A Centre for Eco-Friendly City Freight Distribution: Urban Logistics Innovation in a Mid-size Historical City in Italy

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INTRODUCTION

Freight distribution urban processes are, together with private traffic flows, one of the major sources of energy consumption, noxious gas emissions and noise levels in urban areas and result in the well known negative impacts on life and environmental quality of our cities (Koriath et al., 1998; Bestufs, 2001). Looking at the situation in Italy, 80% of deliveries normally take place in urban areas and although the related freight flows correspond to about 10% of total vehicles, they are responsible for 20% of traffic and 50% of environmental effects.

The importance of adequate infrastructures and systems for an efficient management of City Logistics is increasing in most developed countries (Ambrosino et al., 2005 a). In Europe, and particularly in Italy, given the large number of mid-sized cities, often including historical centres and dense urban areas with their typical constraints for traffic and mobility processes, this is a major theme, a central one in the larger context of the continuous search for and realisation of integrated city mobility management schemes, involving a mix of measures (e.g. traffic management, access control, parking guidance, etc.) and their supporting ITS applications.

This article provides a full account about the ongoing developments of the CEDM project in the historical city of Lucca, Italy. CEDM is an innovation project aiming at the implementation of a number of city logistics measures in Lucca, based on the realisation and
start up of a Centre for Eco-Friendly City Freight Distribution (CEDM). The experience is carried out in collaboration with Aalborg (Denmark) where also innovative city distribution schemes are being developed to improve logistics processes involving destinations within the historical centre.

The article first introduces the overall context of city distribution in Lucca, highlighting the main characteristics of the city and the major issues related to city logistics and freight transport processes. Then, the activities of LIFE CEDM project in Lucca are introduced, illustrating the key objectives at city level and the ongoing developments of CEDM implementation, including the physical infrastructure, the provided city logistics services and the supporting ICT infrastructure and services.

Finally, the main issues concerning management and financing aspects of CEDM are briefly discussed.

**CITY FREIGHT DISTRIBUTION IN LUCCA**

**The urban context: Lucca historical centre**

Lucca is a mid-sized city with an important historical centre located in central Italy, in the north-west part of Toscana Region. The town lies within a circle of 16th century walls (Fig. 1) which, in the 19th century, were transformed into a tree-lined avenue. It has therefore maintained its characteristic medieval structure and counts, nowadays, about 79,800 inhabitants over a total surface of 185,54 square kilometres, thus showing a population density of about 430 inhabitants per square kilometre.

![Figure 1: Aerial view of Lucca historical centre and (part of) conurbation](image-url)
Lucca’s economy is based on agricultural produce from the fertile surrounding countryside (olives, fruit, cereals, grapes) and the town acts as a commercial and transformation centre (oil mills). Industry is traditionally present in pulp and paper, textiles and clothing but there are also chemical, engineering and building firms. The Renaissance Walls, the most significant monument of the city, is an intact circle of about 4 km in length, with a series of ramparts. These walls have allowed the historic centre to maintain its homogeneous and balanced appearance.

However, as can be understood, the historical centre poses by itself a number of problems for traffic and mobility of both people and goods. This requires special attention and search for innovative solutions able to guarantee efficient processes while ensuring environmental respect, preservation of the high value historical assets and of the high level of quality of city life. As previously observed, this situation and the background urban context are rather common in Italy, thus the Lucca application case is to be seen as a paradigmatic example of both the type of problems addressed and the innovative solutions searched.

City freight transport and distribution: applied measures and problems

Given the relevance of the problem for the quality and development of city economic context, Lucca administration has invested over the last years relevant resources to achieve significant reductions of traffic related energy consumption, noxious gases emissions and noise, and to preserve the quality of the environment and the historical and tourist assets. This has been done through specific regulatory initiatives and mobility schemes and the realisation of telematics infrastructures devoted to mobility management, improvement of quality of public transport and regulation of city logistics processes under environmental preservation constraints.

The set up of the first pedestrianised area in Lucca dates back to 1976. Since then, several city regulations and norms have been issued by the city administration providing various policies and constraints as regards the regulation of access, transit and parking of vehicles within Lucca historical centre. Specifically, two types of pedestrianised areas have been established – A Zone, with stricter parking and transit policies, and B Zone, where parking is allowed to specific user categories.

