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Resilience and Digitalization in Short Food Supply Chains: A Case Study Approach

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Abstract: The interest in short food supply chains (SFSCs) has grown significantly in the last decade, notably in respect of their potential role to achieve more sustainable food chains. However, a major barrier to achieving sustainable supply chains is the uncertainty associated with supply chain activities. Therefore, this paper aims to explore the different resilience capabilities that SFSCs possess and the potential role of digital technologies as enablers of SFSCs' resilience. Using a case study research approach, semi-structured interviews were conducted in two SFSCs in Mexico. Collected data were analyzed using thematic analysis. Findings suggest that SFSCs possess the supply chain resilience (SC resilience) capabilities investigated here, namely flexibility, redundancy, collaboration, visibility and agility. A key finding is the importance of low-cost digital technologies (including freeware and social media) that can support flexibility, collaboration, visibility and agility. These findings raise important implications for SFSCs actors exploring opportunities to improve their collective resilience. This study expands the current literature by proposing a conceptual framework that summarizes a wide variety of strategies that support SC resilience capabilities in the context of SFSCs.

Keywords: alternative food networks; resilient agri-food chains; digital transformation; local food systems

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1. Introduction

Food Supply Chains (FSC) are engaged in a process of reinvention. Climate change, the sustainable development goals, and the unexpected COVID-19 pandemic have resulted in further tensions within traditional FSC and changes in consumers' behaviors [1–4]. Even though food systems have been able to deal with the exceptional challenges that emerged from the COVID-19 pandemic [5], consumers, organization managers and researchers continue looking at developing FSC resilience to cope with sources of unexpected turbulence. Supply chains are expected to regain their original configuration soon after any natural disaster (such as earthquakes, floods, hurricanes, tsunamis and diseases), accidents or intentional disruptions (such as strike action, acts of terrorism or sabotage) [6]. The ability to anticipate and prepare for such disruptions seems fundamental to succeed in this endeavor [7]. Some of the suggested strategies for achieving this are to increase FSC resilience by shortening the supply chain [8] and the use of digital technologies [9].

With regards to shortening the supply chain, Short Food Supply Chains (SFSCs) have been gaining attention in food systems research during the last decade. SFSCs comprise a wide variety of initiatives, such as community-supported agriculture (CSA), farmers' markets and farmer shops, often characterized by geographical and relational proximity, local food and commitment to co-operation [8]. Several benefits are expected

from SFSCs, such as "economic benefits to both producers and consumers, strengthening social relations, preserving the environment, improving nutritional aspects, and enhancing local development" [10] (p. 3). However, the sustainability and continuity of supply chains (SCs) are constantly threatened. Sustainable SCs need resilience to prepare, respond and recover from unexpected disruptions and to continue their operations [11,12]. It has been argued that, in the presence of unexpected disruptions, the resilience of an SC determines its capacity to sustain its economic, environmental and social performance [13]. On the other hand, it is also argued that sustainability in SCs can support recovery after disruptions, but the outcome will depend on its associated resilience capabilities [14].

Even though the sustainability o SFSCs has been extensively documented [15,16], the resilience of SFSCs remains largely unexplored. It is still unclear whether different types of SFSCs possess key SC resilience capabilities and what strategies they implement against disruptions. Thus, this paper draws on theory from SC resilience literature to investigate how resilience manifests within SFSCs. Similarly, some studies have documented the impact of digital technologies on supply chain resilience [7,17–19], but their potential role in the context of SFSC remains unexplored. Further research is needed to understand whether digital technologies support resilience capabilities and associated strategies.

Accordingly, this paper has two research objectives:

1. To examine the supply chain resilience (SC resilience) capabilities of SFSCs;
2. To explore the role of digitalization in enabling resilience within SFSCs.

To achieve both research objectives, we review the literature to set the context concerning SFSCs and summarize existing findings regarding resilience within SFSC. We also review theory from the literature on Supply Chain Resilience (SC resilience), focusing on capabilities, which is later applied to the study of resilience within SFSCs. The effect of digitalization on the resilience of SCs is also explored. Next, a research design is presented to address the two research objectives proposed. Subsequently, emerging results from two cases are presented and discussed in the context of existing literature. A conceptual framework is derived from the results and discussion. Lastly, we summarize key theoretical and practical implications, as well as limitations and opportunities for future research.

This study contributes to the advancement of knowledge in several ways. First, this study extends existing research on the resilience of SFSCs by offering initial insights about resilient SFSCs in Mexico and providing empirical evidence of resilient SFSCs in a developing country. Previous studies have largely focused on developed countries. Second, drawing on extensive extant literature on SC resilience, this study explores five common SC resilience capabilities and identifies associated strategies, which is a novel attempt in SFSCs literature. Third, this paper provides empirical evidence regarding the role that digitalization can play in supporting resilience within SFSCs, something that previous studies have not covered. A key finding is the importance of low-cost digital technologies that can support several SC resilience capabilities and strategies. Lastly, to the best of our knowledge, our research is the first one to propose a conceptual framework for resilient SFSCs. The paper also identifies future research avenues. From a practical perspective, these findings raise important implications for SFSCs' actors looking to improve their collective resilience against disruptions. This study is part of a larger research project where the relationship between sustainability and resilience is explored in the context of SFSCs.

2. Literature Review

In this section, we first review the different understandings of SFSCs; then, we summarize research on resilience within SFSCs, and finally, we provide an overview of SC resilience theory with a focus on SC resilience capabilities.

2.1. Short Food Supply Chains: Definitions and the Need for Resilience

Marsden et al. [20] and Renting et al. [21] popularized the concept of Short Food Supply Chains (SFSCs) as a substitute for "alternative food networks" in response to the

need for more specific conceptualizations. Marsden et al. [20] originally proposed that the number of intermediaries or the physical distance that products travel is not what ultimately distinguishes SFSCs; instead, the connection between consumers and producers through products embedded with information is what is critical. Following a similar line of thought, Renting et al. [21] defined SFSCs in terms of "shortened" producer–consumer relations and information-embedded products.

Since then, the literature has grown significantly, and the concept has been adopted by governmental institutions for policymaking [22]. For instance, the French Ministry of Agriculture, Food and Forestry suggests that SFSCs are those systems that involve only one or fewer intermediaries [23]. Subsequently, the European Commission defined SFSCs as supply chains "involving a limited number of economic operators, committed to cooperation, local economic development, and close geographical and social relations between producers, processors and consumers" [24].

Despite the popularization of the concept in both academic and political contexts, there is currently no single official or universal definition of SFSCs, which makes comparisons difficult [8]. This may impede progress in knowledge and is particularly troublesome for empirical investigation, since the conceptualization inconsistency complicates the delimitation and identification of real-life phenomena.

