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Unpacking Proximity for Sustainability in Short Food Supply Chains

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ABSTRACT

Short food supply chains (SFSCs) have been frequently named as sustainable alternatives to global chains, associated with the concept of *local chain*, and emphasizing the role of *geographical proximity* for achieving sustainability. However, it is also recognized that geographical proximity is not enough to build SFSCs and create a sustainable impact. A multi-dimensional approach identifies three types of proximity: *geographical, relational, and informational proximity* to define SFSCs. Hence, the aim of this study is to extend that body of literature by investigating the role of relational and informational proximities in SFSCs. We analyze a set of 23 companies in four food industry sectors in Italy to characterize the practices implemented to build proximity, upstream and downstream, in their supply chains. Our findings reveal a combination of different practices along the three proximity dimensions that define SFSCs. These results allow also to underline how specific practices for relational and information proximity are paramount for attaining sustainability objectives in SFSCs.

1 | Introduction

The food industry is dominated by global supply chains of processed foods (Engelseth 2016). These types of supply chains are often perceived as unsustainable due to their long traveling distances and associated environmental impacts (D'Amico et al. 2014), as well as questionable working and living conditions for laborers (Yacamán- Ochoa, Matarán, and Mata Olmo 2019). Global food supply chains contribute significantly to greenhouse gas emissions, resource depletion, and waste generation (Garnett 2011). Furthermore, labor issues and socioeconomic disparities are exacerbated by these extended networks (Kjellström et al. 2019).

Modern consumers are increasingly demanding high quality, healthy food products (D'Amico et al. 2014) and are also willing to recognize higher value in products purchased "from the source" (Todorovic, Maslaric, and Bojic 2018). Additionally, they seek information about provenance and sustainability practices adopted by producers (González-Azcárate, Maceín, and Bardají 2021). This shift in consumer behavior underscores the need for more sustainable food supply chains.

In response to these consumer demands and the need for sustainability, Short Food Supply Chains (SFSCs) emerge as alternative configurations (Renting, Marsden, and Banks 2003) that contrast global food supply chains not only referring

to geographical distance but also in terms of sustainability impact. According to the European Regulation 1305/2013 (Commission 2013), SFSCs are intended to be production models built for sustainability. On one side, SFSCs are indeed characterized by shorter geographic distances (Engelseth 2016), but also by fewer intermediaries and stronger relationships between producers and consumers (Todorovic, Maslaric, and Bojic 2018). These supply chain typologies emphasize their role of "alternative" to global – and often unsustainable – chains, focusing on local and high-quality products and enabling producers to reach consumers in an easier and direct manner. However, it is not always clear how they build their 'shortness' beyond mere distance and whether these stronger relationships are structured with sustainability objectives in mind.

Not all food supply chains can be short or local to achieve sustainability, as certain products must be transported globally to meet consumer demand. For instance, products like coffee, cocoa, and certain fruits and vegetables are grown in specific regions and require global distribution to reach consumers. Therefore, the concepts of "shortness" and geographical distance in these cases appear to be contradictory. To address this, other ways to "shorten" global supply chains are sought. For instance, food supply chains are becoming more proactive in bridging the challenges of large geographical distances through information sharing tools such as certification labels (Renting, Marsden, and Banks 2003), and traceability alternatives built on technology (Ersoy et al. 2022). Technological innovations, such as blockchain and advanced tracking systems, enhance traceability and transparency in global supply chains. These advancements facilitate information sharing, boost consumer trust, and support sustainability efforts (Jraisat et al. 2022). These tools allow global supply chains to build *information proximity* (Higgins, Dibden, and Cocklin 2008), aiming to either complement or compensate for low geographical proximity.

Previous literature identifies another dimension of proximity, as mentioned above, which implies tighter connections among actors. This type of proximity is usually labeled as *relational proximity*, and it refers to reducing the number of intermediaries between producers and consumers (Bos and Owen 2016), and establishing closer and cooperative relationships (Sharfman, Shaft, and Anex 2009) that can complement or compensate for low geographical proximity. Developing these relationships involves various practices where different actors work together more closely. For instance, Jraisat et al. (2021) define collaborative mechanisms such as joint planning and coordinated logistics as essential in creating synergies between supply chain partners, enhancing overall performance and sustainability. These mechanisms help in aligning objectives and sharing resources effectively. In another context, Upadhyay (2020) highlights the importance of cooperative agreements in developing economies, emphasizing that these practices enable resource optimization, and the integration of environmentally friendly practices throughout the supply chain.

Therefore, to define SFSCs beyond geographical location and distance, previous studies argue the need to include these three different dimensions of proximity: geographical, relational, and informational (e.g. Renting, Marsden, and Banks 2003; Caniato and Luzzini 2012). However, a clear operationalization of these theoretical dimensions is currently missing. This lack of clarity hinders companies in the food supply chain from fully understanding and applying these concepts to build SFSCs, particularly when sustainability objectives are in place.

First, previous literature argues that geographical proximity may not automatically guarantee a lower environmental impact of transportation, since this depends on a number of factors, such as the transportation mode adopted, the travelling frequency, the way transportation is planned and organized, and because low volume and local scale might not favor sustainability either (Malak-Rawlikowska et al. 2019; González-Azcárate, Maceín, and Bardají 2021). In contrast, global food chains are traditionally much more efficient when it comes to transportation and logistics thanks to the assets and facilities they count on, and the volumes they move around (González-Azcárate, Maceín, and Bardají 2021). Second, the contribution of SFSCs to the social impact through rural development might not be automatically linked to proximity but could be a result of several other factors such as culture and tradition, institutional factors, community-oriented practices, company mission among others (González-Azcárate, Maceín, and Bardají 2021; León-Bravo and Jaramillo-Villacrés 2021). Third, information sharing and transparency in food supply chains is not determined by distance, whether long or short, but can help enhancing factors such as food quality, safety, and sustainability along the supply chain. For example, León-Bravo, Ciccullo, and Caniato (2022) illustrate that various actors in the coffee supply chain can implement different types of traceability systems for monitoring their products and collecting, tracking, and sharing data. These systems can vary significantly in terms of integration and technology used. The choice and application of these traceability systems can have a substantial impact on the sustainability practices of these companies (Norton et al. 2014).

In account of the previous observations, these two additional types of proximity, i.e., informational, and relational, even if recognized in previous literature, still need to be unpacked for deeper understanding and actionability into specific practices upon which sustainability synergies could be levered. Therefore, this study aims to investigate how relational and informational proximity dimensions can be implemented to help build SFSCs with sustainability goals in mind. The research question we aim to address in this study is: *How can relational and informational proximity be implemented to build short food supply chains with sustainability goals?*

Given the heterogeneity in the food industry, our research aims at covering varied industry sectors, i.e., cold cuts (cured meat), dairy products, fruits and vegetables, and, oil which are among the most critical in terms of sustainability as well (Cannas et al. 2020; Golini, Moretto, and Caniato 2017). We conducted our research in Italy, through multiple case studies. Results from our analysis provide a more comprehensive operationalization of the two additional proximity dimensions that companies in food industry can apply to build or strengthen SFSCs to reach sustainability.

In the following sections, we will present the conceptual background and research framework. Next, we will describe the

methodology and discuss our findings. Finally, we will conclude by presenting the theoretical and managerial implications of our work.

2 | Conceptual Background

2.1 | The Notion of Proximity in Short Food Supply Chains

A state-of-the-art literature review is conducted to identify the main definitions of proximity in food supply chains. Short Food Supply Chains (SFSCs) are often presented as one typology of Alternative Food Networks (Kumar, Wang, and Kumari 2019) contrasting with global food chains (Engelseth 2016; Kumar, Wang, and Kumari 2019) and that stems from the concept of locality (Ilbery and Maye 2006). They are characterized by new relations of time and space (Renting, Marsden, and Banks 2003). Hence, SFSCs, as alternative networks, are built on three key ideas. First, they aim to reconnect producers and consumers (Whatmore, Stassart, and Renting 2003; Hergesheimer and Wittman 2012; Sacchi, Cei, and Stefani 2018). Second, they emphasize transparency, enabling value-laden information to flow along the chain to reach consumers (Marsden, Banks, and Bristow 2000; Whatmore, Stassart, and Renting 2003; Hergesheimer and Wittman 2012). Third, they support local and rural development (Renting, Marsden, and Banks 2003; Forssell and Lankoski 2014), addressing urbanization, rural restructuring (Jarosz 2008), and economic diversification needs (Marino, Mastronardi, and Giannelli 2018; Mastronardi, Marino, and Giaccio 2019).

Scholars developed different models to classify SFSCs according to the concept of proximity. The first fundamental model is presented by Renting, Marsden, and Banks (2003), in which three typologies of SFSCs are identified: face-to-face SFSCs, when there is direct interaction between producer and consumer; proximate SFSCs, where spatial proximity decreases being supported by stronger institutional arrangements, as in the case of cooperatives or Community Supported Agriculture (CSA); extended SFSC, where the connection between producers and consumers is enabled by the value-laden information embedded with the product, differentiating it from other anonymous commodities. In this model, organizational processes and arrangements are inversely proportional to spatial proximity, i.e., as physical proximity decreases, organizational arrangements substitute spatial proximity (Dubois 2018; Renting, Marsden, and Banks 2003).