As a main instrument to implement access, transit and parking restrictions, as well as to enable control and enforcement operations, a system of Administrative Permits has been set up taking into account the needs of a number of different user categories including freight operators. In the historical centre, size and weight limitations – max. weight (full load) 3,500 Kg, max. size 5,40 x 2,00 x 2,20 m – as well as speed limitations – max. speed 30 Km/h – are set for all vehicles.

Commercial vehicles meeting these limitations are allowed to circulate in Zone A and Zone B only if they are provided with a “work order” showing their destinations and type of operation. Parking time is anyway limited to 15 minutes. In addition, more tight restrictions are set to circulation and delivery of specific goods types, which are generally limited to specific time
periods of the day. Table 1 below provides an example of the restrictions applied to some types of goods for delivery within the historical centre.

<table>
<thead>
<tr>
<th>Type of goods</th>
<th>Permit area(s)</th>
<th>Time and other limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perishable goods</td>
<td>LTZ, A Area, B Area</td>
<td>7:00-10:30, 15:00-16:30 and 18:30-20:00</td>
</tr>
<tr>
<td>Medicines &amp; drugs</td>
<td>LTZ</td>
<td>Any time of the day (max. 20 mins parking)</td>
</tr>
<tr>
<td></td>
<td>A Area, B Area</td>
<td>7:00-10:00, 12:00-13:00, 16:00-17:00, 18:30-19:30 (max. 20 mins parking)</td>
</tr>
<tr>
<td>Fuels</td>
<td>LTZ</td>
<td>Any time of the day</td>
</tr>
<tr>
<td></td>
<td>A Area, B Area</td>
<td>8:30-13:00, 14:30-15:30</td>
</tr>
<tr>
<td>Sales representatives (yearly duration permit)</td>
<td>LTZ</td>
<td>Any time of the day. Parking allowed only in dedicated yellow marked lots</td>
</tr>
<tr>
<td></td>
<td>A Area, B Area</td>
<td>8:00-14:00, 14:30-15:30, 19:30-20:00</td>
</tr>
<tr>
<td>Tobacco and state monopoly goods (yearly duration permit)</td>
<td>LTZ</td>
<td>Any time of the day. Parking allowed only in dedicated yellow marked lots</td>
</tr>
<tr>
<td></td>
<td>A Area, B Area</td>
<td>8:00-12:00</td>
</tr>
</tbody>
</table>

Table 1: Restrictions in Lucca historical centre for commercial and freight vehicles

Although in use since a number of years, the current regulation system is not sufficient and a survey conducted in 2004 for the City Administration in the context of MEROPE project (Merope, 2004) has shown that freight access and distribution in the historical centre are still quite ineffective while the impacts of traffic on the environment and quality of city context are rather significant.

In the core area of city distribution – the historical centre and its immediate surrounding urban quarters outside the ancient walls – approximately 700 shops, retail points and commercial activities are located and constitute main destinations of freight flows travelling in the area. Daily deliveries amount to more than 2000 parcel/day, with more than 1680 vehicles entering the area each day. About one fourth (27%) of business located in the area use their own means for goods transport. Generally, freight transport is done very fragmented loads and low capacity usage (less than 30%).

For these reasons, new solutions are investigated by the City Administration with the aim of rationalising the entire distribution system (less travels, better use of available delivery capacity) and reducing the impacts and externalities of traffic flows in the area.
THE CEDM PROJECT IN LUCCA

CEDM is a project part-funded by the European Commission under the LIFE Environment initiative (Contr. No. LIFE05 ENV/IT/000870) whose goal is the implementation of a number of measures – regulatory, organisational, operational and technological – to enable the realisation and operation of a new city logistics system. The key operational concept behind CEDM is based on a City Distribution Terminal (CDT) as a main infrastructure to support rationalized – eco- and business-efficient – city distribution schemes. The CEDM terminal is the pivotal component of the new city distribution system, aimed, initially, to support delivery operations within the historical centre of Lucca – the area enclosed within the ancient walls – and in the immediate surroundings – and possibly, in the future, in other areas of the economic and production milieu within Lucca province.