To delineate the phenomena that are the main focus of this paper, we propose an operational definition of SFSCs, based on the definition of SCs proposed by Christopher [25], and the main characteristics of SFSCs highlighted in the literature:

> *"Short Food Supply Chains (SFSCs) are networks of connected and interdependent actors mutually and cooperatively working together to control, manage and improve the flows of information-embedded products, services, resources, and/or information, from farm to fork, seeking a reduction of intermediaries and physical distance between producers and consumers".*

Overall, SFSCs differ from conventional food supply chains in terms of their relational and geographical proximity [20,21]. SFSCs are also linked to smaller sizes that translate into production that is limited to a small zone and smaller segments of consumers. In terms of technology, long food supply chains have a competitive advantage as they possess the resources to invest in technological innovation [15]. Furthermore, SFSCs have challenged the failures of conventional food supply chains with practices that deliver sustainability outcomes, including reduced economic uncertainties, regular cash flow, food security, food sovereignty and agroecological farming [8]. Even though the sustainability of SFSCs has been extensively documented [15,16,26], the resilience of SFSCs remains largely unexplored, with just a handful of studies investigating the role that SFSCs can play in fostering more resilient food systems in times of crises [27–29]. Nevertheless, some evidence suggests that local and meso-scale shocks can severely affect local and regional supply chains' efficiency [30]. For instance, Smith et al. [28] noted that SFSCs are not able to efficiently connect with government or other organizations during times of crisis. Most recently, Farrell et al. [31] identified that the forced closure of farmers' markets during the COVID-19 pandemic increased food waste and impacted farmers' livelihoods due to their inability to continue selling their products. This anecdotal evidence suggests that the sustainability of SFSCs can be affected by their potentially limited resilience to disruptive events. Furthermore, given the fundamental differences between long and short food supply chains, there is a need for empirical research to determine how resilience emerges within shorter food supply chains.

2.2. Resilience in SFSCs

Globalization and complexity are usually associated with an increase in SC vulnerability [32–34]. Thus, current SC resilience literature mainly addresses SC resilience from a global SC perspective. From the literature, it is also evident that little effort has been directed towards marrying SFSC literature with the principles and frameworks of SC resilience. Until now, these two bodies of knowledge have remained separate.

Despite this gap in the literature, some findings and conceptualizations from the existing SC resilience literature could be transferred and applied to the SFSCs context. For instance, Sullivan-Taylor and Branicki [35] found that SMEs display some characteristics that facilitate their resilience, including little bureaucracy, rapid decision-making, quick and effective internal communications, shorter decision chains, capacity for fast learning, the ability to adapt routines and strategies quickly, and greater external uncertainty, which can favor the businesses showing more flexibility and agility. Considering that SFSCs are attractive marketing outlets for SMEs [21,36,37], it could be argued that SFSCs could also display some of these characteristics. Mari et al. [14] suggested that SC resilience is affected by SC design, particularly by three aspects: (a) the number of nodes in a geographical area; (b) the number of upstream and downstream nodes and interconnections among them; and (c) the relative importance of a node or nodes within an SC.

Examining the resilience of SFSCs, Canal Vieira et al. [38] found that they exhibit two characteristics associated with SC collaboration, namely risk-sharing and equality in decision making. It has been argued that equal distribution of risks and inclusive decision-making processes can improve collaboration, which in turn can facilitate greater levels of resilience in SCs [39–42]. Smith et al. [28] identified several resilience indicators within SFSCs in the wake of a natural disaster. They found that SFSCs displayed high levels of flexibility during the disruption, relying on locally sourced produce (i.e., flexible sourcing) and locally coordinated teams of drivers (i.e., flexible modes of delivery). SFSCs also displayed some redundancy in the form of multiple crops and suppliers. In terms of collaboration, SFSCs exhibited strong relationships between SC actors, particularly between producers and consumers, which facilitated better information flows, and certainty and stability in the supply. However, it was also noted that SFSCs were not able to connect with government or other organizations efficiently and had to rely on their own resources.

MacMahon et al. [27] found some evidence of resilience among SFSCs during times of crisis. Studying the response of SFSCs to flooding in Australia, the authors found that SFSCs were able to continue to source from local producers and deliver to their customers, while long food supply chains (especially to supermarkets) were not. Key strategies that facilitated this response were internal networks of trust and communication and highly flexible delivery modes. This latter strategy relied on local geographical knowledge, which enabled the identification of new road routes. Interestingly, the authors also found that not all types of SFSCs displayed the same level of resilience. Whilst community-supported agriculture (CSA) schemes and farmers' markets showed high levels of flexibility, diversity and adaptability, some community gardens were badly affected by flooding and were losing soil, crops, trees and complete garden plots. Pulighe and Lupia [29] argue that SFSCs, particularly urban agriculture, are drivers of regional and local food security, as they are less susceptible to global changes. The authors explained that there had been a surge in demand for urban allotments during the COVID-19 pandemic and, therefore, suggest that SFSCs may reduce uncertainties and create more resilient urban food systems.

Overall, literature exploring the resilience of SFSCs is categorically scarce. A few studies have started to shed some light on the characteristics of SFSCs that may foster resilience. However, little is still known regarding the strategies adopted to face disruptions. Available literature offers insights into how SFSCs have responded to disruptions, particularly natural disasters, but it is still unclear whether the inherent characteristics of shorter food supply chains offer any advantages for creating resilience. It is also still unclear whether different types of SFSCs possess key SC resilience capabilities such as agility, collaboration, flexibility, redundancy and visibility. Thus, this paper draws theory from SC resilience literature to investigate how resilience manifests within SFSCs. This study adopts the concept of SC resilience capabilities, which are defined as "attributes that enable an enterprise to anticipate and overcome disruptions" [39]. The following section provides an overview of SC resilience theory with a focus on SC resilience capabilities.

2.3. Supply Chain Resilience Capabilities

The concept of supply chain resilience (SC resilience) gained attention in the early 2000s after the publication of influential research by Christopher and Peck [32] and Sheffi [43]. Since then, several studies defining SC resilience have been published, and its antecedents and consequences have been explored [44]. Two topics are at the forefront, namely globalization of SCs [41,45,46] and the limitations of supply chain risk management [41,47]. Furthermore, the inadequacy of traditional supply chain risk management (SCRM) to deal with unexpected events has driven the interest in SC resilience [39,44].

Literature reviews by Hohenstein et al. [40], Kamalahmadi and Parast [33] and Ribeiro and Barbosa-Povoa [46] have identified over 30 different definitions of SC resilience. Based on some of these definitions (see Table 1), SC resilience can be characterized through attributes such as SC capability, SC readiness, SC response and SC recovery. However, terms such as SC capabilities, capability factors, SC characteristics, resilience strategies, resilience enhancers and SC resilience competencies are used interchangeably in the literature [40,44]. In this study, the term "SC capabilities" is adopted to describe the capability to create resilience against disruptions [11,39].

Table 1. Some definitions concerning Supply Chain Resilience (SC resilience).

Author	Definition of SC Resilience
Christopher and Peck [32] (p. 2).	"The ability of a system to return to its original state or move to a new, more desirable state after being disturbed."
Ponomarov [48] (p. 34).	"The adaptive capability of a firm's supply chain to prepare for unexpected events, respond to disruptions, and recover from them in a timely manner by maintaining continuity of operations at the desired level of connectedness and control over structure and function."
Hohenstein et al. [40] (p. 108).	"The supply chain's ability to be prepared for unexpected risk events, responding and recovering quickly to potential disruptions to return to its original situation or grow by moving to a new, more desirable state in order to increase customer service, market share and financial performance."
Kamalahmadi et al. [33] (p. 121).	"The adaptive capability of a supply chain to reduce the probability of facing sudden disturbances, resist the spread of disturbances by maintaining control over structures and functions, and recover and respond by immediate and effective reactive plans to transcend the disturbance and restore the supply chain to a robust state of operations."

