Horizontal collaboration and sustainability in freight distribution networks: A Systematic Literature Review SLR and recommendations for future research

Aymen Aloui[1], Nadia Hamani[1], Ridha Derrouiche[2], Laurent Delahoche[1]

[1]University of Picardie Jules Verne, Laboratory of Innovative Technology, 80025 Amiens, France
[2]University of Strasbourg, EM Strasbourg Business School, 67000 Strasbourg, France

Horizontal collaboration and sustainability in freight distribution networks: A systematic literature review and perspectives

Abstract

In the last few years, competitiveness, problems of globalization and concerns about sustainability require new approaches and models for the planning of transport networks. Horizontal logistics cooperation has been considered an emerging and innovative approach in the design and management of sustainable supply chains. This approach is based on the sharing of resources between actors at the same level in different supply chains. This study provides a Systematic Literature Review (SLR) about sustainability and collaboration in the freight transport sector. It aims to analyze the existing literature in order to reveal the studies already conducted and to identify gaps and opportunities for future research. A total of 89 articles have been published between 2010 and 2020 which have been examined. The results show that the integration of these three dimensions of sustainable development in the field of collaborative network optimization, especially the social considerations have been little studied. In addition, the analysis shows that most of the authors have focused their research on transport optimization at the operational level, with few works on the problem of designing and managing the integrated supply chain.

Keywords: Horizontal collaboration, Sustainability, Systematic literature review, Freight transport, Transport planning

1. Introduction

Today's business world is influenced by the globalization of markets, the rapidly changing requirements of customers, and concerns about sustainability. Consequently, companies are constantly searching for new strategies to improve their logistics performance and ensure their competitiveness in today's market (Aloui et al., 2020). Especially on their goods distribution network, which represents a major component in all supply chains (Muñoz-Villamizar et al., 2019a). In this context, logistics collaboration is considered as one of the most effective mechanisms for companies who wish to increase their logistics efficiency and to achieve their goals of economic, environmental and social sustainability (Ben Jouida et al., 2017; Vanovermeire and Sörensen, 2014). This approach focuses principally on the coordination and integration of processes between supply chain actors (Stellingwerf et al. 2019). It can be horizontal between a group of stakeholders from different supply chains acting at the same level, vertical by considering hierarchical relationships in a supply chain or integrated by combining horizontal and vertical synergies, known as lateral collaboration (Soysal et al., 2018).

In recent years, researchers and practitioners have increasingly focused on horizontal collaboration, through the multiple benefits that it generates by sharing resources (warehouses, distribution centers, vehicles, etc.) between actors in different logistics networks (Pan et al., 2019). This strategy has been involved at different levels of planning of transportation networks. At the strategic level, the use of the horizontal collaboration concepts are focused on designing common logistics networks in order to consolidate flows and achieve economies of scale (Ballot et Fontane, 2010; Nataraj et al., 2019; Pan et al., 2013; Verdonck et al., 2016). At a tactical and operational level, route optimization and organization are the most discussed issues in the literature (Buijs et Wortmann, 2014; Defryn et Sörensen, 2018; 2018; Montoya-Torres et al. 2016; Quintero-Araujo et al. 2016; Wang et al. 2020, 2017a, 2018a). Most studies, from the strategic to the operational level, focus on quantifying potential economic savings through horizontal collaboration. However, as mentioned above, the logistics networks' effectiveness must be evaluated with the three sustainability aspects.

The literature and industry practices in this topic increasingly emphasize that horizontal collaboration is an effective means of balancing the three dimensions of sustainability and increasing transport efficiency. However, scientific research on horizontal collaboration and the integration of the Triple-Bottom-Line (3TBL) dimension is still at an undeveloped level, it is therefore necessary to conduct a detailed analysis of the state of knowledge. This study has identified four literature reviews that differ from the objectives of this research. In fact, Verdonck et al. (2013) and Guajardo et Rönnqvist (2016) reviewed methods of sharing the gains generated by horizontal collaboration in freight transportation. At the operational level, Gansterer et Hartl (2018) examined optimization models for collaborative transport planning. Pan et al. (2019) provided a comprehensive review of existing horizontal collaboration solutions and implementation issues in freight transportation. To the best of our knowledge, no study has been conducted on horizontal collaboration and sustainability in the freight transportation sector. To fill this gap, this article addresses the horizontal collaboration and sustainability in freight distribution. In particular, this research aims to answer the following two questions: Firstly, what is the existing work and what are the current research trends on horizontal collaboration and sustainability in freight transportation? Secondly, what are the existing research gaps and what are the potential contributions for future work?

The rest of this paper is organized as followed. The second section presents the methodology of the review. A descriptive analysis of the selected articles is described in the third section. The fourth section categorizes and discusses in detail the existing work according to categorization criteria. Research trends and gaps are discussed in the fifth section. The sixth section aims to identify some directions for future research. Finally, the seventh section is the conclusion.

2. Research methodology

To answer the research questions identified in the previous section, an SLR is conducted in order to provide a detailed and comprehensive analysis of the state of the art. In this study, the guidelines proposed by Durach et al. (2017) to conduct an SLR in supply chain management have been used. The methodology of this study consists of six steps:

(i) Formulation of the search question and choice of keywords,

(ii) Definition of inclusion and extrusion criteria,

(iii) Search in databases,

(iv) Papers selection, discussion and analysis of the results, and

(v) Reporting of the results.

Fig. 1 summarizes the methodology used in this study.

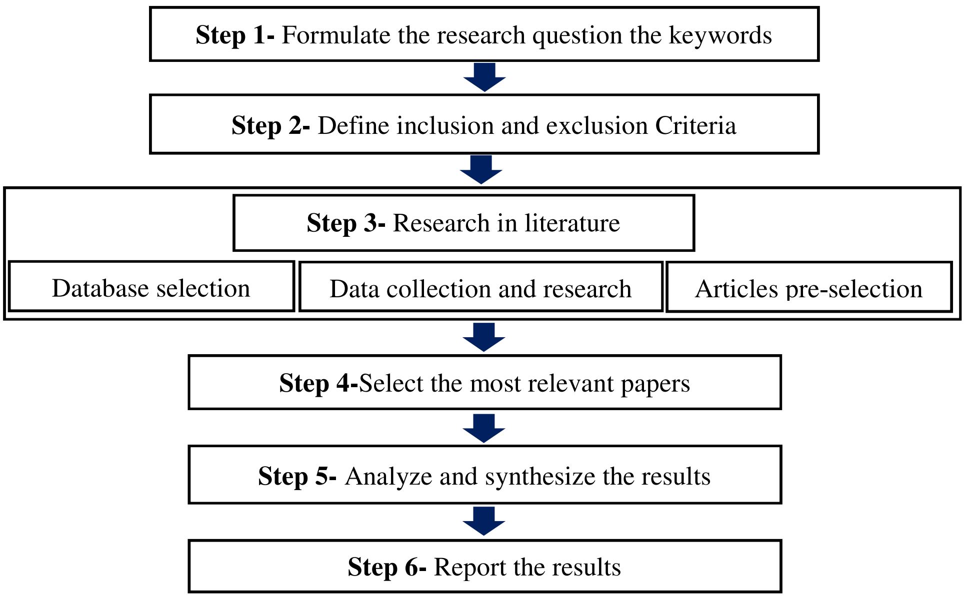

Fig. 1. Six-step Research Methodology.

2.1. Question formulation and keywords definition

The first step in an SLR is to clearly define one or more research questions. In this sense, the main topic of our research is to examine the existing state of the art dealing with horizontal collaboration in freight transport and to study how aspects of sustainability are included in strategic, tactical and operational decisions. Also, based on the research purpose, it is necessary to define a list of keywords in order to localize and limit this study. Accordingly, two categories of keywords are proposed. The main keywords in the first category are: "*collaborative transport*", "*cooperative transport*", " and "*coalition transport*". In the second category, we have identified the following words: "*sustainable development*", "*sustainability*", "*social*", "*ecological*", "*green*" "*economic*" and "*environmental*".

2.2. Inclusion/exclusion criteria

In addition to the keywords defined previously in the first step, a list of inclusion and exclusion criteria was established to limit the literature search and to select the articles that we would focus on. The set of criteria developed in this search is presented in Table 1.

Table 1. Inclusion and exclusion criteria used to select papers.

