freedom of competition between operators of logistics.

Recent Initiatives

Recent initiatives carried out by the Municipality of Milan are being oriented towards three directives: a more articulated regulation of the circulation of goods vehicles, the promotion of ecological vehicles for the distribution of goods within the centre, and a greater will to proceed towards the organisation of a co-ordinated system of CUDs. Concerning the policies for the limitation of circulation and waiting times of commercial vehicles, the following regulation has recently been set up:

- Prohibition of transit and dwell for any vehicle or set of vehicles[1] whose length is longer than 7 metres for each day of the week, for the area included within the Cerchia dei Navigli (so-called "Ipercentro", see Figure 8.36); this regulation is there to try to protect one of the most ancient areas of the city where the road network does not

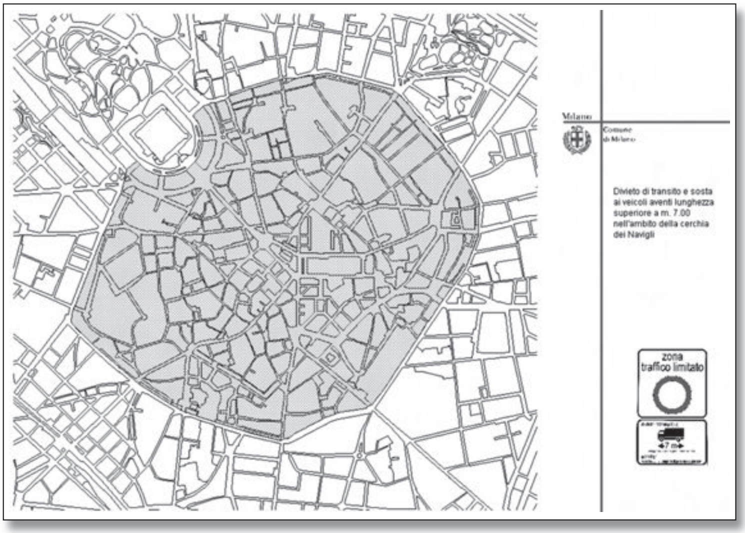


Figure 8.36: **Area prohibited to the transit and dwelling of vehicles longer than 7 metres**

1 For all the rules mentioned the following exceptions are applied:

- All the vehicles for maintenance and daily management of public services such as aquaduct, AMSA, ATM, Italian Mail and other societies relating to postal services, etc.;
- Shipyard vehicles such as travelling cranes, cement mixers, etc.;
- Vehicles for the transport of valuables;
- Vehicles for the provision of fuel for heating systems and for the discharging of wells
- Vehicles that have specific requirements and have permits from the police of the municipality according to directives provided by the council on transport and mobility.

allow for the circulation and the stop and dwell of long vehicles. The regulation does not limit access to lorries whose weight is greater than 35 quintals, but only those longer than 7 metres, thus allowing access to fridge plants that, despite their small dimensions, have a great weight because of their requirements;

- Prohibition of transit and dwell for any vehicle or set of vehicles[2] whose length is longer than 7 metres in the period 07:30 to 21:00 over the whole week in the area between the Cerchia dei Navigli and Cerchia dei Bastioni (Centro, see Figure 8.37); this policy does not try to discourage high capacity lorries but instead tries to minimise the problems to the traffic caused by vehicles whose dimensions are incompatible with the current infrastructure;

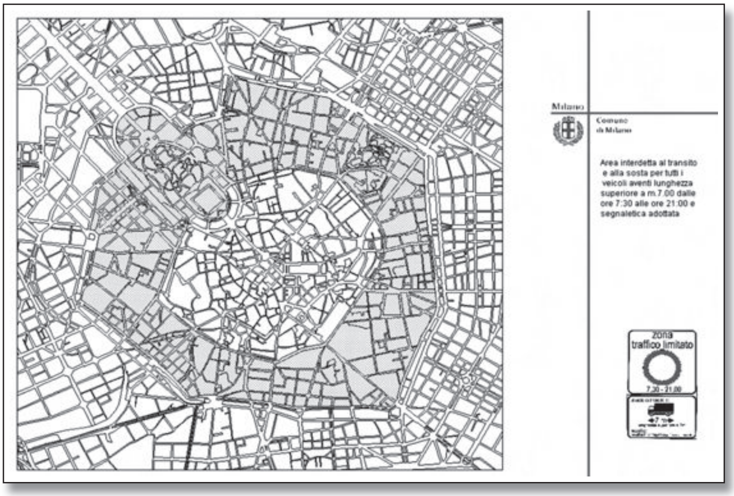


Figure 8.37: **Area prohibited to the transit and dwelling of vehicles longer than 7 metres from 07:30 to 17:00**

- Prohibition of transit and dwell for lorries and HGVs during the day (from 07:30 to 21:00) over the whole week, for the urban area delineated by appropriate signals (see Figure 8.38); this policy allows the traffic of lorries and HGVs in the outside sector of the city to access the hubs of the companies for international haulage and the major logistics centres; these vehicles are allowed to travel from 21:00 to 07:30 in all the city apart from within the Cerchia dei Navigli.

Using "clean" transport technologies is important for the administration to foster the use of LPG commercial vehicles by private operators. The plan for alternative energy of the municipality includes the installation within a few years of 10 distributors of LPG in the city.

Within the Milan hinterland there is a large dispersion of logistic hubs for the distribution of goods (more than 250) that cause a considerable difficulty to extra-urban

2 See footnote 1.

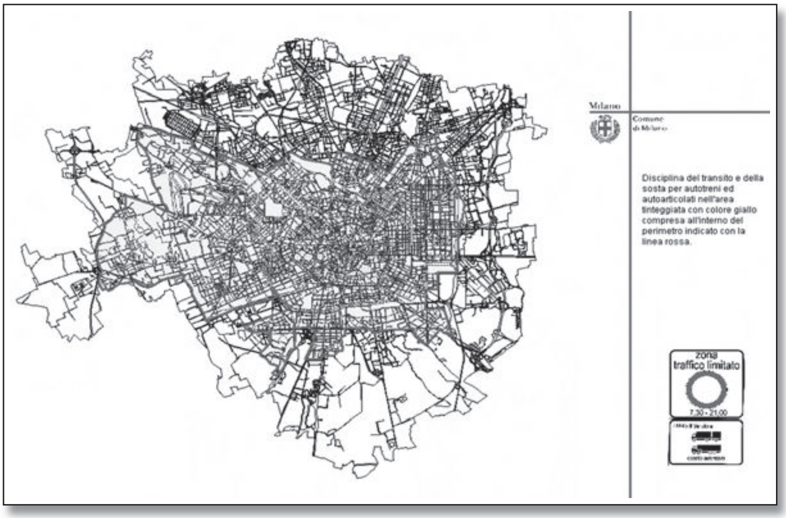


Figure 8.38: **Area prohibited to the transit and dwelling of lorries and HGVs from 07:30 to 21:00**

traffic because of their numbers and disorganised development. The municipality of Milan do not view the creation of new logistics hubs in a good light and also they have approved legislation to prevent this from happening. The identification of areas for the creation of these hubs is difficult and often not appropriate to the requirements. However, as part of an evaluation conducted at the research stage (the choice has not yet been made by the political parties), there is a possibility for two large CUDs (first level) situated in the north-west and south-east areas and at least four small CUDs (second level) for the city. The dimensions of each of the big CUDs have been evaluated to be about 40,000 square metres (of which 10,000 covered) and with completely automated equipment for sorting and generating goods to be distributed according to micro-zones and type of transport operators. In order to work the equipment must be able to "talk" to any information system available and also must be able to read different languages for barcodes.

The creation of big CUDs which could also be part of the re-utilisation of already-existing structures should be developed at the same pace of strategic vision for the entire development in this particular area of work and together with the councillors of the Municipality of Milan and all the municipalities around it which are involved in the plan. A different perspective must be adopted for the small CUDs; their positioning and dimension are more strictly correlated to the area where they are and to the function they are planned to fulfil. Based on the data produced by on-site surveys, the dimensions for a second level CUD at the service of the Milan Centre has been assessed in relation to a number of significant variables such as the number of vehicles entering it, their capacity, the load factor, the destination of the vehicles, the type of goods and the number of companies that can use it.

Table 8.13 shows a possible profile for the demand as a function of the elements mentioned above up to a total of 1.9 thousand tons per day, it is considered that a CUD should be able to manage about 1,000 tons of goods per day considering that only a few types of goods can be effectively dealt with by it.

Therefore, in order to effectively serve the Cerchia dei Bastioni four hubs would be sufficient, each with a capacity of about 250 tons per day. It has been estimated that each of them should have an area of about 3,000 square metres to include both covered and uncovered areas.

Type of goods transported	Quantity %	CDU Managed	%	Goods manageable by a 2nd level CDU (ton)
Food running out	11,58	no	0	0
Food not running out	4,49	yes	4	86
No food for retail	2,24	yes	2	43
Furnishings and other home delivery	8,09	yes	8	154
Building material	34,54	no	0	0
Raw products	1,36	no	0	0
Finished goods	16,18	yes	16	309
Other	21,52	yes	22	411
Total	100,00		53	1003

Table 8.13: **Distribution of goods by type and estimation of the quantity that could be dealt with by the second level CUDs**

8.10 Heavy vehicle transport regulation in the city centre of Prague

J Mach

8.10.1 Introduction

Prague is the capital of the Czech Republic. It is the administrative, cultural, educational and economic heart of the country. Prague's GDP is 164% of EU (2004) average and is well above the average of the Czech Republic. It seats many educational institutions with research centres and more than 100,000 students, the state administration and many business headquarters. The city centre is a composition of mediaeval buildings and an historical, narrow and curved street network. Since 1992, Prague's historical centre has been listed on the UNESCO heritage list and with an area of almost 8.6 km^2 it is one of the largest places on the list. But it's not only the history that interests hundreds of thousands tourist every year. Prague is also well known for its vital life. Besides attracting many tourists the city centre still remains the living, shopping and business area for its 1.2 million inhabitants and about 500,000 commuters. It creates a necessity of solid transport coverage of goods and passenger flows.

Besides the public transportation system, there are more than 775,000 motor vehicles registered in Prague and about 70,000 of them are heavy vehicles. This places a huge stress on the city's infrastructure and is a challenge for the city administration.

8.10.2 The 6t Zone

The necessity of preserving historical buildings at a time of growing intensity of heavy road transport must lead to appropriate transport measures. Already in the 1960's a zone of restricted access to the historical zone for heavy freight vehicles was introduced. This zone makes a restriction for vehicles over 5.5 (later upgraded to 6) tons. The fall of the communist regime and the subsequent social changes had, besides others, a significant impact on transportation in Prague, as well as on Prague itself. The rapid growth of transportation in Prague can be easily seen from Figure 8.39.

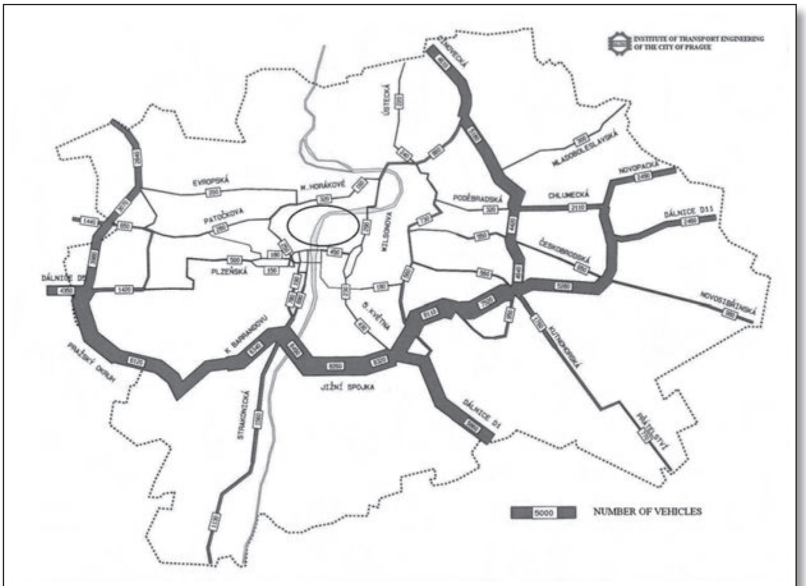


Figure 8.39: **Million vehicle kilometres travelled on an average workday – total road network**

The main reason for creating the restriction zone was to decrease the heavy vehicle traffic in the city centre. This traffic was pushed away from the city centre to newly constructed trunk roads around the wider city centre. After 1990, the city of Prague became a tourist hot spot and at the same time a business and shopping centre. A number of new shops and offices needed to be supplied. In 1990 the restriction zone was enlarged to the densely populated northern part of the wider city centre. This led to a fall of heavy freight transport in this area of about 85%. Heavy transport shifted to newly constructed trunk roads, where transport rose by 30 – 50%. In 2000 the 6t zone covered almost 17 km^2 of the city centre and surroundings and besides restriction for heavy trucks; it also restricts buses from parking inside the zone with exception for marked places.

8.10.3 The 3.5t zone

In 1999 a new zone, inside the older one, was introduced. The zone of restriction for vehicles over 3.5 tons (3.5t zone) spreads over the real historical centre, an area of around 5 km^2. The reasons for this zone were to preclude semi-heavy vehicles (lorries from 3.5 to 6 tons) from through traffic and to regulate their movement in the city centre during pedestrian peak hours. Vehicles over 3.5 t can only go in to this zone from 18:00 to 08:00 and buses can't stop inside this zone. Time allowances for nights and early mornings allow deliveries into shops and businesses (Figure 8.40).

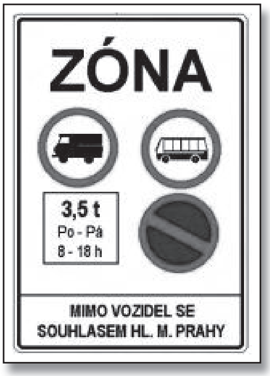


Figure 8.40: **The 3.5t zone**

For both zones the City can grant a permit to enter the zone for vehicles that are generally restricted from entering. For example in 2001 there were 264 short-term and 3,523 long-term permissions to enter the 6t zone. Table 8.14 illustrates the significant effect of this zone on freight traffic in the city centre.

	Central cordon						Outer cordon					
	Passenger cars		Lorries		Total		Passenger cars		Lorries		Total	
Year	number	%	number	%	number	%	number	%	number	%	number	%
1961	0		30	8%	120	%	14 000	14%	14 000	41%	36 000	26%
1971	241 000	63%	38 000	97%	299 000	69%	50 000	50%	23 000	68%	77 000	55%
1981	247 000	64%	39 000	100%	292 000	67%	67 000	66%	31 000	91%	104 000	74%
1990	385 000	100%	39 000	100%	435 000	100%	101 000	100%	34 000	100%	140 000	100%
1996	543 000	141%	30 000	77%	581 000	134%	222 000	220%	38 000	112%	265 000	189%
2000	594 000	154%	23 000	59%	627 000	144%	304 000	301%	43 000	126%	351 000	251%

	Central cordon						Outer cordon					
	Passenger cars		Lorries		Total		Passenger cars		Lorries		Total	
Year	number	%	number	%	number	%	number	%	number	%	number	%
2001	556 000	144%	21 000	54%	589 000	135%	310 000	307%	43 000	126%	358 000	256%
2002	560 000	145%	18 000	46%	590 000	136%	329 000	326%	45 000	132%	379 000	271%
2003	561 000	146%	18 000	46%	590 000	136%	376 000	372%	50 000	147%	432 000	309%

Table 8.14: **Vehicle movements in Prague, 1961-2003**

The number of lorries entering the central cordon falls significantly to less than 50 % of the number in 1990 despite the fact that the total number of cars grew and the number of lorries outside the city centre rose to almost 150% of the 1990 number. Though restriction zones were originally designed to decrease the number of heavy vehicles in the city centre, it has also other significant advantages. Emissions and noise pollution decreased as well. But though heavy freight transport was pushed away, streets are no freer, because space is used by the growing number of passenger cars.

One can conclude that the original goal – of decreasing heavy vehicle traffic in city centre – was successfully achieved by regulation of heavy vehicle traffic by the restriction zones. The effect of pushing heavy freight transport away from city centre can be easily seen from the following maps (Figures 8.41 – 8.42).

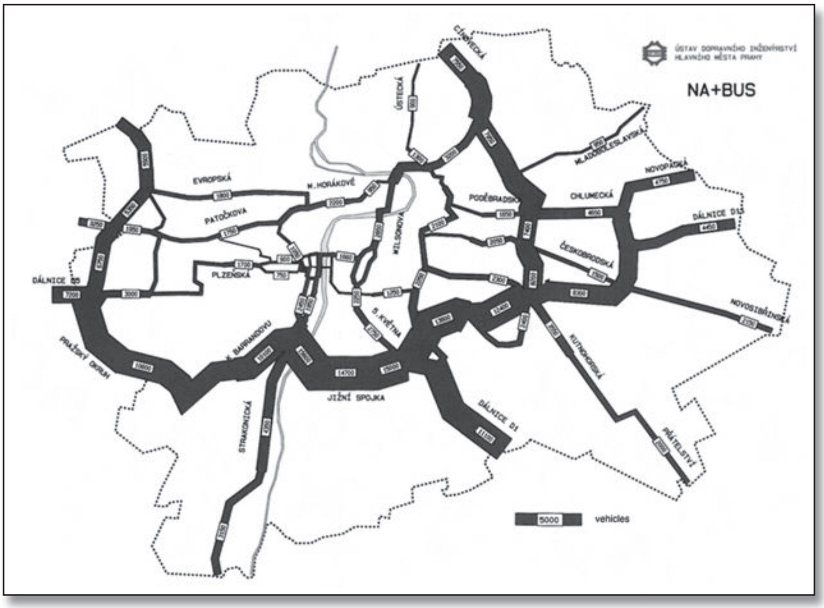


Figure 8.41: **Traffic Volumes of Lorries + Buses (average working day, 06:00 – 22:00, historical city centre in red circle)**

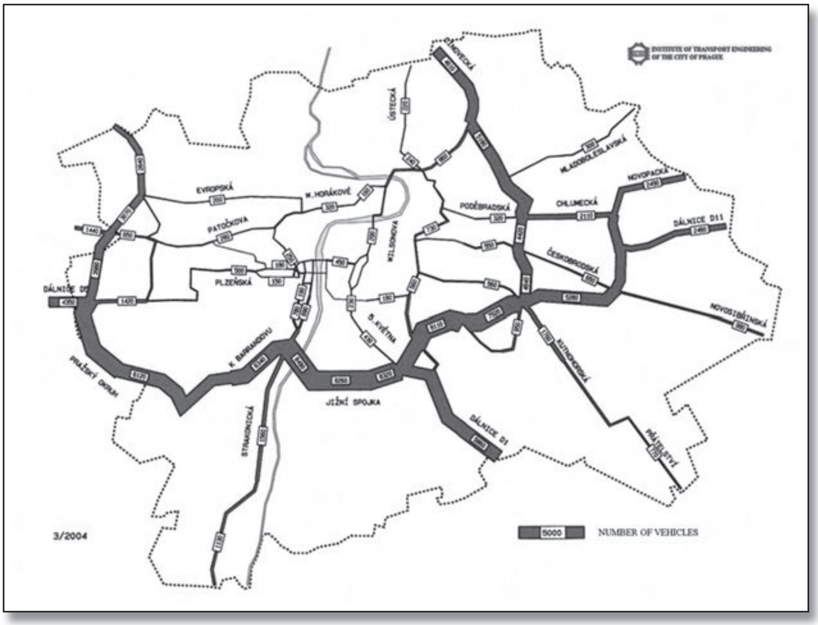


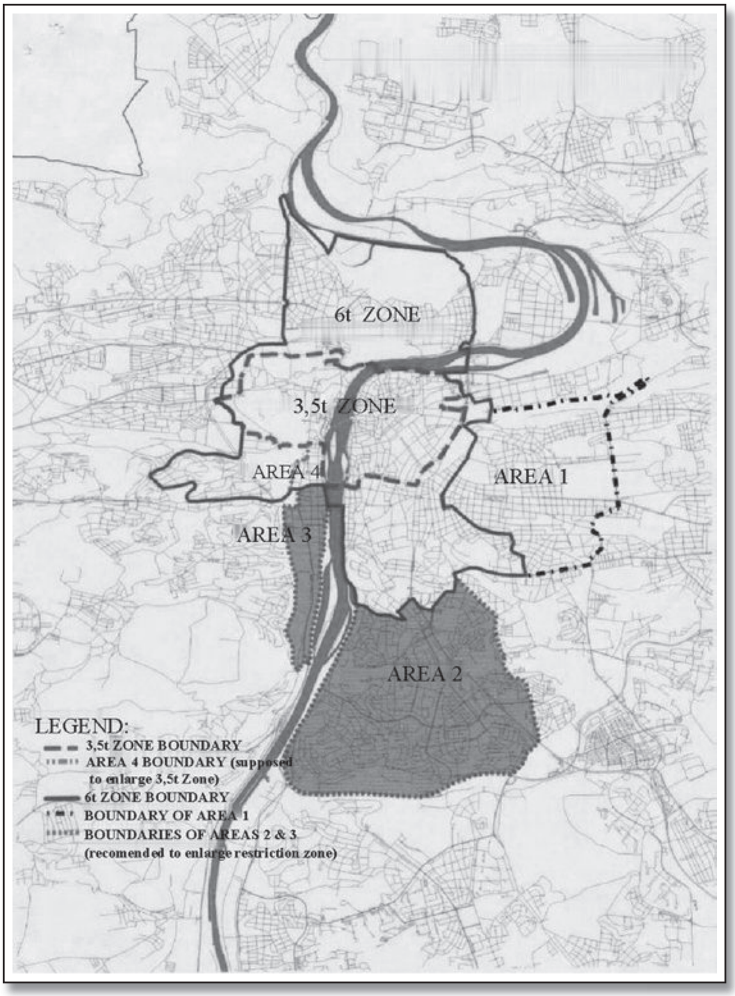
Figure 8.42:
Traffic volumes of freight transport over 6 tons (average working day, 06:00 - 22:00, historical city centre in grey circle)

8.10.4 Zone enlargement

In 2002 the City of Prague took part in the EC CIVITAS initiative and joined the TrendSetter project with 3 ideas. One of the ideas was the enlargement of the zones of restriction for vehicles heavier than 6 tons. By extending the regulation effect to a wider area, the City of Prague pursued the following goals: reducing heavy vehicle share in traffic flow, reducing emissions, reducing noise and enhancing the flow of traffic in the wider city centre. In short: improving the city environment. In 2002 preparatory work began with proposal of 4 possible areas of enlargement and preliminary study of the expected impacts of enlargement (see Figure 8.43). The study was carried out by the Institute of Transport Engineering of the City of Prague (ÚDI Praha).

The preliminary study expected that:

- Numbers of vehicles that start or end their route in proposed areas and that already have permission to enter to 6t zone will not change.
- Vehicles that are only going through the zone without stopping and that have no permit to enter to 6t zone will change their route outside the zone.
- Vehicles that supply the study area expect the following changes: Ask for permit (expectations of 30%), change to lighter vehicles that need no permit (around 30%).
- It can be expected that the number of vehicles entering the zone without a permit will rise (around 20-40%) unless transport control is enhanced
- Increase in the number of vehicles with a permit to enter the 6t zone will raise the number of such vehicles (about 5-10%) in the existing zone



Legend
Existing zone 3.5 t
Considered area # 4
Existing zone 6 t
Considered area # 1
Areas 2 & 3 recommended for enlarging restriction zone

Figure 8.43: **Overview of potential areas of enlargement**

Through an evaluation process ÚDI Praha has conducted detailed surveys of road freight transport in chosen areas. The survey gathered information about the number of freight vehicles entering and going out of the proposed zones, the number of freight vehicles going through them without stopping there and classification of them (light, semi-heavy and heavy freight vehicles). The lists of entering vehicles were compared with the lists of vehicles with permission to enter the existing zone. Frequent destinations of freight transport were also defined. The survey showed that, besides others, transit transport comprises 21 – 32 % of freight transport in the areas, of which 19 – 38 % is made up by vehicles over 6 tons.

With these expectations an analysis of the impact of enlarging the zone was made for all areas with the following results (Table 8.15).

Area:	1	2	3	4
Decrease in total number of vehicles:	76	181	141	101
Decrease of vehicles entering the area:	55 (9% of total)	132 (19%)	129 (21%)	59 (9%)

Table 8.15: **Impact of enlarging the zone of restriction**

After considering all data, ÚDI Praha recommended that the restriction zone be enlarged by areas 2 and 3. In June 2003 the City Council approved the resolution concerning the outcome of the analysis and the proposal for the expansion of the existing 6t zone. The expansion needed to be approved by city borough authorities into which the zone will enlarge. In August 2003, representatives of Prague 4 and Prague 5 city boroughs approved enlargement of the zone in their areas.

Meanwhile the citizens were informed and large local businesses and shops were contacted with information about the proposed zone. In total 611 businesses and shops were informed. There was no rejecting response, only some demands for more details. This non-existence of negative reaction and easy spreading of information to public is probably caused by the fact that the City doesn't create something new but only enlarges an already existing zone that is recognized and positively accepted by public. Businesses and shops managers do know that this zone will not make deliveries harder. But on the other side, in proposed areas there is no heavy industry any more.

In September 2003 the City council passed the resolution concerning the setting up of the 6t zone. Enlarging of the 6t zone by area 2 came into effect on 1.12.2003. Enlarging by area 3 was contingent on the opening of the new part of the Prague inner ring (Mrázovka Tunnel). This was opened in August 2004 and enlarging of the zone came into effect at the same time. Nowadays the 6t zone covers more than 26 km^2 of the city centre. The project will be finished by analysis of the real impact on the transport situation in Prague. This analysis will be comparable to the preliminary study.

Regulation of heavy vehicle transport in the city centre in Prague through access restriction zones is very successful and improves the environment not only by a decrease in emissions, noise and vibrations, but it has also positive impact on road safety and the subjective feelings of citizens and tourists.

The project of enlarging the environmental zones is part of the CIVITAS TrendSetter project and was co-financed by the European Commission.

CHAPTER 9

Lessons Learned from European Initiatives: the BESTUFS Project

M Quispel

9.1 Best Urban Freight Solutions

The European Commission established the Thematic Network on *BEST Urban Freight Solutions* (BESTUFS) in January 2000. BESTUFS identifies and disseminates best practice with respect to urban freight transport. BESTUFS aims to obtain the co-operation of experts and projects with existing or just emerging experiences and expertise. BESTUFS has established and maintains an open European network between urban freight transport experts, user groups/associations, on-going projects, interested cities, the relevant European Commission Directorates and representatives of national, regional and local transport administrations. The overall objective is to identify, describe and disseminate best practice, success criteria and bottlenecks with respect to the movement of goods in urban areas.