Pettit et al. [47] consider that the importance of studying SC capabilities lies in their potential to increase resilience and diminish vulnerabilities. Several SC capabilities for developing SC resilience have been proposed: (a) a focus on logistics capabilities such as timeliness, postponement and effectiveness of logistic processes [49]; (b) a framework to improve SC resilience that considers dispersion, adaptability and flexibility [39]; (c) an SC capabilities taxonomy that incorporates agility, flexibility, redundancy, collaboration and others [44]; and (d) an identification of the most common SC capabilities, namely flexibility, redundancy, collaboration, visibility, agility and multiple sourcing [40]. Other SC resilience capabilities also identified in the literature consider information sharing as an enabler of agility [40] and capacity as an enabler of redundancy [39]. Finally, there are also interrelationships among the key SC resilience capabilities, with flexibility considered an antecedent of agility [50] and visibility an enabler of collaboration [32].

Review of literature reveals that some of the most cited SC capabilities are agility, collaboration, flexibility, redundancy and visibility. This is consistent with the findings of Christopher and Peck [32], Hohenstein et al. [40], Pettit et al. [39] and Ponis and Koronis [50]. Table 2 summarizes the key SC resilience capabilities together with authors who have referred to, identified or investigated them.

Table 2. Summary of key SC resilience capabilities, strategies and relevant articles.

SC Capability	Strategies	Relevant Articles
Agility	Communication, quick SC redesign, velocity, visibility and flexibility, close collaboration with suppliers, reduced in-bound lead-times and non-value-added time reduction.	[33,39,40,43,44,49–53]
Flexibility	Alternate distribution channels, flexible production facilities, multi-sourcing, postponement, mass customization, standardization of parts, processes and production systems.	[6,33,39,40,43,44,49–51,54]
Collaboration	Risk sharing, collaborative forecasting, communication and information sharing, trust, joint decision-making, supplier certification and development.	[32,33,39,40,43,44,49–51,53,54]
Redundancy	Emergency back-up and storage facilities, back-up sites, overcapacity, multiple sourcing, surplus raw materials and finished inventory.	[32,33,39,40,43,44,50–53,55]
Visibility	Business intelligence gathering, information exchange, collaboration with customers and suppliers, Information Technology (IT), early warning indicators, real-time/financial monitoring and information management.	[33,39,40,43,44,49–53]

This review shows how the increasingly popular topic of SC resilience can be applied to the study of resilience within SFSCs. To this end, strategies of resilience within SFSCs are investigated and summarized. The literature also offers some insights regarding how SFSCs have responded to disruptions, particularly natural disasters, but it is still very limited in terms of the wide variety of strategies that can support resilience within SFSCs. Because SFSCs differ widely from conventional supply chains in a number of factors, including the unique attributes of food [42], as well as the reduction of steps and physical distance between producers and consumers [23], the relevance and suitability of SC resilience literature need to be validated.

2.4. The Effects of Digitalization on SC Resilience

Initial efforts to document the impact of digital technologies on supply chain resilience are underway [7,17–19]. For Ivanov and Dolgui [18], the impact of digitalization on SC resilience can be complex. They highlight the use of data analytics to improve visibility, forecast accuracy and contingency plan activation. In the same vein, Big Data is said to have the potential to help in the recovery from disruptions [17]. Another study points to the fact that recent studies have focused on single digital tools at a time when in practice, companies can introduce several tools simultaneously. Therefore, the level of adoption of different digital tools can impact SC resilience [7]. Regarding food supply chains, digital technologies are said to have a significant impact on the reduction of uncertainty through the delivery of real-time data, which can increase flexibility, agility and resilience from farm to fork [19]. However, further research is needed to better understand the interrelation of the different technologies' impacts and the challenges for implementing existing solutions [19]. In short, further analysis is needed to better understand the contributions and the complex interplay of digital technologies and SC resilience capabilities [7,18,19]. In the context of SFSCs, the effect of digitalization on the resilience of the supply chain remains unexplored.

3. Case Study Research Design

Since empirical research on resilience in SFSCs is very limited, an exploratory approach seems pertinent and timely [56]. The use of case study research seems particularly suited, because the phenomenon (i.e., resilience within SFSCs) appears to be complex (there are many variables) [57,58] and deeply rooted in the real-life context [59], and the boundaries that separate it from context are not evident [58]. The research design was guided by the inherent advantages and disadvantages of the selected method and was constructed in light of restrictions on traveling, movement and socialization due to the ongoing COVID-19

pandemic. At the time of writing, social distancing measures to halt the spread of COVID-19 were still in place. Considering these restrictions, research methods that required a greater degree of social interaction (e.g., observation or participant observation) had to be disregarded as they were deemed unsuitable due to the health crisis.

3.1. Case Selection

A case study approach was used to study resilience within SFSCs. To ensure variation [60], two different SFSCs cases were selected to maximize what can be learned from a case study [57,59]. Multi-case studies also produce more parsimonious and robust evidence than single-case studies [58,61]. The selection of the cases followed a purposeful sampling procedure to discover, understand and learn as much as possible [62]. In this case, the aim was to cover the most common types of SFSCs documented in the literature: (a) farmers' markets and (b) cooperatives [63]. The selected cases serve as illustrations of the most common types of SFSCs and display different characteristics in terms of their configuration, years of operation and size. The selection of Mexico as the fieldwork setting takes advantage of the authors' familiarity with the context. Nevertheless, it also responds to the current bias in the geographical distribution of SFSCs research; most existing studies have been conducted in the USA and European countries [63]. This may hinder the transferability of findings to countries in the Global South.

The case study design focused on resilience and digitalization across the selected cases (SFSCs), not on the SFSCs cases themselves. The cases then acted as vehicles to better understand the issues being explored, and they were chosen because they were instrumental [57] in developing further understanding of specific issues [57,59,60]. Following a replication logic, each case was treated as an experiment, where each of them served to confirm, disconfirm or extend the findings [58].

3.2. Data Collection and Analysis

This study adopted semi-structured interviews as one of the methods to collect data from the selected multiple-case studies (i.e., SFSCs) because these facilitate the collection of rich data related to participants' views [64,65], with the required degree of structure and flexibility [62], and they increase reliability by ensuring that the data collection procedures can be replicated [58]. Semi-structured interviews also allow a more consistent interviewing approach within each individual case [58] and facilitate analysis and comparability of results [64]. Synchronous online interviews were administered using video-conferencing platforms [66], which allowed us to reach participants who were not otherwise accessible due to the COVID-19 pandemic. This contact method was a cost-effective and convenient alternative to face-to-face interviewing, particularly in this research, as participants are geographically dispersed [67].

Interviews with members of SFSCs took place in October 2020 and lasted 60–90 min. The interview guide consisted of two main parts, namely (A) introductory questions, and (B) SFSC resilience and digital technologies. Themes for part B of the interview were identified through the review of SC resilience literature. The focus is on some of the most commonly cited SC resilience capabilities, including flexibility, redundancy, collaboration, agility and flexibility (see Table 2). Open-ended questions were also included to identify any digital technologies that support SC resilience capabilities. The interview guide was validated through pilot testing among the intended respondents. A complete description of the semi-structured interview is included in the Appendix A. Interviews were audio-recorded and later transcribed for analysis.

SFSCs usually involve three main actors: producer (or supplier), organizer and consumer. Overall, most of the participants recruited had at least two roles within the SFSCs studied (i.e., organizer and consumer) or even three roles (producer, organizer and consumer). Therefore, the selection of interviewees was based on diversity [66] and their ability to provide different perspectives to reduce potential interview bias [61], as the most

relevant factor is not the number of respondents, but the personal contributions to the development of insight and understanding of the phenomenon [62].

