Designing the Venue Logistics Management Operations for a World Exposition

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World Expositions, due to their size and peculiar features, pose a number of logistics challenges. This paper aims at developing a design framework for the Venue Logistics Management (VLM) operations to replenish food products to the event site, through a combination of qualitative and quantitative research approaches. First an in-depth interview methodology, combined with the outcomes of a literature review, is adopted for defining the key variables for the tactical and operational set-up of the VLM system. Second, a quantitative approach is developed to define the necessary logistics resources. The framework is then applied to the case of Milan 2015 World Exposition. It is the first time that such a design framework for a World Exposition is presented: the originality of this research lies in the proposal of a systematic approach that adds to the experiential practices constituting the current body of knowledge on event logistics.

Keywords: venue logistics management, event logistics, logistics operations, world expositions, mega-events

1. Introduction

Mega-events have been defined as large-scale cultural events that run for a limited time, are “stage-managed”, have popular mass appeal and enjoy international significance (Dornscheidt, Groth and Reinhard 2001). They are generally described as “mega” in relation to their size and to the level of public financial support (Dornscheidt, Groth and Reinhard 2001). Among mega-events, it is possible to mention:

- trade shows, exhibitions and World Expositions;
- cultural events which involve cities (e.g. World or European Capital of Culture);
- sports events (e.g. Olympic games, Soccer World Cup);
- World level political events (e.g. G8).

In particular World Expositions, which represent the focus of this research, are world-level exhibitions with six-month duration hosted every five years by a designated country. The aim of this kind of event is to promote the industrial and technological progress at a global level, showcasing the latest scientific and technical innovations that can improve the social and economic life. A World Exposition is further characterized by the broad scope of the chosen theme, which must be of universal concern to all of humanity. Between two World Expositions, an International Exposition usually takes place, with three-month duration. The international body that regulates the development and the organization of Expositions is the Bureau International des Expositions (BIE), founded in 1928 in Paris by 31 countries, which signed the first international treaty governing the organization of international exhibitions.

Taking into account the abovementioned unique features of mega-events and the consequent implications of organizing and performing mega-events, it is possible to state that they pose a number of special problems in terms of logistics management for three essential reasons (Minis, Paraschi and Tzimourtas 2006):

- the convergence of heavy flows of attendants and staff at one or several venues;
- strong time/space concentration of logistics flows;
- non-repetitive operations which have to "work right from the first time". Furthermore, in case of World Expositions, they also have to provide an excellent service level on a long time (i.e. six months).

In order to stage mega-events, there are immense logistics challenges that focus on planning, managing and executing the receipt, tracking, storage, transportation, distribution, installation and recovery of all equipment and materials (Kimmeskamp 2009; Minis, Paraschi and Tzimourtas 2006). These processes require to be performed ensuring an excellent logistics service in terms of timely deliveries and reliability of service. An excellent design and organization of the abovementioned logistics activities is essential due to the complexity and non-repetitiveness of the staging of a mega-event, where manifold players act simultaneously in the supply chain, affecting the overall outcome from every stakeholder's perspective (as shown in Athens 2004 Olympics – see Minis, Paraschi and Tzimourtas [2006]). Furthermore, an optimized design of the supporting logistics systems in terms of resources allows for compressing the logistics costs related to the event (Singh and Sharma 2014).

Being part of the scope of event logistics, the abovementioned processes can be specifically included in the so-called Venue Logistics Management (VLM) (Minis, Paraschi and Tzimourtas 2006). Among them, one of the major tasks of VLM is to support the replenishment of food supplies to the venue, which encompasses additional criticalities such as the management of the chilled/frozen food chain and of the shelf life typical of perishable food products. The considered processes are extremely important for a good staging of a mega-event. In fact, a well conducted design of their operations is fundamental for ensuring a proficient execution of those activities which allow providing one of the most essential and basic services to visitors: the catering service.

Even though the current body of knowledge is rich of examples of contributions containing guidelines and recommendations for addressing the problem of logistics and supply chain configuration and optimisation (from both a service and cost viewpoint), from a general perspective (e.g. Chopra and Meindl [2013], D. Simchi-Levi, Kaminski and E. Simchi-Levi [2008]), for different industries (e.g. Baghalian, Rezapour and Farahani [2013] for the agri-food sector; L.J. Fernandes, Relvas and Barbosa-Povoa [2013] for the petroleum supply chain; Chaudhry and Hodge [2012] for the textile and apparel sector; Creazza, Dallari and Rossi [2012] for the automotive sector; Carlsson and Ronnqvist [2005] for the forestry sector) and specific logistics requirements (e.g. Abdallah, Diabat and D. Simchi-Levi [2012], Chaabane, Ramudhin and Paquet [2011] and Beamon and C. Fernandes [2008] for supply chain sustainability, Singh and Sharma [2014] and Salvador, Rungtusanatham and Forza [2004] for supply chain flexibility, Colicchia, Dallari and Melacini [2010] for supply chain resilience), very little attention has been given to the logistics challenges of organizing and staging mega-events, as it will be subsequently described in detail. Besides the general lack of contributions focused on the object of our investigation, from a theoretical viewpoint the existing works don't take into account and don't apply to the specific analysed context the variables for designing a logistics system discussed in the literature.

This represents the trigger for our study, where we present a systematic design framework for the VLM operations for the food replenishment process of a World Exposition. We especially focus on the definition of the tactical and operational set-up for the VLM process of replenishing food supplies to the venue, along with an estimation of the necessary logistics resources in terms of vehicles, warehouse spaces, manpower and materials handling systems (Pirttilä and Hautaniemi 1995). We finally provide an application of the framework to Milan Expo 2015 World Exposition, in order to showcase in a detailed fashion the implementation of the proposed design framework to a real-life context.

The remainder of the paper is organized as follows: starting from a literature review on logistics systems design and on logistics management for mega events (Section 2), we then present the Research Questions of the study and the adopted methodology. This introduces a design framework built first on the analysis of the literature and of past experiences for deriving the key variables for the VLM tactical and operational set-up of the food replenishment process (Section 5). Second we complete the design framework through the development of a quantitative approach for the VLM resources estimations. Section 7 describes the results of the application of the design framework to Expo 2015 context and final remarks along with further research areas conclude the paper.

2. Literature review

The Systematic Literature Review is an efficient technique for identifying, selecting and evaluating existing contributions (Colicchia and Strozzi 2012; Denyer and Tranfield 2009). The first phase is represented by the question formulation, i.e. the definition of the scope of the research according to the objectives of the research itself.

Given the objective of the present research, our literature review will start from an analysis of the existing literature related to the typical variables for designing a logistics system. This is preparatory to focus the review on the investigation of event/exhibition logistics, with a particular attention to VLM for exhibitions and the design/organization of the logistics operations.

A number of keywords and search strings were identified to conduct the search on the citation databases. The selected sources of information were: peer reviewed journals and scholarly articles, conference papers, technical papers. The following criteria have been considered to include/exclude papers:

- papers presenting a high relevance to the themes under consideration were included;
- papers published in peer-reviewed scientific journals or presented at international conferences.

The search has been extended to non-academic sources, i.e. trade publications and white papers, which can provide very useful information about the examined issues covering both theory and examples from the practice and past events.

2.1 Design variables for logistics systems

An integrated logistics system consists of suppliers, providers of services, plants, distribution centres and storage facilities, retail outlets and receivers of goods in general along with the flows of information, work in process and finished products among the various facilities and players involved (Chopra and Meindl 2013; D. Simchi-Levi, Kaminski and E. Simchi-Levi 2008). Managers face complex decisions when designing the configuration and the organization of logistics activities (Droge and Germain 1998), which significantly impact on the firm’s performance both in terms of cost efficiency and effectiveness in serving customers.

The design of a logistics system typically embrace variables at the organizational, configuration and operational levels (Van der Vorst, Beulens and Van Beek 2000; Droge and Germain 1998; Stank and Traichal 1998).