Alternatively, in the model proposed by Aubry and Kebir (2013), geographical and organized proximity are combined to identify four typologies of food supply chains. First, when both geographical and organized proximity are weak, is the conventional long supply chains. Second, SFSCs with indirect relations refer to local supply of products, mediated by an intermediary, thus having strong geographical proximity and weak organized proximity. Third, SFSC with distant relations does not imply the co-localization of producers and consumers, but they share values and confidence through information (strong organized proximity, weak geographical proximity). Lastly, the ones having both strong geographical and organized proximity, which entails the full meaning of a SFSC according to those authors.

A more recent model is proposed by Malak-Rawlikowska et al. (2019), in which organized proximity includes, first, organizational proximity as the number of intermediaries in the chain and, second, social proximity, based on mutual trust and transfer of information. In a similar approach, Forssell and Lankoski (2014) recognized three dimensions of distance: physical distance, value chain distance (number of intermediaries) and informational distance (availability of information about food and place and method of production). These last two models consider all the relevant dimensions of proximity, giving information a primary role, without considering them as competing dimensions.

The above-mentioned models in previous literature have indeed argued how distance and proximity can be explained with different dimensions; however, how these proximity dimensions are actually implemented in food supply chains is not yet addressed in literature, especially when actors in the chain aim at sustainability as well. Thus, there is the need to unpack the operationalization of the proximity dimensions in such a way that actors in the food supply chain could apply them to build a SFSC with sustainability purposes in mind.

Table 1 provides a detailed summary of the various dimensions of proximity as defined in previous literature, highlighting key aspects and their implications for food supply chains.

2.2 | Sustainability and Proximity in (Short) Food Supply Chains

The European Regulation 1305/2013 (European Commission 2013) defines SFSCs as a production model that is able to achieve economic, environmental and social benefits. The interplay of different contrasting or synergistic effects between and within the different sustainability dimensions is a predominant discussion in literature and policy making referring to SFSCs.

On the economic dimension, the value that SFSCs generate can represent an important recognition in the market and in particular, a larger share of this value is expected to be captured by producers. Such positive effect on producers can be attributed to having better control and greater independence on price setting and on demand management, thanks to direct selling (Yacamán- Ochoa, Matarán, and Mata Olmo 2019). Moreover, the value of reduced information asymmetry, and thus a higher *information proximity* along the food supply chain, is positively perceived by consumers, leading to higher satisfaction from the shopping experience compared to conventional food chains (Luzzini, Golini, and Crippa 2013; Carbone 2017). This value perception means also that food products from SFSCs are generally considered of a higher quality and frequently associated with a premium price (Malak-Rawlikowska et al. 2019; Sellitto, Vial, and Viegas 2018).

The environmental impact of SFSCs, and in particular, the role of *geographical proximity*, is highly debated in literature. On the one hand, SFSCs are often linked to the adoption of environmentally sound practices, such as small-scale production that is considered to be more energy-efficient than industrial agriculture (Woodhouse 2010). Nonetheless, evidence in support of the

TABLE 1 | Proximity dimensions in literature.

Dimension	Definition	Measures
Geographical proximity	Shorter geographic distance (Engelseth 2016)	• Geographic kilometric distance of actors determining supply and distribution flows (Torre and Rallet 2005)
Relational proximity	Closer relationships with supply chain partners based on disintermediation and integration (Aubry and Kebir 2013; Torre and Rallet 2005)	• Number of tiers between the processor and farmers (upstream)/consumers (downstream) (Bos and Owen 2016; Malak-Rawlikowska et al. 2019; Mastronardi, Marino, and Giaccio 2019) • Intensity of the relationship between customers and suppliers (i.e., type of contractual agreements) (Edelmann, Quiñones-Ruiz, and Penker 2019; Fischer et al. 2009) • Degree of vertical integration (Aubry and Kebir 2013) Upstream (farming) Downstream (distribution and/or retail)
Information proximity	Information that is embedded into a single product and that reaches the consumers (Renting, Marsden, and Banks 2003; Marsden, Banks, and Bristow 2000; Whatmore, Stassart, and Renting 2003) as well as other supply chain stakeholders (Wognum, Bremmers, and Trienekens 2011)	• Type of information traced upstream and downstream (Caniato and Luzzini 2012) • Tools adopted for traceability (Astill, Dara, and Campbell 2019) • Degree of visibility Information depth (i.e., how far upstream and downstream the information is traced) (Folinas, Manikas, and Manos 2006; McEntire et al. 2010) Information breadth (i.e. the amount and granularity of traced information) (Opara 2003; McEntire et al. 2010)

reduced environmental impact is scarce in literature (Kneafsey, Venn, and Schmutz 2013; Sellitto, Vial, and Viegas 2018). On the contrary, Van Hauwermeiren et al. (2007), in their work on a life cycle-based impact of local food product, showed that local food systems have slightly higher energy consumption and carbon emissions with respect to traditional food systems, in conditions of full summer and inland production. Another controversial aspect is the impact of transportation activities. A main argument against environmental sustainability in SFSCSs consists in the management of small volumes with frequent deliveries (Malak-Rawlikowska et al. 2019) that in turn can increase pollution. In the fresh products supply chains, as the dairy supply chain, inefficient logistics and packaging plays a major role in determining the detrimental environmental impact of SFSCs (Sonesson and Berlin 2003).

Finally, on the social sustainability dimension there is larger consensus of the positive impact of SFSCs, specifically regarding the concept of *relational proximity*. Ethical aspects are critical success factors associated with a closer relationship between producers and consumers (Sellitto, Vial, and Viegas 2018) in more collaborative models along the supply chain (Sharfman, Shaft, and Anex 2009). Jraisat et al. (2021) emphasize the importance of collaboration mechanisms in sustainable supply chains. Their research illustrates how collaboration among supply chain actors can improve relational proximity, leading to improved sustainability outcomes. Additionally, SFSCs foster social inclusion and fairness among supply chain actors, reconnecting with the rural areas, thus favoring local and rural development (Forssell and Lankoski 2014; Lanfranchi and Giannetto 2015; Renting, Marsden, and Banks 2003; González-Azcárate, Maceín, and Bardají 2021).

If SFSCs are expected to address sustainability in all the triple bottom line dimensions, the specifics on how building "shortness" when there is low geographical proximity while keeping the sustainability objectives in mind is still a topic of debate in the academic and management spheres. Hence, there is the need to better identify actionable practices to build relationships and information proximity that companies in the food supply chain could apply when setting up sustainable SFSCs.

3 | Research Framework

The multiple facets connected to the notion of proximity in food supply chains are still unexplored in theoretical and empirical terms. An effort devoted to analyzing the relational and information proximity would help to better understand how to build SFSCs and their implications connected to sustainable development.

For the aims of this study, the concepts of proximity in its three dimensions are initially derived from literature and will be adopted for the empirical part of the research. Therefore, first, geographical proximity is described by the spatial distance between actors along the supply chain (Torre and Rallet 2005). However, distance is a relative measure: morphological characteristics of the space under consideration and the availability of transport infrastructure should also be considered (Torre 2011), since they enable the potential of being geographically close to be effectively exploited. Distance refers to the spatial and physical separation between the focal company and its nearest upstream and downstream actors. To operationalize this construct, we consider distances of less than

100 km and greater than 100 km, based on Regulation (EU) No 807/2014, which defines SFSCs as food systems where foods are produced, processed, and sold within a defined geographical area, typically within a 20 to 100 km radius (European Parliamentary Research Service 2016).

Second, informational proximity is presented as the embeddedness of information in the product that reaches the consumer (Marsden, Banks, and Bristow 2000). It is strongly related to the notion of transparency, as the "shared understanding of and access to product-related information" by supply chain's stakeholders (Wognum, Bremmers, and Trienekens 2011, p. 65) and information sharing that makes the information available (Kiil, Hvolby, and Trienekens 2019). Informational proximity is also connected to the notion of traceability for sustainability, which Garcia-Torres et al. (2019) present as a comprehensive concept involving information sharing, visibility and accessibility for the supply chain actors. Traceability plays a crucial role, as it enables the tracking and tracing of products and their history (Garcia-Torres et al. 2019), monitoring environmental and social practices among food supply chain partners (Ersoy et al. 2022) and thus, increasing proximity between actors for sustainability purposes.

Innovative technological tools enhance supply chain sustainability by improving transparency and traceability, essential for trust and efficient information sharing. Jraisat et al. (2022) show that blockchain technology supports sustainability in reverse supply chain networks by enabling real-time access to product details, such as origin and production methods. This transparency helps reduce informational distance and strengthen both informational and relational proximity by also promoting trust among supply chain partners.

In agri-food systems, the characteristics defining traceability systems are valuable for unpacking informational proximity. This concept is closely tied to the level of detail and specificity of information shared throughout the food supply chain. Such clarity is essential for effectively assessing and managing sustainability information, and thereby influencing potential sustainability impacts. Hence, informational proximity can be defined through three key elements: (i) breadth, which concerns the amount and type of information exchanged; (ii) depth, which indicates the extent to which the system can trace information upstream or downstream; and (iii) tools, where the type of tools used can affect the accuracy and reliability of the information collected and shared (McEntire et al. 2010). These elements contribute to defining the level of detail and specificity of information shared throughout the supply chain. In practice, the level of detail can vary significantly, ranging from general information dissemination to specific details about individual products.