Document analysis (DA) was also adopted to select, review, evaluate and synthesize documents to gain understanding and develop a thicker description of the cases. Among the advantages of DA, we find cost-effectiveness, stability (documents are not subject to change so they can be revisited), coverage (in terms of time, events, and settings) and availability [68] and an increase in credibility [69]. In this study, selected documents included text from web pages and social media, newspapers, academic studies and reports, [65] as these have proved to be useful in previous SFSC studies [70–72].

The data analysis process of semi-structured interviews and documents was based on a six-phase thematic analysis approach [73]. A thematic analysis approach guided the coding and categorizing of data, which are processes suited for the systematic, comprehensive and cumulative analysis of case study data [59]. The process is summarized in Figure 1. Phase 1 required the familiarization with the data and established a preliminary understanding of possible patterns emerging from the data. Phase 2 called for the identification of initial codes across the data. "Codes identify a feature of the data [. . .] that appears interesting to the analyst" and can be assessed to gain a better understanding of the phenomena under study [73] (p. 18). The outcome of this phase was a list of codes identified across the data. Phase 3 involved categorizing the identified codes into emergent themes. Here, consideration was given to "how different codes may combine to form an overarching theme" [73] (p. 18). Themes have been defined as significant concepts that link substantial portions of the data together [74]. In phase 4, identified codes and themes were refined. This step involved the review of "coded data extracts for each theme to consider whether they appear to form a coherent pattern" [75] (p. 9). In phase 5, names were assigned to the overarching themes based on the main aspects of the data that they represented. Lastly, phase 6 involved the writing up of individual case reports.

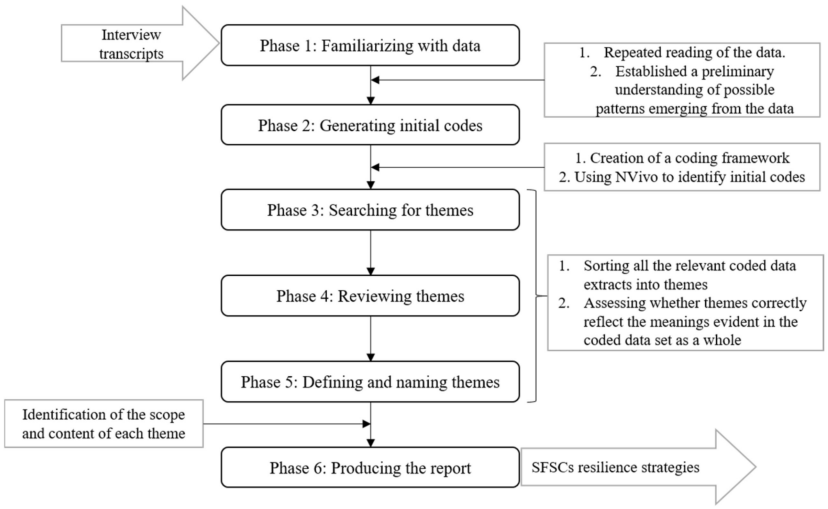

Figure 1. Thematic analysis process adopted in this study (adapted from [73]).

3.3. Research Quality and Rigor

Several criteria were used to ensure the goodness or quality of the research [76]. The audit trail was particularly important to increase dependability and transparency of the thematic analysis [77]. This technique involved keeping track of the entire coding process. A significant aspect of documenting this process is providing verbatim quotes linked to specific codes. These links are what connect participants' words (i.e., raw data) to "the data summary and interpretation generated by the researcher" [77] (p. 95). This approach can increase the capacity of external reviewers to judge the research findings fairly. Therefore, a list of codes generated during the thematic analysis was compiled, accompanied by quotes to illustrate each code.

Furthermore, transferability was addressed by comparing emerging results with existing literature. Adopting this strategy within case studies can result in wider transferability and stronger credibility [78]. This goal can be achieved by asking what is similar, what is contradictory and why. Lastly, a "thick description" of the context of the selected cases was provided, which is said to increase the ability to transfer findings to other settings [62,79].

4. Case Study Findings

4.1. Case 1—Mercado de las Cosas Verdes Tianquiskilitl

Mercado de las Cosas Verdes Tianquiskilitl was born in 2015 as a direct marketing project for *chinampa* producers in the area of Xochimilco, Mexico City. The term chinampa (from the Nahuatl word "chinamitl") refers to an ancient agricultural system integrated into shallow lake areas. The chinampas located in Mexico City comprise more than 2000 hectares, generate around 40 thousand tons of agricultural production per year and support the livelihoods of more than 12 thousand people. The agricultural system is important in terms of biodiversity as it houses 2% of the world's biodiversity and 11% of the national biodiversity, including 139 species of vertebrates, 21 species of fish, 6 amphibians, 10 species of reptiles, 79 species of birds and 23 species of mammals [80]. In 1984, chinampas were declared Cultural Heritage of Humanity by UNESCO for preserving pre-hispanic agricultural knowledge and technologies. In 1992, the Mexican government declared the zone a natural protected area [81].

Apart from offering agroecological products grown in chinampas, such as vegetables, honey, flowers and dairy, chinampa producers organize workshops related to activities that they perform daily in the chinampas. Before the COVID-19 pandemic, Mercado de las Cosas Verdes Tianquiskilitl took place every Sunday from 10:30 am to 4:00 pm [82]. However, since March 2020, it operates as a newly formed network named "Red de consumo solidario Tianquiskilit" (solidarity consumption network Tianquiskilit). Through this network, members of Mercado de las Cosas Verdes Tianquiskilitl carry out home deliveries or collections from two different locations [83]. This means that the farmers' market is not operating in its regular venue, and socialization has been drastically reduced to slow the spread of COVID-19.

The different actors involved in Mercado de las Cosas Verdes Tianquiskilitl are consumers, organizers, processors and producers. The logistical and managerial work is handled by a set of organizers and a coordinator. All the organizers are producers or processors too. Currently, Mercado de las Cosas Verdes Tianquiskilitl has seventeen members, including producers and processors. Table 3 provides a categorization of current members.

Table 3. Mercado de las Cosas Verdes Tianquiskilitl members characterization.

Category	Description
Producers	Small-farmers, and agricultural collectives, associations, cooperatives or small enterprises in chinampas
Processors	People, collectives, associations, cooperatives or small enterprises who use artisan processes
Customers	People ("allies") committed to the farmers' market and the individual projects of producers
Organizers	People responsible for logistical and managerial work

Interviewee 1 (INT1) explained that at the beginning of the farmers' market, all members were *chinamperos* (chinampa producers). However, because chinampas are not suitable for growing fruits, the organizers of Mercado de las Cosas Verdes Tianquiskilitl decided to expand the selection of products by inviting producers who do not use chinampas. Currently, only the producers of vegetables, maize, dairy and flowers are *chinamperos*. The rest are local producers from the preservation zones of Mexico City. Preservation zones cover 59% of Mexico City surface, with more than 28,599 hectares destined for agricultural

production [84]. INT3 explained that most members are small farmers or small collectives that offer mostly seasonal produce. This means that during the year, the produce on offer will vary depending on availability. This also means that the number of members offering products during the year will fluctuate depending on the seasons.