In BESTUFS II (2004-2008) the network will be continued. BESTUFS II will further identify the problems and the requirements of the cities as well as of all private actors involved in urban freight and will maintain the environment for establishing policy as well as research recommendations. The most relevant and helpful findings will be promoted in BESTUFS II in the form of guides for actors in medium-sized cities together with national seminars organised in 22 countries. Furthermore, BESTUFS II will describe the urban context and the role urban freight transport plays in a city. A group of experts will quantify freight transport related processes and measures compared to other transport modes as well as compared to different sustainability objectives. Finally, common data models and applied practical modelling tools are to be addressed in more detail by European experts that will consider this topic at roundtables and prepare suggestions for a European harmonisation and roadmap.

BESTUFS II has a geographic coverage of 22 countries: Ireland, Spain, Italy, Sweden, Finland, Slovenia, Slovakia, Bulgaria, Romania, Denmark, Poland, Belgium, Ireland, Austria, Estonia, France, Great Britain, Czech Republic, Hungary, Switzerland, Netherlands and Germany. It will contribute to the improvement of the quality of life in urban areas by analysing and developing environmental-friendly and town planning compatible strategies that reduce the goods transport intensity of economic growth[1].

9.2 Main issues of urban freight transport

Currently, more than 80% of road freight trips in European conurbations are of distances below 80 km and can be defined as urban or urban-regional transport. Urban areas are characterised by a concentration of residential, trading and commercial activities. Due to heavy trade and commerce activities there is an important urban economy that needs a well functioning logistics system for freight and passengers.

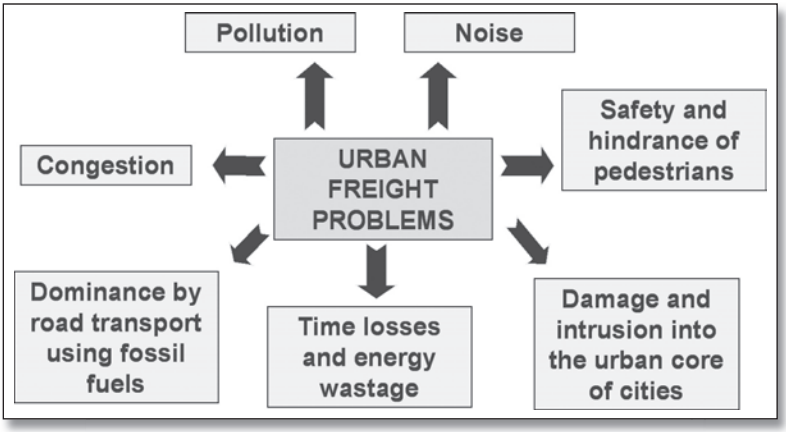


Figure 9.1: **Problems in urban freight transport**

The delivery and collection of goods within urban and metropolitan areas, especially in the core areas of cities with old and established centres has a major impact on the local community concerning the economic power, quality of life, accessibility and attractiveness of a city. The retail industry is an especially dominant player in urban areas. Because of the nature of the retail industry (direct selling of goods to consumers), they need an adequate goods transport system that provides them with their merchandise. From an economic point of view the urban freight transport system is therefore very important

1 More information can be found at www.bestufs.net.

for the urban area. Nevertheless, it is clear that there are a number of problems caused by goods transport operations in urban environments as shown in Figure 9.1.

Although trucks account for a small percentage of all transport operations in urban areas they are responsible for a high share in pollution and noise. Figure 9.2 presents recent trends regarding the emissions of road transport in general.

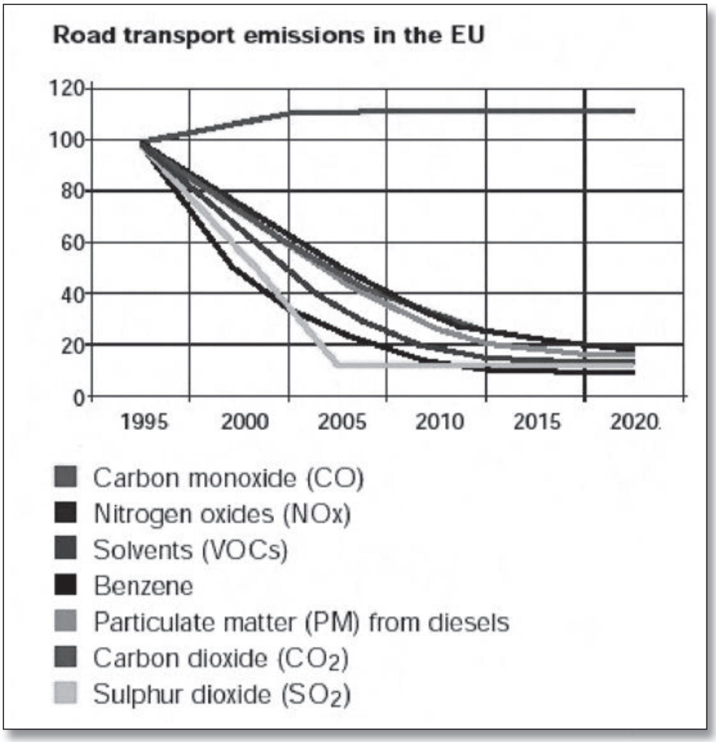


Figure 9.2:
Development of road transport emissions in the EU (1995 = 100)

Source: Auto Oil 2, Transport Base Case, 1999

One can conclude that the problems with pollutants will strongly decline in the near future. This is the effect of efforts by the truck manufacturing industry that are pushed by European legislation (Euro-norms for the emissions of the engines). However, the carbon dioxide emission (CO_2) is expected to increase slightly. CO_2 is the main contributor to transport greenhouse emissions (97 %) and road transport is in turn the largest contributor to these CO_2 emissions (92 % in 2000).

Noise emissions of driving vehicles will be reduced. The remaining noise hindrance will be caused by loading / unloading activities and tyre noise when the vehicle is moving. Noise is critical in night distribution. In several countries there are limits on the noise levels during night time. In that case measures can be taken to reduce the noise. Measures one can think of are usage of silent equipment, surface adaptations, guidelines for drivers, etc.

Because of the expected growth of mobility and freight transport it is expected that congestion is a growing problem in European cities. Although the share of freight traffic is rather low, vans and trucks also contribute to congestion problems. This is due to their slow acceleration and low speeds. Furthermore they can block lanes if there is no suitable place available to load or unload cargo. The congestion causes time losses and energy wastage. Because of the size and weight of the vehicles, freight vehicles can be seen as a threat to cyclists and pedestrians. Furthermore they can bring physical damage to the infrastructure (e.g. road surfaces).

Several actors are directly or indirectly involved in urban goods transport. Table 9.1 shows these actors and their own specific interests to be regarded during planning and implementation of a measure or project.

Actor	Main interest in regard of urban goods transport
Shipper	Delivery and pick-up of goods at the lowest cost while meeting the needs of their customers
Transport-company	Low cost but a high quality transport operation, satisfaction of the interests of the shipper and receiver (shop)
Receiver/ hop owner	Products on time delivered at a short lead-time
Inhabitant	Minimum hindrance caused by goods transport
Visitor/shopping public	Minimum hindrance caused by goods transport and a high variety of the latest products in the shops
Local government	Attractive city for inhabitants and visitors: minimum hindrance but having an effective and efficient transport operation
National government	Minimum external effects by transport, maximum overall economic situation

Table 9.1: **Main interest groups in urban freight transport**

To find an optimal compromise between all different interests of the actors involved is a difficult challenge. The following possible measures relevant for the urban freight transport domain have been identified:

Supplying infrastructures:

- Public logistics terminals for promoting co-operation
- Traffic information systems with digital maps for supporting efficient vehicle routing and scheduling planning
- Loading/unloading space for freight vehicles
- Booking system for car parks
- Underground or rail freight transport systems

Regulation:

- Regulation for logistics facilities

- Truck routes, truck lanes
- Time windows and limitation of vehicle types for entering urban areas
- Regulation for hazardous gas, noise, vibration
- Load factor controls
- Parking space for trucks attached to buildings
- Time windows for loading/unloading
- Standardisation for pallets, containers, IC tags
- Standardisation for EDI, bar codes

Economic measures:

- Road-use pricing
- Weight tax, Fuel tax, environment tax
- Subsidies for co-operative freight transport systems
- Subsidies for intermodal terminals
- Subsidies for environment friendly vehicles

9.3 The Market Environment

It should be acknowledged that managing urban freight transport operations is quite complex. Chapter 2 has shown that there are different requirements of different users of freight services and there are diverse operations, structures and sizes of different vehicle operators. Also the destinations are heterogeneous (terminals, factories, construction sites, warehouses, shops, offices, homes, etc.). Moreover there is fierce competition between the road transport operators and the margins/profits of these operators are rather poor.

Road transport operators are confronted with regulations set by local governments concerning city access, parking regulations and access time regulations. Examples are:

- Vehicle-limiting measures (e.g. only vehicles with a high standard concerning noise and emissions, length/width/height) or weight regulations (axle-weight, total train weight).
- Access regulations depending on (only at certain points) existing regulations within the urban infrastructure (e.g. narrow bridge).
- Fee for parking or use of special delivery window (city-centre-licence).
- Pedestrian zones in which deliveries can only be carried out at certain times of day or night or certain events.
- Protected zones that have to be kept completely or partly free of trucks.
- Establishing special protected loading zones in areas where there is considerable delivery traffic, parking places.

These access regulations are traditionally designed and implemented by the local government (see Chapter 3 for more detail). The decision making process in a local government is subject to political opinions. Politics are sensitive to the opinion of local inhabitants because the inhabitants vote. “Goods don’t vote, people do” is to some extent a problem for the transport industry because their interests are not always taken into account sufficiently in the decision making process. Furthermore, due to different political settings in European cities and fragmentation of decision making there is a great variety in Europe of types of regulation.

Some local governments are very active on the subject of freight transport while some local governments pay minimum attention. City authorities often give priority first to passenger/public transport and therefore the amount of staff working on urban freight issues if very limited. It can be concluded that the numbers of full-time staff working on urban freight transport planning is quite low when compared to passenger transport planning. The BESTUFS city inquiry showed that 19% of the 43 European cities questioned do not have any person in charge of urban freight planning. Most of the cities have less than half a full-time employee dealing with freight transport planning. So in many cities urban freight issues are neglected compared to passenger transport issues on account of insufficient manpower.

Transport companies have to cope with these situations and regulations. It is clear that access restrictions impose logistic restraints on their operations. These restraints may result in a reduction of transport efficiency. Bigger (but more efficient) distribution vehicles are only allowed to deliver and pick-up goods in cities during a certain time period (e.g. between 0700 - 1100). Because of such time-limits there is less flexibility and reduced productivity of large freight vehicles. As a result operations are replaced by an increased number of smaller vehicles. However, when analysing the impact one can observe a net-increase of transport costs, more road use, more environmental damage and more energy consumption. Therefore, tight access restrictions and time windows can be unsustainable from a macro perspective. Local environmental problems may be shifted outside the city or can return by means of more (but less or not-restricted) smaller vehicles that are entering the city.

In Europe the access restrictions (time, weight, dimension) are clearly not harmonised, often not even at a regional level. Furthermore, one should be aware of the fact that decision-makers within (urban) supply chains do not necessarily operate locally. In many cases regional distribution centres are used to replenish shops in several cities by means of making round trips. Because of this logistic system the transport operators have to cope with various local access constraints. The lack of standardisation of regulations makes the optimisation process for operators more difficult which results in less efficient transport.

9.4 Economic and service aspects

In many supply chains urban freight transport is often the final piece of the total transport chain (from production to retailer/consumer). In most cases this is a relatively small transport distance but the costs are quite high. Because of the fragmentation of delivery points and low volumes per delivery there are high costs for transportation and delivery. Therefore a focus should be on reducing the costs of urban freight transport because this has a big impact on the overall transport costs.

On the other hand transport costs have a relatively small share in the total cost-price of a product. Globalisation of markets has caused increased transport distances in the supply chains. Producers (especially those of high value goods) have become more specialised and have created scale advantages. Producers build large factories in countries with the most beneficial conditions (e.g. low labour costs, low material costs). This global competition is enabled by market liberalisation and harmonisation and has been boosted by Information and Communication Technologies (ICT) (e.g. Internet and EDI). Wider distribution of consumer goods is driven by the globalisation of culture. Increasingly, countries are moving closer together in their consumer demands. As a result of this companies find that they can supply the same product to wider geographical areas. Traditional examples are products of brands like Coca Cola, Heineken and McDonalds that can be found all over the world.

Together with globalisation a consumer need for a bigger variety of products that can be purchased has arisen. Due to this demand, retailing chains have started to offer the consumer 'one stop shopping' solutions with a big variety of products. In the past decades the supermarkets and mega-stores have more or less replaced the traditional one-man businesses like bakers, butchers and greengrocers. One-man businesses and traditional shops were however to a large extent self-supporting and the length of their supply chains was rather limited. Modern retailing chains do have continental/global supply chains and have set-up their own distribution systems and own distribution centres. This caused a major difference in decision making within the supply chain and caused a strong need for supply chain management. Due to the big growth in the variety of products and the increase of (urban) land value, the local storage is increasingly replaced by display room for products. The drive to minimise costs has led to changes to maximise return on space. Service and shop premises have found ways to use maximum space for direct service provision and showing products in order to maximise revenues. However, this has resulted in less space available for storage and other back-office functions. This reduction of storage has a direct effect on transport which now needs to be 'just-in-time'.

The delivery expectations are rising and there is a need to reduce delivery lead times. This makes the urban delivery process even more complex. A medium-sized supermarket within the city already receives around 30 deliveries per week. Clearly the developments lead to an increasing transport frequency and to a reduction of the average drop size. More freight transport movements in urban areas have been performed by smaller goods vehicles.

Due to e-commerce and its consumer expectations (delivery often within 24 hours) the lead times are decreased even further. This strengthens the scaling down development of the vehicle fleet. Consolidated deliveries to shops (with delivery trucks) are replaced by direct deliveries to the consumer's doorstep carried out by courier services using small vans. However, in the long term it is not certain that e-commerce will actually result in more freight traffic. More information exchange and innovative logistics schemes and concepts can be used to consolidate transport flows. This could result in delivery services that will be faster, more reliable and more efficient compared to traditional urban freight patterns.

9.5 The main conclusions and recommendations of BESTUFS

The limited urban transport infrastructure and the emission of noise and pollution are of major interest for European cities. Considering that individual supply chains and related vehicle activities are almost optimised, trips in these supply chains are unlikely to be reduced further. Therefore it is important for policy measures to recognise the existing efficiency of operations at supply chain level. On the other hand, urban road space is becoming increasingly congested with negative effects on the environment and on the quality of life. A strategic approach is required considering all key factors of urban freight transport.

One can conclude that due the complexity of urban freight planning the city authorities often can't meet the required level of expertise for making effective and sustainable policy on local urban freight. Policy makers should first understand all relationships between urban freight transport, the urban economy and the urban environment. Furthermore they should recognise the conflicts and trade-off effects that exist between logistics efficiency and (local) environmental goals.

The concept of Public-Private Partnerships (PPP) was introduced in order to establish improved urban goods transport solutions which are difficult to be reached from one side only and in order to fulfil the objectives of both the public and the private sector. The co-operative city distribution of otherwise competing transport operators (now ideally located in one and the same freight village) is perhaps one of the best known and most widely applied PPP ideas. But yet this approach has not proven to be a success and in Europe its related enthusiasm has vanished. Nevertheless, understanding the constraints and problems of the "other side" and discussing and looking together at potential new goods transport solutions, which might sometimes already be realised as pilots in other cities or countries, seems to be one of the actual best approaches to further the improvement of urban freight movements.

It can be concluded that it is very difficult for city authorities to make in-depth analyses about the impacts that are caused by introducing certain policy measures. The input of the private sector (shippers, transport operators, logistic service providers, chambers of commerce, consultants) is essential to feed the process with the required level of knowledge. The private sector should be able to be a sounding board for policy initiatives. In this way the private sector can point out the specific problems that they experience and this creates mutual benefits.

A co-operative approach between stakeholders involved in urban freight issues is therefore vital in all aspects of urban freight transport planning. Measures based on urban regulations should be created flexibly, allowing a permanent introduction of changes leading to more sustainable urban mobility. Also, acceptance of restrictions, regulations and enforcement measures have to be ensured among the actors involved. BESTUFS therefore recommends a co-operative approach to solving problems related to urban freight transport. This means that all actors involved are integrated in the decision making process in all planning and decision stages, allowing the conflicting interests to be noted and accepted, and a compromise reached. Communication and exchange of information between actors is therefore the starting point. During the process, the parties together will be able to develop a common accepted approach to overcome the problems. This approach and process will create mutual benefits and will therefore keep the parties involved.

Currently, different measures regulating city accessibility exist in EC member states. With the enhanced integration of the European market vehicles entering the cities are increasingly international. The European dimension of actors operating in urban freight transport has to be considered when setting regulations. Therefore a major step will be to harmonise the different regulation measures existing in the different EC member states by increasing transparency over the existing regulations. In the longer term, more harmonisation of EC regulations to define a framework for urban freight transport should be initiated.

Moreover, cities need statistical data on urban goods flows and transport means related to the urban infrastructure in order to decide about local measures and policies. Basic statistical data is currently rather weak. Furthermore, data sources generated at a local city level are hard to compare with each other due to different methodologies and approaches used. This also makes it difficult to compare, analyse and benchmark urban freight transport patterns and solutions at a European level. BESTUFS therefore recommends that base statistical data on urban freight transport are established for large European cities, and that both the information content of statistics as well as the methodologies on how to collect the data, are harmonised at a national as well as at a European level. The importance of appropriate evaluation methods has been emphasised in Chapter 7.

Furthermore BESTUFS recommends that cities establish an overall approach which integrates passenger and freight transport planning. Measures on freight transport should not only concentrate on regulations for the vehicle or the transport process alone, but should include anticipating and/or accompanying measures, while giving attention to interrelationships of passenger and freight transport systems. BESTUFS stresses that urban freight transport can't be addressed by "one" overall measure or policy but needs a consistent policy mix which integrates regulations and incentives as well as an improved basis for transport operations. The effects on the supply chain structure should also be taken into account. In addition, project relevant enforcement support (enforcement of rules and regulations) has to be regarded because it is a critical factor in the success of the policy and city access in general. New applications of ICT may improve the "enforcement efficiency" and enlarge the scope of enforcement.

BESTUFS concludes that ICT offers big opportunities to make the situation more transparent and to facilitate logistics efficiency improvements. As Chapter 5 has illustrated telematics applications within urban distribution vehicles are gaining more and more importance. BESTUFS recommends that this development is actively supported by promoting best practice in the deployment of telematics devices and software for urban distribution. Presently, cities are offered different technical solutions for cities from different suppliers. In particular, the interoperability of the systems providing data and the application systems of the actors in urban distribution should be improved. Therefore, BESTUFS recommends that cities become more integrated into the urban supply chain.

Regarding the engine technology high expectations exist on the development of the Fuel Cell. Due to the high efficiency in the use of energy of this technology a significant reduction in terms of energy consumption and negative environmental impact is expected. Within BESTUFS it is concluded however that the market maturity of this technology is still uncertain. It can therefore be stated that the majority of urban goods transport will still be carried out with combustion engines in the mid-term future. Therefore one should also pay attention to alternatives like CNG, LNG, biogas, hybrids and electric vehicles. BESTUFS recommends authorities to continue promoting the operation of "cleaner" engines in cities. An integrated approach should be used considering the factors of reliability and practicability on the one hand and the efforts made on emission reduction at conventional combustion engines (Euro Norm) on the other.

CHAPTER 10

Institutional and Regulatory aspects for the implementation of City Logistics Services

W Scapigliati, A Liberato, R Bellini

The high level of investment (e.g. buildings, vehicles, technological platform, etc.) and the wide range of processes that must be carried out and managed by a Logistics Agency (or city logistics services central management) creates the need for the foundation of a specific Management Authority.

The objective of this chapter is to highlight the need for operational schemes to fit the objectives of the Logistics Management Authority. This chapter describes the institutional, political and regulatory aspects that characterize the Italian framework in order to depict how this Authority can be established in Italy. Additionally, further specifications are also presented between the management and the ownership of the infrastructure and the management of the logistics services.

10.1 Political aspects

In Italy following the current regulation (Law 267/00 on Local Administrations) urban logistics services cannot be considered as public local services (i.e. public transport) but there is no doubt that the social relevance highlights the high value of these services when focused on the improvement of quality of life in the inner core of the city (decrease in traffic, reduction in emissions and noise, safety improvement for the pedestrian areas, etc.).

In highlighting this objective it is proposed to launch a pilot/experimentation phase of a logistics services Agency in which the costs related to ownership of buildings and area will be excluded from the logistics services management Agency point of view.

In the following it is supposed that assets and investment will be made available by Local Public Administrations in two different ways:

- directly through a fee that is supposed to be quite low during a start up phase; and
- indirectly through a targeted asset organisation in which associations of transport operators or a supporting private partner (through a public tender) will be represented.

On the other hand the management of the Agency can be carried out by a targeted management organisation that will be owner of the vehicle fleet.

As in public transport services, the relationship between the two organisations (related to asset and services management) will be regulated in a service contract with the rental fee costs for the assets and investments and the qualitative level of the logistics services.

The implementation of the Logistics Agency and the related services can not limit the fair competition. In particular, the activities carried out by Logistics Agency (optimisation of goods distribution in the traffic limited zone (TLZ) area) must be available to all the other transport companies that will be able to match the regulatory requirements for access to the TLZ planned by Local Administrations: permission for vehicles that overcome the minimum level of load required to access the inner centre, ecological vehicles, etc.

Through this kind of regulation it is possible to launch the process of asset organisation and the services management for the implementation of Logistics Agency without limitation of the fair competition among the carriers and the transport operators.

10.2 Institutional Aspects

10.2.1 Selecting an organisation to manage assets and investments for the Logistics Agency

From the analysis of former experience developed at national and European level it can be highlighted that the Local Public Administration will only face the investments and assets related to the implementation of the Logistics Agency in order to guarantee economic sustainability, at least in the start up phase of the pilot. Local Administrations can support the launch of the Agency with the availability of buildings and areas of which they are owners.

In the second phase of the implementation it is suggested a targeted organisation be created for the management of assets and investments that will plan to also involve the public transport operators and carriers associations as partners. The selection of this organisation will be carried out by Local Administrations through a public tender challenge.

A public-private company is able to bring back the achievement of public expectation as advantageous from the citizen's point of view (reduction in noise and emissions, improvement in quality of life, etc.) while respecting the efficiency of the services and economic sustainability of city goods distribution from the transport operator's point of view.

The organisation has two principal activities:

- Management of the assets of the Agency; and
- definition of objectives to be achieved through the service contract in order to put into practice the political objectives of the Public Administrations without tackling the economic needs of the transport operators.

From this point of view the kind of company that seems to be best matched to these objectives is the stock exchange company that has a Director Board and an Auditing Board selected by the partners.

10.2.2 Selecting an organisation to manage logistics services

The selection of the organisation that is in charge of the management of the overall logistics service process will be carried out by Local Administrations through a public tender.

In the evaluation criteria operators that have a specific experience in the field will be advantaged as they can guarantee a better management of the service both at human resource and vehicles level. In particular, it is hoped that a high quality level will be reached through the participation of transport operators and carriers associations that will be able to involve carriers that already manage logistics services and are not required to face high start up costs (i.e. the fleet of vehicles). On the other hand they will be able to better exploit the revenues of the service. Indeed in the start up phase it is planned to face high costs for the asset and investment (rental fee, allowance of vehicles and infrastructures) and minimum costs for operational costs (fuel, management costs, personnel, etc.).

10.3 Regulatory aspects

From a legacy point of view, the implementation of a Logistics Agency model for the distribution of the goods in the city centre doesn't change the overall relationship between the stakeholders involved in the logistics chain.

The logistics chain of goods distribution follows the schemes that transport operators are currently used to. The process is the same and no change has brought about. All the carriers that are involved in the city logistics chain must be listed in a specific database (National Carriers Association) and they will own the license to transport freight and parcels by the Italian Minister of Transport. Distribution will follow current Italian regulation (art. 1693/1694, L. 450/85, L. 162/93) and in the framework of terms edited by the National Carriers Association (dated 7th January, 1997).

From the insurance point of view, the entitlement of the damage is limited to 6.2/kg when the liability is up to the carrier. This entitlement faces the loss of parcels, the damage of goods and all the cases in which directly or indirectly the liability of the carriers has been proved.

The liability towards the freight relate to the specific documentation added to the transport and is not be applied in case of general terms; this follows from L. 450/85 as insurance regulation. Regarding the lack of liability of the carrier, this is not applied when the freight has been stolen during the transportation or in the warehouse centre.

In general L. 450/85 doesn't allow the clients to ask for more than the limit that the regulation establishes. When this limit has to be increased (over what is established by L. 450/85) a specific agreement will be joined between the client and the carrier and an appropriate insurance will be contracted by the carrier. In this case the agreement must be defined, put on paper and signed before the delivery of the freight to the carrier in order to transport it to the destinations. The costs for the contract are up to the client and the limit for the claimed costs is usually €100,000 each delivery.

It is permitted for the carriers to refuse the delivery of some specific kind of goods. Examples include:

- Limit on weight and volume: parcels with a weight over 1,000 kg, a height over 180 cm, a length over 400 cm (140 cm if the weight is more than 50 kg), and a maximum perimeter more than 700 cm.
- Unpacked parcels.
- Parcels that are hard to handle.
- Dangerous or inflammable freight.
- Freight that are not allowed to be delivered (weapons, tobacco, revenue stamps, etc.).
- Goods that can be damaged by time.
- Goods that have to be stamped with UTIF stamp (mineral oil, etc.).
- Paintings, coins, jewels and valuables.

CHAPTER 11

An Innovative Approach to Urban Environment Sustainability: the MOSCA Project

P Cossu, G Valenti

11.1 Introduction

In most European cities the Central Business Districts (CBDs) are emptying of citizens and heavy industries, while the concentration of commercial activities (the tertiary sector) is constantly increasing. People prefer to live out of the city, going downtown for business and shopping. As a consequence traffic increases and less people use public transport which is often insufficient in suburban areas. Meanwhile the current management practices (regulations) of freight logistics are mainly based on constraint and limited access to the city centre for freight operators. Such an approach is often unsatisfactory and unpopular for both city managers and freight operators.

