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Food Supply Chain: A Review of Approaches Which Enhance Sustainability with a Focus on Social Responsibility

Danijela Tuljak-Suban

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Abstract

The sustainability of food supply chain management in a global market after the Economic Crisis is increasingly relevant; the economic and environmental pillars have been closely studied and examined, while the social pillar is considered only marginally and never independently. We propose a literature review focused on 28 articles regarding sustainability in the food supply chain. The proposed review (a) detects methods that could be used to enhance sustainability, (b) highlights the most used methods and their shortcomings, and with regard to social sustainability (c) highlights the fact that most of the studies were found to be based on empirical approach. Moreover, we propose the use of a fuzzy framework to evaluate sustainability (in particular, the social aspect), since fuzzy variables could better explain phenomena and situations generally described verbally.

Keywords: Sustainable Supply Chain Management (SSCM), Food, Information Technology, Social Sustainability, Literature review

1. Introduction

Globalization and the establishment of a global market have transformed the process of production, storage, transportation and the sale of perishable goods as well as the extension of delivery times and the scattering of production and storage locations. It therefore follows that the supply chain has become a complex process composed of many factors. Food as a perishable good is most certainly freight, which requires careful attention during the various stages and processes of the supply chain.

The sustainability of the supply chain is generally defined as a union of three dimensions: economic aspects, environmental performance and social responsibility [1]. The economic aspect is analysed in the majority of papers, while interactions with environmental performance are also taken into consideration. Social responsibility is examined only marginally and generally from the economic point of view.

In the case of food, the combined analysis of the three aspects could be hampered by the particular characteristics of this freight which deteriorates over time. In this chapter, we review approaches which enhance sustainability with a focus on social responsibility with regard to food.

The appearance of food is vital, being that appearance is often linked to quality. Food quality could be quantified according to its chemical, physical, microbiological or sensory characteristics. Factors which influence the kinetics of food deterioration are non-enzymatic browning, vitamin loss, microbial death or growth, oxidative colour loss and texture loss [2].

The transportation and handling of food are certainly sensitive parts of the supply chain, since it is during these phases that an increasing number of factors cause deterioration and quality changes. In particular, it becomes difficult to ensure stable conditions to limit deterioration, making it necessary to carefully monitor the entire process. It makes sense to include human resources and also use sensors and detectors in the process of verifying quality to improve performance. The proper use of suitable information technology (IT) allows one to maintain a high level of quality and to make corrections in real time.

In this chapter, we present a detailed review of the procedures and methods used to manage the supply chain of perishable goods, with a focus on food. The choice of literature database and keywords were carefully made, taking into account that food (as a perishable good) could be examined from very different angles (economic, biological, logistic, social, etc.), which are all not necessarily directly connected with supply chain management.

The time period examined in the review also includes that of the Global Economic Crisis to examine whether economic changes influence social responsibility (local production of food, shortening of the supply chain and development of the local economy) and environmental performance (reduction of waste—spoiled food and increase of recycling) with regard to food.

The chapter is composed of four sections and a conclusion. The relations between the sections are presented in **Figure 1**.

In the introduction, we present the motives that led to writing about the methods used to manage the supply chain of perishable goods with a focus on food.

Sustainability in the supply chain is defined in Section 1. A definition of sustainability related to the food supply chain is also proposed, with a particular focus on social responsibility with regard to food.

In Section 2, a step by step literature review of methods used to manage the food supply chain is defined. The starting point is the classical Economic Order Quantity (EOQ) model for perishable goods, with exponential inventory and deterioration function. The review is then

extended to other differential and integral methods used to optimize the ordering period and to the network optimization methods applied to the supply chain network.

In Section 3 are classified procedures and methods used to manage the food supply chain. Detected critical factors (social, economic, technical, etc.) in the supply chain are highlighted, and IT implementation is examined or suggested.

