EMPIRICAL EXAMINATION OF FOOD HUB ENTREPRENEURSHIP MODELS, SUPPLY CHAIN RISKS, AND NETWORKS

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ABSTRACT

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Over the last three decades, increasing consumer demand in the United States for locally produced food has led to a re-emphasis on local and regional food systems and the emergence of new organizational structures to coordinate these food systems. One specific food system innovation has been the introduction of organization known as food hub. Although the number of food hubs in the United States has grown over the past decade, a dominant design for these organizations is still emerging and there still exists a lack of clarity about their purpose in the food system. Secondly, little is known about the risks that this novel type of organization faces. Finally, there is a dearth of knowledge about the specific networks that are critical to support food hub viability.

Food hubs have the potential to be key drivers of the success of local and regional food supply chains. If food hubs are to be viable in the long run, it is important to further investigate the key characteristics of these organizations, identify and assess risks that foods hubs face, and identify and examine specific networks critical for food hubs' viability. This has underlying implications for the development of more effective strategies for practitioners and policymakers, and the economic viability of small- and medium-sized farms and food entities that supply those food hubs.

Consequently, to fill these research gaps, the first paper of this dissertation employs a case study research design to examine the entrepreneurial processes in food hubs to identify key similarities and differences among food hubs with different organizational structures. The second

paper focuses on identifying and assessing food hub supply chain risks by employing an exploratory sequential mixed methods research design. Finally, the third paper examines social capital in food hub networks in the form of food hub managers' advice networks by using a survey research design.

The findings of the dissertation have implications for food hub practitioners as well as policymakers and other stakeholders involved in the development of food hubs. First, the findings show that food hubs are social enterprises simultaneously creating social and economic value. This work also provides a systematic comparison of different food hub models and develops an *Empirical Framework of Food Hub Models* to capture key similarities and differences in food hubs. Second, this work is the first in the field of food hubs to systematically identify and assess supply chain risks. The findings show that the top ten supply chain risks perceived by food hubs are present in all levels of the supply chain. Finally, the third paper is the first attempt in the field of food hubs to model and examine social capital in the form of advice. The results show that the characteristics of individuals, ties, and networks are associated with the likelihood of receiving food hub-related advice in food hub managers' professional networks.

To my mother, Narine, and late father, Myasnik.
With all my love.

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INTRODUCTION

Over the last century, the U.S. agri-food system has experienced wide-sweeping structural changes. Two of the major structural changes are reflected in the production and retail sectors. In the sphere of the production, there has been a dramatic decline in the number of small- and medium-sized farms and a concurrent rise in farm size (Lobao and Meyer, 2001). Furthermore, the medium-sized independent family farms (referred to as "agriculture-of-the-middle") are endangered and predicted to disappear (Kirschenmann et al., 2008).

The second major structural change has been the consolidation in the retail sector (Maciel and Bock, 2012). The restructuring of the food retail sector has dramatically impacted smaller farmers and food processors. The demands of increasingly large food retailers make it more difficult for smaller producers and food processors to respond and compete effectively (Hendrickson and Heffernan, 2002). In particular, smaller producers and food processors face significant barriers to entry that limit their ability to consistently deliver the quantity and product quality standards required by large food retailers. These barriers include: lack of economies of scale and scope, costly food safety requirements (ZumBrunnen et al., 2015), and limited access or lack of infrastructure (Merrigan, 2012; Pirog and Bregendahl, 2012). As a result, many smaller farmers and food processors have been increasingly excluded from regional agri-food markets (Hendrickson and Heffernan, 2002).

These structural changes have major implications not only for independent family farms whose livelihoods rely on farming, but also for society at large. In particular, among the major social and environmental benefits these independent family farms generate are: providing consumers with an opportunity to choose foods with desirable attributes (i.e., diversity of food, choice), providing habitat for wildlife, crop diversity (as opposed to monocrops), and diversified

farmland (Kischernmann et al., 2008). The rapidly declining number of smaller farms will result in long-term losses for society in terms of diversity of food and environmental resources.

In response to the consequences of the structural changes in the production and retail sectors, a new agri-food movement, the local food movement, has emerged (Galt, 2017; Hinrichs and Eshleman, 2014; Pirog et al., 2014; Marsden and Franklin, 2013; Nonini, 2013; Lyson, 2011; Turrell, 2011; Starr, 2010; Wright and Middendorf, 2008; Coit, 2008). One of the central objectives of the local food movement is supporting small- and medium-sized farmers' economic viability (Coit, 2008). The local food movement has significantly catalyzed the demand for local foods among consumers. Coit (2008) categorized "four main areas of concerns" that consumers have as a basis for their decision to buy local foods: (1) sense of connection between consumers and agricultural producers, (2) product quality, (3) environmental impacts and energy consumption, and (4) social and political support for local farmers. This increasing demand for local foods among consumers has led to the reemphasis of local and regional food systems and the emergence of new organizational structures to coordinate and strengthen these food systems. Farmers' markets and community-supported agriculture (CSA) are among the well-known organizational structures and forms of direct marketing primarily for small farmers and food entities. The number of farmers' markets and CSAs in the U.S. has grown rapidly over the past three decades. In the early 1980s, the CSAs numbered only in the single digits, and in the early 1990s there were fewer than 2,000 farmers' markets (Phillips and Wharton, 2015). According to USDA (2020), currently there are 8,771 farmers' markets listed in the National Farmers Market Directory. Also, based on data collected by USDA in 2015, there are approximately 7,398 CSAs (USDA official website). Previous research has shown that farmers' markets and CSAs play an important role for small farmers' economic viability as well as for community development.

Despite these benefits, these organizational structures also have limitations for small- and medium-sized producers who intend to scale up their production in order to reach financial returns they need to "survive and subsist into future as a business" (Phillips and Wharton, 2015). Additionally, there are limitations associated with time spent at multiple farmers' markets, week-to-week sales fluctuations, among other limitations.

While farmers' markets and CSAs have been booming over the last two decades, a new organizational structure known as food hubs has emerged. Food hubs source food from local and regional farmers and food entities and market the foods locally and regionally primarily to wholesale buyers such as grocery stores, institutions (e.g., schools and hospitals), and foodservice companies. According to a USDA report (Feldstein and Barham, 2017), there are approximately 360 food hubs in the U.S., three-quarters of which were established since 2007.

Although the number of food hubs in the U.S. has grown over the past decade, a dominant design for these organizations is still emerging and there is no universal consensus as to what constitutes a food hub. Part of the reason for this is that the purpose of food hubs in the food system is still debated among practitioners and in the academic literature. Specifically, there is a lack of clarity about whether food hubs primarily pursue a social mission, monetary incentives, or both simultaneously. This debate becomes even more complex when taking into consideration the heterogeneity of food hubs' legal business structures and the primary markets they serve. Food hubs have the potential to be key drivers of the success of local and regional food supply chains. If food hubs are to be viable in the long run, it is important to further investigate the characteristics of these organizations and better understand the purpose of food hubs in food systems. This, in turn, has underlying implications for strategy development for practitioners and policy makers.

Accordingly, the first paper of this dissertation, entitled *Empirical Examination of Food Hub Entrepreneurship Models: A Comparative Case Study Analysis Approach*, proposes that to understand the purpose of food hubs in the broader food system, it is important to examine the entrepreneurial processes by which they are formed. The study employs a multiple-case study research method and application of the social entrepreneurship framework proposed by Austin et al. (2006) to systematically compare and analyze four food hubs with different organizational structures in the state of Michigan. Based on the results, a new framework specific to food hubs is developed—*Empirical Framework of Food Hub Models.* The framework encompasses the key similarities and differences between the food hub models.

The contribution of paper one is twofold. First, it helps to shed light on the ongoing debate among practitioners, researchers and other stakeholders about whether food hubs primarily pursue a social mission, monetary goals, or both simultaneously. Additionally, the proposed empirical framework of food hub models can serve as a tool to analyze or develop a food hub model in a given context. This has underlying implications for practitioners and policymakers. From the perspective of the existing and potentially emerging food hub practitioners, the study can serve as a tool for strategy development with regard to starting a food hub as well as revising or refining food hub strategies to achieve strategic alignment with food hub priorities. From the perspective of policymakers, the study can serve as a tool to help develop scale-appropriate instruments and resource allocation strategies to help food hubs achieve strategic alignment with their priorities. Second, the study contributes to the emerging empirical literature on food hubs and social entrepreneurship where there is a huge gap.

While food hubs undertake their activities through their diverse network partners, they are also exposed to various types of supply chain risks. Depending on the type of a food hub and

its level of involvement in the local and regional food supply chains (e.g., only aggregation; aggregation and distribution, etc.), the types of risks it faces may vary. However, little is known about supply chain risks faced by food hubs. There are only a limited number of studies that briefly mention some risks faced by food hubs (e.g., Berti and Mulligan, 2016; LeBlanc et al., 2014; Matson et al., 2013; Matson and Thayer, 2013). Taking into consideration the novelty of food hubs in the food system, their heterogeneous business structures, and the multiplicity and diversity of the stakeholders involved in the development and operations of food hubs, it is critical to have a deeper and clearer understanding of food hub supply chain risks. This, in turn, has underlying implications for continuity of food hubs, in particular, and the high performance of food hub supply chains, in general.

Accordingly, the second paper, entitled *Identification and Assessment of Food Hub Supply Chain Risks,* employs an exploratory sequential mixed methods research design (Creswell, 2014) and applies the Failure Mode and Effect Analysis methodology (Christopher, 2011) to identify and assess U.S. food hub supply chain risks from a focal firm's perspective. Additionally, analysis of variance (ANOVA) tests are conducted to examine an association between risk type and food hub characteristics. Finally, risk attitudes of food hub managers are elicited through risk experiments to examine associations between assessed risk and risk attitudes.

Identifying and assessing key food hub supply chain risks offers further guidance for practitioners such as food hub managers in the area of strategic decision making while considering supply chain risks, especially for deciding which risks must be prioritized and which risk mitigation strategies should be employed by different types of food hubs and where the hubs' scarce resources may be allocated. This, in turn, has economic sustainability implications

for both food hubs and small- and medium-sized producers who supply those food hubs, in particular, and for strengthening of local and regional food systems and the communities in which they are embedded, in general. That is, the study will serve as a resource for anticipating potential food hub supply chain disruptions and developing action plans (both preventive and responsive). Second, the study informs policymakers and other key stakeholders supporting the development of local and regional food system initiatives to design and implement the most needed instruments fostering the development of food hubs. Examples include scale-appropriate policy instruments for food safety standards, educational workshops and materials on effective risk management in food hubs, and customized risk mitigation strategies for different types of food hubs. Third, the study contributes to the broader literature on supply chain risk management where there is a call for more empirical research in the field of supply chain risk assessment.

While examining food hub models and identifying and assessing food hub supply chain risks is important, there is also a third, understudied area of food hubs. The heterogeneous legal business structures and primary markets food hubs serve (Barham et al., 2012) result in the generation of relations or ties with multiple diverse stakeholders and networks. The formation, maintenance and/or resolution of network ties require resources (e.g., human and financial) (Monge and Contractor, 2003). Having limited resources (Fischer et al., 2013), food hubs seek to manage these networks effectively and efficiently in order to enhance their performance. However, food hubs are a new type of enterprise in the U.S. food system and there are limited experiences to draw upon for strategic action. The emerging literature on food hubs has no explicit studies exploring or examining food hub networks. There are a limited number of studies that mention some aspects of food hub networks. Little is known about specific networks that are critical for food hub performance.

Accordingly, the third paper, entitled *Emergent Organizational Networks: The Case of Food Hub Managers' Advice Network*, focuses on a specific network—food hub managers' advice network—and develops a selection model of how food hub managers choose from whom to receive advice about operating a food hub enterprise. The study examines the role of individual, tie, and network characteristics (Wellman and Frank, 1999) in the likelihood of receiving advice about operating a food hub enterprise. It draws from both theoretical and empirical literature on social capital and social tie formation.

Identifying factors that are associated with the development of social capital offers further guidance on how to increase the level of social capital—in this case advice—for food hub managers. This, in turn, will foster the design of effective networking strategies both by food hub managers and organizations aimed to support the development of food hubs to achieve valued organizational outcomes more effectively, such as food hub enhanced performance. Second, the study contributes to the broader empirical literature on social capital and social networks, as a step forward in the direction of filling the gap in the empirical literature on social capital.

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1. EMPIRICAL EXAMINATION OF FOOD HUB ENTREPRENEURSHIP MODELS: A COMPARATIVE CASE STUDY ANALYSIS APPROACH[1]

1.1 Introduction

Over the last three decades, increasing consumer demand in the U.S. for locally produced food has led to a re-emphasis on local and regional food systems and the emergence of organizational innovations such as food hubs to coordinate these food systems. Food hubs source local and regional foods from local farmers and food entities and market the foods locally and regionally. Although the number of food hubs in the U.S. has grown over the past decade (Feldstein and Barham, 2017), a dominant design for these organizations is still emerging and there is no universal consensus about what constitutes a food hub. Part of the reason for a lack of dominant design and universal definition for food hubs is that the purpose of food hubs in the food system is still debated among practitioners and in academic literature. Specifically, there is a lack of clarity in whether food hubs primarily pursue a social mission, monetary incentives, or both simultaneously. The existing literature points to three main research streams regarding the purpose of food hubs in the food system. The first body of literature proposes that food hubs are market-led innovations intended primarily for market efficiency. The second body of literature proposes that food hubs are primarily community-level innovations aimed to create sustainable food production and a consumption culture for local foods. Finally, the third body of literature proposes that food hubs can simultaneously perform both of these functions.

[1] Note: Selected sections of this paper have previously been published in the following article: Avetisyan, T., and R.B. Ross. 2019. The intersection of social and economic value creation in social entrepreneurship: A comparative case study of food hubs. *Journal of Food Distribution Research* 50(1): 97-104.

This debate becomes even more complex considering the heterogeneity of food hubs' legal business structures and the primary markets they serve, the two main principles by which food hubs are classified (Barham et al., 2012). The markets include farm-to-business/institution models (i.e., selling to wholesale buyers such as food cooperatives, grocery stores, institutions and foodservice companies), farm-to-consumer models (i.e., selling directly to end-use consumers), and hybrid models (i.e., selling both to wholesale buyers and directly to end-use consumers). The findings of the most recent National Food Hub Survey (Colasanti et al., 2018) indicate that out of the 131 regional food hubs that participated in the survey, 35 percent were identified as farm-to-business/institution or wholesale models, 19 percent were identified as the farm-to-consumer models, and 46 percent were identified as hybrid models (part wholesale and part direct to consumer).

Food hubs are also classified based on their legal business structure which includes nonprofits, privately held for-profits (e.g., LLCs), cooperatives, and publicly held food hubs (e.g., city-owned public markets or farmers markets that carry out food hub activities) (Barham et al., 2012). The findings of the most recent National Food Hub Survey (Colasanti et al., 2018) indicate that out of the 131 regional food hubs that participated in the survey, 42 percent were identified as nonprofits, 37 percent were identifies as for-profits such as LLCs, S, C, and B Corporations, 18 percent were identified as cooperatives such as consumer, producer, and hybrid cooperatives, and three percent were identified as publicly owned or another legal structure.

Food hubs have the potential to be key drivers of the success of local and regional food supply chains. If food hubs are to be viable in the long run, it is important to further investigate the characteristics of these organizations and better understand their purpose in food systems. In

turn, this has underlying implications for the strategy development for practitioners and policy makers.

This study proposes that in order to understand the purpose of food hubs in the food system, it is important to examine the entrepreneurial processes by which they are formed (i.e., "how" entrepreneurship is organized in food hubs). One approach towards implementing this examination is to identify and compare key similarities and differences between different types of food hubs from the perspective of entrepreneurial processes by which they are formed. Therefore, this study employs a multiple-case study research method to examine four food hubs with different organizational structures in the U.S. state of Michigan. In order to guide a comparative case study analysis, the study applies the social entrepreneurship framework proposed by Austin et al. (2006) to systematically analyze and compare the four food hubs across the five dimensions of the framework, namely opportunity, context, people, capital, and social value proposition.

The contribution of paper one is twofold. First, it helps to shed light on the ongoing debate among practitioners, researchers and other stakeholders about whether food hubs primarily pursue a social mission, monetary goals, or both simultaneously. Additionally, the proposed empirical framework of food hub models can serve as a tool to analyze or develop a food hub model in a given context. This has underlying implications for practitioners and policymakers. From the perspective of the existing and potentially emerging food hub practitioners, the study can serve as a tool for strategy development with regard to starting a food hub as well as revising or refining food hub strategies to achieve strategic alignment with food hub priorities. From the perspective of policymakers, the study can serve as a tool to help develop scale-appropriate instruments and resource allocation strategies to help food hubs

achieve strategic alignment with their priorities. Second, this study contributes to the emerging empirical literature on food hubs and social entrepreneurship where there is a huge gap.

This paper is structured as follows: section two presents literature review on food hubs and social entrepreneurship. Section three presents the theoretical framework of the study, namely the social entrepreneurship framework. Section four presents the methods employed to collect and analyze data. Section five presents the results and discussion of the study. Section six presents the new framework developed in the study. Finally, the paper concludes with final remarks and implications.

1.2 Literature Review

This section builds on two bodies of literature, namely literature on food hubs and social entrepreneurship. Key studies in each of these bodies of literature relevant to this study are included below.

1.2.1 Literature on the emergence and purpose of food hubs in the food system

There are three major streams of research explaining the emergence of food hubs, especially regarding their purpose in the food system (Barham et al., 2012; Morley et al., 2008). The first body of literature proposes that food hubs are organizations created for market efficiency in local and regional food systems (e.g., Diamond et al., 2014; Cleveland et al., 2014; Matson et al., 2013; Matson and Thayer, 2013; Reynolds-Allie et al., 2013; Diamond and Barham, 2012; Day-Farnsworth and Morales, 2011). For example, according to Matson and Thayer (2013), food hubs emerged as "logistical vehicles" that efficiently connect producers to wholesale buyers and individual consumers. According to this stream of research, a food hub is a "business or

organization that actively manages the aggregation, distribution, and marketing of source-identified food products primarily from local and regional producers to strengthen their ability to satisfy wholesale, retail, and institutional demand" (Barham et. al, 2012: 4). Thus, the first stream of research emphasizes the aggregation and distribution functions of food hubs.

The second stream of research proposes that food hubs are organizations aiming to create a sustainable production and consumption culture for local foods. It refers to food hubs as sustainability- and community-oriented organizations (Le Blanc et al., 2014; Blay-Palmer et al., 2013). According to the sustainable food community development approach, food hubs are social innovations emerging at the community level in contrast to a market-led innovation. Within this approach, food hubs are considered to be community-based initiatives aimed at linking producers and consumers "as directly as possible" to bring about social change through civic agriculture (Lyson, 2011), food justice, community education, healthy eating, ecological well-being, community cohesion, improve local food access, etc. Following this approach, Blay-Palmer et al. (2013: 524), for example, define food hubs as "networks and intersections of grassroots, community-based organizations and individuals that work together to build increasingly socially just, economically robust and ecologically sound food systems that connect farmers with consumers as directly as possible."

Based on their literature review of food hubs, Berti and Mulligan (2016) conversely claim that this dichotomous approach to defining food hubs does not fully capture the complexities of food hubs' experiences. The authors argue that food hubs are values-based agri-food supply chains. This approach derives mainly from the values-based agri-food supply chain theory. According to this approach, food hubs are new organizational forms aimed at supporting small- and medium-sized producers to meet the growing demand for local foods by accessing wholesale

buyers (e.g., restaurants, institutional buyers, such as schools and hospitals). This approach views food hubs as market-driven organizations capable of bridging the gap between the small- and medium-sized producers and wholesale buyers (Berti and Mulligan, 2016). Berti and Mulligan (2016: 22) define food hubs as "an intermediary organization or business […] which works as a supply chain manager and provides a logistical and organizational platform for the aggregation and distribution of source-identified food products from local and regional producers to both wholesale buyers (institutions, food service firms—restaurant, hotel, pubs, etc.—retail outlets) and end consumers (individuals and groups)." As the authors claim, this definition emphasizes organizational boundaries of food hubs as well as captures the complexities of food hub practices.

Finally, there is an emerging body of literature proposing that food hubs can perform *both* purchasing and distribution functions along with social mission goals (Fischer et al., 2015; Koch and Hamm, 2015). For example, Fischer et al. (2015) propose that the National Food Hub Collaboration's definition of a food hub (which aligns with the first body of literature) is broad and has a major limitation in terms of not being able to distinguish food hubs from other types of businesses involved in regional food purchasing and distribution. As the authors state, in addition to serving as regional food aggregators and distributors, food hubs implement key social functions (or, as the authors state, "plus" functions) that distinguish them from other types of businesses involved in regional food purchasing and distribution. These social functions include: helping to grow regional food systems, increasing healthy food access, and having positive impacts on local economies in which food hubs operate. Therefore, Fischer et al. (2015: 97) propose the following definition of a food hub: "Food hubs are, or intend to be, financially viable businesses that demonstrate a significant commitment to place through aggregation and

marketing of regional food." As the authors state, the term "commitment to place" is used in order to articulate the "plus" nature of food hubs.