Organizational variables include (Esper, Defee and Mentzer 2010; Defee and Stank 2005; Droge and Germain 1998; Stank and Traichal 1998):

- centralization: the degree to which decision making authority is delegated;
- specialization: the division of tasks and activities depending on specialism;
- formalization: the degree to which decision and working relationships are governed by formal rules and standard policies and procedures.

Configuration variables refer to decisions related to parties involved, roles to be performed, ways of cooperating among parties, constraints to executing roles, information technology and physical infrastructure to be used, including manufacturing and storage facilities along with distribution processes (Verdouw et al. 2011; Makatsoris and Chang 2004; Van der Vorst, Beulens and Van Beek 2000).

Design variables at operational management and control level determine how the cooperation and integrated planning of operations can be managed within the given configuration, with the aim to improve the timing, accuracy, quality of information flows and business processes (Van der Vorst, Beulens and Van Beek 2000).

Taking the perspective of the present research, it clearly emerges that for addressing the exceptional challenges of organizing and staging a mega-event, all of the above described design variables are relevant. However, given that a logistics system for a mega event needs necessarily to “work right from the first time” in conditions of great concentration of heavy logistics flows in a short time, the organizational design of the system (especially in terms of centralization and specialization) plays an even more critical role due to its low level of short-term flexibility, compared to traditional business situations where incremental organizational adjustments can be performed also in the medium/long term.

2.2 Event and exhibition logistics

Despite the business importance of mega-events and the unique aspects of event logistics, exhibition logistics, especially in terms of operations, has been largely overlooked by and under explored in the relevant literature. Moreover, notwithstanding the considerable potential of exhibition logistics to improve efficiency and thus reduce the cost of the trade fair operations, it is still considered as a peripheral function

(Delfmann and Arzt 2005). As a consequence, the literature in this field is remarkably scarce.

From a general perspective, exhibition logistics includes the planning, implementation, coordination and control of the flow of goods, people and information to and from exhibitions (Kimmeskamp 2009; Obergfell and Senghas 1997). In details, it regards the physical and information flows during the three fundamental phases of any event: the bump-in phase (before the event), the on-stage phase (during the event) and the bump-out phase (after the event and dismantling) (Kimmeskamp 2009).

The literature is mainly dealing with the logistics of mega-events in terms of the impact of hosting mega-events on transportation systems and on the mobility of people and vehicles for the hosting cities (e.g. Clark 2008; Bovy 2006; ECMT 2002). Also economic (Kirkup and Major 2006; Owen 2005; Kasimati 2003), safety and security (Taylor and Toohey 2007) impacts and tourism implications (Brown 2007) of mega-events have been addressed in the recent literature.

Only sporadic scientific contributions focus on the design of the logistics operations of exhibitions and mega-events. From a strategic point of view, Kimmeskamp (2009) performs a survey on the challenges in exhibition logistics faced by exhibition freight forwarders. The most important challenges of the exhibition freight forwarders' business are the internationality and different requirements of clients (exhibitor vs. organizer), the huge variety of services and the variety of goods to handle. By conducting a detailed analysis of the international market of exhibition freight forwarders, the author focuses on the identification of different types of companies that diversely face the challenges. The study aims to support exhibition freight forwarders by identifying best practices and market positions.

Minis, Paraschi and Tzimourtas (2006) propose a design process of the organization, processes and systems of Olympic logistics, developing a systematic methodology for designing the strategy and the tactical operations of the Athens 2004 Olympic Games. The authors, the only ones which take into account the essential issues of Venue Logistics Management, offer the analysis of factors such as Olympic-specific characteristics, host country characteristics, as well as lessons learned from previous games. In this way, the authors succeeded in generating and evaluating some strategic alternatives and business models to provide forecasts regarding the requirements of resources to be employed.

Another operations related contribution on exhibition logistics is presented by Ke, Peng and Wang (2008) which discuss how technological solutions, such as RFId, could enhance the logistics operations during mega-events.

Other papers are focused on trade competitiveness and logistics challenges in Asia (Haixia 2010; Miao 2010; Wang and Zhang 2009). However these articles seem to be hardly generalizable and extendable to other contexts.

Thus, the literature seems to be particularly wanting of contributions focused on the design of logistics operations for exhibitions management from a tactical-operational point of view. The extant body of knowledge, besides considering transportation and mobility issues, is mainly centred on strategic aspects of exhibition logistics (Kimmeskamp 2009). To the best of authors' knowledge Minis, Paraschi and Tzimourtas (2006) represent the only contribution focused on the organizational strategic and tactical issues of event logistics but the scope of this work is centred on Olympics and the essential design variables reported in Section 2.1 are neglected while proposing a solution for the logistics system of the Olympics.

3. Research questions

The analysis of the literature clearly shows that a study to design the logistics operations for mega events such as World Expositions is missing. In particular, a systematic approach able to propose a design framework for mega-events building upon the typical variables characterizing the design of logistics systems according to the literature (see Section 2.1) has not been proposed yet. Likewise, our analysis completely shows a lack of scientific contributions focused on the Venue Logistics Management for World Expositions, i.e. the focus of our investigation.

Thus, based on our purpose and on the abovementioned research gaps, we intend to contribute to the extant literature by providing an answer to the following Research Questions:

- RQ1: what are the specific variables for designing the VLM system to replenish food supplies to the venue of a mega-event?
- RQ2: how is it possible to quantify the necessary logistics resources to operationalize the VLM system devised through the specific logistics design variables?

4. Methodology

McCracken (1988) states the necessity to rely on both qualitative and quantitative methods to grasp all the nuances for developing and advancing logistics research. The author in fact asserts that qualitative and quantitative research approaches are not substitutes for one another; rather they observe different aspects of the same reality. Different methodologies are suitable under different context (i.e. tactical or operational level) and, taking into account the research questions of the present study, different research methodologies are needed since all of them cannot be solved with the same approach. A twofold methodology was thus adopted, combining a qualitative and quantitative approach (Figure 1).

With respect to the food replenishment process, an in-depth interview methodology was first adopted with the aim to determine the specific key variables for the tactical and operational set-up for the VLM system, by combining literature evidence and insights from empirical investigation. Second, a quantitative approach was developed to define the necessary logistics resources on the basis of the identified tactical and operational set-up.

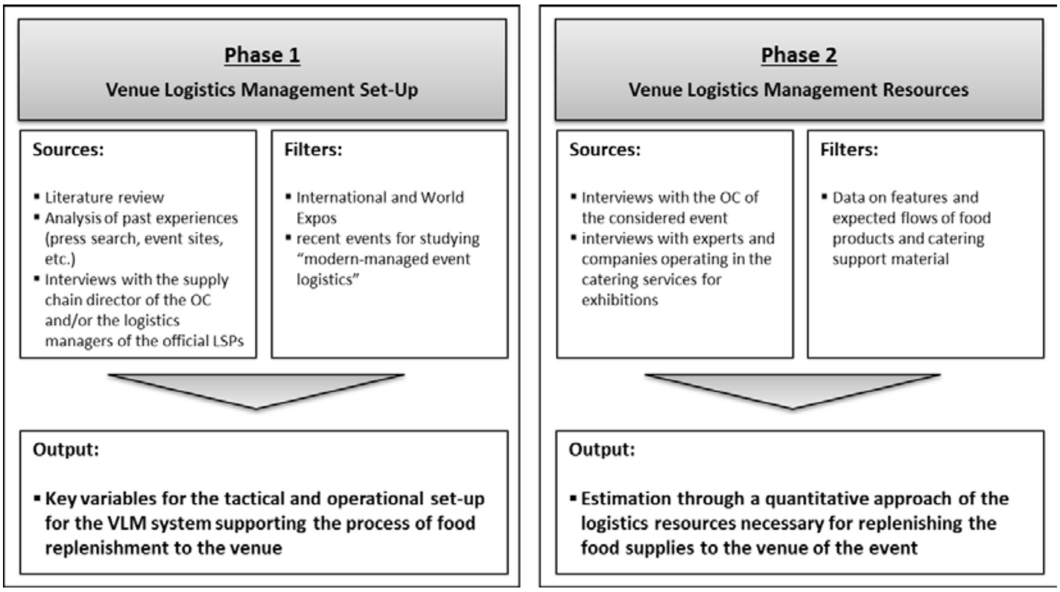


Figure 1. Research methodology

Taking into account that the organization of logistics operations for mega-events is a largely under-explored area, we decided to initially adopt a qualitative research methodology. In fact, a qualitative research methodology, such as in-depth interviews, can be particularly appropriate during the early stages of investigation of a phenomenon (Eisenhardt 1989; Yin 1994). Moreover, we decided to adopt a multiple interview approach, which allows the researcher to reach a deeper understanding of a phenomenon under examination (Miles and Huberman 1994; Yin 1994). This allows improving external validity (Yin 1994) and to create a rich theoretical framework (Ellram 1996).