The CEDM measures are based on city logistics schemes integrated in the broader context of mobility and transport measures, thus allowing Lucca to achieve high standards of energy efficiency and environmental quality. These measures include:

- Adoption of restrictions to regulate freight deliveries in the protected historical centre; e.g. time slots (for different types of goods), minimum load factor (e.g. > 60% of available capacity), electrical vehicles for final deliveries.
- Access for deliveries in the protected centre granted only to freight operators meeting access requirements
- Cooperation between freight operators to cover last mile city distribution - e.g. load consolidation, transhipment at freight transit points, etc. – meeting access requirements and economic efficiency
- Implementation of innovative citizens and tourists oriented delivery schemes with goods consignment via dedicated collect points (e.g. at hotels, freight transit points, etc.)
- Efficient management of reverse logistics, i.e. ‘secondary’ freight flows originated from shops and retail points and directed outside the historical centre such as flows related to returned goods, delivery waste materials, etc.

The CEDM Eco-Friendly City Logistics Agency

The CEDM CDT is conceived to operate as a City Logistics Agency providing a number of services to support city distribution processes and the main actors of the city logistics service chains.

The main activity of CEDM is organising and implementing freight deliveries to (and collection from) final destinations (shops, services, businesses, private citizens locations) in the CEDM service area. In that, CEDM operates as a traditional CDT (Fig. 2):

1. The CEDM centre is supplied daily by transport operators and couriers with the freight and goods to be delivered to final destinations in the historical centre of Lucca. It is also collecting and receiving goods from locations (e.g. shops) in the service area, for further deliveries (e.g. outgoing freight flows, reverse logistics).
2. The demand of freight delivery to the CEDM (by transport operators and couriers) is provided in advance (by means of suitable ICT tools) in a way that allows CEDM pre-planning delivery operations in time.

3. Incoming goods is processed at the CEDM achieving “groupage” (i.e. grouping freight items according to final destinations and delivery dates) and “load consolidation” (reaching high load factors for final delivery vehicles).

4. Deliveries to final destinations are carried out by the CEDM fleet of electrical eco-vehicles within the date/time limits required by the customers.

However, a major aim of CEDM is to provide an expandable scheme which allows achieving the most rational use of logistics resources and infrastructures in the area, facilitating the cooperation among the different logistics operators in the system with a minimum impact on their normal operations.

To this end, the operation of the CEDM is further expanded allowing to involve the logistics resources (warehouses, depots) of participating transport operators, which can be used as additional logistics bases for freight transhipment prior to the final delivery in the CEDM service area. CEDM eco-vehicles are then used to collect freight and consolidate loads not only at the CEDM CDT but also from the depots of the other participating logistics operators (e.g. national couriers, like Bartolini Express Courier, operating in the area) (Fig. 3).

This way, the CEDM operational architecture evolves from a single physical CDT to the concept of a “Virtual City Distribution Terminal”, where several physical logistics resources are virtually connected to the CEDM to maximize the efficiency of the delivery process.
infrastructures – the CEDM CDT proper and other depots/warehouses co-located in the area – are seen and managed as a single infrastructure for coordination and optimisation of city distribution processes.

This scheme has a dual advantage: not only it reduces the impacts of the new city logistics scheme on current operations – as freight forwarders can still use their own depots for transhipment – but it also reduces freight traffic flows in the area – as these operators are not required to travel to the main CEDM CDT to obtain delivery to final destinations by the CEDM vehicles.

![Figure 3: Enlarged CEDM operational scheme; the “virtual” city distribution terminal](Image)

**The CEDM platform**

The CEDM physical platform is currently under construction in a service area outside Lucca historical walls, conveniently located at less than 1 Km distance from the walls as well as from the A11 tollgate (Via Citta’ Gemelle; figure 4). This will allow proper operation of the fleet of CEDM electrical vehicles on the one hand and, on the other hand, goods accessibility of the distribution terminal by long range freight transport operators using the motorway network for their service within the region and nationwide.

The main physical requirements and characteristics of CEDM physical logistics base can be summarised as follows:
1. CEDM operating surfaces (covered areas for goods load/unload operations, open manoeuvre areas for heavy vehicles and for CEDM ecological vehicles) are determined according to:

   a) Design of handling areas in order to minimize transhipping operations and the waiting time of incoming trucks. This is achieved by distributing unloading operations on one side of the warehouse and reloading operations on the opposite side.

   b) The peak situation with incoming trucks for transhipment at CEDM.