The literature on food hubs also highlights a number of social mission goals of food hubs through which benefits for society are created, including actively helping to grow local and regional food systems, enhancing the competitiveness of small- and medium-sized producers in securing access to larger markets, improving local economies by creating jobs and circulating resources within the region, helping to increase access to healthier food, and creating demand for local foods through education and outreach (e.g., in hospitals and schools) (Berti and Mulligan, 2016; Fischer et al., 2015).

Thus, the literature review on food hubs shows that there are divergent views about the emergence and purpose of food hubs in the food system. Further investigation of this debate is important for defining more clearly what a dominant food hub model looks like or should aspire to.

A similar approach to defining an enterprise—based on its focus on social mission, economic value creation, or both simultaneously—is found in the literature on social entrepreneurship. Therefore, this study draws from the social entrepreneurship literature to further explore the extent to which food hubs pursue a social mission, economic value creation, or both simultaneously. The following sub-section will elaborate on the literature on social entrepreneurship and its application for food hubs.

1.2.2 Literature on social entrepreneurship

Social entrepreneurship is a relatively new, emerging field of study within entrepreneurship research, one rife with various conceptualizations and definitions of social entrepreneurship.

These definitions fall into three main categories where social entrepreneurship is referred to as: (1) non-for-profit initiatives in search of alternative funding strategies, (2) socially responsible practice of a commercial business engaged in cross-sector partnerships, and (3) a means to address social problems and catalyze social transformation (Mair and Marti, 2006). An example of the first category would be an already established nonprofit organization getting involved in a commercial activity as a means for alternative funding. An example of the second category would be a commercial business launching a corporate social responsibility initiative.

However, as Mair and Marti (2006) state, neither of these two categories fully describes and captures the essence of social entrepreneurship. One highly cited article on social entrepreneurship broadly defines it as "a process involving the innovative use and combination of resources to pursue opportunities to catalyze social change and/or address social needs" (Mair and Marti, 2006: 37). Bornstein and Davis (2010: 1) define social entrepreneurship as "a process by which citizens build or transform institutions to advance solutions to social problems." According to Peredo and McLean (2006), social entrepreneurship is exercised by a person or a group when the following conditions hold true: (1) the purpose is to create social value (exclusively or in some major way), (2) value creation is initiated based on recognizing and taking advantage of opportunities, (3) innovation is an integral part of it, (4) the process of creating social value entails an above-average degree of risk accepted by the initiators of the enterprise, and (5) the initiators tend to be "unusually resourceful."

As these definitions show, social value creation is a key component of social entrepreneurship. Social value is created in the form of addressing various social needs or catalyzing effective social change. In their review of the definitions of social entrepreneurship, Dacin et al. (2010: 41) concluded that "it is unlikely that a definitive set of characteristics can be

applied to all kinds of social entrepreneurship activity across all contexts." Following this line of thinking, others have proposed that the most important factor that should be common for social entrepreneurship in all contexts is the primary mission, which should be "creating social value by providing solutions to social problems" (Dacin et al., 2011: 1204).

However, some researchers criticize this approach for ignoring the importance of the economic value creation (e.g., in the form of revenue) in social entrepreneurship (Zahra et al., 2009; Mair and Marti, 2006). These researchers argue that focusing merely on the social mission is not sufficient for defining social entrepreneurship. The economic outcomes should be an integral part of the mission of a social enterprise.

At first glance, social entrepreneurship might be thought to be different from commercial entrepreneurship in that the former is associated with altruistic motives, while the latter is associated with profit motives. Some researchers argue that, in fact, both social and commercial entrepreneurship can have social value creation motives (Dacin et al., 2011; Mair and Marti, 2006). While it is true that commercial entrepreneurship primarily focuses on economic value creation, it does not exclude other motives such as creating social value. Examples are social wealth creation and change by creating new technologies, new jobs, new institutional forms, and the like (Mair and Marti, 2006). On the other hand, in social enterprises, a social value creation mission does not preclude economic value creation motives. Economic value creation, in fact, is critical for the viability of a social enterprise because financial resources are crucial for continuing social value creation (Dacin et al., 2011).

To demonstrate this point more specifically, Mair and Marti (2006) analyzed three successful cases of social entrepreneurship in developing countries, namely the Grameen Bank in Bangladesh, the Aravind Eye Hospital in India, and Sekem in Egypt. The authors found that in

each of these cases both social *and* economic values were created. The distinctive characteristic of social entrepreneurship is that these initiatives were launched in response to particular social needs. That is, social value creation is the *primary* focus of social entrepreneurship. They successfully catalyzed social transformation in these developing countries. Additionally, economic value creation is a necessary condition for financial viability. That is, economic value creation is not the primary mission of social entrepreneurship, but it is an integral part of it. Dacin et al. (2011) support this argument by stating that social and economic value creation are ordered hierarchically; social value creation takes priority.

Thus, one of the main distinguishing characteristics of social entrepreneurship from commercial entrepreneurship is that social enterprises are created in response to social needs or for catalyzing social change. These enterprises, however, have the important task of balancing economic and social value creation. Without economic value creation the enterprise and its mission will not be sustainable. Understanding the role and importance of economic value creation in a social enterprise is critical.

As mentioned in the previous sub-section, social entrepreneurship literature offers an approach for defining enterprises—based on whether they focus on a social mission, economic value creation, or both. This can also be applied to food hubs. The following sub-section will elaborate on the existing work on food hubs that has attempted to frame them as social enterprises. Additionally, research gaps will be identified.

1.2.3 Social entrepreneurship in the context of food hubs

This section locates the food hub literature as an empirical application within the social entrepreneurship literature to further frame a case for the extent to which food hubs can be

defined as social enterprises based on the premise that they pursue a social mission and economic value creation simultaneously.

In the context of agri-food systems, the terms ‘social enterprise’, ‘social economy’, and ‘community food enterprise’ are used by various researchers to refer to local food initiatives and organizations, such as cooperatives, community-supported agriculture (CSA), farmers’ markets, food hubs, community gardens and urban farms, all of which engage in economic activities with social as well as ethical goals (Berti and Mulligan, 2016). Another characteristic of these claims is that these alternative agri-food initiatives serve as a cornerstone for building sustainable communities and local ecologies (Blay-Palmer et al, 2013). Although these authors refer to some characteristics of a social enterprise, such as being engaged in economic activity and having social or ethical goals, they do not explicitly draw from social entrepreneurship literature. The closest attempt is made by Crabtree et al. (2012: 10) where the authors use the term ‘community food enterprise’ for an organization that “receives income through trading or contracts, is involved in the growing, harvesting, processing, packaging, marketing, distribution, wholesaling, retailing or serving of food, and which has at least some degree of local ownership and control.” The authors refer to this practice as a social enterprise because the returns are reinvested in the enterprise to advance the business and the community instead of profit maximization for the owners. This approach emphasizes two main characteristics of social entrepreneurship: (1) social mission goals are a priority, and (2) the enterprise creates economic value which, however, is not intended for profit maximization. There is also an emerging literature on food hubs that refers to food hubs as social enterprises (e.g., Berti and Mulligan, 2016; Fischer et al., 2015), but there are no explicit theoretical links to the social entrepreneurship literature.

Thus, in the agri-food system literature there is a gap in terms of defining and describing social entrepreneurship by explicitly drawing from social entrepreneurship literature.

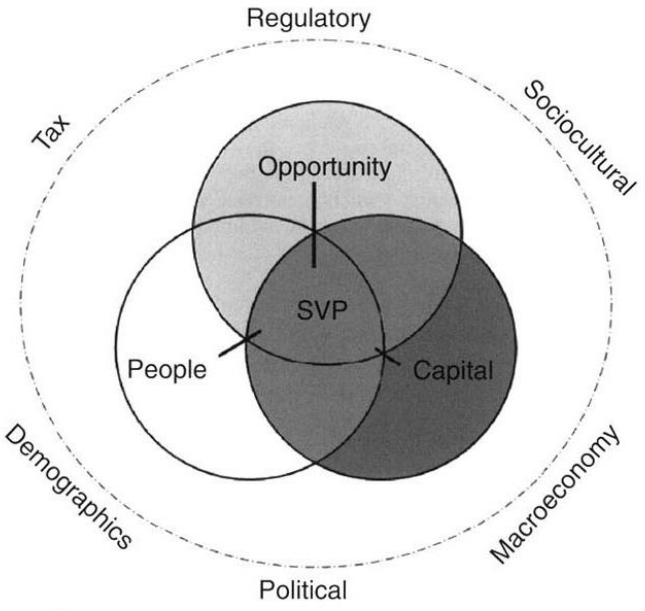
1.3 Theoretical Framework

Austin et al. (2006) proposed the social entrepreneurship framework to examine entrepreneurial processes in a social enterprise. The framework is based on sound theoretical claims. It emerged from a framework originally designed to examine entrepreneurial processes and was customized by Austin et al. (2006) to be used in the context of social entrepreneurship. In Figure 1.1, the framework is presented as a Venn diagram. It includes five key components: namely opportunity, people, capital resources, social value proposition (SVP), and context. The major premise of the framework is that its first three components "need to be related to and integrated by the core social-value proposition (SVP)" (p.16). That is, the SVP is the central construct of social entrepreneurship. The authors argue that social enterprises are ventures with social responsibility (i.e., "social value proposition") at the core of their mission and strategy.

In the social entrepreneurship framework, *social value proposition (SVP)* refers to the distinctive mission of a social enterprise and the multifaceted nature of social value creation. The *people* and *capital* categories refer to human and capital resources, respectively. In the model, economic and human resources are separated as distinct variables for analytic reasons. The reason for this separation is the recognition that financial and human resources are mobilized in social enterprises very differently from each other as well as from commercial entrepreneurship. For example, one of the distinguishing characteristics of social entrepreneurship is that social entrepreneurs often successfully mobilize resources they do not possess themselves. The *opportunity* is defined as an activity that promises a better or desired state in the future. The

nature of opportunity and how it is viewed is one of the important distinctions of social entrepreneurship. For example, certain situations that may look unattractive for commercial entrepreneurship, resulting in market failures, may be seen as attractive for social entrepreneurship. The *context* refers to factors that an entrepreneur has no control over. These elements, however, greatly affect the success or failure of an enterprise (e.g., demographics, lifestyles, sociocultural factors, the macroeconomy, regulatory structure, and political environment). In the words of Austin et al. (2006: 16), "what might be deemed an unfavorable contextual factor for market-based commercial entrepreneurship could be seen as an opportunity for a social entrepreneur aiming to address social needs arising from market failure."

Figure 1.1: Social entrepreneurship framework



Note: Source - Austin et al. (2006)

In order to be able to deliver effectively on the *social value proposition*, a state of alignment (both externally and internally) among the key components of the framework—the opportunity,

people, capital, and context—must be achieved by the social entrepreneur. The external alignment, specified through the category *context,* is more complicated because of the dynamic nature of change forces (Austin et al., 2006).

Now that the social entrepreneurship framework has been elaborated, the following paragraphs will describe how it is applied to food hubs. A comparative analysis of food hubs for each of the SEF dimensions is performed. The goal is to first identify the key similarities and then identify key differences regarding each dimension of the framework for food hubs. In particular, the *opportunity*, *context*, and *people* dimensions of food hubs are first examined. Afterward, the discussion focuses on the *capital* dimension of food hubs. Finally, the *social value proposition* of each of the food hubs is identified, compared, and discussed. The key differences in these dimensions are illustrated by specific examples drawn from food hubs.

Thus, this study applies the social entrepreneurship framework introduced by Austin et al. (2006) to systematically analyze various types of food hubs across the five aforementioned dimensions. Since the comparative analysis is performed in the form of qualitative principles, the dimensions of the framework are operationalized in ways described below.

The *opportunity* and *context* dimensions of food hubs are identified by learning the foundation history of each of the four entities and their trajectory. Regarding these variables, the goal was to identify and analyze the "nature of opportunities" that served as a basis for the establishment of each food hub (captured at the time of their establishment), and the contextual factors that were favorable the hubs' establishment. Exploring the evolution or trajectory of each of the food hubs offers further guidance on the nature of opportunities they tend to capture. The *people* and *capital* dimensions of the food hubs are identified by learning about how food hubs mobilized and continue to mobilize both financial and human resources to organize and maintain

their operations. Key funding sources and founders/staff are explored. Finally, the *social value proposition* of the food hubs was identified by asking food hubs about their long-term mission and short-term goals. The latter sheds light on the level of alignment between food hub mission and goals. The above-mentioned operationalization of the social entrepreneurship framework for the context of food hubs is summarized in Table 1.1.

Table 1.1: Operationalization of the social entrepreneurship framework for food hubs

Dimension	Operationalization
Opportunity and context	Foundation history and trajectory
People	Key individuals involved in the establishment of the food hubs
Capital	Key funding sources critical for food hub establishment, survival and growth
Social value proposition	Long-term mission and short-term goals

1.4 Methods

This study employs a multiple-case study research design (Yin, 2003) to conduct a comparative analysis of four different food hubs located in the U.S. state of Michigan across the five dimensions of the social entrepreneurship framework, namely social value proposition, people, capital, opportunity, and contextual forces. The goal was to better understand the similarities and differences in the aforementioned processes in food hubs. The choice of the multiple-case study research design is appropriate because it includes an intensive study of a small number of cases and follows replication logic similar to the logic of multiple experiments (Yin, 2003). The advantage of integrating multiple case studies in this study makes the evidence as well as insights derived from it more robust (Herriot and Firestone, 1983).

The choice of the case study research design for this study is deliberate. A case study is an empirical inquiry where the phenomenon under study is intensively investigated in its real-life context and where drawing boundaries between the phenomenon and its real-life context is not easy. The contextual conditions are deliberately taken into consideration with the premise that they are an integral part of answering a given research question. The distinct advantage of case study research design is demonstrated in situations when the following three conditions are present: (1) the study focuses on *how* or *why* research question(s), (2) the study focuses on a contemporary set of events, and (3) the investigator has little or no control over the events being studied (Yin, 2003).

Case study research has been extensively used for new theory development (Gerring, 2007; George and Bennett, 2005; Eisenhardt, 1989). This is one of the main strengths of case study research. It allows for generating new hypotheses or propositions. Although some case studies may not be definitive in nature, they may generate seminal ideas. Previous research shows that in-depth study of a case or a few key cases has fostered introduction of new ideas or existing ideas in a profoundly new way or perspective. Examples are the emergence of Piaget's theory of human cognitive development, the neo-institutionalist theory of economic development by North, the structuralist theory of human cultures by Levi-Strauss, and so forth. These theories were developed through in-depth study of a few key cases (Gerring, 2007).

Entrepreneurship scholars also emphasize the importance of employing qualitative research approach to capture the entrepreneurial context and complex relationships in organizations (Dacin et al., 2011; Hoang and Antoncic, 2003). Case study research is one of the primary designs used in organizational research (Berg, 2007; Langley and Royer, 2006). It allows for generating new insights and has high validity among key stakeholders such as

practitioners (Voss et al., 2002). Therefore, the application of case study research design in this study allows capturing contextual characteristics of different types of food hubs.

A purposive sampling strategy was employed to select four food hubs with different organizational structures, namely Food Hub A[2], Food Hub B, Food Hub C, and Food Hub D. The food hubs include a nonprofit organization, Food Hub A, a for-profit organization, Food Hub B, an organization that operates as one of the separate projects of a larger nonprofit, Food Hub C, and an organization that is a partnership between two different entities, Food Hub D. Sampling of food hubs' informants was based on the expert sampling principle. This type of purposive sampling is based on individuals having particular expertise and/or knowledge that most likely can meet the research needs. In the case of food hubs, in order to construct case studies it was important to interview individuals who were the most aware of each organization's management and relations to its key stakeholders. Therefore, the main respondents for this sample are food hubs' top managers or founders.

Semi-structured interviews served as the main instrument for data collection. The interview protocol was designed following the principles of semi-structured interview schedules (Berg, 2007) including primarily essential questions and probing questions (or probes). The face-to-face interviews were conducted with food hub managers or founders from July-November of 2015. The interviews were recorded and transcribed. These data were primarily used to construct case studies employing open and axial coding principles (Patton, 2002; Creswell, 1998). Additionally, supplementary secondary data were collected through publicly available food hub websites and food hub public meetings for the purposes of triangulation. Specifically, since 2015

[2] Actual names of the food hubs are represented by letters to protect the identity of the food hub and individuals employed therein.

attendance in the MI Food Hub Network quarterly meetings fostered learning more about food hubs. The MI Food Hub Network was formed in 2012. It is one of the first formal communities of practice focusing on food hubs (Colasanti et al., 2018; Pirog et al., 2014). The meetings were open for the general public with prior registration. Among the key stakeholders attending the meetings were food hub managers and staff, local farmers, university extension and government representatives, and the like.

Additionally, some of the producers and customers of food hubs were contacted following the snowball sampling approach. Specifically, semi-structured phone interviews were conducted with a total of ten producers and eight customers of case study food hubs. The contact information of producers and customers was obtained from food hubs. The interviews were conducted from January-March of 2016. The interviews were recorded and transcribed.

Afterward, a comparative case study analysis of four food hubs across the five dimensions of the framework were performed to identify key similarities and differences between the case study food hubs with different organizational structures. Additionally, producer and customer perspectives were integrated into the analysis. The study specifically focuses on *how* the case study food hubs organize entrepreneurial processes instead of the numerical value of their financial resources *per se*.

Finally, it is important to note that the theoretical framework used in this study (i.e., the social entrepreneurship framework) is neither definitive nor exhaustive, but rather serves as a theoretical framework to guide the comparative analysis. The analysis provides a basis for drawing lessons that can be useful for practitioners, in particular (e.g., food hub managers), as well as informs policymakers and researchers, in general. Additionally, integrating a theoretical

framework for the construction of case studies allows making analytic generalizations (cf. statistical generalization) of the results and, in turn, strengthens the external validity of the study.

1.5 Results and Discussion

This section presents results of a comparative case study analysis based on the social entrepreneurship framework proposed by Austin et al. (2006).

1.5.1 Opportunity, context, and people

To operationalize and identify the *opportunity* and *context* dimensions of the framework, the food hubs were asked about their foundation history and trajectory. To operationalize the *people* dimension of the framework, the food hubs were asked about key individuals involved in the establishment of their food hubs.

1.5.1.1 Food Hub A

Food Hub A is a nonprofit food hub that operates in an urban area of Michigan. It was originally established in 2009 as a community garden organization during a local community meeting by the participating members. The goal was to form an organization that would help local community members start community gardens which were requested by local community members. It would serve as a network of community gardens while educating the community about issues surrounding food, improve food access in the city and engage local youth. The organization was proactively involved in finding resources for community gardens, conducting workshops with community gardeners on topics such as rain harvesting, planting techniques, food preservation, and the like. The workshops were led by the community members and the organization's network members who were knowledgeable about these topics.

As a newly established organization, when it first received grant funding, the funds were utilized to establish a youth program and hire 15 youths to work in community gardens and start a small project—a local convenience store. The next opportunity that the organization took was a project establishing a mobile market. A community foundation offered and funded this project, which expanded the reach of the organization beyond the convenience store and served to improve food access in the city. This initiative was a success since it allowed selling produce to assisted living facilities, senior homes and places where Senior Project FRESH coupons were given to the residents. These coupons are provided to eligible older adults to purchase unprocessed, Michigan-grown produce. The Senior Project FRESH program provides fruits, vegetables, honey and herbs for older adults. Food Hub A was able to receive these coupons and redeem them at the bi-weekly farmers' market. This enabled the residents to utilize their coupons and increase Food Hub A's sales. At this time Food Hub A was not buying produce from local farmers. They were buying produce from a local grocery store and selling in a mobile market without adding any mark-ups.

While these social mission goals were appealing for Food Hub A, the management called it a "huge learning experience." It was time to think about the sustainability of the organization. Specifically, after a short time the management of Food Hub A realized they needed a small van instead of a big trailer to organize the mobile market. Also, they realized that instead of buying the produce from a grocery store, it would be better to buy it from local farmers. They had previously established relationships with local farmers through community education and gardening projects. However, at that time Food Hub A had insufficient demand and capacity to buy the existing supply of produce from local farmers. Local farmers usually farm four to five days a week and then go to a farmers' market to sell their produce. By recognizing this need, the

organization gradually started to pick up more produce from local farms as well as from different farmers' markets and sell it through the mobile market. As the head of the food hub stated, "We became a food hub before we knew what it was. We started buying from local farmers and selling through the mobile market."

The next opportunity taken by Food Hub A was applying and receiving two acres of land in the middle of their city through a lease agreement from a land bank. The land was in the center of one of the most economically depressed neighborhoods. The spot was also surrounded by approximately six acres of land. The land was used to enable production of local foods as well as involve the youth in income-generating activity through their paid jobs on the farm. This was the first youth-run urban farm in the city. The farm was active for three years. Food Hub A also started hoophouses where they produced specialty crops, micro-greens, etc. However, after a period of time the management of Food Hub A realized that hiring new youth each year to learn to farm created losses. The youth working on the production farm typically are not expert farmers and require considerable training. In terms of the organization's financial viability, it was more feasible to buy the produce from 12-15 farmers instead of paying the youth to produce it on the farm. After realizing this, Food Hub A made it a priority to intentionally purchase food from local farmers.

Moving forward, Food Hub A took another opportunity—it acquired and renovated a 20x20 abandoned building in rough condition. The local community volunteered to help Food Hub A with the renovation. The building has several sections serving a number of functions: 1) there is a tool library (i.e., a place to keep tools that the food hub had purchased over time), 2) a cooler, 3) a packaging area (with sinks and steel tables), 4) a walk-through market, and 5) office

space. Site improvements also were made. In addition to acquiring the building, Food Hub A also hired a food hub manager. This was all accomplished through grant funding.