Building upon Minis, Paraschi and Tzimourtas (2006), who considered recent past Olympic Games for designing the logistics operations for the Athens 2004 Olympics, we decided to consider a series of suitable “past experiences”. The past experiences to be analysed, whose features are illustrated in Table 1, were selected considering the typology of the event (i.e. International and World Expositions) and the date of hosting of the event (i.e. very recent events for studying the “nowadays management of event logistics”, including the current years’ security and safety issues). Thus, Shanghai 2010 World Exposition in China, Zaragoza 2008 International Exposition in Spain and Aichi 2005 World Exposition in Japan were selected, since they represent the most recently hosted Expositions, whose information is currently available.

With respect to each considered past event, we interviewed the supply chain director of the Organizing Committee (OC) and/or the logistics managers of the official logistics service provider(s) and/or we deeply analysed secondary data (e.g. press search, event sites, official after-event reports, official documents, official procedures).

We developed an interview protocol with a semi-structured questionnaire, which helped in gathering all the relevant data from the key informants. The questionnaire was developed on the basis of the reviewed literature. In particular, it included sections related to:

- the players and the activities of the food replenishment process (derived from the major tasks described by Minis, Paraschi and Tzimourtas [2006] - see Table 2);

- the organizational model of the logistics department in terms of level of outsourcing for the activities (according to the centralization and specialization design variables proposed in the literature);
- the adopted VLM model including delivery options and required logistics facilities (according to the configuration design variables proposed in the literature);
- the access restriction policies and the security procedures (according to the formalization and operational control design variables proposed in the literature).

We performed three interviews with each informant and each interview lasted on average two hours, it was picked up with a digital recorder and transcribed for analysis. An interview report/summary was developed which included further notes and observations by the researchers. In addition, we also examined and referred to the official after-event reports and documentation (for triangulating information). All the gathered information was recorded in a template, verified and validated by the informants. Through a cross analysis, combined with the literature evidence, we extracted the key variables to be considered for defining the VLM set-up.

We then adopted the quantitative approach for completing the design framework for the VLM operations. The class of research adopted is normative based on empirical data, since the present research deals with real-life data and it is created to help managers make better decisions. Indeed quantitative empirical research dealing with real-life data, as well as situations, offers the potential for fulfilling the managerial relevance requirement (Reiner 2005).

The aim of the quantitative approach is to provide an estimation of the logistics resources necessary for replenishing the food supplies to the venue of the event, in terms of vehicles, warehouse spaces, manpower and materials handling systems. The quantitative approach allows modelling the considered process and permits to estimate the amount of necessary logistics resources. This step, for its practical operationalization, requires additional interviews with the OC of the event and with companies operating in the catering services for exhibitions, for collecting all the necessary input data.

The entire framework was applied to Milan 2015 World Exposition case study in order to provide an example of its usefulness and applicability.

Table 1. Features of the events included in the "past experiences" sample

Event	*Event Typology*	*Duration*	*Visitors*	*Venue Surface*	*Theme*
Aichi 2005	World Exposition	6 months	22 millions (120,000 visitors/day)	170 hectares	Nature's Wisdom
Zaragoza 2008	International Exhibition	3 months	5.6 millions (68,000 visitors/day)	25 hectares	Water and sustainable development
Shanghai 2010	World Exposition	6 months	71 millions (400,000 visitors/day)	560 hectares	Better city, better life

Table 2: Considered tasks and activities in the food replenishment process of a World Exposition (adapted from Minis, Paraschi and Tzimourtas [2006])

VLM Task	*Description of the activities*
Freight forwarding	Inbound transportation and temporary storage of items and food products from extra EU countries
Customs clearance	Customs brokerage and clearance processes for food products from extra EU countries
Management of the storage areas	Stock keeping in warehouses, receipt, quality control, cross-docking, put-away, picking, consolidation for shipment, assurance of cold/chilled chain integrity for food products
Deliveries	Physical distribution to the venue, milk run and/or multi drop deliveries, collection of empty/reusable unit loads
Security management	Goods security and safety by means of inspections and goods scanning on inbound flows of products and unit loads
Venue access checking	Vehicle screening, documental controls and drivers' checking

5. Past Experiences

The analysis of past events was carried out through a multiple in-depth interviews approach, according to the research protocol described in Section 4. For brevity reasons, a summary of the information for the considered past events is reported, according to a common template (Tables 3, Table 4 and Table 5). This helps identifying the key variables to be taken into account in the design of the logistics operations, as it will be discussed in the cross analysis. Sensitive information and details have been secreted for confidentiality reasons.

Table 3. Aichi 2005 World Exposition

Level of outsourcing				
Task	*Planning*	*Coordination*	*Execution*	*Control*
Freight forwarding	In-house	Outsourced	Outsourced	Outsourced
Customs clearance	In-house	In-house	Outsourced	Outsourced
Management of the storage areas	In-house	In-house	Outsourced	Outsourced
Deliveries	In-house	In-house	Outsourced	Outsourced
Security management	In-house	In-house	In-house	In-house
Venue access checking	In-house	In-house	In-house	In-house

Number and role of logistics service providers
Logistics provider 1 (exclusive designated logistics provider for the cargo handling at the site warehouse, local delivery, international freight cargo management) Logistics provider 2 (local delivery, international freight cargo management) Official Transport Agents (10 freight forwarders including logistics provider 1 and 2, approved by the Association as being competent regarding cargo handling and customs clearance services)

Venue Logistics Management
Delivery options Direct deliveries to the users in the venue Deliveries via proximity warehouse
Proximity warehouse: one building (Association Warehouse) Location: close to the venue boundaries Surface: 2,250 m^2 of covered surface (580 m^2 for refrigerated storage for fresh and frozen food) Functions: warehousing, transit point, inspections and customs clearance
Venue storage areas Location: areas in the pavilions and in the catering units Surface: n.a. Functions: storage areas for participants and catering units daily operating needs
Access restriction policies and security procedures Participants, their official representatives or their authorized companies select one of the Logistics providers and entrust cargo handling to them. Participants can select any transport agents for transportation of cargo from other places to the venue. Official transport agents and Logistics providers could have direct access to the venue after documental control, while other non-appointed operators have to go through the Association warehouse.