4.2. Case 2—Colectivo Zacahuitzco

Colectivo Zacahuitzco was founded in 2015 in Mexico City. It is an SFSCs that prioritizes the direct relationship between producers of healthy food with urban consumers concerned about the quality of the food they consume and farmers' livelihoods in rural areas [85]. An initial objective of founding members was to get access to foods without pesticides, hormones or synthetic additives, acquired outside of large commercial chains, directly from small producers or processors. A second objective was to provide the opportunity for some of the founding members to participate as producers or processors. The axis of action of the group is the exchange: of money for products, of products for other products, of products for services or exchange of knowledge. Thus, Colectivo Zacahuitzco is understood by its members as a cooperative or collective of consumption–production–exchange [86].

Colectivo Zacahuitzco members include consumers, producers and processors from Mexico City and neighboring states such as the State of Mexico, Puebla, Tlaxcala and Morelos [87]. Currently, Colectivo Zacahuitzco offers products from more than 60 producers that are delivered to more than 200 members via *Mawi*, a solidarity store [88]. There is not a clear organizational structure because the collective is owned by all its members. A characterization of current members is provided in Table 4.

Table 4. Colectivo Zacahuitzco members characterization.

Category	Description
Consumer members	Members that buy from *Mawi* but do not participate in the operations of the store or Colectivo Zacahuitzco.
Supplier members	Members that supply *Mawi* regularly and are involved with the operations of Colectivo Zacahuitzco. Typically, small-farmers and agricultural collectives, associations, cooperatives or small enterprises.
Members	People involved in running Colectivo Zacahuitzco or *Mawi* but do not supply.
External suppliers	People not involved in the operations of Colectivo Zacahuitzco. Typically, small-farmers, and agricultural collectives, associations, cooperatives or small enterprises.

Most members involved in the operations of Colectivo Zacahuitzco are both consumers and suppliers. These are involved in a dynamic co-creation process, where members may decide to become more actively engaged in the operations of Colectivo Zacahuitzco at any point or step down to a more passive role as a mere consumer member [88]. It is also common for consumer-members to become suppliers.

4.3. A Cross-Case Analysis of SC Resilience Capabilities within SFSCs

Findings from interviews suggest that both Mercado de las Cosas Verdes Tianquiskilitl and Colectivo Zacahuitzco possess all the SC resilience capabilities identified in Table 2, namely flexibility, redundancy, collaboration, visibility and agility. The main strategies adopted are summarized below in Table 5. It is interesting to notice that some strategies are adopted in both cases under study, even though they are two different types of SFSCs. For instance, collaboration with external actors (e.g., other SFSCs and producers) and the use of digital technologies for information sharing were identified as enablers of resilience in both cases. Similarly, multiple sourcing and the ability to quickly replace a supplier were highlighted as strategies that enable redundancy in both organizations.

Table 5. A summary of the main themes associated with different SC resilience capabilities.

	Mercado de las Cosas Verdes Tianquiskilitl		Colectivo Zacahuitzco	
SC Resilience Capability	**Themes**	**Illustrative Quotes**	**Themes**	**Illustrative Quotes**
Flexibility	Product diversification and small-scale production	"As we do not produce on a large scale, it is a little easier to be able to sell a wide variety of products. I mean, we offer about 200 different products supplied by more than 15 farmers or collectives, and the fact that we offer most of the products of the basic food basket makes us quite adaptive. We could sell our products in any market thanks to their quality, freshness, variety and uniqueness" (**INT1**)	The adaptability of the consumer base.	"They know that there will not always find everything in Mawi. We are not a supermarket where you find Mango in May, in December, or at any time of the year. Here everyone knows what is in season. They know that during a certain time we are going to have a lot of mandarins, but that they are going to run out and the guavas are going to follow." (**INT8**)
	Flexibility in fulfillment	Regarding the situation during the COVID-19 pandemic: "Well, everything has changed, from how we communicate with our allies to how we handle orders and deliver the products. We had to develop new skills because we are just producers, we did not know how to take orders via the internet. And compiling orders and keeping inventories up to date is really time-consuming" (**INT3**)	Flexibility in fulfillment	"The pandemic affected the availability of volunteers to run the store. Members who regularly volunteered, suddenly had to stop because they were older and at a greater risk of getting COVID-19. The same happened with members who were younger but lived with their parents. Fortunately, other members stepped in. For example, there were people who had strict office hours but during the pandemic they worked from home. So, they had a little spare time or more flexibility to volunteer in the store" (**INT6**)
	Flexibility in sourcing (Collectives or cooperatives multi-sourcing)	"That is why it is important to work with organized groups, collectives or cooperatives, because we know that the commitment is different and, if one person cannot be there, another one will get the work done. We have seen that it works." (**INT5**)	Flexibility in sourcing	"When an earthquake fractured the chinampa of our main supplier of vegetables, we were able to source from one of our external suppliers. Clearly from an offer of 20 vegetables, maybe we had 8 vegetables, 8 varieties. And it took us around 2 or 3 months to repair and replant the chinampa. So, for three months we had to live with a smaller variety of vegetables from our external (secondary) suppliers, so during that time they became our primary suppliers" (**INT9**)
Redundancy	Multiple sourcing	"When we first decided to switch to online delivery and collections due to the pandemic, a couple of producers who supply meat and amaranth did not join us because they thought the new system would not work. Luckily, we were able to quickly replace them. At the end, the producers that left decided to come back." (**INT3**)	Multiple sourcing	"Regarding perishables it is easy to substitute a supplier because we know a lot of people. So, for example, if a producer runs out of onions, well, we already know another one. So, in terms of perishables, yes, we have the ability to find replacements, we already have a list. Some Colectivo Zacahuitzco members have a lot of contact with producers because of their jobs. For instance, X has a list of people she has met before who produce, and who can be our temporary or permanent suppliers." (**INT6**)
	Back-up facilities and savings	"We received some funding from a project last year, so we decided to rent a second storage unit. So when we were affected by the pandemic we were already prepared with that, which allowed to quickly set up a collection point for customers" (**INT4**)	Inventory	"In terms of perishable goods, for example vegetables, I think we have enough to survive a natural disaster, right? The fact that we have a greenhouse in the farm gives us a lot of protection during weather-related disasters. In terms of non-perishable products, we have the capacity to stock 30 days' worth of inventory at best." (**INT8**)

Table 5. *Cont.*

	Mercado de las Cosas Verdes Tianquiskilitl		Colectivo Zacahuitzco	
SC Resilience Capability	**Themes**	**Illustrative Quotes**	**Themes**	**Illustrative Quotes**
Collaboration	An atmosphere of trust and support	"I feel that our collaboration is based on trust and constant communication among members. For instance, if there is something, a problem that is preventing us or making it difficult for us to continue operating, we sit down, talk and try to solve things in the most efficient way and as quickly as possible." (**INT3**)	CSA-style partnership	"Our rice suppliers were badly affected during the earthquake of 2017. Their mill collapsed so we gathered tools and materials and took them to their farm so they could start repairing the damages. After that, we supported them for two consecutive years by paying in advance for certain amounts of their production." (**INT6**)
	Connection with other SFSCs	During the pandemic, there were some farmers' markets that approached us to ask for support regarding how we were working, right? Which were the mechanisms that we were using to receive orders from our allies? And then there was an exchange of advice, right? From them to us too. Like when we need to quickly replace a supplier, we come to them. (**INT5**).	Connection with other SFSCs	"During the pandemic, we were worried about us but also other food networks. Because, well, we have a physical store and we didn't need to close. However, for example, the MAT had to close down because they use a public venue. So, we quickly started wondering how to help MAT producers to distribute their product. Luckily, some producers were able to join our collective to keep afloat and that also helped us to keep up with the increased demand." (**INT8**)
Visibility	Centralized communication	"As organizers, we are always aware of everything that may affect the producers' attendance to the market. They communicate it to us directly. And if they want help from us, we see a way to help them, for example, when they have a money problem. Where we have a blind spot is in the production process. For instance, we are not following their production schedules, we only visit their production units or farms from time to time to check that the required agroecological practices are met." (**INT4**)	Decentralized communication	"Information flows quite efficiently because there is no purchasing department that manages all the suppliers. Instead, each of us is responsible for a few suppliers. We are the direct link with those suppliers, so they communicate with us if an issue regarding production or supply emerges. This way, we can solve problems immediately in most cases." (**INT6**)
	The use of digital technologies	"One time, it was the middle of the week when we noticed that traffic was getting really bad close to our collection point because of the construction of a bridge nearby. So, we decided to change our collection point. This was communicated to our consumers on a Thursday, which gave them a three-day notice. Luckily, they all supported the change and were able to collect their products from a different location." (**INT3**)	Use of digital technologies	"Well, before the pandemic, we had already set up the chats and implemented the 'order and collect' system to minimize food waste. So, when the pandemic started, we were able to implement home deliveries quickly. I think having the chats helped us a lot." (**INT9**)