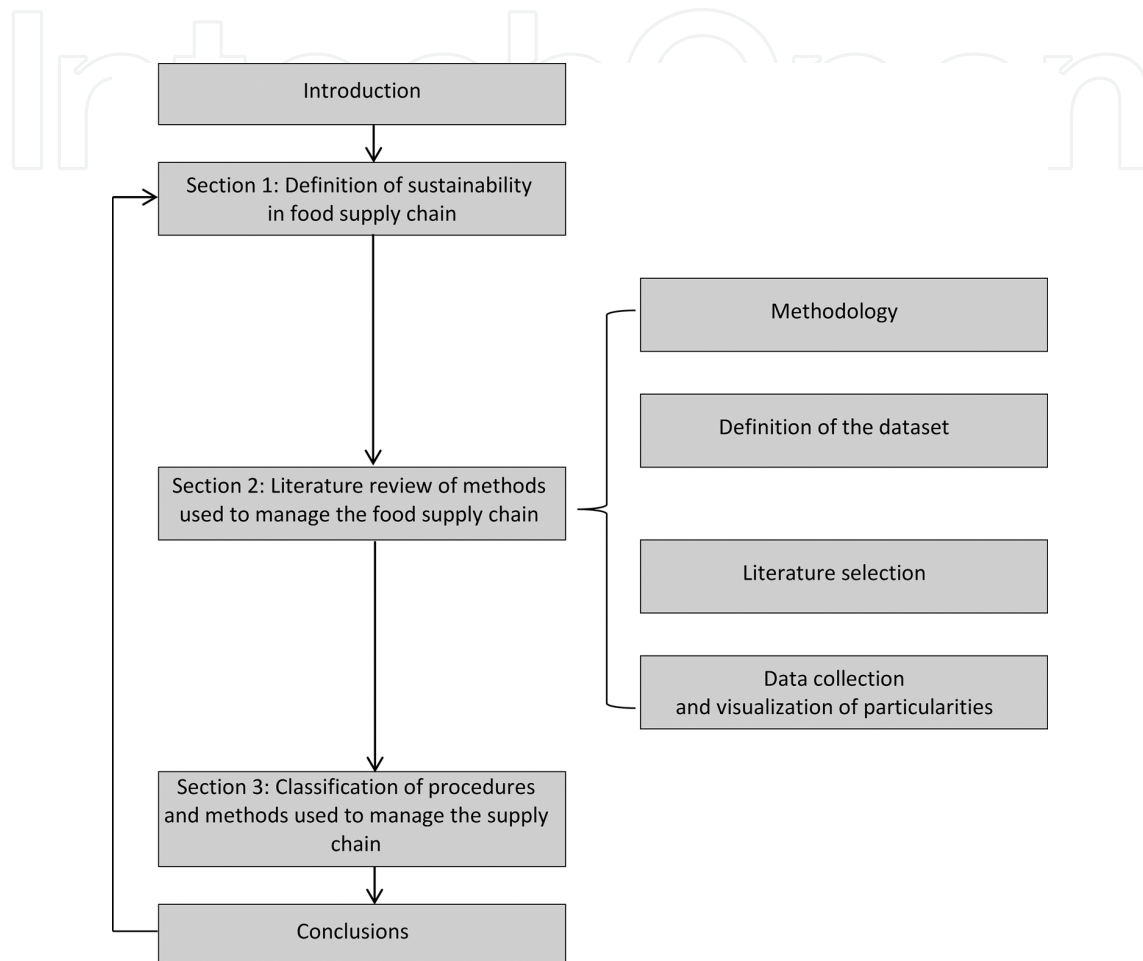


Figure 1. Structure and relations between the sections of the chapter.

The proposed classification is done to highlight:

- a. Leading methods used to improve the sustainability of the supply chain,
- b. Connectivity options between different approaches with a particular focus on the appropriate use of IT to improve sustainability, and
- c. Neglected aspects of sustainability with a particular focus on social responsibility.

2. Definition of sustainability in the food supply chain

The first and most commonly known definition of sustainable development is from the Brundtland Report [3]:

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

- *the concept of **needs**, in particular the essential needs of the world's poor, to which overriding priority should be given; and*
- *the idea of **limitations** imposed by the state of technology and social organization on the environment's ability to meet present and future needs."*

This definition is abstract and not balanced, because it is focused on the human factor. We consider it more advantageous to adopt a more stable and complete definition based on the three pillars: social, environmental and economic sustainability [1,4].

Economic sustainability has become increasingly important since the Global Economic Crisis; a concerted effort has been made to reduce bribery, antitrust claims, tax evasion and to prevent a new financial crisis [5].

In addition, the Climate Change Conference held in Paris at the end of 2015 confirmed that environmental sustainability is also of great significance, since pollution, emission of greenhouse gases, ozone depletion, excessive or unnecessary packaging, water scarcity, heat-waves, droughts and production of waste are deteriorating the planet and reducing quality of life. The reduction of these phenomena is necessary, but it is often connected to economic sustainability, and unfortunately environmental and economic aspects are generally not proportionate [5].

Social sustainability is connected to the reduction of risks related to excessive hours of work, unfair wages, child labour, discrimination, an unhealthy and unsafe work environment, exploitative hiring policies, unethical treatment of animals and social instability. The achievement of social sustainability is the most complex among the pillars of sustainability, since data and research regarding these issues are often insufficient or altered, and the social aspect is generally at odds with its other two counterparts [5].

On the basis of the data presented in the literature [1] one can note that in supply chain management, the economic and environmental dimensions of sustainability are the most analysed, while the social dimension is the less considered aspect. In addition, connections between the social aspect and the economic and environmental aspects are poorly considered. Hence, the social aspect of sustainability in supply chain management is the weakest aspect and requires further analysis and integration with its counterparts.

The integration of all the three aspects plays a central role in improving sustainability, but from the previously discussed findings it is possible to conclude that the social dimension needs much better integration with economic and environmental issues [6].

The three-pillar definition of sustainability is presented in **Figure 2**.

The below-given definition of sustainability in the supply chain can also be used with reference to food supply. In this case, the social aspect is connected with the production and consumption

