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Abstract

This paper discusses the impact of sustainable practices in food supply chains. Practices are identified from the literature and their implementation maturity level by companies is assessed. Through a systematic literature review, current best sustainable practices about supply chain management in the food industry are identified. Then, a questionnaire survey is administered to professionals, and the results are quantitatively analyzed using the Kruskal-Wallis test. Twenty-five best sustainable supply chain management practices are considered. Among these, some practices appear to be well established on both the academic and industrial sides, such as sustainable supplier management practices. On the contrary, other practices widely discussed in the literature, such as green shipping and distribution, or collaborative practices are still rarely adopted. Moreover, some practices appear to have a direct influence on the economic, environmental, and social dimensions a business should be accountable for. This work includes the point of view of professionals that are increasingly dealing with the sustainability issue.

Keywords Sustainability, Supply Chain Management practices, food industry, literature review, survey

1. Introduction

It is widely recognized that the food industry plays an important role in every individual's life (Manzini and Accorsi, 2013). A Food Supply Chain (FSC) can be defined as all the conventional processes from 'farm to fork' or from 'plough to plate' (Pardillo Baez *et al.*, 2020). One of the biggest challenges that today's companies are facing is compliance with sustainable development standards (Afum *et al.*, 2022) and the related Sustainable Development Goals which, coupled with internationalization, has led to an increase in competition among organizations (Nosratabadi *et al.,* 2019). Sustainable Development is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (CMED, 1987). The integration of the sustainability concept within a Supply Chain (SC) can enable a company to achieve a

competitive advantage in the market (Khoja *et al*., 2022). Moreover, the investigation of sustainability practices in SC arena has become a relevant field of research (Fritz *et al*., 2022) Sustainable Supply Chain Management (SSCM) is defined as a set of supply chain practices designed to have a reduced environmental impact (measured in terms of carbon dioxide emissions, waste reduction, water consumption, etc.), to improve the social condition of the various stakeholders while contributing to the long-term economic development of the chain (Stiller and Gold, 2014). Three dimensions are *de facto* critical in SSCM: economic, environmental, and social; these are theorized under the Triple Bottom Line (TBL) approach (Martins *et al*., 2020). The adoption of suitable practices is therefore required to satisfy the dual objective of improving the overall performance of a company and fulfilling the sustainability requirement. A best practice is defined as any practice or experience which has proved its value, or which is used in an efficient way in an organization and can be applied in other organizations. Chardine-Baumann and Botta-Genoulaz (2014) define a best practice as having three characteristics: it is formalized, reusable, and effective. This means that the value created by the implementation of the practices must be relevant, coherent, effective, efficient, robust, and sustainable.. This paper discusses the impact of SSCM practices focusing on the food industry. To this end, these practices are identified from the literature and their implementation maturity level by companies is assessed. This study focuses on Italian- and French-based food companies. In addition, the proposed research is aimed at examining the importance given to the three sustainability dimensions and their relationship with sustainable practices. It provides a general framework that might be adopted by organizations operating in the food industry to reach the sustainability goal more easily.

Studies on SSCM practices are typically carried out for the automotive, textile, apparel, and luxury industries, while the food industry appears to be analyzed less in the literature (Nosratabadi *et al.*, 2019). Moreover, even though the sustainability issue and related sustainable practices are receiving a lot of attention from researchers, studies across the food sector typically fail to consider the whole FSC or focus on a subset of sustainable practices (Mittal *et al.*, 2018). By contrast, in this paper the adoption of the identified best SSCM practices is investigated for each stage of a FSC. The primary production, post-harvest, processing, distribution and consumption stages are all taken into account, in order to achieve a systemic and comprehensive perspective on the whole supply chain. Finally, the social aspects, which are slightly less studied in the FSC literature, are evaluated here together with both economic and environmental aspects.

The remainder of the paper is structured as follows. The research methodology is introduced in Section 2. The systematic literature review carried out to identify best SSCM practices in the food industry, along with its results, are presented in Section 3. Section 4 focuses on the empirical analysis performed to explore the actual integration of SSCM practices in food companies. Section 5 presents the results of the statistical analysis focusing on the sustainability drivers and on the triple bottom line dimensions. . Finally, conclusions are drawn in Section 6, with proposals for further research.

2. Research Methodology

The methodological steps carried out in this research are as follows. The first one refers to a Systematic Literature Review to identify the present status of the literature (Ritchi *et al*., 2023) and the most relevant practices adopted in SSCM in the food industry. The second step aims to assess the level of adoption of these practices in the food industry and a questionnaire survey was developed and administrated to a sample of professionals working in the sector. The third step is related to the empirical analysis of the results obtained via the questionnaire. Finally, the last step focuses on the comparison between the literature perspective and the professionals' point of view, focusing on the sustainability drivers and on the triple bottom line dimensions.
A Systematic Literature Review can be defined as an approach to making sense of large bodies of information in a systematic way, in order to provide convincing evidence for addressing some compelling issues (Chan *et al.*, 2020). With this method, a combination of several key terms was used to sample the documents published in the Scopus database. Scopus was used since many researchers consider it to be one of the most complete bibliometric databases of scientific and technical peer-reviewed literature (Lagorio *et al.*, 2020). The studies published from 2008 (first year found through the query) to 2020 and to 2021 for those documents available online were considered for analysis. Both journal and conference papers were considered. The documents were then read by one of the authors and collectively analyzed. The initial query included the words "Supply Chain Management" and "Food Supply Chain" in title, abstract and keywords, of English-written papers. 433 papers appeared. The research was then limited to articles and review papers obtaining 379 papers. Biochemistry, biology, chemistry, immunology, microbiology, pharmaceutics, veterinary neuroscience and nursing were excluded. 324 papers were finally obtained. Out of these 324 papers, 137 by reading the abstract and the conclusions and other 30 papers were erased after reading the full manuscript. An initial corpus of 157 papers was finally obtained. After that both backward and forward

snowballing were carried out in order to include other relevant research in the study. The backward snowballing showed 90 papers. However, 35 were already considered in the initial corpus. Similarly, 99 papers come up through the forward snowballing, and 36 documents were already included in the analysis. Thus, 55 and 63 papers were then analyzed and finally 24 and 44 were finally included. The final corpus was then made up of 224 papers. The findings are presented in Section 3.

For the second step, based on the outcomes of the Systematic Literature Review, a survey was developed and administrated to a sample of professionals. The questionnaire was made up of two different parts. First, a set of demographic questions were asked. Then, respondents were called to evaluate the level of adoption of every practice. The questionnaire is presented as Appendix (Table 3). In scientific research a survey involves the collection of data from a sample of elements for a well-defined population using a questionnaire (Visser *et al.*, 2000). This approach is largely used in study SC phenomenon (Appiah and Obey, 2023; El Baz and Ruel, 2023) The statistical population involved in this study consisted entirely of food companies based in Italy and France, the top two EU food and drink producers in terms of number of companies, based on the 2020 report provided by the FoodDrink Europe Organization (2020). Before launching the questionnaire, a first draft was pre-tested by two experts from academia dealing with SSCM. During this phase the questionnaire was translated into the respondents' native language, Italian and French, respectively, to facilitate its understanding. For the same reason, a cover letter was attached to the questionnaire, presenting the purposes of the research to the potential respondents.

Since the firms involved in the survey were not known a priori, the first part of the questionnaire was designed to establish the respondents' profile. First, the nature of the business was analyzed. In the EU economy, cooperatives play an important role. In the agriculture sector, 55% of the market share in Italy and 50% in France is held by cooperatives (European Commission, 2021). A cooperative is defined as "an autonomous association of persons united to meet common economic, social, and cultural goals. They achieve their objectives through a jointly owned and democratically controlled enterprise" (European Commission, 2021). As some SSCM practices address only a specific stage of the FSC (see

Figure 1), the type of network in which the company operates, i.e., number of actors up- and down-stream and the main stage of the SC in which it is positioned are considered, according to the FSC model adopted to investigate the literature. The actors in a SC are described as independent companies that participate in the network to produce and deliver the products from raw materials to the final consumer.

