Developing sustainability in the Italian meat supply chain: an empirical investigation

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Abstract

Although sustainable supply chain (SC) management has been widely investigated in recent years, the focus has mainly been on the practices adopted by a single company, so missing the big picture at SC level. This study of the Italian meat industry considers the SC as a whole, identifying the critical points for each stage in terms of economic, environmental and social sustainability. To this end, a first set of case studies was conducted of companies at different stages of the SC before turning to focus on the meat processing stage, which was identified as critical and highly relevant. A second set of case studies analyzed how these companies leverage SC management practices to develop sustainable SCs. In so doing, specific attention was paid to drivers and contingent variables that foster the adoption of sustainable practices. The results of the two steps were then merged to illuminate how practices adopted by the meat processors can impact on the whole chain, confirming their pivotal role in driving sustainability. These results provide a holistic view of the phenomenon, encompassing the entire chain from end to end and highlighting the interdependences across various stages of the meat SC.

Keywords: supply chain management; sustainable manufacturing; food industry; sustainability; case studies

1 Introduction and research background

In the Brundtland Report of 1987 (World Commission on Environment and Development 1987), sustainable development was defined as meeting "the needs of the present without compromising the ability of future generations to meet their own needs". The basic idea here is that to achieve sustainable development, any action should take account of social and environmental as well as economic issues. Increasingly, researchers and practitioners in different areas of management are taking account of issues of sustainability. This is certainly the case in the area of supply chain management (SCM), where the issue of sustainability has been addressed from multiple perspectives, employing such concepts as green purchasing, purchasing social responsibility, socially sustainable supplier management, green SCM and sustainable SCM (Carter and Jennings 2004; Klassen and McLaughlin 1996; Pagell and Wu 2009; Seuring and Müller 2008; Vachon and Klassen 2006; Zhu et al. 2013). The link between sustainability and SCM is most closely and comprehensively expressed by the term *sustainable SCM* (Ahi and Searcy 2013), referring to social and environmental issues in SCM practices.

Different industries face differing issues of sustainability because, among other things, their supply chains (SCs) may differ (Maloni and Brown 2006), inviting an industry-specific focus. Many studies have developed from this seminal idea, with increasing intensity of interest in this topic in such sectors as manufacturing (e.g. Gualandris et al. 2014; Seuring 2004; Seuring and Müller 2008), the food industry (e.g. Elkington 1998; Hamprecht et al. 2005), agriculture (e.g. Seuring and Müller 2008), the automotive industry (e.g. Günther et al. 2014) and oil and gas (e.g. Matos and Hall 2007).

In the present study, we focus on the agri-food industry as among the most challenging and interesting in sustainability terms. The agri-food industry has a significant economic impact (Stock 2004); in the European Union in 2011, it realized a turnover of 956 billion Euro, involving 274,000 firms and creating direct employment for more than four million people (FoodDrinkEurope 2012). Beyond its economic influence, several authors have demonstrated its critical role in

environmental and social sustainability (Yakovleva and Flynn 2004), and food provision is, in fact, the human activity with the single largest environmental impact (Smil 2001).

Within this industry, the importance of meat production is widely acknowledged, not only in terms of overall turnover but also because its essential involvement with humans, animals and the environment has significant implications for sustainability. Additionally, in recent decades, the rising demand for meat in developing countries has serious implications for global warming, as greenhouse gas emission due to meat production is far higher than for other types of food (Godfray et al. 2010).

A common feature of the present literature on sustainability is that it takes account of the entire SC, as sustainability issues must be solved at this level, beyond the individual firm. In the absence of this more holistic perspective, an improvement at one company or stage of the SC may result in a negative overall impact (Seuring and Müller 2008). In this regard, the literature also reflects the importance of analysing the impact of SC contingencies on the adoption of specific behaviours (Gonzalez Benito and Gonzalez Benito 2010). To date, little attention has been devoted to sustainability in the meat SC as a whole. With regard to the soybean meal and beef production chains, Kamali et al. (2014) have highlighted the importance of defining sustainability issues from this whole-chain perspective, as issues of sustainability emerge at various stages along the production chain. Soysal et al. (2014) proposed a model for designing beef logistics networks with due regard to emissions considerations.

There are few other relevant works, as most adopt a geographical or regional perspective (Alemayehu 2011; Euclides Filho 2004). For that reason, this paper considers the entire meat SC and the drivers that affect companies' behaviour. Our empirical research focused in particular on the Italian meat industry. Producing about 709 thousand of tons of beef in 2014, Italy represents the 10% of the EU cattle production (Eurostat 2015). To begin, it was decided to adopt a SC perspective to analyze structure and relationships along the entire chain. We then focused more specifically on the processing stage to investigate existing practices and their impacts on performance at company level. The processing stage was selected for a number of reasons. First, this stage is central to the SC and so provides a good perspective on the preceding and subsequent stages. Second, as the most industrialized stage, this is also of greatest relevance from an operations management standpoint. Third, as previous

work has highlighted the strong influence of processing industries on a range of decisions in food SCs, this focus should help in evaluating the effects of local decisions on sustainability (Barrett et al. 1999; Poole et al. 2002).

In summary, this paper will first analyze all issues of sustainability in the meat SC by identifying critical points for each stage in terms of economic, environmental and social sustainability. To this end, a first set of case studies examined companies at different stages of the SC. Turning to the meat processing stage, a second set of case studies analyzed how these companies leverage SCM practices to develop sustainable SCs, paying specific attention to the drivers and contingent variables that foster the adoption of SCM practices.

The remainder of the paper is organized as follows. Section 2 describes the research framework and research questions, and Section 3 deals with the research methodology. In Section 4, the main results are presented and discussed. Finally, Section 5 presents our conclusions and directions for future research.

2 Research framework and research questions

Seuring and Müller (2008) noted that, when addressing sustainability issues, it is important to consider not only companies but also the SC they belong to. Following this approach, our research involves two steps. In the first (Step A), we analyze the Italian meat SC from end to end to gain an overview of sustainability issues along the SC, the main actions undertaken by companies at the different stages and impacts on the SC as a whole. Then, in Step B, we focus on the industrial processing stage, which plays a pivotal role in the development of sustainability, investigating in depth the sustainable SCM practices of companies at this stage and the drivers and contingencies that influence their actions. Figure 1 illustrates this research framework and the related research questions, including both steps, which will now be described in more detail.

INSERT FIGURE 1

2.1 Step A: Analysis of the SC as a whole

The adoption of a SC perspective to analyze the food industry—and in particular the meat SC—from raw materials to final customers is not a new idea (e.g. Francis et al.

2008; Taylor 2005). Previous studies (Francis et al. 2008; Kelepouris et al. 2007; Lowe and Gereffi 2009) identified the following stages in the meat SC.

- *Fodder supply*. In this stage, fodder is produced by large specialized companies or by the breeders themselves.
- *Breeding*. Animals are reproduced and raised until they reach the required size and age.
- *Slaughtering*. The animal is subjected to veterinary controls (ante- and post-mortem) and then slaughtered. In some cases, the animal is also cut into two parts.
- *Industrial processing*. From the slaughtered animal, industrial processors produce the different cuts of meat (or other processed items) and package them.
- *Distribution*. Small or large retail companies sell the meat products at their outlets. Wholesalers usually serve smaller retailers.

These stages, which tended in the past to be relatively independent, have come to interact more closely in recent decades in the face of several challenges (Fearne 1998). In fact, each significant food crisis (e.g. "mad cow" disease in 1987, cases of Campylobacter and Escherichia coli) has focused attention on SC control at all levels.

Based on these phenomena, several authors have analyzed the critical points for sustainability in the meat SC, including use of a local workforce, paying attention to the environment, respecting animal welfare and promoting food culture (Apaiah et al. 2005; Hamprecht et al. 2005; Ilbery and Maye 2005; Maloni and Brown 2006). Additionally, several non-academic reports have identified key practices that might serve to increase sustainability in the meat SC (e.g. the FAO animal production and health report).

While previous studies have considered the stages in the meat SC (Ilbery and Maye, 2005; Lowe and Gereffi, 2009) and related governance structures and distribution of power, there is little evidence of a SC perspective on sustainability, although sustainability issues can change or differ completely in each stage of the SC. Thereby, our first research question seeks to characterize sustainability issues within the Italian meat SC:

RQ 1: What are the main sustainability issues at the different stages of the Italian meat SC?