The MOSCA project – co-funded by the European Commission IST (DG-INFSOC) under the Fifth Framework Programme – aims at finding new ways of supporting transport planning and management in cities and agglomerations. MOSCA stands for: Decision Support System for Integrated Door–to-Door Delivery: Planning and Control in Logistic Chains.

Key applications are tools for integrated planning and control of production and transportation processes supporting sustainable development. MOSCA aims at highly reducing several problems affecting freight distribution in European metropolitan areas, such as booking and reservation procedures, vehicle routing, loading/unloading areas reservations, emergency management support.

The Mosca methodology is based on software solutions to encourage the meeting of the city administrations (information suppliers) with the freight logistics operators (information consumers). Thanks to Mosca suppliers of information can even become consumers and provide a better quality of the information in the next iteration. Therefore the vision is that sophisticated technology allows the actors involved to collaborate on urban freight distribution. Each local authority or company, influencing traffic by its decisions on traffic regulations, road maintenance and transport, is considered to be both a sender and a receiver of traffic–related information. Common planning tools are improved by modules which allow the lack of integration of business traffic and freight transport in existing tools to be overcome and which consider the changing needs of the users of the urban infrastructure networks.

The supply side is represented by local authorities, responsible for traffic infrastructure, while the demand side is constituted by production and transportation companies. This is the reason behind the fact that Mosca system has been designed as "facilitator" to integrate different and (often) opposite needs of City Administrations (e.g. Municipalities) and Operators (e.g. transportation and production companies). Therefore a collaborative approach model, which involves both city administrations and freight logistics operators, is proposed.

From the technological point of view, Mosca is designed for future added value services with several modules (short path, tour planner, on-line routing, shop delivery planning) being implemented in this project. The core concept is based on state-of-the-art technologies with open interfaces to other services. Synergy, sharing technologies and services among stakeholders in the urban environment are the key words in the Mosca approach.

This chapter summarizes the specifications, results, achievements, outputs, conclusions of the Mosca project.

11.2 Objectives

The key objective of the Mosca project is to provide a set of tools for improving the efficiency of door-to-door transport of goods in urban areas by collaboratively providing demand and supply-side information in one single environment/system. Starting with this idea a number of modules were developed which try to answer the main problems and needs of the cities' administrations and transport operators.

The basic motivation of the Mosca scientific approach is the hypothesis that all organisations, institutions and citizens affected by urban traffic will benefit from sharing knowledge and information. Exploiting information which is only locally available yields some myopic profits, but in the long run, co-operative strategies pay off better.

The main challenge is an improvement of the complex situation of business traffic and freight transport in European metropolitan areas and as a consequence an improvement of the negative impacts for the environment and the citizens. Starting points are booking and reservation procedures for loading/unloading areas, vehicle routing as well as transport modelling.

Supply-oriented system components provide more precise transport models which allow the city administration to make more precise business traffic and freight transport planning. Furthermore a more precise estimation of social costs is possible. By use of information from the demand side (i.e. tours), represented by the production and transportation companies, existing models can be improved to some extent. Demand-oriented system components allow improvement of the knowledge of the loading/unloading situation at shops or private customers (e.g. time windows, time patterns). The use of dynamic information is foreseen (e.g. changing traffic situation, new incoming orders).

The main project outcomes are validated prototypes for demand services and integrated supply-oriented traffic and transport models together with a user-oriented decision support system (DSS) and these are described below.

11.3 Methodology and approach

The design of the Mosca system has been performed starting with the user requirements to identify both the supply and the demand side (the essential role of user needs analysis was discussed in Chapter 2). From the user requirements, a set of suitable applications were selected. For these applications necessary modules have been identified and developed. Once the Mosca tools have been implemented and tested the results have been analysed and then evaluated.

11.3.1 Information system specification

For the definition of the user requirements a survey (in parallel) in Germany, Italy and Switzerland was carried out. This task was the basis for the Mosca system architecture design. As a result of the interviews with potential end users a catalogue of requirements, available technical equipment, objectives and measurement criteria was established. The list of user requirements is shown in Table 11.1.

The user requirements have been translated into the functional and technical specification of the Mosca system. Functional specifications have been developed (on the basis of the survey results) by splitting the system into modules referring to communication, storage and user interface. Mosca modules and functionalities are designed as solutions to the needs and problems of both the supply and demand side. A modular structure was chosen where a rough distinction between supply side and demand side modules was made.

Needs of cities and institution	Needs of production and transport companies
Freight transportation models and analysis of the traffic system	On-trip control
Optimisation of freight transport	Carrier-customer information exchange
Customer services	Customer access: problems found when approaching the point of service
Integration of information	City access: administrative regulations of city access with freight transport vehicles
Impact measurement: (Freight) transport and social cost	
Location planning	

Table 11.1: **User Requirements**

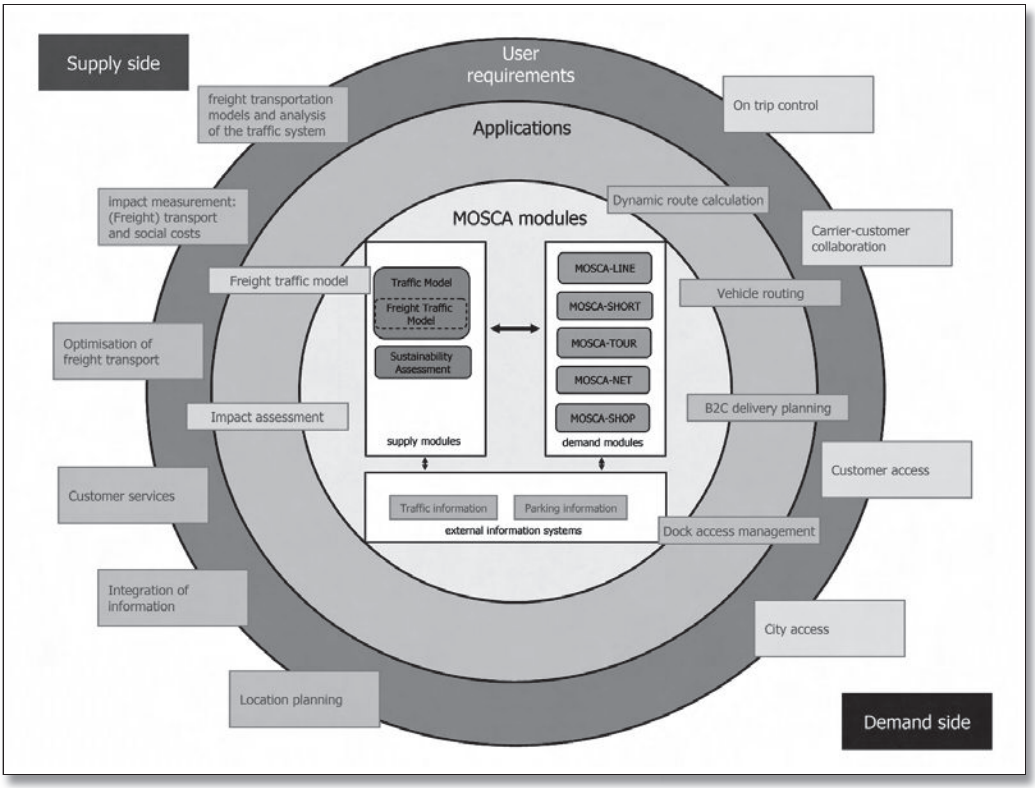


 Figure 11.1: **Relation between MOSCA modules and user requirements**

Figure 11.1 gives a summary of how the user requirements (external circle) impact the applications (middle circle), which are in turn mapped into the MOSCA modules (inner circle).

From the technical point of view the MOSCA system consists of several modules with simple input-output relations and these are described below.

11.3.2 Supply-oriented system components

The main objective of this task is to develop models and supply-oriented system components based mainly on urban road networks, on demand models and on road based shipments. These models and systems are developed for usage as a DSS for city planners allowing a sustainability assessment, an important criterion for assessing the environmental and social impact of traffic planning.

The current environmental legislation and laws and the relative implementation in European cities and which software tools exist for estimation of environmental effects in urban areas have been analysed.

One of the two modules developed as supply oriented system components is the sustainability assessment module - MOSCA-SUSTAIN. Data and information, available at city-level, have been used in this module. A schematic concept of the software assistant, which can help cities to assess evaluated active (e.g. road closing) and passive (e.g. road surface) noise reduction measures has been developed, and several scenarios have been calculated (see Figure 11.2).

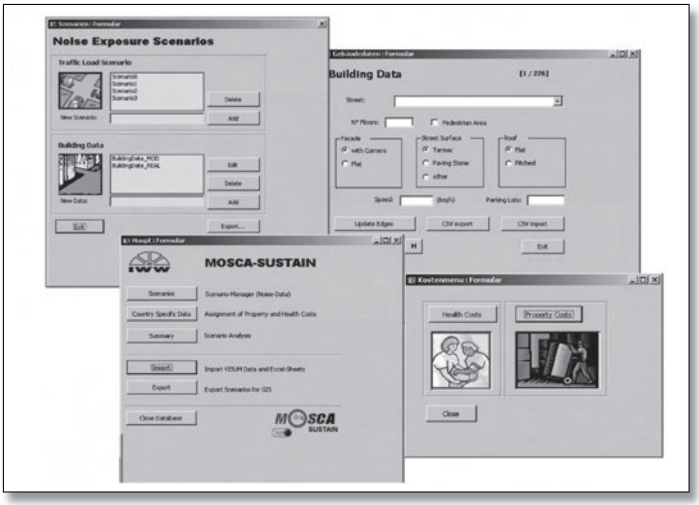


Figure 11.2: **Screenshot MOSCA-SUSTAIN (source: Glücker et al. 2003)**

The other module is MOSCA-FREIGHT (VISEVA-W) for modelling of urban business traffic and freight transport demand (see Figure 11.3). VISEVA-W is now integrated into the overall model structure of the VISEVA model for passenger transport demand and

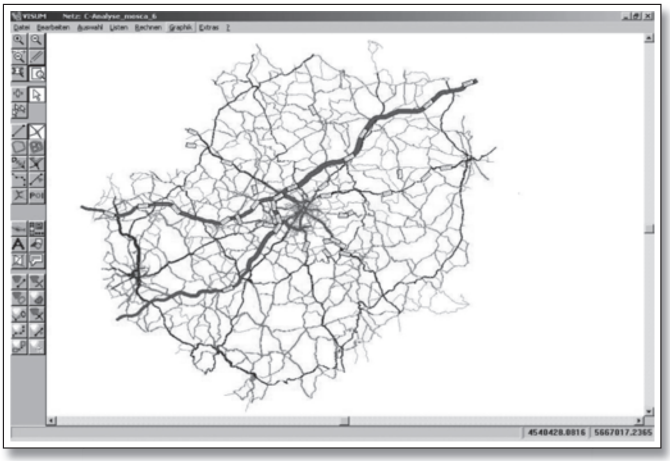


Figure 11.3: **Screenshot MOSCA-FREIGHT (source: Glücker et al. 2003)**

the VISUM model for traffic assignment. A “user manual” showing how to set up an urban business traffic and freight transport demand model by use of VISEVA has been produced.

Furthermore the integration and modelling of specific issues for freight transport policy managers and also the integration of individual transport in the MOSCA-FREIGHT module as a DSS have been analysed.

11.3.3 Demand-oriented system components

The objective of this task is the development of services for logistics and production allowing users to access the information system in order to store and retrieve traffic related data. Service architecture and dedicated systems for integrated production and transportation planning with sustainability support have been developed. MOSCA demand side modules are software tools which can be provided to the private end-users of the MOSCA integrated environment (transport operators, B2C-clients, shops, etc.) for information exchange and processing. These modules are summarised below.

MOSCA-SHORT is an algorithm which finds a “robust” path within a city if variable traffic conditions are given. MOSCA-SHORT can calculate convenient (reliable) paths between two points in the case of a dynamic urban traffic network in the situation where travel times along the network arcs are not known in advance with certainty. The results can either be just information on the length/duration of a path or may be a list of location identifiers that allows the user to re-construct the route calculated by MOSCA-SHORT.

MOSCA-TOUR is an algorithm to plan delivery tours for a vehicle fleet if variable traffic conditions are given. MOSCA-TOUR is embedded into logistics application software, which must invoke it to provide data of the orders to be serviced, the objective function, and the characteristics of the vehicles’ fleet. Distances and travel times can either come from MOSCA-SHORT or a traffic model. After receiving all input data, the algorithm calculates the most efficient vehicle routes. The result is a set of optimized routes that is output back to the logistics application software.

Mosca-Line is an algorithm to plan on-line deliveries following unexpected events such as a new customer request or a traffic jam. Mosca-Line is able, given the current position of vehicles, the road network situation and the list of orders to be processed, to reorganize the next stops on the basis of the available information. The module can also gather information about the traffic conditions from the incoming communications from vehicles and it can use this information to produce better plans, taking into account new traffic situations.

Mosca-Net is a web service for managing preferred delivery locations (information hub for delivery data of freight consignments). Mosca-Net receives information about delivery locations, profiles and time windows from B2C, i.e. private customers. Customers store the information on the module's database using the user interface while being connected on-line to it. The information on delivery location and time windows is given upon request to logistics application software if it queries Mosca-Net using the query interface application (Figure 11.4).

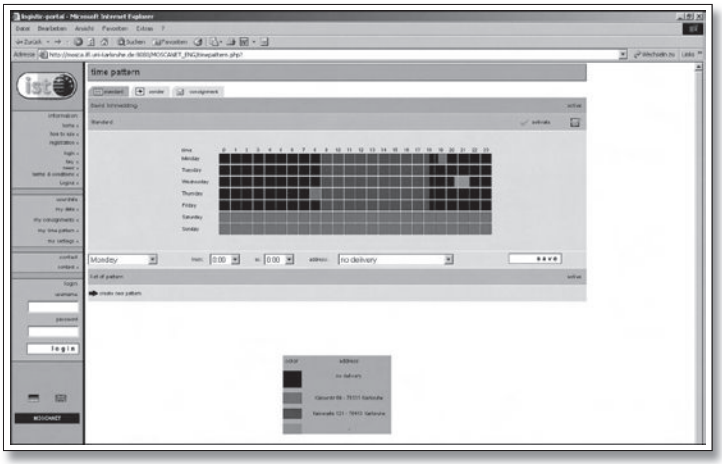


Figure 11.4: **Screenshot Mosca-Net (source: Glücker et al. 2003)**

Mosca-Shop is a web service to schedule the reservation of ramp access for urban freight deliveries (Figure 11.5). It provides information on free dock access and allows booking of access time slots. This module is mainly used by carriers for planning of service anticipating waiting times at the shops' loading dock. The carrier enters shipment data and requests dock access bookings. Shops give their accessibility information and instructions for carriers to Mosca-Shop. Using this functionality, dock reservations and delivery instructions are passed to the carrier and incoming requests are sent to the shop. Additional functionality can recommend access times to carriers. A quality

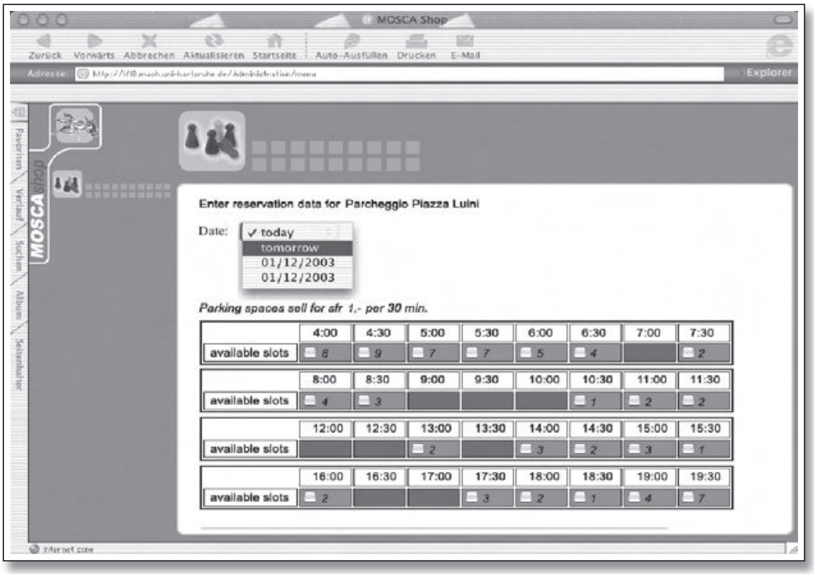


Figure 11.5: **MOSCA-SHOP Reservation for Parcheggio Piazza Luini (Lugano)**

feedback function allows carriers to assess the quality with which shops adhere to their access guarantees and at the same time gives shops the possibility to assess the quality of service of the carriers concerning dock access regulations.

11.3.4 Test sites

Four test sites (Stuttgart, Chemnitz, Padova and Lugano) have been selected in order to test the MOSCA modules in a real environment. The four test sites present rather different situations with regard to the number of inhabitants of the city and surrounding areas, the geographical situation, traffic conditions and measures taken. Therefore the test environment and the implementation of the different modules are of very high interest.

11.3.5 Evaluation of information system and the test sites

The effects of the MOSCA system and prototyped technologies were evaluated on the basis of the user needs surveyed at the beginning of the project and the experiences recorded during the project. The effects of the modules are quantified in terms of costs, utilization, lateness, traffic flow, travel time, trip number, etc. A fuller discussion of methods available for the evaluation of the telematics applications is found in Chapter 7.

The Relaxed Cost-benefit analysis (relaxed CBA) is an evaluation method which can cope with several inputs and outputs. It is a sensitivity analysis which can find best solutions if the cost levels e.g. for noise exposure vary, and was used for comparison of the different MOSCA-modules and at test-site level. Performance values for each module and test-site were calculated with this evaluation method.

The evaluation has therefore been divided into two main parts. The first part includes the evaluation of the MOSCA-modules and the second part includes the evaluation of the MOSCA test-sites.

11.3.6 Dissemination and exploitation

MOSCA dissemination activities are aimed both at promoting the project and improving access to useful inputs from other relevant projects and organisations Moreover this task aims to encourage the acceptance and subsequent exploitation of the project results by end-users. The specific objectives of both awareness raising and dissemination activities are to:

- identify the target audience with whom MOSCA needs to have links;
- initiate and carry out activities which increase awareness of the MOSCA system among the target audience;
- provide an interface between MOSCA and other interested actors;
- establish the dissemination of the results for the freight transport operators to use and for the information of transport decision makers;
- establish the dissemination of the results for a wider community than those directly interested and concerned with the topic of the project.

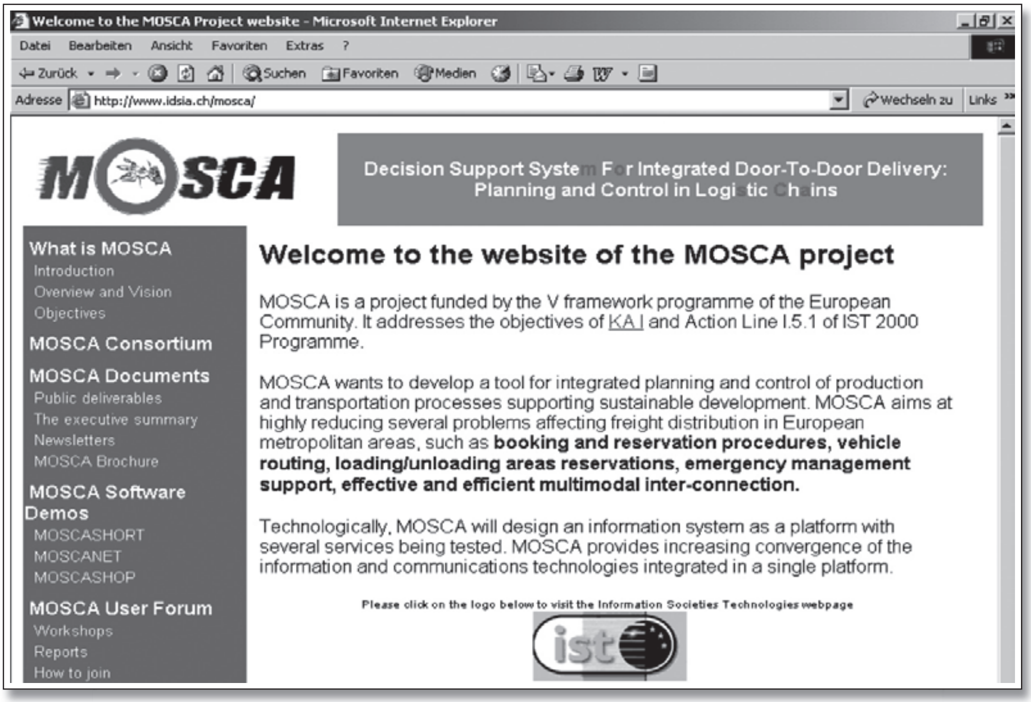


Figure 11.6: **MOSCA Web Site Interface/Home Page www.idsia.ch/mosca**

11.4 The MOSCA system architecture

Starting from the user requirements a set of suitable applications has been selected. For these applications necessary modules have been identified and developed. The MOSCA system modules communicate with each other and further external systems. A modular structure was chosen where a rough distinction between supply side and demand side modules was undertaken. Figure 11.7 shows the communication flows between the modules in MOSCA and the external traffic information module.

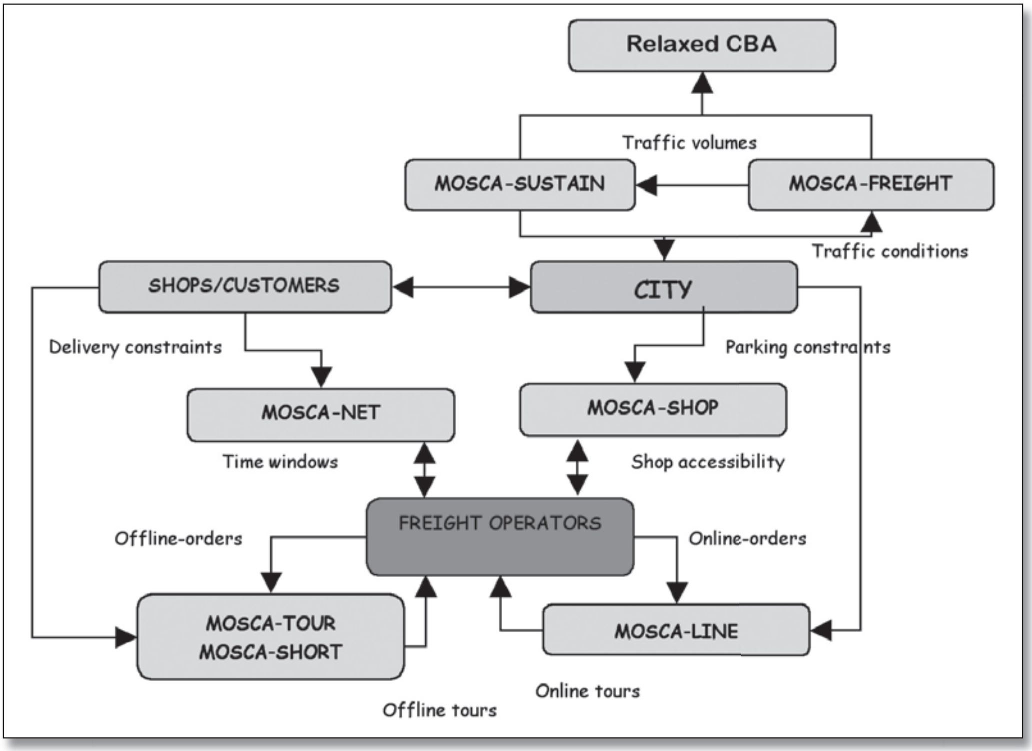


Figure 11.7: **The MOSCA information system**

As MOSCA-LINE, MOSCA-SHORT and MOSCA-TOUR are algorithms that are being called from application software they are shown as being internal to the software. MOSCA-NET and MOSCA-SHOP communicate via user interfaces to human end users. In addition, MOSCA-NET also has a communication link to application software and in particular to MOSCA-TOUR. Traffic information is not used directly in MOSCA but through the traffic model as an interface.

11.5 Testing the MOSCA modules

The key results of the testing phase of the MOSCA modules are shown in Table 11.2.

Module	Main Results
MOSCA FREIGHT	The module allows the calculation of business traffic and freight transport demand matrices of a city or region. The effort for data collection/processing depends on the availability of behavioural data and the definition of business traffic classes. VISEVA supports individual definitions of business traffic classes. The module can be integrated in an overall model structure including a passenger transport demand model (VISEVA) and a network/assignment model (VISUM). Based on this model detailed analyses of the commercial transport in connection with the passenger transport are possible.
MOSCA SUSTAIN	The module allows the calculation of noise emissions and the according social costs. A rather high number of data input is necessary but as a result good estimations of the real noise levels are possible.
MOSCA-SHORT	The heuristic algorithm for the robust shortest path is very suitable to be applied to real problems. The concept of robust path, applied here for the first time to a road network problem, can be very useful. The results of the tests suggest that it is the fastest algorithm available at present to solve robust shortest path problems, at least on road networks.
MOSCA-NET	It is possible to integrate personal time windows which can then be used by transport operators.
MOSCA-LINE	The architecture developed is able to work on real problems. The tests reported give an idea of good values for the number of time-slices in a real problem. In particular the results obtained suggest that a number between 10 and 50 (e.g. 25) represents the best compromise between too short run for the heuristic algorithm on static-like problems and not enough up-to-date information.
MOSCA-SHOP	Both the integration of shop-related data and the integration of information on parking spaces in the MOSCA-SHOP data base via the Internet are possible.
MOSCA-TOUR	The model includes a TDVRP (time dependent vehicle routing problem) integrated with a RSP (robust shortest path) algorithm to deal with a complete graph, represented by the data available. The time dependent VRP is suitable for an application to real world situations, like an urban context, where traffic data are available and where traffic conditions can not be neglected for accurate optimization/planning.
Relaxed CBA	The relaxed CBA is an evaluation method which can cope with several inputs and outputs. It is a sensitivity analysis which can find best solutions if the cost levels (e.g. for noise exposure) vary.