The history and trajectory of Food Hub A show that it emerged to meet a specific need in the local community—issues of food access in the city. People involved in the establishment of the food hub include local community members and pioneer-leaders such as the chief executive officer of the food hub. They addressed this issue by organizing a network of community gardens and education initiatives to help the community members with their gardening projects. The food hub also hired youth to help with community gardens as well as encourage their involvement in food production. The food hub expanded its reach to further meet food access needs by establishing a convenience store and a mobile market to sell produce in places such as assisted living facilities and senior homes. While working on the network of community gardens, the food hub also established relationships with local farmers. During this time, it identified another need in the community—farmers needed help selling their produce as their supply exceeded demand at the farmers' markets. Thus, the nature of opportunities captured by Food Hub A revolve around social mission goals such as improving food access, local community building through gardening, youth involvement in farming, and helping local farmers expand their markets.

As the food hub was involved in the economic activity of selling food, it had to also focus on the financial viability and capacity building of the organization to be able to carry out its activities and social mission in the long run. The management had to regularly reevaluate the priorities of specific projects and resource allocation in the organization. Since the social mission of Food Hub A is multifaceted, the management realized not all opportunities that aligned with social mission goals were equally beneficial for the financial viability and stability of the

organization in the long run. Even when some opportunities were funded through grants, social value creation was insufficient for taking on or continuing certain projects. This suggests that not every opportunity that aligns with the social mission of a food hub is beneficial for the organization in the long-run. Therefore, balancing social and economic value creation in food hubs is one of the most important aspects of building a successful enterprise.

1.5.1.2 Food Hub B

Food Hub B is a for-profit food hub operating in an urban area of Michigan. It originally started in 2007 as a small commercial operation by one local community member who noticed that there was interest in buying local foods in the community. He utilized his own truck to sell primarily lettuce and tomatoes in the local community. Over time, the demand for local foods rapidly increased. Since a distribution operation is capital intensive, by the year 2008 the founder was looking for additional investment, primarily for building infrastructure capacity. He succeeded in bringing in some outside investors. The following year the investors decided to hire a professional full-time operations manager. At that time the food hub had two trucks and five personnel. They started to restructure the organizational model by focusing on food safety and expanding product offerings. Food safety had been determined to be one of the food hub's primary focus areas. In 2009 and 2010, the food hub staff worked very hard to get food safety certification, upgrading all of the policies and procedures along with documentation. Second, the management of Food Hub B decided to expand the range of its product offerings by adding proteins, fish, meat, cheese, and dairy products. Also, the food hub started to source value-added products such as jams, jellies, and salsas. This strategy was employed to "get to the center of the

plate" and offer year-round deliveries to its customers as well as to create a year-round market for its products. This is especially important in areas that have a very short growing season.

With the expansion of its operations, the next step was moving out of a 4,000- square-foot facility into a 16,000-square-foot facility through a lease agreement. At the end of 2013, the food hub purchased an old hockey arena which had 30,000 square feet of warehouse area, 12,000 square-feet of offices and a locker room area. Food Hub B refurbished the building the following year and moved into the facility in February of 2015. As a result, the food hub was able to increase its freezer capacity ten-fold, cooler capacity six- to seven-fold, and the dry storage by at least three times.

One of the major factors that made a fundamental difference for this food hub was that early on the management realized they needed to have a social mission at the core of the food hub's strategy. The food hub strived to go beyond seeking profit, to create local economies where people would feel a sense of empowerment and ownership in what they do. Preservation of family farms and maintaining a farm identity throughout the food supply chain became a central component of the mission of the food hub. The food hub started to decentralize its operations. As the manager of the food hub stated, the main idea was the following, "Let's completely rethink our business model, our connections to the community, and let's make sure that when we make decisions, we are using the same criteria ... [so that] as [we] grow and [we] are separated from the top of that, [we] can still make those connections and decisions in the way it is consistent." The decentralization process assumed creating a certain hierarchy in the decision-making process to allow people to make decisions based on the social mission of the food hub. That is, the social mission of the food hub was incorporated into its core strategy and was at the core of its decision-making process.

As can be seen from the history and trajectory of Food Hub B, it emerged to catalyze social change in the local community—meet the demand for local foods and promote buying local foods by making it accessible for community members. People involved in the establishment and restructuring of the food hub include local community members such as the founder, manager, and other investors who also had strong commitment to local. They catalyzed social change by promoting buying local foods by building a reliable infrastructure capacity including distribution and scale-appropriate food safety procedures, so that local community members would be able to buy locally. The food hub also intentionally restructured its organizational model to integrate a social mission into its core strategy. This would ensure that connections and decision-making were aligned with the core social mission. The multifaceted social mission of Food Hub B includes preserving family farms, maintaining farm identity throughout the supply chain, and empowering growers to participate in the decision-making process.

As the food hub was involved in the economic activity of selling food, it also focused on the financial viability and capacity building of the organization to be able to carry out its activities and catalyze social change in the long-run. The food hub focused on building distribution infrastructure by bringing in outside investments and carrying out the increasingly complex operations more professionally. This included establishing food safety policies and procedures for the food hubs. The overarching goal is to transform local and regional food systems along with local economies by establishing a scale-appropriate distribution infrastructure to offer year-round deliveries of local and regional food to customers and create a year-round market for its products, especially for areas that have a very short growing season. This is how Food Hub B catalyzed social change around buying local foods.

1.5.1.3 Food Hub C

Food Hub C operates as one of the projects of a larger nonprofit organization in an urban area of Michigan. The food hub was launched in 2011 based on a long-term relationship with a farmers' market that was also housed at the larger nonprofit organization. The idea of starting a food hub emerged when the farmers and food producers at the farmers' market recognized that there was a gap between the demand for local food in the area and the means by which to get the food into the hands of interested buyers. Initially, the larger nonprofit organization's director and the farmers' market manager, in collaboration with the vendors, started to think about ways to build a multi-use, multi-functional food resource center. At the time, the concept of a food hub had started to gain popularity, but the precise definitions of a food hub were still in flux. The project initiators started to explore various food hub models in the area. They also reached out to some partners of the larger nonprofit organization. Additionally, they conducted surveys with vendors at the farmers' market. The goal was to start an entity that would fit the community and its needs. At the time, the umbrella organization housed a seasonal outdoor farmers' market and was also involved in food-related experiential education and youth programs.

At that time, the umbrella organization acquired an abandoned building which was in rough condition but in a good location. They renovated the facility within two years with the help of community volunteers. The facility includes functional units such as a commercial kitchen, the food hub, dry and cold storage units, and an indoor farmers' market for fall, winter, and spring.

The food hub operates as an online wholesale market for the vendors and food suppliers to sell their products to commercial buyers, such as restaurants, hospitals, schools, and buying clubs. Many of the vendors who sell at the farmers' market also utilize the food hub. The food

hub serves as another outlet for them to sell their products throughout the year. Many of the farmers have products available year-round, and so having an additional marketing channel was important. There is a lot of overlap. For example, the same producer may rent and use the commercial kitchen, sell at the farmers' market, and post their products on the food hub's online marketplace. Many of the vendors at the farmers' market scaled up their production of produce and value-added products.

For their vendors and producers who utilize the food hub and the farmers' market, the larger nonprofit also organizes capacity-building workshops on topics such as food business management and marketing, scaling up a food business, utilizing the food hub's online platform, and food safety. The workshop topics are selected based on the regular surveys the organization implements with its producers to better identify and meet their needs.

The food hub operates as an online marketplace. The food hub partnered with an online marketplace service provider to design the page and help with the logistics involved in operating online, including helping producers post their products. The online platform connects producers with commercial buyers. Suppliers have the opportunity to post their products for sale. The food hub staff regularly assists the suppliers in posting products and updating their inventory. The food hub also aggregates orders that are dropped off at the suppliers.

One of the most important lessons learned by Food Hub C was that it is critical to set up policies and procedures in place related to customer relations, sales, etc. beforehand to be able to run the food hub smoothly as a business entity. This certainly affects producer and customer relationships, especially newly established relationships to grow the supplier and buyer base, as well as resources and services provided by the food hub.

The food hub intensively implemented outreach initiatives to build up awareness of the newly established food hub, both on the producer and customer side. The goal was to engage as many suppliers and buyers as possible. Having gone through this establishment process during a time period when there was limited knowledge available on the best practices for food hubs, Food Hub C's management suggests it would be more stable and manageable if practitioners start with approximately 20 main suppliers and about that many buyers. This would facilitate the building of close relationships with suppliers and buyers which are critical for the success of the food hub. Then they can gradually scale up their operations. Food Hub C started with about 80 suppliers and buyers, which was more than what a newly established organization with a small number of staff could effectively manage.

The food hub also made changes in their infrastructure, including the addition of the walk-in cooler and a larger dry storage unit. The food hub restructured its internal processes and procedures for developing a food safety plan, recall procedures (e.g., if the food hub rejects a product from a vendor), payment procedures, sales and customer relationships, setting additional purchase days. Another important aspect of revisions to the operations was developing a more effective communication plan with both suppliers and buyers about the ordering, delivery, and purchasing schedules, procedures, and policies. These are critical parts of operating a food hub.

Thus, as can be seen from the history of Food Hub C, it emerged to help local farmers to expand their markets. People involved in the establishment of the food hub include local farmers and individuals who were already involved in the activities of supporting local farmers such as the director of the umbrella organization and the farmers' market manager.

1.5.1.4 Food Hub D

Food Hub D is a partnership between two entities that operates in an urban area of Michigan. It was established by three individuals who were working with local farmers in the region in the areas of education, community outreach, and conservation. One of the co-founders (Co-Founder D1) noticed that small farmers in the region were talking about challenges they experienced in trying to sell their products to buyers such as restaurants. The Co-Founder D1 shared this observation with the Co-Founders D2 and D3 who knew each other because of the nature of their work in the region. The Co-Founder D1 suggested having an intentional conversation about their work and how they can leverage what each of them was doing to address some of the prevalent issues faced by small farmers. Co-Founder D2 had been working with some farmers that were interested in potentially starting a farmers' association in the region. These farmers noticed what the co-founders were doing and expressed interest in working with them. Each of these individuals was working in different parts of the region and knew other individuals who were interested in identifying ways to help farmers and were interested in food systems growth in the region.

They started to organize a series of community meetings composed of approximately 25 people who were mostly farmers as well as representatives from hospitals, universities, and other potential buyers. These attendees were primarily interested in identifying prevalent needs that small farmers and the food systems faced in the region. They had the capacity to contribute but needed direction. They organized three community meetings which resulted in establishing a formalized network in one part of their region.

At the same time, the co-founders of the food hub established a connection with the Michigan Food Hub Network. They started to attend the Network's meetings and were able to

establish relationships with stakeholders at the state level. This enabled them to apply for and receive one of the first regional food systems grants. Food Hub D was then formally launched in November 2012.

Food Hub D began to focus on capacity building and network formation across the region as well as better identifying the existing issues around storage, aggregation, and distribution. In 2011, Food Hub D implemented a region-wide agricultural assessment. The assessment was replicated in 2013. This allowed them to identify some of the prevalent needs on which they could focus, including infrastructure, storage, distribution, aggregation, and food safety. A university was one of the largest purchasers in the region that was interested in local foods, which also requires Good Agricultural Practices (GAP) certification of their vendors. This led Food Hub D to focus on food safety issues and get involved with the Group Good Agricultural Practices (GroupGAP) pilot study team.

Food Hub D's primary focus has been on network formation. It has an online marketplace that connects local producers and buyers. Food Hub D is an initiative and a partnership; it is not a separate legal entity. The administration is housed and supported through another farmer-owned organization. In addition, Food Hub D has various ranges of partners that provide funding, resources, and technical assistance. As the Co-Founder D1 stated, "There is so much overlap in the work we do. We did not have the capacity to create something that was going to generate enough revenue in the short-term to fund staff. In order to create a separate legal entity we would have to figure out how to do the work on top of what we were already doing. We identified what the needs were and the interested parties. We focused on identifying what the partners could do to support the different pieces and figuring out how that works within

their existing structure rather than saying, ‘Here is the structure, now let’s figure out how to do this.’”

Each of Food Hub D’s partners brings resources along with staff members. For instance, if there is an event to be organized by Food Hub D, partners will share staff members, resources and coordination responsibilities.

Thus, as can be seen from Food Hub D’s foundation history, it was established based on local farmers’ challenges in trying to market their products to larger buyers such as restaurants. Some of the prevalent needs farmers had in the region’s food system included infrastructure, storage, distribution, aggregation, and food safety. That is, in this case the nature of the captured opportunity was helping local farmers. In response to these needs, Food Hub D created a resource pool through a network of diverse stakeholders who would contribute to the betterment of small farmers and the food system in the region. Also, one of the biggest opportunities captured by Food Hub D was their involvement in the Group GAP pilot study team.

1.5.1.5 Discussion of opportunity, context, and people for food hubs

Thus, the description of each of the four food hubs establishment history shows that Food Hub A has evolved and grown from being a community garden organization to a food hub. Opportunities captured by the organization revolve around its core social mission goals, such as local community building through gardening, youth involvement in farming and food production, and improving food access. Food Hub B started as a small commercial venture, but over time restructured its organizational model by incorporating a social mission into the core of its business strategy and decision-making. Preserving family farms, maintaining farm identity throughout the supply chain and allowing growers to have part in decision-making aimed to

transform local and regional food systems and local economies. Food Hub C started in response to local farmers' needs to expand their markets. Food Hub D was established based on local farmers' challenges in trying to market their products to larger buyers such as restaurants. Some of the prevalent needs farmers had in their food system included infrastructure, storage, distribution, aggregation, and food safety. That is, in this case the nature of the captured opportunity is helping local farmers. In response to these needs, Food Hub D created a resource pool through a network of diverse stakeholders who would contribute to the betterment of small farmers and the food system in their region. Table 1.2 presents a summary of these results.

The results also show that the food hubs followed a three–step establishment process. They first identified particular needs and issues faced by smaller farmers, local community members or their local and regional food systems participants (except for the for-profit food hub which, however, later restructured its organizational model to focus on strengthening local and regional food systems through food safety, preserving farm identity, and distribution). This was followed by identifying interested stakeholders and partners who were willing to contribute and form formal or informal networks. This largely determined the resource pool available for starting a food hub. In step three, the legal business structure of the food hub was chosen. The selection of a business structure for the food hubs was mainly for financial reasons. The food hubs were strategic about choosing a legal business structure for their initiatives. It was not about social mission goals; it was more about the capacity to create something that would generate enough revenue in the short term to fund staff and related costs. These findings reinforce what the social entrepreneurship literature says about choosing a legal business structure for an enterprise. However, the organizational boundaries in terms of involvement in the supply chain are directly linked to its social mission goals.

Table 1.2: Nature of opportunities captured by case study food hubs

Food hub name	First established as	Nature of opportunities captured	Current legal business status
A	Community garden organization	· Local community building through gardening · Youth involvement in farming/food production · Improving food access	Nonprofit
B	Small commercial operation	· Preserving family farms · Maintaining farm identity throughout the supply chain · Allowing growers to have part in decision making · Food safety	For-profit
C	A separate project of a larger nonprofit entity	· Local farmers and food processors' identified need that there was a gap between the demand for local food in the area and the way to get it to those who needed it	A separate project of a larger nonprofit entity
D	Partnership between two entities	· Local farmers' challenges in trying to market their products to larger buyers such as restaurants · Food safety	Partnership between two entities

The results also show that at some point food hubs needed a brick-and-mortar building as aggregation points, office space, etc. Some of the case study food hubs acquired abandoned buildings and utilized local community members' support to renovate them. Moreover, resiliency is an integral part of being a successful food hub. The food hubs have one or more social mission goals, but not all opportunities aligned with those goals benefited the organization's financial viability and long-term stability. Even when these types of opportunities were funded through grants, social value creation was insufficient for taking on the opportunity. That is, not every

opportunity that aligned with the social mission goals of the organization was beneficial for its long-term survival.

In terms of people involved in the establishment of food hubs, three main similarities were identified. First, the results show that people who were pivotal in the food hub establishment process had prior experience in working with local farmers and their local or regional community, in general. Second, investors have invested in food hubs not merely to receive a return on investment. Instead, these investors have a strong commitment to local and regional food initiatives. Third, there was multi-stakeholder involvement—partners from different organizations helped build capacity. On the other hand, the results of the study show that there was a divergence in terms of the number of people involved in the establishment of the food hubs.

1.5.2 Capital

To operationalize the capital dimension of the framework, the food hub representatives were asked about their key funding and revenue sources.

1.5.2.1 External funding

In this study, the food hub funding network has been identified to be one of the strategic networks critical for food hubs' on-going operations. A food hub funding network is defined to include all the strategic ties food hubs have with various sources (e.g., organizations, individuals) that have been utilized to mobilize financial resources necessary for their organization's establishment, survival, and growth. Overall, the semi-structured interview results show there

were several funding network relationships critical for a food hub's establishment, survival and growth.

Food Hub A's funding network ties are with philanthropic organizations and the federal government. The former played a critical role in the establishment of the food hub. Philanthropic organizations are one of its major funding providers. This funding is provided in the form of grant revenues. Overall, the qualitative data analysis shows that these philanthropic organizations can be divided into two categories: (1) organizations supporting local community development initiatives, and (2) organizations supporting local/fair/healthy/food initiatives.

Food Hub B's funding network ties are mainly with private investors (e.g., owners of the food hub). The funds from private investors have played a critical role in the establishment of the food hub. Additionally, the food hub has established network ties with organizations to bring in programs for building infrastructure.

Food Hub C's funding network is closely tied to the umbrella organization's funding sources. The latter seeks to build up revenue streams to be more self-sufficient. Funding streams change over time and across various dimensions. The organization seeks to identify and generate additional revenue sources to become more financially viable. This includes revenues from the kitchen and storage rentals, the farmers' market and the food hub.

Food Hub D's funding network ties represent a mixture of partnerships with institutions and organizations such as the federal government, state departments (e.g., Health Department), a university extension, and private organizations. The funds from the federal government come in the form of grant revenues and played a critical role in the establishment of the food hub. The rest of the food hub's funding ties with the aforementioned institutions and organizations are mainly in the form of partnerships where these institutions and organizations contract with the

food hub to implement capacity-building projects (e.g., trainings) for local farmers and producers as well as to provide education in food safety and school garden projects.

The summary of major funding sources of case study food hubs is presented in Table 1.3.

Table 1.3: Major funding sources of case study food hubs

Food hub name	Funding source
A	Foundation Nonprofit organizations Local community foundation Federal government programs
B	Private investments State Department program
C	Nonprofit organization and its respective funding sources
D	Federal government programs State Department Privately held company University

1.5.2.2 Revenue-creation activities

Food hubs are involved in economic activity through marketing and sales of source-identified food products from local and regional small- and medium-sized farm and food entities. Marketing and sales are "activities associated with providing a means by which buyers can purchase the product and inducing them to do so, such as advertising, promotion, sales force, quoting, channel selection, channel relations, and pricing" (Porter, 1998: 40). All four case study food hubs are involved in marketing and sales of food products sourced from local producers.

Customers get regularly informed about product offerings and availability in three different ways: (1) the food hub's official website (Food Hub C), (2) contacting a food hub's sales representatives (Food Hub B), or (3) receiving a private e-mail from a food hub's staff (Food Hub A and Food Hub D). Customers place orders through a food hub's website and/or contacting sales representatives or staff.

Marketing and sales are one of the fundamental and most critical activities food hubs implement for their organization in particular and for their suppliers in general. All four food hubs are actively involved in cultivating a customer base for the products they source. This step is critical not only because it generates potential sales for the food hub through margins and fees, but because it also establishes a platform for the existing and new producers to have an alternative marketing channel. In the face of fierce competition in the marketplace creating a customer base can be challenging. Traditional marketing channels are not necessarily utilized. Instead, food hubs primarily utilize face-to-face meetings with potential buyers for relationship building and sharing with them the greater mission and vision of the organization.

In order to better understand revenue-creation activities of food hubs, target customers of food hubs were identified. Table 1.4 shows a summary of these target customers. Target customers of Food Hub A are institutions, particularly senior living homes, hospitals (i.e., cafeterias and direct-to-staff), and foodservice programs at schools. The food hub sells local foods to seniors through its mobile market according to their “meet people where they are concept.” Food Hub A also works with schools.

The target customers of Food Hub B are restaurants and grocery stores. Restaurants are the initial and early adopters of local foods marketed by the food hub. Grocery stores are mainly

large chain grocery stores in Michigan that have local food sections in their stores. Food Hub B also works with a number of institutions, such as schools and hospitals.

The target customers of Food Hub C are institutions, particularly workplaces, where the food hub implements a multi-farm CSA program. Customers in these workplaces receive a CSA box composed of local foods from multiple farms working with the food hub. This model has been chosen to mitigate consistency issues related to quality and quantity of foods supplied by local producers. The food hub partners with worksite wellness programs to establish relationships with customers and deliver CSA boxes each week. Besides workplaces, the food hub also works with a number of schools, restaurants and a few individuals who want to buy in bulk.

The target customers of Food Hub D are retailers and restaurants. The food hub connects local producers with two major retailers, particularly with natural foods cooperatives that have their retail stores, as well as with local restaurants.