Companies chosen actions in response to these issues can affect other players, both downstream and upstream. Traditionally (e.g. Cooper et al. 1997), SCM has been seen as a way of achieving a global optimum—for instance, by reducing the use of resources along the chain to serve demands that cannot be met if every player acts independently through arm's-length relationships. This principle of collaboration between SC partners for optimal outcomes also applies to the development of sustainable SCs. For instance, Vachon and Klassen (2006) showed how buyer-supplier partnerships foster the development of green SCs, and other authors have highlighted the importance of collaboration in sustainable SCs (De Marchi 2012; Gualandris et al. 2014; Seuring and Müller 2008). This leads to a second research question:

RQ 2a: What are the main actions undertaken by meat SC companies in response to sustainability issues?

RQ 2b: How do these actions affect the other players upstream and downstream?

Finally, previous works have demonstrated that some decisions within SCs are strongly influenced by focal companies, including decisions related to sustainability (Beske et al. 2014; Humphrey and Schmitz 2000; Ras et al. 2007). As a consequence, Step A of our research also seeks to confirm the focal position of industrial processors, as already suggested in the literature (Barrett et al. 1999; Poole et al. 2002), in support of our decision to focus on this stage of the meat SC in Step B.

2.2 Step B: Analysis of industrial processors

As noted above, Step B of our research focuses on meat processors and their SCM practices. The identification of sustainable SCM practices that might usefully be adopted by meat industrial processors seems critical in helping companies to select the right approach. The literature identifies a broad array of practices that can be used to improve sustainability at different stages of the SC. For instance, companies can adopt sustainable sourcing practices such as supplier assessment and monitoring (Gualandris et al. 2015) or they can integrate with suppliers (Pieter van Donk et al.

2008). Further downstream in the chain, the adoption of cleaner production (Klemeš et al. 2012) or green logistics practices (Erdoğan and Miller-Hooks 2012; McKinnon 2007) can achieve further improvements. Finally, product traceability has been advocated as a fundamental means of ensuring food safety (Kelepouris et al. 2007; Opara 2003; Van der Vorst 2006). To date, however, all of these practices have been studied separately, and it remains unclear how they should be used or combined to improve sustainability performance in the meat value chain. Our third research question, then, is the following:

RQ 3: Which SCM practices do industrial processors adopt to develop sustainability in the meat SC?

After identifying the sustainable SCM practices of industrial processors, we want to understand why companies select different sets of practices. Several authors (Carter and Dresner 2006; Klassen and Vachon 2009; Zhu and Sarkis 2006) have sought to identify the main drivers of sustainability—that is, the elements pushing companies to pursue a sustainable strategy and the implementation of sustainable SCM practices). In particular, following Walker et al. (2008), we consider two main groups of drivers:

- internal drivers such as reduction of internal costs, values of the company/founder and employees' welfare;
- external drivers such as regulation (current as well as anticipated future provisions), market requirements (e.g. consumer demand, retailer pressure, brand image, corporate reputation) and social and community issues (e.g. stakeholder pressures and relations with local communities).

However, despite this interest in sustainability drivers, the link between company-level drivers and implementation of sustainable SCM practices is not yet properly understood. Moreover, existing studies (e.g. Belz and Schmidt-Riediger 2010; Carmona-Moreno et al. 2004; Gonzalez-Benito and Gonzalez-Benito 2010) have highlighted the influence of a number of contingent variables in this regard:

- Company size, (number of employees and turnover);
- Level of internationalization (membership of a multinational group and percentage of products sold abroad);
- Listing on the stock exchange.

Here, too, the existence of a specific link among contingent variables and SCM practices is not yet fully understood. These considerations inform our fourth research question:

RQ 4: How do drivers and contingent variables influence the adoption of sustainable SCM practices by industrial processors in the meat SC?

3 Methodology

To address these research questions, we chose to adopt a case-based methodology as an appropriate means of describing phenomena in their real-world context (Voss et al. 2002). Although limited in terms of standardization and generalization of findings beyond the particular empirical setting, case study research also has interpretative advantages (Larsson and Lubatkin 2001).

In addressing the research questions, two distinct sets of cases were examined: eight companies at the different stages of the SC in Step A, and five industrial processors in Step B. According to Yin (2009) and Eisenhardt (1989), the size of these two sets of cases can be considered adequate to provide an accurate empirical account, as the purpose is mainly exploratory.

As the second stage of the analysis focused exclusively on industrial processors, only some of the cases from the first stage (cases A, B and H) were retained. However, as cases A and B were too small to exert any significant influence on the SC, we retained only case H. Interviews were conducted at two different moments in time and with different objectives, which also helped to connect the two steps of the analysis.

Following the procedure described by Eisenhardt (1989) and Yin (2009), we selected cases according to different criteria looking for theoretical replication. While the companies differed in size and vertical integration, all were Italian firms operating in the meat industry. The twelve case studies were conducted by means of semi-structured face-to-face interviews. An interview protocol (Annex 1) was followed to ensure that all the relevant information was collected, and interviewees were free to provide further information if they felt it was of relevance. On-site visits were also conducted to collect further information and to verify the correctness of data from the interviews, referring to relevant documents to ensure triangulation of sources. In each company, we interviewed at least two managers who were involved in SC activities.

The next section reports key characteristics of the Italian meat value chain, as the context in which the participating companies operate.

3.1 The Italian meat value chain

The meat industry in Italy is worth 32 billion euros annually. The combined turnover of the beef, poultry and pork sectors is around 22 billion euros, mainly from meat processing; beef and poultry each account for 6 billion euros while pork is valued at 10 billion euros. This is significant in the context of the overall annual food sector turnover of 180 billion euros, which represents 10–15% of Italian GDP. The meat industry employs 180,000 workers (55,000 in the poultry sector, 44,000 in pork and 80,000 in beef). Most livestock farms are concentrated in the north of Italy, where about 70% of Italian beef farms, 87% of pig farms and 71% of poultry producers are located (Eurocarne 2015). According to the latest Italian agricultural census, about 80,000 livestock farms, 2,200 slaughterhouses and 50,000 food retail outlets were operating in Italy in 2010 (ISTAT 2010).

Italian beef cattle operations specialize in fattening rather than producing calves and depend heavily on imports of young calves from other countries, especially France (70% of imports), where the industry has invested in beef cows and calf production (USDA, 2012). As in most EU Member States, the tendency for small farms to be replaced by larger ones is also observed in Italy. Most of the farms that fatten calves are found in the north of Italy, in the regions of Lombardia, Veneto and Piemonte. Young bulls are reared in indoor feedlots and consume local feed (principally fodder maize, along with some other cereals). The indoor rearing system means that fields can be cultivated for maize (corn and fodder), with one of the world's highest yields. The availability of local feed for beef cattle production enables producers to i) increase the added value achievable through field crop production and ii) improve the quality of beef and rate of daily weight gain by virtue of the diet's high quality and energy content (Trestini 2006).

The slaughtering stage is also concentrated among a few big companies, as slaughterhouses must follow strict veterinary controls and regulations. A few major retailers also dominate the distribution side, with continuing decline in the number of independent small outlets. All stages of the SC are characterized by strict regulation, especially those involving live animals (i.e. breeding and slaughtering). Following the

BSE crisis, proof of country of birth, rearing and slaughter became mandatory for (prepacked and non-prepacked) processed beef and associated products (e.g. minced beef) (Regulation (EC) No 1760/2000).

3.2 Step A (RQ 1 and RQ 2)

For the first two research questions, we first performed a content analysis based on secondary sources, principally including the following:

- Italian Health Agency (ASL);
- National Breeders Association (AIA);
- Regional and National Agriculture Agencies;
- Animal Production Research Center (CRPA);
- National Council of Economy and Work (CNEL);
- National Laws and Regulations;
- National Statistics Agency (ISTAT);
- Institute of Services for the Food Agricultural Market (ISMEA);
- Good Agricultural Practices (GAP) as developed by the Food and Agricultural Organization of the United Nations (FAO);
- Global Reporting Initiative (GRI) and related Food Processing sector supplement;
- Sustainability reports of the main companies in the value chain.

We focused on the main environmental, social and economic issues—that is, on issues that are common to most firms operating in that stage at national level. Issues at the level of the single firm or region were not considered. In this way, we developed a first list of sustainability issues, which were integrated and validated through the development of eight case studies (see Table 1 for sample description and value chain phases for each company). The aim was to interview participants from companies at different levels of the value chain, including owners, purchasing managers and technical managers.

INSERT TABLE 1

As reported in the interview protocol (Annex 1) and based on the previously identified list of sustainability issues, we asked interviewees whether their company

was affected by a specific issue, and what (if any) countermeasures they adopted. Where an action was undertaken, we asked whether this action impacted on their suppliers or customers in terms of economic, environmental and social performance.

3.3 Step B (RQ 3 and RQ 4)

The second stage of our research involved further interviews at five industrial processing companies.[1] The personnel interviewed at these companies included quality and sustainability directors, CSR managers, general directors, and SC managers. Table 2 summarizes the main characteristics of these companies.