Table 4. Zaragoza 2008 International Exposition

Level of outsourcing				
Task	*Planning*	*Coordination*	*Execution*	*Control*
Freight forwarding	In-house	Outsourced	Outsourced	Outsourced
Customs clearance	In-house	In-house	Outsourced	Outsourced
Management of the storage areas	In-house	Outsourced	Outsourced	Outsourced
Deliveries	In-house	In-house	Outsourced	In-house
Security management	In-house	In-house	In-house	In-house
Venue access checking	In-house	In-house	In-house	In-house

Number and role of logistics service providers
Logistics provider 1 (international freight cargo management, customs clearance, management of the storage areas) Logistics provider 2 (local freight cargo management, local deliveries to the venue)

Venue Logistics Management
Delivery options Direct deliveries to the users in the venue Deliveries via proximity warehouse
Proximity warehouse: one building (called "Logistics Centre") Location: 10 km away from the venue (in the PLAZA Logistics Platform, Zaragoza outskirts) Surface: 1,000 m^2, with 400 m^2 of refrigerated areas + 4,000 m^2 for the parking and trailer court Functions: warehousing, transit point, inspections and customs clearance
Venue storage areas Location: in the venue buildings' basement Surface: 125,000 m^2 Functions: storage areas for participants and catering units daily operating needs
Access restriction policies and security procedures Mandatory check-in facility for all suppliers at the Logistics Centre, including food suppliers (except for certified suppliers, which could perform direct deliveries to the Internal Service Areas after a documental control at the gates of the venue). Non-certified suppliers have to unload goods at the Logistics Centre for inspection, where X-ray scanning on goods can be performed. The official logistics provider subsequently performs the deliveries to the venue.

Table 5. Shanghai 2010 World Exposition

Level of outsourcing				
Task	*Planning*	*Coordination*	*Execution*	*Control*
Freight forwarding	In-house	In-house	Outsourced	In-house
Customs clearance	In-house	In-house	In-house	In-house
Management of the storage areas	In-house	Outsourced	Outsourced	Outsourced
Deliveries	In-house	In-house	Outsourced	In-house
Security management	In-house	In-house	In-house	In-house
Venue access checking	In-house	In-house	In-house	In-house

Number and role of logistics service providers
Logistics provider 1 (exclusive designated logistics provider for fresh and frozen food warehousing and local delivery, principal international freight cargo management) Logistics provider 2 (warehousing and local deliveries to the venue for dry food and catering support material) Logistics Provider 3 (minor international freight cargo management, warehousing and local deliveries to the venue for dry food and catering support material – resigned before the event)

Venue Logistics Management
Delivery options Direct deliveries to the users in the venue Deliveries via proximity warehouse
Proximity warehouse: three buildings Warehouse N.1: Location: within the venue, in the eastern section Surface: 3,500 m^2 of covered surface (refrigerated warehouse for fresh and frozen food) Functions: storage of basic/urgent food products for the venue operating needs Warehouse N.2: Location: at the southern boundary of the Venue, directly communicating with the outer areas Surface: 23,000 m^2 of covered surface (3,600 m^2 of refrigerated warehouse for fresh and frozen food products) Functions: general cargo storage, refrigerated storage, bonded warehouse, high value products safe storage, customs clearance. A part of this warehouse is rented to official food suppliers, managed by the official logistics providers Warehouse N.3: Location: within the venue, in the northern section Surface: 5,100 m^2 of covered surface Functions: general cargo storage, dry food products storage, mainly used for local products and the needs of the Chinese departments
Venue storage areas Location: small areas in the pavilions and in the catering units Surface: n.a. Functions: storage areas for participants and catering units daily operating needs
Access restriction policies and security procedures Warehouse No. 1 and No. 3 are facilities for storing only inspected and security checked products, the access is permitted only to the official logistics providers after documental controls at the gates of the warehouses. Warehouse No. 2 is the principal cargo gate of the venue: certified suppliers and the official logistics provider have direct access after documental control, non-certified suppliers have to unload their goods at the unloading docks and leave their management to the official logistics providers, since no operation is allowed within the fenced-up area. Goods are X-ray scanned.

6. Development of the design framework

In this section we first report the outcomes of the cross analysis of the past experiences section, combined with the outcomes of our literature review. Following we develop the quantitative approach for the estimation of the logistics resources.

6.1 VLM set-up variables

Moving from the evidence gathered during the analysis of the past experiences and combining this with the outcomes of the literature review on the design variables for logistics systems, it was possible to identify the following key variables, specific for determining the VLM set-up of an Exposition:

- Level of outsourcing (Variable 1).

  Literature suggests that decisions about the centralization must be made to ensure the strategic decisions are integrated and that the organizational efforts are focused in a common direction (Stank and Traichal 1998). In the context under investigation, the level of centralization is largely determined by the level of outsourcing of the logistics activities. The outsourcing of the logistics activities was a choice shared by all the OCs of the past events, according to the level of criticality of each logistics activity, as suggested also by the literature (Solakivi, Toyli and Ojala 2013). All the considered OCs identified a set of activities (e.g. security management) suitable to be directly managed by them and not only supervised as opposed to other activities (e.g. local deliveries to the venue), whose execution was outsourced to external providers, consistently with the literature (see Minis, Paraschi and Tzimourtas [2006]).

- Number and role of third-party logistics providers (Variable 2).

  After discussing the level of centralization, a related design variable is represented by the specialisation through which the roles and activities are assigned within the logistics system to improve efficiency and productivity (Droge and Germain 1998; Stank and Traichal 1998). This translates in the definition of number and role of third-party logistics providers in charge of different tasks within the VLM system, depending on each own specialism. The OCs of the past events selected more than one single logistics provider for the operations depending on the specialization (see Zaragoza 2008 for the segmentation of the local and the international freight cargo management) and/or on the volume of products to be handled (see Shanghai 2010 for the 71 million visitors to be served). In Aichi, two main providers were appointed, and 10 other freight forwarders were approved, for granting a high degree of flexibility, especially for the international import flows.

- Delivery model (Variable 3).

  A first element of the configuration of the logistics system is the organisation of the distribution processes (Van der Vorst, Beulens and Van Beek 2000) that can be translated into a model for delivering products to the consignees.

  In the context of VLM, all the OCs of past events adopted a delivery model based on two delivery options:

  - direct deliveries to the venue;
  - deliveries to the venue through one or more warehouses located in the surroundings of the venue (i.e. proximity warehouses);

  The direct delivery option is adopted in order to reduce the need for warehousing spaces. However, the direct deliveries that can be performed are function of the number of suppliers which are able to sign an official partnership with the OCs for obtaining the status of certified supplier for directly access the venue, as it will be explained in detail hereinafter.

- Proximity warehouse (Variable 4).

  Van der Vorst, Beulens and Van Beek (2000) indicate that the configuration of a logistics system is then strongly dependent on the physical infrastructures to be used. These embrace also the storage facilities.

  The past experiences show that at least one proximity warehouse is installed, for decoupling the logistics flows from suppliers to the users in the venue, to rationalize the deliveries and, if needed, to provide an amount of stock. The basic functions of this kind of facility are: being a transit point for cross-docking the food products to the venue, storing food products and catering support materials for non-certified suppliers or for certified suppliers as well, in case a section of the warehousing space is rented to them. The number and size of warehouses mainly depend on the following elements.

  - The number of direct deliveries to be performed: the higher the number of direct deliveries, the lower the number of proximity warehouses and the necessary warehouse space (see Aichi, where accreditation for direct deliveries in the bonded area within the venue was entrusted to many operators).
  - The possibility to rent warehouse space to official suppliers (see Zaragoza versus Aichi and Shanghai): if certified suppliers can establish their distribution centre in the proximity warehouse, the requirements of floor space will increase.

- The surface of the venues: widespread venues will require more than one warehouse (see Shanghai 2010).
- The configuration of the venue: small storage areas within the venue will require more than one single warehouse and more warehouse space (see Shanghai 2010). Vice-versa, large storage spaces very close to the catering users will reduce the need for space in the proximity warehouse (see Zaragoza 2008: 125,000 m2 of Internal Service Areas entailed the need for a 1,000 m2 single Proximity warehouse).

- Venue storage areas (Variable 5).