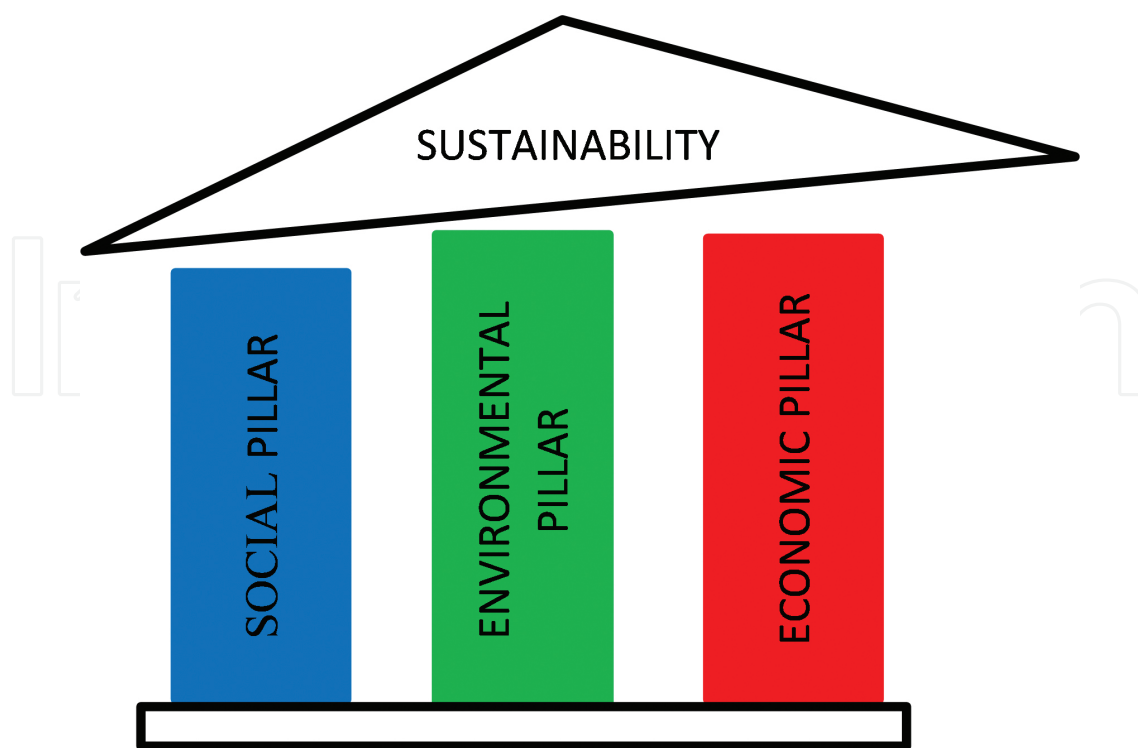


Figure 2. Three-pillar definition of sustainability.

of food. The relationships between the economic, environmental and social aspects become more complicated and at times conflictual in nature.

3. Literature review of methods used to manage the food supply chain

Over the last decade (from 2006), many literature review articles were written on the supply chain, which reviewed methods needed to improve the economic and environmental aspects of sustainability. The social aspect of sustainability was rarely considered and poorly examined. Among these articles, no literature review dealt with the food supply chain which focused on the social aspect of sustainability. **Table 1** presents the supply chain review articles. Highlighted are our findings and the sustainability aspects which were taken into consideration. Seventeen review articles were examined which were published in relevant journals found on the web platform, Science Direct (SD).

On the basis of the data from **Table 1**, it is possible to see that:

- i. Almost all the papers reviewed (94%), except that by Seuring and Zhang [6], took into consideration the economic aspect of sustainability.
- ii. In almost all the papers reviewed, two aspects of sustainability are dealt with—the environmental and the economic. Also, only the economic aspect is considered individually, except in the paper by Seuring and Zhang [6], where the environmental aspect is considered individually.

- iii. Only 19% of papers reviewed investigated the social aspect of sustainability.
- iv. The social aspect of sustainability is always aggregated to the other two aspects of sustainability.
- v. In four review papers [12,13,15,16], sustainability in the food supply chain was analysed, but the social pillar was not considered. Of all the papers considered, only that by Beske et al. [12] dealt with the social aspect, and that too marginally.

The analysis of the data has shown a clear lack of research papers regarding the social aspect of sustainability in the food supply chain. Next, a literature review which attempts to fill this gap will be presented.

Authors and publication year	Title	Sustainability aspect	Article focus	Findings
Grillo et al., 2016 [7]	A review of mathematical models for supporting the order promising process under Lack of Homogeneity in Product and other sources of uncertainty	Economic aspect	Review of mathematical programming models	Support to the order process
Mulyati, 2016 [4]	Sustainability in Supply Chain Management Casebook: Applications in SCM: a book review	Economic aspect, environmental aspect and social aspect	Review of practical examples	Handbook
Wang et al., 2015 [8]	Service supply chain management: A review of operational models	Economic aspect	Review of operational models in service supply chain management	Identification of the research challenges
Eskandarpour et al., 2015 [1]	Sustainable supply chain network design: An optimization-oriented review	Economic aspect, environmental aspect	Review of network design	Identification of modelling, solution techniques and fields of application
Bazan et al., 2015 [9]	A review of mathematical inventory models for reverse logistics and the future of its modelling: An environmental perspective	Economic aspect, environmental aspect	Review of mathematical models for reverse logistics	Outline that an environmental issue in RL is not modelled. Presentation of a new

Authors and publication year	Title	Sustainability aspect	Article focus	Findings
				modelling approach for green RL
Sternberg and Andersson, 2014 [10]	Decentralized intelligence in freight transport – A critical review	Economic aspect	Review of network design	Overview of research on decentralized freight intelligence
Steadie Seifi et al., 2014 [11]	Multimodal freight transportation planning: A literature review	Economic aspect	Review of network design	Identification of strategic, tactical, and operational levels of planning
Beske et al., 2014 [12]	Sustainable supply chain management practices and dynamic capabilities in the food industry: A critical analysis of the literature	Economic aspect, social aspect	Link Sustainable Supply Chain Management with the Dynamic Capabilities Theory	Identification of specific Dynamic Capabilities for managing sustainable supply chains in the food industry.
Dabbene et al., 2014 [13]	Traceability issues in food supply chain management: A review	Economic aspect	Review of network design and optimization	Involvement of traceability issues in supply chain design and optimisation.
Martínez-Jurado and Moyano-Fuentes, 2014 [14]	Lean Management, Supply Chain Management and Sustainability: A Literature Review	Economic aspect, environmental aspect	Evaluation of the links between Lean Management, Supply Chain Management and Sustainability	Identification of contradictions and inconsistencies
Yared Lemma and Gatew, 2014 [15]	Loss in Perishable Food Supply Chain: An Optimization Approach Literature Review	Economic aspect	Review of literature	Identification of the main issues (production, transportation and inventory) of loss of food in agricultural supply chain
Dora et al., 2013 [16]	Food quality management system: Reviewing assessment strategies and a feasibility study for European food small and medium-sized enterprises	Economic aspect, environmental aspect	Review of quality management models	Identification of benefits from the implementation of QM principles
Seuring, 2013 [6]	A review of modelling approaches for sustainable supply chain management	Economic aspect, environmental aspect, Social aspect	Review of quality modelling approaches	Confirmation that the social dimension needs much better integration with the economic and environmental ones