INSERT TABLE 2

We asked the interviewees from each company which SCM practices they adopted to develop sustainability in their SC. The interview protocol (Annex 1) included a list of sustainable SCM practices from the literature, which was integrated and revised in line with interviewees' responses. The initial literature-based list of practices is included in Annex 2; practices are classified according to the Supply Chain Operations Reference (SCOR) model proposed by the APICS Supply Chain Council (http://www.apics.org/sites/apics-supply-chain-council/frameworks/scor). This model addresses processes that include Source, Make, Deliver and Return. Product Development (especially packaging activities) is also considered, as product configuration decisions impact strongly on SC structure (Krikke et al. 2003; Pero et al. 2010). We also included a list of cross-processes such as Traceability (Golan et al. 2004; Pagell and Wu 2009) and Transparency (Pagell and Wu 2009). Finally, we added SC Configuration as a strategic process that includes such practices as supplier

[1] The cases were selected in two steps, with the goal of interviewing companies that take a proactive approach to sustainability. First, Italian meat companies were identified on the basis of ATECO 2007 classification and ranked on the basis of turnover. An extensive analysis of companies' websites then served to identify certified companies (e.g. ISO 14000 and EMAS) that explicitly mention sustainability as a core element of their strategy. This approach to case selection captured both large and small-medium companies, enabling dimensional comparison across heterogeneous case studies.

proximity (Caniato et al. 2013; Golini et al. 2016) and fair trade SC (Bacon 2005; Castaldo et al. 2009).

4 Results and discussion

This section details the cross-case analysis and results for each research question.

4.1 Identification of critical issues in each stage of the SC (RQ 1)

Investigation of the first research question led to the identification of a series of critical points in the meat SC. As mentioned in the Methodology section, a list of critical points was assembled from secondary sources and validated by means of the case studies. All the issues that emerged were then grouped into 9 categories: waste disposal (including packaging); intensive agriculture/farming model and industrial pollution; traceability, food safety and hygiene; animal well-being; worker skills and satisfaction; social reputation; market concentration; low margins; and dependence on imports. Finally, each category was assigned to the relevant stages in the value chain, and to a specific sustainability pillar, on the basis of the most consolidated framework in the food sustainability field (the Global Reporting Initiative)—for example, animal well-being was assigned to the social pillar.

Figure 2 summarizes the results of our analysis. As there was general agreement about the identified issues, we did not report single-case answers. This general agreement reflects our aim of identifying the principal issues in the Italian meat SC at the industry level rather than the specific issues of any one company.

INSERT FIGURE 2

One critical topic for environmental sustainability is waste disposal, and this issue affects almost all the SC stages other than distribution and fodder supply. This matter is of such significance that it is regulated at both European and national level (e.g. Directive 91/676/CEE). Another issue of concern is the impact of intensive models of agriculture and farming, as companies involved in fodder supply and breeding usually adopt intensive models that can degrade natural resources.

With regard to social sustainability, it is important first of all to ensure food safety. For that reason, there are very clear regulations governing traceability and hygiene. For instance, at the European level, HACCP certification has been mandatory for all

food industry companies since 1997 (directive 43/93/CEE). The entire distribution phase is also subject to regulations governing food safety and hygienic conditions; in particular, the cold chain necessarily increases operational costs.

Animal well-being represents a critical point for those phases that involve livestock, and again, there is a European regulation about minimal spaces for housing animals. This regulation requires an acceptable level of animal well-being and a good working environment for employees. Workers' skills and satisfaction are also issues for social sustainability, and skill empowerment is relevant throughout the SC. For example, in the industrial processing of the carcase, a high skill level is required in order to cut the meat in the right way. In this regard, company E mentioned that "*high quality meat requires that meat is cut at perfection. It is a very difficult skill to find on the job market and takes time to be taught*." As already mentioned, worker satisfaction is also related to respect for animal welfare and hygienic conditions.

Finally, the social reputation of companies operating in the meat industry is important, as public opinion reacts badly to mistreatment of animals. As company H stated, "*We must be careful that animals are not mistreated at any stage of our SC. For instance, when transporting animals, we must verify that each animal is in healthy condition for the trip, and truck drivers are monitored with GPS systems to verify that they do not exceed driving times, and that they take the right breaks to allow the animals to rest and have water*".

In terms of economic sustainability, the Italian meat sector is characterized by high concentration of fodder suppliers, slaughterhouses and retailers. In particular, given the high costs induced by environmental regulations, the slaughtering stage is so concentrated that it is difficult for small companies such as D and G to compete. In contrast, breeders operate in a fragmented market. As a consequence, despite the high added value they provide, breeders have the lowest margins in percentage terms. This also relates to breeders' dependence on imported adult animals, undermining a significant part of the added value they might otherwise provide.

In summary, we note that while most of the critical points for sustainability are shared by several actors (e.g. waste management, food safety and traceability, social reputation), some are specific to one stage, in line with the findings of previous studies adopting a SC perspective (e.g. Balkau and Sonnemann 2010; Taylor 2005). We also note the simultaneous presence of environmental, social and economic issues at each stage of the SC as suggested by the Triple Bottom Line approach. Another

important finding is that the breeding stage accounts for most sustainability issues and should therefore be the focus of any improving actions. However, this is also one of the most vulnerable stages as it attracts the lowest margins, and any action may prove difficult to implement because of economic constraints.

4.2 Actions undertaken and cross-stage impacts (RQ 2)

As a second phase of analysis, we investigated how companies react to the critical issues noted above, and the ensuing impacts on other stages of the value chain (see Table 3).

From the interviews, we built a database of actions, which were then grouped into 17 categories. Finally, we organized the information in Table 2, proceeding from the sustainability issue and value chain stage and representing the different actions undertaken by the participating companies, along with their upstream and downstream impacts.

INSERT TABLE 2

Critical issues will be separately discussed for each dimension of sustainability (environmental, social and economic).

4.2.1 Environmental issues

With regard to waste disposal, actors always follow the regulations specific to their sector. Where possible, breeders use the sewage as fertilizer for their fields (cases D and G) or for those of local growers (case B). In fact, the use of manure as a fertilizer has a number of benefits, enabling self-production of high quality fodder, reducing disposal costs and preserving the terrain. The upstream effect of this practice is a reduction of the dependency on fodder suppliers. The downstream effect is that high quality fodder produces higher quality meat. In the other stages (slaughter, packaging and distribution), as this type of waste requires specialized processing, waste disposal is outsourced to specialists to reduce the risk of contamination. Industrial processors also engage in the recovery, reuse and recycling of primary and secondary packaging.

While these practices do not affect the other stages, they do reduce environmental impacts and costs.

With regard to intensive agricultural and farming models, the companies involved in producing fodder (D, G) follow the FAO GAP principles, even if they are not always aware of doing so. As one interviewee from company G pointed out, "*crop rotation today is seldom put in practice; the preferred approach is to use fertilizers and other chemicals, but it is not the same. That is why we keep as much as possible to traditional agricultural methods, such as crop rotation".* Interestingly, interviewees from company G thought themselves old-fashioned, but FAO GAP principles actually recommend crop rotation.

In respect of the pollution emitted by industrial processors, there are two groups of techniques: Best Available Techniques (BAT) and cleaner production technologies (see Annex 2).

4.2.2 Social issues

In addressing issues of food safety and security, industrial processors adopt HACCP and traceability systems. Company G (a large retailer) commented: "*Our customers more and more frequently verify the origin of the meat on the package, and if it is Italian, it is considered worthier*." This of course implies a reduction of the supply base to only those suppliers that are certified and come from specific areas, which aligns with the findings of Maloni and Brown (2006). All the companies involved in this stage also adopt the technique of conservation in vacuum or modified atmospheric conditions, as this preserves food at an economically viable price. As company E pointed out, "*Vacuum conservation makes the meat brick red, and with a mixture of CO2 and oxygen, the meat remains red. To the customers, this is a sign of freshness and quality*".