Figure 1: Generic FSC stages

Organizations are distinguished by considering the headcount in units. The classification adopted is the one proposed by Eurostat (2021): large enterprises have 250 or more employees, small and medium-sized enterprises have fewer than 250 employees. Of the latter, micro-enterprises have fewer than 10 employees, small enterprises have between 10 and 49 employees, and medium-sized enterprises have between 50 and 249 employees. There are certain drivers that steer an organization towards the adoption of sustainability requirements. According to Khan *et al.* (2020), drivers are the main reasons for the implementation of sustainable practices in a FSC. They can be both internal and external. Since external drivers depend on the surrounding conditions in which a company operates, such as influences exerted by government regulations, or other firms on which the focal firm depends, information about whether the firm is part of a group, and the size of the company are collected.

All the questions in the on-line questionnaire are closed-ended, multiple-choice (by means of a rating scale). Thus, all possible answers are included in a scale able to cover all significant degrees of response and to perform quantitative data analysis (Zenezini *et al*., 2022). Even if the rating scale selected could influence the results of the analysis, there is no general rule of thumb to define it. Therefore, the extent to which the three dimensions of the TBL are considered important is evaluated on a 1 to 4 rating scale where 1 means not important at all and 4 very important. The economic dimension is defined as the economic benefit of an organization, the environmental dimension as the coexistence with the environment and the responsible use of natural resources, and the social dimension as fair and beneficial business practices with regard to labor, the community, and the region in which the company conducts its business.

The degree of implementation of SSCM practices is evaluated against two key properties of a practice: its stability, i.e., the regularity of its implementation by the company, and its extension, i.e., whether the activities are carried out for only a few products or for all the products. A practice that is occasionally implemented on a few products will not have the same impact on sustainable development as a practice that is systematically adopted for all products (Chardine-Baumann and Botta-Genoulaz, 2014). The following 0 to 4 rating scale is thus appropriate:

- 0: I don't know (i.e., the respondent cannot assess the degree of implementation of the SSCM practice analyzed).
- 1: The practice is not adopted within the company.
- 2: The practice is rarely adopted for certain products.
- 3: The practice is rarely adopted for a large number of products, or the practice is frequently adopted for some products.
- 4: The practice is frequently adopted for a large number of products.

In the third step of the methodology, the data collected through the survey have been statistically analyzed. As they are based on a Likert scale, they are not normally distributed. A non-parametric approach has therefore been identified to process the relevant data properly. In particular, the Kruskal-Wallis test has been applied. This test is based on the null hypothesis that different populations of the sample have the same median. If the p-value associated with the test is lower than the critical threshold of 5%, the null hypothesis must be rejected. In practical terms, this means that there is at least one difference within the group considered (Wiśniewska andCzernyszewicz, 2023). However, before carrying out the test a validation of the sample was completed. In particular Cronbach's Alpha coefficient was calculated to evaluate the internal consistency related to the reliability of the survey (Taber, 2018).
Finally, the last methodological step is referred to the comparison of the empirical results with the literature outcomes.

3. Systematic Literature Review

The 224 papers finally selected were analyzed to identify the most common SCM practices that a company should implement to achieve sustainable development. SSCM practices can be both internal and external. The former refers to those without direct supplier or customer involvement which can be managed and implemented by an individual company, while the latter refers to management practices which need partial cooperation and transactions with suppliers or customers (Panghal *et al*., 2022). A total of twenty-five main SSCM practices were identified: some were well-known SCM practices that had shown a positive impact on sustainable development, while others had emerged as new practices dedicated to improving sustainable development. They were classified according to four main dimensions typically considered in dealing with SCM (Gruat La Forme *et al.*, 2010; Zimon *et. al.*, 2019): upstream, focal, downstream, and transverse. They are summarized in **Figure 2**, where the percentages in brackets refer to the relative attention the literature gives to each practice.

Figure 2: SSCM practices

3.1 Upstream Practices

Voluntary practices that companies pursue to improve their social and/or environmental management of their suppliers' activities can be defined as *sustainable-sourcing practices* (Thorlakson *et al*., 2018; León-Bravo *et al*., 2017; Gimenez and Sierra, 2013) and account for 18.6% of the corpus. These include two key activities*: Suppliers' Assessment (P1)* and *Supplier Collaboration (P2)* (Mangla *et al*., 2018). This first category also includes *Green Purchasing (P3)*.

- Supplier Assessment (P_1) refers to selection of a supplier by considering its sustainability performances, e.g., certifications provided, monitoring of suppliers (Patrucco et al., 2021).
- Supplier Collaboration (P_2) refers to the implementation of supportive activities that seek to improve the relationship between the buyer and the supplier, such as supplier development and/or engagement programs (Badraoui et al., 2022), corrective action plans, training, workshops, and employees transfer (Grimm *et al.*, 2014;).
- Green Purchasing (P_3) refers to every sourcing when, the purchase is based on cost, quality, and performance, together with its impact on the environment (Govindan *et al.*, 2017).

It is worth emphasizing that P_1 is widely addressed in the literature, followed by P_3, while less attention is paid to P_2. This means that the issue of collaboration, even it can be considered as crucial for successful SC operations – as the Covid-19 pandemic has demonstrated (Lotfi and Larmour, 2021) –, is still not investigated in depth in the literature. On the contrary, the evaluation of the supplier is given more consideration since this aspect is expected to assume greater importance in the near future, both horizontally and vertically (Münch *et al*., 2021). Considering the attention paid to the practices included in this category, from the point of view of both the number and the year-wise distribution of the work performed so far, it can be stated that these practices are well-established. Their importance has long been discussed in the literature as support in achieving SSCM.

3.2 Focal company Practices

From the focal company's point of view, the practices implemented to achieve Sustainability represent more than a third of the corpus (33.6). They are *Green Design (P4)*, *Green Packaging*

(P5), *Green Production (P6)*, *Green Manufacturing (P7)*, *Materials and Products Recycling and Remanufacturing (P8)* and environmental management systems activities that is decomposed in *Protection of Animal Welfare (P9)*, *Soil Conservation and Management (P10)* and *Responsible Use of Natural Resources (P11)*.

- Green Design (P_4) is designing a product with enhanced quality and reduced adverse impacts on the environment throughout its life cycle (e.g., avoid the use of harmful/toxic materials), taking into consideration end-of-life scenarios, type of storage required during transport, and type of packaging required (Raut *et al.,* 2019; Govindan *et al.,* 2015).
- Green Packaging (P_5) includes the selection and use of the proper type of packaging to prevent food wastage and to lower the environmental burden, such as appropriate materials, size and shape, biodegradability or bio-based plastics (León-Bravo *et al.,* 2017).
- Green Production (P_6) encapsulates all the environmentally friendly methods for reducing the environmental burden, adopted at the agricultural or primary stage within a FSC, such as grass-fed beef, free-range poultry, certified organic food, crop diversification, agroforestry (Bos *et al.,* 2014).
- Green Manufacturing (P_7) includes the set of actions or technologies deployed in manufacturing activities to decrease the environmental burden, such as the reduction of emissions and of energy and water consumption (Raut *et al.,* 2019).
- Material and Product Recycling and Remanufacturing (P_8) consists in extracting and efficiently recovering value-added components from food wastage (Centobelli *et al*., 2022).
- Integration of Environmental Management Systems is the set of activities carried out to preserve the external environment and increase operational efficiency. Many practices are found in the literature. However, the focus here is on Protecting Animal Welfare (P_9), Soil Conservation and Management (P_{10}), and Responsible Use of Natural Resources (P_{11}) such as energy and water (León-Bravo *et al.,* 2017; Mantino and Forcina, 2018; Glover *et al.*, 2014).

It is worth noting that P6 and P7 have gained more attention than the others in recent years. These four green practices (Green Design, Green Packaging, Green Production, Green Manufacturing) account for 16.70% of the corpus studied. Their importance is related to the goal of reducing the environmental impacts of products and processes, and at the same time increasing the operational efficiency of the company.

3.3 Downstream Practices

This cluster of activities includes *Inventory Management (P12)*, *Green Warehousing (P13)*, *Green Shipping and Distribution (P14)*, *Reverse Logistics (P15)*, and *Corporate Green Image Management (P16).*

- Inventory Management (P_{12}) is aimed at monitoring the level of stock for, in turn, deciding how much and how often orders should be placed so as to align demand and supply (Mittal *et. al.*, 2018).
- Green Warehousing (P_{13}) is the design of warehouses for lowering the environmental burden by considering both the point of view of the location of the facilities and the internal aspects of the warehouse itself (Mittal *et. al.*, 2018; Facchini *et al.*, 2018).
- Green Shipping and Distribution (P_{14}) requires lowering the impact on the environment by selecting fewer polluting modes of transportation, such as eco-friendly refrigerants, intermodal means of transport (Raut *et al.*, 2019).
- Reverse Logistics (P_{15}) is handling and collecting all the returned end-of-life materials, products, or components from the end user back to the point of origin (Manzini and Accorsi, 2013).
- Corporate Green Image management (P_{16}) implies the development or improvement of environmentally friendly processes and products to enhance the green image of a company and, in turn, act as a lever of competitive advantage in the market (Raut *et al.,* 2019).