Table 1.4: Target customers of case study food hubs

Food Hub	Target customers
A	Institutions (schools, hospitals, senior living homes) Food-service company (restaurants)
B	Food-service company (restaurant) Retailers (grocery stores) Institutions (schools and hospitals)
C	Institutions (workplaces and schools) Food-service companies (restaurants) End-consumer (individuals)

Table 1.4 (cont'd)

Food Hub	Target customers
	Retailers (natural foods co-op stores)
D	Food-service company (restaurants)
	Institutions (school)

These results show that food hubs actively pursue revenue-creation strategies through diversified customer base and additional sources of funding in the form of grants or donations.

1.5.2.3 Discussion of capital

Overall, there are several funding network relationships that have been critical for food hubs' establishment, survival and growth. The results of qualitative data analysis show that there are several key similarities between the food hubs. First, although food hubs generate revenues through charging fees from suppliers for utilizing the food hub as a marketing channel, the funds from the philanthropic organizations and federal government have been shown to be the most critical in the establishment and survival of these food hubs. The funds were utilized to establish the food hub, build infrastructure for its initial operations, and to support the staff. Second, food hubs have made strategic choices in terms of identifying and establishing diversified complementary funding sources along with a diversified customer base. Third, food hubs were strategic in the utilization of these funds in terms of choosing business structures, as well as establishing and adjusting the scope and scale of their infrastructure capacity to operate more effectively and efficiently. For instance, some of the food hubs have been very proactive in utilizing their network ties with private organizations and state departments to achieve cost savings and building infrastructure. Fourth, for-profit food hub investors have invested in food

hubs not only to receive return on investment. The semi-structured interview results show that these investors have a strong commitment to local and regional food system initiatives.

Despite these similarities, the food hubs have some key differences regarding their funding network. Specifically, two of the major funding providers for non-profit food hubs are philanthropic organizations and the federal government in the form of grant revenue. Overall, the results show that these organizations belong to two main categories: (1) organizations supporting local community development initiatives, and (2) organizations supporting local/fair/healthy food initiatives. For-profit food hubs, on the other hand, were established based on private investments (e.g., owner of the food hub).

In terms of revenue-creation strategies, the analysis shows that the food hubs have been strategic in their decisions to choose their target customers. The first key factor food hubs have taken into account is their own capacity to consistently deliver the quality and quantity of products demanded by a particular customer along with other requirements or specifications. In turn, this largely depends on food hub suppliers' ability to consistently meet the quality and quantity required to satisfy customer demand. For example, Food Hub C has adapted a multi-farm CSA model to mitigate issues related to consistency of quality and quantity of products supplied by producers. This strategy has allowed the food hub to consistently deliver quality food to its customers as well as build capacity of suppliers to meet the demand requirements over time.

Furthermore, those food hubs that have already gone through the stage of overcoming consistency issues and have established sound infrastructure (e.g., refrigerated trucks, warehouses), have been able to adapt a growth strategy where they started to also work with retailers such as large chain grocery stores. For example, Food Hub B has been able to work with

large chain grocery stores because of its ability to secure a consistent supply and high quality of local foods for these grocery stores. In order to do this, the food hub has expanded its product offerings by sourcing a wide range of products from different producers. Scale has been a very important factor for the food hub to be able to work with retailers. Selling to retailers (e.g., grocery stores) not only expands opportunities for small- and medium-sized farm and food entities to have access to larger markets, but it also helps to mitigate food access issues in areas where not everyone has access to quality food. As the food hub indicated, they want to make sure grocery stores have an adequate supply of local foods. Finally, the food hub wants to make sure that the vulnerable as well as the underserved in the community have an opportunity to receive quality food. Selling to retailers has been a significant part of the growth strategy for Food Hub B which already has an established reliable infrastructure system in terms of warehouses and refrigerated trucks.

1.5.3 The social value proposition

The social value proposition (SVP) refers to the distinctive mission of a social enterprise and the multifaceted nature of social value creation (Austin et al., 2006). To identify the social value proposition of the food hubs, respondents were asked about both the long-term mission and short-term goals of their food hubs.

Food Hub A's long-term mission includes the following: (1) supporting the farmers from which it sources its products by expanding their access to markets and increasing their family income, (2) encouraging the emergence of new farmers as a way to lower the median age of an average farmer, and (3) improving food access in their city. Food Hub A has the following major short-term goals: 1) generating increased revenue to be able to pay salaries of its key personnel,

2) self-funding equipment and costs related to the food hub, and 3) reducing dependence on philanthropic funding.

Food Hub B's long-term mission is to build a resilient and socially just food system by preserving family farms, maintaining farm identity throughout the supply chain, and allowing growers to participate in decision-making. It aims to transform local and regional food systems and local economies. It has two major short-term goals. The first is to become an expert in the area of food safety. The food hub took over the GroupGap pilot program by building on the initiatives and developments of another food hub. Since the demand for local foods has increased dramatically, the GroupGap program is essential for supplying products that meet food safety requirements. The second short-term goal is to become an organization that individuals and organizations would seek to contact for finding answers and solutions to various questions or issues they experience.

Food Hub C has a long-term mission of 1) helping small- and medium-sized food growers and producers to rely on farming for their livelihoods, 2) helping low-income families in the local community have access to healthy food, and 3) helping to meet the demand of institutions participating in "20 percent by 2020" initiative. The latter refers to one of the six goals of Michigan Good Food Charter according to which "Michigan institutions will source 20 percent of their food products from Michigan growers, producers and processors" (Michigan Good Food Charter, 2016). Food Hub C has the following short-term goals: 1) build the food hub and generate more sales, 2) help growers to build up their capacity, 3) have more occupants for the incubator kitchen and storage facility.

Food Hub D has a long-term mission of 1) supporting farmers who want to scale up to serve markets beyond merely farmers markets, 2) help start school gardens, 3) provide services

in the area of food safety, and 4) partner with organizations to help with food access and health issues. Food Hub D's short-term goal is to increase awareness within the region about the food hub's activities and how the community members (e.g., farmers, consumers) can benefit from them. The key components of long-term missions and short-term goals of food hubs are summarized in Table 1.5.

Table 1.5: Key components of long-term missions and short-term goals of food hubs

Food hub name	Mission/goal	Long-term mission and short-term goals
A	Long-term mission	• Support the existing farmers from whom it sources the products. • Encourage new people to be engaged in farming. • Improve food access.
	Short-term goals	• Generate more revenue to be able to pay salaries of food hub's key personnel. • Self-fund equipment or costs related to the food hub. • Be less dependent on philanthropic funding.
B	Long-term mission	• Build a resilient and socially just food system. • Preserve family farms. • Maintain farm identity throughout the supply chain. • Allow growers to participate in decision-making.
	Short-term goals	• Become an expert in the area of food safety. • Become an organization that individuals and organizations would seek to contact for finding answers and solutions to various questions or issues they experience.
C	Long-term mission	• Help small- and medium-sized food growers and producers to rely on farming for their livelihoods. • Help low-income families in local community to have access to healthy food. • Help meet the demand of institutions participating in "20 percent by 2020" initiative.
	Short-term goals	• Generate more sales. • Help growers to build up their capacity. • Have more occupants for the storage facility.

Table 1.5 (cont'd)

Food hub name	Mission/goal	Long-term mission and short-term goals
D	Long-term mission	• Support farmers who want to scale up to serve markets beyond merely the farmers' market. • Help start school gardens. • Provide services in the area of food safety. • Partner with organizations to help with food access and health issues.
	Short-term goals	• Increase awareness within the region about the activities of the food hub and how the community members (e.g., farmers, consumers, etc.) can benefit from them.

1.5.3.1 Food hub value creation from the perspective of producers

It is also important to have producers' perspectives to better understand food hub value creation for their suppliers. The semi-structured interview results showed that food hubs are a relatively new additional marketing channel that producers utilize to sell their products. Producers have also been utilizing at least two or more of the following marketing channels: farmers' markets, community-supported agriculture (CSA), retailers (e.g., grocery stores, smaller retails stores in downtown areas, retail markets), wholesale venues (e.g., directly selling to processors), and directly working with restaurants.

Producers have been utilizing these marketing channels at various degrees depending on their production scale. To better understand the producers' primary motives for working with food hubs, they were asked to specify the main reason they have decided to supply the food hub. The analysis of the semi-structured interviews showed the following themes: (1) utilize surplus production, (2) guaranteed sales, (3) marketing network expansion, and (4) distribution.

First, producers are able to utilize their surplus production through food hubs. In this regard, producers view food hubs as an extension of farmers markets or other marketing channels they have already been utilizing. Second, producers expressed that food hubs guarantee sales of their products before they put work into growing. There is less weekly variation compared to direct-to-consumer or direct-to-restaurant market. Also, food hubs buy relatively large amounts on a consistent basis. Third, producers view food hubs as marketing network expansion, an opportunity to expand marketing networks and connections in the marketplace. Food hubs have been instrumental in connecting producers with institutional buyers (e.g., food-service representatives in universities, etc.). Finally, producers who previously had efficiency issues regarding small-scale distribution (e.g., ordered quantities by individual customers were not cost-efficient to deliver individually) utilize the food hub where the orders are combined into a scale more efficient to deliver.

Producers were also asked to specify major ways food hubs helped producers to reach their operational goals (i.e., the role of food hubs for their operations). The analysis revealed four key areas in which food hubs directly help producers to reach their goals: (1) increase access to wider markets and more diversified customer base, (2) marketing, (3) market analysis for demand to help with informed decision-making and planning for producers, and (4) distribution.

First, food hubs help producers increase access to wider markets and a more diversified customer base by actively establishing a customer base for their products. Access to new customers, with whom the producers otherwise would not be able to do business helps producers to sell off all of their products which, in turn, prevents food waste. It also increases producers' ability to market products. Diversification of customers allowed some of the producers to sell their products locally instead of selling to larger, out-of-state buyers. Diversification of

customers also allowed some of the producers to expand their sales from local to regional markets. Finally, the food hub model offers food soverenity and access to good-quality food for people who do not necessarily always have that access (i.e., a different customer segment).

Second, food hubs help producers by actively promoting and marketing local foods, in general, and/or individual producers, in particular (e.g., handouts, a billboard that promotes local produce with a farmer's picture on it). As some of the producers mentioned, they often do not have much time to dedicate to marketing their products. Having assistance in making those connections and facilitating those sales has been helpful in getting their products to a wider customer base. They also mentioned that hubs "create" demand for their products.

Third, food hubs help producers by conducting market analysis for suppliers to identify what can be sold at a given time of the year. Food hubs do market analysis for products—skills that producers said they do not necessarily have due to time constraints or other reasons. However, the food hub can track a lot of sales and find places for the food. This helps producers to reduce the likelihood of food waste. Additionally, food hubs help to plan for larger production and give some assurance that the products will be sold. Finally, food hubs are perceived as reliable customers—producers plan effectively based on the demand of the food hub.

Fourth, food hubs help producers by offering distribution services. Food hubs help deliver products to customers—the distribution aspect of the food hub model—even in cases when the producer already has a pre-established relationship with the customer.

Thus, the results show that producers working with food hubs benefit from food hubs services in multiple ways.

1.5.3.2. Food hub value creation from the perspective of customers

In order to better understand food hubs value creation, a subset of food hub customers (i.e., schools and restaurants) were interviewed. Food hub customers were asked to indicate and explain the main reasons they decided to buy from a particular food hub. Table 1.6 provides a summary of the results. Throughout the analysis, four main categories of reasons were identified which food hub customers indicated as being critical for their buying decisions. This includes: 1) food hub organizational characteristics, 2) product characteristics, 3) social responsibility of customers, and 4) end-consumer driven.

First, food hub customers indicated that one of the main reasons they decided to buy from a food hub is the food hub's organizational characteristics including: 1) offering better variety of local foods, 2) being easiest to work with in buying local foods, 3) flexibility in providing smaller quantity of products as needed, 4) reliability, 5) cooperation with educational programs at schools, and 6) providing a specific variety of products that customers look for. Customers indicated that individual small farms cannot grow everything whereas food hubs partnering with multiple farms are able to aggregate and offer a much larger variety of the products they need.

The second category of main reasons customers decided to buy from a food hub is product characteristics offered and marketed by food hubs. The analysis of the semi-structured interviews revealed four different product characteristics indicated by customers—high quality, fresher, nutritious, and healthier food products offered and marketed by food hubs. Higher quality of food hub products was the most frequently mentioned product characteristics. One of the implications of these results is that products offered and marketed by food hubs are highly competitive in the marketplace in terms of their quality. Customer expectations are satisfied which demonstrates that food hubs employ various techniques and strategies to consistently

identify customer needs and expectations and communicate them to their suppliers. On the other hand, this demonstrates that by working with food hubs small- and medium-sized local producers have the capacity to offer highly competitive products to meet current consumer demand for local foods. Most customers indicated the importance of the high quality products offered by food hubs. Even though they mentioned relative costliness of products offered by food hubs, they are willing to buy from food hubs because of the high quality and other product characteristics mentioned above.

The third category of the main reasons customers (i.e., restaurants and schools) buy from food hubs is their own organizations' commitment to social responsibility. The results show that participating food hubs' customers have a commitment to support their local communities including local growers, businesses, and the local economy.

The fourth and final category of main reasons customers (i.e., restaurants and schools) buy from food hubs is pursuing their own end-consumers' interests. In terms of restaurants, this refers to current high end-consumer demand for local foods. In terms of schools, this refers to food justice (i.e., providing access to more nutritious food to students in schools who might not have that opportunity in their homes) and education (e.g., food hubs working and supporting schools to start food gardens). Food justice has been identified to be an important reason schools buy local foods. Very often those students who live in food deserts and come from low-income families do not have access to transportation to get to grocery stores to buy fresh and nutritious food.

Food hub customers were also asked to indicate the unique characteristics of food hubs compared to other marketing channels from which they buy local foods. Table 1.7 provides a

Table 1.6: Main reasons restaurants and schools buy from food hubs

Category	Definition	Examples
Food hub organizational characteristics	Refers to organizational characteristics of food hubs as potential marketing channels to purchase local foods from.	‣ Provide better variety of local foods ‣ Easiest to work with in buying local foods ‣ Flexible in providing smaller quantity of products as needed ‣ Reliable ‣ Cooperate with educational programs at schools ‣ Provide specific varieties customers look for
Product characteristics	Refers to products offered and marketed by food hubs	‣ High quality ‣ Fresher ‣ Nutritious ‣ Healthier
Social responsibility	Refers to food hub customers' social responsibility	Supporting local community including: ‣ Growers ‣ Businesses ‣ Local economy
End-consumer driven	Refers to food hub customers' own end-consumers' interests (includes regular end-consumers and school students)	‣ End-consumer demand for local foods ‣ Food justice ‣ Education

summary of the results. Customers listed the food hubs' ability to research, cultivate relationships with producers and aggregate available local foods as one of the most important characteristics. This has a few underlying implications for them. First, since food hubs are sourcing local foods from multiple farms, this enables them to offer a wide variety of products to their customers—"There is a little bit of everything" (Food Hub Customer). Second, the

aggregation function makes it easier for food hub customers to use the service. Compared to individual small farm operations, food hubs aggregate and offer a wider variety of products, which helps customers to save time and resources while sourcing local foods. They do not have to spend time and resources to search and find producers as well as keep arranging logistics every week. Third, the online ordering system makes the customers' buying experience easier and quicker; and importantly it is a "one-stop shopping." Finally, the delivery of products and the flexibility of delivery days have been identified to be another important characteristics highly valued by food hub customers.

Table 1.7: Unique characteristics of food hubs from customer perspective

Characteristics
Offer wide variety of products
Online ordering system – "one-stop shopping"
Delivery of products
The best place in the area providing fresh and nutritious food
Ability to research and cultivate relationships with producers
Product aggregation
Ease-of-use of the service
Easy to order
Flexibility of delivery days
Less carbon footprint
Knowledge about the product source
More personal connection with farmers, products, and story sharing

Food hub customers were asked to indicate the role of food hubs in achieving their own operational goals. The results show that this is an important aspect of customers' work with food hubs. Table 1.8 provides a summary of the results. First, as some of the customers mentioned, they previously were getting a variety of food products, but they were not local products. By working with food hubs, these customers are able to get the variety of products locally which, in turn, is a better way to promote local foods and be involved in a farm-to-table initiative. Thus, by offering much more variety of local products food hubs enable their customers to promote local products to their own end-consumers. Furthermore, as one of the respondents stated, school kids waste less food because of the greater variety and high quality of food served in schools.

Second, food hub customers who promote local foods during their own operations benefit from working with food hubs. Instead of spending time and resources to find local producers and organizing logistics with each of them on a weekly basis, food hubs provide access to local foods and eliminate the extra work they would have to do on their own. Also, food hubs do the ground-work of identifying and offering local products that customers would potentially need.

Third, food hubs have shown to be very responsive to some of the choices and commitments that food hub customers have made. For example, some of the food hub customers have made commitments to buy meats and a variety of other products that do not have preservatives or artificial colors in them. Food hubs have shown to be responsive to these types of commitments.

Finally, food hubs handle food safety requirements, as well as specific products characteristics (e.g., size, quantity and price) that customers prefer. Food hubs do this by working closely with producers and communicating to them customer expectations. This makes

customers' buying experience smoother and aligns well with the procedures these customers had previously established to handle product supply operations.

Table 1.8: How food hubs help their customers to achieve their operational goals

Customers' operational goal	Contribution of food hubs
Incorporate variety of local foods into menus to promote local foods to end-consumers	‣ Work with multiple farms and offer much more variety of local foods
High quality fresh fruits and vegetables	‣ Offer high quality products (i.e., better flavors and colors)
Purchase local foods	‣ Identify and offer local foods ‣ Find local producers ‣ Organize logistics of product aggregation ‣ Communicate specific product characteristics to producers (e.g., size, quantity and price)
Food safety	‣ Handle food safety requirements
Specific choices	‣ Flexible and responsive to customers' specific choices (e.g., buy meats and variety of other products that do not have preservatives or artificial colors in them, order smaller quantity of products)
Specific commitments	‣ Responsive to customers' specific commitments (e.g., support local communities by participating in community events)

1.5.3.3 Discussion of social value proposition

Overall, the comparative analysis of social value proposition of food hubs shows that the long-term missions of the food hubs are rooted in social mission goals. Short-term goals, on the other hand, revolve around building an economically viable enterprise through economic value creation (i.e., revenue) and capacity building. This reinforces the theory of social entrepreneurship where social and economic value creation must be balanced. Social value proposition differs by food hub type and the nature of social value creation has shown to be multifaceted. In terms of key differences regarding the social value proposition, analysis of long-term missions of food hubs shows that the nature of social value creation focuses on: 1) helping small- and medium-sized producers—both existing and new—to rely on farming for their livelihoods, 2) improving access to healthy food in local communities, and 3) building locally and regionally integrated resilient food systems by focusing on food safety.

In this study, helping local small- and medium-sized producers has major implications not only for the independent family farms, but also for society at large. In particular, among the major social and environmental benefits the independent family farms ("agriculture-in-the-middle") generate are providing consumers with an opportunity to choose foods with desirable attributes (i.e., diversity of food and choice), providing habitat for wildlife, crop diversity (as opposed to monocrops), and diversified farmland (Kischernmann et al., 2008). The decline of these family farms will result in long-term losses for society in terms of diversity of food and environmental resources. Therefore, this study proposes that meeting specific needs of local community members, such as small- and medium-sized farmers (e.g., establishing scale-appropriate infrastructure, expansion of buyer base) and/or catalyzing social change (e.g., fostering buying local foods by actively establishing buyer base, raising awareness and making

local foods accessible for interested buyers) in local communities and/or in the region are important food hub social mission goals. The results show that supporting the ability of small- and medium-sized farmers to rely on farming for their livelihoods was a core motive for establishing the food hubs. Farmers were considered as integral parts of the local community (e.g., at a city level). Fostering access to local foods and/or buying local foods in local communities was another key underlying factor that played a role in the emergence of food hubs. These efforts undertaken by foods hubs have a ripple effect in terms of strengthening locally and regionally integrated food systems and consumption culture of local foods.

1.6 Proposing an empirical framework of food hub models

The results of the comparative case study analysis and discussions in previous sections show that there are key similarities and differences between the food hubs. Based on these results, this study proposes a framework that captures the key similarities and differences between different types of food hubs from the perspective of the entrepreneurial processes by which they are formed. The framework is titled *Empirical Framework of Food Hub Models* (see Figure 1.2). It can be used as a tool to develop or analyze a food hub model in a given context. It integrates key entrepreneurial processes in food hubs and identifies areas that may vary depending on a given context. This is the first framework in the food hub literature that attempts to systematically model fundamental entrepreneurial processes in food hubs. It helps to reduce the ambiguity in what a food hub model looks like or what it should aspire to. Therefore, it can be used by both food hub practitioners and other stakeholders interested in the development and advancement of food hubs.

Context and Opportunity Recognition: The results showed that first identified particular needs or issues faced by smaller farmers, local community members or their local and regional food systems. One of the food hubs was first involved in catalyzing social change in local food consumption and later restructured its organizational model to focus on strengthening local and regional food systems through food safety, preserving farm identity and distribution.