Authors and publication year	Title	Sustainability aspect	Article focus	Findings
Govindan, 2013 [17,18]	Embedding Sustainability Dynamics in Supply Chain Relationship Management and Governance Structures: Introduction, Review and opportunities	Economic aspect, environmental aspect	Review of data	Adds governance and relationship aspects to agenda
Styles et al., 2012 [18]	Environmental improvement of product supply chains: A review of European retailers' performance	Environmental aspect	Review of data	Identification of European retailers' environmental improvement of supply chains.
Awudu and Zhang, 2012 [19]	Uncertainties and sustainability concepts in biofuel supply chain management: A review	Environmental aspect, social aspect	Review of mathematical simulations and programming	Summary of differences and sustainability concepts of the first, second, third and fourth generation biofuel
Gupta and Palsule-Desai, 2011 [20]	Sustainable Supply Chain Management: Review and Research Opportunities	Economic aspect, environmental aspect	Review of strategic considerations; regulation and government policies; integrative models and decision support tools	Development of an integrative framework to summarise literature

Note: Highlighted articles are related to the food supply chain.

Table 1. Literature review articles on sustainability in the supply chain.

3.1. Methodology

The starting point of all research is certainly a detailed analysis and classification of the results obtained by the researchers in this field. A methodical literature review could potentially bring to light the results obtained till date. In this paper, systematic methods of review will be used in order to summarize results presented by the authors of papers found in international publications (journals).

The classical narrative method of review will be used only as a complement to the systematic method of review, since a chronological list of articles and the accompanying results allow one to have an overall evaluation, but not to highlight the peculiarities or deficiencies of the searches.

The systematic method of review permits one to aggregate similarities, identify topics that have not yet been examined, classify results according to various criteria (country of origin, method of analysis, obtained solutions, etc.) while still maintaining an overall view. Also, some statistical methods typical for the meta-analysis of published data are adapted to the structure of the analysed database [21–23].

The systematic literature review used in the next paragraph is composed of the following main steps [24]:

I. Definition of the database

In this phase, the database is defined, and specifically, journals which are the basis for the article search will be collected.

II. Literature selection

The criteria used in the search are carefully defined. It is very important to detect proper keywords that entirely include the defined criteria and at the same time can be neither too general nor too restrictive. The database is searched for titles, abstracts and keywords which match the chosen search criteria.

III. Data collection and visualization of peculiarities

Articles are organized in a table which includes data regarding the authors, the name of the journal which published the article, publication date, the data related to the geographic region in question, methods used, results obtained and data regarding the examined aspects of risk in food supply chain management.

3.2. Definition of the database

The dataset composed of articles and books is extracted from the web platform, Science Direct (SD). This platform was chosen because access to all titles and abstracts of the articles is free for the researchers of the University of Ljubljana, and also the text of most articles is free. Non-academic users must subscribe to access the complete databases. In addition, articles from this database are all peer-reviewed and are representative of a majority of the studies and results in this field. All articles are in English; therefore, the same English keywords could be employed.

3.3. Literature selection

The keyword search is defined hierarchically by the definition of an initial large dataset of articles and other contributions through the use of keywords, which are not too specific, and then subsequently narrowing the search by increasing the specificity of the keywords.

In the first step, the general terms *supply chain management* were used, and then the selection was further restricted by using the term *sustainability*, and then by the term *food*. Keywords were combined by the Boolean operators AND and OR. The search was conducted between the Title words, Keywords and words in the Abstract. The term *sustainability* is also often used in the adjectival form *sustainable*; so, the search was extended to both forms. Also, the term *food*

is often replaced by the terms *goods* or *perishable goods*; so, the search was extended also to the term *goods*. The replacement of the term *food* with terms *goods* or *perishable goods* did not produce additional results, which suggests that researchers do not use the term *goods* with regard to sustainability of food supply chain.

An additional condition used in the search was the publication year, as it is generally reasonable to avoid making use of literature which is more than 5 years old. However, for the purposes of this paper, a greater time interval was used from the year 2006 to the present. This allows one to measure the influence of the Global Economic Crisis and climate change on the sustainability of the food supply chain by detecting the number of related articles published during this period.

To verify the quality of the constructed dataset of articles, using the same keywords, Scopus and Web of Science platforms were also inspected. The obtained results were the same, with only a few different articles being found. Unfortunately, these articles are not freely accessible, and therefore were not included in the dataset.

Furthermore, the snowball or reverse search technique which enables obtaining additional articles by tracing citations from articles already included in the dataset was not used, since, on the basis of the literature review analysis presented in **Table 1**, it is possible to conclude that: (a) the contents of the cited articles are more general than the contents of the final set of articles on sustainability in food supply chain management, (b) they are dated before the articles already included in the dataset and (c) the results are abstracted in the original and review articles already included in the dataset.