As to animal well-being, the dire economic conditions of breeders mean there is very little scope for sustainability initiatives, as these would incur additional costs. For instance, case B is particularly active in selecting fodder, rotates animals among boxes, and cleaning processes are well above the minimum standard. During the interview, the company's owner said: "*We do not care much about the regulations because we know we are above. We do not care if this carries higher costs; we want our workers and animals to be in the best possible conditions. And, at the end of the*

day, we have less turnover but more productivity and less veterinary control costs". Animal well-being is also important in slaughterhouses for economic reasons; if the animal is too stressed before being slaughtered, this can affect the taste of meat. Case H was particularly interesting in this regard: "*We slaughter up to 3.000 cows per day, but we are not an automobile factory; we deal with live animals that are pretty aware they are going to die. That is why we take all possible precautions to make this process smooth for the animals. Recently, we started a collaboration with a university to identify and monitor the stress level of the animals".*

In general, addressing social issues enhances social reputation and food quality in subsequent stages. For that reason, those operating in highly concentrated stages tend to gain control of upstream phases. This means that breeders are subject to greater control from their customers, and from their customers' customers. This can be seen to help maintain control of sustainability aspects (for instance, animal well-being), but on the other hand, the imposition of breeding practices and price lists reduces breeders' margins and autonomy.

4.2.3 Economic issues

Breeders try to increase their margins in various ways, including vertically integrated upstream (case D), downstream (case B) or both (case G). They also try to differentiate aiming at higher quality products through fodder selection, imported animals' selection and breeding conditions. Moreover, some (e.g. case E) sell the product directly to remain independent from large retailers, which differs from the norm for this industry. As company E pointed out, "*If we sell our product in the supermarkets, it will be put in a white tray identical to all the others, and in terms of price, so all our quality turns into a loss*". Such actions help these companies to survive but do not provide high profit margins.

At the end of Step A, we could draw some conclusions that proved useful for Step B.

1. First of all, sustainability issues are transversal to the meat SC and are often shared by many players. This calls for joint and coordinated actions in the chain and significantly limits the positive effects of individual initiatives, echoing the acknowledged importance of a SC perspective in the existing literature (e.g. Vachon and Klassen 2006).

2. As environment-related practices are often associated with cost reduction, they are more easily diffused or self-initiated. On the other hand, social practices often entail an increase in costs and therefore require coordination and mutual support. For this reason, tighter chain relationships (vertical integration or collaboration) can increase sustainability performance, as well as reducing the complexity to be managed by the individual actor (Seuring and Muller 2008).
3. It is difficult to foster collaboration among players at the different stages. In reality, several companies are in key positions and can exert a degree of control over the other players, so influencing the sustainability performance of the whole chain. Interestingly, however, while slaughterhouses and distributors seem more focused on issues of cost and quality, industrial processors seem to place more emphasis on sustainability practices, and those of their suppliers, by extension of codes of conduct and vendor rating systems that include sustainability performance. This may relate to their brand status and a desire to improve their reputation. However, further investigation is needed to understand the practices and drivers behind this positive attitude, given that companies at the same level may adopt differing approaches.

In conclusion, the pivotal role of industrial processors supports our decision to focus on these players in analyzing sustainability practices and related drivers and contingencies.

4.3 Identification of the SCM practices of industrial processors (RQ 3)

The second set of case studies focused on the industrial processors. These companies are particularly concerned with sustainability issues, and they adopt a broad set of practices. In addition to those already mentioned, some (L and N) sought to select breeders that were geographically close and followed organic food practices. If suppliers are local, transportation time is shorter, and animals experience less stress. It is also easier to control and trace incoming meat. These objectives are well synthesized in the mission of company N, which the owner expressed as "*producing high quality products, with great attention to environmental sustainability as well as being rooted in the local territory*". In terms of the delivery phase, the interviewed industrial processors supported adoption of transportation sharing solutions (either in conjunction with other industrial processors to deliver to a single retailer or from a

single distribution centre to several retailers in a single trip). They also favoured vehicle routing optimization in the interests of cost savings and environmentally friendly distribution. Finally, most of these companies followed Design for Environment (DfE) rules for product packaging and were engaged in the development of healthier products. For example, the manager we interviewed in company I stated: "*We are continuously working in two directions: reducing the amount of material used for packaging, and increasing the use of low-impact materials—that is, recycled or recyclable materials*". Table 4 summarizes by process the main practices identified among industrial processors.

INSERT TABLE 4

The cross-case analysis as described so far has allowed us to identify three main groups of practices that characterize the behaviour of industrial processors in respect of sustainability. These three groups have been identified according to the level of adoption of practices across the sample.

1. The first group encompasses compulsory practices prescribed by law (traceability and HACCP planning) and therefore consistent with the existing literature (e.g. Maloni and Brown 2006). As these practices have clearly been implemented by all companies in the sample, they cannot be considered a distinguishing characteristic. The practices in question are strongly related to social sustainability issues such as traceability, food safety and hygiene (a critical issue for industrial processors) and workers' skills and satisfaction, as well as social reputation. While mandated by regulation, these practices are quite expensive from an economic point of view, highlighting a potential trade-off between social and economic pillars.
2. The second group includes practices that are implemented by all the companies in the sample but are not mandated by regulations and may therefore be considered key sustainable practices for industrial processors. These practices include cleaner technology and BAT (make), transportation sharing solutions and vehicle routing (deliver), packaging and product recovery (return) and DfE (product development). The participating companies mentioned that these practices tend to improve both economic

performance and either environmental or social sustainability, giving companies that implement them a clear advantage.

3. The third group of practices were implemented by just a few companies and include supplier proximity or organic SC (SC Configuration); sustainability vendor rating and code of conduct (source); choice of transportation mode and load and shipment planning (deliver); and development of healthier products (product development).

Finally, no fair trade or product scheduling practices were identified within the sample, and respondents stated that these are not of relevance to the meat industry. Table 5 summarizes the three groups of practices.

INSERT TABLE 5

To better understand the reasons behind the adoption of "exceptional" practices where there is no consensus among companies, with a broader impact on the SC, an analysis of drivers and contingent variables was performed. This is described below.

4.4 Influence of drivers and contingent variables on adoption of SCM practices (RQ 4)

Cross-case analysis enabled us to identify the main drivers and contingencies that account for the adoption of "exceptional" sustainable SCM practices (Table 6).

INSERT TABLE 6

First, the most common recurring drivers towards sustainability are reduction of operational costs and market drivers that include customer requirements, retailer pressure, brand image and corporate reputation. The evidence suggests that profit is also a fundamental driver in sustainability choices, in terms of both cost reduction and increased market share. This result is consistent with Bansal and Roth's (2000) claim that the strongest drivers are linked to the economic benefits obtained through sustainability. While it would be unrealistic to suggest that companies operate against

individual economic benefits, our results suggest that several sustainability practices can also impact positively on economic performance.

Second, the founder's values were seen as a critical driver only in the cases of L (a family company) and N (where the owner is the company's top manager). This finding is only partly consistent with the existing evidence, as the literature presents this as the most powerful driver (e.g. Basu and Palazzo 2008). Indeed, SC Configuration practices were reported only by the two companies that mentioned this driver. Both referred to the owner's strong influence in implementing these practices, despite their inconvenience from a purely economic perspective. The words of the owner of company N clearly reflect this approach: "*We are a family company, and we take great care of our employees, their families and the community to which we belong. Sustainability for us is a way of taking care of our people and our land*". This suggests that this driver is significant only when power is relatively concentrated in the organizational governance, so that the founders' values coincide with those of the company. Third, contrary to the literature, drivers related to regulation were perceived as somewhat irrelevant. This result may have been biased by the approach to sample selection, as only sustainability-oriented companies were considered.

Other external drivers seem to play a significant role in the cases under review; in particular, retailer pressure was found relevant in most cases. This is no surprise, as it was anticipated that the meat SC (like many food SCs) would be strongly affected by retailers. Pressures from stakeholders and local communities were also identified as significant influences on what companies do. Relationships with other organizations are therefore a key influencing factor—not only because they require companies to be proactive but because they foster critical competences that can make adoption of SCM practices easier and more affordable.

In conclusion, one-to-one explicit connections between drivers and practices can be identified in only a few cases. For example, company M—the only company that mentioned regulation as a driver—does not implement any "exceptional" SCM practices, indicating an approach that is more reactive than proactive. Company N—the only company that mentioned customer requirements as a driver of sustainable behaviours (e.g. better quality, reduction of company impact on the environment)—is the only company implementing commercial disintermediation, which is a practice directly visible to customers. As already mentioned, the disruptive practices

introduced by companies L and N (such as SC configuration) are driven by company/founder values.

We next analyzed the effect of contingencies on adoption of "exceptional" SCM practices. In line with the literature (e.g. Gonzalez-Benito and Gonzalez-Benito 2006), company size seems important, especially in determining the adoption of SC Configuration practices. The only company that has introduced all the SC Configuration practices is the smallest of the group. Other companies have not adopted these practices because they are often not applicable for larger volumes and scale. In reality, SC Configuration practices are very disruptive as they are oriented to completely reshaping the structure of the SC as a whole towards a sustainable approach. For instance, in case N, this has meant the elimination of all forms of commercial intermediary and the use of suppliers who are all located within 20 kilometres.