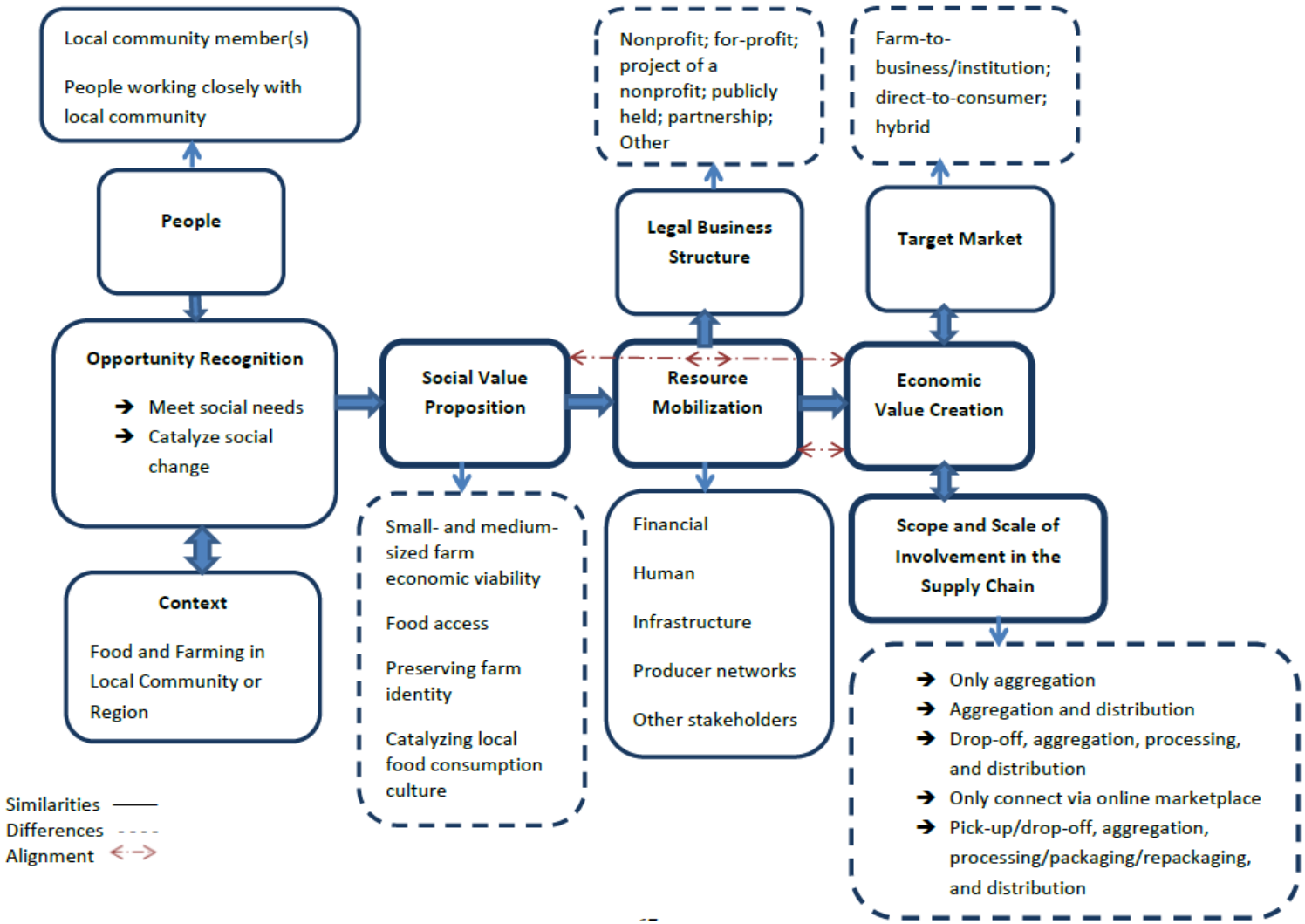
Social Value Proposition: The results showed that social value proposition of food hubs which may be single or multifaceted in nature. Examples include supporting small- and medium-sized farmers economic viability, food access, preserving farm identity, and catalyzing local food consumption culture.

Resource Mobilization: This was followed by identifying interested stakeholders and partners who were willing to contribute in the form of financial and human resources, infrastructure capacity building, and forming informal networks. This largely determined the resource pool available for starting a food hub. The funds from the philanthropic organizations and federal government have shown to be the most critical in the establishment and survival of these food hubs. The funds were utilized to establish the food hub, build infrastructure for initial operations, and to support food hub staff. Food hubs made strategic choices in terms of identifying and establishing diversified complementary funding sources.

Choosing a Legal Business Structure: Food hubs were also strategic in choosing business structures that would fit their resource pool. They critically assessed the scope and scale of their infrastructure capacity. It was mainly financial motives, rather than social mission goals, that drove the selection of a business structure for the food hubs. It was not about social mission goals. It was more about the capacity to create something that would generate enough revenue in the short-term to fund staff and related costs.

Economic Value Creation: (a) *Scale and scope of involvement in the supply chain:* The organizational boundaries in terms of involvement in the supply chain are directly were linked to its resource pool, infrastructure capacity and social mission goals. *(b) Target markets:* In terms of revenue-creation strategies, food hubs have been strategic in choosing their target customers. The first key factor food hubs have taken into account is their own capacity to consistently deliver the quality and quantity of products demanded by a particular customer along with other requirements or specifications. In turn, this largely depends on food hubs suppliers' ability to meet consistency of quality and quantity required to satisfy customer demand. Additionally, those food hubs that have already overcome consistency issues and have established sound infrastructure (e.g., refrigerated trucks, warehouses) have been able to adapt a growth strategy where they started to also work with retailers, such as large chain grocery stores.

Figure 1.2: Empirical Framework of Food Hub Models



1.7 Conclusion

Part of the reason for a lack of dominant design and definition of food hubs is that the purpose of food hubs in the food system is still debated among practitioners and in the academic literature. Further investigation of the purpose of food hubs in the food system offers further guidance on how to design a start-up food hub or how to revise existing food hub models to achieve higher levels of strategic alignment of food hub priorities. In turn, this has underlying implications for the further enhancement of the food hub sector. This study proposed an approach for identifying food hub motivations and intentions. Specifically, it compared key similarities and differences between different types of food hubs from the perspective of entrepreneurial processes by which they were formed.

The comparative case study analysis show that food hubs are social enterprises aimed to simultaneously create social and economic value. The social mission is at the core of their strategy and decision making. Social value is created by addressing the needs of small- and medium-sized farmers to access larger markets and rely on farming for their livelihoods, establishing scale-appropriate local and regional food infrastructure and food safety procedures, involving youth in farming, improving access to healthy food in local communities, preserving family farms, maintaining farm identity, and/or strengthening local and regional systems as a whole. The social value proposition, however, differs by food hub type.

By looking at the foundation history and the nature of captured opportunities and context, it was revealed that food hubs are initiatives that were launched in response to particular social needs or sought to catalyze social change through food-related activities in local communities. That is, social value creation is a primary focus of food hubs. The nature of social value creation in food hubs can be multifaceted and a given food hub can have one or more of social mission

goals. Since the identified list of social values is not exhaustive, food hubs may create other social values beyond these mentioned. One common thread is that all four food hubs included supporting local small- and medium-sized farms as part of their mission. Therefore, this study concludes that missions to offer such support should be included as one of the key distinguishing characteristics of food hubs.

Meanwhile, food hubs meet one or more of these social needs or catalyze social change in local communities by engaging in economic activity within the context of local and regional food markets. They are involved in economic activity within the context of food markets and create economic value in the form of revenues. Economic value creation is an integral part of their strategy, and they actively pursue revenue-creation strategies. Diversifying the customer base, funding sources and strategies that align with food hub social value proposition are critical for food hubs' survival and growth. These results are consistent with the social entrepreneurship literature. Food hubs balance economic value creation with social value creation.

In this study, helping local small- and medium-sized producers has major implications not only for the independent family farms, but also for society at large. In particular, among the major social and environmental benefits the independent family farms ("agriculture-in-the-middle") generate are providing consumers with an opportunity to choose foods with desirable attributes (i.e., diversity of food and choice), providing habitat for wildlife, crop diversity (as opposed to monocrops), and diversified farmland (Kischernmann et al., 2008). The decline of these family farms will result in long-term losses for society in terms of the diversity of food and environmental resources. Therefore, this study proposes that meeting specific needs of local community members such as small- and medium-sized farmers (e.g., establishing scale-appropriate infrastructure, expansion of buyer base) and/or catalyzing social change (e.g.,

fostering buying local foods by actively establishing a buyer base, raising awareness and making local foods accessible for interested consumers) in local communities and/or in the region are important food hubs' social mission goals.

Following Dacin et al.'s (2010: 4) statement that "it is unlikely that a definitive set of characteristics can be applied to all kinds of social entrepreneurship activity across all contexts," this study concludes that a similar statement applies to food hubs. However, there are key entrepreneurial processes that characterize food hubs through the similarities identified in this study. First, food hubs in all contexts have a primary mission of creating social value or catalyzing social change by providing solutions to social problems in local communities through local foods. The nature of social value creation may be multifaceted or single depending on a particular case. Therefore, there is no defined set of social mission goals towards which food hubs aspire. But social value creation is fundamentally rooted in meeting a need(s) or catalyzing social change in a local community, which has a ripple effect in the region. Second, food hubs simultaneously create economic value through building diversified a customer base and funding sources to create economically viable enterprises.

Third, the key differences in food hub models stem from their legal business structure, the markets they serve, their level of involvement in the supply chain (e.g., only aggregation; aggregation and distribution, etc.) and the scale and scope of mobilized resources. The legal business structure does not define whether or not they pursue a social mission. The results of this study show that the selection of a legal business structure largely depends on the best fit for a food hub's financial situation and availability of resources, such as financial, human, infrastructure resources.

These results have two main implications. First, the study helps to shed light on the ongoing debate among practitioners and researchers about whether food hubs primarily pursue a social mission, monetary goals, or both simultaneously. By analyzing the food hub processes, this enhances ones understanding of actual managerial practice as a whole in food hubs and potentially leads to improvement and/or providing guidance for emerging food hubs. The knowledge generated through this study helps to understand how a start-up food hub can structure itself in order to be more effective. It also serves as a useful resource for existing food hubs to refine or revise their strategies.

This study also contributes to the emerging empirical literature on social entrepreneurship and food hubs, in which there exists a huge gap. It allows examining the key processes through which food hubs organize their operations. The in-depth comparative analysis points to the key similarities and differences between food hubs. Enhancing ones understanding of these aspects of food hubs is important from the perspectives of both current and potential practitioners especially for strategy development purposes such as developing and implementing scale-appropriate resource mobilization strategies, defining organizational boundaries, opportunity recognition and exploitation, adapting and responding to contextual changes, and achieving and maintaining strategic alignment with social value proposition. From the perspective of policymakers and other stakeholders interested in the advancement of food hubs, the study can serve as a resource to help develop scale-appropriate infrastructure, instruments, and resource allocation strategies to help food hubs achieve strategic alignment with food hub priorities.

The study also adds to the empirical literature within the social entrepreneurship field, where there is a call for more empirical work. This study also provided a systematic comparison of different food hub models and developed an *Empirical Framework of Food Hub Models* to

capture key similarities and differences in food hubs. It can be used as a tool to develop or analyze a food hub model in a given context. Since this is the first attempt in the field to model food hub entrepreneurial processes, future research can test this model by using a larger sample size of case study food hubs.

APPENDICES

APPENDIX 1A: Food hub supply chain functions

Table 1A.1: Food hub supply chain functions

Food hubs described the full sequence of activities involved in getting the food from producers to their customers.

Procurement

Producers regularly (e.g., weekly) post a list of their product offerings on a food hub's website (Food Hub C), send a private e-mail to a food hub (Food Hub A), or a food hub lists the products on its own website (Food Hub B). Producers are notified (e.g., via e-mail) as soon as an order is placed.

Inbound Logistics

The food hub picks up food products from producers' locations (e.g., A, B), meets producers at a third location (e.g., A), or producers deliver the products at a food hub's location (e.g., A, C). In cases when a food hub does not carry out product aggregation and distribution functions, producers deliver products directly to customers or meet them at a certain location (e.g., D).

Operations/Aggregation

The three out of four case study food hubs are involved in this step of the supply chain. This choice largely depends on the availability of aggregation facility and the nature of customer orders.

The food hub aggregates food products in its warehouses/storage space. There are two major ways of aggregating products. One of the ways is to keep all the farm products separate from each other in order to preserve farm identity (B). Another way is to repackage food products in bigger orders with other items (A, C) or directly deliver them to customers (A).

Outbound Logistics

The three of four case study food hubs are involved in this step of the supply chain.

This step includes delivery of food products from food hub to its customers. Delivery option depends on a food hub's capacity and customer preferences. There are two main ways in which this activity is organized. First, the delivery is carried out by a food hub (A, B) using their own trucks. Second, the delivery is organized in partnership with a third party such as a local community organization (C).

A food hub's capacity to deliver products largely depends on their access to resources such as refrigerated trucks and efficiency (which depends on the volume of the products being delivered and density of customers). The second key factor in delivery process is customer preferences. The case study food hubs identified delivery of products to their customers as one of the values-added to their service. This adds convenience to customers, but also requires investments on trucks and maintenance as well as efficiency must be attained.

Marketing and Sales

All four case study food hubs are involved in marketing and sales of food products sourced from producer.

Customers get regularly informed about product offerings and availability in three different ways: (i) Food hub's official website (C), (ii) contacting a food hub's sales representatives (B), or (iii) receiving a private e-mail from a food hub's staff (A, D). Customers place an order through a food hub's website, contacting sales representatives or staff.

APPENDIX 1B: Food hub models

Table 1B.1: Summary of food hub models in term of their involvement in the supply chain

Food Hub Model #1: Procurement -> pick-up -> aggregation -> distribution **Key activities:** Fully owns the product after purchasing from producers Charges commission fees Engages producers in decision-making and planning by offering market analysis Offers contracts to producers and customers (optional) Offers product pick up and distribution as key functional areas of the enterprise Utilizes its own or leased transportation infrastructure Adds food hubs brand on the product Actively creates buyer base
Food Hub Model #2: Procurement -> producers drop off products -> aggregation -> distribution **Key activities:** Charges commission fees Utilizes a third-party distributor from local community Does not brand products, producer brand is the sole identifier Actively creates buyer base
Food Hub Model #3: Creating online platform, connecting producers and customers **Key activities:** Does not take ownership of products Charges commission fees Mainly serves as a connection facilitator between producers and customers Focuses more on creating a buyer-base in the region Brings together buyers and producers to identify mutual expectations and specific needs Actively promotes local foods and local farmers No contractual relationship between producer-food hub or food hub-customer

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2. IDENTIFICATION AND ASSESSMENT OF FOOD HUB SUPPLY CHAIN RISKS

2.1 Introduction

Since the early 2000s, both practitioners and researchers began to emphasize the importance of investigating supply chain risks from a focal firm's perspective, regardless of the industry. This is because supply chain risks can potentially be harmful and costly. For example, supply chain disruptions may cause financial investments for recovery of firms, affect their reputation as well as result in losing customers and underperforming competition (Griffis and Whipple, 2012; Juttner, 2005; Christopher and Peck, 2004; Zsidisin et al., 2000). The broader literature on supply chain risk management highlights the importance of *ex-ante* identification and assessment of risks to ensure continuity of firms, in particular, and the high performance of supply chains in which they operate, in general. Within the context of local and regional food supply chains, over the last three decades, the increasing demand for locally produced food among U.S. consumers has led to the emergence of organizational innovations known as food hubs to coordinate the flow of local and regional food from small- and medium-sized farm and food entities to mainly wholesale buyers such as retailers, institutions (e.g., schools and hospitals) and foodservice companies (Diamond and Barham, 2012). While food hubs undertake these activities through their diverse network partners, they are also exposed to various types of supply chain risks. Depending on the type of food hub and its level of involvement in local and regional food supply chains (e.g., only aggregation; aggregation and distribution), the types of risks it faces may vary. However, little is known about supply chain risks faced by food hubs. There are only a limited number of studies that briefly mention some risks faced by food hubs (e.g., Berti and Mulligan, 2016; LeBlanc et al., 2014; Matson et al., 2013; Matson and Thayer, 2013). Taking into

consideration the novelty of food hubs in local and regional food systems, their heterogeneous business structures, and the multiplicity and diversity of the stakeholders involved in the development and operations of food hubs, it is critical to have deeper and clearer understanding of food hub supply chain risks. This, in turn, has underlying implications for continuity of food hubs, in particular, and the high performance of food hub supply chains, in general.

This study employs an exploratory sequential mixed methods research design (Creswell, 2014) and Failure Mode and Effect Analysis methodology (Christopher, 2011) to identify and assess U.S. food hub supply chain risks from a focal firm's perspective. Following the approach of Harland et al. (2003), this study focuses on one specific type of flow in a supply chain: the flow of food products. In order to be able to identify food hub supply chain risks, supply chain risks are first categorized according to a framework proposed by Christopher and Peck (2004). This framework separates supply chain risk sources into three major categories based on their "position" in the supply chain: (1) supply- and demand-side risks, (2) internal processes and controls of the focal organization, and (3) the external environment. This study further identifies specific food hub supply chain risk sources (i.e., disruptions in the flow of food products in a supply chain) within each category. Additionally, analysis of variance (ANOVA) tests were completed to identify association between risk type and food hub characteristics. Finally, risk preferences of food hub managers were elicited through risk experiments to examine association between assessed risk and risk preferences.

The contribution of this study is threefold. First, identifying and assessing key food hub supply chain risks offers further guidance for practitioners such as food hub managers in the area of strategic decision making while considering supply chain risks, especially for deciding which risks must be prioritized and which *ex-ante* risk mitigation strategies should be employed by

different types of food hubs and where the scarce resources of a food hub may be allocated. This, in turn, has economic sustainability implications for both food hubs and small- and medium-sized producers who supply those food hubs, in particular, and for strengthening of local and regional food systems and the communities in which they are embedded, in general. That is, this study will serve as a resource for anticipating potential food hub supply chain disruptions and developing action plans (both preventive and responsive). Second, this study informs policymakers and other key stakeholders supporting the development of local and regional food system initiatives to design and implement the most needed instruments fostering the development of food hubs. Examples include scale-appropriate policy instruments for food safety standards, educational workshops and materials on effective risk management in food hubs, and customized risk mitigation strategies for different types of food hubs. Finally, this study contributes to the broader literature on supply chain risk management where we increasingly witness a call for more empirical research in the field of supply chain risk assessment.

This study is structured as follows: Section two focuses on literature review on food hubs with an emphasis on studies that refer to risks in food hubs. Section three sets up the theoretical framework of the study by detailing the risk construct, supply chain risk from a focal firm's perspective, and developing supply chain risk propositions specific to food hubs by drawing from both supply chain risk literature and food hub literature. Section four presents data collection and analyses processes. Section five presents the study results and discussion. Finally, concluding remarks are summarized in the final section of the study.

2.2 Literature on Food Hub Risks

Although the emerging literature on food hubs continues to grow, there are limited studies that systematically examine supply chain risks in food hubs. The existing literature on food hubs can be categorized into five main topic areas: (1) studies focusing on organizational dynamics of food hubs (Krejci et al., 2016; Hardy et al., 2016; Severson et al., 2015; Cantrell and Heuer, 2014; Cleveland et al., 2014; LeBlanc et al., 2014; National Good Food Network, 2014; Stroink and Nelson, 2013; Anselm, 2013; Brannen, 2013 Fischer et al., 2013), 2) studies aimed at clarifying the evolving concept of food hubs (Fischer et al., 2015; Barham et al., 2012; Barham, 2011; Horst et al., 2011), 3) studies discussing or examining the role of food hubs in creating sustainable regional and local food systems/local food supply chains/market functions (Berti and Mulligan, 2016; Koch and Hamm, 2015; Diamond et al., 2014; Matson et al., 2013; Matson and Thayer, 2013; Blay-Palmer et al., 2013; Diamond and Barham, 2012; Day-Farnsworth and Morales, 2011; Morley et al., 2008), 4) studies focusing on the economic impact of food hubs (Schmit et al., 2013; Western Rural Development Center, 2012), and 5) feasibility studies of food hubs (Gerencer et al., 2015; Applied Development Economics Inc. et al. 2014; Cambier, 2013; Dion and Shugart, 2013; Intervale Food Hub, 2012; Ryan and Mailler, 2011; Melone et al.,2010).

Of the aforementioned studies, only a limited number briefly mention any risks faced by food hubs (e.g., Berti and Mulligan, 2016; LeBlanc et al., 2014; Matson et al., 2013; Matson and Thayer, 2013). Matson et al. (2013) identify potential disruptions in food hub operations that may originate from a mismatch between the food hub and suppliers[3] on planned or forecasted sales growth in the future, quantity expected from each supplier, and the production capacity of

[3] Suppliers refer to any grower, producer, or processor from which food products are sourced.

the individual supplier. Matson et al. (2013) further state that many of the suppliers with whom food hubs work have the most experience with direct markets (e.g., farmers' market, CSA, etc.). As a result, these suppliers may not be willing to or may not be used to producing food products that meet required consistency, quality, and volume needed for the wholesale buyers that food hubs serve. Another risk source identified by Matson et al. (2013) is when a food hub relies on one or a limited number of suppliers for a given product. In this case, if a supplier is not able to meet production goals, the food hub will be unable to supply the ordered products to its customers (e.g., schools and restaurants). Matson et al. (2013) also found that one of the major food hub risks from the buyers' side is not being able to meet food safety requirements such as the Hazard Analysis and Critical Control Points (HACCP) and Good Agricultural Practices (GAP) required by food hub customers to ensure food quality and safety.