Less attention is given to sustainable practices from the downstream perspective (10.40% in total), except for P14 (Green Shipping Distribution). This means that the downstream part of the SC in the food sector is still scarcely explored, in terms of establishment of best practices.

3.4 Transversal SSCM practices

37.50% of the practices make up the base of the model*: Green Product Innovation Design (P17), Corporate Social Responsibility Programs (P18), Green Human Resource Management (P19), Adoption of Standard and Certifications (P20), Collaborative Supply Chain: Information (P21) and Green Targets (P22) planning, Strategic Supply Chain Collaboration (P23), Supply Chain Integration System (P24) and Adoption of Information and Communication Technologies (P25).*

- Green Product Innovation and Design (P_{17}) consists in adapting Research & Development activities for introducing or obtaining environmentally friendly products or packaging (de Paula *et al*., 2020).

- Corporate Social Responsibility programs (P_{18}) are the set of voluntary activities addressing social or environmental concerns (Thorlakson *et al.,* 2018) such as food donations, written environmental target objectives, code of conduct, acts for workers' rights (León-Bravo *et al.*, 2017).
- Green Human Resource Management (P_{19}) is aimed at spreading green values and culture within an organization through the creation of teams in charge of solving environmental problems, a system of rewards based on the environmental performance of managers and employees, ecological training, and hiring of workers based on their environmental commitment (Ahmad 2015).
- Adoption of Standard and Certifications (P_{20}) as a demonstration that processes and/or products are compliant with the requirements (Raut *et al.,* 2019).
- Collaboration within a SC is recognized as one of the most important practices to achieve sustainability. This includes collaborative SC planning that can be referred to, involving both upstream and downstream partners to share planning information (P_{21}) and sustainability targets (P_{22}), Strategic Supply Collaboration (P_{23}), and Supply Chain Integration System (P_{24}). P_{23} implies the establishment of strategic alliances to achieve mutually relevant benefits through the exchange, sharing, and co-development of resources and capabilities with partners (Han *et al.,* 2020). P_{24} requires the implementation of sustainable practices with other SC actors, such as collaborative waste reduction, sharing of environmental innovations and technologies, and joint development of recyclable products (Touboulic and Walker, 2015).
- Adoption of Information and Communication Technologies (P_{25}) is the adoption of identification tags, "data logger" devices (Manzini and Accorsi, 2013) or blockchain, with the final aim of increasing product traceability and transparency, and enhancing communication and coordination among actors in the SC (El Bilali and Allahyari, 2018). It is consequently possible to reduce costs, increase productivity, and lower resource consumption, food losses, and waste.

Based on the resulting frequency distribution of the keywords and the abstract processing, it appears that although the concepts of Corporate Social Responsibility and Green Human Resource Management are treated as practices, they seem to be more relevant than the others in the transition towards sustainability. Companies' commitment to sustainable development (P_{18}) and collaboration among SC actors ($P_{21} - P_{24}$) are widely recognized as very important for achieving sustainability in a FSC. Thus, the issue of collaboration becomes crucial for achieving sustainable practices (Münch *et al*., 2021). This demonstrates the complexity of the

FSC that calls for systemic involvement of the different stakeholders for enhancing sustainability. Moreover, while broad attention is paid to the effectiveness of the adoption of standards and certifications (P_{20}) and of information and communication technologies (P_{15}), P_{17} and P_{19} appear to be less discussed. It appears therefore that human resources are still not considered as an effective lever for meeting sustainability goals, and that innovation and design are not adequately considered.

4. Empirical Research

According to the third methodological step, the survey was conducted to investigate the maturity of the implementation of the identified SSCM practices in French and Italian food companies. 1448 organizations were contacted by e-mail or via their website (from March to May 2021). 104 replies were received, which is a response rate of 7.2%. As Dörnyei (2007) recommends a minimum of 100 participants as a rule of thumb for a study designed to describe features of a population, this value can be considered acceptable for carrying out further analysis on the answers since it is close to those of previous studies (Arditi *et al.*, 2015).

4.1 Sample Description

The sample analyzed consists of 104 companies. 72% are operating in Italy while 28% are French-based companies. It is worth noting that 13.8% are cooperatives. Looking at the distribution of the organizations involved in the survey according to the main stage in which they operate (cf. **Figure 1**), we see that 12% are primary production companies, 2% operate at the postharvest handling and storage stage, 74% are processing companies, and 11% are distribution companies. With reference to the subset of cooperatives, most of them operate at the processing levels (65%) and primary production (24%). Large enterprises make up 29% of the sample while 18% are micro enterprises, 30% are small enterprises and 25% are medium-sized enterprises, equally distributed between France and Italy.

Most of the practices can be implemented in all the stages of the SC, from the primary production to the distribution process. But there are some practices that are more typical of a specific stage of a SC. For instance, Green Production (P15) is mainly related to the Primary Production stage, and Green Manufacturing (P7) is mostly associated with Processing. With regard to material and product recycling and reprocessing (P_8), 61.8% of the respondents convert food wastage into new materials, while the 48.8% of the respondents extract and efficiently recover value-added components from food wastage to produce other goods such as fertilizer and energy. The handling and collecting activities of all the returned end-of-life

materials (P_{15}) are mainly carried out by a third party (74.0%) rather than by the company itself (39.8%).

In general terms, the respondents consider all three dimensions important and very important. In particular, the social dimension is rated as important (44%) and very important (42%) by 86% of the respondents. The economic dimension shows the highest value in the very important class (54%). Less than 30% of the respondents rated all three sustainability dimensions as having the highest value of importance. Therefore, even if sustainability in the food industry appears to be a growing concern, these three dimensions are not considered equally important by professionals in the food sector. On the other hand, the social dimension has the lowest cumulative relative frequency for the first two values of the rating scale.

In section 4.2, the maturity of the implementation of SSCM practices is examined and some research hypotheses are discussed. The relation between SSCM practices and drivers is then addressed in section 4.3. Finally, the influence of sustainable practices per each TBL dimension is carried out.

4.2 Perception of SSCM practices by the companies

4.2.1 Upstream practices

Upstream practices are broadly adopted by food companies as shown in Figure 3. By comparing results from the literature which is less focused on P_2 than on P_1 and P_3, we see that in the industrial world P_2 is almost as prevalent as P_1 and P_3. The mode for these three practices shows the highest possible value of the rating scale as "the practice is frequently adopted for a large number of products". The median is slightly: "The practice is rarely adopted for a large number of products or frequently adopted for certain products". Moreover, it can be assumed that the higher the number of actors up- or down-stream, the more difficult it is for the focal company to assess the environmental and social performance of each actor (P_1) and to implement supportive activities (P_2).

4.2.2 Focal company's practices

To analyze the focal company's practices, the main stage of the SC at which the company operates is considered (cf. Figure 3). Due to the lack of available information, these results are not computed for the post-harvest handling and storage stages of the SC. By considering the cumulative frequency distribution, the set of activities aimed at preserving natural resources (P_{11}), protecting animal welfare (P_9), and soil conservation and management (P_{10}) are widely implemented at the primary production stage. By contrast, green packaging, and production (P_5, P_6) appear to be adopted slightly less. At the processing stage, the mode of all the practices

considered have the highest value (practice frequently adopted for many products). Median values are different, based on the practice considered. The median shows the highest value for P_7 and P_{11}, while for P_4, P_5, P_9 it is equal to 3, that is, a practice rarely adopted for many products or frequently adopted for certain products. At the distribution stage, both the mode and median for P_5 and P_9 have the highest value. P_4 and P_{11} appear to be adopted slightly less. The results for sustainable practices are aligned with the literature findings (cf. **Figure 2**). Furthermore, it is worth noting that there is a statistical significance, considering the stage of the SC in which a company operates, and the importance given to the environmental dimension, as p-value = 0.043. Companies operating at the primary production stage give greater importance to the environmental dimension (median equal to 4, i.e., very important) than do processing and distribution companies (median equal to 3, i.e., important). There is not a significant difference for the economic and social dimensions.