  Within the physical infrastructures that are part of the configuration design variables (Van der Vorst, Beulens and Van Beek 2000), a very specific facility to be included in the design of the VLM system is represented by the venue storage areas, commonly installed for serving the daily operational needs of the event, in terms of available food products and support materials. They are essential to further decouple the consumption and replenishment flows and ensure good service level performance for the needs of the catering users. However, the availability of space devoted to the storage of products within the venue is dependent on the space allocated to warehousing in the venue design phase.

- Access restriction policies and security procedures (Variable 6).

  The formalization and operational management and control design variables proposed in the literature (Van der Vorst, Beulens and Van Beek 2000; Droge and Germain 1998) play a crucial role in the context of VLM in order to smooth operations in presence of heavy concentration of logistics flows typical of a mega-event and for being ready to effectively manage exceptions. These can be translated in formal rules and standard policies and procedures. For mega-events they typically include access restriction policies/protocols to certify suppliers/providers, entailing the possibility for them to directly access the venue after documental or screening controls. Else, non-certified players are subject to inspections on the vehicles and on the goods at the proximity warehouse, where they have to unload their products. The security procedures adopted in all past events were drawn on the basis of international standards, based on the regulations of the airport security (IATA - International Air Transport Association).

6.2 VLM resources

In Figure 2 a schematization of the process for the estimation of the resources (i.e. warehousing spaces, materials handling and vehicles for the deliveries, manpower) is provided.

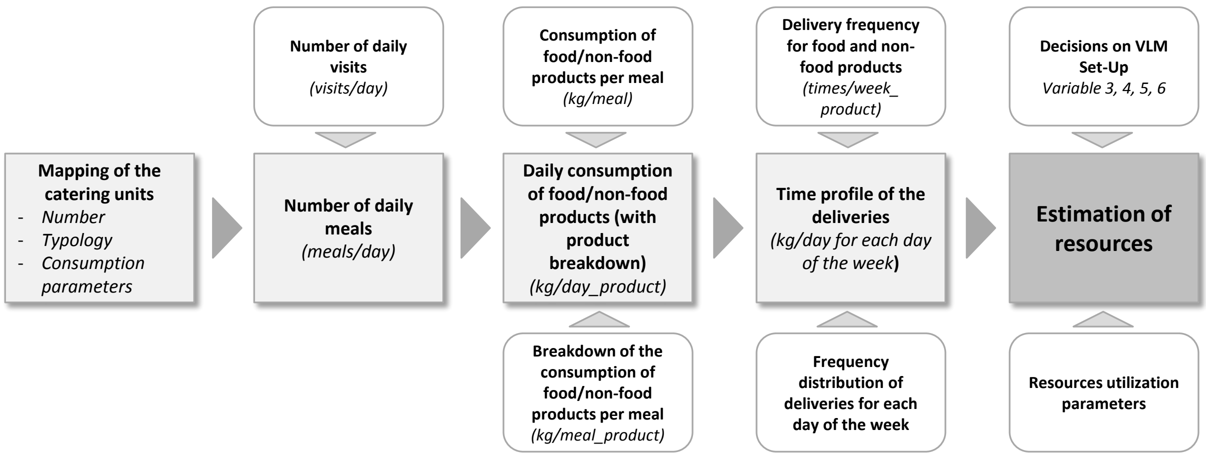


Figure 2. Estimation of the logistics resources

6.2.1 Mapping of the Catering Units of the venue

Since Catering Units (CUs) are the “consumers” of food within the venue, they must be the focus of the analysis. The CUs of an Exposition can be subdivided in three main categories:

- Restaurants: medium sized/large CUs including thematic and ethnic lounges, fine dining and food courts. They are characterized by the consumption of complete meals;
- Quick-Service Areas (QSA): self-services and fast-foods, characterized by medium/large size;
- Bars: generally small/medium sized CUs, including kiosks and refreshment stalls, they offer breakfast products, quick meal solutions and drinks.

It is thus necessary to map the number of each category of CUs and their location across the venue, along with the estimated subdivision of the overall served meals among them.

6.2.2 Number of daily meals served by the CUs

The expected number of overall visits during the event should be provided by the OC, along with the seasonal profile of the visits. This number must be converted in the average number of daily visits and expected served meals, considering the monthly and weekly seasonal profile. The overall number of meals must be allocated to the different CUs (“percentage split”), considering their nature and size.

6.2.3 Daily consumption of food and non-food products

For deriving the parameters regarding the average food consumption of the different types of CUs, it is necessary to perform additional interviews with experts and companies operating in the catering services for exhibitions.

It is thus possible to obtain an average value of the consumption (expressed in kg) of food and non-food products per meal for the different CUs. Considering the percentage split of the meals allocated to the various CUs, it is possible to obtain a weighted average consumption of food/non-food products per meal. Then, taking into consideration the overall number of served meals it is possible to estimate an overall daily flow of food and non-food products. This overall flow must be then subdivided considering the standard amount of different product types consumed by the different CUs: Beverage, Catering support material, Dry food, Fresh food, Frozen food.

6.2.4 Time profile of the deliveries

Since every product type is characterized by different shelf-life and features, it is mandatory to determine, through the abovementioned additional interviews, the weekly replenishment frequency for each of them, along with the amount of products to be supplied. For the sake of realism, each day of the week must be assigned a percentage value of the frequency distribution of deliveries, according to the number of deliveries per week for the various products types to be supplied.

6.2.5 Estimation of the resources

Variables 3, 4, 5 and 6 of the VLM set-up represent the tactical decisions which influence, as it will be evidenced, the daily operations of the venue logistics.

The estimation of the resources comprises: vehicles, warehousing spaces, manpower and materials handling equipment.

The estimation of the vehicular traffic to and from the venue impacts on the definition of all the other resources. Based on the delivery model formalized during the VLM set-up and on the basis of the security choices made with respect to Variable 6, three different "kind" of traffic can exist: direct deliveries from certified suppliers to the venue, deliveries from non-certified suppliers to the proximity warehouse, deliveries from the proximity warehouse to the venue, usually performed by the OC's vehicles or by the appointed official logistics service provider(s) (Figure 3).

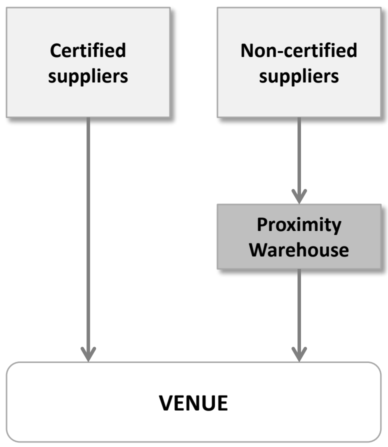


Figure 3. Vehicular traffic to the venue

It is necessary to translate the above flows of products into vehicular traffic. This should be done with particular respect to the maximum daily traffic according to the time profile of the deliveries previously determined (i.e. the most critical traffic conditions for the venue logistics system):

- direct deliveries from certified suppliers: each vehicle corresponds to 1 access to the venue. The maximum number of daily accesses can be determined converting the maximum daily flow of products directly delivered in “equivalent vehicles” on the basis of the average vehicle loading capacity;

- deliveries to the proximity warehouse from non-certified suppliers: each vehicle corresponds to 1 access to the proximity warehouse. The number of daily accesses can be determined converting the maximum daily flow of product delivered via proximity warehouse in “equivalent vehicles” on the basis of the average vehicle loading capacity;
- deliveries from the proximity warehouse: since the same vehicles perform several deliveries to the venue in the available delivery time window, each vehicle corresponds to more than 1 access. The daily number of deliveries per vehicle can be determined considering an available time window, the average time required for reaching the venue from the proximity warehouse, the average number of drops per delivery (based on an estimated average drop size at the CUs and on the average vehicle loading capacity) and the average time required for each drop including the time for unloading and moving between two subsequent drops. Taking into account the flow of products to be delivered from the proximity warehouse the number of vehicles needed for fulfilling the delivery requirements can be estimated.