Food safety risk is another major risk identified in food supply chains. According to Matson and Thayer (2013), lack of food safety certifications and protocols in local food supply chain organizations such as food hubs may hinder their ability to sell their products to wholesale buyers (e.g., hospitals and schools). The reason for this mandatory certification requirement is not necessarily derived from end-consumers, but rather from liability concerns of the wholesale buyers of food hubs. Matson et al. (2013) identify lack of food safety protocols and adequate processing facilities to be one of the main sources of risk in food hubs. Some of the main processes in food hubs such as processing or storing organic products separate from non-organic may require additional capital investments in physical infrastructure (e.g., storage and warehouse facilities) and certification (e.g., organic). Matson et al. (2013) also state that new food safety regulations may be a potential risk source for food hubs because significant financial resources are necessary to meet those requirements.

Another potential source of risk for food hubs is their reliance on employees, especially volunteers, who might not be skilled or may not be reliable (e.g., not show up to complete the tasks). This risk is especially emphasized to be present in non-for-profit food hubs (Berti and Mulligan, 2016; LeBlanc et al., 2014). Matson et al. (2013) further emphasize that it is very important that food hubs ensure that their teams (e.g., employees and volunteers) are skilled and have experience in food product handling such as packaging, quality control, and inventory management.

2.3 Theoretical Framework

2.3.1 The origin of the term risk

The term risk has been defined in various ways in academic literature. There still is no universal consensus on the definition of risk. The origin of the word risk is still debated in academic literature. Some researchers suggest that the origin of the word risk dates back to the fourteenth century, stating that it originates from the Greek word "rhizikon" which is a navigation term and means avoid "difficulties at the sea." This term was used by the maritime traders in the Northern Italian city states. Risk at that time was perceived by maritime traders as a "danger of losing their ship". In the context of maritime traders' business activities, risk expressed the fear to lose their ship or incur losses due to external factors (e.g., storms, piracy, and diseases). That is, their business was vulnerable. In addition to this, vulnerability of their business was related to merchant-specific factors (e.g., owning only one ship or being involved in only a single commodity trade) (Heckmann et al., 2015). Others suggest that the word risk originates from the Italian word "risicare" which means to dare (Khan and Burnes, 2007; Bernstein, 1996).

Although the concept of risk has been around for a longer period of time, the systematic study of risk began in the seventeenth century when French mathematicians Blaise Pascal and Pierre de Fermat applied mathematics in gambling (Frosdick, 1997). Later on, this led to the development of probability theory which lies at the core of the risk concept (Khan and Burnes, 2007).

Over time, risk, and its management, have become a central concern and research area in various disciplines. As such, the concept of risk has been studied from various perspectives including health care (Kuhn and Youngberg, 2002), emergency planning (Hodges, 2000), psychology (Breakwell, 2007), and economics (Kahneman and Tversky, 1979).

Within the context of management studies, risk and its management emerged in the second half of the 20th century. Technological advancements, change in the size of companies, and globalization of organizations created some concerns about risk (Khan and Burnes, 2007). The concept of risk has been studied in strategic management and finance (Bettis and Thomas, 1990), international management (Ting, 1988), and supply chain management (Heckman et al., 2015; Khan and Burnes, 2007; Juttner, 2005).

2.3.2 Defining risk: Variance-based vs. hazard-based definitions

In academic literature risk has been defined in various ways. One of the reasons for the divergence in definitions is the disagreement about the nature of risk itself (Rao and Goldsby, 2009). Two of the most widely cited definitions of risk are the variance-based and hazard-based definitions (Christopher and Peck, 2004) which reflect the major difference in the nature of risk.

The variance-based definition of risk is rooted in the assumption that risk encompasses both positive and negative connotations. The theoretical basis for this approach is classical

decision theory where risk is defined in terms of "variation in the distribution of possible outcomes, their likelihoods and their subjective values" (March and Shapira, 1987: 1404). This implies that the possible outcomes can be both positive and negative. Moore (1983) argues that "risk encompasses both the possibility of loss and the hope of gain." Following this perspective of studying risk within an organizational context, some researchers suggest that, for example, taking risks in the areas of organizational strengths can result in gaining or maintaining competitive advantage (Peck, 2006). Another example is the establishment a long-term relationship with a given supplier that has both the promise of significant benefits and possibility of loss in case one of the parties behaves opportunistically (Khan and Burnes, 2007). In decision theory it is argued that risk is not solely the downside possibility of performance. Rather, it can also have the possibility that performance in a given context may be higher than expected. It is more about the uncontrollability of a situation rather than solely a downside possibility (Rao and Goldsby, 2009). In classical decision theory, risk is "the possible upside and downside of a single rational and quantifiable (financial) decision, usually illustrated with examples from gambling" (Peck, 2006: 130). Kahneman and Tversky (1979) argue that decision-making under risk is the process of choosing between prospects which have different outcomes (can be both negative and positive). Thus, this approach argues that choice is a key component of risk (Khan and Burnes, 2007).

While many discussions of risk still start by referring to classical decision theory (Peck, 2006), there was a major shift in the study of risk in the area of organizational management. In their seminal paper, March and Shapira (1987) found that managers, in fact, perceived risk in terms of its negative connotations. This gave birth to a new perspective to studying risk, known as the hazard-based approach. Following this finding, the Royal Society (1992) redefined risk as

"a combination of [the] probability, or frequency, of [an] occurrence of a defined hazard and the magnitude of the consequences of the occurrence." That is, risk is presented in the following terms: "Risk=Probability (of a given event) x Severity (negative business impact)" (Christopher and Peck, 2004: 3).

A literature review by Rao and Goldsby (2009: 100) shows that in business literature most of the authors appear to use the term risk "to refer to some form of negative change with respect to performance." Mitchell (1999) proposes to define risk as expectation of loss which is subjectively determined. Similarly, Rowe (1980: 23) suggests defining risk as "the potential for realizing unwanted negative consequences from causal events." Thus, in the organizational context, managers seem to be occupied with the downside worry rather than the upside possibility (Khan and Burnes, 2007).

Within the context of supply chain management, risk has negative connotations (Wagner and Bode, 2008; Peck, 2006). Wagner and Bode (2008: 310) define "a negative deviation from the expected value of a performance measure (resulting in negative consequences for a focal firm) as a 'supply chain risk' when this deviation is the result of a supply chain disruption." As Christopher and Peck (2004) state, the hazard-based interpretation of risk is mainly used in risk management.

Since this paper focuses on studying risk in food system organizations from the supply chain management approach, the hazard-based definition of risk is adapted as suggested by the literature review. This approach to risk is defined in terms of the probability of occurrence of a triggering-event (or disruption/ disturbance) and severity of impact. As can be seen from the discussion above, the hazard-based perspective on the study of risk is significantly different form the variance-based perspective. It has the strength of being able to more accurately reflect the

reality of how managers think about risk. Moreover, this perspective on the study of risk allows quantifying and measuring specific risks in organizational contexts which serve as a point of reference for the development of risk mitigation strategies.

The main shortcoming of the hazard-based perspective (along with the variance-based perspective) highlighted by critiques is that some researchers argue that risk is a subjective construct and cannot be accurately measured (Yates and Stone, 1992). Following this line of thought, the hazard-based perspective is criticized in terms of probabilities and severity of impact not being defined accurately. This is because often the probabilities are defined based on expert opinions (e.g., managers). In the words of March and Shapira (1987: 1407) "managers see risk in ways that are both less precise and different from risk as it appears in decision theory." Managers' views on risk, in turn, are directly linked to risk attitudes of managers. March and Shapira (1987) found that risk taking propensities of managers vary depending on individual and context. The variation across individuals is a result of their incentives and experience. Yates and Stone (1992) argue that risk is a result of interaction between the risk taker and the alternative. Thus, in the hazard-based perspective on the study of risk (where probability of occurrence of a hazard and severity of impact are determined by a manager, for example) decision-maker's risk preference will play a role as well. This study also attempts to address this issue by incorporating food hub managers' risk preferences into their risk assessment process.

Overall, the debate on the objective vs. subjective nature of risk has been in academic literature for a long time. As Khan and Burnes (2007) state, it is not known if it will be resolved anytime soon. Although these concerns are legitimate and researchers and managers must be aware of these considerations, it is important to identify and measure supply chain risks as

closely as possible. If organizations do not identify and measure risks, it would be less practical to manage them.

2.3.3 Supply chain risk management from a focal firm's perspective: Risk identification

Supply chain risk management is a complex, dynamic, and recurring process that involves several critical steps, including risk identification, risk assessment, risk treatment (or mitigation), risk monitoring, and continuous improvement (Louis and Pagell, 2019) (see Figure 2A.1 in Appendix). This study focuses on the first two steps within the context of food hub supply chain risks.

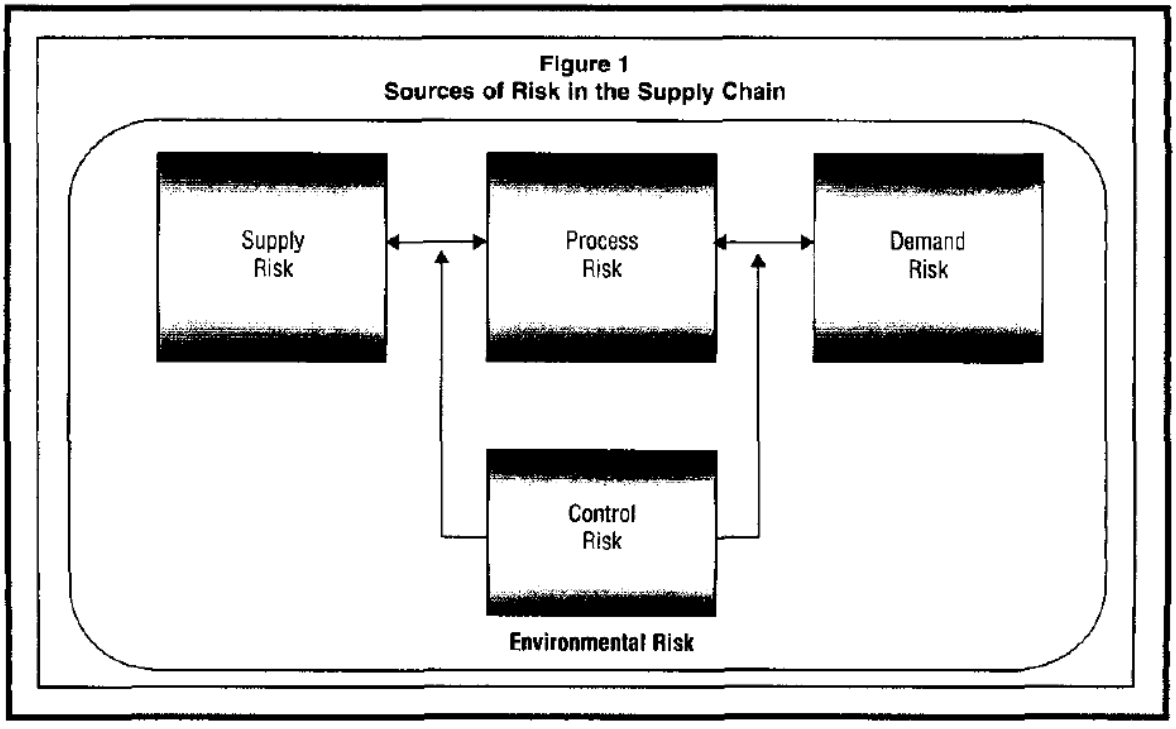
Risk identification is one of the key components of the risk management process (Louis and Pagell, 2019; Hallikas et al., 2004). The first step towards identifying risks is to categorize them. In their attempt to differentiate supply chain risks from other business risks, researchers have proposed various approaches to categorizing supply chain risks (Wagner and Bode, 2008). For example, Christopher and Peck (2004) proposed categorizing supply chain risks according to the position of sources of risks in the supply chain, namely supply-side, internal processes and control mechanisms, demand-side, and the external environment. Peck (2005) proposed categorizing supply chain risks according to the operational level of the sources of risk, namely the value stream/product or process, assets and infrastructure dependencies, organizations and interorganizational networks, and the environment. Wagner and Bode (2008) divided supply chain risk sources into five distinct categories, namely demand-side, supply-side, regulatory/legal/bureaucratic, infrastructure, and catastrophic.

Since research on supply chain risks emerged in the early 2000s, many aspects of this research field are still developing. This study builds on Christopher and Peck's (2004) approach

to study risks in food hubs as Christopher (2005; 2011) later proposed an approach to operationalizing and assessing supply chain risks. Furthermore, Wagner and Bode (2008) conducted an empirical study closer to Christopher and Peck's (2004) approach.

Christopher and Peck (2004) adopted a framework originally developed by Mason-Jones and Towill (1998) to categorize supply chain risk sources into three major categories based on their position in the supply chain: (a) internal to the focal organization, namely *internal processes and controls*, (b) external to the focal organization but internal to the supply chain, namely *demand-* and *supply-side* risk sources, and (c) external to both the focal organization and the supply chain, namely the *external environment* (see Figure 2.1). In the following subsections, each of these categories will be discussed separately and will be applied to food hubs.

Figure 2.1: Sources of risk in the supply chain



Note: Source - Christopher and Peck (2004)

2.3.3.1 Supply-side risk

Over the past few decades many companies have shifted their strategies from vertical integration within their supply chains to outsourcing. The major premise of this significant change in vertical coordination of activities is that companies focus on their core competencies. Outsourcing has become a widely applied strategy in many companies with the promise of gaining a competitive advantage. However, it has also increased the exposure of the outsourcing companies to many unexpected events with their suppliers. As a result, supply-related risks may or may not be able to be controlled by purchasing companies (Zsidisin et al., 2000). Food hubs are not exception. In essence, these organizations outsource the production aspect of the local food supply chain. Moreover, instead of relying on large producers, food hubs procure local foods from multiple small- and medium-sized farm and food entities. This, in turn, increases their exposure to supply-side risks. There are numerous risks related to inbound supply of products to a focal company. Supply-side risk is defined as "the probability of an incident associated with inbound supply from individual supplier failures or the supply market occurring, in which its outcomes result in the inability of the purchasing firm to meet customer demand or cause threats to customer life and safety" (Zsidisin, 2003: 222).

One of the well-known authors in the area of supply-side risks, Zsidisin (2003), conducted an empirical study to investigate how risk is defined by purchasing organizations. The study showed that the majority of case study organizations did not have a formal definition of risk. However, the managers had conceptions of what supply risk meant to their organizations. The study found that, from a focal firm's perspective, the supply-side risks originate from two major sources: individual supplier failures and market characteristics. Individual supplier failures refer to situations such as delivery failures, relationship issues, quality problems, price increases,

and inability to meet the quantity demanded. The second major source of supply-side risk originates from market characteristics including market shortages and geographic concentration of suppliers. In addition to this, a literature review by Zsidisin et al. (2000) identified several other key supply-side risks that exist in many organizations. This includes supplier's business risk, supplier's capacity constraints, and technological changes in production.

Within this context, supply-side risk has negative connotations. For a focal firm, the supply-side risks can have two major negative effects: (1) inability of a focal firm to meet its customers' requirements, and (2) threats to a focal firm's customer safety. The inability to meet customer requirements includes situations such as failure to meet customer specifications and missed shipments, which can negatively affect the focal firm's revenues and profits as well as cost the focal firm the customer's business. The second dimension is threats to customer safety. This includes situations when there are issues with product reliability, integrity, and durability as well as quality failures resulting in loss of life (Zsidisin, 2003).

While the literature on food hubs has not yet included discussions of all of these important risks, this study uses the aforementioned supply-side risk sources as a point of reference to discuss the most relevant risk sources for food hubs. Dani (2015) identified loss of suppliers and unavailability of supply (e.g., raw materials) as major risks in food supply chains. Matson et al. (2013) identify potential disruptions in food hub operations that may originate from a mismatch between the food hub and suppliers on planned or forecasted sales growth in the future, quantity expected from each supplier, and the production capacity of the individual suppliers. Matson et al. (2013) further state that many of the suppliers with whom food hubs work have the most experience with direct markets (e.g., farmers' market, CSA, etc.). As a result, these suppliers may not be willing to produce, or may not be accustomed to producing,

food products that meet the required consistency and quality volume needed for the wholesale buyers that food hubs serve. Another risk source identified by Matson et al. (2013) is when a food hub relies on one or a limited number of suppliers for a given product. In this case, if a supplier is unable to meet production goals, the food hub will be unable to supply its customers (e.g., school, restaurant, etc.) with the ordered products.

Thus, by deriving key insights from the supply chain risk literature in general and food hub literature in particular the following propositions in regard to food hub supply-side risks and their sources are made: [4]

- *Poor quality of products:* Food hub operations may be disrupted in cases when the procured food products do not meet quality requirements set by food hubs and their customers. Food hubs may specify product quality in terms of a) product attributes (e.g., size, local, etc.) and/or b) food safety requirements (production and handling practices, etc.).
- *Insufficient quantity of products:* Food hub operations may be disrupted in cases when food hubs are unable to provide the quantity of product demanded by food hub customers due to constraints on the suppliers' production capacity (e.g., limited land, labor, equipment, or other necessary facilities).
- *Supplier's delivery failures or delays:* Food hub operations may be disrupted in cases when a supplier is unable to deliver orders on time or fails to deliver at all. One potential

[4] Note: As it will be made more explicit in the Methods section of this study, in addition to literature review, the propositions are grounded in knowledge and insights drawn from a key informant, communication with the industry experts and participation in Michigan Food Hub Network meetings.

example is the supplier failing to process (harvest, package, label, etc.) and/or transport orders in a timely manner.

- *Loss of suppliers:* Food hub operations may be disrupted in cases when a supplier terminates production (e.g., bankruptcy, goes out of business, stops farming for another reason) or prioritizes other marketing channels. Unexpected termination of the relationship may result in problems with product availability and fulfilling orders.
- *High volatility in local food supply:* Food hub operations may be disrupted due to high volatility in the supply of local food products, which may occur due to seasonality of production. This may subsequently cause periods of inactivity or losses in the operational capacity of a food hub during seasons when there is limited or no production of certain food products marketed by the food hub.

2.3.3.2 Internal processes and controls

The second category of supply chain risks, internal processes and controls, focuses on the disruptions that may occur within a focal firm, namely disruptions related to its internal processes and control systems. Processes refer to value-adding as well as managerial activities of a focal organization. Examples of process risk are disruptions to assets owned and managed by a focal firm, supporting transportation infrastructure, etc. Control mechanisms refer to rules and policies within the focal organization regarding order quantities, safety standards, etc. (Christopher, 2011; Juttner, 2005; Christopher and Peck, 2004). In food hubs, the main processes regarding physical product flows are packaging, repackaging, basic processing (e.g., washing, cutting, freezing), value-added processing (e.g., mixing), product storage, etc. (Berti and

Mulligan, 2016). Depending on the size and operational capacity of a food hub, it may implement some or all of the aforementioned processes.

In terms of the internal processes and control mechanisms, the literature on food hubs identifies several key areas where risk sources reside. Food safety risk is one of the major risks identified in food supply chains. According to Matson and Thayer (2013), lack of food safety certifications and protocols in local food supply chain organizations such as food hubs may hinder their ability to sell their products to wholesale buyers (e.g., hospitals and schools). The reason for this mandatory certification requirement is not derived from end-consumers, but rather from liability concerns of the wholesale buyers of food hubs. Matson et al. (2013) identify lack of food safety protocols and adequate processing facilities to be one of the main sources of risk in food hubs. Some of the main processes in food hubs such as processing or storing organic products separately from non-organic ones may require additional capital investments in physical infrastructure (e.g., storage and warehouse facilities) and certification (e.g., organic). Another identified potential source of risk is food hubs' reliance on employees, especially volunteers, who may be unskilled or unreliable (e.g., not show up to complete the tasks, etc.). This risk is especially emphasized to be present in not-for-profit food hubs (Berti and Mulligan, 2016; LeBlanc et al., 2014). Matson et al. (2013) further emphasize that it is very important that food hubs ensure that their teams (e.g., employees and volunteers) are skilled and have experience in food product handling such as packaging, quality control and inventory management. The National Food Hub Survey (Hardy et al., 2016) shows that 49 percent of the surveyed food hubs in the U.S. have their staff take responsibility for the food hub's internal food safety compliance. Dani (2015) identified loss of information technology, food product contamination and packaging problems as major risks in food supply chains.

Thus, by deriving key insights from the supply chain risk literature in general and food hub literature, in particular, the following propositions in regard to food hub internal risks and their sources are made:

- *Food safety*: One of the main disruptions that can happen to any food-related company, including food hubs, is poor food handling practices. Food hubs may be unable to handle food products properly due to: (a) a lack of adequate facilities and infrastructure (i.e., proper storage and/or handling facilities, etc.), and (b) employees or volunteers that lack adequate knowledge of and/or training in food safety and food handling standards (e.g., food handling, warehouse keeping, procurement, etc.).
- *Poor planning:* Food hub operations may also be disrupted in cases when the food hub is unable to fulfill customer orders or has unsold and/or expired products due to: (a) poor planning or forecasting, and/or (b) the reliance on a limited number of suppliers for a particular product.
- *Information technology malfunctions or breakdowns*: Food hub operations may be disrupted in cases when information technology (IT) breaks down or malfunctions. For example, a food hub's website may break down and customers are not able to view available products or place orders online.
- *Staff underperformance:* Food hub operations may be disrupted in cases where employees or volunteers underperform (e.g., tardiness or absence from work, misrepresenting abilities, etc.).
- *Unexpected liability issues:* Food hub operations may be disrupted in cases when the food hub faces liabilities (e.g., employees get into accidents while driving their own cars for food hub deliveries).