4.2.3 Downstream practices

Figure 3 describes the maturity of implementation of downstream practices. In the survey results, P_{14} appears as the least implemented practice, despite the attention paid to this practice in the literature. Only 21% of all respondents select fewer polluting methods of transport for many products and for 33% the practice is not adopted. This points out the need to introduce transportation innovations in local, regional, and national food systems, and in the way they are organized. Moreover, it is worth noting that even if P_{12} appears to be widely implemented, its definition does not specifically relate to a "green" issue.

4.2.4 Transversal practices

Collaboration within a SC is recognized in the literature as one of the most important practices to achieve sustainability. This aspect is not reflected in the frequency distribution of the implementation of the collaborative practices addressed in the questionnaire (P_{21} – P_{24}) (cf. **Figure 3**). Kruskal-Wallis test results show that there is not a statistical significance between the extent of implementation of collaborative practices and the number of actors in the supply chain. It can be stated that cooperatives show a higher degree of implementation of P_{22}, and that sustainability targets are shared with the other actors in the SC (p-value = 0.025). The other collaborative practices considered do not show the same results. An initial step toward achieving holistic sustainability objectives lies in a corporation's orientation toward sustainability (P_{18} and P_{19}). Even if the concept of Corporate Social Responsibility (P_{18}) is well known in academia, in the business world it does not seems to be widely implemented. Moreover, P_{19} appears to be one of the least implemented practices. The Kruskal-Wallis

findings that do not show significant p-values highlight the fact that a company will have the same perception as a cooperative with regard to P_{18} and P_{19}. This consideration might be extended to the adoption of information and communication technologies (P_{25}). Kruskal-Wallis test results prove that the number of actors up- or down-stream does not significantly influence P_{19} and P_{23}. By focusing on the level of adoption, it is worth noting that standards and certifications (P20) are frequently used by a large proportion of the respondent (more than 70%). This is an indication that these aspects have become crucial in food operations, due to increased attention to food quality and safety. It is also important to point out that the adoption of ICT (P_{25}) in FSC is currently a well-established practice that is largely adopted (61% of the respondents).

Significantly, having "The practice is not adopted" in most of the answers, demonstrates that even though the focus on sustainability concerns is increasing, this transition still takes a lot of time.

Figure 3. Degree of implementation of SSCM practices

5. Statistical Investigation on drivers and TBL dimensions

A statistical analysis is here presented to see whether the researchers' efforts coincide with the expectations of the socio-economic world. Furthermore, the relationship between the twenty-five practices and the three sustainability dimensions are explored.

Before carrying out the Kruskal-Wallis test, we computed the Cronbach Alpha coefficient to assess the reliability of our survey design and the robustness of the multiple-question Likert scale survey. Values higher than 0.7 were considered satisfactory, meaning that the items considered refer to the same construct (Sony *et al*., 2021). Since the survey respondents did not implement all the proposed practices, it was not possible to calculate the Cronbach Alpha for all the identified ones. As a proxy, it was computed among the practices P11-P25, which are the practices that all the respondents claimed to implement in their company. The results in **Table 1** show the values of the Cronbach Alpha coefficient that are broader than 0.6. The reliability of the data can therefore be assumed, and further analysis can be carried out.

Table 1: Cronbach's Alpha Coefficient

5.1 Sustainable practices vs. sustainability drivers

The sustainability drivers addressed in the questionnaire are whether the company is part of a group, and the number of employees (cf. **Table 2**). The results are reported for p-value <.05. First, the correlation between having a company part of a group and the extent to which it implements sustainable practices is tested. Firms that are part of a group show a higher degree of implementation on P_{11}, P_{19} and $P_{20.}$ Therefore, being part of a group positively influences the adoption of sustainable practices. The median values are higher in all cases. With reference to P_{20}, the mean for firms that are part of a group is 3.76 while for firms that are not part of a group it is 3.32.

Table 2: Outcome of Kruskal-Wallis tests vs. drivers

Similarly, the size of the company influences the implementation of SSCM practices. Numbers in **Table 2** report the median values of each subgroup. The results demonstrate that medium-sized and large organizations show more extensive implementation of SSCM practices compared with micro and small organizations. Small companies systematically show the lowest median value, except for P_{20}. It can nevertheless be assumed that medium-sized and large companies have more financial availability for implementing SSCM practices.

5.2 Sustainable practices vs. TBL dimensions

The relation between the importance given to the TBL dimensions and the degree of implementation of SSCM practices is also investigated. The underpinning assumption is that a company that gives greater importance to each of the TBL dimensions also implements practices aimed at lowering the impacts at the environmental and social levels and enhancing the economic dimension. Kruskal-Wallis test results are reported, considering the importance given to the three TBL dimensions and the degree of implementation of SSCM practices (cf. **Table 3**). Rating scale data for the economic, environmental, and social dimensions columns show the median value of the degree of implementation of each practice. By considering the economic dimension, it is possible to state that environmentally friendly processes and products are developed to obtain a competitive advantage in the market (P_{16}). Thus, the more importance is granted to the economic dimension, the more technologies to reduce the environmental impact are deployed in manufacturing activities (P_7). To lower the environmental impact and to preserve natural resources, suppliers are selected for their sustainability performance (P_1), and products are purchased based on cost, quality, and performance, together with

environmental impact (P_3), and/or are designed with enhanced quality standards and reduced adverse impacts on the environment throughout their life cycle (P_4). In this regard, a set of actions or technologies is deployed in manufacturing, with the intent to reduce emissions, energy, or water consumption (P_7). The implementation of P_4 and P_7 are effective also on reducing social impacts. The selection and use of the proper type of packaging to prevent food waste and to lighten the environmental burden (P_5), the adoption of environmentally friendly methods deployed at the primary stage (P_6), and the deployment of environmental management systems specifically focused on the responsible use of natural resources, protection of animal welfare and soil conservation and management (P_9, P_{10}, P_{11}), seem not to have a statistical significance on the importance given to the environmental dimension. Furthermore, designing warehouses by considering both their location and their internal design (P_{13}), selecting fewer polluting modes of transportation (P_{14}), and developing or improving environmentally friendly processes and products to enhance the green image of a company and, in turn, as a lever of competitive advantage in the market (P_{16}) also helps to improve the environmental dimension. However, there is no evidence that green product innovation and design (P_{17}) has a statistical influence on the environmental dimension. On the other hand, the implementation of corporate social responsibility programs (P_{18}), together with the spreading of green values and culture (P_{19}) within a company, are effective for enhancing both the environmental and the social dimensions. Sustainable collaborative practices that specifically address environmental issues have a statistical influence on the environmental dimension, but not on the social one. Thus, sharing sustainable targets with suppliers and customers (P_{22}), creating strategic alliances with other actors in the SC to achieve mutually relevant benefits (P_{23}), and performing sustainable collaborative activities such as collaborative waste reduction and environmental innovations, the introduction or adoption of environmental technologies, and the joint development of recyclable products (P_{24}), effectively reduce the environmental burden.

Table 3: Outcome of Kruskal-Wallis tests: TBL dimensions vs. sustainable practices

6. Discussion and Conclusions

Since sustainability and sustainable development are increasingly important issues, the present empirical research was designed to investigate the ways in which companies in the food sector are dealing with this challenge. To this end, a systematic literature review was carried out to

define sustainable best supply chain management practices that companies operating in the food sector should implement to reach the Sustainable Development target. All the practices identified were introduced as a conceptualization of a general model, which was then empirically validated. In particular, the most relevant practices, from both academia and industry, were identified as sustainable supplier management practices associated with the programs that a supplier might carry out to improve its environmental record. From the point of view of the focal company, we consider SSCM practices as crucial because they require a company's commitment to dealing with TBL issues. With regard to the adoption of Transversal Practices, our empirical results are aligned with the outcome of the literature review, as they show that the use of standards and certifications has spread broadly throughout FSCs. ICT systems supporting SC operations are well established in companies as a way to make the processes more effective and reliable, even though they account for only 7.3% of SSCM practices studied in the literature corpus. This has been a growing trend in recent years, due to the large-scale take-up of Big Data Analytics in SC (Wei *et al*., 2022). Finally, aspects focusing on green design and on green human resource management are still in their infancy, from both the academic and professional perspectives. Corporate social responsibility programs are discussed in depth in the literature but not fully exploited in the professional world.