	Criteria	Justification
Inclusion	Articles published between 2010 and the first semester of 2020	To focus on the most recent publication
	Publications in peer-reviewed journals, conference papers and chapters	To concentrate on high-quality articles (Pilbeam et al., 2012) and other documents for a broader and more comprehensive literature search
	Papers focused on horizontal collaboration and freight transportation	The emphasis on work related to horizontal collaboration in transportation is the research problem for this study
	Empirical and experimental studies and review articles	To include the Different research approaches used
Exclusion	Papers focusing only on vertical collaboration	The purpose of the research is to review the existing literature on horizontal collaboration in freight transportation
	Studies in a language other than English and French	The researchers involved in this project can read these languages (French and English)

2.3. Data search

In this step, we have defined three sub-steps: The first concerns the selection of databases. Consequently, we have selected the following source databases: *Google Scholar*, *Web of Science*, *Scopus*, *Taylors & Francis*, *Springer*, *Science Direct* and *Wiley Online Library*. We then commenced a data search of the various databases identified by combining the keywords defined in the first step, for example, "*horizontal collaboration*" in combination with "*sustainability*". In the literature search phase, we identified a first set of articles based on the relevance of the title according to the context of the study. A total of 156 articles were identified in this phase.

2.4. Selection of the most relevant papers

To reduce the size of the database constructed in the previous step and to review a reasonable number of studies, we applied a filter using the inclusion/exclusion criteria. This step aims to identify the most relevant studies to focus on and eliminate irrelevant studies from our study. During the selection phase, we read the full text of each article and reviewed the list of references for each. In addition, we identified the main authors contributing to freight transportation optimization in order to perform a second search based on their names. After that, we added the papers that were not initially found in our database. Finally, a set of 89 papers were selected for review and analysis as relevant studies.

2.5. Analysis, synthesis and results reporting: Classification methodology

Once the relevant papers have been identified, steps (5) and (6) aim to synthesize the literature and to report the results. Firstly, a descriptive analysis of the identified literature was conducted according to the distribution of the work in the different journals and over time. Secondly, based on the research questions presented in the first section, the papers have been classified according to the decision problem addressed (network design, profit-sharing, inventory management, distribution organization, vehicle routing) and sustainability dimensions evaluated (economic, environmental, social). Besides, the studies reviewed have been categorized according to the research methodology used. Papers that use mathematical models such as optimization, simulation and game theory are classified in the experimental category. The second sub-category contains exploratory research that focuses on the definition of new concepts, case studies or interviews with practitioners to identify the challenges of real-world horizontal collaboration, and empirical studies. The last sub-category contains literature reviews or surveys on horizontal collaboration in freight transportation in general.

In the following sections, we have concluded an in-depth analysis of the literature identified according to the above categorization criteria. This categorization allows us to determine the current trend of horizontal collaboration and sustainability in freight transportation and to identify research gaps in this field.

3. Results and findings

3.1. Publications per year

In this section, distribution analysis of the papers identified has been done to study the current research trends between 2010 and 2019, we only have data for the first half of 2020.

Fig. 2 shows the annual distribution of the selected studies. We can see that the number of publications has increased in recent years, 53% of the papers have been published since 2015. This analysis reflects the emerging trends and increased attention paid to research into horizontal collaboration in freight transportation. In addition, 4 papers were identified in the first half of 2020 (5%), which allow us to predict another year of growth for research areas, especially in the area of research into freight transport sustainability due to increasing external pressures from authorities on sustainable development.

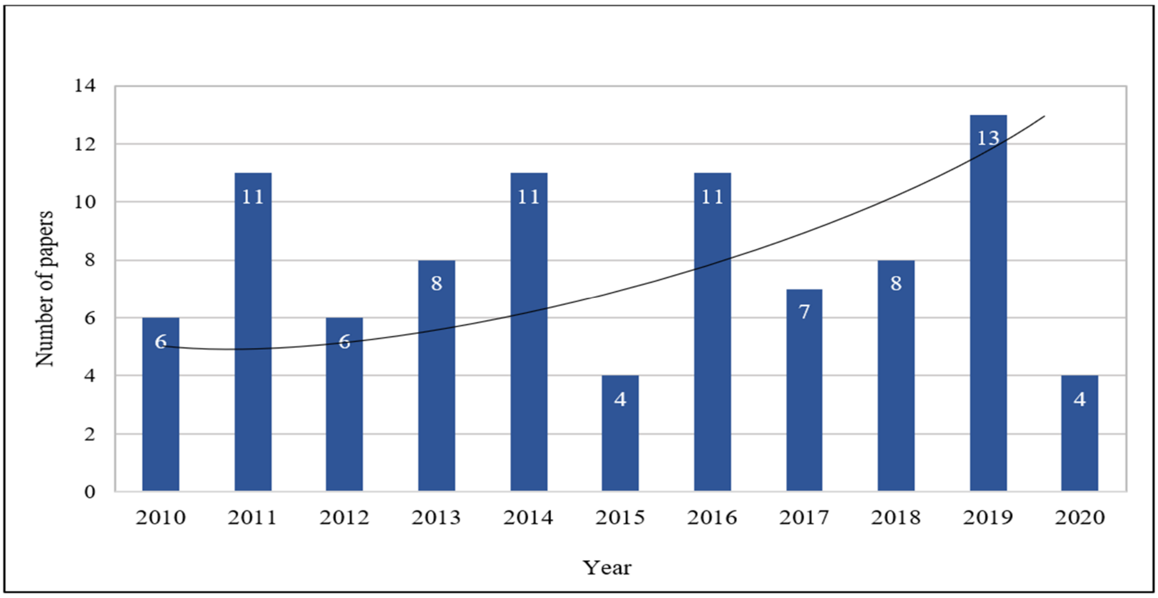

Fig. 2. Annual distribution of identified literature.

3.2. Publications by journal

The selected papers were distributed in a total of 44 international journals and communicated at 5 international conferences in the field of logistics and transport. As shown in Fig. 3, 16 journals contain more than 50% of the papers, while the rest are found in 32 different journals and at 5 different conferences. The journals of The *European Journal of Operational Research*, *Transportation Research Part E: Logistics and Transportation Review*, *Computers*

& Operations Research and *Journal of Cleaner Production* represents ¼ of our sample. The *European Journal of Operational Research*, *Transportation Research Part E* and *Journal of Cleaner Production* occupy first, second and third rank, with 10, 5 and 5 publications, respectively.

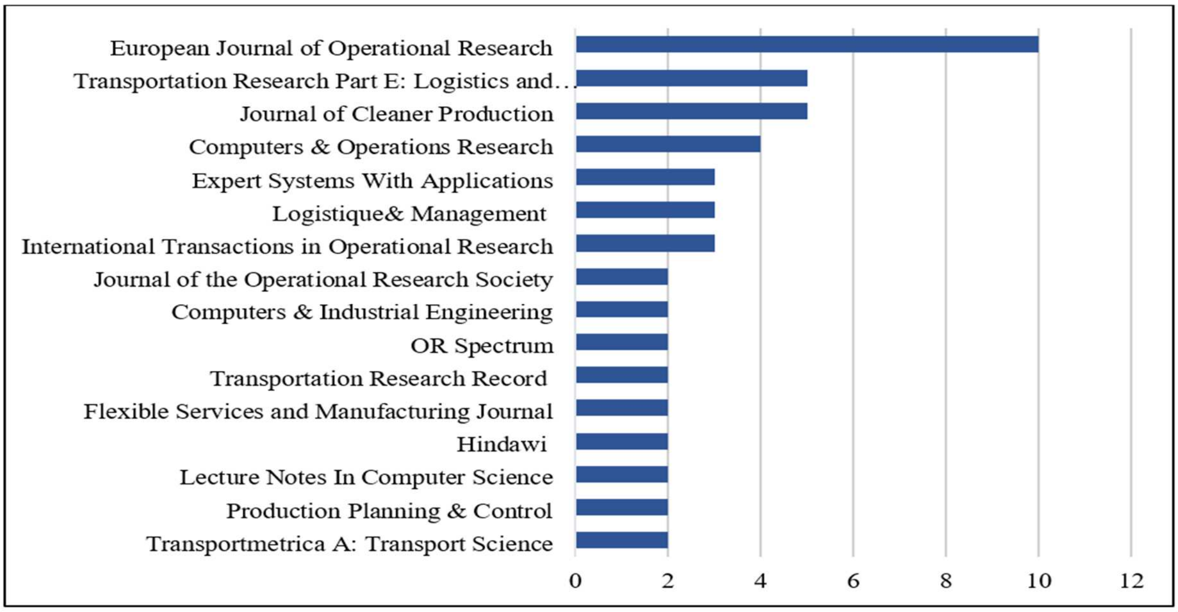

Fig. 3. Distribution of papers reviewed by journal who have published two or more articles.