2.3.3.3 Demand-side risk

The third category of supply chain risk is demand-side risks. Demand-side risks relate to downstream supply chain operations. This risk relates to distribution (or outbound logistics) and product demand. In particular, demand-side risks relate to potential or actual disruptions to the flow of products originating from within the distribution network, between the focal organization and the market (Christopher 2011; Wagner and Bode, 2008; Juttner, 2005; Christopher and Peck, 2004). Among the major demand-side risk sources identified in the literature are poor coordination of outbound logistics such as product delivery delays or failures. These disruptions, in turn, have negative consequences for supply chain performance—both upstream and downstream—such as costly excess inventory (Wagner and Bode, 2008), loss of customers and negative effects on customers' businesses.

Matson et al. (2013) found that one of the major food hub risks from the buyers' side is not being able to meet food safety requirements, such as the Hazard Analysis and Critical Control Points (HACCP) and Good Agricultural Practices (GAP), required by food hub customers to ensure food quality and safety. The National Food Hub Survey (Hardy et al., 2016) shows that the top five customer segments to which food hubs sell products are restaurants, schools, small or regional supermarket chains, online stores, and universities. The survey results show that the top wholesale buyers' requirements of food safety certification, namely GAP and Good Handling Practices (GHP), are different from smaller buyers' requirements. For example, among the surveyed food hubs who sold products to businesses (e.g., restaurants) or institutions (e.g., schools, universities, etc.), 77 percent of the food hubs indicated that, on average, 35 percent of their customers require GAP certification. In terms of the Good Handling Practices (GHP), 72 percent of the surveyed food hubs working with businesses or institutions indicated

that an average of 32 percent of their customers require GHP certification. The survey further found that if we take all the surveyed food hubs along with all of their customer segments, "about half of hubs (GAP: 48 percent, GHP: 50 percent) had only one to ten percent of their customers requiring certification" (Hardy et al., 2016: 30). This suggests that as food hubs expand their market segments from smaller buyers (e.g., senior care, mobile retail units) to larger businesses and institutions, the GHP and GAP certification requirements become more urgent and mandatory. Food hubs that do not comply with these requirements may risk not being able to sell their products to a growing segment of wholesale buyers such as schools and restaurants.

Thus, as a result of deriving key insights on demand-side risks and their sources from the supply chain risk literature in general and food hub literature in particular the following propositions in regard to food hub demand-side risks and their sources are made:

- *Delivery failures:* Food hub operations may be disrupted in cases when a food hub is unable to deliver customer orders on time or fails to deliver them at all. This may occur, for example, when a food hub has a shortage of transportation (e.g., trucks) or when a product is not ready for pickup or delivery.
- *Product rejection:* Food hub operations may be disrupted in cases when products are rejected by the customer due to failure to meet order specifications (e.g., delivery timing, packaging type, etc.) or customer dissatisfaction with product quality attributes (e.g., does not meet food safety requirements).
- *High volatility of demand:* Food hub operations may be disrupted in cases when there is a mismatch between a food hub's projections and actual demand due to unanticipated or very volatile customer demand.

2.3.3.4 The external environment

The fourth and final category of Christopher and Peck's (2004) framework is the risk sources that are external to the focal organization and the supply chain. These are risk sources that originate from the external environment in which a given focal organization operates. Environmental risk sources include disruptions such as unfavorable weather, fire, earthquake, changes in regulations (Christopher, 2011; Juttner, 2005; Wagner and Bode, 2008). For food hubs, one of the major risk sources is unfavorable weather. Specifically, food hub operations may be disrupted when suppliers are unable to provide the quantity demanded by food hub customers due to weather-related shortages (drought, storm damage, etc.).

Thus, by deriving key insights from the supply chain risk literature in general and food hub literature in particular, the following proposition with regard to food hub external risks and their sources are made: [5]

- *Insufficient quantity of products:* Food hub operations may be disrupted in cases when food hubs are unable to provide the quantity of product demanded by food hub customers due to suppliers' inability to provide the quantity demanded because of weather-related shortages (drought, storm damage, etc.).

Thus, the aforementioned subsections identified food hub supply chain risk sources specified in the food hub literature and experts in the field as well as those suggested by the supply chain risk management literature. As it will be made more explicit in the Methods section

[5] It is important to note that there is only one risk source stemming from the external environment (i.e., macro-level) listed in this study. The survey included the most relevant risks at the time when the instrument was designed. Other potential risk sources such as price shocks, climate shocks, fuel shocks, pandemics, etc. could also impact the supply chain. Hence, future research may investigate these types of risk sources.

of this study, in addition to the literature review, these propositions are grounded in knowledge and insights drawn from key informants and participation in Michigan Food Hub Network meetings. The summary of the risks and their sources are presented in Table 2.1.

Table 2.1: List and description of food hub supply chain risks included in the study

Supply chain risk category	Supply chain risk source
Supply-side risks (SS)	♦ Insufficient quantity of products: Suppliers' own production capacity constraints ♦ Inability to meet quality requirements: Product attribute requirements ♦ Inability to meet quality requirements: Food safety requirements ♦ Product delivery delays by suppliers ♦ Supplier prioritizes other marketing channels ♦ Supplier terminates production ♦ High volatility of supply: Seasonality of production
Internal risks (I)	♦ Workforce issues: Employees/volunteers underperform ♦ Poor planning or forecasting: Relies on a limited number of suppliers for a given product ♦ Poor planning or forecasting: Inadequate forecasting of demand by the food hub ♦ Poor food-handling practices: Lack of adequate facilities and infrastructure ♦ Poor food-handling practices: Employees/volunteers lack adequate knowledge and/or training on food safety standards ♦ Breakdown or malfunction of information technology ♦ Unexpected liability issues
Demand-side risks (DS)	♦ Unexpected or very volatile customer demand ♦ Customer delivery failures or delays ♦ Product rejection by customer: Dissatisfaction with product quality attributes ♦ Product rejection by customer: Failure to meet other order specifications
External environment (EE)	♦ Insufficient quantity of products: Weather-related production issues

The following section will further specify how the aforementioned propositions are developed and examined, that is, the specific process through which supply chain risks were identified and assessed in this study. Risk assessment is the second critical step in a supply chain risk management process (Louis and Pagell, 2019; Hallikas et al., 2004).

2.4 Methods

2.4.1 Data collection

Since risk identification and assessment are two separate, complex tasks, this study employs an Exploratory Sequential Mixed Methods research design (Creswell, 2014), in which a qualitative research phase is followed by a quantitative research phase. Data collected in the first phase are analyzed and the insights are used to build the second phase of the research study.

2.4.1.1 Phase one of data collection

Identification of food hub supply chain risks was implemented through extensive review of literature on supply chain risk management and food hubs. Additionally, qualitative data regarding food hub risks were collected through an interview with a key informant in July of 2016. The interview was recorded and transcribed (see Table 2B.1 in Appendix for the main risks identified through qualitative interview with the key informant). Finally, regular attendance at Michigan Food Hub Network meetings since 2015—organized quarterly by the Center for Regional Food Systems at Michigan State University—served as a platform to learn more about supply chain dynamics of food hubs directly from practitioners and experts. Therefore, risk identification in this study is primarily based on the literature review and the insights drawn from practitioners.

2.4.1.2 Phase two of data collection

In the second phase of this study, food hub supply chain risks were assessed through an online survey distributed directly to U.S. food hub managers via Qualtrics software from November 29, 2018 to November 30, 2019. The survey was first distributed to the food hubs that had completed the 2017 National Food Hub Survey. The list of these food hubs was provided by the Center for Regional Food Systems (CFRS) at Michigan State University. Additionally, CRFS provided access to the 2017 National Food Hub Survey which included characteristics of food hubs. The reason for this approach was to link supply chain risk data with food hub characteristics and avoid survey fatigue in food hubs. The survey also included a section that aimed to elicit the risk preferences of respondents through risk experiments.

Out of 130 food hubs, 63 completed the survey from November 29, 2018 to March 5, 2019. Respondents received $10 Amazon gift cards for completing the section on supply chain risks. They also had an opportunity to receive more depending on their overall payoff results from the risk experiments (see Appendix 2B for risk experiment payoffs). A total of 61 food hubs completed the section on risk experiments. Survey participants received an average of $28 Amazon gift cards for completing the supply chain risk survey and risk experiments sections. The gift cards were sent to respondents via Amazon.com within 48 hours of completing the survey.

With the goal of increasing the response rate, the survey was also distributed to food hubs that had completed the 2015 Food Hub Survey (excluding the ones that completed the 2017 Food Hub Survey) and the list of food hubs available on the U.S. Department of Agriculture's website. The survey included a section on food hub characteristics. In the second round, it was distributed to a total of 177 food hubs from August 1, 2019 to November 30, 2019. A total of 27 food hubs

responded to the survey. Respondents received $25 Amazon gift cards upon completion of the survey. Additionally, the food hubs that completed the survey in round one received a follow-up request to complete a section on food hub characteristics, which lasted from August 1, 2019 to November 30, 2019. The goal was to have consistency in the data on food hub characteristics and to address missing data in the National Food Hub Surveys originally planned to link to the food hub supply chain risk data. Forty-four food hubs in total completed the food hub characteristics section of the survey. After finishing the survey respondents then received $15 Amazon gift cards.

Table 2.2 shows the overall result of survey completion numbers and timeline by survey section.

Table 2.2: Survey completion numbers and timeline by survey section

Survey section	Number of food hubs the survey section was distributed to	Number of food hubs that fully completed each section	Response rate	Timeline
Food hub supply chain risk assessment	130	63	48%	11/29/2018 – 3/5/2019 (Round 1)
	177	27	15%	8/1/2019 – 11/30/2019 (Round 2)
Risk experiments	130	61	47%	11/29/2018 – 3/5/2019 (Round 1)
Food hub characteristics	307	73	24%	8/1/2019 – 11/30/2019 (Round 2)

Table 2.2 (cont'd)

Survey section	Number of food hubs the survey section was distributed to	Number of food hubs that fully completed each section	Response rate	Timeline
Combined: Food hub supply chain risk assessment, risk experiments, and food hub characteristics	See above	44	See above	See above
Combined: Food hub supply chain risk assessment and risk experiments	See above	61	See above	See above
Combined: Food hub supply chain risk assessment and food hub characteristics	See above	73	See above	See above

The response rate for the 2017 National Food Hub Survey was 33 percent (130 food hubs) which included both completed and partial responses. This suggests that the response rates in this study (see Table 2.2) are reasonable given the dynamics in the field.

The structure of the survey instrument was developed following the Failure Modes and Effect Analysis (FMEA) methodology. This methodology has been extensively applied in the areas of product and process reliability analysis. It allows for structured analysis of possible failures or malfunctions in a given system, as well as allows for assessing the effects of failures on a given system (Lauritsen and Stalhane, 2009). FMEA allows for identification and prevention of process or product failures before they occur. It has been widely applied for both process improvement and risk reduction purposes (Tummala et al., 2014). FMEA has been applied in various contexts, including healthcare (Thornton et al., 2011), project risk management (Carbone and Tippet, 2004; Ng et al., 2003; Tummala and Mak, 2001) food

production and manufacturing (Ozilgen, 2013; Varzakas and Arvanitoyannis, 2007; Scipioni et al., 2002), resource planning system implementation for enterprises (Shirouyehzad et al., 2011), and supply chain risk management (Tummala et al., 2014; Bertolini et al., 2006; Elkins et al., 2005). The application of FMEA in the food supply chain risk context is a relatively recent phenomenon.

According to the FMEA methodology, each of the identified risk sources (listed in Table 2.1) is assessed for its *likelihood of occurrence, severity of impact,* and *detectability.* While there are various FMEA scaling approaches and categorizations available in the literature for different contexts, this study adapts Christopher's (2011) approach to define the scaling and categories (see Table 2.3). The reason for this choice is that Christopher (2011) customized FMEA categories specifically for a supply chain risk management context. Christopher's (2011) proposed categories are further customized for the food hub supply chain context to make it more pragmatic for food hub managers (see example question in Figure 2C.1 in Appendix 2C). In particular, the following five categories of *likelihood of occurrence* are defined along with the occurrence scores: weekly (likelihood of occurrence = 5), monthly (likelihood of occurrence = 4), several times a year (likelihood of occurrence = 3), once a year (likelihood of occurrence = 2), and almost never (likelihood of occurrence = 1). That is, the higher the ranking (score of 1-5), the more likely it is for a given disruption (i.e., failure mode) to occur (Thornton et al., 2011). In general, the likelihood of occurrence of a failure mode is assessed based on previous adverse events and personal experiences of individuals working on a given process or product (Thornton et al., 2011).

Christopher's (2011) approach is adapted to define the categories for *severities of impact* (i.e., consequences of a failure or disruption) as well. Categories are customized to reflect the

severities of impact on food hub operations if a given disruption occurs. In particular, the following five categories of severity of impact are defined along with the severity scores: operations close to shutdown (severity of effect = 5), serious disruption (severity of effect = 4), definite disruption (severity of effect = 3), minor disruption (severity of effect = 2), and no direct effect (severity of effect = 1). That is, the higher the ranking (score of 1-5), the more severe is the effect of a potential failure mode (Thornton et al., 2011).

Finally, Christopher's (2011) approach is also adapted to define the categories for *detectability* along with scores. In particular, the following five categories of detectability are defined along with the detectability scores: very detectable (detectability = 1), considerable warning before occurs (detectability = 2), some warning before occurs (detectability = 3), little warning before occurs (detectability = 4), and almost undetectable (detectability = 5). That is, the higher the ranking (score of 1-5), the less likely it is that a disruption (i.e., failure mode) will be detected before it occurs (Thornton et al., 2011).

Table 2.3: Risk assessment scoring system

Score	**Likelihood of Occurrence**	**Score**	**Severity of Impact**	**Score**	**Likelihood of Detection**
5	Weekly	5	Operations close to shutdown	5	Almost undetectable
4	Monthly	4	Serious disruption	4	Little warning before occurs
3	Several times a year	3	Definite disruption	3	Some warning before occurs
2	Once a year	2	Minor disruption	2	Considerable warning before occurs
1	Almost never	1	No direct effect	1	Very detectable

Note: Adapted from Christopher (2011)

As mentioned earlier, the survey also included a section on food hub chaacteristics. The National Food Hub Surveys were reviewed as a basis for developing the section. Access to the surveys was given through collaboration with the Center for Regional Food System at Michigan State University. A list of food hub characteristics was developed and inluded in the survey as a separate secton. Tabel 2.4 provides a list and description of independent variables included in the models in this study.

Table 2.4: List and definition of variables used in ANOVA tests

Variable name	Categories	Variable definition
Provides liability insurance services to suppliers	0; 1	Equal 1 if the food hub provides liability insurance services to suppliers, 0 otherwise
Number of suppliers	0; 1; 2	Food hub's total number of suppliers in 2018: 0=Less than 50; 1=50-100; 2=More than 100
Business model	1; 2; 3	1=Farm-to-business/institution (F-B); 2=Hybrid: part farm-to-business/institution and part farm-to-consumer; 3=Farm-to-consumer (F-C)
Provides inbound logistics services	0; 1	Equal 1 if the food hub offers inbound logistics services 0 otherwise
Provides outbound logistics services	0; 1	Equal 1 if the food hub offers outbound logistics services, 0 otherwise
Number of employees andvolunteers	0; 1; 2	Food hub's total number of employees/volunteers during peak season(s) in 2018: 0=Less than 15, 1="16-30", 2=More than 30
Facility	0; 1	Equal 1 if the food hub currently uses physical facilities that it currently owns, rents or leases from others, 0 otherwise
Food safety certification	0; 1	Equal 1 if the food hub has food safety certification, 0 otherwise
Gross sales	0; 1; 2	Food hub's gross sales (includes sales plus products sold on commission) in 2018: 0=Less than $500,000, 1="$500,000-$1,500,000", 2=More than $1,500,000
Organizational model		1=For-profit only; 2=Hybrid: part for-profit and part non-profit; 3=Non-profit only

Table 2.4 (cont'd)

Variable name	Categories	Variable definition
Insures against supply chain risks, if possible	0; 1; 2; 3; 4	0=For none of the products; 1=For a few of the products; 2=For half of the products; 3=For most of the products; 4=For all the products
Region	1; 2; 3; 4; 5	Region where the food hub is located: 1=Northeast; 2=Southeast; 3=Midwest; 4=Southwest; 5=West

Table 2.5 shows the descriptive statistics of the aforementioned variables.

Table 2.5: Descriptive statistics for food hub characteristics included in ANOVA tests

Variable name	Frequency					
Provides liability insurance services to suppliers	Yes 18%	No 82%				
Number of suppliers	Less than 50 58%		50-100 30%	More than 100 12%		
Business model	Farm-to-business/institution 22%		Hybrid: part farm-to-business/institution and part direct-to-consumer 51%		Direct-to-consumer 27%	
Provides inbound logistics services	Yes 77%	No 23%				
Provides outbound logistics services	Yes 88%	No 12%				
Number of employees and volunteers	Less than 15 68%		16-30 26%	More than 30 5%		
Facility	No 23%	Yes 77%				
Food safety certification	Yes 59%	No 41%				
Gross sales	Less than $500,000 53%			$500,000-$1,500,000 22%		More than $1,500,000 25%

Table 2.5 (cont'd)

Variable name	Frequency					
Organizational model	For-profit only 52%		Hybrid: part for-profit and part non-profit 21%		Nonprofit only 27%	
Insures against supply chain risks, if possible	For none of the products 36%	For a few of the products 5%	For half of the products 10%	For most of the products 11%	For all the products 38%	
Region	Northeast 25%	Southeast 21%	Midwest 30%	Southwest 5%	West 19%	
Number of observations	73					

Finally, in addition to collecting data on supply chain risks and characteristics of food hubs, risk experiments were conducted to elicit respondents' measures of risk preferences. In order to investigate if the risk preferences of respondents (i.e., food hub managers) played a role in their assessment of supply chain risks for their organizations (i.e, examining association between risk type and food hub manager's risk preferences), three measures of risk preferences were elicited: the parameter of risk aversion, the parameter of loss aversion, and the parameter of non-linear probability-weighing function (Liu, 2013; Tanaka et al., 2010). The experiments were completed following the principles of Prospect Theory (Kahnemann and Tversky, 1979). To estimate the risk preference parameters, namely risk aversion coefficient, loss aversion coefficient, and non-linear probability weighting measure, risk experiments were conducted with surveyed food hub managers to capture the extent to which their risk preferences might affect their assessment of supply chain risks. Only a subset of respondent food hubs—61 out of 90—completed this section of the survey. The risk experiment section involved assigning a decision exercise with individual food hub managers who also assessed supply chain risks for their food hub. Risk experiment participants were given three different series of decisions. The

first and second series contained 14 choices and the third series contained seven choices between two lotteries: A and B (see Figures 2C.2-2C.4 in Appendix 2C).

2.4.2 Data analyses

Three types of statistical analysis are performed to analyze the data: (1) ranking of supply chain risks based on risk exposure values (REV) and risk priority numbers (RPN), (2) Analysis of Variance (ANOVA) and Tukey HSD tests to examine association between risk type and food hub characteristics, and (3) linear regression analyses to examine association between assessed risk and food hub managers' risk preferences.

2.4.2.1 Ranking of supply chain risks

First, the data collected in phase two are analyzed following the FMEA methodology. To assess the relative importance of the identified supply chain risks, risk exposure values (REV) and risk priority numbers (RPN) are calculated and ranked.

Risk exposure values (REV) are calculated for each identified food hub supply chain risk. The REVs are calculated following Tummala et al.'s (2014) approach, where only the *likelihood of occurrence* (also called "risk probability index") and *severity of impact* (also called "risk consequence index") of risk sources are taken into consideration. According to Tummala et al. (2014), risk exposure value is defined as follows:

$$Risk\ Exposure\ Value = Likelihood\ of\ Occurence\ \ x\ \ Severity\ of\ Impact \quad (1)$$

where the scored for *likelihood of occurrence* and the *severity of impact* of each identified supply chain risk source are directly taken from respondents' (i.e., food hub managers) survey responses

(see Table 2.3 for scoring scale). In order to rank risk exposure values of food hub supply chain risks, first risk exposure value for each food hub was calculated. Afterward, the mean REV was calculated for each supply chain risk.

In addition to REV, to assess the relative importance of the identified supply chain risks, risk priority numbers (RPN) are calculated (Giannakis and Papadopoulos, 2016). It is a quantitative measure which is used to assess a failure mode. RPN is derived from the product of numeric ratings for *likelihood of occurrence*, *severity of impact*, and *detectability* described above. Risk priority numbers are defined as the following:

$$Risk\ Priority\ Number = Likelihood\ of\ Occurence\ \ x\ \ Severity\ of\ Impact\ \ x\ \ Detectability \quad (2)$$

In order to prioritize failure modes, the RPNs are ranked. The highest RPNs are the ones that need to be prioritized by food hubs. The major difference between REV and RPN is the "detectability" component. As Griffis and Whipple (2012) state, previous research on supply chain risks has mainly examined the likelihood of occurrence and severity of impact of a risk. They also propose that an additional risk factor, likelihood of risk detection, can be beneficial for companies.