Furthermore, this work, focused on 104 companies operating in Italy or France, statistically analyzes how external factors (such as the number of actors involved in the SC and the main stage of the SC in which a company operates, or the status of a company itself) might have an impact on the adoption of SSCM practices.

Building on the TBL paradigm, the findings reveal those SSCM practices that have a significant influence on economic, environmental, and social dimensions. In particular, they show that companies develop or improve environmentally friendly processes and products to obtain a competitive advantage in the market and thus to improve their profit margin. For the same reason, technologies designed to reduce environmental impacts are increasingly used in manufacturing activities. The selection of suppliers based on their sustainability performance, and the purchase of products based on cost, quality, and performance, as well as their impact on the environment, have a statistical significance in the environmental dimension. Green design, green warehousing, green shipping, and distribution also play a role in alleviating the environmental burden. The implementation of corporate social responsibility programs, together with the spreading of green values and culture within a company, are effective for enhancing both the environmental and the social dimensions. The social dimension

nevertheless appears to be one of the least implemented practices – an indication that companies still have considerable difficulties to overcome in developing social programs.

This work has several theoretical and practical implications. From a theoretical perspective, it might be relevant since it enlarges the body of knowledge on the adoption of SSCM practices in the food industry by proposing an empirical analysis of the maturity of the implementation of sustainable practices. In particular, by exploiting the established and rigorous systematic literature review methodology, along with a survey questionnaire, the analytical method developed represents a contribution that includes the point of view of professionals in industry. In their daily work, these professionals are increasingly dealing with sustainability issues. Until now, the literature has mostly focused on studying sustainable practices in manufacturing SCs, and often evaluates these practices singularly. Our paper offers an updated and comprehensive study on the implementation of the practices that foster sustainability in the food industry.

From a practical point of view, this paper might support food companies in the identification of the most promising practices that might be adopted for promoting sustainability programs in their SC. At the same time, this work might support public policy makers in undertaking strategies towards sustainability. It allows us to capture less mature practices that may require some additional time for a more effective implementation. Finally, this research deals with a crucial topic that is acquiring a vital role at international level. In fact, the recent events related to the war in Ukraine are underlining the importance of food security and of an effective food SC, since violent conflicts are a driver of food crises (Kemmerling *et al*., 2022). At the same time, our research points out the key role of food SCs in reducing the food waste phenomenon (Papargyropoulou *et al*., 2014). The analysis is carried out by focusing on two of the major European countries in the food industry. To expand on the takeaways, future work will consider more companies operating in other geographical areas.

7. References

Afum, E., Agyabeng-Mensah, Y., Baah, C., Asamoah, G., & Kusi, L. Y. 2022. "Eco-market orientation in the logistics industry: a conveyor belt for achieving organizational outcomes via green logistics practices." *The International Journal of Logistics Management*, 33(2): 712-734. DOI 10.1108/IJLM-07-2021-0383

Ahmad, S. 2015, "Green human resource management: Policies and practices.", *Cogent Business & Management*, 2(1). doi.org/10.1080/23311975.2015.1030817

Appiah, L. O., & Obey, V. Q. 2023. "Social capital, joint knowledge creation and relationship performance in buyer-supplier relationships". *Supply Chain Forum: An International Journal* 24(2):217-232 doi 10.1080/16258312.2023.2183709

Arditi, D.; Mangano, G.; De Marco, A. 2015. "Assessing the smartness of buildings." *Facilities* 33:553-572. doi.org/10.1108/F-10-2013-0076

Badraoui, I., van der Lans, I., Boulaksil, Y., & van der Vorst, J. G. 2022. "Antecedents of horizontal logistics collaboration in agri-food supply chains". *The International Journal of Logistics Management*, 33(1) 239-260. doi.org/10.1108/IJLM-09-2020-0362

Bos, J. F., de Haan, J., Sukkel, W., and Schils, R. L. 2014. "Energy use and greenhouse gas emissions in organic and conventional farming systems in the Netherlands", *NJAS-Wageningen Journal of Life Sciences*, 68:61-70. doi.org/10.1016/j.njas.2013.12.003

Centobelli, P., Cerchione, R., Cricelli, L., Esposito, E., and Strazzullo, S. 2022. "The future of sustainable supply chains: a novel tertiary-systematic methodology", *Supply Chain Management: An International Journal,* 27(6):762-784. https://doi.org/10.1108/SCM-08-2020-0383

Chan, H. Y., Abdul Halim-Lim, S., Tan, T. B., Kamarulzaman, N. H., Jamaludin, A. A., and Wan-Mohtar, W. A. A. Q. I. 2020. "Exploring the Drivers and the Interventions toward Sustainable Food Security in the Food Supply Chain.", *Sustainability*, 12(19):7890 doi.org/10.3390/su12197890

Chardine-Baumann, E., and Botta-Genoulaz, V. 2014. "A framework for sustainable performance assessment of supply chain management practices", *Computers & Industrial Engineering*, 76: 138-147. doi.org/10.1016/j.cie.2014.07.029

de Paula, I. C., de Campos, E. A. R., Pagani, R. N., Guarnieri, P., and Kaviani, M. A. 2020. "Are collaboration and trust sources for innovation in the reverse logistics? Insights from a systematic literature review". *Supply Chain Management: An International Journal*, 25(2): 176-222. doi.org/10.1108/SCM-03-2018-0129

CMED (1987), "Notre avenir à tous*"*, available at: http://fr.wikisource.org/wiki/Rapport_Brundtland (accessed July 2021).

Dörnyei, Z. (2007), "*Research methods in applied linguistics*", Oxford university Press.

El Baz, J., and Ruel, S. (2023). "Investigating the role of business continuity during COVID-19: an empirical examination" *Supply Chain Forum: An International Journal* 1-14 doi 10.1080/16258312.2023.2199127

El Bilali, H., and Allahyari, M. S. 2018. "Transition toward sustainability in agriculture and food systems: Role of information and communication technologies", *Information Processing in Agriculture*,5(4): 456-464. doi.org/10.1016/j.inpa.2018.06.006

European Commission (2021), "Internal Market, Industry, Entrepreneurship and SMEs", available at: https://ec.europa.eu/growth/sectors/social-economy/cooperatives_en (accessed July 2021).

Eurostat (2021), "Glossary: Enterprise size", Available at: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Enterprise_size (accessed July 2021).

Facchini, F., De Pascale, G., and Faccilongo, N. 2018. "Pallet picking strategy in food collecting center", *Applied Sciences*, 8(9):1503. doi.org/10.3390/app8091503

FoodDrink Europe (2020), "Data & Trends EU Food & Drink Industry", available at: https://www.fooddrinkeurope.eu/wp-content/uploads/2021/02/FoodDrinkEurope-Data-Trends-2020-digital.pdf (accessed February 2021).

Fritz, M. M. C., Silva, M. E., and Touboulic, A. (2022) "Practicing sustainability in operations and supply Chain management". *Supply Chain Forum: An International Journal* 23(4): 323-328 doi 10.1080/16258312.2022.2138160

Gimenez, C. and Sierra, V., 2013. "Sustainable supply chains: Governance mechanisms to greening suppliers". *Journal of business ethics*, 116(1): 189-203. doi.org/10.1007/s10551-012-1458-4

Glover, J. L., Champion, D., Daniels, K. J., and Dainty, A. J. 2014, "An Institutional Theory perspective on sustainable practices across the dairy supply chain", *International Journal of Production Economics*, 152:102-111. doi.org/10.1016/j.ijpe.2013.12.027

Govindan, K., Khodaverdi, R., and Vafadarnikjoo, A. 2015. "Intuitionistic fuzzy based DEMATEL method for developing green practices and performances in a green supply chain", *Expert Systems with Applications*, 42(20): 7207-7220. doi.org/10.1016/j.eswa.2015.04.030

Govindan, K., Kadziński, M., and Sivakumar, R. 2017. "Application of a novel PROMETHEE-based method for construction of a group compromise ranking to prioritization of green suppliers in food supply chain", *Omega*, 71:129-145. doi.org/10.1016/j.omega.2016.10.004

Grimm, J. H., Hofstetter, J. S., and Sarkis, J. 2014. "Critical factors for sub-supplier management: A sustainable food supply chains perspective", *International Journal of Production Economics*, 152: 159-173. doi.org/10.1016/j.ijpe.2013.12.011

Gruat La Forme, F. A., Baumann-Chardine, É., Campagne, J. P., and Botta-Genoulaz, V. (2010), "Modeling and Evaluation of Industrial Practices' Impacts on Performance", In: *Supply Chain Performance: Collaboration, Alignment and Coordination*, Direction V. Botta-Genoulaz, J.-P. Campagne, D. Llerena, C. Pellegrin, ISTE Ltd (London, UK) and John Wiley & Sons, Inc. (Hoboken, NY, USA), 95-138.