Since the deliveries from the proximity warehouse to the venue are generally performed by means of OC vehicles, managed by its certified logistics provider(s), this part of the vehicular traffic represents the quantification of the necessary vehicles to be procured by the OC.

The vehicular traffic resulting from the direct deliveries from certified suppliers and the deliveries to the proximity warehouse from non-certified suppliers are the starting point for estimating the warehouse spaces (with reference to the space for the parking and trailer court and the floor space of the proximity warehouse).

In particular:

- the space for the parking and trailer court (for the check-in procedures for the vehicles from certified suppliers, if the decisions taken with respect to Variable 6 include this option) can be calculated moving from the maximum number of daily accesses of certified suppliers to the venue, converted into square meters by means of usual coefficients of vehicle land utilization (i.e. 50 m^2/vehicle for vans and light trucks, 80 m^2/vehicle for rigid HGV up to 10 tonnes; 110 m^2/vehicle for articulated HGV);
- the floor space of the proximity warehouse can be estimated considering its different functional areas:
    - inbound area: it can be estimated moving from the number of necessary unloading docks, to be calculated from the number of vehicles directed to the proximity warehouse, according to a suitable time profile of the vehicles arrivals, which should allow for determining the expected maximum number of contemporary hourly arrivals. Then, the space occupied by a single dock should be considered, including the area for the operations;
    - cross-docking area: it can be estimated based on the flow of goods to be delivered to the venue from the proximity warehouse and on the space utilization of pallets and other delivery unit loads such as roll-containers, including the area for the cross-docking activity and operations area;
    - outbound area: it can be estimated based on the outbound flow of delivery unit loads directed to the venue and on the number of loading

docks necessary for fulfilling the shipping requirements, based also on the estimated loading dock turnovers in the available time window. Then, the space occupied by a single dock should be considered, including the area for the operations. It is necessary to include a space for the unloaded returnable unit loads from the venue;

- other areas: additional storage space to be offered to the certified suppliers, to the participant countries and to the OC for the support materials, along with repacking areas and other technical service areas can be also considered depending on the specific needs of each event.

The warehouse spaces include also the storage areas within the venue, constrained to an upper bound by Variable 5 of the VLM set-up. It can be estimated from the cycle stock and safety stock for guaranteeing the operating daily needs of the catering units. It is thus necessary to consider the maximum and average overall flow of products (direct deliveries and deliveries from proximity warehouse), along with an expected average stock coverage index and an estimated coefficient of space utilization of unit loads in the buildings dedicated to the venue storage areas.

The necessary manpower can be estimated according to the Full Time Equivalent (FTE) principle (i.e. the ratio between the total number of required working hours during a period - part time or full time – for completing an activity and the number of working hours in that period). It is necessary to consider the maximum daily throughput of goods to be handled and delivered in the proximity warehouse(s), along with average values of hourly manpower productivity for the various handling activities, inspections and controls on documents and products. For the estimation of the required materials handling equipment it is necessary to collect suitable allowance factors, for determining the number of forklift trucks and other equipment to be used.

The values of manpower productivity and allowance factors can be gathered from the abovementioned additional interviews.

7. Milan 2015 Word Exposition Case Study

In the present section we present an application of the devised design framework to the case of Milan 2015 World Exposition, which represents a detailed implementation on a real-life context.

Milan 2015 World Exposition, whose theme is “Feeding the Planet, Energy for Life”, will take place from May, 1st 2015 to October, 31st 2015.

In Figure 4 the map of the venue is reported, according to the project approved by the BIE: the venue, located in the north-western outskirts of Milan, is a 100-hectare area which host the exhibitors’ pavilions and the so called “Service Areas”. The Service Areas constitute the buildings where the catering units (CUs) will be hosted. Basements are present under the ground floor of the Service Areas and they are the only space, across the whole venue, devoted to the storage of products.

Figure 4. Expo 2015 venue (courtesy Expo 2015 S.p.A.)

7.1 Expo 2015 VLM set-up

7.1.1 Level of outsourcing (Variable 1)

On the basis of the information gathered from the OC we defined a suitable level of outsourcing for each of the task and activities in the food replenishment process of a World Exposition (Table 6).

Table 6. Level of Outsourcing for Milan 2015 World Expo

Activity	*Planning*	*Coordination*	*Execution*	*Control*
Freight forwarding	Outsourced	Outsourced	Outsourced	Outsourced
Customs clearance	Outsourced	Outsourced	Outsourced	Outsourced
Management of the storage areas	In-house	In-house	Outsourced	Outsourced
Deliveries	In-house	In-house	Outsourced	In-house
Security management	In-house	In-house	In-house	In-house
Venue access checking	In-house	In-house	In-house	In-house

7.1.2 Number of third-party logistics providers (Variable 2)

Basing on the practices adopted in the previous events, and according also to a risk pooling approach, and finally considering that according to a recent survey (see Marchet, Melacini and Tappia [2012]) the Italian contract logistics industry presents a range of specialized services, it seems suitable the choice of one provider specialized in the last mile delivery service for the food replenishment within the venue, supported by one international freight forwarder for the management of import flows.

7.1.3 Delivery model (Variable 3)

According to the past experiences the adoption of the abovementioned delivery options was selected. Basing on the estimations provided by the OC, it was possible to determine a percentage split of the number of deliveries between the two considered options. We obtained:

- direct delivery from certified supplier: 63% of the flows;
- delivery from proximity warehouse: 37% of the flows.

7.1.4 Proximity warehouse (Variable 4)

Taking into consideration the most similar events to Expo 2015 in terms of size and venue features (Aichi 2005 and Zaragoza 2008) it was possible to state as necessary:

- one proximity warehouse for the storage of catering support materials, for the cross-docking of food products in transit to the venue, for the preparation of the delivery unit loads for the CUs in the venue, for the return of empty units loads from the venue and for the security control of the products incoming from non-certified suppliers;
- a parking and trailer court for documental checking and for providing basic services to the vehicles directed to the venue from certified suppliers.

7.1.5 Venue storage areas (Variable 5)

The storage areas will be placed in the basement of the Service Areas' buildings. Considering their role in the food replenishment process and according to the indications received from the OC, they will include also refrigerated rooms.

7.1.6 Access restriction policies and security procedures (Variable 6)

Mainly due to the presence of a potentially very similar security infrastructure and public law enforcement and considering the reference territory, even if not comparable to a World Expo for any other aspect, Turin 2006 Winter Olympics was considered as the most replicable model only for the access restriction policies and security procedures scheme. Consequently, its essential elements were replicated (Figure 5):

- the Soft Ring, a logical entity representing the external boundaries of Expo 2015 operations area, which includes the proximity warehouse;
- the Hard Ring, overlapping with the boundaries of the venue, which is physically delimited and characterized by a high level of security.

Safety and security procedures are selected based on the IATA security standards. The defined model implies that the players operating within the Hard Ring (i.e. OC or certified suppliers) are able to directly replenish the CUs, by means of compliant vehicles, passing through the trailer court for the documental controls. Non-certified suppliers are required to deliver their products to the proximity warehouse, where goods will be controlled and certified.