Third, relational proximity represents the actors' ability to interact (Torre and Rallet 2005) and the ways they have to be close to each other, disregarding the level of geographical proximity (Torre 2011). Usually, this feature combines the concepts of disintermediation and vertical integration along the chain (Aubry and Kebir 2013), thus relational proximity is mainly defined by the number of intermediaries along the chain (Bos and Owen 2016; Malak-Rawlikowska et al. 2019; Mastronardi, Marino, and Giaccio 2019). However, it is not only the number of tiers that plays a role, but also the intensity of these relationships. The intensity of relationships is related to the type of inter-organizational arrangements established between actors, serving as an indicator of the robustness of their connections. Drawing on Edelmann, Quiñones-Ruiz, and Penker (2019) and Fischer et al. (2009), four possible inter-organizational agreements are identified based on the type of organizational agreements and the duration of trade relations: (i) spot contracts, where transactions are completed without a permanent and lasting relationship between the actors; (ii) relational contracts, where actors engage in repeated transactions based on trust and reputation, leading to enduring but informal relationships; (iii) formal contracts, where relationships are explicit and formalized, varying in completeness depending on the variables and time horizon covered; and (iv) integration, where the company is vertically integrated, either in the upstream area of production or in the downstream area of distribution to the end consumer.

Another element crucial to achieving relational proximity is the implementation of practices that foster robust relationships within the supply chain. Three main practices are identified: (i) training and learning activities, which involve direct interactions between processing companies and producers to build stronger relationships; (ii) benefit and risk sharing, which addresses the vulnerabilities of smaller actors, particularly small producers, by implementing agreements to mitigate economic and environmental risks and bridge gaps between upstream and downstream actors; and (iii) fair price settings, which involve negotiating fair prices through balanced arrangements, ensuring fair compensation and reducing power imbalances in a market often dominated by large food retailers (Edelmann, Quiñones-Ruiz, and Penker 2019). These practices are not only expected to enhance relational proximity but are also recognized to have significant sustainability implications.

Then, once the proximity dimensions are operationalized upstream and downstream in the chain, the sustainability implications will be identified as well. The graphical representation of the research framework is depicted in Figure 1.

4 | Research Methodology

This study adopts a multiple case study approach to investigate the three dimensions of proximity for building SFSCs with sustainable impact. We apply this qualitative research method for addressing a contemporary issue that has not been yet explained in detail (Barratt, Choi, and Li 2011; Yin 2014) with theory building purposes (Voss, Tsikriktsis, and Frohlich 2002). Given the heterogeneity in the industry and the multifaceted research problem that aims at investigating the three dimensions of proximity along three dimensions of sustainability, upstream and downstream in the supply chain, the qualitative research methodology applied in this study becomes the most appropriate approach for grasping the complexity of these issues (Gummesson 2006; Yin 2014). As Gummesson (2006) notes, qualitative research is ideal for dealing with complexity and context, capturing nuances that quantitative methods might miss. Moreover, according to the literature, a specific qualitative method — multiple case studies — helps capture intangible factors and the intricate nature of managerial processes (Gummesson 2006; Massaro,

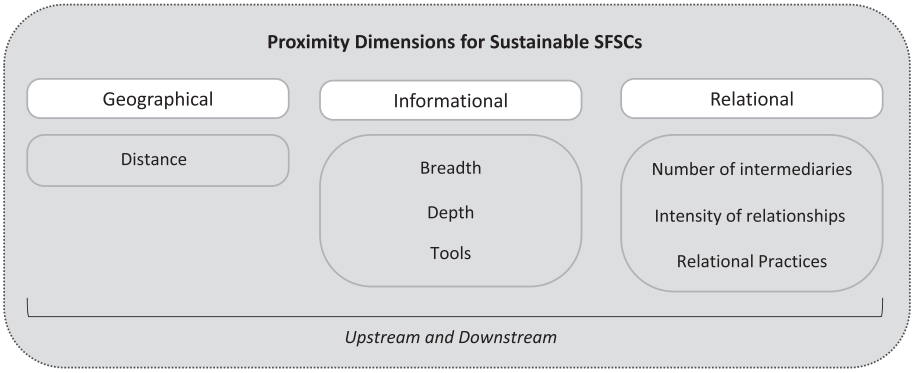

FIGURE 1 | Research framework.

Dumay, and Bagnoli 2019). Thus, the multiple case study methodology allowed us to investigate the variety of applications in the industry along with the differences and similarities among various industry sectors (Hancock and Algozzine 2017). By examining multiple cases, we can draw more robust conclusions and develop a nuanced understanding of the factors influencing sustainability in different contexts. This methodology is particularly suited for exploring new or poorly understood phenomena, as it enables an in-depth, context-rich analysis that can reveal insights not accessible through other research methods (Yin 2014; Creswell and Poth 2016).

4.1 | Case Selection

This study includes four food sectors in Italy, cold cuts (meat), dairy, fruits and vegetables, and oil given their relevance in the country in terms of production volumes and income, and also to have a wider view on the food industry heterogeneity by including animal origin and vegetal origin product sectors.

Italy is one of the main PDO (protected designation of origin) and PGI (protected geographical indication) producer countries with 63 cheese types, 44 meat derivates, 130 fresh fruits and vegetables, and 53 oils and fats.[1] This type of products requires breeding, growing, and processing in specific geographical areas; hence, companies are usually located close to the breeding or growing sites. Hence, this aspect is one of the sampling criteria in this study, thus including processors of PDO and PGI products, in closer geographical proximity with the upstream supply chain, i.e. breeders and slaughterhouses, usually establishing tight relationships with them (e.g., own farms, cooperatives, exclusivity contracts). Other companies instead have adopted other types of certifications (e.g., organic) for which there is the need to demonstrate the adherence to the adoption of specific sustainability standards. Hence, they are companies that very likely would assign importance to the direct control (also through geographical closeness) of their upstream supply chain, focusing also on building trustful relationship with supply chain actors and which are committed in demonstrating sustainability through transparency.

Additionally, companies were selected based on their interest on sustainability issues with strategies implemented in terms of animal welfare, product quality, attention to nutrition, and reduction of contamination. Furthermore, companies selected are varied in terms of size, location, years of creation, and type of operations performed in the supply chain.

This way, the study considers a set of 21 companies that represent 23 units of analysis, i.e., product lines with different supply chain configurations, and this way Cases L, M and N belong to a single company. Table 2 presents a comprehensive summary of the companies involved in the study, providing insights into their operations and characteristics. The information covered includes the industry sector each company belongs to, the main product line they offer, their specific supply chain activities (such as production or distribution), and key demographic details like company size and years of operation. Together, these details present a well-rounded picture of the companies.

4.2 | Data Collection and Analysis

Multiple sources of evidence compose the data in this study. Information from the companies was collected mainly via semi-structured interviews with the representatives of the companies who had knowledge of supply chain configuration and sustainability strategies. Interviews were conducted in two rounds, by two or three researchers, recorded and transcribed. The first round involved the animal origin products (i.e., cold cuts and dairy), the second round was focused on the plant origin products (i.e., fruits and vegetables and oil). In addition, data information from secondary sources such as sustainability reports, when available, news articles, and company presentations was gathered.

Table 3 presents the data collection specifics, including interviewees, duration, and number of interviews per company. It is relevant to mention that food industry in Italy is fragmented, composed by many small and medium companies, thus, in most cases, a single respondent was identified as the responsible person for sustainability matters and/or supply chain strategies in the company. The interviewee role could range from the CEO, company owner, marketing or operations manager, quality manager, product development manager, etc.

While relying on a single respondent per company may introduce some bias due to the heterogeneity of respondents in other cases, this approach was necessary given the industry structure. To mitigate and reduce potential biases, we triangulated the information gathered in the interviews with publicly available

TABLE 2 | Set of cases analyzed in this study.

Cases	Industry sector	Funded in	Staff	Sales 2020 (M€)	Supply chain activities	Main product line
A	Cold cuts	1975	91	48	Breed, slaughter & process	Cold cuts (certified & non)
B	Cold cuts	1930	143	55	Farm, breed, process & age	Cold cuts (certified & non)
C	Cold cuts	1962	500	290	Cooperative, farm, slaughter, process & condition	Cold cuts (certified & non)
D	Cold cuts	1911	700	122	Slaughter & process	Cold cuts (regular)
E	Cold cuts	1985	400	176	Cooperative, farm, slaughter & process	Cold cuts (certified & non)
F	Cold cuts	1812	2.600	989	Process	Cold cuts (certified & non)
G	Dairy	1952	Avg 150	60	Process	Cheese
H	Dairy	1900	650	411	Cooperative, Farm & process	Dairy product & certified cheese
I	Dairy	1994	140	32	Process	Buffalo milk & cheese (certified)
J	Dairy	1900	480	502	Process & age	Cheese (certified & non), & butter
K	Dairy	1975	150	35	Process	Cheese (certified & non)
L	Dairy	1954	700	222	Farm, process & condition	Cheese (certified & non), & butter
M					Process & age	
N					Process	
O	Fruits &vegetables	1966	2.767	872	Process	Fruits &vegetables
P	Vegetables	1853	14.700	2.779	Process	Frozen vegetables
Q	Vegetables	1990	150	30	Cooperative, produce & process	Packaged salad bags
R	Fruits	1940	1.500	1.040	Process	Ready to eat fruits
S	Fruit & vegetables	1967	2.100	290	Cooperative, produce & process	Frozen vegetables
T	Oil	1946	150	265	Process	Olive oil
U	Oil	1983	250	818	Process	Seed oil
V	Oil	1955	650	666	Process	Olive oil
W	Oil	1920	136	155	Process	Olive oil

information on company websites and documentation shared by respondents. This triangulation helps ensure the validity and reliability of the data (Creswell and Poth 2016; Patton 2014). Additionally, the use of multiple case studies allows for the comparison and contrast of findings across different contexts, further enhancing the robustness of our conclusions. The table also summarizes the additional primary and secondary sources consulted that allowed triangulation. Triangulation is a crucial research method that utilizes multiple data sources or methods to increase the validity and reliability of findings. It enhances credibility, identifies inconsistencies, and provides a more comprehensive understanding of the phenomenon under study strengthening validity and reliability.