Han, C., Pervez, A., Wu, J., Shen, X., and Zhang, D. 2020. "Home-Delivery-Oriented Agri-Food Supply Chain Alliance: Framework, Management Strategies, and Cooperation Stability Control", *Sustainability*, *12*(16) 6547. doi.org/10.3390/su12166547

Kemmerling, B., Schetter, C., & Wirkus, L. 2022. The logics of war and food (in) security. *Global Food Security*, 33, 100634. doi.org/10.1016/j.gfs.2022.100634

Khan, S. A. R., Yu, Z., Golpîra, H., Sharif, A., and Mardani, A. (2020), "A state-of-the-art review and meta-analysis on sustainable supply chain management: Future research directions", *Journal of Cleaner Production,* 278:123357 doi.org/10.1016/j.jclepro.2020.123357

Khoja, F., Adams, J., Kauffman, R., & Yegiyan, M. 2022. "How SMEs benefit from environmental sustainability strategies and practices", *Supply Chain Forum: An International Journal* 23(2):97-112 doi.org/10.1080/16258312.2022.2036580

Lagorio, A., Zenezini, G., Mangano, G., and Pinto, R. 2022. "A systematic literature review of innovative technologies adopted in logistics management", *International Journal of Logistics Research and Applications*, 25(7) doi.org/10.1080/13675567.2020.1850661

León-Bravo, V., Caniato, F., Caridi, M., and Johnsen, T. 2017. "Collaboration for sustainability in the food supply chain: A multi-stage study in Italy", *Sustainability*, 9(7):1253 doi.org/10.3390/su9071253

Lotfi, M., and Larmour, A. 2021. "Supply chain resilience in the face of uncertainty: how horizontal and vertical collaboration can help?", *Continuity & Resilience Review,* 4 (1): 37-53. doi.org/10.1108/CRR-04-2021-0016

Mangla, S.K., Luthra, S., Rich, N., Kumar, D., Rana, N.P. and Dwivedi, Y.K., 2018. "Enablers to implement sustainable initiatives in agri-food supply chains", *International Journal of Production Economics*, 203: 379-393. doi.org/10.1016/j.ijpe.2018.07.012

Mantino, F., and Forcina, B. 2018, "Market, policies and local governance as drivers of environmental public benefits: the case of the localised processed tomato in Northern Italy", *Agriculture*, 8(3): 34. doi.org/10.3390/agriculture8030034

Manzini, R., and Accorsi, R. (2013), "The new conceptual framework for food supply chain assessment", *Journal of Food Engineering*, 115(2): 251-263. doi.org/10.1016/j.jfoodeng.2012.10.026

Martins, V. W. B., Anholon, R., Sanchez-Rodrigues, V., Leal Filho, W., & Quelhas, O. L. G. 2020. "Brazilian logistics practitioners' perceptions on sustainability: an exploratory study", *The International Journal of Logistics Management*, 32(1): 190-213. doi.org/10.1108/IJLM-02-2020-0091

Mittal, A., Krejci, C. C., and Craven, T. J. 2018. "Logistics best practices for regional foodsystems: A review", *Sustainability*, 10(1): 168. doi.org/10.3390/su10010168

Münch, C., von der Gracht, H., A., and Hartmann, E. 2023. "The future role of reverse logistics as a tool for sustainability in food supply chains: a Delphi-based scenario study", *Supply Chain Management: An International Journal,* 28(2):262-283. https://doi.org/10.1108/SCM-06-2021-0291

Nosratabadi, S., Mosavi, A., Shamshirband, S., Kazimieras Zavadskas, E., Rakotonirainy, A., and Chau, K. W. 2019). "Sustainable business models: A review", *Sustainability*, 11(6): 1663. doi.org/10.3390/su11061663

Panghal, A., Manoram, S., Mor, R. S., & Vern, P. (2022, June). "Adoption challenges of blockchain technology for reverse logistics in the food processing industry", *Supply Chain Forum: An International Journal* 1-10, doi.org/10.1080/16258312.2022.2090852.

Papargyropoulou, E., Lozano, R., Steinberger, J. K., Wright, N., and bin Ujang, Z. 2014. "The food waste hierarchy as a framework for the management of food surplus and food waste", *Journal of Cleaner Production*, 76: 106-115. g/10.1016/j.jclepro.2014.04.020

Pardillo Baez, Y., Sequeira, M., and Hilletofth, P. 2020, "Local and Organic Food Distribution Systems: Toward a Future Agenda", *Operations and Supply Chain Management: An International Journal*, 13(4):336-348. doi.org/10.31387/oscm0430274

Patrucco, A., Frattini, F., and Di Benedetto, A. 2021, "Characteristics of supplier performance measurement systems in collaborative innovation projects: the role of the purchasing department", *Supply Chain Management: An International Journal*, 27(2): 207-231. doi.org/10.1108/SCM-11-2020-0551

Raut, R. D., Luthra, S., Narkhede, B. E., Mangla, S. K., Gardas, B. B., and Priyadarshinee, P. 2019. "Examining the performance oriented indicators for implementing green management practices in the Indian agro sector", *Journal of Cleaner Production*, 215: 926-943. doi.org/10.1016/j.jclepro.2019.01.139

Ritchi, H., Harnowo, A., Sugianto, L. P. M., Setiono, K., and Saputro, V. (2023). "Reviving the information veracity in healthcare supply chain with blockchain: a systematic review", *Supply Chain Forum: An International Journal,* 1-20, doi 10.1080/16258312.2023.2199904

Soni, M., Dawar, S., & Soni, A. 2021. Consumer social responsibility (CnSR): antecedents and tool validation. *World Journal of Science, Technology and Sustainable Development*. 18(4): 422-437. doi.org/10.1108/WJSTSD-01-2021-0012

Stiller, S., and Gold, S. 2014. "Socially sustainable supply chain management practices in the Indian seed sector: A case study", *Supply Chain Forum: An International Journal* 15(1):52-67 doi.org/10.1080/16258312.2014.11517333

Taber, K. S. 2018. "The use of Cronbach's alpha when developing and reporting research instruments in science education", *Research in Science Education*, *48*(6): 1273-1296. doi.org/10.1007/s11165-016-9602-2

Thorlakson, T., de Zegher, J. F., and Lambin, E. F. 2018. "Companies' contribution to sustainability through global supply chains", *Proceedings of the National Academy of Sciences*, 115(9): 2072-2077. doi.org/10.1073/pnas.1716695115

Touboulic, A., and Walker, H. 2015. "Theories in sustainable supply chain management: a structured literature review", *International Journal of Physical Distribution & Logistics Management*, 45(1/2):16-42. doi.org/10.1108/IJPDLM-05-2013-0106

Visser, P. S. Krosnick. J. A, and Lavrakas, P. J. (2000), "Survey research". In HT Reis & CM Judd (Eds.), *Handbook of research methods in social psychology*. New York: Cambridge University Press. 223-252.