4. Categorization analysis

Based on the categorization criteria defined above, our discussion is mainly based on the summary results of Table 2 and Fig. 4. Table 2 presents the classification of the literature. Fig. 4 shows the number of papers by classification criteria.

Table 2. Classification of the literature based on the problem addressed, the sustainability assessed and the research methodology adapted

Article	Decision problem					Context		Decision-making		Sustainability			Methodology		
	Network Design	Profit-sharing	Inventory	Organization	Routing	Deterministic	Uncertain	Independently	Simultaneously	Economic	Environmental	Social	Experimental	Exploratory	Review
Abbad et Salaun (2019)	√													√	
Ackermann et al. (2011)					√	√				√			√		
Adenso-Díaz et al. (2014a)					√	√				√			√		
Adenso-Díaz et al. (2014b)					√	√				√			√		
Allaoui et al. (2019)	√		√	√	√	√		√		√	√	√	√		
Ankersmit et al. (2014)					√	√				√			√		
Audy et al. (2011)		√				√				√			√		
Audy et al. (2012)		√				√				√			√		
Bailey et al. (2011)					√	√				√			√		

Ballot et Fontane (2010)	√										√			√	
Ben Jouida et al. (2017)		√				√				√			√		
Berger et Bierwirth (2010)					√	√				√			√		
Björnfot et Torjussen (2012)	√													√	
Buijs et Wortmann (2014)					√	√				√			√		
Buijs et al. (2016)					√	√				√			√		
Chabot et al. (2017)					√	√				√	√		√		
Chai et al. (2013)	√													√	
Chen (2016)					√	√				√			√		
Cruijssen et al. (2010)		√				√				√			√		
Dahl et Derigs (2011)					√	√				√			√		
Dai et Chen (2012)		√				√				√			√		
Defryn et al. (2019)		√			√	√				√			√		
Fernández et al. (2016)					√	√				√			√		
Fernández et al. (2018)					√	√				√			√		
Fernández et Sgalambro (2020)	√					√				√			√		
Frisk et al. (2010)		√				√				√			√		
Gansterer et Hartl (2018)					√										√
Gonzalez-Feliu (2011)	√			√		√		√		√	√		√		
Gonzalez-Feliu et al. (2013)	√			√		√				√			√		
Gonzalez-Feliu et Morana (2011)					√									√	
Guajardo et al. (2018)		√				√				√			√		
Guajardo et Rönnqvist (2016)		√													√
Habibi et al. (2018)	√	√					√	√		√			√		
Hacardiaux et Tancrez (2019)	√		√				√		√	√	√		√		
Hernández et al. (2011)					√	√				√			√		
Hernández et al. (2012)	√					√				√			√		
Hernández et Peeta (2011)					√	√				√			√		
Hernández et Peeta (2014)					√	√				√			√		
Kuyzu (2017)					√	√				√			√		
Leitner et al. (2011)	√									√				√	
Li et al. (2016)		√				√				√			√		
Liu et al. (2010a)					√	√				√			√		
Liu et al. (2010b)					√	√				√			√		
Lozano et al. (2013)		√				√				√			√		
Makhloufi et al. (2015)					√		√			√	√		√		
Martin et Tanguy (2019)	√													√	
Molenbruch et al. (2017)					√	√				√			√		
Montoya-Torres et al. (2016)				√	√	√			√	√	√		√		
Moutaoukil et al. (2013)				√		√		√		√	√	√	√		
Moutaoukil et al. (2015)					√	√				√	√		√		
Muñoz-Villamizar et al. (2019a)				√	√				√	√	√		√		
Muñoz-Villamizar et al. (2019b)					√	√				√	√		√		
Muñoz-Villamizar et al. (2020)					√	√				√	√		√		
Nadarajah and Bookbinder (2013)					√	√				√			√		
Nataraj et al. (2019)	√			√	√	√			√	√	√		√		
Ouhader and El Kyal (2017)	√	√		√	√	√			√	√	√	√	√		
Ouhader et kyal (2020)	√	√		√	√	√			√	√	√		√		
Özener et al. (2011)					√	√				√			√		
Özener et al. (2013)		√			√	√				√			√		
Pan et al. (2013)	√					√				√	√		√		
Pan et al. (2014)	√			√		√		√		√	√		√		
Pan et al. (2019)	√	√			√										√
Pérez-Bernabeu et al. (2015)					√	√				√	√		√		
Quintero-Araujo et al. (2016)					√		√			√			√		
Quintero-Araujo et al. (2019)	√			√	√	√			√	√	√		√		
Ruel (2019)	√													√	

Sanchez et al. (2016)		√		√		√				√	√		√		
Soysal et al. (2018)			√		√		√		√	√	√		√		
Sprenger et Mönch (2014)					√		√			√			√		
Stellingwerf et al. (2018)			√		√	√			√	√	√		√		
Stellingwerf et al. (2019)		√			√	√				√	√		√		
Tang et al. (2016)	√					√				√			√		
Vanovermeire et Sörensen (2014)		√				√				√			√		
Vaziri et al. (2019)					√	√				√			√		
Verdonck et al. (2013)					√										√
Verdonck et al. (2016)	√	√				√		√		√			√		
Wang et al. (2014)					√	√				√			√		
Wang et al. (2017a)		√		√	√	√			√	√			√		
Wang et al. (2017b)		√		√	√	√			√	√			√		
Wang et al. (2018a)		√		√	√	√			√	√			√		
Wang et al. (2018b)		√		√	√	√			√	√			√		
Wang et al. (2018c)		√		√	√	√			√	√	√		√		
Wang et al. (2020)		√		√	√	√			√	√			√		
Wang et Kopfer (2014)					√	√				√			√		
Wang et Kopfer (2015)					√	√				√			√		
Weng et Xu (2014)					√	√				√			√		
Wick et al. (2011)		√				√					√		√		
Xu et al. (2012)		√				√				√	√		√		
Yilmaz et Savasaneril (2012)		√					√			√			√		

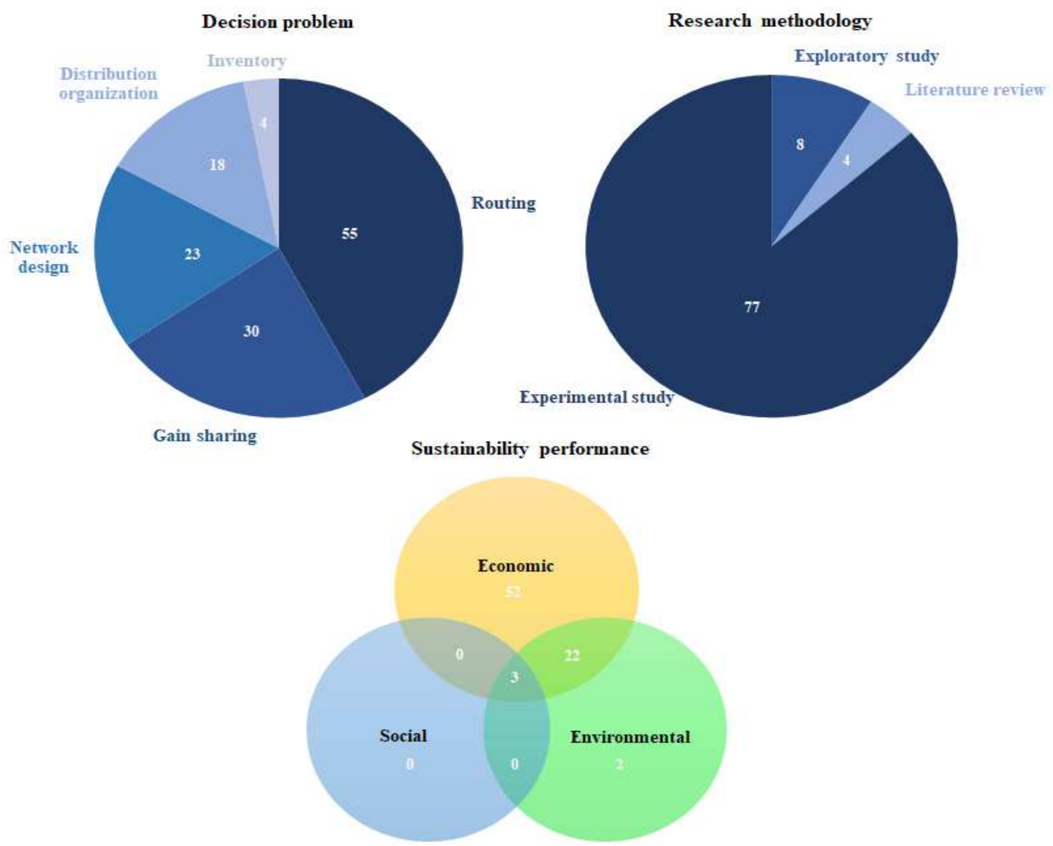

Fig. 4. Number of articles according to the classification criteria.