Finally, it was necessary to remove from the list of contributions any article that contained the above-mentioned keywords, but which, upon closer inspection, was found to be not directly connected with the topics analysed in this article. Two articles about the biofuel supply chain management were removed. In **Figure 3**, the progress and results of the search are presented.

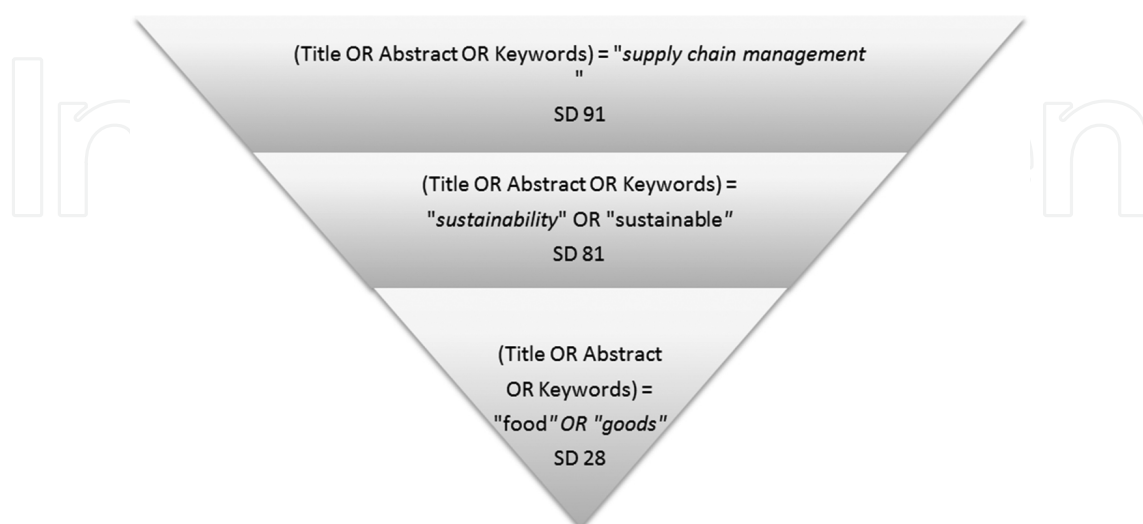


Figure 3. Search progress steps in the literature dataset definition.

The final dataset is composed of only 28 articles, even if the singular use of the keywords generated much larger sets. This would suggest that the aggregation of sustainability and food to the supply chain management has not been sufficiently examined by researchers.

3.4. Data collection and visualization of peculiarities

In this phase, it is necessary to encode the acquired data; each record in the dataset contains the following fields: (1) publication year, (2) author data, (3) title, (4) journal title, (5) considered sustainable aspect, (6) definition of the analysed method used, (7) use of IT and (8) case study. In **Table 2**, the original articles about sustainability in the food supply chain are presented.

Article data	Sustainability			Method used	IT	Case study
	Economic	Environmental	Social			
Al-Busaidi et al. [25]	■	■		SWOT analysis		■
Tidy et al. [26]		■	■	Data analysis		■
Verdouw et al. [27]	■			Network design	■	■
Saleh and Roslin [28]	■			Statistic approach/ Empirical test		■
Fedrigotti and Fischer [29]	■	■	■	Statistic approach/ Empirical test		■
Garrone et al. [30]		■	■	Availability Surplus Recoverability Waste (ASRW)		■
Grekova et al. [31]		■		Empirical model		■
Grimm et al. [32]	■			Qualitative analysis of critical factors		■
Papargyropoulou et al. [33]	■	■	■	Hierarchy method/ Statistic approach		
Li et al. [34]	■	■		Game theory		
Validi et al. [35]	■	■		Mathematical optimization model		■
Turi et al. [36]	■	■	■	Mathematical optimization model		

Article data	Sustainability			Method used	IT	Case study
	Economic	Environmental	Social			
Martikainen et al. [37]	■			Classification methods	■	
Eksoz et al. [38]	■			Empirical testing	■	
Chen et al. [39]	■			Analytical optimization model		■
Bourlakis et al. [40]	■			Empirical model/ Statistic approach		
Aung and Chang [41]	■			Clustering	■	
Ala-Harja and Helo [42]	■	■		Operation Research models	■	
Agustina et al. [43]	■			Mixed integer programming		■
Gold et al. [45]	■		■	Pyramidal method/ Qualitative approach		
Manzini and Accorsi [46]	■			Empirical testing		
Wang et al. [47]	■	■		Mathematical optimization model		
Zanoni and Zavanella [48]	■	■		Mathematical optimization model		■
Lazaridesa [49]	■	■		Empirical testing		

Table 2. Original articles about sustainability in the food supply chain.

4. Classification of procedures and methods used to manage the supply chain

In this section, the particularities of the original articles included in the dataset are explained. We propose different classifications and have highlighted the differences with respect to the results proposed in the review articles about the sustainable supply chain from **Table 1**.

The original papers considered do not address all the three dimensions of sustainability, that is, the economic, environmental and social aspects. In **Figure 4**, the distribution with respect those dimensions is proposed.

