Extended abstract

Objectives and motivation
An Urban Distribution Center (UDC) is an useful City Logistics policy instrument. An UDC can produce interesting impacts on the dynamics of urban freight distribution, but its success depends on many factors: an appropriate location; a well-balanced presence of spaces and equipment; an efficient and effective organization of internal services; a connection with the surrounding area and with the related transport services; a management structure that meets different and complementary requirements; a capacity to support itself.

The paper proposes a methodology for evaluation of UDC operational capacity based on a micro-simulation approach.

In literature the operational capacity is mainly defined in two different ways, depending on whether the terminal system is considered as a whole or single elements of the productive chain are taken into account. In the former case, the capacity is defined as “the possibility of assuring the treatment of a certain quantity of goods in a specified period of time” (UNCTAD, 1980; National Ports Council of Great Britain, 2004). In the latter case, the capacity is defined as a vector whose elements represent the capacity of the different functional areas that constitute the terminal supply. In other words, the capacity is defined at a micro level taking into consideration the operational characteristics and the capacity of each functional subsystem and the relationships they have with each other. From this point of view, the capacity of the freight terminal should not be meant as the maximum point of production, but as a combination of various productive factors which characterize the operation and functionality of the node (Brennan, 2001; Gaur, 2005; One Stone Consulting Group, 2006).

The proposed methodology is defined according to typical supply system of UDC. It foresees the determination, by using appropriate functions of the single operative elements capacity.

The analysis of UDC capacity has been realized by using a discrete-event micro-simulation model. The simulation allows the evaluation of the operational capacity of existing UDC or to be made, by offering managers summary indicators to support decisions related to planning activities at different levels (strategic, tactical and operational). The model allows, through “what if” and/or “what to” procedures, the analysis of the operational capacity of UDC according the node working conditions and to the managerial policy adopted by the terminal operator.

General description
An UDC can be defined as "a logistic platform for the centralized management of takings and deliveries, which is aimed at goods distribution in an urban area through the aggregation of freight flows and the optimization of routes" (Da Rios and Gattuso 2003). In other words, an UDC is a logistic platform of cross-docking where goods directed to an urban area are received and distributed and groupage / degroupage activities are carried out.

In order to highlight the physical and operational components of an UDC, the supply has been represented by block diagrams. In this perspective, the structure of a logistic site can be schematized in 6 macro-functional areas operating in sequence:
- gatehouse, composed of a parking area to receive trucks arriving and waiting for service;
- input docks, reserved for trucks from suppliers and for loads of goods that are destined to end customers located in urban area;
- receipt area, sized to ensure the unloading of goods, the qualitative and quantitative controls and the possible labeling for the sorting of inbound goods;
- warehouse, organized to store the sorted goods;
- composition area, sized to ensure the formation of outbound load units and the loading of the vehicles used for secondary distribution;
- output docks, reserved for the vehicles which are utilized for the secondary transport and represent the final distribution link.

The methodology to evaluate the operational capacity has been developed with reference to the physical and organizational structure of an UDC. Depending on the physical and organizational components of a logistic platform, it is possible to obtain two different capacity measurements: the one refers to entry/exit areas, represents the number of vehicles that can be served at the receipt/consignment docks in the reference period and is measured in vehicles/h; the other refers to internal areas of the node, represents the capacity of handling inbound and outbound load units (unloading, control, sorting, handling, storage, groupage/degroupage, loading) and is measured in Load Units/h. Hence, the capacity of a logistic platform can be defined by two vectors representing the capacity of the node to receive and serve vehicles (\(C_g\)) as well as its capacity to handle LUs in its different operational areas (\(C_{UDC}\)).

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\begin{align*}
C_g &= (C_G, C_{BOUND}, C_{OUTBOUND}) \\
C_{UDC} &= (C_S, C_H, C_W, C_G, C_C)
\end{align*}
\]

\(C_g\) is the capacity of the gatehouse where trucks waiting for the service are received and served; \(C_{BOUND}\) is the capacity to serve...
inbound trucks; \( C_{\text{OUTBOUND}} \) is the capacity to serve outbound vehicle for urban distribution; \( C_S \) is the unloading capacity for trucks; \( C_{H1} \) is the sorting and handling capacity of inbound goods; \( C_W \) is the storage capacity; \( C_{H2} \) is the handling capacity of outbound goods; \( C_C \) is the loading capacity for the vehicles used for the urban distribution.

Since the capacity is a dynamic variable and a function of the operational characteristics of the node, a stochastic dynamic discrete event micro-simulation model was used to evaluate it in a dynamic way (Gattuso & Cassone, 2012). The model was specified, calibrated and validated on the basis of statistical analyses performed on data collected through direct surveys at an Italian logistic platform. The model was implemented using the software WITNESS. In order to carry out the capacity analysis of the node some specific functions were introduced.

The decision variables of the model are represented by the time "lost" at the different operational areas of the logistic platform, i.e. waiting time, service time, unloading time, handling time between the different areas of the platform, groupage time, load composition time and loading time.

**Results and conclusions**

The simulation of the logistic activities of an UDC is a fundamental tool to optimize the activities and to evaluate its performance and impact on the city. The paper proposes a methodology to analyze the problems related to the functional organization of an UDC with reference to the operational capacity of the node.

Capacity is one of the most important indicators for measuring the performance of a freight terminal. In the case of an UDC, capacity arises from the composition of the capacity of the node functional elements and varies over time in relation to the operational procedures and policies adopted by the operator.

The paper proposes a methodology for evaluating the global capacity of the logistics center, derived from the functional representation of the terminal. Since capacity is a dynamic variable, its evaluation and analysis were carried out by using a dynamic and stochastic discrete event micro-simulation model. This allowed an evaluation of capacity in relation to the management and operating conditions of the UDC.

The proposed model is an useful decision support tool for the operators of logistic centers because it is possible to make evaluations on the operational level that can direct the planning of tactical and strategic actions.

**References**


**Keywords**: Urban distribution center; capacity; micro-simulation model