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► To cite this version:

Laura Palacios-Argüello, Salomé Ruel, Jesus Gonzalez-Feliu, Natacha Gondran. Logistic requirements considering environmental sensitive demand: evidence from the French food distribution sector. 8th International Conference on Information Systems, Logistics and Supply Chain, Apr 2020, Austin, United States. emse-02881914

HAL Id: emse-02881914

<https://hal-emse.ccsd.cnrs.fr/emse-02881914>

Submitted on 26 Jun 2020

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Austin, Texas April 22-24, 2020

Logistic requirements considering environmental sensitive demand: evidence from the French food distribution sector

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Abstract. As described in the literature, the demand characteristics could influence the food distribution configuration. The aim of this paper is to explain how these demand characteristics can be used to describe the logistic requirements for food distribution configuration. With this aim, the chosen methodological approach integrates a literature review, interviews of stakeholders involved in the distribution system and a survey to the French industrial sector. Results describe the logistic requirements from for food distribution found in the literature review according to the different actors, products and distribution configuration adopted. Furthermore, the logistic requirements extracted from the literature review are compared with the primary data collected to establish the main logistic requirements linked to the conscious demand in the food supply chain for the food distribution configuration. The main logistic requirements defined are linked to facility location, supplier selection and distribution optimization due to the logistic platforms and transportation strategies development. Finally, the results of this research provide information to food supply chain actors when designing the food distribution circuits aiming to answer to conscious demand characteristics that are emerging.

Keywords: Logistic requirements; food distribution system; environmental sensitive demand

1. Introduction

To feed the world, food logistic organization is a crucial factor [1]. The goal of the urban food supply system is to satisfy the food city requirements considering the quality and quantity specifications demanded [2]. Nowadays, there is an increasing need for developing food distribution strategies on a social, economic, and environmental sound basis that have been encouraging a research effort in the fields of food system sustainability. This is reinforced by increased product quality demands [1] and the increasing environmentally consciousness of consumers [3].

Oglethorpe and Heron [3] listed emerging solutions that encourage the reduction of large distribution networks. It involves less processed food, packaging reduction, more organic products and local products consumption making the food distribution process less environmentally damaging. This is one of the reasons why these changes in food quality and consumptions patterns influence changes in how the food is supplied and distributed, and consequently, the way the food distribution circuits are designed. This makes possible to configure different food distribution schemas and a variety of distribution channels by which food is supplied to final consumers [4].

Consequently, the food distribution systems become extremely divers and complex, increasing the complexity of defining and classifying the consequent supply chains []. This complexity can be reflected

in the number of food actors involved, the logistic requirements according to the food type and the distribution configuration adopted [4].

With the aim of decreasing this network complexity and of satisfying consumers who demand greater quality and traceability in the food supply chains, alternative forms of consumption in conventional food systems have emerged [1][**Erreur ! Source du renvoi introuvable.**][6]. One of those is the consumption of local products restringing a distribution configuration with a maximum of one (or ideally none) intermediary between the producer and the consumer, reducing externalities caused by conventional long distribution circuits [6].

As described above, the demand characteristics may influence the food distribution configuration. This paper explains how these demand characteristics can be used to describe the logistic requirements for food distribution configuration. With this aim, the paper begins with the definition of the food flows in the distribution system, then explains the food supply and distribution actors, types of products and detail the different configurations of distribution circuits, channels, and networks. Furthermore, it explains the logistic requirements for food distribution according to the different actors, products and distribution circuits adopted. Considering the institutional catering as a sector with a stronger environmental consciousness demand [8], the logistic requirements are identified and compared based on the primary and secondary data collected to establish the main logistic requirements linked to the conscious demand in the food supply chain for the food distribution configuration.

2. Literature review

This subsection explains the main logistic requirements found in the academic literature regarding the actors, the types of products and the distribution schemas adopted. According to Fredriksson and Liljestrand [1], the main stakeholders in the food supply chain can be grouped in 4 categories:

- primary producers: agriculture producers which grow the raw fresh products;
- industrial producers: transformation companies which transform raw products into agro industrial products;
- wholesalers and distribution companies which deal with the distribution processes,
- and retailers which remain the interface with end-consumer.

Moreover, in food retailing and Ho.Re.Ca. (Hotels, Restaurants and Catering), it is important to distinguish between independent retailers, organized/franchised/corporate retailers and grocery stores [9].