4.1. Decision analysis

4.1.1. Strategic decisions

Although strategic decisions are the most crucial in supply chain management, these decisions are less studied in the literature. In the literature, these decisions have been integrated with other planning decisions whose aim is to solve simultaneously or independently the various associated problems. Usually, strategic decisions in logistics and transport concern the design or co-design of distribution networks in order to create a competitive advantage and achieve the desired objectives.

Much of the literature used strategies to consolidate flows and achieve economies of scale. In this context, Ballot and Fontane (2010) were the first contributors to consider logistics pooling as a form of horizontal collaboration that makes it possible to consolidate flows and reduce greenhouse gas emissions. Then, Gonzalez-Feliu (2011) assessed the economic and environmental benefits of logistics pooling in urban freight transport. To do this, the author generated scenarios representing realistic situations within the city of Lyon. To simulate and evaluate the various scenarios, Gonzalez-Feliu (2011) proposed an integrated simulation framework combining a demand generator and a routing optimization model. A structural and organizational framework is developed by Leitner et al. (2011) to optimize transport efficiency between shippers in horizontal cooperation. The framework is based on the definition and design of new structures and processes to ensure the sustainable success of the cooperation. Logistics models as well as organizational models have been demonstrated using a case study from Romania. The results obtained showed that collaboration between the partners allowed them to realize benefits from an economic and an environmental perspective. Likewise, Gonzalez-Feliu et al. (2013) addressed the design problem and evaluation of collaborative scenarios in urban freight transport based on a hierarchical clustering technique and a dominance analysis method to identify the best collaborative scenario. Furthermore, Pan et al. (2013) independently explored the environmental and economic impact of the pooling of warehouses and distribution centers between shippers. Their findings indicated that pooling is a more effective approach to reducing greenhouse gas emissions and logistics costs. Another study conducted by Moutaoukil et al. (2013) which aims to propose and simulate several scenarios to help small and medium agri-food enterprises design a distribution network by optimizing the three sustainability dimensions. Other scenarios concerning logistical organization have also been proposed by Pan et al. (2014). The researchers treated the network distribution design problem by independently optimizing the economic and environmental objectives. To solve this problem, linear programming models were proposed to determine the best number and location of hubs among a set of hubs and to define transport plans in each network.

All the work mentioned above assumes the choice of the location was resolved beforehand, and the main purpose of their contributions was to define new strategies and organizations for consolidating flows, Tang et al. (2016) contributed to this topic by studying the problem of location of regional distribution centers in collaborative distribution networks for horticultural products in France, while minimizing transportation and facility opening costs. Verdonck et al. (2016) also focused on the problem of locating distribution centers to quantify the economic benefits of horizontal collaboration in two-echelon distribution networks. Similarly, Hernández et al. (2012) addressed the problem of locating centralized and hybrid hubs. The proposed model is hybrid because it authorizes the direct shipment of goods, but it is centralized in the sense that the activities of all carriers are grouped in a hub-and-spoke system to consolidate flows. Fernández et Sgalambro (2020) have proposed and analyzed several collaborative policies to solve the location problem of the non-centralized and non-hybrid hub. A decision-making tool for collaborative planning in sustainable supply chains has been proposed more recently by Allaoui et al. (2019). The proposed tool allows us to generate optimized scenarios in order to design a supply chain according to the weight and the sustainability criteria preferred. Naturally, strategic decisions have a considerable impact on logistics performance in the long-term. Therefore, uncertainties regarding costs and data need to be considered in order to guarantee the efficiency future of logistics networks. Only one paper has been presented in this context (Habibi et al., 2018). This study considers the uncertainty of the costs in the hub location problem of two collaborative distribution networks.

Although the work mentioned above deals with levels of planning other than strategic decision making, the different decisions are treated separately. In recent years, a few contributions have been made in the literature that propose integrated decision models for collaborative transportation planning. In this context, Ouhader and El Kyal (2017) have studied the design problem of collaborative distribution network using a two-echelon Location Routing Problem (LRP) model. The main objective is to design a collaborative logistics network and to optimize future routes jointly while optimizing the three dimensions of sustainability, namely logistics costs, CO_2 emissions and job opportunities created. To quantify the impact of horizontal collaboration in freight transport, the authors compared the results obtained through collaboration with those obtained in the non-collaborative scenario.

The results confirmed that horizontal collaboration can contribute to a reduction in GHG emissions and transportation costs, but it has a negative impact on the social aspect evaluated, i.e., the number of jobs. Most recently, an extension of this study was published in (Ouhader and kyal, 2020). In this contribution, the researchers were interested in ways of balancing economic and environmental concerns in a collaborative coalition by using a multi-objective approach. Similarly, Quintero-Araujo et al. (2019) and Nataraj et al. (2019) studied the urban distribution network design based on the LRP. The researchers examined the use of horizontal collaboration concepts in integrated routing and location decisions for a single-echelon distribution network. Several scenarios with different levels of collaboration were proposed and resolved using meta-heuristics with a single objective, namely, to optimize distribution costs. Hacardiaux et Tancrez (2019) studied the Location Inventory Problem (LIP) to assess the environmental benefits of horizontal collaboration in a two-echelon distribution network. In this study, the proposed model is principally aimed to optimize the economic dimension, while the environmental footprint assessment has been assessed after the economic resolution.

In addition to the quantitative studies discussed above, there are also a few empirical studies that examine the strategic effects of logistics collaboration and their barriers in industrial sectors. Björnfot et Torjussen (2012) and Abbad et Salaun (2019) studied the advantages of pooling logistics and the successful conditions for a collaborative project in the freight distribution industry based on real case studies. Concerning the obstacles to logistic pooling, Chai et al. (2013), Martin et Tanguy (2019) and Ruel (2019) surveyed a few industrialists to identify the reasons and barriers to the implementation of horizontal pooling. The results of these different surveys showed that the main obstacle of implementing collaboration between competitors is the need for information sharing, this has not yet been studied in detail.

4.1.2. Tactical decisions

The tactical level in supply chain planning usually concerns medium-term decisions. It is at this level that decisions are made regarding the size of the shipment, the gain sharing, the elaboration of transport or distribution modes, the frequency of customer visits and the inventory management.

4.1.2.1. Profit allocation

Because the main objective of horizontal cooperation is to increase the participants' logistical efficiency and since collaboration is often expressed in gains or additional savings, many works which have addressed the tactical planning and horizontal collaboration in freight distribution focus on how to share the benefits obtained equitably among the different stakeholders. The literature can be divided into two sub-categories. The first regroups the work that aims to propose only methods for gains and savings allocation, while the second regroups the work that treats other levels of decision making with the consideration of the benefit-sharing where existing allocation methods are used.

A significant part of research treats the first sub-category by focusing on collaboration between shippers/carriers and cost-sharing. As such, Yilmaz et Savasaneril (2012) studied the problem of coalition formation among small shippers in an uncertain environment. The objective of their study is to determine the optimal policy of coalition under uncertainty and to propose allocation mechanisms based on game theory while guaranteeing a budget balance between shippers. Cruijssen et al. (2010) discussed the outsourcing problem of transport activities for shippers using a case study with four Dutch grocers. In this study, the authors discussed how logistics service providers are the initiators of the outsourcing of logistics activities from shippers. To achieve this, they proposed a selection procedure that chose shippers with a high potential of synergy. To allocate the savings obtained by outsourcing transportation activities between shippers in the same coalition, an allocation method based on the Shapley value is proposed. In (Frisk et al., 2010), some sharing mechanisms based on cooperative game theory were studied and a new method has also been proposed to allocate gains among participants in collaborative lumber transport. The mechanism designed by Frisk et al. (2010) aims to find a stable allocation so that the maximum difference between the relative savings of two transporters will be minimal. As part of a collaboration between carriers, a case study conducted by Audy et al. (2011) with four Canadian furniture manufacturers, to develop a cost allocation system, based on the Frisk et al. (2010) mechanism, and to provide a sensitivity analysis of the minimum savings amount that could convince the manufacturers to join such a coalition. Based on the latest work above, Dai et Chen (2012) improved the proposed mechanisms by examining the contribution of each carrier to both requests for offers and service requests. The proposed mechanisms have been applied to examine the allocation of the costs between several Less Than Truckload (LTL) carriers in a centralized collaboration. A Mixed Integer Linear Program (MILP) is proposed in (Lozano et al., 2013) to estimate the cost savings that companies can achieve by accepting to participate in a cooperative program and to identify the most profitable opportunities for collaboration. In addition, Lozano et al. (2013) examined the problem of joint cost savings allocation using different methods of cooperative game theory.