For data analysis, the dimensions of proximity were first studied per unit of analysis, i.e., within-case analysis, observing the three dimensions of proximity upstream and downstream. For ensuring validity (Yin 2014), a deductive coding was developed,

TABLE 3 | Summary of data collection.

Cases	Interviewee role	Years of experience	Gender	Interview		Secondary sources
				Duration (min)	Number	
A	Company owner	24 years	Male	50	1	Company website
B	Marketing Manager	4 years	Male	25	1	Company website, sustainability report (2018)
C	Quality Manager	4 years	Male	60	1	Company website
D	CEO and Sales Director	1 year	Female	90	1	Company website, historical data, product catalogue, certifications
E	Sales Director	4 years	Male	60	1	Company website
F	Head of Quality	2 years	Male	60	2	Company website
G	Business Manager (Board member)	3 years	Male	45	1	Company website
H	Logistics Manager	29 years	Male	80	1	Company website
I	Marketing Manager	1 year	Female	60	1	Company website
J	Vice President	1 year	Male	50	1	Company website, sustainability report (2018)
K	Quality Manager	2 years	Male	45	1	Company website, booklets obtained at press conference
L	President	31 years	Male	45	1	Company website, sustainability data received via email
M						
N						
O	Commercial Director	15 years	Male	60	2	Website
	Quality Manager	12 years	Male	60		
P	Italy Agro-Manager	1 year	Male	60	1	Website, product packaging
Q	Owner and CEO	13 years	Male	45	1	Website, product packaging
R	Communication Manager	10 years	Female	45	2	Website, sustainability report, informative prospectus
	Investor relator	4 years	Male	45		
S	Supply Chain Manager	38 years	Male	75	1	Website, sustainability report
T	Vegetable oil Product Development Manager	4 years	Female	75	1	Website, internal platform viewing
U	Trading Manager	9 years	Male	60	3	Website, sustainability report
	Logistics Manager	3 years	Male	45		
	Communication Manager	4 years	Female	30		

(Continues)

TABLE 3 | (Continued)

Cases	Interviewee role	Years of experience	Gender	Interview		Secondary sources
				Duration (min)	Number	
V	Global Purchasing Director	12 years	Male	30	2	Website, sustainability protocol
	Global Product Quality Technician	4 years	Male	30		
W	Quality Manager	14 years	Male	75	1	Website, Environmental product declaration (EPD)

based on the constructs coming from the literature and presented in Table 1 and Figure 1. Aiming at evidencing how the coding process was developed, Table 4 shows some coding examples per construct and per proximity dimension.

Subsequently, the cross-case analysis involved the comparison across the cases to find similarities and differences according to the proximity dimensions. The cross-case analysis also allowed us to identify new patterns of practices toward proximity that have been implemented.

5 | Findings: Unpacking Proximity Dimensions in SFSCs

This section presents the findings for each proximity dimension, analyzing the main observations across themes. It explains how different dimensions of proximity are observed in the cases, using specific examples to illustrate these dynamics. The analysis highlights key patterns and insights, demonstrating how proximity emerges in the cases and how it influences sustainability. Table 5 supports this discussion by summarizing the cross-case analysis, showing the proximity dimensions, related constructs, and measures. In the table, a darker dot represents a measure consistently applied across all product lines, while a hollow dot indicates a measure used only in certain instances, showing partial application.

5.1 | The Role of Geographical Proximity

Companies selected in this study had the commonality of high geographical proximity upstream in the supply chain. This was a methodological choice for ensuring that cases in the study already had the interest in developing SFSCs. Downstream in the supply chain, instead, the proximity varies. Even if a certain level of geographical proximity is expected in all the cases, being an important facet of SFSCs, cases show that having high geographical proximity downstream is a choice motivated by supply chain integration and visibility, or by the demands of the market according to the product typology and perishability. As Case B mentioned about geographical proximity:

> "*We made a conscious choice of proximity in order to better control our fully integrated supply chain.*"

Companies do not rely solely on geographical proximity. The other dimensions of proximity – relational and informational – both upstream and downstream, may or may not be present. When they are present, they can take different forms according to the company's characteristics, strategies, and supply chain configuration.

5.2 | Information Proximity and Sustainability

The cases under analysis also explore the dimension of informational proximity, defined by the breadth and depth of information and the tools used along the supply chain to reduce distances (McEntire et al. 2010). Table 5 reveals that the majority of companies in our study invest in informational proximity both upstream and downstream.

Upstream, most cases achieve full information visibility with access to various types of information, including quality and sustainability. Downstream, across all cases, partial information visibility is achieved, with some instances attaining full visibility, particularly in animal-based supply chains. For example, Case B illustrates partial downstream visibility: the firm uses labels to convey specific product quality information and usage recommendations, while sustainability claims are limited to general information on the company's website. This approach is common among producers dealing with fresh, minimally processed products sold unpackaged, making direct consumer communication at the point of sale challenging. In contrast, Case G achieves full downstream visibility by transparently communicating information about regulatory standards, quality and sustainability from breeders to the final consumer. This is accomplished through direct communication with breeders, detailed product packaging and accessible customer support channels, ensuring full transparency and trust throughout the supply chain. Similarly to upstream, a variety of information types, specifically encompassing product quality and sustainability (as shown in Table 5), are collected and shared across the majority of companies examined.

Findings also indicate significant differences among companies in terms of the tools used for information sharing, whether they adopt simple or innovative technological tools to streamline and "shorten" the supply chain. As explained in

TABLE 4 | Examples of coding analysis.

Dimension	Quotation	First order code	Second order code
Information proximity	"We ask suppliers to provide us with timely data, such as the register of treatments, production quantities and yields, irrigation methods, agronomic plan and how many people besides the owner are involved (...)" Case T "(Suppliers) sign a voluntary agreement to transmit data for the calculation of environmental footprints and then allow us to carry out periodic controls (...)" Case T	Information to compute resource productivity and environmental footprint	**Breadth**—Sustainability information
	"We have a supply chain portal, we upload documents to collect information, technicians both within and outside the farming organizations upload the information" Case T	Internal web portal to communicate with farmers and agronomists	**Tools**—Innovative tools
	"When we participate in tenders for catering services in schools, we need to grant high level of details about product origin and each treatment that the product undergone. (...) there I s an increasing sensitivity" Case S	Detailed documental traceability for tenders (downstream)	**Depth**—Full visibility
Relational proximity	"We interact with independent producers from Colombia and Costa Rica (...). In Costa Rica we work directly with the largest independent group and then with a couple of other producers for bananas, and 7–8 pineapples suppliers" Case R	Direct relationship with producers (upstream)	**Steps**—Zero
	"As food processing company we are part of a producer organization, and we plan with the producers what they can grow from year to year (...) We cannot be closer to our partners since they are our owners (...)." Case S	The processing company and the farmers are part of the same organization	**Intensity**—Integration
	"Our principle is to avoid an economic damage that causes the farmers to lose money if the damage depends on us, for example if we have an issue in our factory for which we cannot accept the agreed volume of product from suppliers, it is not their (i.e. suppliers') fault, so we pay them for the entire volume of product we agreed upon and at the agreed price" Case S	The processing company avoiding potential losses for farmers	**Practices**—Risk sharing

(León-Bravo, Ciccullo, and Caniato 2022), simple traceability tools refer to documents, invoices and the like, while innovative (authors named them advanced and integrated tools) include protocols, certification and more technological instruments or platforms. Almost all companies utilize simple tools, with only a few incorporating innovative tools alongside more common methods for information collection and sharing among supply chain actors. The adoption of innovative tools is expected to enhance the reliability and accuracy of shared information efficiently among actors. One example is Case I, a dairy company that uses blockchain technology to ensure transparency in its PDO-certified cheese supply chain. This initiative aims to show every step from milking to packaging, ensuring quality and preventing "Made in Italy" counterfeiting. Each PDO product features QR-coded "Blockchain – Quality Certificate" labels, giving consumers details like lot numbers and expiration dates. This integration of blockchain and traditional methods builds trust by providing clear supply chain information.

A key communication tool is the packaging where companies exhibit the certification labels, ensuring consumers the level of quality and origin of the product. For instance, Case J, which produces certified Grana Padano cheese, invests in certifications such as SMETA (Sedex members ethical trade audit) that promotes practices along four pillars: work, health and safety, environment, and ethics. Also, for Case G packaging is the communication tool used for reaching the consumer with information such as animal welfare as well as other sustainability practices such as the water footprint reduction. In addition, Case M also communicates information collected upstream from the suppliers in the package. Case E explained

TABLE 5 | Cross-case analysis.