The logistic requirements according to the food product types impose constraints such as: perishability, sensitivity to the surrounding environment, seasonality in demand and supply, the dependency on natural conditions for production and the demands on quality and traceability [1]. Moreover, food quality regarding the sensory properties of fresh products (taste, odor, appearance, color, size, and image), and the food traceability regarding the product safety issues are important [1]. For chilled products, demands on the duration and conditions of storage, processing, and transportation, which limit the possibilities of distribution are important. Finally, for frozen products, the warehouse location, either close to the harvest/production or close to the market is important.

Nevertheless, various authors [10][4][11] define as logistic requirements for all types of food products:

- Short lead times and just-in-time deliveries.
- Specific handling procedures.
- Regulatory issues (related to temperature requirements): thermal integrity of the shipments.

Compared with other non-highly perishable food and non-food supply chains, these logistic requirements result in higher consumption of energy, lower levels of consolidation and lower efficiency, leading to additional costs for transport operations [1].

Finally, [1] and [13] describe the main logistic requirements according to the distribution circuit adopted. [16] describes the main logistic requirements according to the distribution circuit and channel adopted. [1], [4] and [10] define the logistic requirements according to the food distribution channels regarding the place

of food consumption: logistic requirements for food distribution "at home" consumption and for food distribution "out of home" consumption. Table 1 summarizes this overview.

Table 1: Logistics characteristics and requirements for each stakeholder's category in the food supply chain (authors' elaboration, adapted from [1], [4] and [10].

Stakeholders	Logistics characteristics and requirements
Primary producers	<ul style="list-style-type: none">• They need to ensure food traceability and quality during the distribution process.• Collective organization to transport the food.
Industrial producers	<ul style="list-style-type: none">• They are interested in delivery speed and geographical location, considering products' perishability and specific distribution solutions, being then cost-sensitive.• They prefer not to postpone production steps to suppliers, because they think logistics service providers have limited knowledge of food quality or lack flexibility.• They need manufacturing flexibility because of their relatively high product and volume variety.
Wholesalers	<ul style="list-style-type: none">• They are interested in improving the distribution because for them transport costs are an important issue when source their fresh food products.
Retailers	<ul style="list-style-type: none">• They are interested in distribution issues because a substantial part of the operations costs of food retailers are the logistics costs.• They depend on high availability on the store's shelves.• They are looking for well-developed distribution strategies that provide them with a competitive advantage.• They promote vertical integration within retailer's networks, focus on logistics management aiming to improve their logistics systems continuously.
Corporate retailers	<ul style="list-style-type: none">• They invest heavily in distribution networks to take control of deliveries and increase overall supply chain efficiency.• They are interested in consolidating supplies upstream of stores at centralized distribution centers.• They are interested in achieving economies of scale through centralized, more consolidated and less frequent deliveries.
Independent retailers and Ho.Re.Ca. ¹ sector	<ul style="list-style-type: none">• They often do not control deliveries, a shippers are responsible for goods transport.• They usually do not pay for the transportation directly and have no contact with carriers except for the receipt of the delivery.• They are supplied frequently, because they have diverse suppliers, with a predominant use of their own vehicles and low vehicle fill rates.

3. Methodology

The proposed methodology is structured as follows:

1. First, a literature review of logistics requirements and needs was carried out to identify the main logistics requirements related to green food supply chains already shown in the literature. This phase has made the object of previous published works [11][12]. The results of this review allowed identifying a first set factors influencing green products' demand, in agrifood supply chains.
2. Once this first set of factors identified, a set of semi-structured interviews was carried out to affine those factors' set and pre-select a set of requirement categories and prepare a quantitative survey to go in-depth on the question.
3. From that pre-selection of requirements, a quantitative survey is carried out to define the most relevant requirements to green food supply chains. That survey will state on the potential of each requirement category to improve and green the food supply chains (a first part of the survey related to green logistics factors influencing products' demand is presented and analyzed in [11]).
4. With the survey's results, an assessment method is deployed to state on the potential gains (in terms of transport distances and/or times). This part is an ongoing work and will be not presented

¹ Hotels, Restaurants, Catering

here, but it is important to show that the present work aims at feeding a quantitative modelling and assessment approach.