Frequently, companies are not only looking for efficiency but also flexibility in their logistics organization. In this context, Vanovermeire et Sörensen (2014) introduced the flexibility of delivery times in the operational transport planning optimization and the profit allocation. To achieve their goal, Vanovermeire et Sörensen (2014) proposed an approach to measure and recompense the value of flexibility in the gain repartition between two partners. A methodology based on the Shapley value has recently been proposed by Stellingwerf et al. (2019) to allocate the monetary gains in a way that considers the contributions of partners to cost and emissions savings in Joint Inventory Routing problem JIRP. All the work mentioned below shows that horizontal collaboration generates economic gains of up to 30% compared with the non-collaborative case. A literature review on existing methods for allocating collaborative transport costs is published in (Guajardo et Rönnqvist, 2016). In this, the authors concluded that many of the proposed methods are combinations of allocation models defined in the literature and usually come from cooperative game theory.

In addition to cost savings, there are also environmental savings that are usually quantified in terms of CO_2 emissions. Since environmental preoccupations have pushed companies to declare their CO_2 emissions. As a result, the environmental benefits obtained through horizontal collaboration must be shared equitably among stakeholders. Abbad et al. (2011), Salaun et al. (2011) and Wick et al. (2011) proposed the first solution on how to allocate GHG emission savings using the Shapley value concept of cooperative game theory. Likewise, Xu et al. (2012) proposed a method of allocation that was equitable by adapting the Shapley value concept. These savings are measured in terms of transport cost and a carbon tax to consider the environmental impact.

Additionally, some studies have used existing methods to allocate the gains generated by such a strategy of horizontal collaboration or by solving such a decision problem, these are the papers of the second sub-category. For example, Li et al. (2016) used a cooperative game theory approach to solve the cost allocation problem in the context of collaboration between LTL retailers of perishable products, in particular, in the decision on allocation of transport means. A comparison of existing allocation methods has been done in (Ouhader et El Kyal, 2017, 2020) to help coalition members to share the economic, environmental and social benefits generated by combining planning decisions. Also, Verdonck et al. (2016) examined the different gain-sharing mechanisms to equitably share the savings obtained by solving the facility location problem. In (Sanchez et al., 2016; Wang et al., 2020, 2018b, 2018b, 2018c, 2018a, 2017b, 2017a), the researchers used benefit allocation mechanisms based on game theory to allocate the benefits of cooperative vehicle routing. The existing mechanisms for allocating benefits were also used by Guajardo (2018) to allocate emissions among the different actors involved in joint transport activities. Özener et al. (2013) compared different cost allocation methods for cooperation in the joint optimization of inventory and transport decisions.

Since the mechanisms of benefit sharing are important to ensure the stability of such a coalition, the gain sharing problem can be extended to the coalition stability problem. Most of the literature cited above only considers the coalition involving all actors, in other words, a large coalition is formed. However, coalition actors can leave the alliance at any time (Audy et al., 2012), and some actors may be more interested in joining sub-coalitions that are not a large coalition but offer better benefits for all coalition members (Cruijssen et al., 2010). Consequently, the question that now arises is how to find the most stable and profitable sub-coalitions, where they exist? This problem corresponds to what the literature calls coalition formation or configuration. Coalition configuration has received less attention in the literature. Only a few studies have examined coalition formation in collaborative transport. Audy et al. (2012) were interested in issues of gain sharing and coalition building. A model is proposed in (Audy et al., 2012) to find the most stable and credible coalition. In addition, Ben Jouida et al. (2017) proposed a cooperative replenishment algorithm to solve the problem of forming the most profitable coalitions. Guajardo et al. (2018) studied the overlapping coalition-building problem in freight transport. In this study, the authors proposed two approaches to configuration. The first one is based on zones, which assumes that the total territory is divided into zones, while the second one consists of integrating the coalition configuration into the transport problem. In the studies cited above, only common objectives are considered in the distribution organization. In this circumstance, (Defryn et al., 2019) have contributed to this topic by proposing an approach that considers the common objectives of the coalition and those of the partners in order to optimize the transport of freight.

4.1.2.2. Inventory decisions

The decisions concerning inventory management have been combined with other planning decisions to simultaneously optimize them. These decisions were included in the logistic modelling of perishable products. Recently, the Inventory Routing Problem (IRP) was studied by Stellingwerf et al. (2018) in the case of temperature-controlled food distribution. In this study, a linear programming model that minimizes logistical costs, emissions or a linear combination of two objectives is proposed to find the optimal route and inventory plan. From a similar perspective, Soysal et al. (2018) proposed a model to treat the green IRP with uncertainty in the case of perishable products. Each product is assumed to have a fixed shelf life, beyond which it will be wasted, resulting in a penalty cost. Finally, a Mixed Integer Quadratic Program (MIQP) has been proposed by Hacardiaux et Tancrez (2019) to jointly optimize location and inventory decisions and to assess the environmental benefits of horizontal collaboration while satisfying the uncertain demands.

4.1.2.3. Distribution organization

One of the key issues in transport optimization is the freight distribution organization. The use of joint routes and the consolidation of means is considered as the main source of savings. Several existing studies proposed collaborative schemes to optimize freight distribution. These schemes are essentially based on the consolidation of means. Companies can share their means of transport and share resources to serve a set of customers. For example, Pan et al. (2014) compared four scenarios, including the case of joint route distribution between suppliers, to identify the most efficient transport plan in terms of cost and CO_2 emission reductions. As well, in (Moutaoukil et al., 2013) various configurations have been examined to determine the best distribution strategy that integrates the 3TBL. Other studies begin with a non-cooperative scenario and then analyze the potential benefits that can be achieved by a collaborative practice. For example, Ouhader and El Kyal (2017, 2020) compared two decision-making scenarios, a scenario in which there is no cooperation between suppliers and a second scenario which is totally collaborative in which decisions are taken jointly. Similarly, Quintero-Araujo et al. (2019), Nataraj et al. (2019), Gonzalez-Feliu (2011), Gonzalez-Feliu et al. (2013), Sanchez et al. (2016), Wang et al. (2016), Wang et al, (2017a, 2017b, 2018a, 2018b, 2018c, 2020) and Montoya-Torres et al. (2016) focused on last-mile distribution to develop and optimize a collaborative distribution network. Their main objective is to assess the benefits obtained through collaboration and joint planning. Recently, Muñoz-Villamizar et al. (2019a) considered a fleet of electric vehicles as a strategy in collaborative routing in the urban area. A case study from actual data has been conducted to quantify and analyze the different advantages of using a mixed vehicles fleet (electric and diesel). The results show that electric vehicles are more profitable, economically and ecologically, for cooperation periods of over three years.

4.1.3. Operational decisions

Most of the literature on horizontal collaboration in freight transport focuses principally on operational planning, in approximately 60% of the studies reviewed. Operational planning consists of establishing optimal or efficient transportation plans by sharing resources in order to improve the operational efficiency of carriers/shippers. In fact, the researchers mainly concentrate on the operational problems related to vehicle routing under several variants. Reviews of the literature provide a detailed overview of techniques and solutions of operational planning problems (Verdonck et al., 2013; Gansterer et Hartl, 2018). Regarding experimental studies, most work focuses on the quantification of benefits and the roles of joint route planning (Adenso-Díaz et al., 2014a; Fernández et al., 2018; Molenbruch et al., 2017; Montoya-Torres et al., 2016; Pérez-Bernabeu et al., 2015; Quintero-Araujo et al., 2016; Sanchez et al., 2016; Soysal et al., 2018; Sprenger and Mönch, 2014; Wang et al., 2018c; Yilmaz et Savasaneril, 2012, Adenso-Díaz et al., 2014b; Buijs et Wortmann, 2014; Dai et Chen, 2012; Morana et al., 2014; Gonzalez-Feliu et Morana, 2011). The literature indicates that joint vehicle routing planning in freight transport can provide economic benefits as well as environmental gains (Chabot et al., 2018; Muñoz-Villamizar et al., 2020, 2019a, 2019b; Wang et al., 2018c), which improves the profitability of companies through the inclusion of external resources (Wang et al., 2014).