Table 11.2: **Main results per module**

11.6 Evaluation of the MOSCA modules

The aim of the evaluation is to document MOSCA project efforts with users in real-life situations. Based on the user needs surveyed at the beginning of the project and the experiences recorded during the project the effects of the Mosca System and prototyped technologies were evaluated. Whether the prototypes are successfully fulfilling the user requirements was accounted in the evaluation process. The evaluation of Mosca modules is mainly based on the input of the Mosca module developer and on the results of the test site implementation. The evaluation of the Mosca modules was achieved via relaxed cost-benefit analysis developed during the Mosca project. For this evaluation a virtual test site has been created where the impacts of the different modules can be easily documented.

11.6.1 The virtual test site

The facts of this virtual test site are described below in Table 11.3.

noise exposure [persons]	< 45 dB	30.000
	45- < 50 dB	8.000
	50- < 60 dB	10.000
	60- < 65 dB	5.000
	< 65 dB	2.000
distance [km]	car	58.753.800
	HGV	10.368.000
travel-time [km]	car	1.175.076
	HGV	259.200

Table 11.3: **Facts of the virtual test site for the evaluation of Mosca-modules**

For this "virtual" test site six main scenarios have been calculated:

- current situation (basis for comparison);
- implementation of Mosca-Net;
- implementation of Mosca-Short;
- implementation of Mosca-Line;
- implementation of Mosca-Shop;
- implementation of Mosca-Tour in combination with Mosca-Short (Mosca-Tour is only available in combination with Mosca-Short, so it would not be sensible to assess Mosca-Tour on its own).

For each main scenario four sub-scenarios have been calculated: a) only the module/ actual data; b) speed limit (set up of a speed limit - 30 km/ h - in the virtual test site); c) HGV access restriction (access restriction in the city centre for all HGV with more than 7.5t (total weight); d) road closing (close down of one important main road for all HGV).

Data used for the evaluation of the Mosca modules is based on the impacts of each module on the virtual test site, which were given by the module developer or calculated in parts with MOSCA-SUSTAIN. With MOSCA-SUSTAIN it is possible to calculate the number of inhabitants concerned about noise. Therefore it is not possible to assess MOSCA-SUSTAIN on its own because it is part of the evaluation process. It is also not possible to assess MOSCA-FREIGHT because this module delivers the data input for most of the modules in the form of information about travel times, traffic network, etc. So it is accounted for in the context of the evaluated modules. Figure 11.8 visualises the efficiency scores calculated for all MOSCA modules in combination with the pre-defined sub-scenarios. The calculation was done with the Relaxed-CBA method. The relaxation steps are 2.5% which means, starting from fixed prices, the margin increases at each relaxation step ± 2.5%.

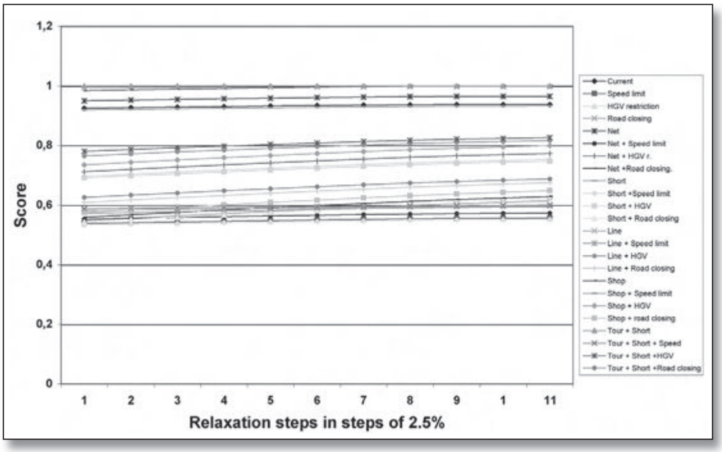


Figure 11.8: **Relaxed-CBA for all MOSCA-modules in combination with four sub-scenarios**

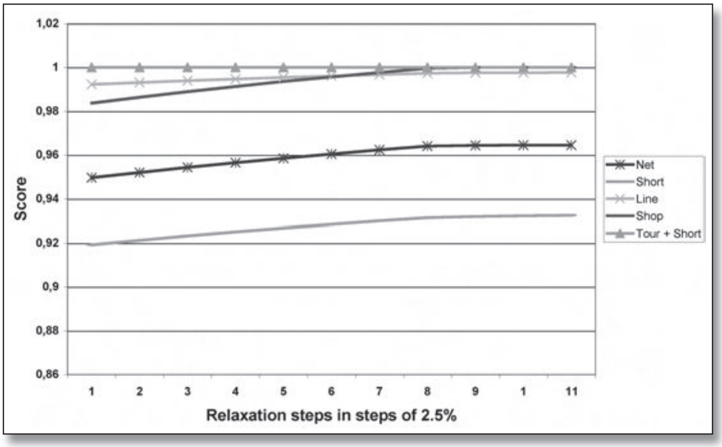


Figure 11.9:**Detailed depiction of the stand-alone modules (Part of the Relaxed-CBA for all MOSCA-modules in combination with four sub-scenarios)**

To illustrate the different efficiency scores for the Mosca modules more clearly Figure 11.9 shows some result-lines from Figure 11.8 in more detail.

The results-lines, which can be found in Figure 11.9, are the efficiency scores for Mosca-Net, Mosca-Short, Mosca-Line, Mosca-Shop and Mosca-Tour in combination with Mosca-Short.

From the previous diagrams it is possible to see what Mosca-Tour has achieved in comparison to the other Mosca modules and the Mosca modules in combination with the four sub-scenarios, against the highest efficiency score (100%). Mosca-Line and Mosca-Shop accomplish the highest efficiency score after a few relaxation steps.

Mosca aims to exploit project outputs supporting applications in existing and newly developed information systems. The information system development is market-led having involved both transport operators and relevant service providers. Software tools and methods are now available at different levels with regard to the future exploitation:

- The Mosca-Freight prototype can easily be led towards a new product
- The prototypical application Mosca-Sustain can easily be passed towards a consulting application
- Mosca-Tour, Mosca-Short and Mosca-Line are scientific prototypes which can be led to customisable applications for products
- Mosca-Shop and Mosca-Net finally represent first examples which can be developed towards first scientific prototypes.

11.7 Recommendations for future research

For Mosca-Tour an improvement of the features of the module might be accomplished by also considering the dependence of path on time. In this test the vehicles' capacity optimization has not been considered if different sized vehicles are used. Furthermore, the optimization of the tour starting time was not looked at for the complexity of the problem in the time dependent context. Here further research is necessary.

For Mosca-Freight additional research is necessary especially with regard to the available data and integration of specific "business" cases into the model. For many specific questions the module derives the basis for the calculation of the demand matrices but the necessary primary data (e.g. with regard to the behaviour of certain industry sectors) are not available. Therefore up to now these business cases are not integrated in the model.

For Mosca-Sustain further adaptations and work has to deal with the special situation in different cities with regard to the data availability in order to reduce the high effort for manual data editing. More detailed information about the cost rates (health- and property cost) or other cost rates to be examined might also be integrated in future.

11.8 The Mosca User Forum

The Mosca User Forum is an open panel of key actors allowing the establishment of an effective bridge between research and production/transportation operators on ground reality. These groups worked at different stages of the project, accordingly to project activities as follows:

Start Up - User Forum representatives were invited to the kick-off meeting and involved in the start up of main project aspects;

Step - User requirements: they gave their input in the identification of system components (modules) and data collection for the definition of the user requirements in order to set up Mosca system technical and functional specifications;

Step II - Test sites: User Forum representatives were directly involved during the test site activities. In particular they provided information and data for implementing Mosca test sites, also supporting measuring performance and acceptance of the Mosca system;

Step III - Evaluation: User Forum members provided their feedback for the Mosca system and module evaluation.

Continuous information exchange and calibration of the project progress were achieved throughout the Mosca User Forum preferred channel. Some of the members of this board have themselves been promoter of Mosca outcomes and added value partners in the synergy between National initiatives (e.g. in Italy ARTIST) and EC R&D projects. Thanks to the involvement of the User Forum Members, including both city administration from different European cities, and selected logistics operators, the working steps of Mosca have been examined and approved for further development activities.

11.9 Main conclusions

The objectives of Mosca have been achieved by development, implementation, testing and evaluation of the different Mosca modules which can be used in combination or separately depending on the aims of the potential users. It was demonstrated that the Mosca tools are able to improve the management of the logistics process promoting a mutual exchange of information between logistics operators and city.

The combination of the new software tools, information exchange platforms and algorithms with existing models and planning software will improve the working and information basis of all users (e.g. traffic planners, citizens, transport operators).

The Mosca project therefore has successfully provided software tools to assist authorities to plan, assess and control freight transport tailored to their needs and production/transportation operators in better planning their transport services. Possible interactions between the modules have been evaluated: Mosca-Freight delivers data on traffic flows for Mosca-Sustain but it is also able to estimate the effects on the transport network (if e.g. Mosca-Shop or Mosca-Net were implemented in the city). The relaxed cost benefit analysis allows an overall and standardised comparison of different measures in a city which were modelled and assessed by use of Mosca-Freight and Mosca-Sustain. The Mosca-Short, Mosca-Line and Mosca-Tour modules represent algorithms which improve the tour planning of transport operators. They make use of the output of a transport model in the wider sense and *vice versa* the information on the tours can be used in a transport model like Mosca-Freight for calibration.

Outlook

The Mosca-Freight prototype will become a new product and also the prototypical application Mosca-Sustain will be used as a consulting application. Mosca-Tour, Mosca-Short and Mosca-Line are scientific prototypes available to become customisable applications for products. Mosca-Shop and Mosca-Net finally represent first examples to be further developed towards first scientific prototypes. The method of the relaxed cost benefit analysis is implemented as a software application. For the future further improvements are foreseen. The aim is to establish the relaxed cost benefit analysis as a widely used evaluation method.

In future, planning and control of traffic and transport will gain still greater importance. In view of the continuing need for better efficiency and route optimisation, the Mosca goal is the promotion of new approaches by introducing more intelligence in the transport infrastructure planning and use. This is in line with the EC policies regarding intelligent infrastructure and goods urban transport.

Mosca puts particular emphasis on the use of telematics in “mobility chains” for freight, promoting competitiveness, economic growth and employment, safety and operational efficiency. Transportation and the mobility of goods will be facilitated by the Mosca information and communication system modules providing traffic management and other transport planning services. A method like the relaxed cost benefit analysis realised as a software tool facilitates the decision of the city planners between alternative measures. It therefore represents a very valuable decision support tool.

The prototypical Mosca developments and algorithms will flow into new product development to harmonize freight related urban transport planning (e.g. optimisation from the public side) and might also lead to an improvement of transport planning tools for private operators. Mosca is a new approach offering advantages due to the growing interest of cities in goods movements and to the expected structural changes within city delivery caused by e-business. Thus an increasing demand for urban planning and modelling tools is expected to lead to an increase of turnover and market gain in the next years. The Mosca outcomes will be used at the policy planning level in order to evaluate the impact of alternative structural and managerial decisions, enabling a more efficient and sustainable development of urban goods delivery systems all over Europe. Not only will the city planners work with better and more detailed reflections of their traffic networks but also the transport operators will ask for more detailed and up-to-date traffic information. Up to now on-line traffic information or new urgent orders are not (or only rarely) integrated in the tour planning of transport operators. In future the more difficult traffic conditions but also the higher service requirements of the clients will ask for a more precise and flexible transport organisation. The new algorithms (Mosca-Short / Mosca-Line / Mosca-Tour) developed within Mosca project can make use of this information and allow the transport operators to immediately integrate special events like e.g. traffic jams or construction sites in their tour planning systems. Also time-patterns of the shops or private clients (Mosca-Shop / Mosca-Net) can be integrated which allow a more efficient pick-up and delivery planning. These abilities will certainly contribute in the competitiveness of the transport operators.

It can be concluded that not only the more difficult traffic conditions but also the new legislation and customer requirements will ask for a wide use of new transport planning and assessment tools in the future. The Mosca modules are therefore important tools to meet the future challenges in European cities and regions.

CHAPTER 12

Urban Mobility and Freight Distribution Service: the 14 Cities of the MEROPE Project

P Frosini, S Gini, F Agostini

12.1 Introduction

MEROPE is an INTERREG III B MEDOCC (Western Mediterranean) area project which started in September 2002 and ended in October 2004[1]. In particular MEROPE addresses axis 3 - Transport Systems and Information Society; Measure 3.4 (Innovative communication and information technologies for the development of the territory). MEROPE's overall objective is to investigate and develop evaluation models and telematics instruments which can manage and control mobility and logistics in urban and metropolitan areas, in order to promote the development and application of innovative Information and Communication Technologies (ICT) in support of integrated transport systems. The expected impacts of the project are: a greater economic competitiveness, improved mobility and enhanced quality of life.

[1] Interreg III is the initiative of the European Community for the period 2000 – 2006, financed by the FEDER (Fond Européen de Développement Régional). The MEDOCC programme is included in the Interreg programme (in particular in the section of co-operation among countries) and it allows the realization of projects that aim to contribute to a lasting, harmonious, and balanced development and to a better territorial integration within the western Mediterranean area (that includes regions of the south of Spain, of France, of Italy and of Portugal). The global objectives of the programme are: to increase the territorial competitiveness of the MEDOCC area in order to make it a relevant area of economic integration; make the policy for the territorial development more coherent within the co-operation area through a wider institutional integration; encouraging richer and larger international co-operation.

The Merope (Telematic instruments for innovative services for mobility and logistics in urban and metropolitan areas) consortium includes 12 partners from 3 European countries and 1 partner from the South Mediterranean area (Morocco). The partners belong to a wide range of sectors: local administrations, universities, public transport companies, and associations for research. A total of 14 cities are involved, all carrying out either a study project or a demonstration project.

The partners and the related regions and cities are listed below and the geographical coverage of Merope is illustrated by Figure 12.1:

1. Regione Toscana: Firenze, Siena, S.Gimignano and Lucca;
2. Regione Emilia Romagna: Piacenza and Modena;
3. Regione Umbria: Terni;
4. Regione Calabria: Cosenza;
5. Comune di Genova: Genova;
6. Compagnia Trasporti Pubblici SpA: Pozzuoli (Napoli);
7. Federtrasporto: Roma;
8. AICIA: Sevilla;
9. Universitat Politécnica de Catalunya;

 Figure 12.1: **Geographical coverage of the Merope Consortium**

10. Govern de les Illes Balears: Palma de Mallorca;
11. Centre de Recherche Armines - LGI2P;
12. Centre de Recherche CETE Méditerranée;
13. Communaute Urbaine de Marrakech.

As indicated above, Regione Toscana is the project leader and is in charge of the general management of the project. In carrying out this task Regione Toscana is supported by Siena City Council, which operates through its technical company Siena Parcheggi (the main reference for operational and technical aspects).

In Merope 7 demonstration site projects and 9 feasibility projects were carried out, with the common aim of improve the logistics freight distribution chain in urban/metropolitan areas or managing IT support services (optimising tourist buses on city approaches, ticketing systems, integrated parking systems, etc.).

The demonstration sites were: Firenze, Siena, Genova, Piacenza, Pozzuoli, Sevilla, and Palma de Mallorca. In Cosenza, Lucca (2), Firenze, Modena, Roma, San Gimignano, Perugia and Terni simulation projects were carried out. Marrakech participated as third country, not being part of the Medocc area. Finally, Barcelona (University of Catalunya), Nîmes (LGI2P), Aix en Provence (CETE) developed the methodology for collecting data and evaluating results. The choice of the sites for local applications was considered carefully in order to include cities with different characteristics and different levels of experience with respect to their use of ICT in support of urban logistics.

This chapter aims first to describe the overall context, and then to explain the concept and system approach and innovation in Merope.

12.2 General context

It is common knowledge that current trends in urban transport are not sustainable and that they provoke relevant and harmful impacts. The transport sector is unique in that it is the only one in which the energy demand increases as the efficiency of each single vehicle improves.

Merope aimed to address mobility in urban and metropolitan areas and in particular the aspect of freight distribution, that is often neglected by local authorities, although, together with private traffic flows, it is one of the major sources of energy consumption, noxious gas emissions and noise in urban areas. This lack of attention to freight distribution causes not only a deterioration of standards of living and damage to the environment but also a reduction of cities' competitiveness because of delays and high costs.

The main reason for the lack of attention paid to goods distribution is that addressing the urban logistics process implies acting on inter-related city management aspects: institutional, city regulatory and mobility policies, political, social and citizen consensus, city operational and business processes, infrastructural/technological service organisation. Nowadays it is also clearly accepted that rational and sustainable solutions are needed.

The measures foreseen in MEROPE were in line with the set of answers that urban policy makers are implementing, aware of the new social characteristics and their spatial consequences. From the ICT point of view, several projects have been initiated in many European cities for the introduction and development of systems for urban logistics and logistics platforms oriented towards the distribution of goods at urban, regional, or urban-regional levels (see Chapters 5 and 11). The level of development differs among the various sites. The adoption of technological solutions and telematics infrastructures often has an experimental and step-wise character and occurs through the realisation of pilot or exploratory projects on the different technologies and/or on the different organisational solutions implicated.

The development of telematics technology within the last decade has had a primary role in contributing to the development of logistics platforms. Today, the technological supply in this sector includes several technological methodologies and tools, such as:

- Communication technologies and fixed networks, primarily the strong development connected to the expansion of the Internet;
- Mobile platforms (on-board terminals, palmtops and PDAs, code-reading peripherals, etc.) and wireless communication networks (GSM, packet networks, e.g., Mobitex, evolution of mobile phones 2.5G – GPRS, and in future 3G – UMTS);
- Models and software tools for distribution management and planning (route planners, distribution planners, demand-supply managers, etc.);
- Tools and services for message exchange and rationalization of information flows among the different logistics actors; and
- Tools and systems for the integration of the logistics system with the available information on traffic and mobility (TIC, mobility service centres, etc.)

12.3 The approach and objectives of MEROPE

The activities in MEROPE were oriented towards the analysis and definition of mobility, transport and logistics chain features, with a particular attention to their impacts in terms of environment, sustainability and competitiveness. Based on this understanding a methodological approach to the complexity of the problem was developed together with the definition of guidelines for the development of telematics systems. A common evaluation plan of the project's impacts through a comparison of results was also defined.

MEROPE's main goal was to activate study projects, analysis and simulation for the use of ICT in innovative services for mobility and logistics in several urban and metropolitan areas. Moreover at the sites where the approach and solutions to these issues are more mature, demonstration projects were carried out concerning: the application of integrated systems of communication as a support to urban logistics; the development of centres for remote traffic control and to direct vehicles to parking areas; the use of communication networks and telematics equipment to optimise services and information to end users; remote control of tourist buses and on-line systems for booking parking areas; intelligent platform for freight distribution. Additionally, MEROPE developed a common methodology of the application and evaluation of ICT services in urban mobility and logistics management (see Chapter 7 for a discussion on the importance of evaluation in the project life-cycle). In particular, the logistic platforms and information systems developed were based on open architectures and on IT standards. Finally, a series of best practices was defined for the application of these ICT services in mobility and transport policies.

These best practices have been spread to a wider audience through the organisation of and participation in seminars, conferences, and events. The desire to promote and disseminate the project and its results has led to the creation of a web site (www.merope.net), both for providing information to those that beyond the Consortium (public area) and for the exchange of documents and information among the partners (private area).

A summary of the activities developed at each of the MEROPE sites is given in Table 12.1.

Site	Territorial and environmental characteristics	Planned MEROPE activities and interventions	Results obtained
Florentine metropolitan area	Mid sized city with historical and tourist vocation	Technological/informative platform for mobility information, monitoring and management of intermediate services. Pilot project Goods distribution in the historical centre with transit point. Feasibility Study	Definition of a Strategic Plan for the application of IC and telematics technology in the Florentine area. Creation of an integrated computerised base to provide user information on services, integrated timetables and inter modality. Methodology and relative computerised instruments for evaluation of overall accessibility to transport services in the Florentine metropolitan area. Definition of technological services and infrastructures to monitor and control mobility processes Feasibility study for a transit point in Florence, with economic analysis, hypothesis for management, location and dimension of the warehouse and fleet.

Site	Territorial and environmental characteristics	Planned MEROPE activities and interventions	Results obtained
Siena	Historical city with great tourist interest	System of integrated car park, tourist bus and traffic flow management with variable indicators Pilot project	The system for the control and monitoring of vehicle flows has been developed and patented. The system allows the monitoring and management of tourist buses based on data provided by the unit for data collection. Using panels with variable messages tourist bus operators are informed on car park availability.
S. Gimignano	City with historical and tourist vocation.	Feasibility study for automatic control of access to the Limited Traffic Area and identification of the technological system and typology of communication network Feasibility Study	The feasibility study carried out in San Gimignano is one of the council administrations' preliminary evaluation instruments for the possibility of creating a system of control for access to the historical centre.
Lucca Comune	Historical city with great tourist interest	Feasibility study and planning for the creation of a Logistics Service Centre Feasibility study	The cognitive investigation into the structure of a goods distribution system in the historical centre of Lucca was carried out. Furthermore, a data exchange with UPC Barcelona was undertaken in order to develop a simulation of the situation regarding mobility in the historical centre of Lucca.
Lucca Provincia	Historical city with great tourist interest	Development of logistics systems of goods inter-mobility and movement with software elaboration for an applicative simulation Feasibility Study	Evaluation of the potential inclination of local production fabric (Garfagnana - Media Valle del Serchio and Piana di Lucca) to use advanced logistics services to rationalise goods transportation and for the consequent modal rebalancing in favour of railways.

Site	Territorial and environmental characteristics	Planned MEROPE activities and interventions	Results obtained
Genova	Industrial/portal metropolitan area	Development of ICT instruments for the optimisation of goods loading and delivery in the city centre and the metropolitan Pilot project	Experimentation of the already existing M.E.R.C.I. project and widening of the area served to the entire historical centre Improvement of the quality of the existing service with the aid of innovative ICT systems to mange vehicles and routes (new handheld apparatus with Global Positioning System and barcode reader), GPRS transmission technology. In collaboration with CETE Méditérranée a study on the reduction of environmental impacts following low impact vehicles for goods transportation has been carried out.
Modena	Notable tertiary, industrial and commercial activity.	Optimised goods distribution in the urban centre through a transit point. Methodology and guidelines. Pilot project	Through a study involving various subjects an action plan for the rationalisation of goods distribution in the urban area has been developed.
Piacenza Area	Historical and industrial city with surrounding municipal areas	Planning of a goods flow observatory. Vast area logistics plan with logistic intervention and ICT systems. Pilot project	An urban logistics plan has been produced and, as a pilot project, a web site and a database to manage an integrated system of urban logistics has been created. Furthermore, a data exchange with UPC Barcelona was undertaken in order to develop a simulation of the situation regarding mobility in Piacenza.
Napoli (Pozzuoli)	Tourist and industrial historical city.	Telecentre for improved use and management of an integrated public transport parking system. Improved accessibility to insular territory. Pilot project	An initial analysis of technological systems and services to support mobility management in Pozzuoli. The analysis has produced a reference framework for mobility management based on ITS systems and services. System for integrated management of stopping area has been developed by CTP.

Site	Territorial and environmental characteristics	Planned MEROPE activities and interventions	Results obtained
Roma	Tourist and tertiary historical city.	Optimised goods distribution in the urban centre through a transit point. Methodology and guidelines. Feasibility study	An analysis of the demand/supply with identification of a site for a logistics platform was carried out. Data exchange with LGI2P- Armines, a French research centre, for the optimal hub location was successfully carried out.
Terni	Historical city with developing industry and commerce	Study of urban logistics improvement with transit point, communication network between internal and users. Integration logistics system with integrated urban mobility system. Feasibility study	A study has been carried out concentrating particularly on an analysis of transit using electronic gates; a sample survey among commercial operators; a valuation of medium term requirements (quantity, goods category, logistics bases, delivery points)
Cosenza	City orientated towards the tertiary sector, base of administrative, health, commercial and university services.	Feasibility of a system of goods distribution control with simulation techniques to estimate the impact of new management of goods distribution on mobility conditions. Evaluate the effects of different communication strategies on service users and of the structure of the goods distribution process. Quantify the system's impact. Feasibility study	The Regione Calabria has developed a pilot project concerning the feasibility of a goods distribution centre in the urban area of Cosenza and of the relative telematics Systems for traffic control.
Sevilla	Metropolitan area with vast historical centre. Service sector, tourism, growing agricultural activity.	Identification and evaluation of current mobility models and processes. DLZM demonstration (internet use for reservation of loading zones). ICT simulation and evaluation on goods distribution. Pilot project	In Seville a study was undertaken with the aim of identifying a system to manage reservations of loading zones for goods delivery. Following this, a two-week experimental project was undertaken with the participation of various actors.

Site	Territorial and environmental characteristics	Planned MEROPE activities and interventions	Results obtained
Palma de Mallorca	Insular area with strong tourist vocation.	Study to define and implement a system of ticket sales via internet Pilot project	The system of integrated ticket sales via internet has been developed
Marrakech	Metropolitan area, vast fortified historical centre (Medina) Strong tourist and cultural vocation, developing craft activity, growing industrial activity	Report on study relative to General Plan for the management and regulation of traffic and mobility of people and goods. Report	A feasibility study has been carried out and will lead to a car park being built in Marrakech.

Table 12.1: **Activities developed at each site**

12.4 Innovation and added value in MEROPE

The innovative elements characterising MEROPE are represented by the three fundamental directions towards which project activities are addressed:

- At local level: ICT services to manage logistics and urban transport were developed in each MEROPE site in the MEDOCC area.
- At horizontal level: a common methodology was elaborated in order to define the functional and technological requirements of ICT services for towns and to develop models for the impact evaluation of the different schemes and systems.
- Promotion and dissemination of the scientific-technical approach and of the results both from a technical point of view, through several reports on the activities achieved, and on a large scale, through identification of the potential subjects of interest and of the most suitable tools and channels to reach them.

The value of the project also stands in the action of promotion of ICT and services in the field of urban logistics and mobility management to achieve an increase in efficiency, effectiveness and environmental care.

The greatest opportunities are mainly represented by the innovative applications of ICT and services that were defined by the possible interactions with their supply: thus stimulating a positive interaction between the ICT sector and the transport sector.