3.1. Semi-structured interviews

The semi-structured interviews are based on open-end questions to stakeholders of the food supply for the school canteens in Saint-Etienne, France. To conduct semi-structured interviews and ensure high-quality research, two documents were created: an interview protocol, and an interview guide. The interview guide was developed following the IDPA model (in French: *Identification, Diagnostic, Prospective, Amélioration*²) and the details of the interviews, as well as the guides and protocols, are detailed in [8].

The IDPA model establishes four phases: (1) identification of the situation, (2) diagnosis, (3) foresight and (4) improvement. This guide was used to make the questions as effective and efficient as possible without forgetting any important issue to collect and document all impressions and experiences from each interview.

The sample was designed following the snowball sampling method [13]. In total, six semi-structured interviews were conducted. Such interviews can be seen as a preliminary work to identify variables to consider in the quantitative survey. Therefore, the results of the interviews were then completed with an exchange with a focus group of 6 researchers to ensure that a sufficient number of stakeholders were interviewed, as well as with a set of contextual secondary data read prior to the meetings, to increase trustworthiness.

3.2. Survey

The survey questionnaire was part of a larger survey about environmental criteria (see [11]), which aim was to examine the influence of environmental quality on product's demand. However, we present here an unpublished part of the survey, the published part dealing with eco-responsible practices that influence products' demand, and this paper being related to the logistics requirements. That survey was completed with a set of 57 questions regarding how those criteria can be declined into logistics requirements, and starting from the list of requirements issued from the literature review and the semi-structure interviews, the importance of each requirement category and the presence of it in current logistics practices was asked. The survey was administrated through a self-completed questionnaire by internet on Limesurvey survey platform. It was conducted from April to August 2018. Firstly, a pilot survey was carried out among few professionals to validate the understanding of the questions.

Regarding the sample, the respondents' database was obtained from 2 different sources: (i) 6600 e-mails of managers of agro-industrial companies from the French Kompass database, and (ii) 850 emails of producers, transformers and distributors from the agro-industrial sector from the Auvergne-Rhône-Alpes Observatory. After e-mails validation, the final size of the population obtained was 5820. The composition of the sample of respondents is shown in Table 2. In total, 555 anonymous questionnaires were received, 307 questionnaires were excluded due to incomplete information, having 248 valid questionnaires (i.e. a response rate of 9.5%, which is high with respect to surveys of that nature, and a rate of valid responses of 4.2%, an average-high value for this type of surveys).

The majority of respondents work in small and medium companies. However, 43% of the total companies surveyed are part of a group. Industry types were grouped according to their main activity based on the NAF typology of the National Institute of Statistics and Economic Studies (INSEE), since it is the French standard used in freight demand modelling and has recently been compared to other classifications, like the NACE or NAICS for quantitative generation of logistics demand [15][16]. Despite some biases due to sampling and clustering of industries, the distribution among the study industries is fairly representative. The profile of the respondents is over 90% of high qualified profiles, including executive officers and engineers. This fact is confirmed by the years of experience that respondents have in that job, the majority have over 6 years of experience in that job, and more than 50% of the respondents have over 10 years of

² Identification, Diagnosis, Foresight, Improvement

experience. Finally, each area involved is between 10% and 20% of the total answers, which means that each area is fairly representative in the study.

Table 2: Respondents' demographics

		N	%
Company size (INSEE³ classification)	Micro: 5 employees or less	13	5,2%
	Small: Between 6 and 50 employees	111	44,8%
	Medium: Between 51 and 250 employees	84	33,9%
	Large: Over 250 employees	40	16,1%
Group	Part of a group	107	43,1%
Industry type (INSEE classification)	Fruit and vegetables industry	19	7,7%
	Meats industry	43	17,3%
	Fish industry	13	5,2%
	Grain industry	16	6,5%
	Dairy industry	29	11,7%
	Beverage industry	10	4,0%
	Pasta and Bakery industry	34	13,7%
	Animal feed industry	17	6,9%
Job position	Executive officer	170	68,5%
	Engineer	55	22,2%
	Technician	20	8,1%
	External consultant	3	1,2%
Experience	Less than 2 years	19	7,7%
	Between 2 and 5 years	41	16,5%
	Between 6 and 10 years	42	16,9%
	Over 10 years	143	57,7%
Area	Corporate Social Responsibility - Quality	139	19,8%
	Purchasing - Supplies	104	14,8%
	Production	101	14,4%
	Logistics	72	10,3%
	Marketing - Distribution	100	14,2%
	Communication / Marketing	84	12,0%
	Direction – Human Ressources Management	102	14,5%

4. Results

Based on the feedback from the development of the semi-structured interviews, it was possible to determine that the consumer's consciousness is growing and in consequence, there is a strong demand for sustainable food supply. This enforces the need for adapting the food distribution in order to improve its environmental performance while remaining food supply chains economically competitive.

