Sustainable freight distribution and e-logistics services: the case of Lucca

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Abstract

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).

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 environmental impacts, management and financing aspects of CEDM are briefly discussed.
1. Introduction

Lucca is a mid-sized city with an important historical centre located in central Italy, in the northwest 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)

As it can be easily 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. However 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.

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, 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. 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.

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.

2. 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 (Fig. 2).

**Figure 2.** Base CEDM operational scheme; the CEDM as a city distribution terminal

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 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.

![Enlarged CEDM operational scheme; the “virtual” city distribution terminal](image)

**Figure 3.** Enlarged CEDM operational scheme; the “virtual” city distribution terminal

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 CEDM distribution platform is characterised by a covered area of 810 m² and an open area of 900 m² (figure 5).
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 (figure 6).

**Figure 6. A vehicle of the CEDM electric fleet**

*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 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 7. Overview of logical architecture of CEDM ICT infrastructure

Figure 8. Digital map and route display in CEDM city distribution planning component
3. The environmental benefits

The implementation of CEDM project and of the relevant supporting measures are expected to:

- reduce the present level of congestion, mainly due to commercial and freight traffic, by means of the optimisation of vehicle loads and delivery routes and so reducing the total number of light duty vehicles entering the historical centre;
- reduce the current level of local environmental and noise pollution by the above mentioned reduction of freight traffic flows and, at the same time, by the adoption of zero emission vehicles for goods transport;
- reduce the relevant risks of damages for the historical buildings located in the centre of Lucca;
- improve the overall quality of life in the historical centre for both residents, visitors and tourists.

The CEDM project will improve the quality of environment inside the historical area enclosed in Lucca ancient walls and the immediate surrounding suburbs performing significant reductions in traffic impacts on the population residing, working or living daily in this area. Moreover the final aim is not only the protection of citizens’ health and well-being, but also the preservation of historical buildings, monuments and cultural assets located in the old centre of Lucca.

The reduced access in this area by freight traffic, due to new freight distribution schemes, together with the use of a fleet of electric vehicles for CEDM operated deliveries in this area, will significantly reduce both the polluting emissions in the atmosphere and the noise pollution as well. On this regards particular attention shall be paid to benefits coming to Lucca’s historical centre from the expected reduction in emissions and related concentration levels of the air pollutant now considered as most harmful (NOx, PM10).

A preliminary assessment of the expected reduction in air pollutant emissions was made at the right beginning of the project, The expected changes in the urban environment of Lucca were quantified in a pilot study performed by ENEA using the CORINAIR/COPERT III methodology and gave, for the historical centre of Lucca, the following figures of average savings referred to the total commercial traffic in the Limited Traffic Zone (LTZ): energy consumption and CO2 emission by 20%, CO by10%, NOx by 18%, NMVOC by 26%, TPM by 27%.

A further environmental assessment will take place immediately after the ex-post evaluation of CEDM trial results, which are now undergoing.

The implementation of CEDM new distribution schemes is expected to reduce the total number of trips, and so the total number of light duty vehicles entering the Lucca’s historical centre, and somewhat also the average length of trips by rationalizing the deliveries. This will lead to lower levels of freight vehicle traffic congestion in the concerned area and finally will reduce the related losses of time and visual impacts, improving also the pleasure taken from visiting Lucca’s central area.

4. Management and economical 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.

To ensure an effective and smooth start-up of CEDM activities, the management 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.

The final aim 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.

5. 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 second 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 pilot services started during the summer 2007 and also the complete ICT platform was shortly after up and running.

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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