The implementation of MEROPE's local projects and architecture involved a number of advanced enabling technologies:

- Web-enabled information and booking services for the customers (B2C segment), information exchange, resource sharing for e-logistics operators (B2B segment);
- Delivery notification and information through mobile phones and SMS;
- Goods dispatcher software for journey planning and resource (i.e. vehicle capacity) optimisation through the utilisation of vehicle routing techniques and algorithms;
- In-vehicle display units and hand-held devices (palmtops, PDAs, new generation mobile phones based on WAP and GPRS) to support vehicle drivers and goods delivery operators tasks;
- GPS-based or GSM/GPRS-based vehicle location systems;
- Long-range, wireless communication channels (GSM, GPRS) to support interaction and information exchange between the logistics planning/management platform and vehicles / goods delivery operators.

Last but not least, the great value and innovative aspect of Merope project is that it managed to bring together a large number of cities, and subjects, working together on a single project.

12.5 Conclusions

Merope project, through interaction between regional governments, municipalities, public transport societies and research centres, transferred and validated innovative ICT tools from the research community to the stakeholders.

Feasibility studies were successfully undertaken in nine sites, all producing some valuable data and findings regarding not only the local reality but also the wider picture on the current offer and need for mobility and logistics services. Moreover, in seven sites pilot projects and demonstrations have been carried out including projects relating to car park management, traffic flow management, goods distribution, user information, communication and environmental impacts. Each of the projects has, whether ultimately successful and sustainable or not, provided an important demonstration of how innovative mobility services can be developed and integrated into existing services and what benefits they bring to the local reality. In 70% of cases the demonstrations provided by the Merope project will continue as permanent fixtures even after the conclusion of the project. This is not to say that the projects were carried off without any problems: there were many difficulties and changes to original plans. However, ultimately the objectives have been achieved and the problems faced should not be considered wholly negative but rather an important learning process.

The "Merope knowledge base" is now available for those cities, inside or outside Europe, interested in improving mobility and logistics chains in urban and metropolitan areas, using innovative Information and Communication Technologies (ICT).

CHAPTER 13

The City Ports Project

R Rosini, S Melluso, L Mestroni, G Ferilli

13.1 Regional Policy on City Logistics

The necessity to characterize and to implement measures of sustainable mobility in pursuit of important reductions of the negative impacts of urban freight transport has become a fundamental priority of the policy maker at community, national and local level. These are also the reflections and the strategies proposed by the European Commission White Paper "European transport policy for 2010", the Transport General Plan, the Transport Integrated Regional Plan of the Emilia-Romagna Region and by several initiatives from an increasing number of regional, provincial and municipal administrations.

The main reason of this increased interest is the relevant negative impacts that the transport of goods causes to the quality of life in the city:

- the growth of traffic congestion in the urban areas (both in the city centre and on the outskirts of the city);
- the worsening of the quality of life of the residents, with serious and growing sanitary risks for the population;
- the reduction of the commercial attraction of the cities to tourists;
- the decrease of accessibility to the historical centres;
- the worsening of operational efficiency of the transport operators and, in general, in the logistics and transport sectors; and
- the increase of environmental pollution.

In order to combat these effects in a more effective way, the Emilia-Romagna Region has decided to face directly the problems connected to the urban freight transport by starting a regional politics of “city logistics”. An important aspect of this politics is the meaning of “city logistics” to which reference is made. Generally in literature only the routes for the delivery of goods from productive plants to distribution points are considered. This neglects other important phenomena, for example the last important ring of the logistics chain that is the transport of goods from the point of distribution to the residences of the single consumers. The Emilia-Romagna Region, in the development of its own politics of city logistics has adopted a more extensive, comprehensive definition which includes the flow of commercial vehicles that are not carriers of goods but take part in the distribution of essential services for the business activities and for the organization of the city life. In this perspective the field defined as city logistics includes many of the activities for supplying (directly or indirectly) the final consumer. They include therefore also the activities of transformation of the intermediate goods carried out in city centres which make possible the consumption of the relative final goods.

The city logistics concept is constituted from the complex of the services which produce the transfer of goods from their place of production to the exact point in which they are consumed or used, using for this purpose physical infrastructure (networks, dry ports and means of transport) and the virtual nets (technological nets of communication for the transmission of the relative information to the same goods, for the transfer of the relative documents of accompaniment and for the most efficient use of means of transport). It also comprises the services necessary to maintain the efficient flow of goods and to guarantee the intermediate consumption or use in the most favourable environmental and efficiency conditions.

City logistics is defined in specific terms distinguishing it from the most general meaning of distribution that assumes the organization of the flow of the final material goods and of the services. Instead the terms “directly” or “indirectly” are used to include both the activity of pure delivery or of collection of goods and the whole set of connected activities to this function, comprising the transformation logistics carried out in the function of the final consumption. The particular context of transport in the Emilia-Romagna Region is characterized by a clear prevalence of short distance movements. The existing link between city logistics, logistics of productive districts and corridors of transport and regional logistics enables consideration of the wider context.[1]

[1] In order to satisfy the general deficiency of sufficiently detailed and appropriate information on the topic of city logistics, the Emilia-Romagna Region has promoted a large programme of surveys and system analyses stimulating and financially supporting the main municipalities within the regional programme for sustainable mobility. This started with the deliberation of Regional Committee n. 2661/2002 (Criteria for carrying out the measures to encourage sustainable mobility planned in the programme agreement on air quality, 15th July 2002 between Region, Provinces and Municipalities over 50,000 inhabitants).

Urban freight transport cannot be considered without also taking into consideration the ties deriving from the passenger traffic and the impacts that innovative measures of sustainable mobility of freight cause on the latter.

The description of the measures that have been considered also includes the impacts on passenger transport.

13.2 The City Ports project

City Ports is a European project whose scope for intervention is the urban/city logistics for goods; the project utilises funding in part from the European Union and the remainder from public and private sectors (for Italy 50% is funded by the EU and 50% by the Ministry for Transport and Infrastructure).

The Lead Partner of the project, as technical, managerial and administrative responsibility, is the Emilia-Romagna Region, which is assisted by a Temporary Company Association made up of several partners (in particular, for Italy, SCS Azioninnova that has developed the methodology for the conduct of the feasibility studies). Table 13.1 shows the partnership.

Italy	Emilia-Romagna region
	SCS Azioninnova SpA
	Municipality of Udine
	Municipality of Ravenna
	Municipality of Ancona
	Municipality of Taranto
	Brescia Mobilità – Società Metropolitana di Mobilità
	Municipality of Vicenza
	Infomobility S.p.A.
	IT.CITY S.p.A.
	Municipality of Parma
Austria	State Government of Vienna
	IC Consulenten Ziviltechniker G.m.b.H
	City Courier Service Speditions G.m.b.H
	Logline e-logistics Solutions G.m.b.H.
	Forschungsgesellschaft Mobilität – Austrian Mobility Research (Graz)

Slovenia	The Agency for Regional Development of Ljubljana Urban Region
Greece	Centre for Research and Technology – Hellas/Hellenic Institute of Transport
	Transeuropean Consulting Unit of Thessaloniki S.A. (TRUTH)
	Prefecture of Kavala
	Region of Attika

Table 13.1: **The City Ports project partners**

City Ports sets itself the general objective of developing solutions of urban logistics in some European cities for the reorganisation of the urban systems, making several important nodes of the infrastructure network of the EU work in a way that is:
- coherent,
- efficient,
- economically sustainable, and
- stable.

	Italy	Austria	Greece	Slovenia
LEVEL 1	Lanciano*		Athens	Ljubljana
	Lecce*			
	Milan*			
	Padua*			
	Perugia*			
	Rimini*			
	Venice*			
LEVEL 2	Ancona	Graz	Kavala	
	Brescia			
	Ravenna			
	Taranto			
	Udine			
LEVEL 3	Parma	Vienna		
	Vicenza			

Table 13.2: **The City Ports network**

* These cities are the privileged subject of the dissemination activities and are part of the network, but are not City Ports project partners.

For this purpose a certain number of applications (pilot projects) of urban logistics are supported, tested, driven and managed at the local level by the cities taking part in City Ports. The level of involvement of these urban systems is differentiated on the basis of their different level of awareness and maturity, in relation to their policies, strategies and actions undertaken within the scope of urban logistics (see Table 13.2):

- Level 1 – Dissemination: these cities will be involved in the sharing of the City Ports experience.
- Level 2 – Feasibility: these cities are mature enough to design urban logistics solutions. The objective of these pilots is to develop a feasibility study for city logistics actions, based on the methodology developed within the project.
- Level 3 – Implementation: these cities have already started up initiatives regarding urban logistics. The objective of these pilots is to implement and test city logistics solutions already defined at the time of the start-up of the City Ports project

The project, which started in July 2001, is organised in several Work Packages. Figure 13.1 illustrates the basic contents and the relationship between the Work Packages composing the project.

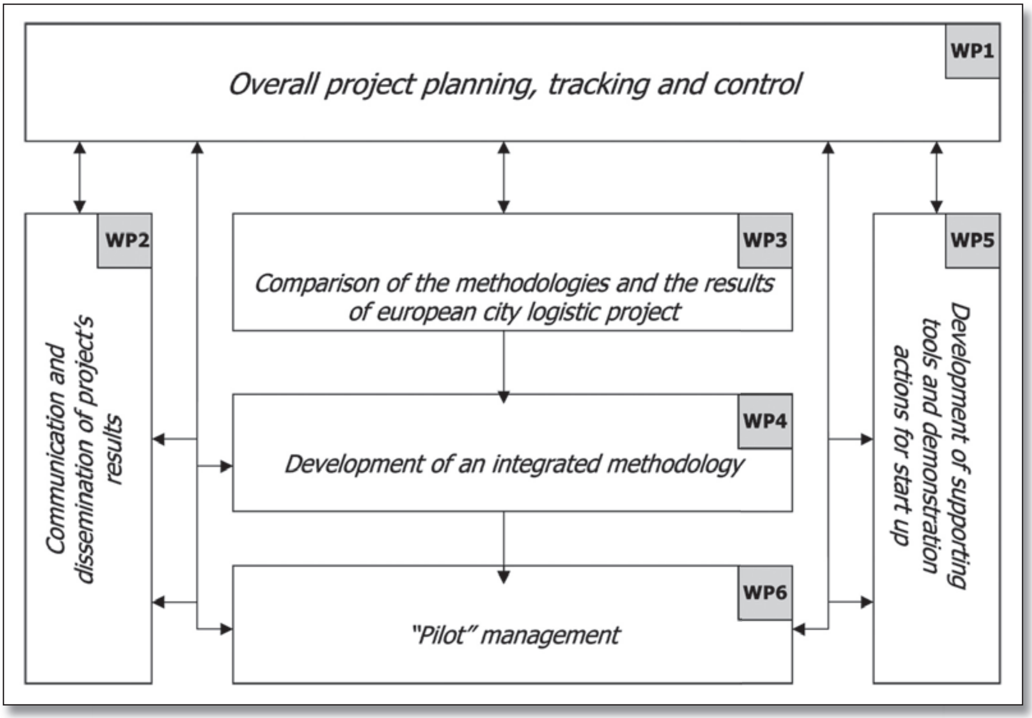


Figure 13.1: **Project structure**

13.3 The City Ports methodology

13.3.1 The objectives

The methodology aims specifically to:

- Build up a common shared vision of the:
  - working mechanisms of urban logistics;
  - modelling criteria;
  - evaluation criteria.
- Provide guidelines and instruments for the:
  - reconstruction and the study of the urban movements of goods;
  - identification of solutions coherent with the context;
  - development of feasibility studies.

13.3.2 The key concepts

The whole methodology is based on three key concepts:

1. the context-based approach: a city logistics solution must be calibrated according to the characteristics of the context in which it will be implemented. In particular, it must take account of the urban and economic characteristics of the territory of reference, and the characteristics of service of the supply chains involved in the solution;

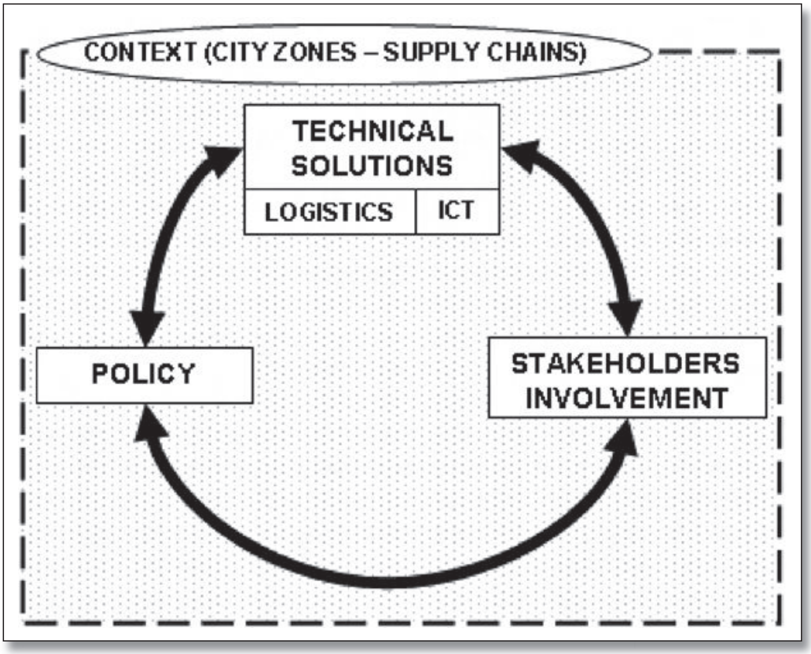


Figure 13.2: **The integrated solution.**

2. the integrated solution: the city logistics solution must be focused upon just one aspect (e.g. the sole ICT component, the sole organisational component, etc.), but must combine a set of different aspects (Figure 13.2):
   - Logistics and technologies (logistics, ICT, transport technologies);
   - Policies (regulations, planning systems, communications, supporting technologies);
   - Organisation and involvement of the stakeholders.
3. the economic sustainability of the solution: in order to endure a city logistics solution must be economically sustainable. It is quite likely that the external costs must be made to emerge (social and environmental) in the evaluation of the economic sustainability, so as to:
   - enhance the stakeholders' awareness and commitment;
   - compensate (at least in part) for the solution's over costs;
   - sustain in time the measures adopted in terms of city logistics.

13.3.3 The approach to the solution

The level 2 pilots must develop a feasibility study for the implementation of a city logistics solution. The development of the latter is the result of a common approach to the various pilots, and represents the central distinctive element of the City Ports methodology. The phases that make up the development process of the solution are:

1. The identification of the intervention priorities
2. The definition of the solution
3. The assessment.

Figure 13.3 reports the general outline to the approach highlighting the phases and the tools to be utilised.

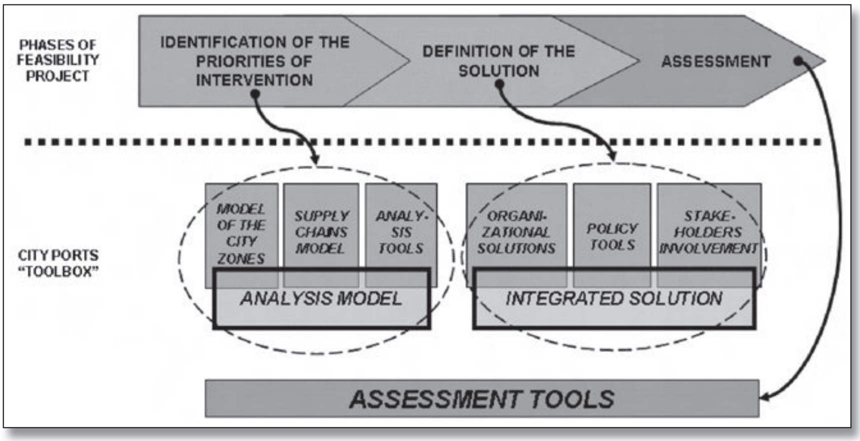


Figure 13.3: **The approach to the solution**

13.3.4 *The identification of the intervention priorities*

The objective of this phase (Figure 13.3) is to define the urban fields that present the major critical factors in regard to goods mobility (congestion, pollution, etc.), and where to focus the intervention.

A city logistics solution is linked to a context in which it must be implemented, that is to say the urban and economic characteristics of the area of intervention and the supply chains that are located in that area. For example, it is unlikely that a city logistics solution devised to rationalise the home deliveries of large electrical appliances in the city centre will be the same as the one devised to act upon the transport of frozen foods to supermarkets on the outskirts.

The identification of the intervention priorities is achieved by using the matrix "zone of the city – supply chain" (Figure 13.4).

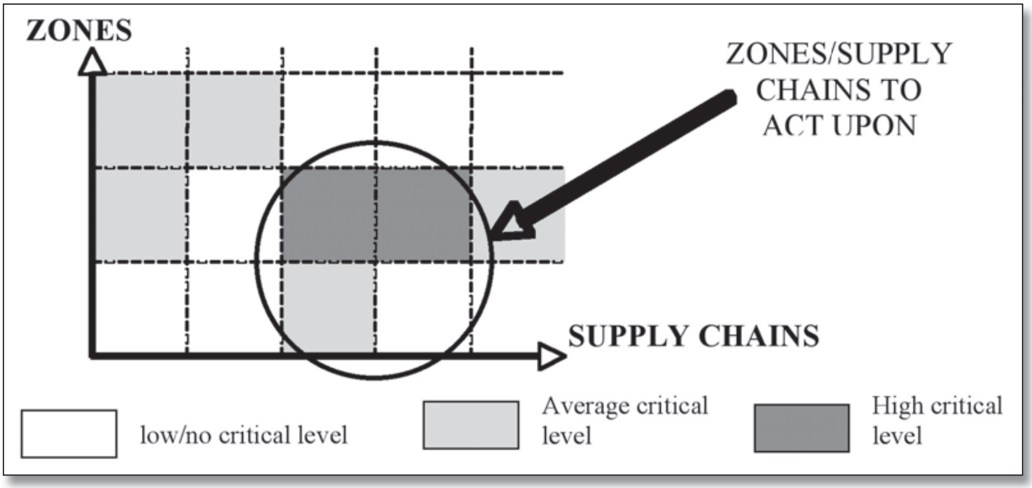


Figure 13.4: **The zone - supply chain grid**

Each row represents a different urban area, each one of which has its own urban and economic characteristics, while each column represents a supply chain, each one of which has its own constraints and critical factors.

This grid can be filled in through an analysis of the distribution of the goods extended to the whole of the urban system. Figure 13.5 reports the analysis model.

The model of analysis is both made up of interpretative models and the results of cognitive surveys.

The interpretative models (model of the zones of the cities and model of the supply chains) serve to define a common base for the data collection and for their subsequent interpretation:

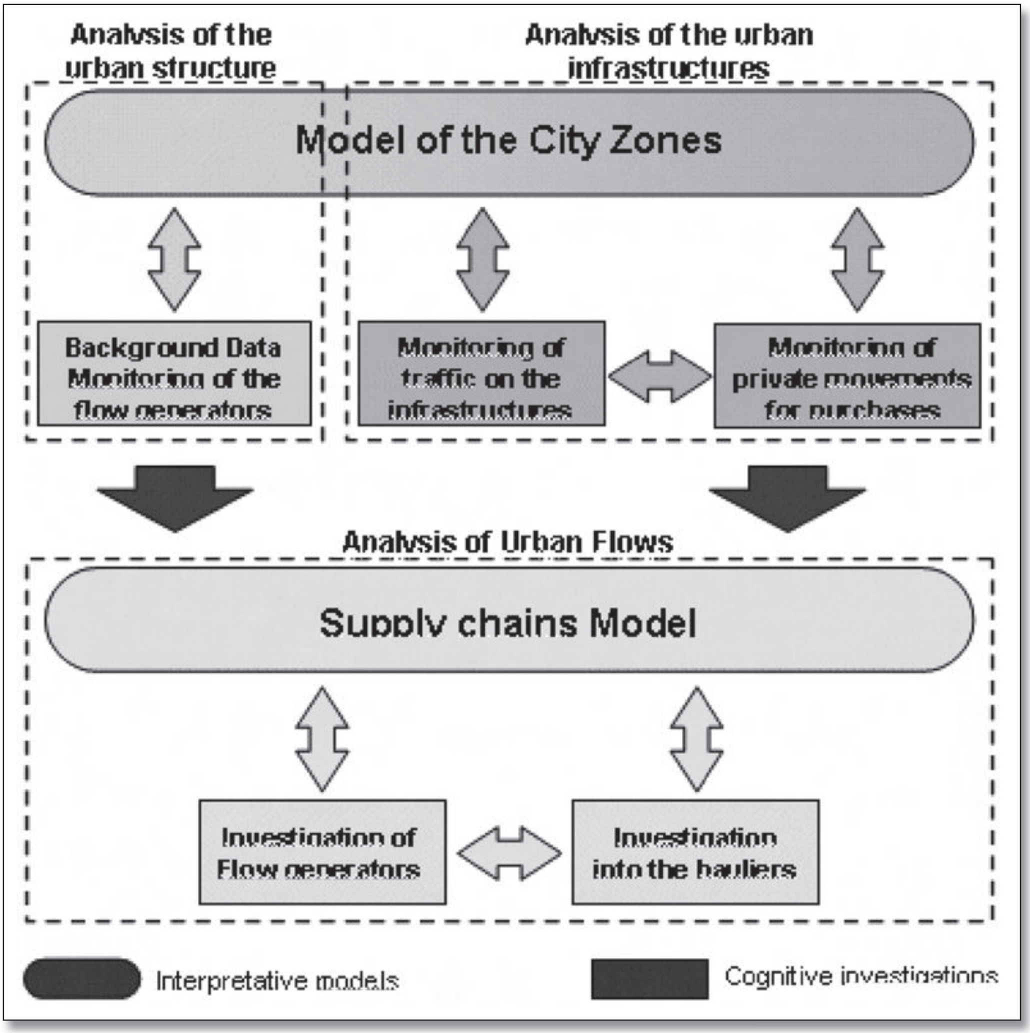


Figure 13.5: **The model of analysis**

- Model of the city zones: the cities are organised into zones that have their own urban (breadth of the roads, levels of congestion, etc.) and economic (density and type of the economic activities, etc.) characteristics. The purpose of the model is to allow for a sub-division of the urban area according to these types of zones.
- Model of the supply chains: the term "supply chain" implies an operative service and goods management mode, thus a supply chain neither coincides with a particular class of goods nor with a particular economic activity. The aim of this model is to recognise the main supply chains present in the territory and to shed light upon the constraints to be taken into consideration during the design phase of the solution.

The cognitive investigations are performed by means of questionnaires to be administered to the flow generators (in other words, to the activities present on the territory), to the transport companies and to the hauliers operating in the city. Such investigations are strongly oriented to highlighting the logistics aspects of the goods distribution: service times, delivery methods, supply chains involved, etc.

13.3.5 The definition of the solution

The objective of this phase (see Figure 13.3) is to define the city logistics solution that best adapts to the characteristics of the context in which the action will be taken.

The solution is born from a mix of different elements:

- Organisational solutions (logistics and ICT);
- Regulatory policies;
- Stakeholder involvement.

A possible pathway for the definition of the solution (see Figure 13.6) consists of two fundamental phases:

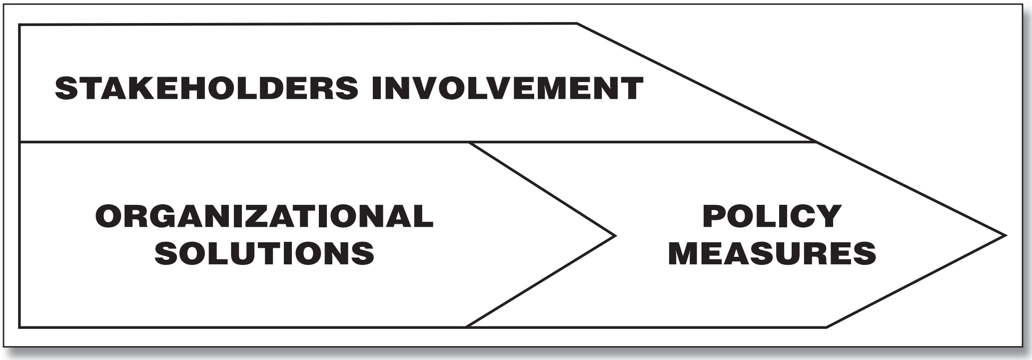


Figure 13.6: **A pathway for the definition of the integrated solution**

a. The first step is the definition of the organisational solution that is most suited to the zones/supply chains identified. An organisational solution concerns the organisation of the transport from the withdrawal to the delivery of the goods; thus it is not always linked to an infrastructure (it is rather a management model that is not bound to the existence of a physical infrastructure, as happens, for example, with the multi-pick or the multi-drop).
b. The second step consists of the definition of the policies supporting the organisational solution found: regulating of access, the areas for loading/unloading, etc. The introduction of new regulations must take account of the existing policies (in regard to public transport, the productive activities, etc.), with which they must be compatible

and any constraints limiting their implementation (e.g. the lack of funds, the acceptability by the different stakeholders, etc.).

The "weight" of the two components (organisational solutions – politicise) in the "mix" of the integrated solutions is strongly context-bound. For example, the intervention in the areas that are hard to regulate (such as the outskirts) will more easily see the adoption of even highly articulated organisational solutions (for example, logistics platforms) rather than the introduction of regulatory measures. Alternatively, in the case in which the intervention is expected in already optimised supply chains, and thus unlikely to be the subject of reorganisation, the adoption of strong measures (e.g. the major penalisation of the use is polluting vehicles in the area involved) will prevail over the organisational solutions. Lastly, there is a third point: the involvement of the stakeholders, which horizontally crosses the first two "steps". The generation of the consensus between the parties involved is to increase the interventions chances of success and to build a stable solution over time.

13.3.6 The assessment

The objective of this phase is to evaluate the overall project performed by pilots in order to produce a feedback of the effectiveness of City Ports methodology.

The assessment considers the following criteria:

- Completeness of the process: behind each action there must be a complete vision of the problem, even in the cases in which the intervention is made in limited fields (e.g. to intervene in the limited traffic zone alone, or to consider the ICT element alone, etc.). Often a circumscribed and profound intervention provides better results, but based on an overall vision of the problem, rather than a series of scattered interventions lacking in incisiveness.
- Coherence with general assumptions: the methodological approach of City Ports is based on the idea that it should have an integrated approach, in order to enhance the chances of a successful a city logistics solution. As a consequence, it is important to determine if a solution considers in an adequate way the three aspects of the integrated solution, in order to evaluate if an approach is coherent with the methodology.
- Efficacy of the intervention: the intervention proposed must effectively pursue the objectives of reduction of congestion, pollution, etc.
- Economic sustainability: one of the main causes behind the failure of the past experiences of city logistics (in particular, the Urban Distribution Centres) has been the scarce attention to the economic aspects of the proposed solution. Indeed, very often, as the "external funding" failed to be delivered (such as the non-repayable loans from the Local Administrations), the solution has proven incapable of being economically self-sustaining. Thus, the solutions identified in City Ports must previously make a careful evaluation of their own economic sustainability.