Table 5. *Cont.*

	Mercado de las Cosas Verdes Tianquiskilitl		Colectivo Zacahuitzco	
SC Resilience Capability	**Themes**	**Illustrative Quotes**	**Themes**	**Illustrative Quotes**
Agility	Extensive networks and connections with other producers and SFSCs	"One Saturday afternoon, a producer of rabbit meat told us that she did not have any rabbits to supply the next day. So, I quickly spoke to a friend who also sells rabbit meat. He told me he got us covered and delivered the rabbits that same day in the afternoon. That way we were able to fulfil orders the next day" (**INT1**)	Collaboration and networking with other SFSCs	"I believe the pandemic forced us to form alliances among us. We came together to send a message to the community to say 'yes, we are open, and we are going to continue providing this service, in these spaces, or in this new way'. So, I think that gave us an opportunity to start differentiating ourselves as alternative food networks." (**INT10**)
	Use of digital technologies	Talking about the adoption of a business model based on "click and collect" and home deliveries during the COVID-19 pandemic:" If I had not come up with the idea, I think that we would have stopped operating, and each producer would have attempted to continue operating individually. In the beginning, there was a reluctance towards online deliveries, but when I explained that I already knew how to do it, they got on board. So, I think the idea and initiative came from a person, in this case, me" (**INT2**)	Use of digital technologies	"The first orders were delivered on a Saturday, and by Monday, a meeting was being called via zoom to talk about emergent issues. For example, we needed to urgently buy a cooler for the delivery of dairy products and meat. In other words, we were talking about all the needs. So, implementing home deliveries was easy, but there was a learning curve." (**INT7**)

On the other hand, different strategies seem to support the same resilience capability within Mercado de las Cosas Verdes Tianquiskilitl and Colectivo Zacahuitzco. For instance, collaboration in Mercado de las Cosas Verdes Tianquiskilitl is based on trust and constant communication among members. An important element of Colectivo Zacahuitzco is its CSA-style partnership, which has allowed it to recover after disruptions through risk-sharing, commitment, solidarity and building networks. Another example relates to visibility. In this regard, the two cases share information using centralized and decentralized communication, respectively. In Mercado de las Cosas Verdes Tianquiskilitl, information flows from consumers to producers mainly through the organizers. On the contrary, in Colectivo Zacahuitzco, information is self-managed and decentralized to a large extent. Some of the members who are more involved with the operations of Colectivo Zacahuitzco are given the responsibility to manage a few suppliers, for instance, to verify products' quality and labeling, timely delivery and payments to suppliers. Both organizations suggested that these strategies support resilience through an improvement in their information sharing.

4.4. A Cross-Case Analysis of the Role of Digital Technologies as Enablers of SC Resilience Capabilities within SFSCs

The role of digital technologies was recurrent within the interviews. Concerning the digital strategies associated with different SC resilience capabilities, Table 6 provides a series of common points that deserve to be summarized before further discussions.

Both cases suggest the relevance of digital technologies and associated strategies to increase the resilience within SFSC. Concerning flexibility, both cases were able to change their modes of operations by adopting online business models and home delivery. In relation to collaboration, interviewees from both SFSC were explicit in the role of digital technologies as facilitators. They explained that digital technologies facilitate constant communication among all the supply chain actors and quicker decision-making, especially during disruptions. Digital technologies were also linked to an increase in visibility. The

use of chats to support communications among the different members was fundamental to facilitate efficient information sharing. Finally, digital technologies increased SFSC agility as they supported digital business models' adoption during the COVID-19 pandemic.

Table 6. Summary of digital technologies contributions to strategic capabilities.

Strategic Capabilities	Mercado de las Cosas Verdes Tianquiskilitl	Colectivo Zacahuitzco
Flexibility	New online model was implemented using Excel to compile orders and WhatsApp to receive orders from consumers.	Quick change to home delivery based on digital technologies (e.g., orders placed via WhatsApp chats)
Collaboration	Digital technologies as facilitators to re-establish or extend communication (e.g., meetings hold via Zoom, Google Meet and WhatsApp).	Digital technologies used to re-establish or extend communication (e.g., meetings hold via Zoom, Google Meet and WhatsApp).
Visibility	Digital technologies, in particular WhatsApp and social media, supports visibility and information exchange along the SC.	The use of digital technologies, such as WhatsApp, and the creation of chats has enhanced visibility and facilitates a quick and efficient flow of information
Agility	Digital technologies fundamental to change operation (e.g., WhatsApp, Excel, etc.)	Use of digital tools for quick decision-making (e.g., Zoom).

A relevant aspect concerning the use of digital technologies to support information management is that the same tools (e.g., Excel, WhatsApp and Zoom) can be used within centralized (Mercado de las Cosas Verdes Tianquiskilitl) and decentralized (Colectivo Zacahuitzco) SFSCs. When it comes to adopting digital technologies, both organizations explained that collaboration with other SFSCs was key to share best practices. Colectivo Zacahuitzco quickly scale up the use of digital technologies to implement an "order-and-collect" system to keep operating safely during the COVID-19 pandemic. Mercado de las Cosas Verdes Tianquiskilitl quickly designed an "order-and-collect" and delivery system to continue their operations after their physical venue's closure. They explained that advice received from Colectivo Zacahuitzco was key for their survival.

5. Discussion

A case study was conducted to provide an initial exploration of the most common SC resilience capabilities within the context of SFSCs. The analysis of flexibility, redundancy, collaboration, visibility and agility indicates that SFSCs display a wide variety of SC resilience strategies. To some extent, our findings are in line with Smith et al. [28], who suggest that some indicators of resilience transcend the long–short supply chain dichotomy. Indeed, several strategies observed within long or global supply chains were also observed within SFSCs. Nevertheless, some strategies, such as postponement, mass customization, standardization of processes/products, multi-modal transportation, collaborative forecasting and early warning indicators [39,43,54], were not identified by participants.