2. Size of covered area around 800 m². This results from (i) the analysis of peak volumes of incoming goods (566 m³/day) (ii) the need of stocking all incoming goods in the CEDM before starting loading and distribution operations and (iii) due consideration of required free spaces for movement of CEDM personnel and handling operations (30% increase of max. volumes required area).

3. The operation side of CEDM warehouse (covered area) reserved to incoming trucks has a total length of 30 m. This is required to realise 5 freight unloading places allowing operation of 5 heavy vehicles at the same time. Since the minimum operation size to allow the handling of heavy vehicles is 20 m wide, the open yard designated for these vehicles is 600 m² wide (30 m x 20 m).

4. The operation side of CEDM warehouse reserved to CEDM ecological vehicles has approximately the same length (27 m). On this side, a 10 m handling area is enough, so the open yard on this side is 300 m² wide (30 m x 10 m). Also, on this side a covering canopy for loading operations is planned to allow more vehicles operating side by side.

Taking these elements altogether, the CEDM distribution platform is characterised by a covered area of 810 m² and an open area of 900 m².

**CEDM City Logistics services**

The city logistics services provided by CEDM can be distinguished in two main categories:
a) Base city logistics services,

b) Additional, value-added city logistics services

**Base city logistics services.** The key function of the CEDM as a City Distribution Terminal is providing services to support “last mile” deliveries to Lucca centre within the wider scale regional (and national) freight logistics chains. In that, CEDM provides all typical CDT services to support cooperation between long-/mid-range freight operators and the local distribution actors (particularly, the CEDM eco-fleet) including: transhipment of goods at the CEDM logistic platform; organisation of best possible operations (e.g. groupage, load consolidation, etc.) for deliveries of goods to their final destinations by the CEDM eco-fleet; provision of ICT services enabling the exchange of updated information – including particularly track-and-trace information – between the transport operators utilising CEDM delivery services, the CEDM itself and all the actors throughout the logistics service chain.

Complimentary to previous services, the CEDM will also provide services to operate freight transport in the opposite direction; i.e. logistic flows with goods collected from locations within Lucca historical centre and final destinations outside the CEDM area.

Finally, the CEDM logistics base can also operate, in principles, as a goods collection location for B2C delivery services dedicated to consumers and citizens in general. In this perspective, the CEDM can operate as a pick-up point for any goods purchased in the historical centre and bound for outside destinations. The purchase process may be originated in the ordinary way (i.e. directly at the selling point) or by any distant selling means (e.g phone order placement, e-commerce purchase, etc.) while the transport service between the selling location and the CEDM is provided by the CEDM fleet of electrical vehicles.

**Value Added city logistics services.** In addition to the base services introduced in previous section, the CEDM operational model includes also a number of value-added services that will be gradually implemented and offered to the users and operators of the city logistics system in Lucca after the start up phase and consolidation of base CEDM services. Such additional services address different city logistics market segments – as well as some services with a a social relevance – and include:

- Home delivery services, for generic users (i.e. citizens living in the service area) or specific user categories (e.g. elderly people, etc.).
- Delivery services to specific locations within the historical centre, such as hotels and other service locations.
- Delivery services via dedicated good collect points (Pick-up-Points, e-Lockers, Safe Boxes, etc.).
- Loading/Unloading Areas within the historical centre, dedicated to own delivery operations and supported by electronic reservation services, used identification, payment.
- Reverse logistics services, for collection and delivery (through the CEDM) of refused/returned goods, packaging materials, logistics wastes, etc.
- Third-party remote warehousing services, providing space rental, remote stocking services and related electronic services (e.g. stock state information, replenishment order submission, etc.) for interested shops and other service operators.
Supporting ICT infrastructure

Central for the operation of CEDM is a distributed, internet-based e-Services platform, hosted in the CEDM and linking all main actors within the city logistics chain – long-/mid-distance freight transport operators, city distribution operators, shops and delivery destinations, freight transit points, eCommerce infrastructures, etc. This multi-service architecture operates as a City Logistics Virtual Agency providing business-to-business (B2B), business-to-consumer (B2C) and business-to-administration (B2A) services to enable cooperation between the different involved actors and improve the operation of city logistics schemes.