Several variants of Collaborative Vehicle Routing Problems (CVRP) have been discussed in the literature. The Multi-Depot Capacitated Arc Routing Problem (MDCARP) with Full Truckloads (FTL) in carrier collaboration has been studied by Liu et al. (2010a) to minimize empty movements. A two-step heuristic has been developed to solve the proposed model and large instance problems. In a similar context, Fernández et al. (2016) developed an optimization model to solve the non-capacitive Arc Routing Problem (ARP). The Multi-Depot Arc Routing Problem (MDARP) has also been studied by Weng et Xu (2014) to fuse flows and to optimize the hub routing of the merged tasks. The authors note that the fusion of transport activities allows companies to achieve important economies of scale. Based on the concept of resource pooling, Nadarajah et Bookbinder (2013) proposed a modelling framework and resolution approach to address the routing problem between LTL carriers. Sprenger et Mönch (2014) developed a decision support system tool for cooperative transport planning in the food industry where several manufacturing companies share their fleets to reduce transport costs. An approach based on decomposition strategies has been proposed in (Buijs et al., 2016) to address the problem of collaborative road transport planning of two Dutch companies. In addition to collaboration in road and rail transport, this strategy has also been envisaged in air transport (Ankersmit et al., 2014). In the latter, the researchers proposed a conceptual simulation framework to identify the potential for collaboration between several freight forwarders at Schiphol-Amsterdam Airport for short distances.

Frequently, shipment requests are not efficiently integrated into a carrier's itinerary. In this case, a collaboration between the carriers that consists of allocating or exchanging requests is necessary to improve the overall efficiency of the distribution network and the profit of each carrier. The different objectives of request exchanges and collaborative planning have been discussed in multiple research studies (Ackermann et al., 2011; Nadarajah et Bookbinder, 2013; Dai et Chen, 2012; etc.). Liu et al. (2010b) have combined the Vehicle Routing Problem VRP with the demand selection problem where carriers receive shipment orders that they must respond to either with internal fleets or outsourced requests via a transport partner. The principal objective is to route vehicles and to select requests by minimizing the total cost when a carrier responds to requests. In the same context, Berger et Bierwirth (2010) studied the problem of reallocation of transport demand in a collaborative network to maximize the total profit to carriers. In reality, to massify the flow and increase the fill rate, companies make their shipments in FTL. In this context, Özener et al. (2011) developed a lane exchange mechanism to treat the problem of exchange demand in decentralized collaboration. Likewise, Kuyzu (2017) studied the fusion and exchange of lanes in collaborative supply between LTL carriers. A decision support system for an express courier collaborative network is developed by Dahl et Derigs (2011). This tool is designed to promote real-time exchange of requests between carriers. The researchers demonstrated that with a real-time exchange system, the network can operate at a level like that obtained by centralized planning. In this latter, planning decisions are taken by a central authority and requests are exchanged via this authority, which can be an online platform (Dai et Chen, 2012), in contrast to decentralized planning.

Chen (2016) developed a combinatorial clock-proxy exchange mechanism for LTL carriers. Another type of planning discussed in the literature is dynamic planning. An example of the work conducted by Wang et Kopfer (2015) studies the dynamic version of the collaborative planning problem with a rolling horizon in which carriers can exchange customer requests. The reduction and optimization of travel time, and particularly the empty returns of trucks. Bailey et al. (2011) contributed to this topic by proposing an efficient method that makes it possible to add delivery and pick-up tasks during the return routing. Two optimization models have been developed to elaborate the vehicle itineraries and to select the requests to be shipped. The first one is modelled as a Linear Program LP, while the second one is formulated as a Mixed Integer Program (MIP). A heuristic and a taboo search are used to solve these models. The results from the actual data show that the percentage of cost reductions can be as high as 27%. Recently, Vaziri et al. (2019) studied the Pickup and Delivery Problem PDP in the context of a FTL carrier. The researchers proposed a MIP to allocate profits equitably among carriers and minimize travel time. Another model has been presented in (Wang et Kopfer, 2014). In this model, the researchers assumed that LTL carriers can exchange all their pick-up and delivery requests in order to reduce transport costs. An extension of the latter study that includes subcontracting is proposed by Wang et al. (2014). In a similar contribution, Hernández et Peeta (2014) addressed the single-carrier collaboration problem in which an LTL carrier seeks to collaborate with other partners by acquiring the external capacity in order to meet the excess demand.

In practice, many constraints exist in collaborative VRP. These constraints lead to several variants of the problems. In fact, the collaborative routing problem should consider the capacity constraints of the carriers (Hernández et al., 2011; Hernández et Peeta, 2011). Hernández et Peeta (2011) studied the centralized collaboration problem between several carriers when capacity depends on time, in other words, carriers can use or provide transport capacity during routing. The problem has been modelled as a Minimum Cost Flow Problem (MCFP) and solved using a Branch-and-Cut (B&C) algorithm. The authors addressed the deterministic and dynamic problem of single-carrier collaboration for LTL Small and Medium-sized Enterprises SMEs. The problem is deterministic because the demands are fixed and the capacities depend on time and are known in advance, but it is dynamic in the sense that the demands have time windows for pickup or delivery. Another research stream attempted to integrate time windows in collaborative transportation planning. For example, Moutaoukil et al. (2015) solved the vehicle routing problem with time windows to study the impact of last-mile delivery on the three sustainability dimensions More recently, Wang et al. (2020) addressed collaborative planning in a multi-depot logistics network with an allocation of time windows to the delivery requests. Finally, a simulation-based decision support system that considers time constraints and stochastic demand for pick-up and delivery has been proposed by Makhloufi et al (2015).

4.2. Sustainability analysis

In the last two decades, due to environmental issues and social development, the sustainability aspects have become important measures in the organization and optimization of distribution networks. Indeed, the sustainability considerations have been included progressively in the collaborative transport optimization, namely in the strategic decisions that have a significant long-term impact on the global performance of companies. The current state of the art in collaborative transport consists essentially of integrating economic and environmental objectives, while the social aspect is less studied in the scientific literature, see Fig.4. Please note that in classifying the literature according to sustainability criteria, we focused on studies that address one or more dimensions of sustainability, the remains of the studies address the collaboration in a general perspective through surveys or reviews

We can see that the economic dimension dominated the distribution network design and optimization problem. From the 79 articles classified in Table 2, 52 deal only the economic objectives, 22 consider the economic and environmental objectives and only three articles address the distribution network optimization problem considering the three sustainability aspects. Only two studies assess the environmental dimension in the freight distribution organization. Finally, no contributions are discussing collaborative transport problems from a single social perspective and at the intersection between the social and environmental or economic dimensions.

4.2.1. Economic measures

In a supply chain, the main objectives are to ensure the satisfaction of customer demands and the functionality of the global network processes. Literature on horizontal collaboration and transportation planning focuses mostly on the economic dimension to achieve these goals. Like the traditional optimization models, much of the contribution seeks to minimize costs or maximize benefits in transportation planning, in the strategic, tactical, operational level, or in the mix of these different decisions. However, maximizing benefits to measure economic performance in decision models has received much less attention. This can be expressed by the fact that manufacturers always seek to obtain a competitive advantage by optimizing their logistics network. In the studies reviewed, the most traditional measure for assessing economic impact is the total cost of the network, which can depend on the planning decisions addressed. For example, at the strategic level, the cost of opening or choosing the location of a facility is present in 9 studies on collaborative network design (Allaoui et al., 2019; Habibi et al., 2018; Hacardiaux et Tancrez, 2019; Hernández et al., 2012; Nataraj et al., 2019; Ouhader et El Kyal, 2017, 2020; Quintero-Araujo et al., 2019; Tang et al., 2016). Usually, in transport planning problems, the costs due to transport is the main component used to assess economic performance. The latter is discussed in almost all studies quantifying or optimizing the economic benefit of horizontal collaboration in freight transport. This cost is generally calculated based on the distance travelled between an origin and a given destination. In addition of these two economic components, other studies include inventory costs (Allaoui et al., 2019; Hacardiaux et Tancrez, 2019; Özener et al., 2013; Pan et al., 2013; Soysal et al., 2018; Stellingwerf et al., 2019, 2018) and logistical costs related to the handling operations and the use of transport (Allaoui et al. 2019; Moutaoukil et al., 2013; Nataraj et al., 2019; Ouhader and El Kyal, 2017, 2020; Pan et al., 2014, 2013; Quintero-Araujo et al., 2019) in the economic criteria modelling. Additionally, Chabot et al. (2018) and Moutaoukil et al. (2015) attempted to assess the service level of horizontal collaboration in freight transport as another measure of economic performance.