Regarding collaboration, the significant role of risk-sharing and inclusive decision-making processes is well established in the literature [38–41]. Our findings suggest that risk-sharing was evident in one of the cases, Colectivo Zacahuitzco, which is a hybrid SFSC. The use of CSA-style partnerships has supported suppliers' recovery after disruptions by means of risk-sharing, commitment, solidarity and building networks. However, this was not evidenced in Mercado de las Cosas Verdes Tianquiskilitl, a farmers' market. Instead, they explained that collaboration is based on trust and constant communication among members, enabling quick decision-making processes. Both SFSCs highlighted the key role that digital technologies, such as YouTube, Zoom, Google Meet and WhatsApp, play in facilitating communication with internal and external stakeholders during crisis times. Unlike findings suggesting that SFSCs are not able to connect with organizations and have to rely on their own resources in times of crisis [28], Mercado de las Cosas Verdes

Tianquiskilitl and Colectivo Zacahuitzco explained that other SFSCs have been supportive and key in fostering knowledge exchange.

In terms of flexibility, the role of flexibility in fulfillment has been identified in previous literature pertaining to SFSCs and conventional supply chains [28,39]. Our findings suggest that this strategy can involve adopting new business models (e.g., home deliveries and click-and-collect) and digital technologies to create electronic product catalogs, WhatsApp chats and databases, as well as the reallocation of resources and quick training of members. Additionally, we identified that flexibility in sourcing is based on two main characteristics. First, suppliers affected by disruption are easily replaced because SFSCs' members bring with them extensive networks of relationships with other producers. Second, many SFSCs' members are collectives, groups or cooperatives themselves rather than individual producers. Therefore, if a particular individual cannot deliver the products, the individual groups can easily substitute that person and ensure that products are still delivered to the SFSCs. In this sense, a network of SFSCs can be nested within another SFSC. For instance, a farmers' market can comprise members who are SFSCs themselves (e.g., CSA schemes, cooperatives, etc.).

SC resilience literature suggests that multi-sourcing is an important strategy associated with redundancy development [6,33,40]. A previous study has also identified that SFSCs can display redundancy in the form of multiple crops and suppliers [28]. Our findings suggest that redundancy is reflected in the ability to substitute producers when needed quickly. Interviewees explained that they are constantly receiving requests from suppliers to join their SFSCs. All their data are saved in case there is a vacancy or the need to substitute a supplier quickly. Another important aspect of redundancy is the availability of redundant resources, for instance, an emergency fund created from the fees paid by members. This emergency fund has been key in helping producers who have faced losses due to weather-related events.

Regarding visibility, SC resilience literature has identified several strategies that support the ability to see the structures, processes and products along the whole supply chain [32,39,42], including information exchange, collaboration with customers and suppliers, information technology (IT) and information management [33,40,42]. Our findings suggest that SFSCs also adopt all these strategies, which are increasingly supported by IT. There was a general agreement that digital technologies, such as WhatsApp and social media, have enhanced visibility and facilitated a quick and efficient flow of information along the SC. Information exchange regarding inventory levels, store schedules and consumer orders occurs via WhatsApp chats. This information exchange model has allowed SFSCs to communicate directly with each consumer and supplier to reconfigure their SC in the face of disruptions quickly.

Lastly, the role of agility has not been extensively investigated within SFSCs. Nevertheless, SC resilience literature suggests that strategies such as quick SC redesign, velocity, visibility and flexibility support this capability [32,40,50]. Our findings emphasize the extensive networks and connections and proximity of SFSCs members with other producers and SFSCs. Participants explained that connections and proximity with external producers had supported their quick response to sudden changes in supply. This aspect seems to be linked to the concept of velocity, which refers to the time it takes to move product and materials from one end of the SC to the other [33]. Findings suggest that the shortening of the food supply chain supports velocity and, therefore, agility. In this regard, participants added that collaboration and direct communication with suppliers are important to ensure timely response to fluctuations in supply. By having a direct line of communication with suppliers and reduced in-bound lead times, SFSCs can quickly deal with issues such as shortages or disruptions at the farm level. During the COVID-19 pandemic, communication within and between SFSCs was facilitated by adopting digital technologies such as YouTube, Zoom, Google Meet and WhatsApp. SFSCs also showed the ability to quickly redesign their SC, particularly during the COVID-19 pandemic. This change was supported

by the adoption of new business models based on digital technologies [89] to minimize the effects of disruptions.

The strategies that support the five SC resilience capabilities explored in this study are summarized in a conceptual framework (see Figure 2). This framework highlights the strategies that have supported resilience within SFSCs in the past. It also maps out how the same strategies can support more than one SC resilience capability. For instance, multiple sourcing can support redundancy but is also an integral part of flexibility in sourcing, which can support flexibility. It is also suggested that specific strategies may support others. For instance, the adaptability of the consumer base could be driven by risk-sharing partnerships (e.g., that demand adaptability of consumers by providing produce boxes that vary depending on the season). Nevertheless, further research is needed to corroborate this.

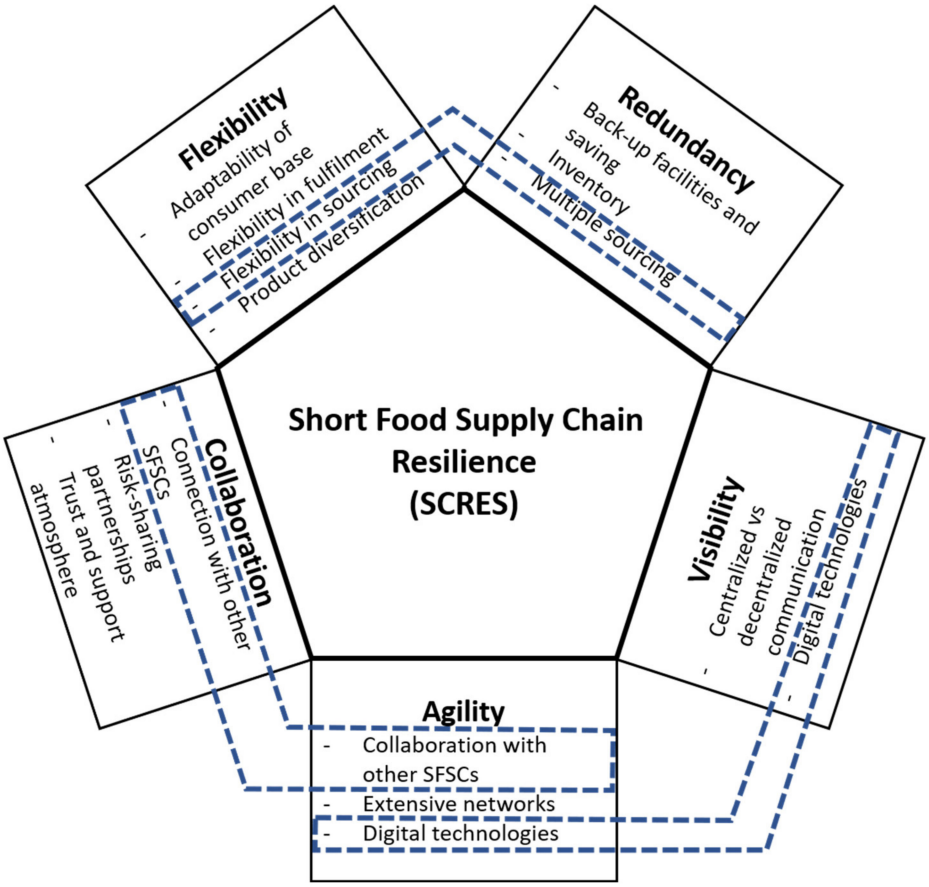

Figure 2. SFSC resilience capabilities and associated strategies (own elaboration).