Being part of a multinational group seems relevant in promoting the adoption of sustainable sourcing practices (Rugman and Verbeke 1998), mainly adopted by H, I and L. Apparently, multinational companies tend more than local companies towards formalized sustainable management of suppliers and are therefore more proactive in implementing such practices as structured sustainability vendor rating or collaboration with suppliers.

The remaining contingent variables (i.e. listing on the stock exchange and international distribution) seem to play no role in the adoption of sustainable SCM practices among industrial processors, despite evidence to this effect in the current literature. The main results for industrial processors are summarized in Figure 3.

INSERT FIGURE 3

Finally, we merged the results of the two steps of our research to show how the practices adopted by meat processors can impact on issues for the whole chain, confirming their pivotal role in driving sustainability (Table 7).

INSERT TABLE 7

Table 7 shows that mandatory practices have only a limited impact on critical issues in the industrial processor stage, as well as in the other stages. This outcome is not

unexpected, as HACCP and traceability regulations are designed to ensure the basic requirements of food safety and hygiene rather than to achieve a more sustainable SC in any broader sense. Interestingly, typical practices also have a fairly focused impact on waste disposal and industrial pollution. This finding can be explained by the strong pressure on industrial companies in recent decades to address environmental issues, sometimes reinforced by regulations. In response, companies implemented those practices that have a direct impact on the activities for which they are accountable. However, only exceptional practices have a significant impact on other stages in the SC.

In summary, these findings highlight a mismatch between the most diffused practices among industrial processors (which neglect other stages in the SC) and the fact that upstream stages—if helped to address their sustainability issues—could have a significant impact on downstream stages in terms of meat quality (as detailed in paragraph 4.2 and Table 3).

5 Conclusions and future developments

This paper has analyzed sustainability practices in the meat SC by identifying the critical issues for each stage in terms of economic, environmental and social sustainability. To this end, a first set of case studies examined companies at all stages of the SC. In a second set of case studies, we then focused on the meat processing stage, analyzing how these companies leverage SCM practices to develop sustainable SCs, with particular attention to the drivers and contingent variables that foster their adoption. Our main findings can be summarized as follows.

- Sustainability issues are transversal to the meat SC and are often shared by multiple players, so requiring joint effort and coordination.
- As environmental practices are often associated with cost reduction, they are more easily diffused or self-initiated. On the other hand, social practices often entail an increase in costs and therefore require the support of pivotal companies.
- Despite this need for collaboration, the most diffused practices among industrial processors (who play a pivotal role in the chain) focus on the specific issues of that stage, although helping other stages may improve the quality and sustainability of the final product.

- The reason for this mismatch can be traced back to the drivers that determine adoption of such practices (mainly cost reduction, retailer pressure, image and corporate reputation), which relate to an approach that is reactive and "business as usual" rather than proactive.

As discussed below, these four points contribute significantly to both research and practice.

5.1 Contribution to research

The present findings make a relevant contribution to knowledge of how sustainability can be implemented in meat SCs. The first phase of the analysis served to identify the main critical issues for the meat SC from a twofold perspective: per single stage and per pillar. This made it possible to clearly identify the stages and practices that would best serve to increase sustainability in this SC. This contribution is both relevant and innovative, as no study to date has analyzed the meat SC from this perspective (Kamali et al. 2014). Additionally, we identified the actions undertaken and their impacts on upstream and downstream stages, so elaborating the potential implications of actions undertaken within each stage of the SC. This is also innovative, providing a cross-stage interactive perspective on the whole chain from end to end that is seldom found elsewhere (Seuring and Müller 2008).

The second step of the study makes a second relevant contribution by identifying the main practices among industrial processors and categorizing these into three main groups (mandatory, typical and exceptional), clarifying which practices are driven by the regulations and which practices are driven by other drivers and contingent variables. These findings offer clear evidence that context is relevant in the application of sustainable practices (Gonzalez-Benito and Gonzalez-Benito 2010), and we identified factors that companies should leverage to improve their performance. For example, the importance of involving external stakeholders and local communities is a key point, indicating that sustainability is not individualistic but depends on the involvement of other parties.

These findings also provide clear evidence of the complexity of sustainability management in the Italian meat industry. The first step of the analysis clearly demonstrates the multiplicity of issues and interconnections between SC stages, and the second step shows how the practices adopted by industrial processors impact on the other stages. Clearly, actors at different stages of the SC share a number of

sustainability issues, and the actions of one in addressing these issues can also impact the other stages. This highlights the need for a holistic approach to handling sustainability issues in the meat SC and finding a global optimum, lending clear support to calls for a SC-wide approach to sustainability (Ahi and Searcy 2013).

On the other hand, among industrial processors (confirmed here as pivotal companies), we found a general tendency to focus only on internal issues and mandatory or typical practices demanded by the regulations or by customers (i.e. large retailers and distributors). These results show that there is no strong incentive to achieve sustainability beyond the requirements of an acceptable social reputation or economic benefits (e.g. case M). This situation limits collaboration in the SC, especially for companies who lack any strong commitment, and ensures that breeders—who could potentially do more for sustainability—are economically disadvantaged. That being so, it seems important to encourage industrial processors to commit more extensively to what we refer to as "exceptional practices", which are rarely adopted and are often promoted only by the values of the company or founder. Our results also suggest that leveraging local communities and stakeholders may be useful in diffusing such practices. This finding augments research on the drivers and enablers of proactive adoption of sustainability-oriented practices (Carter and Dresner 2006; Klassen and Vachon 2009; Zhu and Sarkis 2006).

In analyzing the topic of sustainability in the meat SC as a whole, this paper offers a holistic view of the phenomenon and highlights the interdependences across different stages. Some mutual benefits have been identified, along with some trade-offs. Deep analysis of the main practices implemented by industrial processors highlights their critical role, linking the adoption of these practices either to the critical issues of the stage, the drivers of sustainability or the company's contingent variables. This represents a new perspective on the topic, and the identification of three groups of practices characterizing sustainability actions and their drivers is also a novel contribution.

5.2 Contribution to practice and policy

For practitioners, the paper makes a relevant contribution by identifying the main critical issues for each stage, as well as relevant practices to address these issues. We believe this will assist selection of the best practices for maximizing the benefits and

value of possible investments. This is very important, as managers with a limited knowledge of sustainability may be tempted to adopt practices that are widespread and seem generally applicable, such as a renewable energy strategy. While such practices may offer a point of departure for the journey to sustainability, they may also prove inefficient, and a clear sense of priorities is crucial.

The present findings can also be expected to improve companies' awareness of the impacts of their decisions on upstream and downstream stages of the chain, so developing a will to collaborate towards a common goal. While have demonstrated that this attitude is not yet widespread, our results also confirm the need for this collaborative approach to sustainability.

These results also suggest the relevance of different approaches for small and larger companies. Beyond mandatory practices, the former group might start by implementing "typical" industrial processor practices that minimize initial investment. Where they are willing to introduce "exceptional" practices, selection should be driven by strategic goals—for example, company N has adopted SC configuration practices because these are strongly linked to their values and strategic position on sustainability. On the other hand, big companies should consider both their strategic goals and internal processes, leveraging their power to orient the supply chain as a whole towards sustainability. To this end, big companies should consider the needs and critical issues of other members of the supply chain. For instance, company C, a major Italian retailer, is pushing suppliers to pursue organic production and development of healthy products. From the supplier perspective, however, fair compensation and clear recognition of this value is not always guaranteed, so hampering the improvement process.

Our results should also be of use in policy development, given the clear links that emerged between drivers and practices adopted. Indeed, only the mandatory practices required by the regulations are adopted by all actors, regardless of their own incentives to ensure sustainability. This is also true for smaller companies, who are often more constrained by what is required of them, either by law or by major customers. There is, however, another critical policy implication; as most advanced sustainability practices are also expensive to adopt, the issue cannot simply be "forced", especially in the case of smaller companies. Policy design should be economically sustainable, taking account of the triple bottom line by supporting fair distribution of costs and benefits along the chain.

5.3 Future developments

Granted these contributions, this study has several limitations, suggesting directions for future research. First, the focus here was on the meat SC, and the empirical analysis was confined to companies operating at its different stages. However, several other actors and needs should also be considered. For example, in considering more explicitly the needs and preferences of consumers, the final market must be included as an important factor that affects and is affected by sustainability choices. Additionally, we did not consider pure fodder suppliers, as these belong to a broader agricultural SC; indeed, we considered only companies that deal with animals or meat, and, in some cases, also produce fodder.