4.2.2. Environmental measures

Besides economic objectives, environmental preoccupations have received increasing attention in recent years. The questions relating to the demand for environmental protection and the responsible consumption of natural resources have prompted companies to integrate environmental factors into their planning decisions, giving rise to the optimization of logistics networks from a green perspective. Usually, one of the most important impacts caused by logistics and transport activities comes from the over-exploitation of resources (energy, water, etc.). The use of energy causes some indirect pollution problems, called greenhouse gases, that are considered the major contributors to climate change and global warming by their impact on the greenhouse effect (Pan, 2010). Moreover, according to the Intergovernmental Panel on Climate Change (IPCC) report, the transport sector generates around 25% of global emissions related to the quantity of energy consumed, of which 80% comes from road transport. The combustion of petroleum-based fuels in internal combustion motors is the main source of these emissions. Although emissions are composed of other gases in addition to carbon dioxide (CO_2), such as methane (CH_4) and nitrous oxide (NO_x), their quantity is relatively small compared to the quantity of CO_2, which represents approximately 77% of all greenhouse gases (SOes, 2010). For this reason, environmental impact measures focus primarily on the reduction of CO_2 emissions in the freight transport sector. However, the calculation of CO_2 emissions due to transport requires more complex and sophisticated methodologies, which can only be estimated because of the difficulty to quantify various aspects such as meteorological conditions and traffic congestion. For this reason, most research usually proposes and uses simple estimation methodologies based on distance (see, for example, Gonzalez-Feliu, 2011; Leitner et al., 2011; Montoya-Torres et al, 2016;

Makhloufi et al., 2015; Muñoz-Villamizar et al., 2020) and/or on energy consumption (see, for example, Chabot et al., 2018; Muñoz-Villamizar et al., 2019; Stellingwerf et al., 2019, 2018; Soysal et al., 2018, Wang et al., 2018c). Nataraj et al. (2019) and Quintero-Araujo et al. (2019) used the estimation model proposed by Ubeda et al. (2011) to estimate the environmental impact of the different collaboration scenarios. This model is based on distance and the load carried in each vehicle. Based on previous studies, Ballot et Fontane (2010) and Pan et al. (2014, 2013) developed a model for estimating CO_2 emissions that considers the load transported, the capacity used, the average travel speed and the distance travelled. Additionally, to improve the estimation model proposed in (Ballot et Fontane, 2010; Pan et al., 2014, 2013), Moutaoukil et al. (2015) integrated vehicle manufacturing and amortization of emissions to better quantify the environmental dimension. Likewise, Ouhader et El Kyal (2017, 2020) used the model proposed in the work cited above, but with the consideration of emissions from truck and vehicle returns.

As regards the environmental consideration in the optimization model, all the research work considering both aspects of economic and environmental sustainability, except for (Ouhader et El Kyal, 2017, 2020; Wang et al., 2018c, Muñoz-Villamizar et al., 2019b), mainly optimizes the economic objectives and assesses the environmental dimension a Posteriori. Only the work of Ouhader et El Kyal (2017, 2020), Muñoz-Villamizar et al. (2019b) and Wang et al. (2018c) optimize both objectives, simultaneously using multi-criteria approaches. Consequently, environmental integration in multi-criteria optimization models seems to be a new research topic.

4.2.3. Social measures

Social sustainability has been considered much less than economic and environmental sustainability, only 3 articles integrate social indicators in their decision model. By nature, social sustainability in supply chains is about social welfare. The integration of Corporate Social Responsibility (RSE) into planning decisions allows us to better assess the impact of a supply chain for its stakeholders: customers, employees and local community. It also makes it possible to consider the negative and negative effects of logistics and transport on human life. Guidelines for the corporate social responsibility and the engagement of organizations in sustainable development are presented in ISO Guide 26000. This identifies seven issues central for corporate social responsibility: governance of organization, human rights, working relations and conditions, environment, fair operating, consumer issues and Community and local development. In the subfield working relations and conditions, employment is the main social indicator used in the social performance evaluation, 2 of the 3 studies considering the social aspect focus on the quantification of the number of jobs. Ouhader and El Kyal (2017) assessed the social aspect by the calculation of the variable job opportunities created dependent on the facilities' capacity. The experiments' results showed that collaboration has a negative impact on the social dimension because it reduces the number of jobs created. Very recently, a decision support tool was proposed by Allaoui et al. (2019) to assess the three aspects of sustainability according to the indicator selected and the corresponding weighting for each. In this tool, the social aspect is assessed by quantifying the total number of jobs, the satisfaction of employees and other indicators related to employees' health and safety, such as the accident rate. In (Moutaoukil et al., 2013), the researchers focused on the transporter's safety and the resident's comfort. Because of the difficulty in quantifying these two aspects, Moutaoukil et al. (2013) used an estimation of accident risk and a quantification of the vehicle numbers used to be capable of assessing accident risk and congestion in the transport network, respectively.

The integration of social criteria in sustainable optimization models for collaborative transport networks creates difficulties in modelling and evaluation. As noted above, the social welfare issues concern multiple stakeholders and are multi-disciplinary. As a result, the social performance is difficult to measure with quantitative indicators. In addition, due to the qualitative nature of social aspects, the integration of social objectives with other sustainability dimensions in decision-making models is often very complex and difficult to establish. Multi-criteria approaches should therefore be used to consider all sustainability objectives simultaneously.

4.3. Research methods

It can be seen from Fig. 4 and Table 2 that most studies used optimization concepts and experimental methods. These studies focused on the resolution of planning problems using decision-support tools based on mathematical approaches and simulation techniques. Concerning mathematical approaches, MILP or Mixed Integer Non-Linear Programming (MINLP), heuristics and meta-heuristics are the most used in the literature to treat the optimization problem of transport networks. Since most work addresses only one dimension of sustainability, single-objective optimization is most frequently applied in analytical optimization models (Adenso-Díaz et al., 2014b; Buijs et al. 2016; Nataraj et al., 2019; Pan et al. 2014; Quintero-Araujo et al., 2019, 2016; Stellingwerf et al., 2018; Wang et Kopfer 2014, etc.). Multi-objective optimization has also been used in some studies to incorporate environmental and social considerations in economic decision models. In this context, Muñoz-Villamizar et al. (2019b) used the weighted sum technique to integrate environmental and economic objectives in the planning and organization of last-mile transport. Also, Allaoui et al. (2019) aggregated the three goals of sustainability into a single objective. Ouhader et El Kyal (2017, 2020) applied the ε-constraint method to simultaneously optimize the economic, environmental and social dimension in the two-echelon distribution network design. In the gain sharing problem, cooperative game theory is the main approach adopted to solve this problem (Ben Jouida et al., 2017; Frisk et al., 2010; Lozano et al., 2013; Vanovermeire et Sörensen, 2014; Verdonck et al., 2016; Yilmaz et Savasaneril, 2012). In addition, discrete event simulation (Makhloufi et al., 2015) and multi-agent systems have been used extensively for operational transport planning (Berger et Bierwirth, 2010; Buijs et al., 2016; Sprenger et Mönch, 2014).

The second most used category of research methodology is exploratory studies. Nearly ten per cent of the literature examined in this study focuses on defining and exploring new concepts of horizontal collaboration using case studies (Ballot et Fontane, 2010; Gonzalez-Feliu, J., Morana, 2011; Leitner et al., 2011) or interviews with industrialists (Björnfot and Torjussen, 2012; Abbad and Salaun, 2019; Chai et al., 2013; Martin et Tanguy, 2019; Ruel,2019). Finally, only four papers have been identified which review the state of the art of optimization models (Guajardo and Rönnqvist, 2016; Verdonck et al., 2013; Gansterer and Hartl, 2018) and solutions for horizontal collaboration in freight transport (Pan et al., 2019).