		GP				IP												RP																	
		Distance				Breadth				Tools				Depth				Steps						Intensity								Practices					
		<100 km		>100 km		Product quality		Sustainability information		Simple tools		Innovative tools		Partial visibility		Full visibility		Zero		One		Two		Spot contracts		Relational contracts		Long term agreements		Integration		Training & learning activities		Benefit & risk sharing		Fair price settings	
Cases		U	D	U	D	U	D	U	D	U	D	U	D	U	D	U	D	U	D	U	D	U	D	U	D	U	D	U	D	U	D	U	D	U	D
A	Cold cuts			●	●	●	●	●	●	●	●			●	●		●			●	●		●		●	●	●					●		●		●
B				●	●	●	●	●	●	●	●		●		●	●	●	●	●		●		●		●			●	●	●	●	●		●		●
C				●	●	●	●			●	●				●	●	●	●	●		●		●					●	●	●	●	●		●		
D				●	●	●	●	●	●	●	●		●		●	●	●	●	●		●		●					●	●	●	●	●		●		●
E				●	●	●	●	●	●	●	●		●		●	●	●	●			●		●					●	●	●		●		●		
F				●	●	●	●	●	●	●	●	●			●	●	●			●	●		●					●				●		●		●
G	Dairy	●			●	●	●	●	●	●	●		●		●	●	●	●			●		●					●	●			●				●
H		●			●	●	●	●	●	●	●		●		●	●	●	●	●		●								●	●	●	●		●		●
I		●			●	●	●	●	●	●	●		●		●	●	●	●			●		●					●	●							●
J		●			●	●	●	●	●	●	●			●	●	●	●	●		●	●		●					●	●			●		●		●
K				●	●	●	●			●	●				●	●	●	●	●		●							●	●		●			●		●
L				●	●	●	●	●	●		●	●			●	●	●	●	●		●		●					●	●		●	●				●
M				●	●	●	●	●	●	●	●		●		●	●	●	●	●		●		●					●	●		●	●				●
N				●	●	●	●	●	●	●	●				●	●	●	●	●		●		●					●	●		●	●				●
O	Fruits & vegetables	●			●	●	●	●	●	●	●	●			●	●				●	●		●	○		●			●				●			●
P		●			●	●	●	●	●	●	●	●			●	●	○			●	●		●	○		●		●	●			●		●		●
Q		●			●	●	●	●	●	●	●	●	●		●	●	○	●			●								●	●						
R				●	●	●	●	●	●	●	●				●	●				●	●		●	●		●		●	●				●		●	
S		●			●	●	●	●	●	●	●	●			●	●	○	●		○	●		●			●			●	●		●		●		●	
T	Oil			●	●	●	●	●	●	●	●	●	●		●	●	○		○	●	●	○	●	○		●		●	●		○	●				●
U		●		●	●	●	●	●	●	●	●	●	●		●	●	○			●		●	●	●		●		●	●			●		●		●
V				●	●	●	●	●	●	●	●				●	●	○			●	●	○	●	○		●		●	●			●				●
W		●		●	●	●	●	●	●	●	●			●	●	●	○	○		●	●	○	●	○		●			●		○	●		●		●	

the importance of increasing informational proximity with communication tools:

> "At the supermarket the consumer can find a QR code on our packaged meats which, if scanned, gives the possibility to know from which farms comes that pig used in that product [...] Thus, we have built a real short supply chain: from field to fork."

Other groups of cases implement more advanced and integrated traceability systems (León-Bravo, Ciccullo, and Caniato 2022) for increasing information proximity. An example is Case A, in the cold cuts sector, which works closely together with one of its breeding suppliers developing a new tracking technology that allows obtaining and memorizing detailed information about each animal. The technology uses transponder tags in the animal's ear. Following, the information collected along the supply chain is managed by a certified system that guarantees product traceability, from farm to fork. The certified system complies with national standards and ensures access to regulatory, quality and sustainability information. Another example is Case I explaining the motivation for developing a blockchain project:

> "We wanted to offer the opportunity to the final consumer to read these data [PDO data sent to the Ministry in charge of controlling PDO label], to consult it, to use it. Therefore, the main reason behind our blockchain project is not to trace what was already traced, being a PDO product, but to give free and open access to this information to everyone through a QR code placed on the packaging."

Companies working with PDO and PGI certified products leverage these standards not only to guarantee product quality and production processes, but also to streamline and "shorten" their supply chains through the reliability of shared information. Therefore, these certifications represent a communication tool among actors in the supply chain, specifically, from breeders to processors. As Case M interviewee explained:

> "We have designed a certified "eco-sustainable supply chain", codifying a standard, defining those parameters that our farms must respect. The M chain is an element of great value because it differentiates us from our competitors and, to further ensure the consumer, it has been certified by DNV [accredited certification body]".

The examples described illustrate that information sharing among supply chain actors is a crucial enabler of proximity. However, since one of the objectives of this study is to understand the sustainability implications of informational proximity, a more in-depth analysis of the level of detail in sustainability information is required. To examine this element thoroughly, the cross-case analysis in Table 6 categorizes the companies based on the level of detail in sustainability-related information shared along the food supply chain. The level of detail is divided into three categories: (i) general information, (ii) protocols, and (iii) individual product information.

The starting level of information sharing regards general information about the product and sustainability practices, mainly through their websites, or in some cases, using sustainability reports. Case J exemplifies that sustainability reports go beyond being mere documents; they serve as strategic tools for communicating a company's sustainability strategy, actions, and achievements. According to the interviewee:

> *"Our sustainability report covers our entire supply chain and stakeholders, reflecting our commitment to resource conservation. It highlights initiatives like solar panels, renewable energy purchases, and uses a materiality matrix to prioritize transparency. We showcase efforts from waste recycling to workplace wellness projects."*

Sustainability reports are widely recognized as powerful tools for communicating sustainability-related information. However, from an informational proximity perspective, it is also important to assess the extent in which information flows along the chain. For this reason, a second level of informational proximity is introduced: protocols. This level focuses on companies that implement strict internal guidelines, e.g., origin certified, sustainability protocols and other certifications that also establish specific information that the company asks their supply chain partners for. Hence, to establish closeness along the chain, it helps when value chain actors have advanced knowledge of each other's practices and products, enabling trust, transparency, and collaboration along the supply chain.

Finally, the most intense level of information proximity illustrates companies conveying specific traceability and sustainability information referring to individual products along the supply chain. Case E exemplifies this:

> *"In the supermarket, consumers will find a QR code on our packaged meat products. Scanning it reveals which farms the pig came from and the type of feed it ate, thanks to our traceability system. This creates a true short supply chain, from field to fork".*

Thus, demonstrating the company's efforts to provide detailed traceability and sustainability information for each product, ensuring maximum transparency and consumer awareness.

While in most of the cases, the three of information sharing are cumulative (e.g., if a company relies on protocols this implies that the same company had also shares general information), this is not always the case. For example, case W shares Environmental Product Declarations (EPD) through its website, making the consumer able to access the full set of information about product quality and sustainability performances of the products. For obtaining this level of detail, the company does not ask its suppliers to adhere to a protocol, but they agree with them essential information that they can collect

with limited complexity, and they integrate this information with sustainability impacts coming from secondary sources or databases.

5.3 | Relational Proximity and Sustainability

In the research framework, relational proximity is divided into three elements: the number of intermediaries along the chain, the intensity of relationships, and the practices established among supply chain actors. Table 5 presents the data analysis across the four industry sectors, providing a detailed exploration of relational proximity among the examined companies.

An in-depth analysis of the number of intermediaries and the relationship intensity reveals significant findings. In animal-based supply chains, specifically dairy and cold cuts, scenarios with zero intermediaries upstream – indicating high relational proximity with fewer steps – are consistently associated with intense relationships characterized by long-term agreements. These findings highlight common trends within dairy and cold cuts supply chains, where the absence of intermediaries often prompts companies to establish enduring long-term contracts with suppliers, as illustrated in Case B:

> *"We signed agistment contracts[2] with our breeders, a long-lasting partnership that has a double positive value: on one hand, we support breeders with innovative tools to improve and modernize their breeding farms; on the other hand, we reduce transaction costs and market uncertainties, thus developing an integrated and controlled supply chain."*

Companies that also shared these characteristics are Cases D and E in the cold cuts sector and Cases G, I, K and M in the dairy sector. For instance, Case G levers on a network of 23 breeders, strictly selected and located within 50 km from the factory, with whom the company established long-term exclusivity contracts. Another example is Case H, one of the largest cooperatives in Europe that brings together cattle breeding and processing, ensuring not only high geographical but also relational proximity.

Subsequently, a thorough examination was conducted into the intensity of relationships and practices implemented among upstream supply chain actors, detailed in Table 7. This table evaluates the intensity of relationships, defined by inter-organizational agreements, alongside the relational practices established among these actors. It is important to note that such practices are exclusively evidenced in the upstream, building on the findings from Table 5, which highlighted that keeping a strong relationship upstream is crucial for these companies to build proximity.

Table 7 assesses practices such as (i) training and learning activities, (ii) price setting, and (iii) benefit and risk sharing, implemented upstream, and their correlation with organizational agreements among actors. The findings reveal that relationships characterized by long-term agreements, considered highly intense, correlate with a more extensive adoption of these practices. Therefore, companies engaging in long-term agreements also tend to adopt such practices upstream in the supply chain, thereby reinforcing relational proximity.

A closer examination of the practices outlined in both Table 5 and Table 7 within relational proximity reveals that strengthening relationships among actors implies a commitment to

TABLE 6 | In-depth analysis of sustainability information within informational proximity in SFSCs (letters represent the case name).