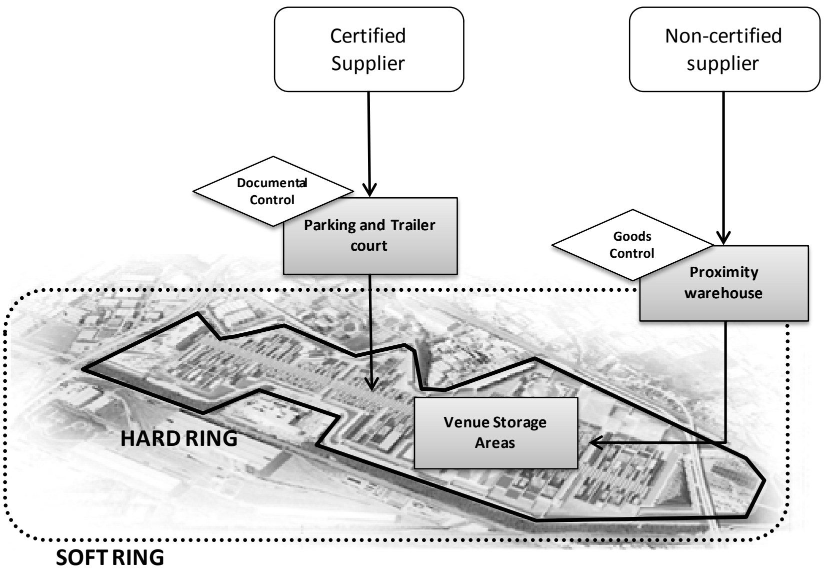


Figure 5. Expo 2015 security scheme

7.2 Expo 2015 VLM resources

The estimation of the logistics resources was performed with respect to two scenarios:

- the "typical" week, i.e. an expected average value of visitors and visits across the week;
- the "peak" week, i.e. the expected maximum value of visitors and visits across the week.

Besides gathering information from the OC, we performed some additional interviews in order to collect input data and parameters for the resources estimation. We interviewed 5 leading companies in Italy, which operate in the catering and logistics industries for exhibitions and mega-events, which provided all the parameters useful for operationalizing the design framework.

7.2.1 Mapping of the CUs

Expo 2015 venue will host approximately 160 Catering Units, including Restaurants, Quick-Service Areas, Bars. For confidentiality reasons, the list and the details of the different CUs cannot be divulgated.

7.2.2 Number of daily meals served by the CUs

The OC estimated the expected number of overall visits equal to 24 million visits (Table 7).

Table 7. Number of daily meals

Typical week		Peak week	
Visits/day	Meals/day	Visits/day	Meals/day
140,000	120,000	250,000	200,000

The overall number of meals was then allocated to the different CUs, as follows:

- Restaurants: 30%;
- Bars: 40%;
- Quick-Service Areas: 30%.

7.2.3 Daily consumption of food/non-food products

Basing on our interviews, we obtained an average value of the consumption of food/non-food products per meal for the different CUs. In particular, we obtained the following values:

- Restaurants: 1.2 kg/meal;
- Bars: 0.8 kg/meal;
- Quick-Service Areas: 1.2 kg/meal.

Taking into account the percentage split of the meals allocated to the various CUs, we obtained a weighted average consumption of 1.1 kg of food/non-food products per meal.

Then, we estimated an overall daily flow of food/non-food products equal to 130,000 kg/day in the “typical” week and equal to 220,000 kg/day in the “peak week”.

The interviews allowed subdividing the estimated daily flow of catering products into the consumption of the different considered product types, deriving the percentage split (in terms of weight) of the flow of products (Table 8).

Table 8. Daily consumption of food/non-food products

Product Type	*Restaurants*	*QSA*	*Bars*	*Weighted average % of the consumption flow*	*Average flow "typical" week [kg/day]*	*Weekly flow "peak" week [kg/day]*
Beverage	40%	50%	43%	45%	58,500	99,000
Catering support material	5%	10%	16%	10%	13,000	22,000
Dry food	20%	24%	20%	22%	28,600	48,400
Fresh food	25%	6%	5%	11%	14,300	24,200
Frozen food	10%	10%	16%	12%	15,600	26,400
Total	40%	50%	43%	100%	130,000	220,000

7.2.4 Time profile of the deliveries

The delivery frequency for each product type was obtained from the additional interviews, along with the daily percentage value of the frequency distribution of the weekly deliveries (Table 9). As regards the Saturday, no deliveries were planned except for the case of products requiring more than three deliveries per week.

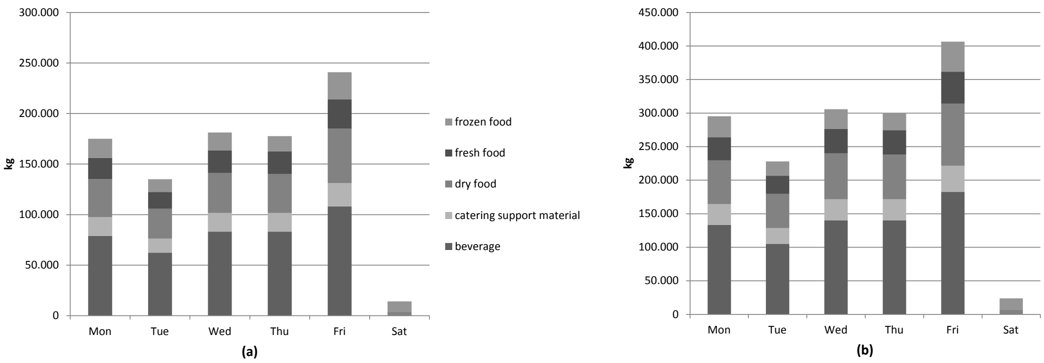
Table 9. The delivery frequency for the various product types

	Delivery frequency (deliveries/week)				
Product Type	*> 3*	*2*	*1*	*< 1*	*TOTAL*
Beverage	0%	20%	60%	20%	100%
Catering support material	0%	0%	20%	80%	100%
Dry food	10%	30%	40%	20%	100%
Fresh food	0%	20%	60%	20%	100%
Frozen food	50%	30%	20%	0%	100%

Table 10. Daily distribution of the weekly deliveries

	Days of the week						
Delivery frequency (deliveries/week)	*Mon*	*Tue*	*Wed*	*Thu*	*Fri*	*Sat*	*Total*
> 3	20%	10%	15%	10%	25%	20%	100%
2	15%	15%	20%	20%	30%	0%	100%
1	20%	15%	20%	20%	25%	0%	100%
< 1	20%	15%	20%	20%	25%	0%	100%

By matching all the gathered information, we obtained the time profile of the deliveries (kg/day) for the typical and peak week, respectively reported in Figure 6 (a) and Figure 6 (b).



	Days of the week						
	Mon	*Tue*	*Wed*	*Thu*	*Fri*	*Sat*	*Total*
Typical week (kg/day)	174,959	135,043	181,243	177,685	240,841	14,230	924,000
Peak week (kg/day)	295,221	227,924	305,887	299,923	406,441	23,853	1,559,250

Figure 6. Time profile of the deliveries

7.2.5 Estimation of the resources

It seemed opportune to perform the estimation with respect to the peak week only, in order to ensure to the OC the availability of resources in the most critical condition for the venue logistics system.

We started from estimating the vehicular traffic to the venue and to the proximity warehouse, assuming the input data reported in Table 11 and Table 12.

Table 11. Accesses (vehicles) of certified and non-certified suppliers

	Direct deliveries from certified suppliers	**Deliveries to the proximity warehouse from non-certified suppliers**
Average loading capacity (tonnes/vehicle)	3.4	4.5
Maximum daily flow (tonnes/day)	256.0	150.4
Maximum number of daily accesses (accesses/day)*	75.3	33.4

**equivalent to vehicles*

Table 12. Necessary OC vehicles for the deliveries from the proximity warehouse

Parameters (estimates)	**Deliveries from the proximity warehouse**
Average loading capacity (tonnes/vehicle)	1.98
Maximum daily flow (tonnes/day)	150.4
Time window (minutes)	360
Loading time at the proximity warehouse (minutes)	10
Travel time to/from the venue (minutes)	20
Time between two subsequent drops (minutes)	10
Number of drops per delivery	6
Number of necessary vehicles (expected)	**19 + 1***

*(*one back-up additional vehicle)*

It is necessary to consider that for each vehicle a driver must be hired (19 units).