- "durability": this factor means to evaluate if the pilot took into any account the stability of the outlined solution in a medium-long term perspective.

Particular attention should be paid to the economic sustainability, as often the solutions found involve logistic over costs (take, for example, the load breakages due to the introduction of logistic platforms), which are incapable of being compensated for by means of the recovery of the transport efficiency. In order to overcome this situation it is necessary to highlight the external costs due to transport (pollution, accidents, time lost due to the traffic, etc.) that are never taken into consideration by the operators in the definition of the tariffs, thus generating "distortion" in the competition.

Various studies have tried to quantify the entity of such external costs: however, such costs clearly cannot be put down to each individual actor, nor can they be asked to wholly bear the coverage of the higher costs generated by the solution. The existence of such costs instead paves the way for two roads:

1. such costs allow the stakeholders to be sensitised and, in the concertation phase, to provide the public partner with some elements in order to ask them to play their part;
2. the public party can reallocate its own costs, devoting a part of the expenses that used to be dedicated to health (via the reduction of pollution and accidents), road maintenance (via traffic reduction), etc. to compensate for the over costs.

13.4 Conclusions

The City Ports project is identifying and sharing among a wide network of medium size cities of the Casdes area the development, experiment and diffusion of a common methodology for the analysis, design, feasibility evaluation and implementation of integrated "city logistics solutions", minimizing times of implementation and project risks. It is developing integrated measures, rather than single technical solutions (often already available), and the definition of a general methodology for the evaluation of their feasibility and sustainability. This wide range of studies and implementations will improve the knowledge of city logistics in the Casdes area.

CHAPTER 14

City freight: evaluation methodology for urban freight transport

T H Zunder, J-C Dellinger

14.1 Introduction

City Freight was a research project supported by the European Commission under the Fifth Framework Programme and contributing to the implementation of the Key Action 4 City of Tomorrow and Cultural Heritage, within the Energy, Environment and Sustainable Development Programme. It ran from early 2002 to late 2004. The main objective of the project was to carry out a comparative analysis of urban freight effects for different cities and situations in Europe, totally seven countries and twenty one cities. The project carried out analyses of selected supply chains schemes and carried out evaluations of their impacts in an urban context, making use of a common assessment methodology. The project deliverables are available at www.cityfreight.org and the reader should view this as an introduction to the material.

The objectives of the City Freight project were to:

- Identify and analyze innovative and promising logistics schemes in the seven countries represented, as well as urban policies that could accompany implementation in order to promote sustainable development;
- Set up a list of criteria and a common assessment method for evaluating those logistics schemes and the related accompanying policies (legal framework, land use planning, road traffic regulation, pricing);
- Analyze their technical and economic efficiency;

- Design, one or more implementation scenarios of these schemes and related accompanying policies;
- Assess and optimize the scenarios according to the criteria of a sustainable development of the city;
- Present guidelines for implementing integrated strategies that could be recommended as "Best Practice";
- Disseminate and exploit the Best Practice Guidelines through collaboration with the Local Authorities for the design of concrete implementation plans of integrated strategies in each of the case study cities.

This chapter draws from the process and experiences of the City Freight project and provides the reader with a methodological approach and analysis of the elements of the three sub-systems organising a transportation system.

The success of urban logistics is not a question of technical innovation. Non-technical factors often have a stronger influence on the supply chain. The various actors in the transportation system have the pre-eminent role in promoting and initiating change. The market has to be available and ready for new methods of urban freight transport and return on investment is a decisive criterion for the majority of key actors involved.

The supply chain includes, particularly at the level of transfer points, a large number of autonomous and intervening parties which complicates the decision making process and consensus finding. This chapter describes the process and guidelines based on the observation, interviews and long-term experiences of the authors as partners in the City Freight project.

14.2 Methodological approach

This section presents a systems approach designed to identify the framework conditions for urban transport in a holistic approach. Transportation is a system made from interrelated elements. These interact such that if an element or interaction is defective the whole system suffers.

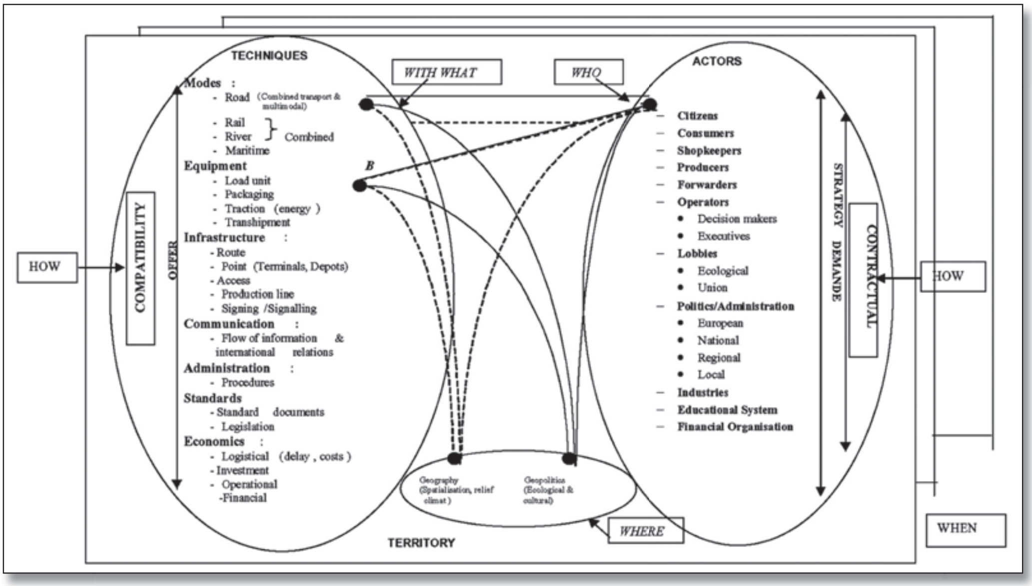
The transportation system may be depicted as mainly organised through three interrelated sub-systems consisting of:

- The society of actors involved (shippers, operators, receivers, government);
- The ensemble of techniques (technology, methods, regulations or systems);
- The environment in which the system exists or will exist (geographic, geopolitical).

The first step is to identify the actors in the environment and to inter-relate their respective goals with each other and with the techniques and environment in which the system is to operate. Within the sub-systems the actors' goals should be analysed both in terms of the contractual links under the heading "society" and compatibility under that of 'techniques'. This shall thus define the actual "demand" with respect to the "offer".

Therefore in the CITY FREIGHT project LT Consultants developed the concept of underground delivery systems in Helsinki by holding workshops of those affected: cities, retailers, shippers and operators. The process of talking within a structured process swiftly identified techniques that would or wouldn't succeed, based both on the existing environment, be it the topography of the city or the existing global logistics networks of the shippers, retailers or operators (Ruiz *et al.* 2004).

At any given moment the process should evaluate the combination of "why" (the goals), "who" (the actors), "with what" (the techniques), and 'where' (the environment) – thus ensuring that the offer is actually a response to a demand in a given time and place (Figure 14.1). The introduction of a 'time' factor "when" into the system allows observation of developments in each of the elements as well as their inter-relations over time in order to deduce effects on the entire system



Source: After Deyris

Figure 14.1: **A systems approach to the organisation of urban transport**

14.3 Application

In consequence the common task for the investigative process consists in identifying the actors concerned with the problems and in drawing up a "game of the actors". The work consists of tracking down the points of view of each player on each particular problem, technique or organisation.

Each type of actor has a demand related to his competence or role in the supply or logistics chain and should be specified in terms of:

- Performance: Efficiency of material in relation to the goods/volume to be treated;
- Logistics: Integration in a wider global network;
- Economy: Acquisition cost of the system(s) and comparison with a 'do nothing' scenario;
- Geography: Spatial location of the new system.

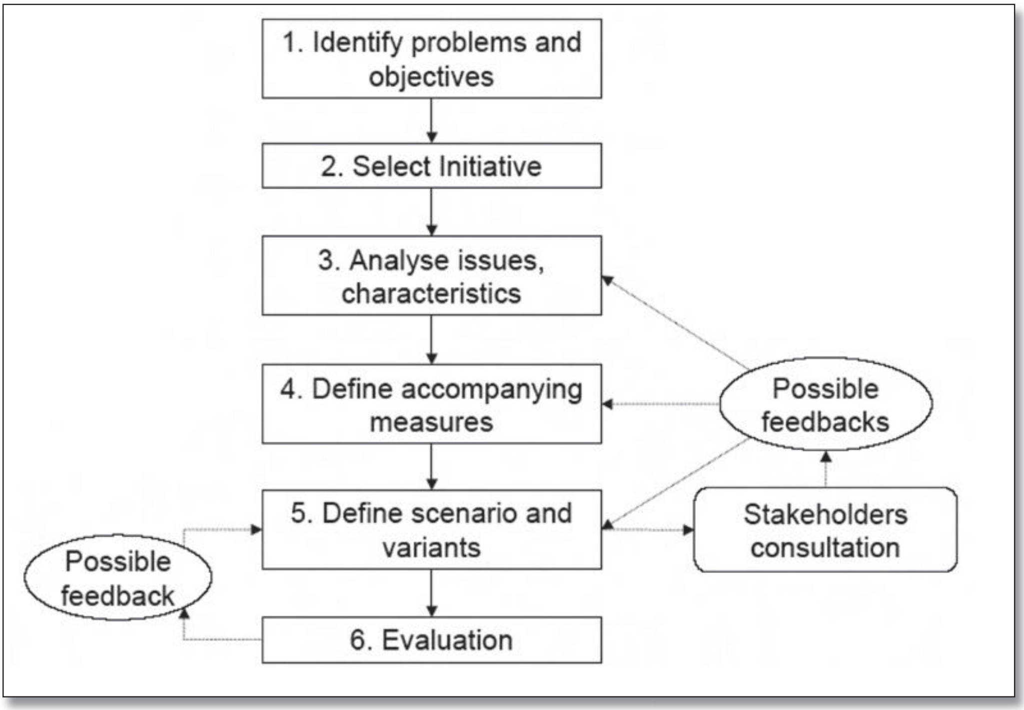


Figure 14.2: **Transportation system development process (Henry *et al.* 2004)**

The application of this methodology thus permits the highlighting of, for example:

- Interoperability: compatibility or inter-relation between the different techniques involved in the concept, while placing them in their environment (environment) and their organisation (inter-relation between the actors).
- Land-Use Planning: compatibility or inter-relation between the different techniques involved (infrastructure, administration, legislation, investment, etc), while placing them in their environment and their organisation: (inter-relation between the actors: politics, lobbies, citizens, operators, investors, etc).
- Key Success Factors: the imperfect or otherwise inter-relations between elements of the system (at the outset or over time).

14.4 Several principles

Several major principles, particularly important during an analysis of situations (present and future) need to be added:

"Think global, act local"

This slogan of the latter decades of the 20th century applies well to the subject under study here. An analysis of the situation at the local level must be analysed by taking into account the ensemble of the transportation chain, from door-to-door, and as one of the links in the global chain.

"People not Technology"

It can be highlighted that a number of technologies are available and adaptable to the needs, but the main problems are in fact concentrated in the following:

- The needs have to be defined at a global level in a realistic manner by all the actors of the chain and not only the operators.
- It is fundamental to obtain synergies between technology, organisation and procedures.
- Human factors are essential, so the (technical) system should be as simple as possible (information is good, communication is better).
- Social-economic aspects are essential and especially the acceptability factors for new and innovative technologies or concepts.

14.5 Analysis of the situation as seen by the actors

As stated above, the demand must come from the actors involved. The freight sector is deliberately placed in a "pull" system: the market indicates its requirements and relevant actors must then propose a corresponding offer. For such a study, one should listen to a certain number of actors who have to express their desires on the selected "problem" or "initiative". Two types of demand have to be considered:

Direct Demands

These are requirements that directly concern the proposed (future in comparison to actual) "solution, alternative, product or technology", whether it concerns structure, installation, operation or costs. These direct demands come mainly from:

- Transport operators or logistics providers;
- Distribution centre or retail centre operators;,
- Shippers of goods.

Indirect Demands

These are requirements concerning more the impacts of the proposed system on the technical, economic, logistic or spatial environment. These indirect demands come mainly from politicians, citizens, professional lobbies, trades unions or others.

The main requirements of these groups have been seen to be:

- Alternatives to the current systems (the necessity to have a choice!);
- Arrangement for storage (distribution in urban areas, suburbs, etc.);
- Small volumes processing;
- The environmental and socio-economic aspects.

The authors note that to date the initiatives identified across the EU are largely involved mainly in niche markets where the transport chain is often controlled by one actor (who has an overall vision of the transport problem) (Salanne *et al.* 2004). This is not representative of the conflicting interactions of city life. Therefore the objective of the process is to place the desired system in its context, by incorporating it in the entire transport chain (in particular, by analysing the interface problems with operating procedures for the transport modes concerned) and in its physical environment, which must provide a fair comparison with conventional or existing systems.

The result of interviews with the actors will certainly reveal the emergence of fundamentally different structures to the city freight transport function with the introduction of new systems. It is clear that the problem of logistics in cities is usually viewed quite differently by actor groups:

- Cities: Congestion, Emissions, Noise, Accidents, Economic Activity.
- Shippers: Reliable Delivery, Supporting lean supply chains.
- Receivers: Customers blocked by freight vehicles, Poor unloading facilities, Poor retail environment.
- Operators: Reliable Delivery, Access problems, Conflicting regulations.

In The Hague retailers were concerned about the increasing disruption to trade caused by multiple deliveries and waste collection. The time window in which collections and deliveries could be made was effectively an hour, and as such the shopping street was congested and blocked. This was exacerbated by shop canopies blocking access for many vehicles and bottlenecking the street. Therefore a group of outlet-owners, together with the local authorities and a number of branch organisations asked Buck Consultants International in 2002 to analyse the existing problems related to urban distribution and industrial waste collection. The results of this analysis led to a strategy of delivery and collection collectivization, combined with voluntary agreements re canopies and retailer/driver behaviour (Ruiz *et al.* 2004).

14.6 Origin of a proposed system

It is useful to analyse the origin of a proposed system. Applying the model of relationships with a clear view as to the origin of the initiative can help in adapting the final solution to better suit the market demand. There are generally three types of system:

Technologically driven systems

This is innovation where the origin is directly related to the technological skills and interests of the system specifier. The system is built from the available technical tools and attempts to access the market by trying to convince the community of actors of the product's advantages. This is finding a demand to suit a solution, potentially disadvantageous to the final system. It can be said that the ELCIDIS project in La Rochelle, whilst it has great virtues, was biased toward electrical vehicles from the onset; thus skewing the system that was developed accordingly (Dellinger, 2002).

This is not a "pull" process but a "Fordian" "push" system where the demand is created. These "solutions" are more closely adapted to niche markets than to comprehensive solutions and will be subject to specific operating conditions, created by the technology itself.

Actor driven systems

This is innovation where the origin is directly related to the experience of an actor who attempts to meet a requirement identified in their activity. This may be delivering goods, retailing or running a city. The approach here is the one preferred by the authors: the system is built from a "demand" to solve a problem and tries to find the right technical solutions without constraint. The adaptation effort is mainly located in the compatibility with the available techniques and the implementation in new environments.

Conceptual and market driven systems

This is a conceptual innovation where the origin is a combination of techniques and demands from parties where interrelations involve an evolution in time. As such, the concept is integrated into the market through a complete evolution of the system in the transport chain and components (technology, organisation, operation, etc.).

The effort resides mainly in the management of the acceptability of a new transport concept and to control the transition period between the current systems and the future concept. This can represent a great organisational and technological change and project management will be essential.

To summarise, considering the diversity of solutions and demands CITYFREIGHT developed processes and guidelines to define the offer, which for each system, reconsiders the demand expressed by the main parties concerned and places the solutions in front of these demands. In this way, it will be possible to assess the proposed system and deduce the adaptations required to access the market whilst assuring interoperability between it and traditional systems.

14.6.1 Society of Actors

The urban freight community is formed from a large number of actors whose interrelations (contractual or otherwise) are often characterised by a manifest lack of clarity. This is an essential point, since it is in this sub-system and the interplay between the actors that decides the strategies and therefore the expression (or otherwise) of the demand(s).

The field of logistics is increasingly driven by a wider concept of supply chain management. This is driving logistics to adopt 'lean' or 'just in time' (JIT) concepts originally developed in manufacturing, and now being expressed strongly across the EU in consumer and manufacturing distribution. Since the pre-eminent concept of supply chain management is the elimination of 'waste' with 'time' viewed as most valuable (Christopher, 1986) and no concept of energy spent as waste, this trend is driving urban freight to change as follows:

- Smaller, more frequent deliveries;
- Lower load utilisation;
- More but smaller vehicles;
- Greater concentration into smaller customer defined delivery slots;
- Goods travel longer distances from more centralised hubs;
- Greater need for travel time reliability (Salanne *et al.* 2004).

Interrelation between offer and demand

The analysis of the demand of the different actors will show that each player has his own preoccupations and that their interrelation constitutes the crucial element for the proper functioning of the transportation chain. A certain 'putting in order' is necessary which allows the system to satisfy the different interests of the actors involved in the context of market competition. This needs to be done at all levels (regional, national and international) and here the 'European' difficulty can be measured, taking into account the geographic and particularly geopolitical diversities (cultures, environments, policies).

As a whole, it is interesting to reconsider the essential points that the "offer" (each proposed system) will have to meet:

- Technical characteristics according to the volume;
- Logistic organisation;
- Economic (investment and running costs, return on capital/sales etc.).
- Environment, safety, qualification.
- Regional planning.

These points have a direct influence on the second sub-system: Techniques.

14.6.2 Techniques

The means for answering demand are not encapsulated by 'technology', but rather by the type of inter-relation between actors and available techniques. Thus, in the past, the protectionism of States was easily manifested by a lack of compatibility (interrelation) between techniques (standards, legislation, technology, etc.) in relation to the particularities of each State (environment). It is similar with the competition between operators who, for example, may favour an incompatibility between modes to limit competition.

The concerns of actors often result in notions that involve the combination of several 'techniques' and this complicates the problem even further.

The example of 'safety / security' that combines technologies, standards and economy demonstrates to what point harmonisation or agreement on a subject can lead to discord.

Here in particular, the notion of the 'environment of application' intervenes and leads to the third major sub-system: Environment.

14.6.3 Environment

As shown above, the combination of offer and demand must be placed in a context, particularly in a geographical and even more in a geopolitical way. This problem assumes its full importance, yet it is rarely considered at its true value when considering the malfunctioning of the transportation chain. These are extremely difficult problems to handle, given the considerable influence of the human factor and its sensitivities (or susceptibilities) particularly at the level of populations.

It should be noted that the political strategies are greatly different from country to country, region to region, and city to city. The degree of urban freight regulation, policy and/or initiatives was seen to vary greatly in the City Freight project. France has a well developed urban freight structure, in which city governments have to agree and publish urban logistics strategies in their urban plan (Dellinger, 2002), and there has been a government-led initiative on city delivery. Italy has no substantial national structure or initiatives and yet has extensive development and initiatives at the local city level (Peterlini, 2002). Since any system is both local and global, and logistics networks often transcend national boundaries, such as in the Benelux region, the degree to which variation impedes or facilitates the system is crucial. To that end the City Freight project defined a 'zoning' system for initiatives (Figure 14.3), to assess to what extent they have impact geographically, and hence politically (Henry *et al.* 2002).

The zoning structure for analysis is not the only element of the environment that can be evaluated; some of the social or political issues may not be geographically influenced, such as demographically issues or ones driven by societal change.

These elements are even more important in that they are frequently manipulated at the level of actors (politicians, lobbyists, unions, ecologists) and that they therefore directly affect on the one hand the offer and on the other the overall operation of the chain. Here the importance of a balanced and sound inter-relationship between the three sub-systems can be noted. This explains why one initiative in a given city, region or country can supply an equal performance yet without necessarily having the same equipment or procedures. What is acknowledged as acceptable in one place is not necessarily acknowledged so elsewhere, even though the end aim remains the same.

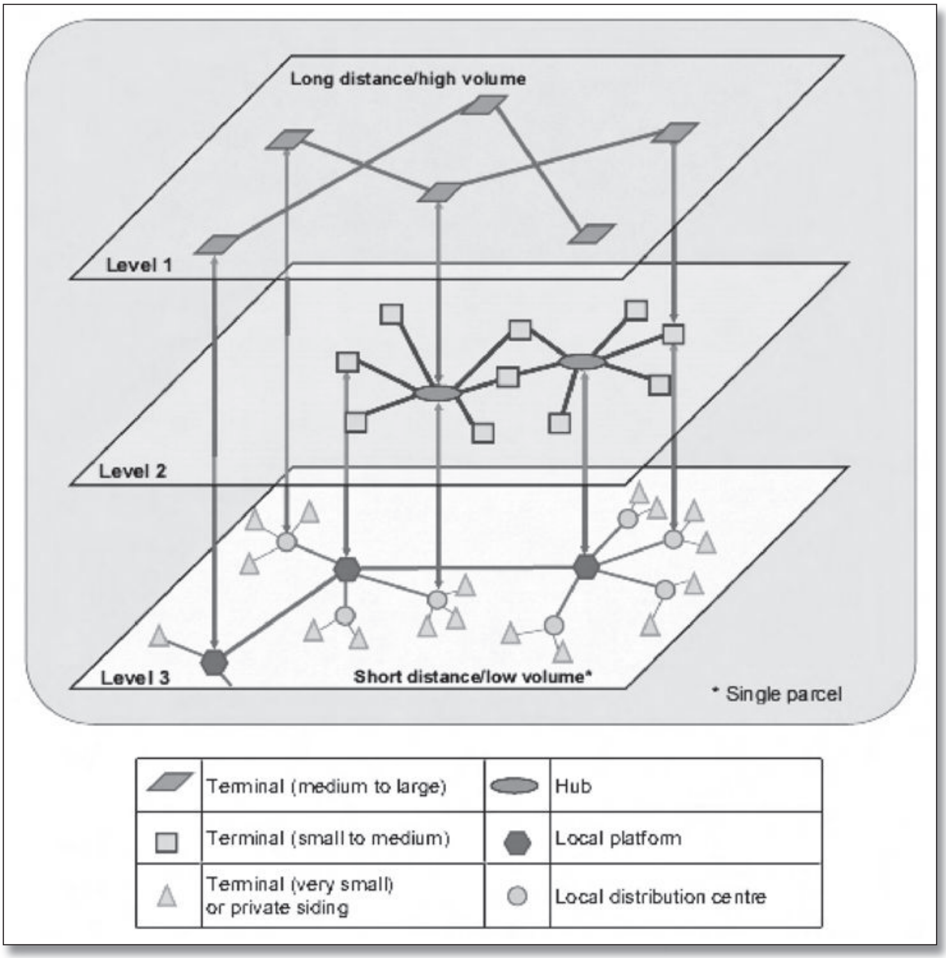


Figure 14.3: **Geospatial structure for supply chain analysis (Dellinger *et al.* 2003)**

This leads to another essential point of the topic under investigation: innovation in urban freight transport. It deals with the acceptability of systems or concepts and the faculty to adapt and to integrate a new environment. Innovation also leads to a new dimension, which is: Time.

14.7 The time factor

This is an extremely important factor since the system, comprising three sub-systems, is undergoing continual development and evolution. In fact, at every level and at every moment, modifications are taking place which have an inevitable effect on the overall situation and therefore the operation of the chain.

Through the notion of time it is interesting to consider:

- on the one hand, the integration of innovation that must automatically accompany the adaptation of the system (synergies between techniques, organisations, procedures) and therefore a transition period between the present day situation and a future one;
- and on the other hand, the strategy for the future, either by anticipating developments presently underway or by forcing changes through actions that target certain elements of the system (privatisation, standardisation, taxation, subsidies, etc.).

14.8 Summary and conclusion

This chapter aimed to give an overview of the structural processes and methodologies developed within and from the CITY FREIGHT project. The authors believe that the material and experiences of the many scenarios evaluated and the wider conceptualisation of how a system is to be devised are useful tools for a practitioner in this field.

In summary, technically driven solutions are common, yet they prejudice the system unnecessarily with a technological bias that may be detrimental to the system. As an antidote to this tendency it is proposed that the process of identifying the combination of "why" (the goals), "who" (the actors), "with what" (the techniques), and 'where' (the environment) ensures that the offer is actually a response to a demand in a given time and place. The introduction of a 'time' factor "when" into the system allows observation of developments in each of the elements as well as their interrelations over time in order to deduce effects on the entire system.

Combined with the transportation system development process one can ensure that the fullest evaluation of the proposed transport system is made; such that all actors' demands are met as fully as is mutually possible and that the appropriate investments are made for the city concerned.

CHAPTER 15

A multi-services Agency for the integrated management of mobility and accessibility to transport services: The AGATA project

P Frosini, S Gini, G Ambrosino, J Huntingford

15.1 Introduction

AGATA is an INTERREG III B MEDOCC (Western Mediterranean) area project started in July 2004 and ending in June 2006[1]. In particular AGATA addresses axe 3 - Transport Systems and Information Society; Measure 3.4 Innovative communication and information technologies for the development of the territory. The general objective of AGATA is the definition, creation and demonstration of a multi-service agency which integrates and co-ordinates different flexible services for mobility and transport in urban and rural areas. Ultimately AGATA works towards a number of goals. These include: exchanging experiences and best practices, carrying out feasibility studies and pilot projects, promoting and diffusing the results, identifying a business model for the agency based on a telecommunication centre and ICT systems able to satisfy the identified needs and to create job opportunities and improve social cohesion in the MEDOCC area.

[1] INTERREG III is the initiative of the European Community for the period 2000 – 2006, financed by the FEDER (Fond Européen de Développement Régional). The MEDOCC programme is included in the Interreg programme (in particular in the section of co-operation among countries) and it allows the realization of projects that aim to contribute to a lasting, harmonious, and balanced development and to a better territorial integration within the western Mediterranean area (that includes regions of the south of Spain, of France, of Italy, of Greece, of Portugal and Gibraltar). The global objectives of the programme are: to increase the territorial competitiveness of the MEDOCC area in order to make it a relevant area of economic integration; make the policy for the territorial development more coherent within the co-operation area through a wider institutional integration; encouraging richer and larger international co-operation.