One of the most common logistic requirements mentioned by all the interviewees was the need for strong involvement of local actors in the food supply. This logistic requirement can be explained as a crucial question of spatial distances; perceived as proximity circuit, a term used to characterize the length in local food approaches [17][18]. which means a short distance between producers and consumers. Another logistic requirement that was raised was the importance of the collaboration between the actors to improve the distribution system activities in the entire supply chain.

This collaboration requirement involves:

- Development of information system to share information about the demand quantities.
- Transportation sharing among the actors involved.
- The food consolidation strategies to be developed between producers to build a robust offer and

³ National Institute of Statistics and Economic Studies in France

a centralized distribution.

This allows them to take control of deliveries and increase overall upstream distribution efficiency. Regarding the sustainability issues of the distribution system, another logistic requirement evoked was the request of using clean technologies during the food distribution. The retailers and the wholesalers use clean vehicles (gas powered freight vehicles) as a call-tender requirement from the public agent. Finally, another logistic requirement mentioned by all the interviewed was the need for a distribution network flexibility. This flexibility is requested in terms of food conditioning and quantities, but also in terms of delivery time and frequency.

Concerning the survey's results, we observe two main macro-categories of requirements. The first deals with purchasing practices and can be used to describe the logistic requirements for sustainable distribution related with the selection of local suppliers. From those, the most popular measures are the selection of local producers (which is selected by 69% of the as a solid way of increasing the product environmental quality), cooperation with suppliers (indicated by 55% of the respondents) or the establishment of a responsible purchasing policy (48%). Figure 1 shows the selection rate (in percentage) for each practice.

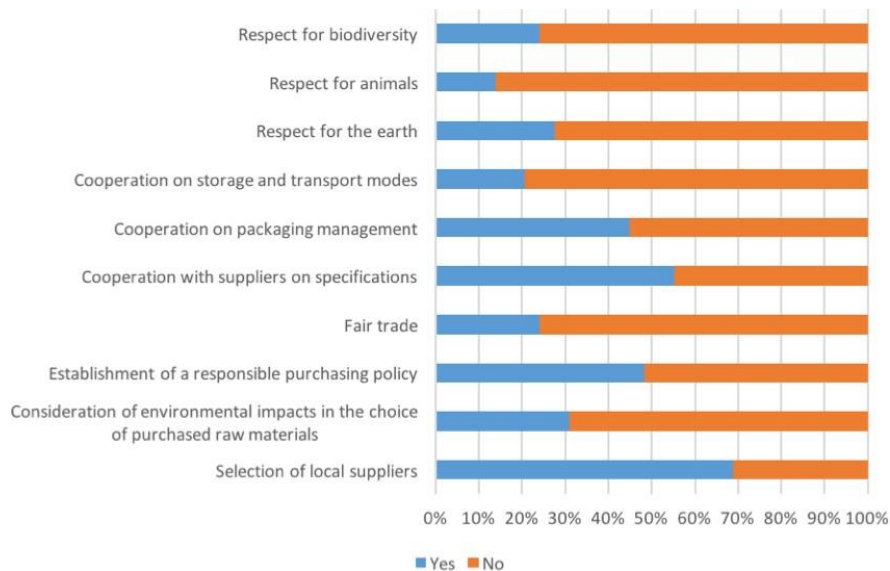


Fig. 1: Logistics requirements in terms of purchasing practices

The second macro-category is related to distribution practices that can be used to describe the logistic requirements for sustainable distribution. The respondents highlighted:

- the optimization of kilometers travelled for transportation and logistics pooling (60,7%)
- internal (warehouse or production) logistics collaboration (53,6%),
- location decisions: near to the market (35,7%) and suppliers (28,6%).