With respect to the other resources:

- the space for the parking and trailer court: assuming 110 m^2/vehicle as the only coefficient of vehicle land utilization (for ensuring the highest flexibility to the court for the hardly predictable arrival of the different truck types) and the maximum daily number of trucks incoming to the venue prior to the opening of the gates (75.3 vehicles/day – see Table 11), we obtained 8,300 m^2 of required surface;
- the floor space of the proximity warehouse: the overall required floor space for the proximity warehouse is equal to 5,880 m^2. See Table 13 (a), Table 13 (b), Table 13 (c) and Table 13 (d).
- venue storage areas surface: the overall surface is equal to 6,410 m^2. See Table 14.
- manpower and materials handling equipment: the required overall manpower units account for 25.7 FTE (see Table 15 (a) for a detailed representation) and the total number of material handling equipment items overall accounts for 27.8 units see (Table 15 (b) for a detailed representation).

Table 13 (a). Floor space for the proximity warehouse inbound area

Parameters (estimates)	
Maximum daily inbound traffic (vehicles/day)	33.4
Expected maximum contemporary vehicles arrivals to the warehouse (vehicles/h)	7
Necessary unloading bays	7
Dock floor space occupation including unloading operations space (m^2/dock)	90
Inbound area (m^2)	**630**

Table 13 (b). Floor space for the proximity warehouse cross-docking area

Parameters (estimates)	
Maximum inbound flow from non-certified suppliers (tonnes/day)	150.4
Average outbound pallet/roll container weight (kg/unit load)	280
Average unit load floor space utilization including operations (m^2/unit load)	3
Cross-docking area (m^2)	**1,610**

Table 13 (c). Floor space for the proximity warehouse outbound area:

Parameters (estimates)	
Maximum number of vehicles for the deliveries (vehicles/day)	20
Loading dock turnovers in the available time window (turnovers/day)	2
Necessary loading bays	10 + 1*
Dock floor space occupation including unloading operations space (m^2/dock)	90
Additional space for empty unit loads returns (m^2)	150
Outbound area (m^2)	**1,140**

*(*one additional back-up dock)*

Table 13 (d). Floor space for the proximity warehouse other areas (estimates):

Functional and service areas (m^2)	**500**
Rework and repacking areas (m^2)	**500**
Storage areas for Expo partners (m^2)	**1,000**
Storage areas for participant countries (m^2)	**500**

Table 14. Floor space for the venue storage areas

Parameters (estimates)	
Maximum flow (overall) to the venue (tonnes/day)	406.4
Average flow (overall) to the venue for the safety stocks (tonnes/day)	259.8
Average pallet/roll container weight (kg/unit load)	280
Average days of stock coverage (days)	1,5
Average unit load floor space utilization including operations – building basement (m^2/unit load)	2,5
Overall venue storage areas surface (m^2)	**6,410**

Table 15 (a). Manpower units

Parameters (estimates)	
Expected throughput (tonnes/day)	150.4
Average unloading productivity (pallet/h)	30
Average cross-docking/sorting productivity (pallet/h)	6
Average loading productivity (unit load/h)	28
Average inspection/control productivity (pallet/h)	10
Net time window per manpower unit (h/day)	7

Manpower units (FTEs)	
Unloading	***2.0***
Cross-docking/sorting	***12.8***
Loading	***2.7***
Inspection/control	***6.1***
(estimated) Supervision	***2***

Overall manpower units	**25.7**

Table 15 (b). Materials handling equipment

Parameters (estimates)	
Average allowance factor for the utilization of the materials handling equipment	85%

Pallet jacks for loading and unloading (FTEs)	**5.6**
Picking carts for cross-docking/sorting	**15.0**
Carts for inspections	**7.2**

8. Conclusions

In the present paper we addressed the topic of the management of the logistics operations for mega-events, specifically focusing on the logistics processes for replenishing the food supplies to the venue of a World Exposition.

The considered processes are extremely important for a good staging of a mega-event. In fact, a well conducted design of their operations is fundamental for ensuring a proficient execution of the catering service, i.e. one of the most essential and basic services to visitors.

In the present paper we aimed at providing readers with a systematic and structured framework to the design of the VLM operations for the food replenishment process.

Moving from the evidence gathered from the literature, we studied the organization of the three most recent World and International Expositions whose information is currently available. By studying the empirical evidence of the past experiences according to a common template and to a cross analysis and by combining this with the outcomes of the literature review on the variables for designing a logistics system, we derived a series of VLM design typical variables for the “VLM set-up” (Phase 1). This provides an answer to RQ1. Phase 2 was represented by a quantitative approach for providing an estimation of the necessary logistics resources in terms of vehicles, warehousing spaces, manpower and materials handling equipment. This provides an answer to RQ2.

In order to give more emphasis to the provided answers to our RQs, we then applied Phase 1 and Phase 2 to the case of the Milan 2015 World Expo, showing how the information gathered from the OC of this event could be transformed into practice.

From a theoretical point of view, we can state that our methodology constitutes an innovative approach to the design of the logistics for a mega-event and in particular for a World or International Exposition. Given the dearth of scientific publications, this paper significantly contributes to the existing body of knowledge: it is the first time that such a structured methodology is presented, along with the definition and formalization of the main VLM set-up variables. That is to say, it is the first time that the practices from the past experiences have been thoroughly analysed, combined with the design variables of a logistics system discussed in the literature, condensed and formalized in a framework, along with the identification of the information requirements that the OCs should consider when they start to design the VLM. Another contribution of this study is constituted by the proposal of a procedure for the preliminary estimation of logistics resources. This could be considered also as a sort of decision support tool for OCs, since it offers the possibility to perform a “what-if analysis” on changing logistics parameters such as the volumes of food to be replenished and the percentage split between direct deliveries and deliveries via proximity warehouse.

This paper has a number of practical contributions also. Our framework offers a preliminary estimation for building a realistic and credible scenario, which could be the basing element for creating Requests for Proposals (e.g. at year -3, i.e. three years before the World Exposition opens).

This is essential, since it will help the OCs to adopt a concurrent design approach for the whole event processes: the anticipation of the logistics requirements is fundamental also for other design phases, such as the technical design of the venue and the installations. Through an early knowledge of the requirements of the logistics activities, it will be possible for the OCs to design the technical aspects of the venue, along with the interactions with the other event processes, for avoiding clashes and interferences.

In fact, moving from the initial estimation of the resources obtained through the adoption of our proposed framework, OCs will be able to perform at year -1 a fine-tuning of the design of the operations and quantification of the resources, together with the appointed logistics provider(s), which could lead to a competitive advantage to the OCs in terms of appropriateness of the adopted logistics solutions through also a more conscious negotiation with providers and suppliers (Chen, Goan and Huang 2011).

Our study has some limitations: first of all it regards only the process for replenishing food to the venue. Then, as it offers an outline design of the VLM system, it is endemically subject to variability depending on the availability of information over time. Furthermore, our approach requires specific information for its operationalization, such as the body of norms and regulations, the definition of the certification programs for suppliers and of the relationships' building with the players of the supply chain, which are all strongly dependent on the hosting country specificities (as pointed out also by Minis, Paraschi and Tzimourtas [2006]).

Further research can be undertaken to demonstrate the applicability and the validity of the devised framework. To do this, first it would be interesting to compare the results of the *ex-ante* application of the developed framework (as presented in this paper) with the field evidence gathered *ex-post* after the hosting of the investigated event. The analysis of the potential differences could provide useful insights regarding the actual planning process for the VLM system.

Moreover, the theoretical and practical contributions of the presented work could pave the way to extend the scope of analysis. Future research could encompass the specific features of other logistics processes, such as the management of the logistics for the construction materials, for the pavilions set-up and for the other operating materials. Extending beyond the remit of World Expositions, the developed framework could be applied to other typologies of mega-events, such as Olympic Games or cultural events. That would require a tuning of the proposed framework with particular respect to the presence of multiple venues and to the interaction with the existing local infrastructural system of the hosting city/country.

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