Levels of detail of sustainability information	Classified cases
General information	A; B; C; D; E; F; G; H; J; K; L; M; N; O; P; Q; R; T; U; W
Protocols	A; B; D; E; F; G; H; I; J; L; M; N; Q; S; T; U; V
Individual product information	B (Bio) P (Bio) R (Bio) S (Bio) U (Bio)
	C (PDO) D (QR code, Animal welfare) E (QR code, Bio) I (PDO, QR code) F (PDO, PGI, B Green, Animal welfare) G (Animal welfare) L; M; N (Water footprint, PDO, etc.)
	H (Kg CO2) O (kg CO2) T (Kg CO2) W (EPD)

TABLE 7 | Analysis of relational proximity in SFSCs (letters represent the case name).

Upstream relationship intensity	Relational practices			
	Producers' training & know-how transfer	**Benefit/risk sharing**	**Fair price setting & financial incentives**	**No indicated initiatives**
Spot contracts			P; U; W	O; R; T; V
Relational contracts	A; P; S; T; U; V	A; O; P; S; U	A; O; P; S; T; U; V; W	R
Long term agreements	B; C; D; E; F; G; J; L; M; N; P; T; U; V	B; J; K; P; R; U	B; D; G; I; J; K; L; M; N; P; R; T; U; V	
Integration	B; C; D; E; H; S; W	B; C; D; E; H; S; W	B; D; H; S; W	Q

sustainability upstream. Implementing these practices not only reduces the relational distance among actors but also underscores a dedication to and contribution toward enhanced sustainability. The practices involve the benefit and risk sharing agreements, as in Case S, which grants farmers the coverage of internal risk (e.g., a machine failure) with a compensation system like insurance, but also fair price settings, as in Case U that assigns to farmers participating to the "traced and sustainable supply chain" project, a higher remuneration. Moreover, as outlined in Table 7, especially those cases with more robust organizational agreements among actors engage in additional sustainability-driven actions that bring interesting sustainability implications. For example, Case W implements innovative agriculture techniques with lower environmental impacts, fair price settings, as well as rural development programs among actors that are either vertically integrated into the supply chain or characterized by long-term agreements, instead of spot contracts.

Considering such relational practices, all the companies in this study support the growth of micro and small enterprises. We can observe two main governance models, both associated with a high relational proximity upstream (i.e., vertical integration and long-lasting partnership agreements with breeders). Both promote closer relationships in support of small producers, with no marked difference between the vertical integration option, in which farmers are members of a cooperative that supplies goods to the dairy or meat processing factory on an exclusive basis, and long-lasting partnership agreements with breeders.

Another practice within relational proximity refers to initiatives that go beyond the long-term contracts and benefit and risk sharing, as Case J, to support farmers in the development of sustainable agriculture techniques with important know-how transfer projects.

6 | Discussion: Relational and Information Proximity as Levers for Sustainable SFSCs

Besides the similarities and differences, even within the same geographical context (Italy), SFSCs are built combining proximity along the three dimensions. In line with previous literature suggesting that proximity encompasses not only localness but also relational closeness (Dubois 2018; Torre and Rallet 2005; Forssell and Lankoski 2014), our cases reveal that high geographical proximity alone is not considered enough to obtain a proper SFSC. Instead, it must be complemented by relational and informational proximity initiatives. Our findings confirm that geographical proximity needs to be paired with these other dimensions to build a SFSC with sustainability purposes in mind.

Our findings extend and build upon the framework proposed by Edelmann, Quiñones-Ruiz, and Penker (2019) by identifying two main approaches to increase proximity in SFSCS with sustainability objectives. On one side, key relational initiatives enhance sustainability and relationship management within supply chains. These initiatives include: (i) training and learning activities, which enhance the skills and knowledge of producers to improve sustainable practices; (ii) price setting mechanisms, which establish fair pricing to ensure equitable compensation for all actors; and (iii) benefit and risk sharing, which distribute gains among all stakeholders while collectively managing and mitigating risks. These relational practices reflect a strategic orientation towards fostering stronger, more cooperative relationships with upstream supply chain actors as a critical factor in building SFSCs.

Furthermore, informational proximity draws upon traceability – upstream and downstream – with elements such as breadth and depth, which are integral to traceability systems (León-Bravo, Ciccullo, and Caniato 2022; Karlsen et al. 2012). Additionally, the role of tools used in information collection and sharing is considered, as they significantly impact accuracy, reliability, and efficiency (Astill, Dara, and Campbell 2019). Our findings indicate that the choice of tools varies significantly among the cases studied, with the majority using simple tools, as detailed in Table 5. Then, when discussing sustainability-related information sharing, the level of detail in sustainability information is seen as a differentiating variable for informational proximity in SFSCs. In this line, with product-specific sustainability information the consumer can establish connections with the entire production process and the whole supply chain; indeed, transparency confirms authenticity and quality of products and processes, restoring trust to the consumer's side (Wognum, Bremmers, and Trienekens 2011). As mentioned earlier, our findings reveal three levels of detail in sustainability-related information sharing implemented by the companies in the sample. These levels progressively contribute to building SFSCs upstream and downstream, starting from general information sharing and establishing information sharing protocols, to the highest level of detail, which includes individual product information.

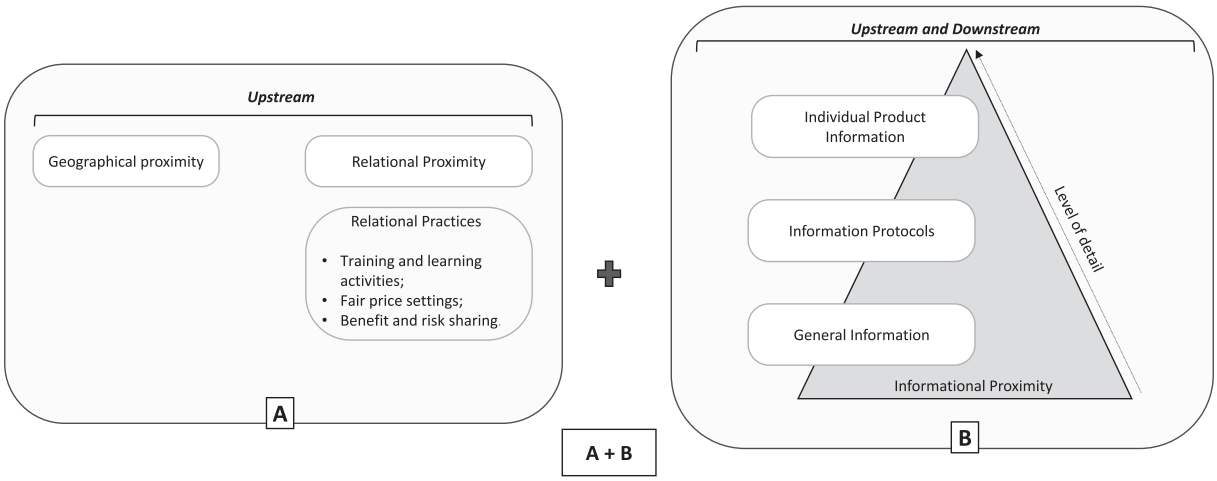

FIGURE 2 | Updated framework of proximity dimensions in sustainable SFSCs.

Figure 2 graphically presents this discussion, illustrating that the combined influence of all three dimensions contributes to the development of more sustainable SFSCs. One side of the graph (A) emphasizes the impact of focusing on the upstream, encompassing geographical and relational proximity, to build strong SFSCs. On the other side of the graph (B), is illustrated that the level of detail in sustainability information within informational proximity along upstream and downstream in the supply chain, has strong implications for SFSC sustainability.

It is relevant to comment that in our sample, certain companies demonstrate significant synergy across all three proximity dimensions (A+B in Figure 2). Origin certifications such as PDO (Protected Designation of Origin) and PGI (Protected Geographical Indication) exemplify this synergy, emphasizing geographical proximity by requiring products to originate from specific regions. This geographic information is embedded directly into the final product, enhancing informational proximity and re-establishing connections between consumers and producers, thereby improving relational proximity upstream as well. Moreover, PDO and PGI certifications uphold stringent production standards that promote regional ecosystems, sustainable farming practices, and animal welfare, aligning with various sustainability goals. This sustainability information is conveyed to consumers through product labeling, enhancing consumer trust. Additionally, these certifications contribute to preserving cultural and natural heritage, enhancing relational proximity alongside information proximity. In summary, PDO and PGI certifications used within SFSCs leverage these three proximity dimensions combined to promote sustainability through responsible sourcing practices and detailed product-specific information sharing.

7 | Conclusions

This study addresses the need for a more holistic and practical definition of SFSCs with sustainability objectives, beyond the pure geographical dimension, to include also relational and informational proximity. This study was carried out in four food industry sectors in Italy: cold cuts (meat), dairy, fruit and vegetables, and oil; analyzing the different dimensions of proximity with an upstream perspective (towards farmers) and downstream (towards consumers). This study provides both theoretical and managerial contributions and opens new research opportunities.

7.1 | Theoretical Contributions

The first contribution of this study is a comprehensive definition of SFSC, which integrates the three dimensions of proximity and provides a structured framework for operationalizing each dimension. Table 5 demonstrates how these proximity dimensions are applied across both upstream and downstream stages of the supply chain, specifying the measures used to unpack and assess proximity at different levels. Tables 6 and 7, along with Figure 2, build on this analysis by introducing an innovative approach that goes beyond merely disaggregating and unpacking proximity dimensions. Table 6 delves into the breadth of sustainability information within the information proximity dimension, outlining various types of data shared and their roles in promoting sustainability and transparency. Table 7 focuses on the levels of intensity within relational proximity, detailing how different degrees of closeness and interaction are implemented across diverse contexts.