The AGATA (Multi-services Agency based on telecommunication centres for the integrated management of mobility and accessibility to transport services) consortium includes 7 partners from 3 European Countries and 1 partner from the South Mediterranean area (Morocco). The partners belong to a wide range of sectors: regional administrations, councils, public transport companies, and research, energy and innovation associations. A total of 10 cities are involved and will carry out a project (a study project or a demonstration project), in addition to contributing to the horizontal tasks (methodology for data collection, projects and operational experience exchange, results evaluation and promotion etc.)

The partners and the related regions and cities are listed below and the geographical coverage of AGATA is illustrated by Figure 15.1:

1. Regione Toscana (Project Leader): Firenze, Livorno, Piombino (I)
2. Technomobility: Cagliari (I)
3. ATAF Spa: Firenze (I)
4. CTP Spa/STI: Potenza (I)
5. Terrassa Municipality: Terrassa (E)
6. AREAL: Monchique and Loulé (PT)
7. Granada Municipality: Granada (E)
8. City of Marrakech (M)

As indicated above, Regione Toscana is the Project Leader and is in charge of the general management of the project. In carrying out this task Regione Toscana is supported by CTP Spa, which operates as Project Co-ordinator.

Figure 15.1: **Geographical coverage of the AGATA Consortium**

The activities to be carried out during AGATA involve 7 demonstration projects and 4 feasibility projects, with the common aim of integrating existing or newly created flexible mobility services with the conventional transport system in order to improve accessibility to urban, metropolitan and rural areas, social cohesion, collective mobility and quality of life. The demonstration sites are: Firenze (Florence Municipality and ATAF), Livorno, Cagliari, Potenza, Terrassa, and Granada. In Monchique, Loulé, Piombino and Marrakech feasibility studies are being carried out. Marrakech participates as a third country, not being part of the MEDOCC area. The sites involved in the project have different levels of experience with respect to the development of flexible services. For example, both Livorno and Firenze, already have active flexible mobility services and should integrate them to reduce costs and improve the service quality, while on the other hand Monchique and Loulé do not currently have any such service. AREAL will thus carry out a feasibility study to successively implement the service in their area.

This chapter aims to describe the overall context, the concept and systematic approach and innovation in AGATA.

15.2 General context

"Flexible Mobility" can be defined as mobility services which answer users' real transport needs, both in the case of passenger transport and in the case of goods delivery (see for example, Ambrosino et al, 2004). In this way, general mobility needs can be satisfied through the implementation of new and flexible transport services. This "flexibility" requires a continuous dynamic capacity of planning, programming, and managing the different mobility and transport services implemented. The most adequate solution to these requirements is the creation of a Multi-services Agency. The Agency acts as multi-service and telecommunication centre for the integration and co-ordination of the different mobility/transport services to be provided in an urban/metropolitan area or in a larger territory composed of different towns and cities. This concept has been explored extensively in Chapter 4.

Another aspect of the question of flexible mobility is that of Information and Communication Technology (ICT). The availability of Information and Communication Technology (ICT) has radically altered the possibilities open to mobility management and to the provision of transport services, in terms of interface with potential users, optimisation and assignment to meet travel requests, and service management. This has been achieved by using advanced ICT applications and mobile communication platforms. Better understanding of both the needs of the users and the potential markets, has stimulated new service concepts based on service flexibility, communications, booking and reservation functions, and customer support. The Agency to guarantee this "flexible and dynamic" capability is based on an ICT platform and infrastructure in order to allow information and work flow management in relation to the urban and metropolitan context in which the Agency operates.

Three main operational contexts have be en identified:

- Communication and integration between operators, thanks to an IT multi-service platform
- Planning and management of logistics and mobility flows and processes using an advanced ICT platform.
- Interaction with mobility service users, thanks both to Internet sites and a set of information services which allow efficient interaction between users and the agency itself

The measures foreseen in AGATA are in line with the many directives and recommendations elaborated by the European Commission and the EU on the importance of flexible services (for example, Conclusions of the European Conference of Ministers of Transport CEMT/CM(2001)15/FINAL/CORR1; the Green paper on the urban environment; the future development of the Common Transport Policy, etc.). All these acts provide a new vision on the reconciliation between citizen's needs and sustainability. AGATA acts according to the recommendations of these acts by promoting and demonstrating the possibility of introducing IC technologies as a support to flexible mobility services. AGATA introduces some new conceptual schemes (the concept of the agency itself) and advanced ICT scenarios for management and for information on flexible services, as requested by the European policies and planned in various European towns and local administrations.

In the last few years the interest in flexible transport services (car sharing, collective taxi, demand responsive transport) has risen remarkably, as it is demonstrated by the large number of experiments carried out in different urban, rural, metropolitan areas. In fact the rapid development of IC technologies (GSM, WAP, GPRS, PDAs, etc.) provide a solid support to the new solutions for the management of the collective transport through the use of flexible transport services (see for example Ambrosino, Nelson and Romanazzo, 2004).

The Agency, from the ICT Infrastructure point of view, is based on a powerful combination of appropriate software applications and an intelligent communication network, services and devices which allow information exchange between the communication platform and all its users.

The enabling technologies of the Agency's IT infrastructure include:

- Internet, web services and portal for the information exchange and services interactions
- IVR (Interactive Voice Response) devices to support (partially) the sending of information, users request, bookings, etc.

- Booking and services purchasing (for example delivery of goods to residence, etc.) based on smart-card
- Delivery customer information and advice by mobile phone, SMS
- Software models, optimization algorithms and decision support tools,
- Advanced GIS software environment for geographical information and service references,
- eCommerce and eBusiness tools and services
- Long-range e-wireless communication network (GSM, GPRS, Bluetooth, Wi-Fi, etc.) to support interaction and information exchange between the ICT platform (Agency) and the service providers and fleet operators
- GPS-based or GMS-based vehicle location systems,
- Mobile devices for interacting with the Agency (in-vehicle terminal, PDA, Tablet PC, etc.)

15.3 AGATA's approach and objectives

AGATA is composed of various different actions (studies, pilot actions, exchange of experiences, diffusion of results and promotion), which will be carried out both at a general project level and at a local level by the different partners. AGATA aims to reach concrete, visible and innovative results regarding the creation of an Agency based on a telecommunication centre which manages the main processes, work and information flows relative to flexible mobility and to increase service accessibility and integration.

The Agency, which is by nature based on modern information and communication technologies, is composed of a network of services able to facilitate interactions between all the actors and subjects and the Agency and the fundamental phases of the work flow that are involved in its operational functioning.

The project idea is based on the needs and requirements of the different territorial realities involved, of the different categories of users and local administration for the development and reservation of flexible transport and information services (free number, infomobility, call centre, transport for handicapped people) – as recommended in Chapter 2.

Taking into consideration that each AGATA site, while having points in common, represents a different reality in terms of geography, local stakeholders, experience and existing provision etc, each site's local project will be developed individually following the adopted reference model. With this understanding a methodological approach to confront the complexity of the problem has been developed, together with guidelines for context analysis and for the creation of telematics systems.

AGATA with the application of IC technologies, besides encouraging the use of computer tools in the transport domain, favours the constitution of transport integrated systems that lead to a greater economic competitiveness and social cohesion, contributing also to the improvement of the accessibility to marginal territories or territories exposed to the risk of marginalisation. In particular, the IC platforms and information systems will be based on open architectures and on IT standards.

At the sites where the approach and solutions for flexible services are more mature, demonstration projects have already been initiated. In these cases AGATA serves to consolidate and expand the existing provision in terms of geography and of services offered and operations adopted. For example, ATAF public transport company in Florence intends to install a web portal to facilitate use of the existing flexible services and in Livorno the existing services will be integrated and co-ordinated under a multi-service agency.

Finally, a series of best practices will be defined for the application of these ICT services in flexible mobility and information services. The best practice will be diffused through the organisation of seminars, conferences, and events. A web site will also be created with the same objective of diffusing information regarding the project to the wider public, those beyond the Consortium interested in project activities (public area) but also for the exchange of documents and information among the partners (private area).

A summary of the activities developed at each of the AGATA sites is given in Table 15.1.

Site	Territorial and environmental characteristics	Planned activities in AGATA
Toscana region Florence metropolitan area Livorno Province	Florence metropolitan area: medium sized town of high historic interest, relevant tourist flow Livorno Province: little dispersed urban areas, tourist flow, with active flexible transport services. Piombino area: a demand responsive transport (DRT) service for disabled users already exists.	Florence metropolitan area: pilot project for the realisation of a technological/information agency for the management of the flexible services for goods distribution and public/private mobility. Livorno Province: pilot project for the realisation of a technological communication centre for the management of the existing transport flexible services in the area. ATM (public transport company) will develop a feasibility study on the extension of existing services and the development of new demand responsive services in the Piombino area.
ATAF Florence	Florence is the centre of a great metropolitan area with 614,000 inhabitants, while the urban zone has approximately 370,000 inhabitants.	The pilot action is the realisation of a web site with the aim of improving the access to the mobility flexible services and the information to the users concerning the state of the public/private mobility in the urban and metropolitan network.
Technomobility Cagliari	The Cagliari metropolitan area in made up of 8 municipalities and has a resident population of 400,000 inhabitants. The city location and Geomorphical conformations create particular transport concerns.	Feasibility Study and Pilot Project for the creation of an integrated service centre based on innovative systems to manage public/private traffic circulation in the Cagliari metropolitan area.

Site	Territorial and environmental characteristics	Planned activities in AGATA
CTP Potenza / Gugliano	Potenza, with 66,000 inhabitants is the main town in Basilicata, with a great economic importance for the region. The area of service experimentation is the rural zone of the municipality. Gugliano is in the Campania region and the Western basin has been chosen for the pilot project. The area has a low population density and three main attraction points: Pozzuoli, Licola Borgo e Lago Patria.	Feasibility study in Potenza and pilot experimentation in Gugliano for a demand responsive bus transport service with a telecommunication centre for management and information.
Terrassa Municipality Terrassa	Terrassa, with 180,000 inhabitants, is situated in the urban area of Barcelona and is facing the increasing use of private cars, also due to the lack of a good public transport service.	Pilot project for the implementation of a flexible mobility service encouraging the shared use of cars to reach the industrial zone. The service will be centralised in a Multi-services Agency, able to plan and dispatch automatically according to the workers' necessities and the availability of cars.
AREAL Algarve Monchique Loulé	The Algarve region has great tourist flow in the summer months and its mobility needs and characteristics are very different in the winter and summer period. The study will be developed in two internal and mountainous zones.	Study for the creation of a call-centre to manage DRT services for the improvement of mobility in isolated places in both zones. The DRT service should provide inter-modal connections and connections to urban centres. The vehicles should be prepared to receive elderly and disabled people and also be environmentally friendly, but able to face the difficulties of the territory (slopes, mud).
Granada Municipality Granada	Granada, with 245,000 inhabitants, is facing an increasing use of private cars to reach the working activities located in the town from the outskirts that are mainly residential.	Creation of a flexible service based on the application of ICT in the form of a collective taxi addressed to the metropolitan area of Granada. The objective is to reduce the use of private transport where there is a lack of public transport service in some territories or in some time bands.
Marrakech Municipality	Metropolitan area with a wide and fortified historic centre, with a great tourist flow. Craft and industrial activities. Realisation for the general plan for the management and regulation of the traffic and of people and goods mobility.	Feasibility study for the realisation of a flexible transport service in the urban and suburban zone of Marrakech, both for residents and for tourists.

Table 15.1: **Activities developed at each site**

15.4 Added value in AGATA

AGATA, through the creation of an Agency for flexible services, provides an effective answer to the various problems of the intermediate transport service (little integration of the transport chain, distribution services models, etc.). It does this by offering co-ordination of different mobility services, by promoting co-operation and information exchange among operators, and by providing accessibility of information and reservation possibilities for users. Starting from some existing ICT tools, developed in various European R&D programmes, AGATA presents a telecommunication centre and ICT services (e-commerce/e-business, Web based components, Internet sites and services, GSM/GPRS, etc.) for operational co-operation among different transport service providers, allowing a customisation of transport services, tailored to the real need of citizen's groups or to the territorial and mobility characteristics of the sites. The AGATA agency, through telecommunication and ICT tools, allows:

- Different transport operators to benefit from an IT infrastructure and from common services for the management of the available flexible transport services.
- The telecommunication centre operators to have a global view of the transport service demand and supply, assuring an effective connection between users and providers.
- citizens, associations, and users categories, to make use of a single management and coordination centre for mobility services, able to satisfy their individual requests.

The AGATA agency, in a global transport system, acts as a single, virtual and flexible organisation able to dynamically manage the citizens' needs, the existing resources (fleets) and the services providers. Moreover the AGATA project develops and evaluates a set of services and ICT systems to support transport management and, more generally, logistics management in urban, rural and metropolitan areas.AGATA by involving different partners from the MEDOCC regions, allows operators to acquire a detailed knowledge of the opportunities and services in which IC technologies can add a real value and cause real benefits in a sector, such as that of transport, which requires a strong rationalisation and optimisation. The activities and results of the AGATA project could contribute to increasing the knowledge and the evaluation capabilities of the local administration regarding the real revenues of investments in IC technology and the overall management cost of flexible mobility services. The added value of the AGATA project will therefore be tangible for different actors: for public transport companies due to the optimisation of resources; for local administrations due to the identification of solutions to common transport problems; for final users thanks to the improvement of the services provided; for enterprises for the competitiveness aspects and finally, also for technology providers due to the potential market evaluation.

CHAPTER 16

New concepts for Flexible Transport Services: CONNECT project

J D Nelson, B Finn, M A Smith

16.1 Introduction

This chapter introduces the CONNECT project[1] - a new European expert network focusing on **Flexible Transport Services (FTS)**. The CONNECT project was launched in January 2004 by the European Commission, DG Research, as a Co-ordination Action under FP6, and spans two years. The starting point of CONNECT is the contention that, in the pursuit of sustainable mobility, the use of flexible collective transport for passenger traffic and small goods traffic (either separately or in combination) has important potential from the viewpoint of environment and city logistics to deliver more effective and competitive transport solutions.

16.2 Vision of the CONNECT project

The scope of CONNECT is Flexible Transport Services (FTS). This term covers the spectrum between (but does not include), on the one hand conventional fixed line transport, and on the other hand own-account non-shared taxi services. This embraces a

[1] Co-ordination of Concepts for New Collective Transport (CONNECT).

range of solutions including: local bus routes with some flexibility, Demand Responsive Transport (DRT), special users transport services, community transport services, shared taxis and car pooling, car sharing and organised lift giving. Logistics, which could be the ancillary business of the passenger services are included and integrated within the term “user” in this project.

Today, at a European level, flexible transport solutions cover just a small proportion of trips, but they can provide an alternative to the private car between 10% and 30% of trips (depending on local characteristics). This innovative transport mode has considerable potential to substantially mitigate the traffic pressure in cities. The use of flexible transport services for passenger traffic and small goods traffic has important potential from the viewpoint of environment and city logistics. There are considerable possibilities to reduce (gasoline-fuelled) private traffic, save operating costs and increase the level of service experienced by the passenger. Significantly, the market segment for the required vehicles is the same as for van and pick-up trucks for commercial use in most metropolitan areas so the prospects for benefiting from on-going R&D activities for alternative fuels and technologies is excellent.

A number of new service concepts and technologies for FTS have recently been developed and demonstrated (e.g. as part of the DGXIII-funded Sampo, Samplus and Invete projects and the DG Infosoc Fams and Emires projects). One example is Demand Responsive Transport (DRT) which provides transport services “on demand” from passengers and where fleets of vehicles are scheduled to pick up and drop off people in accordance with their needs. In recent years, the ability of DRT concepts to provide efficient, viable transport services has been greatly enhanced by the use of transport telematics. This has been further endorsed by the European Conference of Ministers of Transport (ECMT) in its resolution on accessible transport (ECMT, 2001).

Since flexible transport services to date do not yet exploit their true potential, further work is required on the knowledge acquisition, analysis and dispatching functions of the transport solutions that are required in the pursuit of sustainable mobility, as well as the necessary supporting organisational frameworks required to deliver more effective and competitive transport solutions.

Most recently several member state governments’ have embraced the concept making it timely to create the Connect consortium to support this emerging and important area for passengers and logistics in urban, peri-urban and (since considerable experience is to be found) rural areas. While the focus of this activity is on Europe, careful attention will be paid to lessons and methods which can be drawn from developing countries which have a long tradition of innovative paratransit and informal transit.

In summary, Connect is considering the range of flexible transport services, especially DRT services, and will identify the “building blocks” of successful schemes by capturing good practice.

16.3 Towards a definition of Flexible Transport

Recently, more innovative solutions have been enabled by the development of Intelligent Transport Systems (ITS), which allow more flexible transport services in terms of time and space (see for example, Ambrosino et al, 2004). In addition, new ways of thinking about the provision of all types of what might be considered public transport has led to more flexible transport modes becoming available, such as a "bottom up" approach to meeting demand which responds directly to end user needs, permitting the general public on education contract services, the use of taxis for shared public transport and the provision of vehicles enabling access to work.

Flexible transport means that the service is adapted towards the expressed need of the user for their individual trip. This means that the mobility service has some degree of freedom in at least one of the three key dimensions: route, timing and vehicle/facility/driver assignment. The service is collective in the sense that it can have multiple users (even if sometimes there is only one). The service therefore is capable of taking into account the needs of its diverse users, although for reasons of efficiency or effectiveness it may choose to assign customers to different services. Typically, the service manager aims to balance meeting the user needs and optimising the resource use.

Flexible Transport Services (FTS) need to perform three core functions:

- a knowledge-acquiring function to understand the actual demand, or at least the relevant variations on expected demand
- an analysis function to determine what action to take in response to this demand
- a dispatching function to communicate the changes to assignment and operating personnel

The scope of FTS embraces several contexts:

- both with and without ITS / ICT support tools
- in urban, peri-urban and rural areas
- both for general public and for dedicated user groups (e.g. disabled, elderly)
- both for passengers and freight / logistics sectors

16.3.1 The State-of-the-Art

Conventional transport is ideal where there are defined corridors of movement, with clustered travel demand. Here, it is economic and acceptable for many people to use such forms of transport. However, due to the changing habitation patterns and nature of activity such as work, there are many person trips to which conventional transport has become not suited. These include many local trips, areas of diffuse travel patterns, times of low demand, city centre-periphery journeys, commuting etc. With the changing distribution of activities in cities to the outskirts, many person trips cannot now reasonably be made by conventional transport. In Europe over 50% of all trips are less than 5 km, and about 25% of trips are less than 2 km. Moreover, many of these trips are often not suited to conventional transport, so the car has often become the default mode of travel in most urban/metropolitan areas in Europe.

Demand Responsive Transport services have been available as a concept since the early 1970's when initiatives were implemented in the UK and USA, as well as in other countries (see Ashford and Bell, 1978). In the UK the 'dial-a-ride' concept and the 'Postbus' were implemented in many rural communities. Although they achieved their main operational aims, they were restricted by the need to book very much in advance due to communications limitations. Still, the experiences identified the expectations of the potential users and of the operators, and showed some of the difficulties which could be expected if such services were provided on a larger scale.

Since then, systems have been implemented in Europe, USA, Canada and Australia. Examples in rural areas include Minicar in Midi-Pyrenees (FR), Kerteminde (DK), Borgerbussen in Fasterholt (DK), De Lijn (BE) and Ozark (USA). Examples in low-demand situations in urban areas include Ruf-Bus in Hannover (DE), TelBus in Bastogne (BE), Flexroute in Gothenburg (SE), Multibus in Schlakwijk (NL), Dial-a-Bus and Transit Taxi in Adelaide, Australia. All of these systems typically include a strong marketing effort and good involvement of the users, but they have still been limited in their ability to form a strong part of the overall transport supply.

The emergence of Advanced Transport Telematics (ATT) tools to support Intelligent Transport Systems (ITS), as well as the availability of mobile communications has allowed new service options to be developed. These are capable of handling substantial networks of services, managing the booking and reservations, allow the user to make bookings almost in real-time and can have real-time operational control. By meeting the users' requirements, there is now the possibility to improve the viability of the services and to provide the operator with the needed return on investments (see Ambrosino et al, 2004a).

EC-funded projects such as SAMPO and SAMPLUS have developed and demonstrated the fundamental tools for Travel Dispatch Centres and booking and reservation (Mageean and Nelson, 2003); INVETE has advanced the in-vehicle terminals along with their support and communications (Scholliers et al, 2004); FAMS has moved from the stand-alone DRT to supporting a Flexible Agency based on B2B and B2C principles (Ambrosino et al, 2004b); while eDRUL has migrated these concepts to the logistics domain (see Chapter 4). There are a wide range of active sites based on ITS-supported DRT including Florence (IT), Kuopio and Tuusula Regions (FI), Ost-Flanders and Hasselt (BE), Angus and Northumberland (UK).

Zografos et al (2005) note that in parallel to developments of FTS for passengers the development of freight flexible transport services has been driven by the following major objectives: i) to enable the customers to have access to the transport services through several alternative ways (anywhere and anytime), and ii) to improve the management of the available transport resources in order to meet the demand in the most economic way. In this context, a set of existing freight FTS contribute to the improvement of the freight distribution and the logistics processes in urban areas through the integration of e-Commerce and e-Business Services (e.g. eDRUL, as discussed in Chapters 4 and 17). The major objective of this category of FTS is the optimal use and management of the logistics system in a way to realise flexible, demand driven goods distribution schemes. Another major category of freight FTS relates to the development of electronic marketplace applications in which local transportation service providers interact electronically with their customers. The potential advantages of this approach include the facts that such applications: (a) impose minimal infrastructure requirements on the part on the individual users, being accessed through the Internet, (b) offer local providers an electronic presence, and possibly provide a competitive advantage against other companies, (c) could be used as a means for pooling resources and co-operating, and (d) reduce operating and administrative costs, while providing a higher level of service (e.g. Emires system) (Zografos and Salouras, 2005; Citro, 2003).

16.3.2 The emerging role of Value Added Services

Wright et al (2004) provide an introduction to the EC FP5 Emires project which includes applications of freight and passenger DRT services. The strategic objective of Emires (Economic Growth and Sustainable Mobility supported by IST at the Regional Level including SMEs) is to develop and demonstrate a network of Regional Service Centres (RSC) offering personalised, dynamically generated packages of intelligent, Value Added Services (VAS) with transport at the core. The Emires RSCs cover five EU Regions: Andalucia (Spain), the Scottish Highlands (UK), Arta (Greece), North Karelia (Finland) and Jesenik (Czech Republic). Each site is working in different applications and services, (e.g. tourism in Spain, freight in Greece, employment in UK) with transport as the common denominator. The Finnish, Greek and UK sites include applications of DRT.

All five sites share the common Emires Kernel, which has as its core an ontology which facilitates the retrieval and combining of data from varied sources. The Emires web ontology has been designed using DAML as the ontology language. The Vasmod software module allows the publishing of services, and hence defining of service data, to the ontology while the Discomp module can be used to combine data (already described within the ontology) from various external sources. The actual transfer of data between external sources and Emires is achieved using Web Services technology (WSDL). The Regional Service Centre (RSC) represents the hub at which system computers are based. The node is connected via the Internet with customers and data providers located at Service Points. Users access the system through personal, institutional or internet service providers. Data providers allow dynamic links to existing datasets and networked services.The Regional Service Centres represent the main outcomes of Emires. In Spain and the Czech Republic, the RSC is focused on the provision of transport and tourism advanced services. In the UK, the combination of two different sources of information (job vacancies and public transport) in one product provides an innovative tool that facilitates the access of remote areas to the same range of opportunities available for the rest of the region, contributing to the economic development of the areas. The resulting application is complemented with improved user requirements for Demand Responsive Transport (DRT) provision to access job opportunities. A comprehensive DRT application is the main outcome of the RSC in Finland, where the improvement of transport facilities has contributed to reduce the use of private cars by favouring an attractive passenger transport service. Finally, in Greece the implementation of advanced transport services focused on freight DRT has contributed to the economic development of a rural area where the geographic conditions made access difficult and hence, the development of profitable business.

16.3.3 The potential of Flexible Transport Services

In the "City and Region of Tomorrow", the move away from conventional public transport is likely to increase further. The nature of work and access to services will change for many citizens through the increase of teleworking and e-commerce. This will reduce the commuting levels further as well as reduce the number of trips for administrative, business and shopping purposes. On the other hand, there will be more activity at the neighbourhood level (particularly through increases in teleworking) and changes in both the daytime population mix and the level of facilities, for both passengers and logistics, and services available locally will create and increase a demand for more local travel services. The fact that the population is ageing will only accelerate this trend.

The fast and well consolidated technological development in telecommunications (GSM, WAP, Internet, satellites, navigation systems, etc.) and information platforms (portable PCs, palm-tops and hand-held computers, GSM-based communicators, etc.), if well oriented, will push the development of flexible collective transport solutions. This will occur via improved access to information and to a variety of more "personalised" mobility services.

At present, flexible and responsive forms of transport account for a very small proportion of the total person trips. However, as noted earlier, it has the potential to account for 10-30% of trips. The integration of different intermediate transport modes could become a possible solution for the future city/town to lessen the pressure of private motorised trips and to foster public transport in the context of the changed pattern of activities, travel needs and improved access possibilities previously described. These aspects, and their impacts in terms of energy, the environment and social benefits, have not been realistically researched and evaluated before, since the known organisational methods for such transport could not be sustained over a large scale. The changing nature of travel, the need to provide alternatives to private car travel which provide comparable freedom, and the ability of flexible transport to offer a bridge between personal and mass transportation and which offers the potential integration of passenger and logistics trips within the operational area is ripe for further investigation. Additionally, from a vehicle perspective, the major short-term environmental contribution of FTS is likely to be in improved productivity (e.g. ridesharing and reduced empty running of vehicles) and reduced fuel and related pollution from larger vehicles in low demand areas. There is also a strong imperative to promote the use of small alternatively fuelled vehicles. In parallel, the main challenge for e-logistics is to realise flexible, demand-driven distribution schemes which satisfy diverse mobility patterns.

In summary:

- The challenge facing decision-makers is how to assess the potential for FTS, whether to accept and promote it, and if so, how to integrate it into their planning and deployment mechanisms.
- The challenge facing potential implementers is the lack of proven organisational and business models, access to knowledge about technologies and methods, tools to predict usage/revenue, and training tools.