Second, this analysis considered only Italian companies operating in the meat SC. An international comparison, at least at European level, would be interesting and useful in generalizing and contextualizing our findings. Nevertheless, we consider our results to be of relevance to the extent that the Italian meat market has an international dimension and can be considered representative of the European case at least.

More generally, our research design could be extended to other food products, entailing other sustainability issues while sharing the same fundamental characteristics—the interdependence of agricultural, industrial and retail elements of the SC. We are confident not only that the research design can be replicated but also that some of the key findings are likely to be confirmed. These include the deployment of different types of sustainability practices according to different drivers and contingent factors, as well as the strong interdependence of different stages of the chain and the consequent need for a collaborative approach.

Among further developments of this work, the identified critical points for sustainability might be extended to include, for instance, the consumption of land and other natural resources and the preservation of biodiversity. While these issues were beyond the scope of the present work, they emerge as interesting points for future investigation.

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Annex 1

Interview protocol used in Step A

1. General information about the company (size, turnover, year founded, etc.)
2. Activities performed by the companies
    a. Position of the company in the SC
    b. Core and secondary activities
    c. Outsourced activities
    d. Supply side: Who are the suppliers? What type of relationship is established (arm's-length vs. collaborative)? What is the power balance?
    e. Demand side: Who are the customers/distribution channels? What type of relationship is established with customers (arm's-length vs. collaborative)? What is the power balance?
3. Sustainability-related issues
    a. Describe the main sustainability issues encountered in the activities performed by the company.
    b. What is the impact on social reputation?
    c. How is waste disposed? And special waste (e.g. bones, blood)?
    d. How is food safety guaranteed?
    e. How is the meat preserved?
    f. Traceability (What is traced? What is the impact on the business?)
    g. For breeders and slaughterers: How is animal well-being ensured?
4. Sustainability-related actions undertaken
    a. What are the main actions undertaken in response to sustainability issues?
    b. What are the effects on the rest of the SC (upstream and downstream)?

Interview protocol used in Step B

1. General information about the company: size (employees and turnover); year founded; kind of ownership; percentage of distribution abroad; listing on stock exchange
2. Activities performed by the company and SC structure:
    - Core and secondary activities
    - Outsourced activities

    - Supply side: Where are suppliers located? How many tiers? What type of relationship is established with suppliers (arm's-length vs. collaborative)?
    - Demand side: How is the distribution network configured? Which distribution channels does the company serve? Who are the main customers? What type of relationship is established with customers (arm's-length vs. collaborative)?
3. Drivers of sustainability: What drivers push the company to implement sustainable SC practices?
4. Sustainability-related SC practices:
    - SC configuration: supplier proximity; organic SC; fair trade channels
    - Source: certified organic suppliers; sustainability vendor rating; extension of code of conduct; collaborations with suppliers for sustainability; supplier development (financial support, technical assistance)
    - Make: BAT and clean technologies; HACCP system; sustainability goals for production planning and scheduling
    - Deliver: transportation sharing solutions; vehicle routing; planning of load and shipment; choice of transportation mode
    - Return: recovery of primary and secondary packaging; recovery of product and sub-products
    - Product development: design for environment (packaging); development of healthier products
    - Cross-process: system for product traceability; supply partners' involvement; procedures and technologies (e.g. bar codes, RFID)
5. Impact on performance:
    - Sustainability performance impacted by practices the company adopts
    - Observed relationship between green/social performance and economic performance (win-win, win-lose)

Annex 2

Process	SCM practice	Description	Reference
SC Configuration	Supplier proximity	Sourcing from closest supplier (i.e. located in same region or district) to minimize transportation and maximize freshness	(Caniato et al. 2013; Golini et al. 2016; Goodman 2003; Pagell and Wu 2009)
	Commercial disintermediation	Reduction of the number of intermediary levels in outbound SC (e.g. farmer's market, direct sales, vending machines, and local exchange communities).	(Simchi-Levi et al. 2007)
	Organic SC	Sustainable farming and processing practices; no use of chemical fertilizers or pesticides, or of genetically modified organisms in antibiotics and anabolic steroids for animals etc.	(Goodman 2004; Maloni and Brown 2006)
	Fair trade SC	Sourcing from fair trade certified suppliers, guaranteeing a minimum price to suppliers, anticipating 60% of final compensation at beginning of the trade to sustain business survival	(Bacon 2005; Maloni and Brown 2006)
	Supplier collaboration	Collaboration between buyer and supplier in defining and developing environmental and social programs; collaboration to build trust with suppliers and establishing and/or improving sustainability; pursuing close long-term relationships and ensuring SC continuity	(Beske et al. 2014; Gold et al. 2010; Schliephake et al. 2009; Vachon and Klassen 2008; Zhu et al. 2012)
	Alternative food SC	Also known as short food SCs (SFSCs), referring to local food chain activities (e.g. direct food marketing, on-farm food processing) that help to maintain high animal welfare standards and are both healthy and socially inclusive	(Ilbery and Maye 2005)
Source	Sustainability vendor rating Supplier selection	Setting up sustainability criteria for supplier selection and classification; supplier selection based on sustainability as well as economic performance (e.g. life cycle cost, green competencies, green image, certifications, willingness to engage in sustainability practices)	(Gold et al. 2010; Noci 1997; Pagell and Wu 2009)
	Code of conduct implementation	Extension of corporate social responsibility practices (e.g. labour security, rules for non-discrimination, respect for human rights, producer and consumer health and safety, working conditions, environmental management on farmland etc.), requiring suppliers to declare the social and environmental correctness of internal production processes; periodic review and audit of suppliers	(Amekawa 2009; Noci 1997; Thöni et al. 2014)
	Supplier development	Practices oriented to providing technical assistance and transferring knowledge to suppliers; financial assistance to develop suppliers; programs to sustain suppliers, their employees and the local community; helping suppliers to develop their own	(Pagell and Wu 2009; Schliephake et al. 2009)

Process	SCM practice	Description	Reference
		capabilities	
	Supplier continuity	"Trying to ensure that all suppliers in the chain, especially growers, not only can stay in business but stay in a manner that helps to ensure a reasonable quality of life for now and for their future" (see Transparency)	(Pagell and Wu 2009)
	Animal welfare	Ensuring that animals do not endure unnecessary suffering; guaranteeing proper handling, housing, transport and slaughter as an indicator of food safety and quality	(Maloni and Brown 2006)
Make	Cleaner technologies	Process innovation (technological and non-technological) to introduce important economic and environmental improvements	(Catarino et al. 2007)
	Best available techniques (BAT)	Aggregation of single and specific techniques for reduction of water and energy consumption, emission control, waste management, requiring management involvement to exploit their utility, simplicity, low cost and quick results	(Barros et al. 2009; Catarino et al. 2007)
	Product scheduling	Practices oriented to reducing consumption of water, energy, materials for cleaning of machines etc.	(Barros et al. 2009; Berlin et al. 2007)
	Hazard Analysis Critical Control Point (HACCP) plan	Automated control system to identify points of risk to reduce the probability of contamination and increase the hygienic and sanitary quality of food	(Sweet et al. 2010)
	Environmental labelling	Environmental certification of food products that includes private labels and producer brands that reinforce consumer trust towards sustainable products	(Banterle et al. 2013)
Deliver	Choice of transportation mode	Use of innovative and sustainable transport modes (e.g. inter-modality, multi-modality), consolidation practices, vendor-managed inventory and identification of best transport vector taking account of environmental performance	(McKinnon 2007; Van der Vorst et al. 2009)
	New shipping and delivery solutions	Implementing solutions such as multi-drop, multi-pick and cross-docking to rationalize distribution through integration of demand and offer Coordinating and simplifying logistical processes in the SC (e.g. coordinate lot sizes, consolidate goods flows, set new transportation units, reduce human interventions)	(McKinnon 2007; Van der Vorst et al. 2009)
	Vehicle routing	Identification of shorter routes for product transportation to minimize transportation costs and emissions	(McKinnon 2007)
Return	Packaging recovery (primary and secondary)	Recovery of primary (pallet) and secondary packaging at end of life; reverse logistics	(Creazza and Dallari 2007)
	Products and sub-products recovery	Recovery of waste, garbage and sub-products (e.g. gut); reverse logistics, closed-loop SC (i.e. waste used as input)	(Creazza and Dallari 2007; Pagell and Wu 2009)
Product development	Design for environment (DfE)	New packaging design, considering opportunity for disposal, reuse, or recycling at the end of life (analyzing the product life	(Bevilacqua et al. 2008; Garcia-Arca and Prado-