As second contribution, we show that companies in the food industry invest in practices to *integrate* geographical proximity, and not only to *compensate* for geographical distance, with elements of relational and informational proximity. This is achieved not only by relying on organizational changes, such as avoiding intermediaries and/or directly governing all the processes of the value chain through vertical integration, but also by focusing on the intensity of the relationship between supply chain actors (i.e., long-term contracts and partnerships with producers) that can pave the way to relational sustainability practices. Therefore, we can conclude that the three dimensions are synergistic rather than mutually exclusive, and their combination leads to the full implementation of a SFSC.

The third contribution is the demonstration that SFSCs can be built with sustainability goals when adopting various proximity dimensions in combination with sustainability practices. In particular, we showed the synergies between geographical proximity and relational sustainability practices in the upstream supply chain (Figure 2, section A), as well as the

synergies between informational proximity and sustainability practices in both the upstream and downstream supply chains (Figure 2, Section B).

7.2 | Managerial and Policy Implications

We believe that our findings are relevant also for managers who are aiming to shorten their supply chains toward a more sustainable model. Unpacking the SFSCs' definition along three proximity dimensions, operationalized into clear levels, can help companies to identify their current approach and potential strategies for shortening the supply chain with sustainability objectives in mind, especially in the relational and informational dimensions, upstream and downstream. In this line, companies that are working on their sustainability objectives could leverage our findings for identifying the most appropriate combination of proximity dimensions and sustainable practices to build SFSCs while creating sustainable impact.

Our findings are also relevant for policy makers by offering a more comprehensive SFSC definition that incorporates three dimensions of proximity. Current definitions often emphasize a single dimension of proximity, namely, geographic proximity, as highlighted in EU regulations. These definitions also often assume that SFSCs are inherently sustainable without addressing the underlying elements that contribute to their actual sustainability outcomes. Unfortunately, this narrow focus fails to capture the broader range of factors that influence sustainability in supply chains. Our findings address this gap incorporating geographic, relational, and informational proximity. This integrated approach demonstrates that sustainability is not a given but is enhanced through the interactions and synergies between multiple proximity dimensions at various stages of the supply chain, both upstream and downstream. By considering how these dimensions work together, we provide a more realistic and nuanced understanding of what drives sustainability in SFSCs. This broader perspective serves as a valuable foundation for policymakers to develop more precise and effective guidelines, regulations, or roadmaps aimed at promoting sustainability in SFSCs. It also enables the design of assessment systems that can more accurately measure sustainability performance across different sectors.

7.3 | Limitations and Future Developments

Limitations in our study regard mainly the high variety of cases selected in the study. Although being a methodological choice to bring up the heterogeneity of food industry, the choice also involved a limited geographical distance upstream in order to investigate if the other dimensions of proximity could be *integrated*. Nonetheless, this study can serve as a starting point for future studies to be conducted in other settings with a weaker geographical proximity to investigate if the role of relational and information proximity has a higher relevance to offset the physical distance among supply chain actors. Furthermore, since our study is limited to Italy, extending the analysis to other countries can be addressed in future research. In addition, we studied the SFSC from the food processor's perspective since they are usually shaping their supply chain, however, future studies could also consider the perspective of other supply chain stages.

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Conflicts of Interest

The authors declare no conflicts of interest.

Endnotes

[1] DOOR browser: Designation of origin https://ec.europa.eu/info/food-farming-fisheries/food-safety-and-quality/certification/quality-labels/geographical-indications-register/.

[2] The agistment contract is regulated by art. 2170 of the Italian Civil Code. The contract consists in an agreement between the animal owner and the agister, who join forces for the breeding of a certain quantity of livestock and for the execution of related activities, in order to share the livestock growth, the products and profits that derive from them.

References

Astill, J., R. A. Dara, and M. Campbell. 2019. "Transparency in Food Supply Chains: A Review of Enabling Technology Solutions." *Trends in Food Science and Technology* 91: 240–247. https://doi.org/10.1016/j.tifs.2019.07.024.

Aubry, C., and L. Kebir. 2013. "Shortening Food Supply Chains: A Means for Maintaining Agriculture Close to Urban Areas? The Case of the French Metropolitan Area of Paris." *Food Policy* 41: 85–93. https://doi.org/10.1016/j.foodpol.2013.04.006.

Barratt, M., T. Y. Choi, and M. Li. 2011. "Qualitative Case Studies in Operations Management: Trends, Research Outcomes, and Future Research Implications." *Journal of Operations Management* 29: 329–342. https://doi.org/10.1016/j.jom.2010.06.002.

Bos, E., and L. Owen. 2016. "Virtual Reconnection: The Online Spaces of Alternative Food Networks in England." *Journal of Rural Studies* 45: 1–14. https://doi.org/10.1016/j.jrurstud.2016.02.016.

Caniato, F., and D. Luzzini. 2012. Short Supply Chain Configurations in the Italian Food Industry. 21st Int Purchasing Supply Education Research Association Conf (pp 1-14) Edizioni s:1–14

Cannas, V. G., F. Ciccullo, M. Pero, and R. Cigolini. 2020. "Sustainable Innovation in the Dairy Supply Chain: Enabling Factors for Intermodal Transportation." *International Journal of Production Research* 58: 1–20.

Carbone, A. 2017. "Food Supply Chains: Coordination Governance and Other Shaping Forces." *Agricultural and Food Economics* 5, no. 1: 3. https://doi.org/10.1186/s40100-017-0071-3.

Creswell, J. W., and C. N. Poth. 2016. *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*. Thousand Oaks, California: Sage Publications Inc.

D'Amico, M., G. Di Vita, G. Chinnici, G. Pappalardo, and B. Pecorino. 2014. "Short Food Supply Chain and Locally Produced Wines: Factors Affecting Consumer Behavior." *Italian Journal of Food Science* 26: 329–334.

Dubois, A. 2018. "Nurturing Proximities in an Emerging Food Landscape." *Journal of Rural Studies* 57: 1–12. https://doi.org/10.1016/j.jrurstud.2017.10.005.

Edelmann, H., X. F. Quiñones-Ruiz, and M. Penker. 2019. "Analytic Framework to Determine Proximity in Relationship Coffee Models." *Sociologia Ruralis* 60: 458–481. https://doi.org/10.1111/soru.12278.

Engelseth, P. 2016. "Developing Exchange in Short Local Foods Supply Chains." *International Journal of Food System Dynamics* 7: 229–242. https://doi.org/10.18461/ijfsd.v7i3.734.

Ersoy, P., G. Börühan, S. Kumar Mangla, J. H. Hormazabal, Y. Kazancoglu, and Ç. Lafcı. 2022. "Impact of Information Technology and Knowledge Sharing on Circular Food Supply Chains for Green Business Growth." *Business Strategy and the Environment* 31, no. 5: 1875–1904.

European Commission. 2013. "Regulation (EU) no 1305/2013 of the European Parliament and of the Council of 17 December 2013 on Support for Rural Development by the European Agricultural Fund for Rural Development (EAFRD) and Repealing Council Regulation (EC) No 1698/2005." *Official Journal of the European Union* 347: 487–548.

European Parliamentary Research Service. 2016. Short food Supply Chains and Local Food Systems in the EU (PE 586.650), https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2016)586650.

Fischer, C., M. Hartmann, N. Reynolds, et al. 2009. "Factors Influencing Contractual Choice and Sustainable Relationships in European Agri-Food Supply Chains." *European Review of Agricultural Economics* 36, no. 4: 541–569.

Folinas, D., I. Manikas, and B. Manos. 2006. "Traceability Data Management for Food Chains." *British Food Journal* 108: 622–633.

Forssell, S., and L. Lankoski. 2014. "The Sustainability Promise of Alternative Food Networks: An Examination Through "Alternative" Characteristics." *Agricultural Human Values* 32: 63–75. https://doi.org/10.1007/s10460-014-9516-4.

Garcia-Torres, S., L. Albareda, M. Rey-Garcia, and S. Seuring. 2019. "Traceability for Sustainability – Literature Review and Conceptual Framework." *Supply Chain Management- An International Journal* 24: 85–106. https://doi.org/10.1108/SCM-04-2018-0152.

Garnett, T. 2011. "Where are the Best Opportunities for Reducing Greenhouse Gas Emissions in the Food System (Including the Food Chain)?" *Food Policy* 36: S23–S32.

Golini, R., A. Moretto, and F. Caniato. 2017. "Developing Sustainability in the Italian Meat Supply Chain: An Empirical Investigation." *International Journal of Production Research* 55: 1183–1209.

González-Azcárate, M., J. L. C. Maceín, and I. Bardají. 2021. "Why Buying Directly From Producers Is a Valuable Choice? Expanding the Scope of Short Food Supply Chains in Spain." *Sustainable Production and Consumption* 26: 911–920.

Gummesson, E. 2006. "Qualitative Research in Management: Addressing Complexity, Context and Persona." *Management Decision* 44, no. 2: 167–179.

Hancock, D., and B. Algozzine. 2017. *Doing Case Study Research: A Practical Guide for Beginning Researchers*. Columbia University, New York, NY: Teachers College Press.

Hergesheimer, C., and H. Wittman. 2012. "Weaving Chains of Grain: Alternative Grain Networks and Social Value in British Columbia." *Food, Culture & Society* 15: 375–393. https://doi.org/10.2752/175174412X13276629245803.