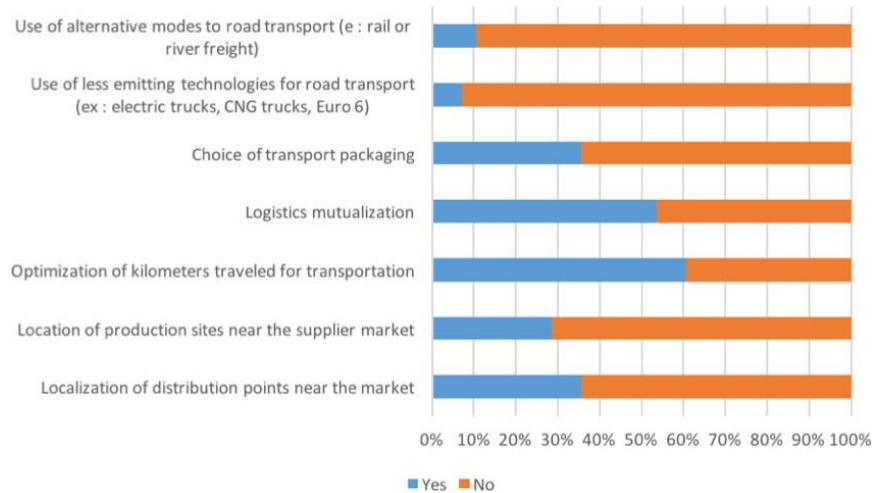


Fig. 2: Logistics requirements in terms of distribution practices

Figure 2 shows the main logistic requirements related to distribution practices. From that, we observe that practices that influence the product demand are related to the geographical proximity with the stakeholders. This impacts the decisions related to the facilities location such as (i) the location of distribution points close to the market and (ii) the location of production facilities close to suppliers.

5. Discussion and conclusion

The actors in the food supply chain are becoming more aware of the need for the food logistic organizations improvement regarding the increasing environmental conscious demand (Palacios-Argüello et al, 2018). Distribution is then a relevant topic of research nowadays with the logistic request of food products going more quickly from primary producers to consumers while they increasingly consider sustainability externalities. However, because of the different logistic requirements, different distribution configurations are needed that reduce the external impacts of food transportation by improving local supply and strengthening the collaboration among the actors of the food supply chain. Therefore, the decision support in distribution scheme configuration is one of the main research directions that will be followed.

Besides, regarding the logistic requirements collected and compared to the literature review, it is possible to affirm, thanks to the semi-directive interviews, that there are three kinds of logistic requirements that actually influence the food distribution configuration: (i) Distribution circuit design regarding the facility location that could be near to the market or near to the suppliers. (ii) Suppliers choice regarding the product characteristics requested and the proximity relationship considering the supplier location. (iii) Distribution optimization considering logistic platforms and transportation strategies (i.e. distance travelled reduction, increasing vehicle's fill rates, decreasing environmental impacts).

In conclusion, the logistic requirement for food distribution configuration collected from the environmental conscious demand characteristics can be: facility location (either near to the market or to the suppliers); the supplier selection (based on product characteristics and supplier location related to a proximity relationship); and the distribution optimization due to the logistic platforms and transportation strategies development (i.e. distance travelled reduction, increasing vehicle's fill rates, decreasing sustainability externalities).

However, the survey being conducted in a national context (France), context and culture factors would have an impact on the nature of responses and transferability issues. Concerning the relationship between cultural factors and the responses, it is difficult to address possible bias and influences with a unique, country-based survey, but two main elements can be stated here. The first is that the agrifood sector, although very heterogeneous, presents a subset of stakeholders having an international, global and standard supply chain orientation. As the surveyed companies were mainly from those supply chains, answers would follow the logic of such global practices, and reduce cultural influences, although they would not be zero. The second is that the methodology is replicable and transferrable, since data collection and processing methods remain standard and follow a scientific path, so they are able to be applied to other contexts. In that sense, replicating the methodology in other countries, if keeping a homogeneity of hypotheses and assumptions,

would allow to produce evidence of this cultural influence (this was not the aim of this research, but would be a possible future development).

Moreover, and to address other research limitations, the logistic requirements for food distribution discussed in this paper are only based on the methodological approach adopted to collect information from the literature review, the interviews of stakeholders involved in the distribution system and the results from a survey to the French industrial sector. However, it is possible that there are some logistic requirements imposed by the final consumers that are not considered. Finally, the results of this research provide information to food supply chain actors when designing the food distribution circuits aiming to answer to conscious demand characteristics that are emerging.

6. Acknowledgements

Part of this work was made in the context of ELUD project (LabEx IMU- Université de Lyon) for the semi-directive interviews and main analysis work and it was also supported by the French National Agency project CONCLUDE in the context of the AAPG 2015 of the ANR.

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