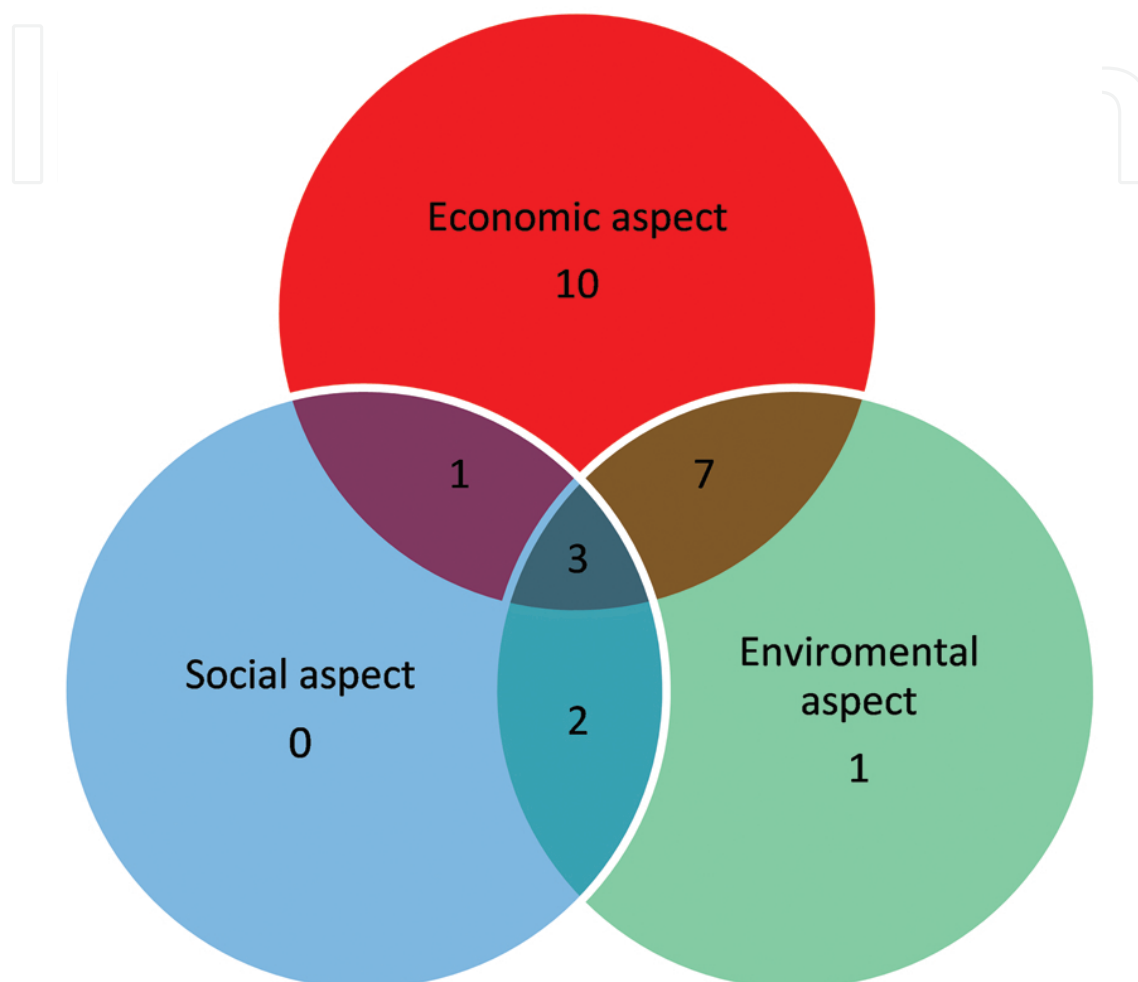


Figure 4. Distribution of the original articles with respect to the sustainability dimensions.

It is possible to see that the researchers considered the economic aspect most significant, since almost all the articles included this dimension in the analysis. The environmental aspect was the second most frequently considered dimension and was generally combined with the economic aspect, with the exceptions of the article by Garrone et al. [30], which did not consider the economic aspect but analysed the environmental and social aspects, and the article by Grekova et al. [31], which considered the environmental aspect individually in the case of Dutch food and beverage firms.

There were no articles which examined the social or environmental aspect individually. The social aspect is generally connected with the economic. The obtained results are in accordance with the findings on general sustainable supply chain highlighted by Eskandarpour et al. [1].

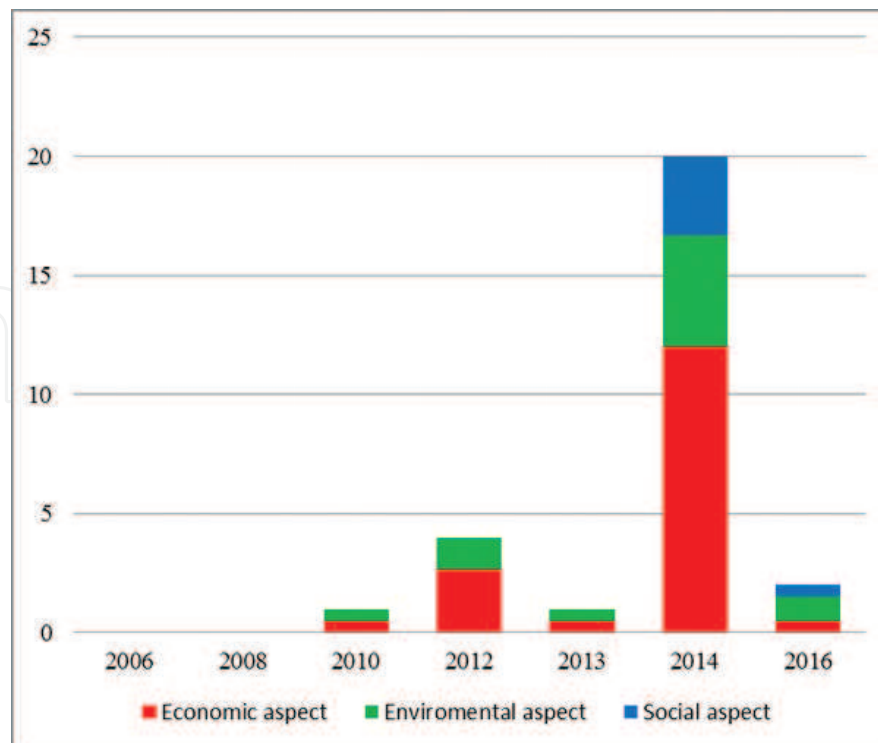


Figure 5. Distribution of the papers in the given time period.