Process	SCM practice	Description	Reference
	(packaging)	cycle, emissions of harmful substances, use of energy etc.); in the food industry, combining life-cycle assessment (LCA) techniques and quality function deployment (QFD) multi-criteria matrices	Prado 2006)
	Safer and healthier product development	This includes green product innovation and green process innovation. The former involves working closely with suppliers to develop healthier products (e.g. free of preservatives, gluten and/or fat). Additionally, this practice entails process redesign to prevent pollution (e.g. use of smart packaging to maintain food quality better and longer; machinery change).	(Chiou et al. 2011; Hopper 1990)
Cross-process	Traceability	Identification of all the steps that each single product has passed through along the whole chain in order to know exactly where products are and which products might be withdrawn from the market in case of problems; "Internal practice of sharing information among chain members about materials and methods (toxins, use of child labour, type of solvents used and so on) to optimize noneconomic chain performance and minimize risks"	(Golan et al. 2004; Pagell and Wu 2009)
	Transparency	Transparency means that organizations demand information on the flow of money through their entire chain. The buying firm is demanding to know the profitability of every supplier in the chain, with the explicit goal of ensuring that chain members upstream make sufficient profits to do more than just subsist.	(Pagell and Wu 2009)
	Orientation to sustainability	Sustainability is considered part of the company mission, with high top-management involvement and shared across the organization. Measurement and reward systems are linked to sustainability. Stakeholders are actively engaged in order to benefit from their sustainability-related knowledge.	(Beske et al. 2014; Pagell and Wu 2009)
	Life cycle assessment (LCA)	"Inter-organizational effort used to measure the environmental impact of production" Includes the analysis of raw material extraction, production and transportation of food products impacts	(Beske et al. 2014; Peacock et al. 2011)
	Logistical integration	Involvement with suppliers and customers for planning and forecasting (e.g. sharing IT systems and infrastructure), so fostering information and knowledge sharing to positively influence sustainability	(Beske et al. 2014; Vachon and Mao 2008)
	Pressure group management	SC and company strategies for dealing with pressure groups (i.e. stakeholders who may have a destabilizing impact and can actually harm the company's reputation or performance)	(Beske et al. 2014)
	Community support	Support provided to local communities, including economic development, philanthropy, arts, educational support, job	(Maloni and Brown 2006)

Process	SCM practice	Description	Reference
		training, volunteering, literacy, health care, childcare	

Figures

Figure 1: Research framework

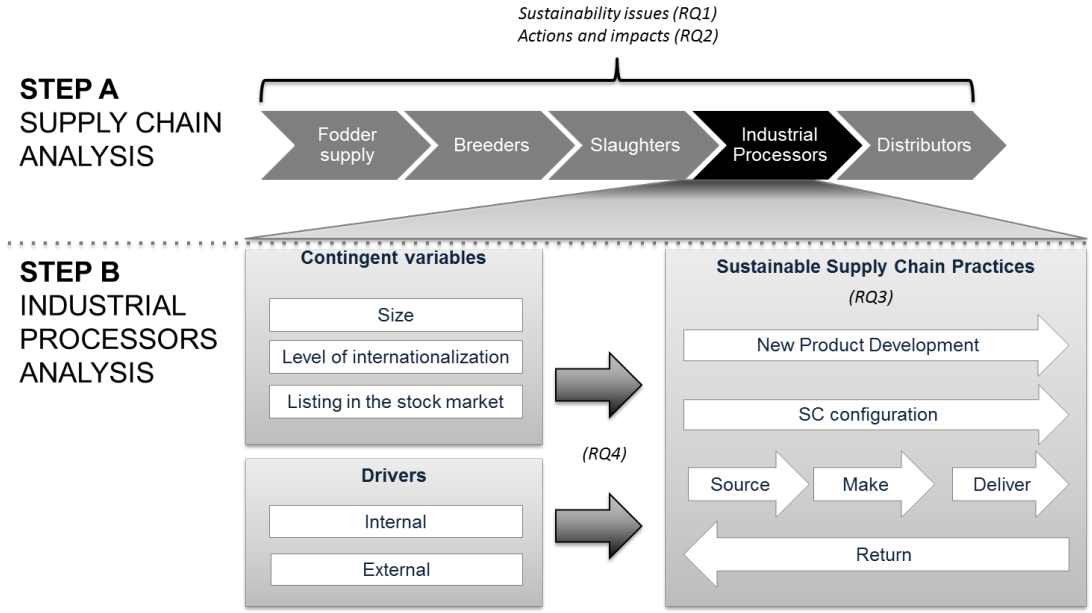


Figure 2: Sustainability critical points along the supply chain

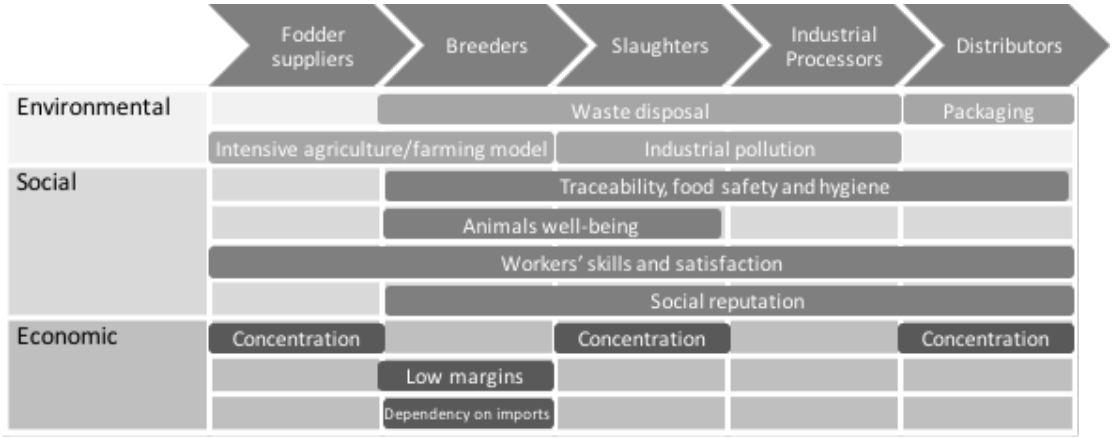
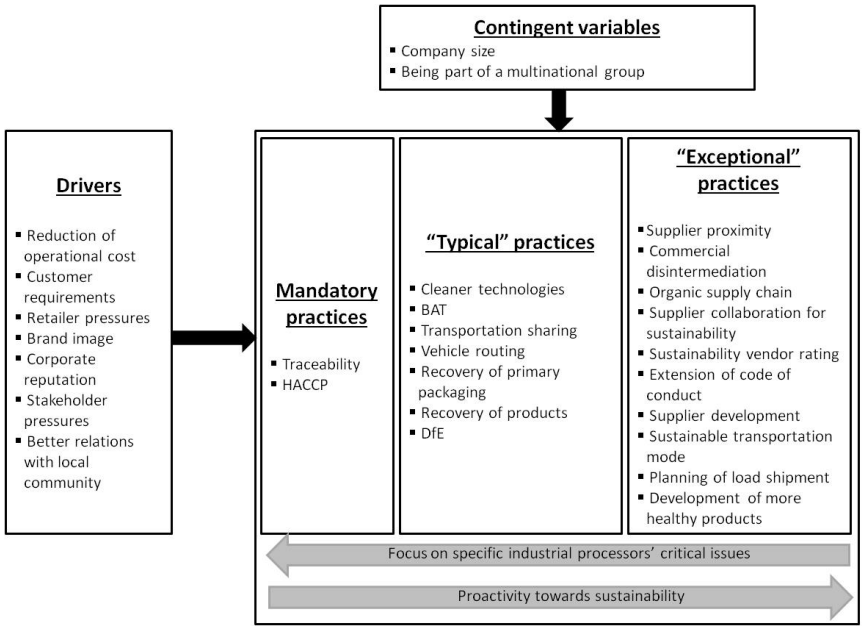


Figure 3: Industrial processors practices, drivers and contingent variables



Tables

Table 1: Characteristics and phases covered by companies of the first sample (black: core activity; dark grey: non-core activities). For case G and H it was not possible to identify one activity more important than the others. (F: Fodder Suppliers, B: Breeders; S: Slaughters; I: Industrial Processors; D: Distributors)

Case	Brief description	Revenue (million of euros)	Number of employees	Main Product	Stage				
					F	B	S	I	D
A	Wholesaler of a broad range of agricultural products	8	35	Fresh meat and cold cuts					
B	Medium enterprise, highly vertically integrated	13	50	Fresh meat					
C	Large national retailer	6,000	19,000	Consumer products					
D	Small breeding company	< 1	<15	Live cattle					
E	Medium company. Slaughtering represents the core business	2	<15	Halves and beef production					
F	Medium company, they cut and distribute meat and other agricultural products	3	<15	Fresh meat and cold cuts					
G	Family business highly vertically integrated. They directly sell the products to the final market	< 1	<15	Fresh meat and cold cuts					
H	Large slaughterhouse that performs also processing and packaging activities	1,142	2,325	Halves and cold cuts					