5. Research trends and gaps

The purpose of this section is to analyze trends and gaps in the research on collaboration and sustainability in freight transportation, in order to identify the future research opportunities.

The first notable observation from Fig.4 is that different planning decisions from the strategic to the operational level have been discussed in the literature on horizontal collaboration in freight distribution. This shows the importance and the development of horizontal cooperation in logistics and transport. In addition, environmental preoccupations and social issues have gained importance in recent years to extend the economic aspects and include other sustainable development aspects. This also demonstrates the relevance and the importance of integrating sustainable development aspects into the planning decisions with a view to achieving efficient and effective logistics.

A second finding is that a lot of attention has been focused on the development of decision-making models, especially for the problem of transportation routing and benefit-sharing. In contrast, the strategic planning, the distribution organization and the inventory management received significantly less attention than the decisions mentioned before.

Thirdly, the inclusion of planning decisions in a single optimization model, to optimize these decisions simultaneously, has attracted the attention of some researchers in the last three years. According to this review, there are three types of problems: the LRP that involves combining vehicle routing when designing a collaborative network, the IRP, which integrates inventory decisions with vehicle routing, and the LIP that combines inventory and location decisions. Further studies would be necessary because of the advantages of considering various decisions simultaneously.

Fourthly, there is very limited research on collaboration with competitors and Logistics Service Providers (LSP). Most of the research focuses on upstream collaboration, among suppliers. Therefore, it would be interesting to study the collaboration with several internal and external entities.

Fifthly, from the perspective of sustainability, the performance measures of horizontal collaboration in freight transport have evolved, passing from mainly economic aspects to also include the environmental dimension. However, as mentioned in section 4.2.3, very little research has been conducted on the social dimension of sustainability or the consideration of all three dimensions simultaneously, compared to the quantity of research on the other two aspects. This conclusion demonstrates the need to find and include social aspects to balance all sustainability considerations.

Finally, in terms of research methodology, many studies have used experimental methods based on mathematical models. This can be explained by the interest of researchers in operational research methods and by the need to model a large variety of problems. Indeed, most work focuses on the development of single-objective and deterministic optimization models. Very little of the research has used multi-objective approaches to consider two or more sustainability objectives. In addition, empirical studies have received much less attention in the literature despite their importance in the experimental modelling of optimization problems. For example, to study collaboration between competing actors, empirical studies are necessary to explore the opportunities and obstacles of implementing such a collaborative strategy. In addition, social modelling will need qualitative research to better understand human goals in societal terms and to integrate them into optimization models.

6. Future research orientations

From the analysis results, we can suggest some opportunities for future research to fill the gaps in the literature on collaborative planning and sustainability in freight transport.

The first opportunity would be to extend collaboration downstream of the distribution system and eventually with external parties such as customers and competitors. Indeed, the integration of the customers in a collaborative approach could increase the overall performance of companies, for example, cooperation with customers during the collection of products returned for recycling. This topic deserves further study in future research on the implementation of a collaborative approach and the development of sustainable practices.

A second research line is to integrate the various decisions related to the strategic, tactical and operational levels into an exhaustive model. In fact, the strategic decisions have a significant impact on the performance of organizations in the long-term, on the one hand, and on tactical and operational decisions and constraints, on the other. Similarly, tactical and operational decisions can have impacts on transport efficiency, for example, the optimization of freight distribution, the modification of delivery frequencies and last-mile distribution mode (electric vehicles, drones, etc.) can reduce logistics costs and other environmental and social consequences, but also have a significant impact on the fill rate of vehicles. According to this analysis, the combination of different levels of planning has been virtually neglected in the literature. As noted in the previous section, no studies have considered inventory, routing and design decisions simultaneously for a single or multiple echelon of a distribution system. Furthermore, few studies have considered the uncertainties relating to parameters (demand, travel time, etc.) and logistical constraints (capacity, time windows, etc.). Consequently, optimization models considering these aspects for integrated planning problems should be developed in future work.

A third research perspective concerns evaluation criteria and optimization approaches. Firstly, concerning performance measurement, the most frequent criterion in the work reviewed was economic performance, namely minimizing operating costs, including variable and fixed costs, transport and logistics costs. Emission taxes could be integrated into the economic assessment in order to encourage companies to use cleaner technologies from a green perspective. In contrast, the other two aspects of sustainability, and in particular, the social criteria, are rarely considered when assessing the performance of a distribution network. Indeed, the environmental dimension is usually limited to the calculation of the CO_2 emissions from transport. Direct emissions from facilities and from inventory activities, for food products, as well as other environmental factors such as the quantity of waste and energy consumption, which could be included in the environmental assessment. As regards the social dimension, the latter is practically absent because of its qualitative nature and is only limited to quantifying the number of jobs created and the health and safety factor for employers. Therefore, future research should be focused on the way this aspect is quantified. In addition, other operational factors such as flexibility, use of resources and quality of service can be considered in assessing the overall performance of logistics networks. Secondly, performance criteria must be balanced, therefore, modelling approaches should be developed for effective decision making. A research opportunity would be to combine classical optimization methods with qualitative (multi-criteria) approaches to consider formal criteria.

A fourth research direction is related to the problem of sharing the gains generated by horizontal collaboration between partners. Almost all the research reviewed on this topic focused on how to share the economic gains equitably in order to maintain the stability of the coalition and to encourage partners to collaborate. The allocation of emissions and social benefits has received much less attention in research. Moreover, the majority of studies have concentrated on the comparison and selection of the most efficient allocation methods. The way of considering sustainable development perspectives in the sharing mechanism seems to be an interesting research topic. In addition, another important research question is how to maximize gains and to form the best coalition from a sustainable perspective. Finally, because of the dynamic nature of real problems, the formation of a coalition may be modified over time. It is then necessary to study how the uncertainties can be integrated in the gain sharing mechanisms. It would then be necessary to study how the uncertainties could be incorporated into the gain-sharing mechanisms.

The final research opportunity concerns operational transport planning. Indeed, collaborative vehicle routing has been the subject of much research due to the decentralized nature of logistics organizations. In this context, auction mechanisms are used as a powerful tool for increasing the benefits of collaboration in economic terms. Environmental and social issues are practically absent in the exchange mechanisms proposed (Pan et al., 2019). Consequently, request exchange mechanisms should take sustainable development considerations into account, especially in last-mile transport, for example, design a mechanism for allocating requests while maximizing transport turnover, but also reducing negative effects on the environment and society (CO_2 emissions, noise, congestion, accidents, etc.). Research on these topics should be developed in future literature.

7. Conclusion

In recent years, horizontal collaboration has become a very effective and emerging strategy in freight transport, particularly from a sustainability perspective. In this paper, an SLR was conducted on collaboration and sustainability in freight transport with a focus on work published over the past decade. This review aimed to identify and examine the existing state of the art. We classified and analyzed the literature according to three categories, namely the decision level, the sustainability dimension and the research methodology used. Then, based on the results of the analysis, we identified some research perspectives that merit investigation in future work to ensure the sustainability of transport.

The results of this review have shown that operational transport planning is the major decision addressed, with nearly 60% of the literature reviewed. Also, the collaboration between external parties such as logistics service providers, competitors and customers has received very little attention. Furthermore, from a performance measurement point of view, more attention has been given to economic and environmental criteria than to social criteria. These are neglected in the literature. Moreover, most research uses experimental methods based on mathematical models, empirical research is not used well despite its importance in modelling problems, for example in measuring social performance.

Based on the results of the qualitative and quantitative analysis, we suggested five promising directions for research that merit further study. Firstly, it is about extending horizontal collaboration with other external parties. Secondly, the different planning decisions can be combined in a global model to improve the overall performance of the logistics network. Thirdly, assessment criteria and modelling approaches should be improved for better decision-making on economic, environmental and social sustainability. Fourthly, it is important to study the stability of a coalition and the sharing of benefits in a sustainable perspective and under uncertain circumstances. Finally, the three aspects of sustainable development should be integrated in request sharing mechanisms to ensure transport efficiency and effectiveness, particularly in urban cities.

In this study, we have focused on studies that concentrate on practical solutions for horizontal collaboration in freight transportation. Innovative solutions such as the physical internet that are not yet fully implemented in industrial applications are excluded in this review. This last point could be considered as a limitation of this study.

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