Wei, S., Yin, J., & Chen, W. (2022). "How big data analytics use improves supply chain performance: considering the role of supply chain and information system strategies". *The International Journal of Logistics Management*, 33(2): 620-643. doi.org/10.1108/IJLM-06-2020-0255

Wiśniewska, M., & Czernyszewicz, E. (2023). "Survey of young consumer's attitudes using food sharing attitudes and behaviors model". *British Food Journal*, 125(1):242-261. https://doi.org/10.1108/BFJ-09-2021-1025

Zenezini, G., Mangano, G., & De Marco, A. 2022. "Experts' opinions about lasting innovative technologies in City Logistics", *Research in Transportation Business & Management*, 100865. doi.org/10.1016/j.rtbm.2022.100865

Zimon, D., Tyan, J., and Sroufe, R. 2019. "Drivers of sustainable supply chain management: Practices to alignment with unsustainable development goals", *International Journal for Quality Research*, 14(1), DOI – 10. 24874/IJQR14.01-14

8. Appendix

Table 4: Questionnaire variables description

Figure 1: Generic FSC stages

Upstream	Focal Company	Downstream
P1. Supplier Assessment (10.9%) P2. Supplier Collaboration (2.2%) P3. Green Purchasing (5.5%)	P4. Green Design (3.3%) P5. Green Packaging (2.8%) P6. Green Production (5.5%) P7. Green Manufacturing (5.1%) P8. Material and Product Recycling and Remanufacturing (8.6%) P9. Protection of Animal Welfare P10. Soil Conservation and Management P11. Responsible Use of Natural Resources *Integration of Environmental Management systems (8.3%)*	P12. Inventory Management (1.3%) P13. Green Warehousing (2.0%) P14. Green Shipping and Distribution (4.9%) P15. Reverse Logistics (2.0%) P16. Corporate Green Image Management (0.2%)

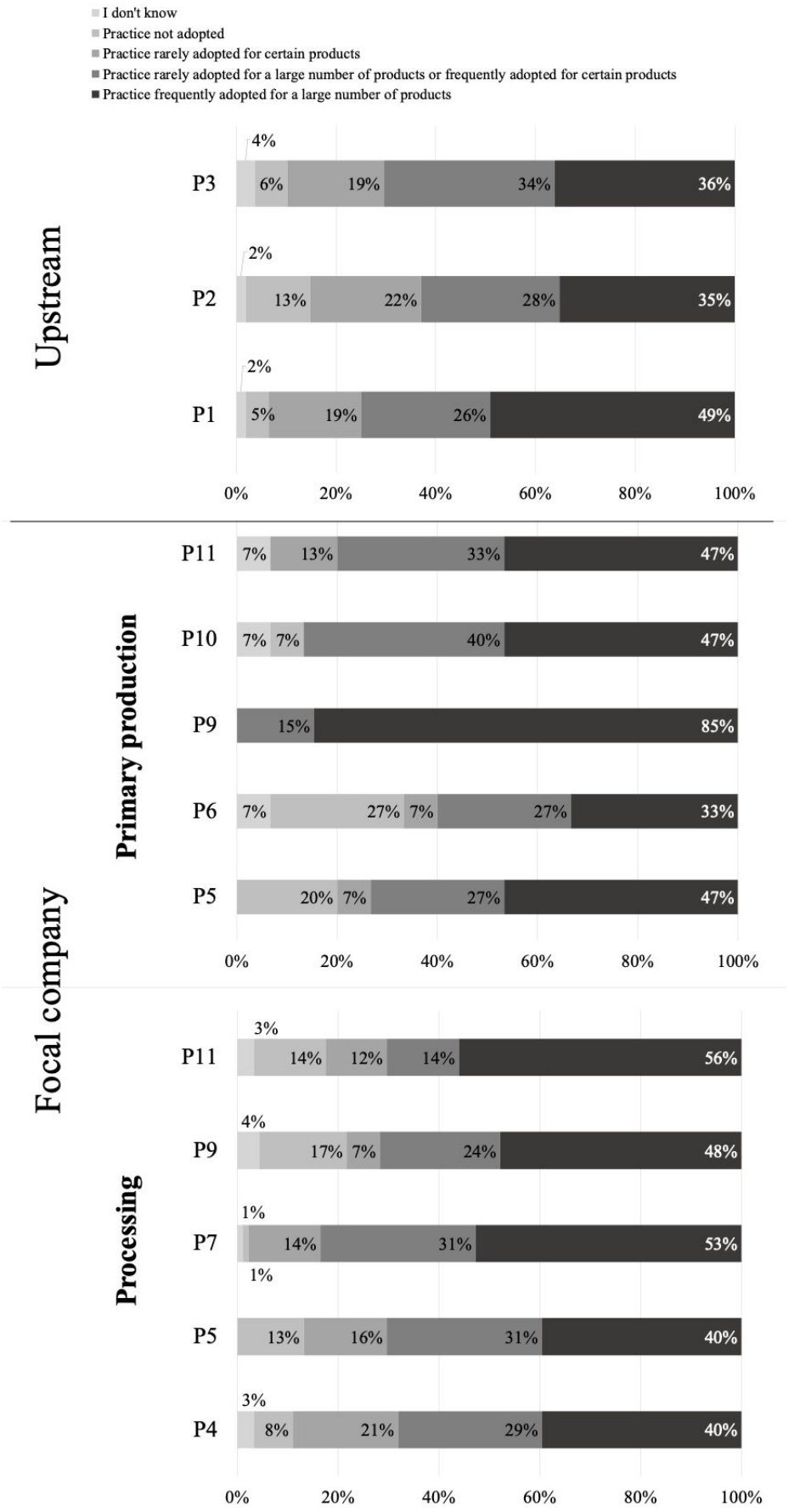
Transversal Practices

P17. Green Product Innovation and Design (1.2%)
P18. Corporate Social Responsibility programs (10.8%)
P19. Green Human Resource Management (2.2%)
P20. Adoption of Standard and Certifications (5.8%)

Collaborative practices (10.2%)

P21. Collaborative Supply Chain: Information Planning
P22. Collaborative Supply Chain: Green Targets Planning
P23. Strategic Supply Chain Collaboration
P24. Supply Chain Integration System
P25. Adoption of ICTs (7.3%)

Figure 2. SSCM practices


I don't know
Practice not adopted
Practice rarely adopted for certain products
Practice rarely adopted for a large number of products or frequently adopted for certain products
Practice frequently adopted for a large number of products
Upstream
P3
4%
6%
19%
34%
36%
P2
2%
13%
22%
28%
35%
P1
2%
5%
19%
26%
49%
0%
20%
40%
60%
80%
100%
Focal company
Primary production
P11
7%
13%
33%
47%
P10
7%
7%
40%
47%
P9
15%
85%
P6
7%
27%
7%
27%
33%
P5
20%
7%
27%
47%
0%
20%
40%
60%
80%
100%
Processing
P11
3%
14%
12%
14%
56%
P9
4%
17%
7%
24%
48%
P7
1%
14%
31%
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P5
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20%
40%
60%
80%
100%