Table 2: Characteristics of the second sample

Case	Brief description	Revenue (million of euros)	Number of employees	Main products
H	Same as Table 1 – Case H			
I	Large company, part of a bigger group	701	1.010	Luncheon meat
L	Large company, focus on the cold cuts. They control the logistics as well	356	909	Cold cuts
M	Medium company, focus on the cold cuts with a special attention to traditional Italian products	130	301	Cold cuts
N	Family company that controls both breeding and production of the products. Strong attention towards typical Italian products.	15	57	Cold cuts

Table 3: Reactions to critical issues along the supply chain (Stage: F: Fodder Suppliers, B: Breeders; S: Slaughters; I: Industrial Processors; D: Distributors)

Critical issue	SC Stage F	B	S	I	D	Case	Action	Internal Impact (at the company)	Upstream impact	Downstream impact
Environmental issues										
Waste Disposal (including packaging)		■				D, G	- Use of sewage for owned fields	- Land and terrain conservation; Higher quality fodder; Reduction in disposal costs	- Independency from fodder suppliers	- Higher meat quality
			■	■		A, B, C, E, F, G, H	- Outsourcing of waste disposal	- Focus on the core activities, lower contamination risk		
			■			H	- Biomass energy production	- Reduction in disposal and energy costs		
					■	A,B, C	- Recovery of primary and secondary packaging	- Reduction of environmental hazard - Cost reduction (reduce and recycling)		
Intensive agricultural/ farming model and industrial pollution	■					B, D, G	- Following agricultural Best Practice (e.g., crop rotation)	- Land and terrain conservation - Higher quality and control of the fodder		- Higher meat quality
				■		H, F	- Adoption of BAT and clean production technologies	- Higher safety and worker satisfaction - Higher costs		
Social issues										
Traceability, food safety and hygiene		■	■	■		All firms involved	- Follow HACCP and specific regulations; Adoption of tracking systems	- Workers and animals well being - Higher costs	- Supply market reduction	- Higher meat quality, food safety; More information to consumers
				■		All firms involved	- Refrigeration, conservation in vacuum or modified atmosphere.	- Guarantee product safety		- Constraints on transportations
Animals well-being		■				B	- More space, rotation of animals in the boxes; High-quality or self-produced fodder	- Increase of animal well-being, quality of the meat - Higher costs		- Higher meat quality - Reduction of veterinary costs - Higher social reputation
			■			H	- Follow specific regulations; - Development of specific analyses and processes to minimize stress	- Workers' satisfaction and animals well being - Higher costs		- Higher meat quality - Higher social reputation
Workers' skills and satisfaction				■		E	- Keep traditional cutting practices; Invest in training	- Higher quality - Higher costs		- Higher meat quality
	■					B, D, G	- Keep a good working environment	- Higher productivity, lower turnover		- Higher social reputation
Social reputation			■	■		H, C	- Reduction of the supply base and control on suppliers	- Reduce risk of reputational damage due to suppliers' misbehavior	- Reduction of margins	- Higher meat quality

Economic issues						
Low margins		D, B, G	- Self-production of fodder; horizontal collaboration (among breeders)	- Cost reduction, reach economies of scale through collaboration		
		E	- Quality differentiation	- Higher margins		- Higher meat quality
		E	- Direct sales	- Higher margins		- Increased competition
Dependency on imports		B, G	- Breeding of owned calves	- Higher margins, quality and independency		- Higher meat quality

Table 4: Sustainable supply chain practices of industrial processors

*(*environmental;°social;^economic)*

	H	**I**	**L**	**M**	**N**
SC Configuration			- Supplier proximity*° - Organic supply chain* - Supplier collaboration*°		- Supplier proximity*° - Commercial disintermediation^ - Organic supply chain*
Source	- Sustainability vendor rating*° - Extension of code of conduct*° - Supplier development*°^	- Sustainability vendor rating*° - Extension of code of conduct*° - Supplier development*°^	- Sustainability vendor rating*° - Extension of code of conduct*°	- Extension of code of conduct*°	
Make	- BAT and cleaner technologies (reuse of internal water; reuse of sewage disposal)*^ - HACCP°	- BAT and cleaner technologies (reuse of water coolant; class A engines)*^ - HACCP°	- BAT and cleaner technologies (electrical engines; combined heat and power plant; recover of defrost water)*^ - HACCP°	- BAT and cleaner technologies (reuse of water from refrigerator; use of gas fuel in spite of liquid one)*^ - HACCP°	- BAT and cleaner technologies (electrical engines; machine drycleaning)*^ - HACCP°
Deliver	- Transportation sharing *^ - Vehicle routing*^	- Transportation sharing *^ - Vehicle routing*^	- Transportation sharing *^ - Vehicle routing*^ - Planning of load and shipment*^ - Choice of transportation mode*^	- Transportation sharing*^ - Vehicle routing*^	- Transportation sharing*^ - Vehicle routing*^ -
Return	- Recovery of primary and secondary packaging*^ - Product and subproduct recovery°	- Recovery of primary and secondary packaging*^ - Product and subproduct recovery°	- Recovery of primary and secondary packaging*^ - Product and subproduct recovery°	- Recovery of primary and secondary packaging*^ - Product and subproduct recovery°	- Recovery of primary and secondary packaging*^ - Product and subproduct recovery°
Product development	- Development of more healthy products° - DfE*	- DfE*	- Development of more healthy products° - DfE*	- DfE*	- Development of more healthy products° - DfE*
Cross-process	- Traceability°^	- Traceability°^	- Traceability°^	- Traceability°^	- Traceability°^

BAT=Best Available Technique; HACCP=Hazard Analysis and Critical Control Points; DfE=Design for Environment

Table 5: Groups of supply chain practices

Group	Practices
Not relevant for meat supply chain	- Fair trade - Product scheduling
Group 1 – mandatory	- Traceability - HACCP plan
Group 2 – "typical" of industrial processors	- Cleaner technologies - BAT - Transportation sharing - Vehicle routing - Recovery of primary packaging - Recovery of organic products and sub-products - DfE
Group 3 – "exceptional" practices	- Supplier proximity - Commercial disintermediation - Organic supply chain - Supplier collaboration for sustainability - Sustainability vendor rating - Extension of code of conduct - Supplier development - Sustainable transportation mode - Planning of load and shipment - Development of more healthy products

Table 6: Drivers and contingent variables for the adoption of "exceptional" practices in the considered cases

			Cases				
			H	**I**	**L**	**M**	**N**
Drivers							
Group	**Sub-group**	**Driver**					
Internal drivers	Cost	Reduction of operational costs	v	v	v	v	
	Company's values	Values of the company/founder			v		v
		Employee welfare		v	v		
External drivers	Regulation	Compliance with current regulation				v	
		Proactive behavior for future regulations				v	
	Market	Customer requirements					v
		Retailer pressure	v	v	v	v	
		Brand image and corporate reputation			v	v	v
	Society and community	Stakeholder pressures		v	v	v	
		Better relations with local community	v	v	v		
Contingent Factors							
Company Size: big (more than 500 employees)			v	v	v		
Part of a multinational group			v	v	v		
More than 50% of distribution of the product abroad			v	v			v
Listing on the stock market			v	v			

Table 7: Link between sustainable practices and critical issues

Group of practices	Industrial processor practices	Industrial processors' critical issues					Other stages' critical issues			
		Waste Disposal	Industrial pollution	Traceability, food safety and hygiene	Workers' skills and satisfaction	Social reputation	Intensive agricultural/ farming model	Animals well-being	Low margins	Dependency on imports
1. Mandatory	Hazard Analysis Critical Control Point (HACCP) plan			V						
	Traceability			V				V		
2. Typical	Cleaner technologies	V	V				V			
	Best Available Techniques (BAT)	V	V				V			
	Vehicle routing		V							
	Packaging recovery (primary and secondary)	V								
	Products and sub-products recovery	V								
	Design for environment (for packaging) (DfE)	V	V	V						
3. Exceptional	Supplier proximity		V	V					V	
	Commercial disintermediation		V						V	V
	Organic supply chain						V	V		
	Supplier collaboration					V	V		V	
	Sustainability vendor rating. Supplier selection			V	V	V	V	V	V	
	Code of conduct implementation	V	V	V	V	V	V	V	V	
	Supplier development				V	V	V	V		
	Choice of transportation mode		V							
	New shipping and delivering solutions		V		V					
	Safer and healthier product development	V	V	V	V		V			