In **Figure 5**, the distribution of the papers (review and original) is presented during the time period [2006–2016]. It is possible to note that sustainability in food supply chain management becomes a topic of consideration after the 2008 Global Economic Crisis. Social aspect of sustainability becomes relevant from 2014.

The number of articles increases and becomes relevant from 2010, while from the papers reviewed in **Table 1**, it is possible to note that sustainability in the supply chain has been consistently studied since the early 1990s.

The articles' dataset could also be classified with respect to the procedures and methods used:

- a. Differential methods and integral methods used to optimize costs,
- b. Network optimization applied to the supply chain network,
- c. Detection of critical factors (social, economic, technical, etc.) in the supply chain, and
- d. IT implementation.

In **Figure 6**, the rate of methods used to optimize and analyse the food supply chain is presented. It is possible to note that in accordance with the results of the general literature review papers from **Table 1**, the cost optimization methods based on the EOQ model and on mathematical optimization are the most commonly used (41% of the articles); SWOT analysis and other methods used to detect critical factor are also frequently used (38% of the articles).

In the analysed dataset, IT is associated with the other methods in 17% of the articles. Only in the article by Verdouw et al. [27] is the use of the Internet of Things proposed for use in managing the food supply chain.

Articles that present case studies (25% of the original articles) generally considered practical examples from European regions, with the exception of the article by Al-Busaidi et al. [25] that examined the seafood supply chain in the Sultanate of Oman.

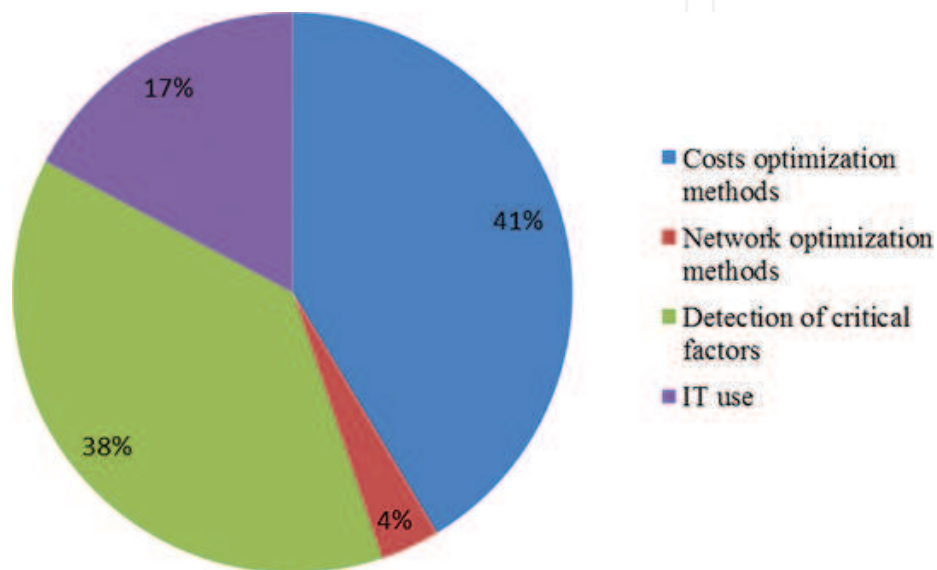


Figure 6. Distribution of the papers with respect to the investigation method used.

Studies which consider the social dimension in supply chain management are all generally based on empirical case studies, and there are no generic models which include all three dimensions of sustainability [1].

In the case of food supply chain management, there are studies which approach the social aspect of sustainability with quantitative mathematical optimization models [30,33,36,44]. These models are not generic but could be a good starting point to improve the importance of the social aspect of sustainability in a general model.

A limitation to all the analysed models is that the social aspect is subordinated to the economic (or environmental) aspect of sustainability. In the articles considered, general solutions on how to develop and improve sustainability as local production of food and shortening the supply chain are not proposed [25–27,29,39].

In **Table 3**, the main aspects and research approaches to the three pillars of sustainability are summarized.

Sustainability in the food supply chain		
Economic aspect	Environmental aspect	Social aspect
Costs optimization: - production costs - inventory costs - transport costs	Waste management Food quality	Food quality Work conditions Local production of food
Mathematical optimization models based on costs and IT implementation [49] [34] [42] [47] [48]	Empirical models, statistic review of data, optimization models [30]	
Empirical models, statistic review of data, optimization models [29] [33] [36]		

Table 3. Main topics and aspects of sustainability in food supply chain.

On the basis of the results summarized in **Table 3**, it is possible to note that there are no articles (detected with the keywords defined in Section 3.3) which use fuzzy reasoning to assess the three aspects of sustainability. The fuzzy approach is generally used to define parameters that are not usually crisp constant, but have values that are defined as words (small, medium, large) used by the experts to describe characteristics of the supply chain, food quality, working conditions, etc. [50].