The solutions adopted for CEDM operation is based on innovations previously achieved in the IST eDRUL project (Ambrosino et al., 2005 b) involving a number of eBusiness and eCommerce solutions developed to improve city logistics processes (Boero et al., 2005; Wild et al., 2005). Overall, the CEDM ICT infrastructure is based on the integration of the following main components (Figure 5):

a) A planning and operation ICT platform, providing a number of tools and services in the City Logistic 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 (Figure 6), algorithms for distribution planning and optimization, etc.;

b) A multi-service web portal providing access to a number of B2B and B2C services related to the city distribution processes operated by the CEDM Agency. This involves the functionalities enabling the interfacing between the end-customers and the goods retail/delivery system, as well as the integration between the management centre and the parties involved in the logistic chain (traders and sale points, wholesalers and goods distribution centres, transport operators) by means of services for information exchange (e.g. track-and-trace information) and for workflow support (e.g. transhipment booking and information);

c) Wired and wireless (e.g. GSM/GPRS, UMTS, WiFi) communication infrastructures to support the flows of information among the logistic operators and between the end-customers and the logistic system;

d) Mobile terminals – in-vehicle and hand-held (PDAs, 2.5/3G smart phones based on GPRS and UMTS) – to ensure the exchange of information among the logistic planning and operation services of the platform and the goods delivery fleet (using real time data exchange) as well as for external parties involved in logistics related administrative operations (e.g. city police for control and enforcement related to access to the restricted area, occupancy of load/unload dedicated spaces, etc.).

e) Interfaces to the other external ITS elements of the overall city mobility management system, the freight system is planned to interact with (e.g Access Control System).
Figure 5: Overview of logical architecture of CEDM ICT infrastructure

Figure 6: Digital map and route display in CEDM city distribution planning component
MANAGEMENT AND FINANCING ASPECTS

The setting up and operation of the management and organisational infrastructure needed to run the CEDM city distribution terminal are obviously a critical factor and a number of experiences done in Europe so far show clearly that, in many cases, this fundamental element determined the failure of the entire initiative of city logistics innovation.

The approach taken in Lucca is based on two main general directions:

1. Developing the entire initiative on the ground of a strong local consensus among the involved stakeholders and user categories.
2. Building up a management organisation with an initial control by the Public Administration in the start-up phase and a plan of gradual transition to private stakeholders once the economic sustainability is consolidated and ensured for the longer term.

The local concertation process is of a strategic importance to ensure an effective and smooth start-up of CEDM activities. The process has been undertaken by Lucca Municipality since the earliest phases of the project and has involved all main stakeholder categories involved in CEDM operations: commerce operators and associations (Chamber of Commerce, shops and commerce associations), local transport operators (e.g. city distribution operators, local courier services, etc.) as well as some major regional and national couriers. Initial agreements have been reached to ensure the starting critical mass needed to support operation of the CEDM services, while the process of enlarging the supporting base of participating actors is still evolving.

As regards the set up of the management organisation, two options have been identified and currently being refined:

- A group of stakeholders (both public and private) will establish and run the CEDM Management Organisation under framework conditions (objectives, requirements, rules) established by the Local Authority. The CEDM logistics services will be then contracted to external suppliers on a service contract basis.
- An open CEDM Management Organisation whose shares, after the set up an initial run period, could be sold to other actors (e.g. forwarders, couriers, transport operators, etc.) joining the organisation and ensuring the management conditions (objectives, requirements, rules) established by the Local Authority. In this case, CEDM logistics services will be provided by both the organisation partners and external organisations appointed on a contract service basis.

These two options are presently being detailed designed and verified with the local stakeholders also in the context of the above mentioned consensus building process. The strategy of the administration is to favour a solutions which is able to ensure the quickest and most solid transition from the initial phase partly supported with public money (participation of Local Administration in the management organisation) to a self-sustaining market initiative.
CONCLUSIONS

The LIFE CEDM project is currently ongoing in Lucca and the measures planned and being implemented represent a major innovation for the logistics and freight distribution context in the city. The project has successfully completed the first year of activity and is currently in its hot phase of implementation of both the physical infrastructures – the CEDM logistics base – and the ICT services.

The start of the first pilot services is planned for late summer 2007 and the full CEDM infrastructures will be ready by the end of 2007 for the start-up phase of full pilot validation early next year.

This article has provided an overview of motivations, objectives and measures realised in Lucca in the context of the CEDM project. More details and updates are regularly published and are available for public information on the project website (http://www.life-cedm.info).

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REFERENCES