16.4 The CONNECT activities

CONNECT is predicated on the basis that there is a clear need for a rapid escalation of a body of knowledge, targeted research, skill development and appropriate ITS tools to support existing, new and emerging Flexible Transport Services. This is the role of the CONNECT Co-ordination Action.

The main activities of CONNECT may be summarised as:

(i) To set up a common information system, which gathers and manages information on on-going research, the state-of-the-art and good practice in flexible transport and its supporting technologies. This will be achieved by the creation of a continuously updated web-based "Virtual Library", containing information on the different aspects of flexible transport: operation of transport services; legal frameworks and institutional aspects; system architecture, interfaces, data modelling; supporting technologies; business models, contracts, financing; and evaluation methodologies.

(ii) To support the development of skills and best practice in the field of FTS through a number of actions, including: provision of course materials and educational resources; facilitation of exchanges of personnel, experience and knowledge; collection, development and promotion of best practice approaches; and identification and development of research opportunities.

(iii) To provide guidelines and recommendations for supporting business development of FTS. To achieve this, CONNECT will produce knowledge on appropriate business models; organisational issues; and regulatory, legal and policy aspects.
(iv) To organise thematic workshops for the User Communities involved in flexible and responsive forms of transport covering systems and operations; technologies; vehicles and vehicle technologies; and impacts and business cases for FTS.
(v) To increase the awareness of CONNECT among a broader audience by the utilisation of a diversity of channels of dissemination.

The outputs of CONNECT, including the Virtual Library, are accessible via: www.flexibletransport.com.

16.5 Discussion: The expected impact of Flexible Transport Services

The impacts on the rural and urban areas of FTS for passenger transport and freight will be very significant in most of the EU Member States. Both rural and suburban areas suffer from structural disadvantages in terms of their economy and quality of life. From the operators' and authorities' viewpoint the awareness of ITS is vital when considering offering new services and technologies for less developed areas and regions. The lack of access to services and to proper transportation facilities reduces the ability of communities to develop in an appropriate manner. In particular, citizens who are disabled, elderly, or whose mobility is restricted have the greatest potential to benefit from the service.

Authorities and operators will learn that the ITS technologies of today are affordable, adaptable, and efficient for a wide range of services and a variety of fleet. In practise this means dramatic reductions in implementation costs throughout the range for designers, developers, suppliers, researchers, operators, authorities, and end-users.

Integration of transport services into a network allowing a true door-to-door service provides greater transport cohesion in districts. Flexible routing of services allows access throughout an area rather than on specific corridors. Improved access to local services, and to some extent to larger centres, is most desirable for communities. Improved mobility generally increases the level of economic activity in the locality, either rural or suburban, and improves the sense of identity.

Flexible forms of public transport, whilst they undoubtedly are enabled by and stimulate the use of new technologies, also require a rethinking of concepts traditionally associated with fixed-route, fixed-timetable transport services. Whilst much work has been performed and is on-going in several of the countries which the CONNECT consortium embraces, there is a need to create a forum for the exchange of experiences and the pooling of knowledge, to permit the development of a common base of concepts and technical know-how on which future research and applications can build.

One of the major inhibiting factors in encouraging modal shift away from private transport is the restriction of public transport to highly specific spatial and temporal paths which frequently fail to connect the user's activities adequately. By 'spreading out' these paths into space-time areas, flexible forms of transport such as DRT can cover activities which would normally only be accessible by private transport. CONNECT aims to identify best practise in the implementation of this type of service and facilitate its dissemination amongst governmental bodies, research organisations, transport operators and private companies with an interest in flexible transport, with a view to widening its use and beneficial effects. By their nature flexible services often tend to be limited in geographical coverage thus making it more difficult to learn best practice without a forum of some sort. Similarly, freight FTS is encouraging the optimal use and management of the urban logistics systems to realise demand-driven goods distribution schemes. In certain circumstances this may entail combined movement of passengers and goods.

The optimisation of telematics-based flexible transport services could enable a significant reduction in the unused vehicle capacity run by "conventional" services, with consequent gains in service efficiency and reductions in emissions. This innovative transport mode has considerable potential to substantially mitigate the traffic pressure in cities. The concepts developed in CONNECT should facilitate the process of application of new technologies and implementation of innovative flexible transport services, which would contribute to these benefits.

CHAPTER 17

The emerging business case for e-logistics services in urban areas

B Finn, G Zomer, G Ambrosino

17.1 Overview

This chapter presents aspects of the emerging business case for urban e-logistics. It is based on research work carried out in the EC funded eDRUL project[1] which has developed the concept of the City Logistics Agency. This includes a demonstration project in Siena, showcases in Aalborg and Lisbon, and a transferability study carried out in the Netherlands.

The primary conclusions to arise from eDRUL are:

1. Under current conditions, the Municipality is the key decision-taker which determines whether urban e-logistics systems are established.
2. Despite potential benefits, transporters and merchants will currently not collectively implement urban e-logistics without an external stimulus.
3. The most effective stimulus is a package of mandatory constraints and restrictions relating to city centre access, loading/unloading times and locations, and vehicle/emissions specifications.
4. There appears to be a positive socio-economic case for urban e-logistics stimulated by restrictive measures.

[1] Relevant aspects of the eDRUL project have been considered in Chapters 4, 5 and 8.2, 8.4, 8.6 and 8.7.

5. The fiscal business case is less clear-cut.
6. City distributors and the e-logistics Agency are able to develop positive business cases.
7. The business cases for the Municipality, long-distance transporters, and merchants are sensitive to the traffic constraints, pricing structure, operational model, allocation of responsibilities, and new business opportunities.

It remains to be seen whether these conclusions are valid over a broader range of sites and circumstances than those researched within eDRUL. Nonetheless, they offer a useful reference set which are derived from experiences in 4 different European countries. Further details may be found in eDRUL (2005).

17.2 The role of the business case

In basic terms, the 'Business Case' explains the 'why?' of a project, whereas the 'Business Model' explains the 'how?' dimensions.

The focus of this chapter is on the business base within the context of e-logistics. Investigation among various definitions of business base shows that there is quite wide interpretation about what exactly is a business case. Among various appropriate definitions is:

"A written expression of the business value of a particular project intended to secure resource allocation and ensure optimal results. A logical and convincing argument justifying a business decision to spend funds" (eDRUL, 2005).

The business base is primarily about providing a logical basis for decision-taking, and justification for public and private resources committed to a project.

There are many stakeholders in an urban e-logistics scheme. These stakeholders are quite diverse and have quite different perceptions and value sets. Most importantly, it becomes clear that urban e-logistics involves public and private partners who have radically different objectives. Local authorities have a wide range of societal objectives, whereas the transporters and merchants have business objectives. These can be compatible, but it requires vision, very careful design, extensive and honest discussion, and the building of confidence and trust. This intersection of public and private interests means that different perspectives need to be used in defining and assessing the business case.

17.3 Key Issues in the business case for urban e-logistics

A further complication is that the stimulus for urban e-logistics – and sometimes the primary justification – is based on compulsory traffic management measures imposed by the local authorities. Hence, the initial stimulus is not the usual perceived business opportunity by the private sector, but rather how best to respond to what is first viewed as a set of restrictions.

For the local authorities, they must consider a complex mix of public purpose, societal impact, and fiscal appraisal. These can be best summed up by questions raised by the City of Lisbon:

- Why should the e-logistics project be undertaken?
- Why should a private or public partner invest in it?
- Why does the project represent a worthy expenditure of public funds?

Similarly, further key issues were raised by the City of Aalborg:

- Who shall pay? For the external costs?
- Who shall establish a logistics-Agency?
- Who are interested in joining?
- What are the roles of the local authority, national and EU?
- What are the barriers?
- What kind of ”city-logistics-infrastructure” are necessary? - to be established by whom?

17.4 Concepts of urban e-logistics

For e-logistics in urban areas, the underlying business logic has been a progression from ‘e-presence’ to ‘e-commerce’ to ‘e-business’.

Four innovative logistics concepts have been developed within eDRUL and are presented in detail in Chapter 4 above:

- Full vehicle load concepts
- City logistics concepts
- Network logistics concepts
- New and extended organisational models

Each of these concepts has relevant institutional and policy aspects. Some specific features of logistics in urban areas can alter the business dimensions, compared to non-urban and long-distance logistics. Four of these factors are:

1. The complexity and density of interested stakeholders, including non-participants in the logistics chain.
2. The effects of congestion on transporters, their costs and their performance, and the “last-mile” problem.
3. The impacts of transportation on society, and the corresponding demand by society for actions to mitigate the negative effects of traffic.
4. The degree of authority exercised by the Municipality, which can determine many aspects of the operating environment permitted to those involved in the logistics chain.

Public policy increasingly requires the implementation of logistics solutions which have less negative impacts, and through various traffic measures and restrictions, can compel the logistics sector and merchants to develop new processes.

17.5 Development of the business case within the eDRUL project

The eDRUL Project was initiated under the EU Research & Technological Development programme for Information Society Technologies (IST). The project was completed in early-2005. Chapters 4 and 5 have presented conceptual and software development aspects of the eDRUL project work.

The eDRUL project aim was to investigate, develop and validate an innovative IST platform, and supported service models, for improved management of freight distribution and logistics processes in urban area. eDRUL had the mission to implement, apply and validate innovative e-logistics solutions in 3 different European sites in Italy (see section 8.2), Denmark (see section 8.4) and Portugal (see section 8.7). A real-life demonstration was implemented in Siena, while showcases were developed in Aalborg and Lisbon. A transferability study was carried out in the Netherlands based on considerable experience of commercial schemes (see section 8.6).

The object of the potential business case was described in a sufficient level of detail to understand the services and products, the means of organisation and delivery, the business logic, and the nature of the participants. A "bottom up" approach was first used to develop the elements of the business case. The sites and applications were considered in terms of the different contexts, challenges and objectives. A set of business case issues using experience gained in Siena was developed. The additional experiences from Aalborg, Lisbon and research findings from Dutch cities were introduced. The Aalborg and Lisbon experiences are drawn from the studied response by key participants to an urban e-logistics 'showcase'. The Dutch experience is drawn from a number of real-life ventures.

The business case is considered in two dimensions – by stakeholder, and by factor. The Stakeholders considered are:

- The Municipality
- The eDRUL Agency
- The City Distributor (short-distance transporter)
- The Long-Distance Transporter
- The Merchants

For each Stakeholder, the Business Case dimensions are:

- Roles and responsibilities
- Benefits
- Costs
- Feasibility

Of course, the business case of each stakeholder is not in isolation from the others, and it is essential to make some reflections on the inter-relationships.

Using the collective experience of the sites, it was possible to draw some conclusions.

Two main things become clear in relation to the business case.

First, urban e-logistics are technically feasible, and there can be a viable business case for at least some of the actors. Second, there is significant inertia, and under current conditions this can only be overcome where the Municipality imposes traffic management restraints, which force the other actors into finding new solutions.

The next two sections will present the specific lessons learned from the Siena case, and the more general lessons on the business base and feasibility of the e-logistics for urban areas.

17.6 Specific lessons learned from the Siena case within the eDRUL project

The main conclusions and lessons learned from eDRUL in Siena (see Section 8.2 above for detailed description of the implementation) are the following:

- The IT platform and the related B2B and B2C e-services are operationally and economically sustainable only if the relevant Local Authorities and the stakeholders and actors concerned are able to establish the operational and economical conditions.
- This requires both the adoption of a suitable city access and distribution regulation framework, and the high functional level of the supporting IT architecture and tools.
- The efficiency of the logistics base(s) is of fundamental importance and should be able to operate with time and costs of deliveries (including the costs for transhipment) competitive with those of express couriers for deliveries in the same area.
- The IT platform for goods distribution can be expanded to other complementary activities (e.g. the Park & Buy service, as experimented in Siena) which can generate new jobs and contribute to improve the quality of life of citizens and tourists.

The experience with eDRUL in Siena is that the Municipality is certainly the key decision maker for adoption of the new (regulated) city logistics schemes. The services demonstrated in eDRUL (City Logistics Agency and its e-services for co-operative deliveries, etc.) are certainly 'facilitators' for the adoption of the new – and more restrictive – schemes, but not a decisive driver.

Although the schemes do provide advantages for both the transport operators and the shops (e.g. potential reductions of 'last mile' costs for long-distance freight transporters thanks to transhipment, value-added services for both local city distribution operators and service providers – e.g. Park & Buy - shop owners, etc.) the impression is that without any decision concerning the closure (or restrictions, time windows, etc.) of the historical centre to traffic – both private and commercial – there would be very little chance to have the new logistics schemes really in place and adopted, and to rationalise city distribution and reduce traffic impacts.

In other words, although the city logistics schemes - and the e-logistics solutions that somehow follow that schemes - are conceived and implemented in a free market logistics context, the decision of local authorities to adopt restrictive regulations is the starting point (or the trigger) of the decision chain that links together the local authorities themselves and the freight operators, service providers, shops and commercial operators.

It is necessary then to also consider the decision-making processes for the Municipality and the other stakeholders. One can suggest that the decision-making process is more complex for the Municipality, since it must determine both whether a scheme will be implemented, and many of the key policy aspects. For the transporters and merchants it is more straightforward. They only face a decision once the Municipality has decided to proceed. Then, they must first decide whether they will participate in the scheme; and second, the basis for their participation.

17.7 Main findings and conclusions about the e-logistics business case

The main findings of the e-logistics business case are considered under six headings:

- Concept Feasibility
- Technical Feasibility
- Organisational Feasibility
- Operational Feasibility
- Commercial Feasibility
- Traffic Management and Traffic Restraint

The **Concept Feasibility** and **Technical Feasibility** generally seem to be assured. Further technical developments will be required for more extensive systems with higher volumes than implemented in Siena. However, provided that the task is not underestimated and adequate resources are planned, this should not present barriers to future schemes.

Organisational Feasibility has already been well demonstrated in Siena, and this is supported by the experience in Aalborg and Lisbon. The type of organisation most likely to implement and operate the eDRUL city logistics Agency concept is probably some form of public-private partnership ensuring the participation and support of Local Authorities to the implementation, operation and control of the innovative logistics schemes.

The careful and inclusive building of relationships with all of the key stakeholders is fundamental to success. It is achievable and should not become a major barrier provided that the task is not underestimated and is properly planned. Nonetheless, it is hard to tell whether there are many cities which do not have the basic industry structures, or where there is deep mistrust and bad relationships among key actors.

Operational Feasibility has been demonstrated in Siena, as described in Section 8.2 above. B2B services are clearly feasible if it is convenient for Long-Distance Service Providers (LDSPs) that the last mile of their deliveries is covered by city distribution operators.

It is of fundamental importance that the logistics base(s) act in an efficient manner, which should be able to operate with time and costs of deliveries (including the costs for transhipment), in order to be competitive with those of express couriers for deliveries in the same area.

Regarding **Commercial Feasibility**, the benefits of B2B services for LDSPs are both economical and organisational. Thanks to the joint delivery scheme, LDSPs can use large vehicles (no need to enter the city centre) use third party facilities for transhipment with a total saving in terms of time, operational and personnel costs. The eDRUL platform and the Logistics Agency have a central role in this.

In the Aalborg case, with an optimized utilisation of the vehicles, fewer vehicles will enter the area. The transport operators calculate a decrease of 10-15 % in kilometres, due to the increase in the degree of utilization also as a consequence of fewer distribution-vehicles.

Provided co-operation services (logistics bases, transhipment, delivery booking services) can be offered and operated at economically sustainable conditions (as the trials have in principle indicated) this will be a main driver to expand the business of local distributors.

The key factor for feasibility of B2B services is the price of the service for the LDSP.

Based on evaluation of Siena trials, the eDRUL city logistics Agency appear to be feasible if:

- The mobility policy framework adopted for the TLA (Traffic Limited Area) includes rules and constraints to manage freight vehicles access and deliveries in the area.
- Long distance transport service providers find it more convenient (organisationally, economically) to use the planning and management services offered by the Agency instead of direct bilateral agreements between them.
- Local city distribution providers are operating in the area and have their logistics bases or freight transhipment facilities (thus reducing significantly the investment costs related to ‘hard’ infrastructures).
- Investment and operational costs are moderate.

In Siena, with the volumes measured during the trials, combining the fleet operator Park & Buy trips with other pick-up and delivery trips is the only way for COTAS (the fleet operator) to achieve economic sustainability. However, this may easily change if Park & Buy volumes increase.

In some cases a combination of two functionalities can be a good starting point for implementation. “Transport planning” could be combined with “inner city route planning” or “(un)loading place reservation” can be combined with “access permission”.

Although **Traffic Management and Traffic Restraint** are an enabler rather than an integral part of Urban e-Logistics, it is clear that they are a necessary stimulus under current conditions. Therefore, it is important to verify that they are feasible in both technical and political terms.

The Siena site has shown that they are feasible both technically and politically. However, circumstances in Siena are not typical of European cities. The Aalborg and Lisbon showcases, as well as experience elsewhere, indicate that the traffic management and restraint dimensions are technically feasible, but are dependent on excellent design and on effective enforcement. They are usually legally feasible.

However, the political feasibility is not so well assured. There appear to be three factors which can work against otherwise-feasible solutions:

1. Inertia.
2. Unwillingness on the part of the transporters.
3. Unwillingness on the part of the merchants and street interests.

Lack of willingness to co-operate would place a Municipality in the difficult position of having to implement unpopular measures (even if they would have good societal or environmental benefits) with resistance from the main direct participants. The political feasibility is key to success. It is achievable, but it requires a well structured, dedicated, long-haul, inclusive approach on the part of the Municipality.

The primary **conclusions** are:

1. Under current conditions, the Municipality is the key decision-taker which determines whether urban e-logistics systems are established.
2. Despite potential benefits, transporters and merchants will currently not collectively implement urban e-logistics without an external stimulus.
3. The most effective stimulus is a package of mandatory constraints and restrictions relating to city centre access, loading/unloading times and locations, and vehicle/emissions specifications.
4. There appears to be a positive socio-economic case for urban e-logistics stimulated by restrictive measures.
5. The fiscal business case is less clear-cut.
6. City distributors and the e-logistics agency are able to develop positive business cases.
7. The business cases for the Municipality, long-distance transporters, and merchants are sensitive to the traffic constraints, pricing structure, operational model, allocation of responsibilities, and new business opportunities.

17.8 Core issues for future development

Given the centrality of the Municipality's decisions, two core issues arise:

1. The complex issues associated with decision-taking, especially the role and value-set of the Municipality, and
2. The balancing of socio-economic policy with the commercial business case. This becomes a central issue, since the Municipality is the prime determiner of the conditions for urban e-logistics, but has a value-set which is fundamentally different from the other main participants.

The serious challenge is how to develop a values framework that allows the Municipality on the one hand to assess the socio-economic benefits against the costs it incurs itself, and on the other to assess its own net cost/benefit against a more speculative net cost or net benefit to the collective business community.

There is a strong parallel with the flexible passenger transport domain. Despite the clear need for such services, to date they have not been possible without intervention of the Municipality or community groups. Experience shows that when the policy, concept and funding frameworks are in place, then the stakeholders are willing to work together to develop the services and the market, and to innovate. However, without the initiative from the Municipality, the collective of other stakeholders is highly unlikely to develop the services. The parallel also extends to the decision-taking processes of the Municipality and the value framework which they use to balance economic and societal costs and benefits.

Care should be taken, however, not to presume that the e-logistics and flexible passenger transport sectors are alike in all aspects. The stakeholders are different. They have different traditions of service concepts, operations, and business relationships. There is good potential in the use of common technical approaches, provided always that they are applied correctly to each sector.

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Web Sites

Research & Innovation Projects

http://www.edrul.com
eDRUL - eCommerce Enabled, Demand Responsive Urban Logistics - research and innovation project in the field of e-logistics(5th FP)

http://www.flexibletransport.com
Connect - Co-ordination of CONcepts for NEw Collective Transport (6th FP)

http://www.bestufs.net
Bestufs - Thematic Network on Best Urban Freight Solutions, IST Programme, DG Information Society (5th FP)

http://www.famsweb.com
Fams - Flexible Agency for Collective Demand Responsive Mobility Services IST Programme, DG Information Society (5th FP)

http://www.agataproject.net
Agata - Multi-services Agency based on telecommunication centres for the integrated management of mobility and accessibility to transport services (Interreg III, Medocc)

http://www.cityports.net
City Ports - Transport and Logistics Goods (Interreg III, Cadses)

http://www.cityfreight.org
Cityfreight - Inter and Intra-Urban Freight Distribution Networks
City of Tomorrow and Cultural Heritage Action, Energy, Environment and Sustainable Development Programme, DG TREN (5th FP)

http://www.innovazione.toscana.it *(interreg section)*
Merope - Telematics instruments for innovative services for mobility and logistics (Interreg III, Medocc)

http://www.emires.net
Emires - Economic Growth and sustainable mobility supported by IST at the Regional Level including SMES, IST Programme, DG Information Society (5th FP)

http://hermes.civil.auth.gr/themis
Themis - Thematic Network in Optimising the Management of Intermodal Transport, DG Transport & Energy (5th FP)

http://www.eutp.org
EUTP Interactive Transfer Point - Thematic Network to support European intermodal freight transport research, DG Energy and Transport (5th FP)

http://www.bpr-logistics.trans.aueb.gr
BPR Logistics - Thematic Network on Business, Policy and Research Implications of Logistics in the e-Economy Environment, IST Programme, DG Information Society (5th FP)

http://www.tellus-cities.net/index_122_en.html
Tellus - Transport & Environment aLLiance for Urban Sustainability, the CIVITAS project including, among other measures, new concepts for the distribution of goods. eCommerce logistics and inner-city logistics centres, SST Programme, DG TREN

http://www.parcelcall.com
ParcelCall - A scalable real-time, intelligent, end-to-end tracking and tracing system for transport and logistics applications, IST Programme, DG Information Society (5th FP)

http://www.idsia.ch/mosca
Mosca - A Decision Support System for integrated door-to-door delivery: planning and control in logistic chains, IST Programme, DG Information Society (5th FP)

http://www.genovamerci.it
Progetto Merci, Genova (Italy)- Sperimentazione di realizzazione di un hub per servizio logistica urbana

http://www.invent-online.de
The Invent initiative: Intelligent Traffic and User Friendly Technology, sponsored by BMBF (Federal Ministry of Education & Research, Germany)

http://www.brunel.ac.uk/depts/math/research/com/maprog/District/district.htm
District - Developing and improving Consumer-Supplier relationship in traditional commerce using information and communication technologies, IST Programme, DG Information Society (5th FP)

http://www.citrotrans.com

Citro - Clustering Individual Truck Owners, IST Programme, DG Information Society (5th FP)

http://www.plsproject.dk/artemis/index.html

Artemis - Architectural framework and interfaces to facilitate integrated supply chain management, Telematics Applications Program, DG Information Society (4th FP)

http://www.frame-online.net

Forum for the European ITS Framework Architecture, IST Programme, DG Information Society (5th FP)

European Commission

http://europa.eu.int/comm/dgs/energy_transport

DG Energy and Transport- Directorate General Energy and Transport

http://europa.eu.int/comm/dgs/information_society

DG Information Society- Directorate General Information Society

http://www.interreg-medocc.org

Interreg III, Medocc - Projects aimed at transnational co-operation in the field of territorial development of Western Mediterranean countries.

http://www.cadses.net

Interreg III, Cadses - Central-European Adriatic South-Eastern Danubian European Space

http://www.eltis.org

Eltis- The European Local Transport Information Service

http://www.civitas-initiative.org/civitas

Civitas- Cleaner and Better Transport in Cities - an European initiative to stimulate adoption of sustainable urban transport policy strategies

http://www.cordis.lu/en/home.html

Cordis- Community Research and Development Information Service, the EC web site on research and innovation

http://europa.eu.int

European Union- The European Union on-line

Agencies & Associations

http://www.elalog.org
European Logistics Association- The European Logistics Association

http://www.freight-village.com
Europlatforms- European Association of Freight Villages

http://www.psd-online.nl
PSD- The Dutch National Forum on Urban Logistics

http://www.eia-ngo.com
European Intermodal Association- The European Intermodal Association (EIA)

http://www.ptrc-training.co.uk/default.asp
European Transport Forum

http://www.uccee.org/SustainableTransport
Unep- Sustainable Urban Transportation workshop Deals on Wheels

http://www.interporto.it
Interporti Italiani- Official site of Italian Freight Villages (in italian)

http://www.elogisticsworld.com
eLogistics World- US directory of logistics technology and e-Commerce resources on the internet

http://www.start4its.com
Start 4 ITS- The Portal of Intelligent Transport Systems

http://www.ertico.com
Ertico- The European public/private partnership for Intelligent Transport Systems and Services (ITS)

Abbreviations

ACS	-	Access Control System
B2B	-	Business to Business
B2C	-	Business to Consumer
BBB	-	Basic Building Blocks
C2C	-	Consumer to Consumer
CDC	-	City Distribution Centre
CG	-	Communication Gateway
CLA	-	City Logistics Agency
COD	-	Cash on Delivery
CUD	-	Centre for Urban Distribution
CVRP	-	Capacitated Vehicle Routing Problem
DRT	-	Demand Responsive Transport
DTMF	-	Dual Tone Multi Frequency
EDI	-	Electronic data Interchange
eGG	-	eDRUL GPRS Communication Gateway
ETA	-	Expected Time of Arrival
FTS	-	Flexible Transport Services
GIS	-	Geographical Information System
GPRS	-	Global Packet Radio Service

ICT - Information and Communication Technology
ISDN - Integrated Services Digital Network
IT - Information Technology
ITS - Intelligent Transport Systems
IVR - Interactive Voice Response
JIT - Just In Time
L&U - Loading and unloading
LD - Long Distance
LDSP - Long Distance Service Providers
LSP - Logistics Service Provider
LF - Local Fleet
P&B - Park and Buy
PDA - Personal Digital Assistant
SCM - Shopping Centre Management
SME - Small and Medium-sized Enterprises
SMS - Short Message Service
TDCM - Traffic Data Collection and Monitoring
TIC - Transport Information Centre
TLA - Traffic Limited Area
TLZ - Traffic Limited Zone
TMMS - Traffic Management and Monitoring System
TRZ - Traffic Restricted Zone
TSP - Travelling Salesman Problem
TTP - Trusted Third Party
UDC - Urban Distribution Centre
UNA - User Needs Analysis
VAS - Valed Added Services
VDC - Virtual Distribution Centre
VOC - Virtual Operating Centre
VRPWT - Vehicle Routing Problem with Time Windows
ZEV - Zero Emission Vehicles

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