6. Conclusions

The resilience of food supply chains is an increasingly important topic considering the current volatile environment surrounding food systems. Despite a growing interest in the concept of resilience from a number of SC research fields, existing research focuses largely on long supply chains. Therefore, little is known regarding the resilience of short food supply chains. In response, the objectives of this study were to examine the SC resilience capabilities of SFSCs and to explore the potential role that digitalization can play in enabling resilience. We chose to conduct a multiple-case study to collect in-depth data from two SFSCs in Mexico. This study revealed a wide variety of strategies that support five SC resilience capabilities, as summarized in Table 5. Findings suggest that SFSCs possess the five SC resilience capabilities investigated here, namely flexibility, redundancy, collaboration, visibility and agility.

Interestingly, the two types of SFSCs investigated coincided in using certain strategies, including multiple sourcing, flexibility in fulfillment and sourcing, collaboration with

external actors, and digital technologies for information exchange and quick redesign of the SC. However, differences were also identified that can be attributed to the inherent characteristics of different types of SFSCs. For instance, risk-sharing was identified as a strategy that increases collaboration in Colectivo Zacahuitzco (a cooperative-CSA hybrid) but was not adopted by Mercado de las Cosas Verdes Tianquiskilitl (a farmers' market).

Our findings suggest that some indicators of resilience transcend the long-short supply chain dichotomy. Indeed, several strategies observed within long or global supply chains were also observed within SFSCs. Nevertheless, some strategies such as postponement, mass customization, standardization of processes/products, multi-modal transportation, collaborative forecasting and early warning indicators seemed irrelevant in the context of SFSCs. Additionally, some strategies such as direct line of communication with suppliers and reduced in-bound lead-times seem to be linked to and supported by the inherent proximity among actors within SFSCs. This could suggest that the shortening of the supply chain plays an important role in the development of SC capabilities and associated strategies.

This study contributes to the advancement of knowledge on the resilience of SFSCs. From an academic perspective, this study extends previous research conducted in developed countries by providing empirical evidence regarding five common SC resilience capabilities and associated strategies. This paper also provides empirical evidence regarding the role that digitalization can play in supporting resilience within SFSCs, something that previous studies have not reported. To the best of our knowledge, our research is the first one to propose a conceptual framework for resilient SFSCs. This study also expands current SC resilience literature to include findings from SFSCs. Short food supply chains are vulnerable to disruptions and their capability to withstand shocks can affect or contribute to the resilience of the wider food system. This contribution seems particularly relevant considering the current COVID-19 pandemic, which has put extra pressure on the entire food system.

From a practical perspective, these findings raise important implications for SFSCs' actors looking to improve their collective resilience against disruptions. Findings summarize the main strategies that have supported the resilience of SFSCs in the past. For instance, SFSCs actors could look to adopt multi-sourcing and product diversification to enable flexibility. Investing resources in back-up facilities and creating emergency funds can improve redundancy. A strategy to increase agility and collaboration is to extend networks and connections with other producers and SFSCs. Consideration could also be given to the use of accessible digital technologies to further develop SC resilience capabilities. For instance, information exchange regarding inventory levels and store schedules, new business models (e.g., home deliveries and click-and-collect) and quick decision-making processes can be supported using freeware, mobile apps and social media. This study summarizes the main strategies that have supported the resilience of SFSC in the past. The conceptual framework can be used as guidance to embed resilience capabilities based on the SC resilience capabilities that SFSCs actors are looking to enhance. A key finding is the importance of low-cost digital technologies (including freeware and social media) that can support several SC resilience capabilities and strategies.

7. Limitations and Future Research Directions

The choice of the case study was justified by the need for exploratory research focused on the resilience of SFSCs within their real-life context. However, we recognize the need for further research to test, expand and refine our findings and conceptual framework. A more rigorous theory-building process could be accomplished by using a wider variety of cases and research methods. However, the comparison of existing SC resilience literature and the findings from this research did not show significant contradictions, which provides some confidence in the ability to transfer results beyond the context of this study. Future research should aim to incorporate additional SC capabilities that were not included in this study. Furthermore, the role of digital technologies within SFSCs deserves additional exploration. For instance, research focused on the challenges for adoption could inform policymakers

interested in supporting the development of SFSCs. Lastly, future research could focus on exploring the relationship between sustainability and resilience within SFSCs to better inform actors regarding strategies that support both goals.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to anonymity and confidentiality purposes.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

INTERVIEW GUIDE
Part A: Introductory questions, supply chain design
Introductory questions

(1) SFSC name:
(2) SFSC age:
(3) Your present position:
(4) Duties and responsibilities:
(5) Years spent with this company:
(6) Total number of producers:
(7) Total number of employees:

Part B: SFSCs resilience and digital technologies
Supply chain resilience definition:

> "The adaptive capability of a firm's supply chain to prepare for unexpected events, respond to disruptions, and recover from them in a timely manner by maintaining continuity of operations at the desired level of connectedness and control over structure and function".
>
> (Ponomarov and Holcomb, 2009)

Supply chain resilience capabilities definition:

> "Attributes that enable an enterprise to anticipate and overcome disruptions".
>
> (Pettit et al., 2010)

Digital technologies definition:

Digital Technologies "refers to the application of a set of technologies related to digital transition whose scope extends beyond organisational boundaries and involves intelligent supply chain and connected customers" (Núñez-Merino et al. [90]).

Flexibility

Definition: "The ability to take different positions to better respond to abnormal situations and rapidly adapt to significant changes in the supply chain" (Kamalahmadi and Parast, 2016).

(1) Do you think that your organization possess the capability of flexibility to anticipate and overcome disruptions? Probing if necessary Can you offer practical examples? (Example: alternate distribution channels, flexible production facilities, multi-sourcing, fast problem solving and decision-making, etc.)
(2) Do digital technologies support the strategies that you mentioned regarding flexibility?

Redundancy

Definition: The capacity to respond to disruptions by investing in resources before they are needed (Kochan and Nowicki, 2018).

(1) Do you think that your organization possess the capability of redundancy to anticipate and overcome disruptions? Probing if necessary (Examples: emergency back-up and storage facilities, back-up sites, overcapacity, multiple sourcing, etc.) Can you offer practical examples?
(2) Do digital technologies support the strategies that you mentioned regarding redundancy?

Collaboration

Definition: "Ability to work effectively with other entities for mutual benefit" (Pettit et al., 2010).

(1) Do you think that your organization possess the capability of collaboration to anticipate and overcome disruptions? Probing if necessary Can you offer practical examples? (Examples: risk sharing, collaborative forecasting, communication and information sharing, trust, joint decision-making, supplier certification and development)
(2) Do digital technologies support the strategies that you mentioned regarding collaboration?

Agility

Definition: "The ability to respond rapidly to unpredictable changes in demand or supply" (Christopher and Peck, 2004).

(1) Do you think that your organization possess the capability of agility to anticipate and overcome disruptions? Probing if necessary Can you offer practical examples? (Examples: quick SC redesign and decision-making)
(2) Do digital technologies support the strategies that you mentioned regarding agility?

Visibility

Definition: "The ability to see from one end of the pipeline to the other" (Christopher and Peck, 2004).

(1) Do you think that your organization possess the capability of visibility to anticipate and overcome disruptions? Probing if necessary Can you offer practical examples? (Examples: effective and efficient flow of information, business intelligence gathering, Information exchange, collaboration with customers and suppliers, Information technology).
(2) Do digital technologies support the strategies that you mentioned regarding visibility?

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