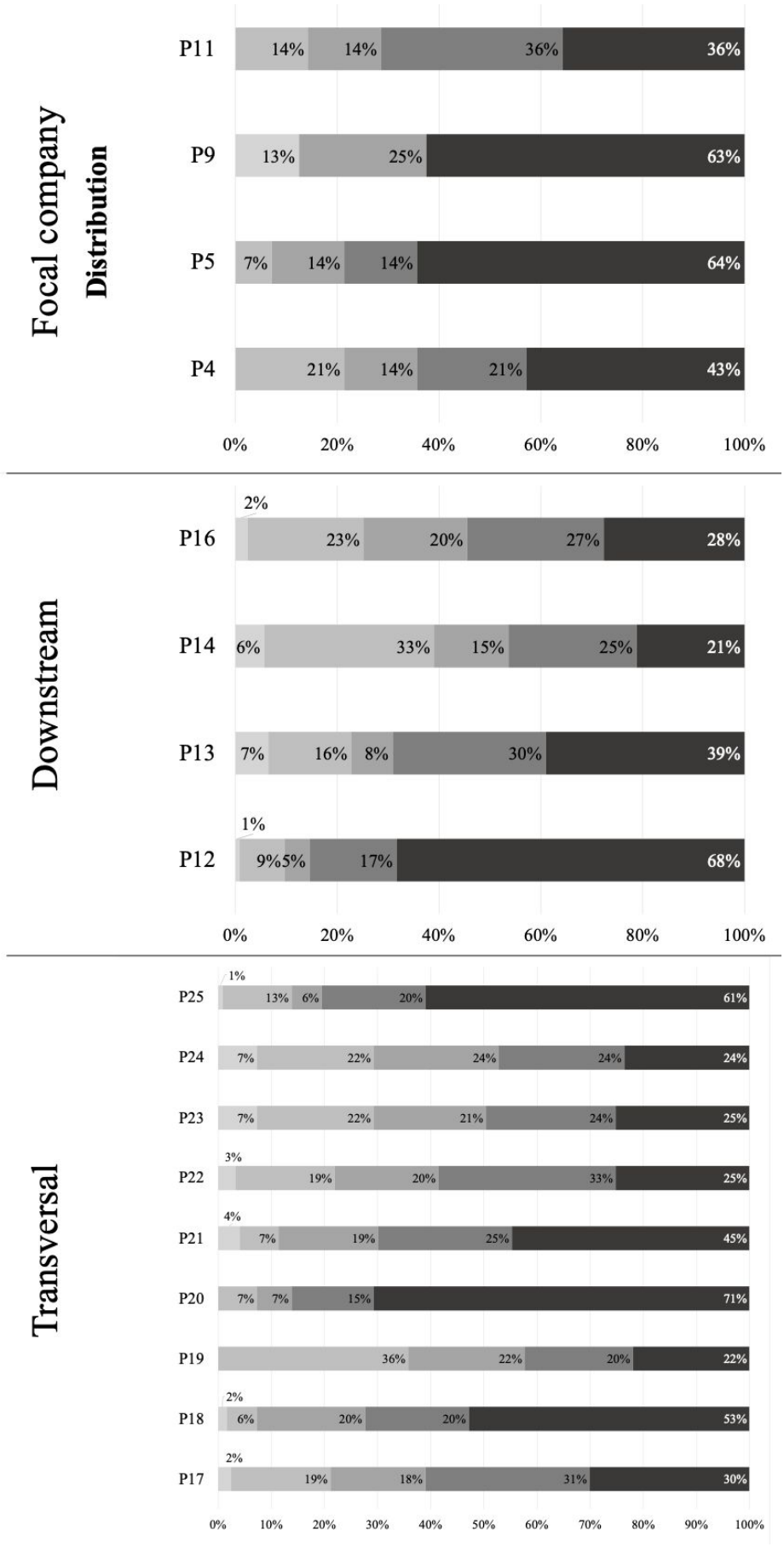

Figure 3. Degree of implementation of SSCM practices

Table 1. Cronbach's Alpha Coefficient

Practice	Cronbach's Alpha
P11	0.8564
P12	0.8658
P13	0.8549
P14	0.8543
P15	0.8679
P16	0.8477
P17	0.8507
P18	0.8519
P19	0.8474
P20	0.8668
P21	0.8638
P22	0.845
P23	0.8489
P24	0.8445
P25	0.864

Table 2. Outcome of Kruskal-Wallis tests vs. drivers

Practice	*Firm part of a group*	*Median*	*p-value*
P11: Responsible Use of Natural Resources	No	3	0.013
	Yes	4	
P19: Green Human Resource Management	No	2	0.004
	Yes	3	
P20: Adoption of Standard and Certifications	No	4	0.019
	Yes	4	

Practice	*Size of the company*				
	Micro	*Small*	*Mediu m*	*Large*	*p-value*
P1: Supplier Assessment	4	3	4	4	0.040
P11: Responsible Use of Natural Resources	3	3	4	4	0.006
P12: Inventory Management	4	3.5	4	4	0.007
P14: Green Shipping and Distribution	3	1.5	1.5	3	0.032
P17: Green Product Innovation and Design	3	2	3	3	0.039
P19: Green Human Resource Management	1.5	1	2	3	0.014
P20: Adoption of Standards and Certifications	3	4	4	4	0.009
P22: Collaborative Supply Chain: Green Targets Planning	3	2	3	3	0.010
P23: Strategic Supply Chain collaboration	2	2	3	3	0.003

Table 3. Outcome of Kruskal-Wallis tests: TBL dimensions vs. sustainable practices

	Rating scale for ECONOMIC dimension				
Practices	*Not important at all*	*Little importance*	*Important*	*Very important*	*p-value*
P7	3	2.5	4	4	*0.002*
P16	1	2	3	3	*0.015*
	Rating scale for ENVIRONMENTAL dimension				
Practices	*Not important at all*	*Little importance*	*Important*	*Very important*	*p-value*
P1	2.5	3	3	4	*0.040*
P3	2	2	3	4	*0.001*
P4	2	2	3	4	*0.002*
P7	2	3	3	4	*0.002*
P13	1	3	3	3	*0.014*
P14	1	2	2	3	*0.007*
P16	1	2	3	3	*0.001*
P18	1	2.5	4	4	*0.003*
P19	1	2	2	3	*0.002*
P22	1	3	3	3	*0.002*
P23	1.5	3	2	3	*0.043*
P24	1	2	3	3	*0.043*
	Rating scale for SOCIAL dimension				
Practices	*Not important at all*	*Little importance*	*Important*	*Very important*	*p-value*
P4	1.5	2.5	3	3	*0.048*
P7	2	3	4	4	*0.030*
P18	1	4	3	4	*0.013*
P19	1	2	2	3	*0.028*

Table 4 – Questionnaire variable description

Variable	*Operational Description*	*Type and Values*
Department	Job title of the respondent	Nominal Variable
Year of experience	Years of experience of the respondent within that department	Ordinal Variable
Country of the group	Country of the group if the firm is part of a group	Nominal Variable
Country of the firm	–	Nominal Variable
Cooperative	Distinction between cooperative and non-cooperative companies	Dichotomous Variable Yes = the company is a cooperative No = the company is not a cooperative
Type of products	Type of products offered by the company	Nominal Variable • Cereals and their product • Roots, tubers and plantains • Pulses, seeds and nuts • Milk and milk products • Eggs and their products • Fish, shellfish and their products • Meat and their products • Vegetables and their products • Fruits and their products • Fats and oils (oils, butters and margarines, etc.) • Sweets and sugars • Spices and condiments • Beverages • Food additives • Composite dishes • Savory snacks • Other
Product Portfolio	Number of products handled by a company.	Ordinal Variable Range = [1, >1]
Degree of processing	Degree of processing of the products.	Nominal Variable • Processed or minimally processed • Ingredients • Ultra-processed
Number of employees	Number of employees of the company used to characterize the size of the company.	Ordinal Variable • Less than 10 • Between 10 and 49 • Between 50 and 250 • More than 250
Stage of the supply chain	The most important stage at which a company operates.	Nominal variable • Agricultural production (including breeding and fisheries activities) • Post-harvest handling and storage • Processing • Distribution • End-of-life

Variable	*Operational Description*	*Type and Values*
Actors upstream	Number of actors between the company and the agricultural production.	Range = [1; 5]
Actors downstream	Number of actors between the company and the final consumer.	Range = [1; 5]
Economic	The extent to which the Economic dimension of the TBL is considered in a company.	Likert scale data Range = [1; 4] 1: not at all important 2: low important 3: important 4: very important
Environmental	The extent to which the Environmental dimension of the TBL is considered in a company.	
Social	The extent to which the social dimension of the TBL is considered in a company.	
P_1	Supplier Assessment	Likert scale data Range = [0; 4] 0: I don't know 1: The practice is not adopted 2: The practice is rarely adopted for some products/services 3: The practice is rarely adopted for many products, or the practice is frequently adopted for some products/services 4: The practice is frequently adopted for many products/services
P_2	Supplier Collaboration	
P_3	Green Purchasing	
P_4	Green Design	
P_5	Green Packaging	
P_6	Green Production	
P_7	Green Manufacturing	
P_8	Material and product recycled or reprocessed by the company or by a third party	Dichotomous: Y/N
P_9	Protection of Animal Welfare	Likert scale data Range = [0; 4] 0: I don't know 1: The practice is not adopted 2: The practice is rarely adopted for some products/services 3: The practice is rarely adopted for many
P_{10}	Soil Conservation and Management	
P_{11}	Responsible Use of Natural Resources	
P_{12}	Inventory management	
P_{13}	Green Warehousing	

Variable	*Operational Description*	*Type and Values*
P_{14}	Green Shipping and Distribution	products, or the practice is frequently adopted for some products/services 4: The practice is frequently adopted for many products/services
P_{15}	Reverse logistic – by the firm or by third party	Dichotomous: Y/N
P_{16}	Corporate Green Image Management	Likert scale data Range = [0; 4] 0: I don't know 1: The practice is not adopted 2: The practice is rarely adopted for some products/services 3: The practice is rarely adopted for many products, or the practice is frequently adopted for some products/services 4: The practice is frequently adopted for many products/services
P_{17}	Green Product Innovation and Design	
P_{18}	Corporate Social Responsibility Programs	
P_{19}	Green Human Resource Management	
P_{20}	Adoption of Standard and certification	
P_{21}	Collaborative Supply Chain: Information Planning	
P_{22}	Collaborative Supply Chain: Green Targets Planning	
P_{23}	Strategic Supply Chain Collaboration	
P_{24}	Supply Chain Integration System	
P_{25}	Adoption of ICTs	