Fuzzy reasoning could be used to evaluate the social aspect, since this category includes aspects that are usually evaluated descriptively; for this reason, empirical models are proposed to analyse this aspect. The environmental aspect is described by empirical models, but optimization models are also proposed. So, in this case, the introduction of fuzzy variables in a crisp optimization model could be appropriate. The economic aspect is the most studied, and many efficient crisp optimization models are detected in the review. An overall assessment of sustainability, taking into account all three aspects and their particularities, could be defined by a fuzzy logic reasoning model which analyses the economic, environmental and social aspects of sustainability and defines a score as much as the human brain does.

The rules used in the fuzzy evaluation model are defined on the basis of the priorities and particularities in the reviewed articles (see **Table 3**). In the model, fuzzy and crisp variables could be used. Fuzzy variables could be defined using three fuzzy terms (bad, good, very good) and triangular membership functions. In **Figure 7**, an example of the fuzzy model is proposed.

Since the proposed framework is very close to neural networks and expert systems, it could be expanded by the use of relevant IT in a smart tool to evaluate the sustainability level of the food supply chain management.

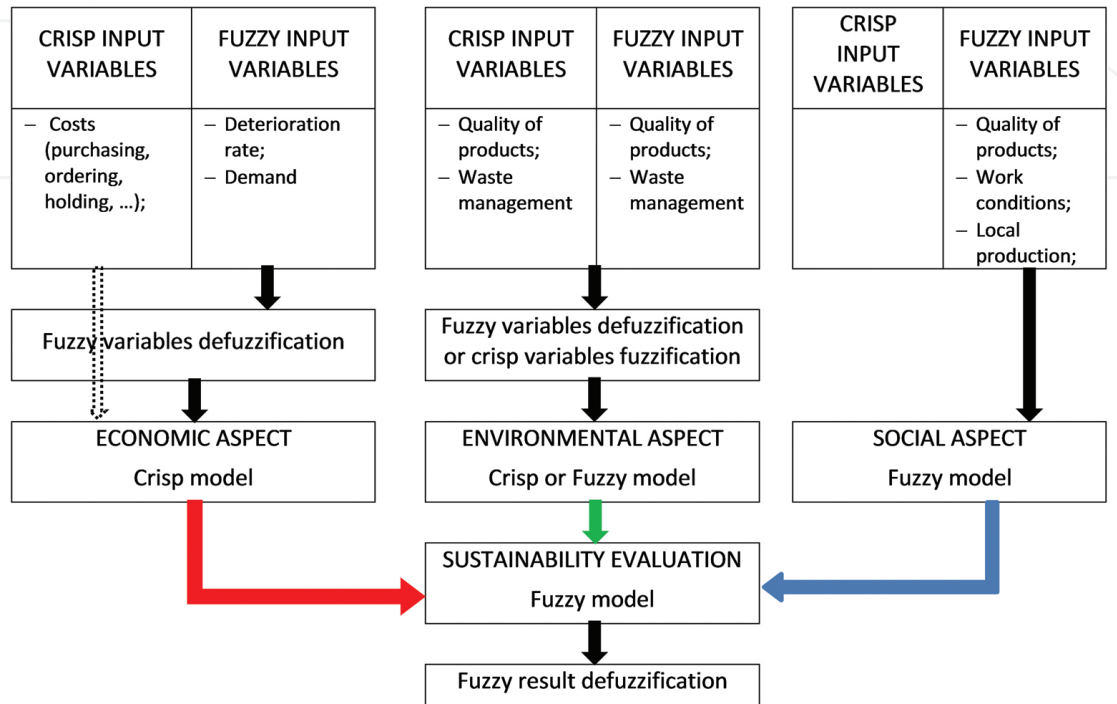


Figure 7. Evaluation of the sustainability level of the food supply chain.

5. Conclusion

The aim of the proposed manuscript is to improve upon the already published reviews of articles on the management of the food supply chain and to present a review of the methods explained in the articles, which are used to improve the food supply chain with a focus on the social aspect. There are many literature reviews regarding sustainable supply chain management (also dealing with perishable goods and food); however, social responsibility and the use of IT to improve social sustainability have not yet been satisfactorily investigated.

From the proposed classification of articles about food supply chain management, it is possible to highlight that:

- I. the social aspect of sustainability is not sufficiently considered and is always combined with the economic or environmental aspect,
- II. the proposed optimization models are local, and the social aspect of sustainability is included in the models only marginally in the conditions,

- III. IT is used as a support to the mathematical or empirical models,
- IV. sustainability has become a relevant issue after the Global Economic Crisis, and
- V. there are no general models.

The articles listed in **Table 3** could be used to define a general frame of sustainability with regard to the food supply chain. The social aspect of sustainability requires further analysis to define qualitative indicators that permit one to measure the level of implementation of social responsibility in the food supply chain. For this purpose, a framework of a fuzzy evaluation model was explained.

We hope that this encourages the food industry to take into consideration the social aspect as a positive addition to the economic and environmental aspects. From the definition of sustainability and the results obtained in the review, it is possible to conclude that only the balanced implementation of the social, economic and environmental aspects of sustainability can be acceptable for the food industry and the customers. For this reason, a framework to define global assessment model of sustainability has been proposed.

Author details

Danijela Tuljak-Suban

Address all correspondence to: danijela.tuljak@fpp.uni-lj.si

University of Ljubljana, Faculty of Maritime Studies and Transport, Portorož, Slovenia.

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