Higgins, V., J. Dibden, and C. Cocklin. 2008. "Building Alternative Agri-Food Networks: Certification, Embeddedness and Agri-Environmental Governance." *Journal of Rural Studies* 24: 15–27.

Ilbery, B., and D. Maye. 2006. "Retailing Local Food in the Scottish-English Borders: A Supply Chain Perspective." *Geoforum* 37: 352–367. https://doi.org/10.1016/j.geoforum.2005.09.003.

Jarosz, L. 2008. "The City in the Country: Growing Alternative Food Networks in Metropolitan Areas." *Journal of Rural Studies* 24: 231–244. https://doi.org/10.1016/j.jrurstud.2007.10.002.

Jraisat, L., M. Jreissat, A. Upadhyay, and A. Kumar. 2022. "Blockchain Technology: The Role of Integrated Reverse Supply Chain Networks in Sustainability." *Supply Chain Forum: An International Journal* 24, no. 1: 17–30. https://doi.org/10.1080/16258312.2022.2090853.

Jraisat, L., A. Upadhyay, T. Ghalia, M. Jresseit, V. Kumar, and D. Sarpong. 2021. "Triads in Sustainable Supply-Chain Perspective: Why Is a Collaboration Mechanism Needed?" *International Journal of Production Research* 61, no. 14: 4725–4741.

Karlsen, K. M., B. Dreyer, P. Olsen, and E. O. Elvevoll. 2012. "Granularity and Its Role in Implementation of Seafood Traceability." *Journal of Food Engineering* 112, no. 1–2: 78–85.

Kiil, K., H. H. Hvolby, and J. Trienekens. 2019. "From Information Sharing to Information Utilization in Food Supply Chains." *International Journal of Information Systems and Supply Chain Management* 12: 85–109. https://doi.org/10.4018/IJISSCM.2019070105.

Kjellström, T., N. Maître, C. Saget, M. Otto, and T. Karimova. 2019. *Working on a Warmer Planet: The Effect of Heat Stress on Productivity and Decent Work*. Geneva: International Labour Organization.

Kneafsey, M., L. Venn, and U. Schmutz. 2013. "Short Food Supply Chains and Local Food Systems in the EU. A State of Play of Their Socio-Economic Characteristics." *JRC Scientific and Policy Reports* 123: 129.

Kumar, V., M. Wang, and A. Kumari. 2019. "Exploring Short Food Supply Chains From Triple Bottom Line Lens: A Comprehensive Systematic Review." *Proceedings International Conference of Industrial Engineering and Operations Management* 2019: 728–738.

Lanfranchi, M., and C. Giannetto. 2015. "A Case Study on the Role of Farmers' Markets in the Process of Shortening the Food Chain and the Possible Economic Benefits for Consumers." *Calitatea- Quality Access to Success* 16, no. 144: 94.

León-Bravo, V., F. Ciccullo, and F. Caniato. 2022. "Traceability for Sustainability: Seeking Legitimacy in the Coffee Supply Chain." *British Food Journal* 124, no. 8: 2566–2590.

León-Bravo, V., and M. Jaramillo-Villacrés. 2021. "Sustainability of Chocolate Production in Ecuador: Drivers, Barriers, and Local Factors." *Latin American Business Review* 22, no. 4: 323–357.

Luzzini, D., R. Golini, and L. Crippa. 2013. Short Food Supply Chain Configurations in the Italian Food Industry. 17th EurOMA Conference, https://doi.org/10.13140/RG.2.1.2222.1846.

Malak-Rawlikowska, A., E. Majewski, A. Was, et al. 2019. "Measuring the Economic, Environmental, and Social Sustainability of Short Food Supply Chains." *Sustainability* 11, no. 15: 4004. https://doi.org/10.3390/su11154004.

Marino, D., L. Mastronardi, and A. Giannelli. 2018. "Territorialisation Dynamics for Italian Farms Adhering to Alternative Food Networks." *Bulleting of Geography Socio-Economic Series* 40: 113–131. https://doi.org/10.2478/bog-2018-0018.

Marsden, T., J. Banks, and G. Bristow. 2000. "Food Supply Chain Approaches: Exploring Their Role in Rural Development." *Sociologia Ruralis* 40: 424–438. https://doi.org/10.1111/1467-9523.00158.

Massaro, M., J. Dumay, and C. Bagnoli. 2019. "Transparency and the Rhetorical Use of Citations to Robert Yin in Case Study Research." *Meditari Accountancy Research* 27, no. 1: 44–71.

Mastronardi, L., D. Marino, V. Giaccio, A. Giannelli, M. Palmieri, and G. Mazzocchi. 2019. "Analyzing Alternative Food Networks Sustainability in Italy: A Proposal for an Assessment Framework." *Agricultural and Food Economics* 7: 1–19. https://doi.org/10.1186/s40100-019-0142-8.

McEntire, J. C., S. Arens, M. Bernstein, et al. 2010. "Traceability (Product Tracing) in Food Systems: An IFT Report Submitted to the FDA, Volume 1: Technical Aspects and Recommendations." *Comprehensive Reviews in Food Science and Food Safety* 9, no. 1: 93–146.

Norton, T., J. Beier, L. Shields, A. Househam, E. Bombis, and D. Liew. 2014. *A Guide to Traceability: A Practical Approach to Advance Sustainability in Global Supply Chains*. United Nations Global Compact Office: New York, NY, USA.

Opara, L. U. 2003. "Traceability in Agriculture and Food Supply Chain." *Journal of Food, Agriculture and Environment* 1: 101–106.

Patton, M. Q. 2014. *Qualitative Research & Evaluation Methods: Integrating Theory and Practice*. Thousand Oaks, California: Sage Publications Inc.

Renting, H., T. K. Marsden, and J. Banks. 2003. "Understanding Alternative Food Networks: Exploring the Role of Short Food Supply Chains in Rural Development." *Environmental Planning a* 35: 393–411. https://doi.org/10.1068/a3510.

Sacchi, G., L. Cei, and G. Stefani. 2018. "A Multi-Actor Literature Review on Alternative and Sustainable Food Systems for the Promotion of Cereal Biodiversity." *Agriculture* 8, no. 11: 173. https://doi.org/10.3390/agriculture8110173.

Sellitto, M. A., L. A. M. Vial, and C. V. Viegas. 2018. "Critical Success Factors in Short Food Supply Chains: Case Studies With Milk and Dairy Producers From Italy and Brazil." *Journal of Cleaner Production* 170: 1361–1368. https://doi.org/10.1016/j.jclepro.2017.09.235.

Sharfman, M. P., T. M. Shaft, and R. P. Anex Jr. 2009. "The Road to Cooperative Supply-Chain Environmental Management: Trust and Uncertainty Among pro-Active Firms." *Business Strategy and the Environment* 18, no. 1: 1–13.

Sonesson, U., and J. Berlin. 2003. "Environmental Impact of Future Milk Supply Chains in Sweden: A Scenario Study." *Journal of Cleaner Production* 11: 253–266.

Todorovic, V., M. Maslaric, S. Bojic, M. Jokic, D. Mircetic, and S. Nikolicic. 2018. "Solutions for More Sustainable Distribution in the Short Food Supply Chains." *Sustainability* 10, no. 10: 3481. https://doi.org/10.3390/su10103481.

Torre, A. 2011. "The Role of Proximity During Long-Distance Collaborative Projects. Temporary Geographical Proximity Helps." *International Journal of Foresight and Innovation Policy* 7: 213–230. https://doi.org/10.1504/IJFIP.2011.040075.

Torre, A., and A. Rallet. 2005. "Proximity and Localization." *Regional Studies* 39: 47–59. https://doi.org/10.1080/0034340052000320842.

Upadhyay, A. 2020. "Antecedents of Green Supply Chain Practices in Developing Economies." *Management of Environmental Quality: An International Journal* 32, no. 6: 1150–1165.

Van Hauwermeiren, A., H. Coene, G. Engelen, and E. Mathijs. 2007. "Energy Lifecycle Inputs in Food Systems: A Comparison of Local Versus Mainstream Cases." *Journal of Environmental Policy and Planning* 9: 31–51. https://doi.org/10.1080/15239080701254958.

Voss, C., N. Tsikriktsis, and M. Frohlich. 2002. "Case Research in Operations Management." *International Journal of Operations and Production Management* 22: 195–219. https://doi.org/10.1108/01443570210414329.

Whatmore, S., P. Stassart, and H. Renting. 2003. "What's Alternative About Alternative Food Networks?." *Environment and Planning A* 35: 389–391. https://doi.org/10.1068/a3621.

Wognum, P. M., H. Bremmers, and J. H. Trienekens. 2011. "Systems for Sustainability and Transparency of Food Supply Chains - Current Status and Challenges." *Advanced Engineering Informatics* 25: 65–76. https://doi.org/10.1016/j.aei.2010.06.001.

Woodhouse, P. 2010. "Beyond Industrial Agriculture? Some Questions About Farm Size, Productivity and Sustainability." *Journal of Agrarian Change* 10: 437–453. https://doi.org/10.1111/j.1471-0366.2010.00278.x.

Yacamán- Ochoa, C., A. Matarán, and R. Mata Olmo. 2019. "The Potential Role of Short Food Supply Chains in Strengthening Periurban Agriculture in Spain: The Cases of Madrid and Barcelona." *Sustainability* 11: 2080. https://doi.org/10.3390/su11072080.

Yin, R. K. 2014. *Case Study Research: Design and Methods*. 5th ed. Thousand Oaks, California: Sage Publications Inc.