Griffis and Whipple (2012) propose a supply chain risk priority continuum in which they differentiate between low priority, mixed priority, and high priority risks (see Figure 2D.1 in Appendix 2D). Ranking of supply chain risks is important for identifying high priority risks that would serve as a reference point for developing and implementing risk mitigation strategies for food hubs.

2.4.2.2 Analysis of variance and Tukey HSD tests

The second set of analyses are applied using Analysis of Variance (ANOVA) tests to examine the association between risk type and food hub characteristics. The goal is to investigate whether certain types of risks are associated with certain characteristics of food hubs. Since the independent variables are all categorical in this study, ANOVA tests are the most appropriate type of analysis.

For ANOVA models, the dependent variable is risk type. For the purpose of this task, risks are grouped into categories as proposed in Christopher and Peck's (2004) framework, namely supply-side, internal, demand-side, and external. For each category, a combined score is calculated by taking the average of REVs within each category. For example, in order to calcualte a combined score for supply-side risk for a given food hub (i.e., supply-side REV), REVs of all supply-side risks listed in Table 2.1 were used to calcualte the average supply-side risk. A similar procedure was implemented to calculate a combined REV score for both internal and demand-side categories. Since there was only one risk source included in the external environment category, no average score was calculated for this category. Food hub characteristics served as independent variables that could potentially explain variation in REV for each category.

Since the results of ANOVA tests do not generate coefficients for each variable to reveal the direction and magnitude of the association between the dependent and independent variables, a Tukey HSD tests were completed to identify if there were statistically significant differences between the categories of independent variables included in the model specifications.

2.4.2.3 Association between assessed risk and risk preferences

In order to investigate if the risk preferences of respondents (i.e., food hub managers) played a role in their assessment of supply chain risks for their organizations (i.e, examining association between risk type and food hub manager's risk preferences), three measures of risk preferences were elicited: the parameter of risk aversion, the parameter of loss aversion, and the parameter of non-linear probability-weighing function (Liu, 2013; Tanaka et al., 2010). In order to identify the risk preference parameters, the switching points in each of the three series were identified. Following the procedure proposed by the Prospect Theory, in order to determine the estimate of risk aversion coefficient, σ, the switching points both in series one and two were used (see Tanaka et al., 2010). Similarly, in order to determine the non-linear probability weighting measure, α, the switching points both in series one and two were used (see Tanaka et al., 2010). The loss aversion parameter, λ, is determined from switching point in series three and the value of sigma.

The parameter of risk aversion, σ, is interpreted as follows: $\sigma < 1$ indicates the person is risk averse, $\sigma = 1$ indicates the person is risk neutral, and $\sigma > 1$ indicates the person is risk loving. As σ decreases, risk aversion increases, and vice versa. The parameter of loss aversion, λ, captures the extent to which individuals overvalue losses over gains. If $\lambda > 1$, this means a person is more risk averse to loses than to gains. That is, as λ increases, loss aversion increases. The non-linear probability weighting measure, α, "captures the degree to which less likely events are disproportionately weighted when valuing risky prospects" (Ray, 2018: 22). If $\alpha < 1$, this means a person overweighs low probabilities of larger losses or gains and underweights higher probabilities (Ray, 2018).

In order to investigate if risk preferences of food hub managers played a role in their risk assessment process, four generalized linear regression models were built following the equations below:

$$Y_{Supply-Side\ Risk} = \beta_0 + \beta_1\ Risk\ Aversion + \beta_2\ Loss\ Aversion + \beta_3\ Probability\ Weighting + \varepsilon \quad (3)$$

$$Y_{Internal\ Risk} = \beta_0 + \beta_1\ Risk\ Aversion + \beta_2\ Loss\ Aversion + \beta_3\ Probability\ Weighting + \varepsilon \quad (4)$$

$$Y_{Demand-Side\ Risk} = \beta_0 + \beta_1\ Risk\ Aversion + \beta_2\ Loss\ Aversion + \beta_3\ Probability\ Weighting + \varepsilon \quad (5)$$

$$Y_{External\ Risk} = \beta_0 + \beta_1\ Risk\ Aversion + \beta_2\ Loss\ Aversion + \beta_3\ Probability\ Weighting + \varepsilon \quad (6)$$

where the dependent variable, Y, represents the score for the following risk categories: supply-side risk, internal risk, demand-side risk, and the external risk in each equation respectively. In each case, the independent variables of interest were the measures of risk preferences. Since this is an exploratory study, no prior hypotheses were constructed.

2.5 Results and Discussion

This section is composed of three sub-sections. These sub-sections present the results of food hub risk rankings, association between risk type and food hub characteristics, and association between risk type and food hub managers' risk preferences.

2.5.1 Ranking of risks

Using the FMEA framework, both Risk Exposure Values (REV) and Risk Priority Numbers (RPN) were calculated for each disruption listed in Table 2.1. For each type of disruption, mean REV was caluclated by summing up the REV for a given type of disruption reported by food hubs and dividing it by the total number of respondents. As can be seen from Table 2.6, the top ten risks faced by food hubs are the following (listed by rank—from highest to lowest risk): 1) insufficient quantity of producrs due to suppliers' own capacity constraints, 2) unexpected or very volatile customer demand, 3) product delivery delays by suppliers, 4) insufficient quantity of products due to weather-related production issues, 5) poor planning and forecasting by a food hub due to reliance on a limited number of suppliers for a particular product, 6) high volatility of supply due to seasonality of production, 7) workforce issues regarding employee and volunteers underperformance, 8) poor planning or forecasting of demand by food hubs, 9) poor food-

Table 2.6: Ranking of food hub supply chain risks based on Risk Exposure Values (REV)

Rank[1]	Food hub supply chain risk source	Mean[3]	Standard deviation	Coefficient of variation	Min	Max	Percent of food hubs that indicated the risk applies to them
1	Insufficient quantity of products: Suppliers' own production capacity constraints (SS)[2]	10.50	4.60	44%	2	20	91%
2	Unexpected or very volatile customer demand (DS)	9.65	5.13	53%	1	25	69%
3	Product delivery delays by suppliers (SS)	9.50	4.31	45%	2	20	84%
4	Insufficient quantity of products: Weather-related production issues (EE)	9.40	3.94	42%	3	20	96%
5	Poor planning or forecasting: Relies on a limited number of suppliers for a given product (I)	9.29	4.97	53%	2	20	86%
6	High volatility of supply: Seasonality of production (SS)	9.20	4.80	52%	1	20	88%
7	Workforce issues: Employees/volunteers underperform (I)	9.13	4.70	51%	2	20	68%
8	Poor planning or forecasting: Inadequate forecasting of demand (I)	9.05	4.51	50%	2	20	72%
9	Poor food-handling practices: Lack of adequate facilities and other infrastructure (I)	7.89	5.03	64%	1	25	61%
10	Customer delivery failures or delays (DS)	7.62	4.06	53%	2	20	68%
11	Inability to meet quality requirements: Product attribute requirements (SS)	7.53	3.63	48%	1	20	78%
12	Breakdown or malfunction of information technology (I)	7.50	4.29	57%	1	20	69%
13	Product rejection by customer: Dissatisfaction with product quality attributes (DS)	6.32	3.44	54%	1	16	86%
14	Supplier prioritizes other marketing channels (SS)	5.88	3.91	67%	1	20	80%
15	Inability to meet quality requirements: Food safety requirements (SS)	5.34	4.47	84%	1	25	49%

Table 2.6 (cont'd)

Rank[1]	Food hub supply chain risk source	Mean[3]	Standard deviation	Coefficient of variation	Min	Max	Percent of food hubs that indicated the risk applies to them
16	Poor food-handling practices: Employees/volunteers lack adequate knowledge and/or training on food safety standards (I)	5.21	3.88	75%	1	15	43%
17	Product rejection by customer: Failure to meet other order specifications (DS)	4.98	2.82	57%	1	15	59%
18	Supplier terminates production (SS)	4.62	2.62	57%	1	12	82%
19	Unexpected liability issues (I)	4.40	2.57	58%	2	12	61%
Number of observations		90					

Note: [1]Ranked based on mean REV – from highest (1) to lowest (19). [2]"SS" denotes Supply-Side Risk, "I" denotes Internal Risk, "DS" denotes Demand-Side Risk, and "EE" denotes External Environment. These categories are color coded. [3]The mean is calculated for food hubs that indicated the risk applies to their hub.

handling practices due to a lack of adequate infrastructure such as storage facilities, and 10) customer delivery failures or delays.

Using the FMEA framework, RPN were calculated for each food hub. As mentioned in the Methods section, RPN score takes into account *detectability* of a given risk in addition to *likelihood of occurrence* and *severity of impact*. As can be seen from Table 2.7, the top ten risks faced by food hubs are the following (listed by rank – from highest to lowest risk): 1) unexpected or very volatile customer demand, 2) product delivery delays by suppliers, 3) workforce issues regarding employee and volunteers underperformance, 4) breakdown or malfunction of information technology, 5) insufficient quantity of products due to suppliers own capacity constraints, 6) insufficient quantity of products due to weather-related production issues, 7) poor planning or forecasting of demand by food hubs,

Table 2.7: Ranking of food hub supply chain risks based on Risk Priority Numbers (RPN)

Rank[1]	Food hub supply chain risk source	Mean[3]	Standard deviation	Coefficient of variation	Min	Max	Percent of food hubs that indicated the risk applies to them
1	Unexpected or very volatile customer demand (DS)[2]	35.40	20.83	59%	3	100	69%
2	Product delivery delays by suppliers (SS)	34.82	16.99	49%	4	80	84%
3	Workforce issues: Employees/volunteers underperform (I)	34.80	17.31	50%	8	80	68%
4	Breakdown or malfunction of information technology (I)	33.43	18.87	56%	5	80	68%
5	Insufficient quantity of products: Suppliers' own production capacity constraints (SS)	32.80	18.06	55%	4	80	91%
6	Insufficient quantity of products: Weather-related production issues (EE)	31.91	16.19	51%	6	80	96%
7	Poor planning or forecasting: Inadequate forecasting of demand (I)	29.55	17.97	61%	5	100	72%
8	Poor planning or forecasting: Relies on a limited number of suppliers for a given product (I)	28.83	18.71	65%	2	80	86%
9	Customer delivery failures or delays (DS)	27.59	16.04	58%	6	80	68%
10	Inability to meet quality requirements: Product attribute requirements (SS)	25.43	13.84	54%	3	60	78%
11	Product rejection by customer: Dissatisfaction with product quality attributes (DS)	24.40	14.61	60%	2	64	86%

Table 2.7 (cont'd)

Rank[1]	Food hub supply chain risk source	Mean[3]	Standard deviation	Coefficient of variation	Min	Max	Percent of food hubs that indicated the risk applies to them
12	Poor food-handling practices: Lack of adequate facilities and other infrastructure (I)	23.56	16.84	71%	2	64	61%
13	High volatility of supply: Seasonality of production (SS)	22.70	15.19	67%	3	75	88%
14	Unexpected liability issues (I)	20.47	11.77	58%	6	50	61%
15	Supplier prioritizes other marketing channels (SS)	19.90	13.99	70%	2	80	80%
16	Product rejection by customer: Failure to meet other order specifications (DS)	19.25	10.45	54%	4	40	59%
17	Poor food-handling practices: Employees/volunteers lack adequate knowledge and/or training on food safety standards (I)	16.74	16.36	98%	1	75	39%
18	Inability to meet quality requirements: Food safety requirements (SS)	14.70	10.74	73%	1	60	49%
19	Supplier terminates production (SS)	14.53	10.08	69%	2	48	97%
Number of observations		90					

Note: [1]Ranked based on mean RPN – from highest (1) to lowest (19). [2]"SS" denotes Supply-Side Risk, "I" denotes Internal Risk, "DS" denotes Demand-Side Risk, and "EE" denotes External Environment. These categories are color coded. [3]The mean is calculated for food hubs that indicated the risk applies to their hub.

8) poor planning and forecasting by a food hub due to reliance on a limited number of suppliers for a particular product, 9) customer delivery failures or delays, and 10) inability to meet quality requirements regarding product attributes.

2.5.1.1 Discussion of the ranking food hub risks

The results showed that the top ten risks are located across all levels of the supply chain. By comparing the top ten REV and RPN, there are overlaps among risks in terms of being in the top ten for both REV and RPN (except for two risks: in the RPN ranking, breakdown or malfunction of information technology and inability to meet quality requirements regarding product attributes). These results suggest that the top risks food hubs are exposed to are also difficult to detect by food hubs.

The results of REV ranking show that the top ten risks are related to imbalances in supply and demand of products, logistical delays, human resources and infrastructure capacity limitations. First, six of the top ten risks are related to imbalances in supply and demand of products. Specifically, food hubs experience product quantity-related disruptions that stem from the supply-side (i.e., suppliers' own production capacity constraints and high volatility of supply due to seasonality of production), internal processes (i.e., poor planning or forecasting due to reliance on a limited number of suppliers for a given product, and inadequate forecasting of demand by the hub), demand-side (i.e., unexpected or very volatile customer demand) and external environment (i.e., weather-related production issues). Five of these six sources of disruption are also in top ten in the RPN ranking (except for high volatility of supply due to seasonality of production), suggesting that food hub managers perceive these disruptions to be difficult to detect before they occur.

Second, the results of REV ranking show that two of the top ten risks are related to logistical arrangements. Specifically, one of the risks stems from the supply-side (i.e., product delivery delays by suppliers) and the second risk stems from the demand-side (i.e., customer delivery failures or delays). Both of these risks were also in top ten for RPN ranking, suggesting that food hub managers perceive these disruptions to be difficult to detect before they occur.

Finally, the results of REV ranking show that food hubs experience disruptions in the physical flow of the products, which are related to human resources (i.e., underperformance of volunteers and employees) and infrastructure capacity limitations (i.e., poor food handling practices due to a lack of adequate infrastructure such as storage facilities). Both of these disruptions that stem from food hub internal processes and control mechanisms.

2.5.2 Association between risk type and food hub characteristics

This section examines association between risk type and food hub characteritsics to identify what risks are important to what type of food hubs.

2.5.2.1 Association between supply-side risk and food hub characteristics

As mentioned earlier, ANOVA tests were completed to examine association between risk type and food hub characteristics. In the model specification, the dependent variable was supply-side risk. The independent variables were food hub characteristics.

The ANOVA test results show that the variables that were statistically significant in terms of explaning variation in supply-side risk (i.e., supply-side REV) are the following: number of suppliers a food hub works with, business model of a food hub, and offering liability insurance services to suppliers (see Table 2.8).

Table 2.8: Association between supply-side risk (REV) and food hub characteristics

Variables	p-values
Number of suppliers	0.041*
Busiess model	0.042*
Offers liability insurance services to suppliers	0.048*
Provides inbound logistics services	0.218
Provides outbound logistics services	0.300
Number of observations	73

Note: ˙, *, **, and *** represent significance at 10, 5, 1, and 0.1 percent level resepectively. P-values are from the results of ANOVA test.

Since ANOVA tests do not show direction or strength of association between dependent and independent variables, Tukey HSD tests were completed along with boxplots to implement pairwise comparison between categories for each independent variable included in the model.

In order to see the difference between the pairs, boxplots were constructed for each categorical variable that was found to be statistically significant in terms of explaining variation in REV. In the boxplots (e.g, Figure 2.2), the bold-typed horizontal lines represent the median REVs of the three categories of number of suppliers, namely “less than 50”, “50-100”, and “more than 100”. The non-bold horizontal lines that make up the lower and upper boundary of the boxes represent the 25 percent- and 75 percent quartiles. The dashed vertical lines extending from the box until the lower and upper limit represent the smallest and largest values that are not more than 1.5 interquartile ranges away from the box. Each data point that would be outside of the range of the dashed vertical lines represents an outlier with an individual small circle (Gries, 2013). For example, Figure 2.2 shows that REV for supply-side risk is lower for food hubs working with less than 50 suppliers when compared to the food hubs working with 50-100 suppliers. Additionally, this difference is statistically significant according to the Tukey HSD test (see Table 2.9). For illustrative purposes, in Figure 2.2, different colors of *A* and *B* letters

indicate a statistically significant difference between the pairs. Having both letters at the same time indicates absence of statistically significant difference between the pairs. For example, *AB* notation (in both blue and red colors) indicates that there is no statistically significant difference between the food hubs working with more than 100 suppliers and the food hubs working with less than 50 producers/supplies. Similarly, there is no statistically significant difference between the food hubs working with more than 100 suppliers and the food hubs working with 50-100 suppliers. These insights are drawn from Tukey HSD test (see Table 2.9).

As mentioned above, there was a statistically significant association between supply-side risk and food hub business model. As can be seen from Figure 2.3, F-B food hubs have higher supply-side REV when compared to F-C food hubs. The Tukey HSD test results also show that this difference between F-B and F-C food hubs is statistically significant (see Table 2.9). Additionally, Figure 2.3 shows that Hybrid food hubs have higher REV when compared to F-C food hubs. However, the Tukey HSD test results did not identify this difference to be statistically significant (see Table 2.9). Similarly, Figure 2.1B shows that F-B food hubs have higher REV when compared to Hybrid food hubs. However, the Tukey HSD test results did not identify this difference to be statistically significant (see Table 2.9). Thus, the difference that is statistically significant in terms of supply-side risk (i.e., supply-side REV) is between F-B and F-C food hubs suggesting that food hubs working only with businesses and institutions perceive to face higher supply-side risk than the food hubs working only with end-consumers. One possible explanation for this might be that wholesale buyers (i.e., businesses and institutions) have stricter standards (e.g., food safety), expectations, and larger-scale orders. For example, delivery delays by suppliers is likely to have less impact on the relationship with end-consumers when compared to

wholesale buyers. The latter have their own customer base, therefore the negative impact of delivery delays, for example, is much higher.

The third variable that was statitically significant in terms of explaining variation in supply-side risk was offering liability insurance services to suppliers (see Table 2.8). Figure 2.4 shows that food hubs that offer liability insurance services to their suppliers are exposed to lower supply-side risk when compared to food hubs that do not offer the service. The Tukey HSD test results identified this difference to be marginally significant (at 10 percent level) (see Table 2.9). One explanation for this finding is that offering liability insurance services to suppliers, in essence, is a risk mitigation strategy. It mitigates the possible financial losses internally.

Table 2.9: Tukey HSD test pairwise comparison for supply-side risk

Variable	Pairwise comparison	p-value
Number of suppliers	1-0	0.041*
	2-0	0.380
	2-1	0.912

Note: Number of suppliers is coded as: 0="Less than 50", 1="50-100", 2="More than 100"

Variable	Pairwise comparison	p-value
Business model	2-1	0.653
	3-1	0.045*
	3-2	0.121

Note: Business model is coded as: 1="Farm to Business", 2="Hybrid", 3="Farm to Consumer"

Variable	Pairwise comparison	p-value
Offers liability insurance services to suppliers	1-0	0.061˙

Note: Offers liability insurance services to suppliers is coded as: 1="Yes, 0="No"

Note: ˙, *, **, and *** represent significance at 10, 5, 1, and 0.1 percent level resepectively. P-values are from the results of Tukey HSD test.

Figure 2.2: Boxplot of the supply-side risk exposure value and number of suppliers

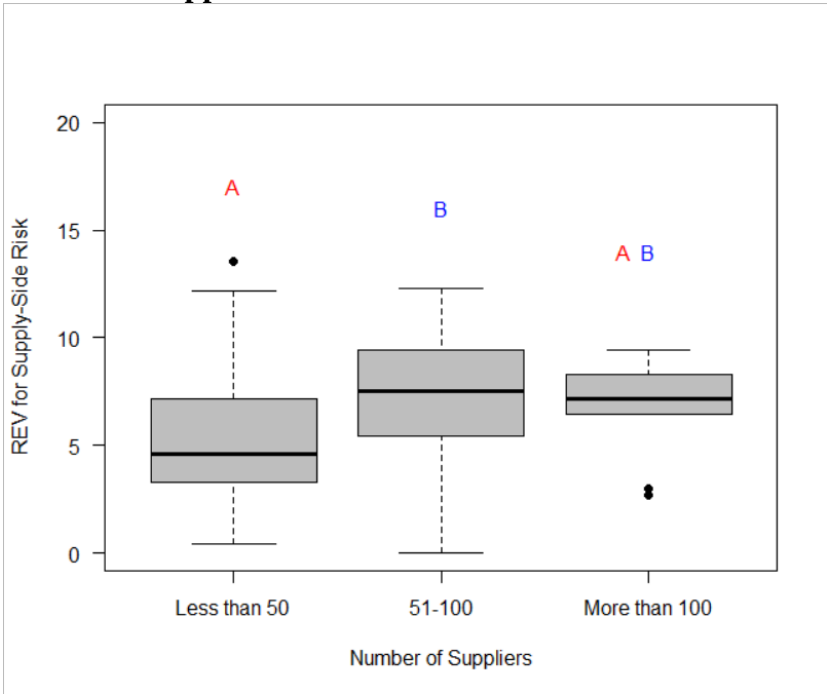


Figure 2.3: Boxplot of the supply-side risk exposure value and business model

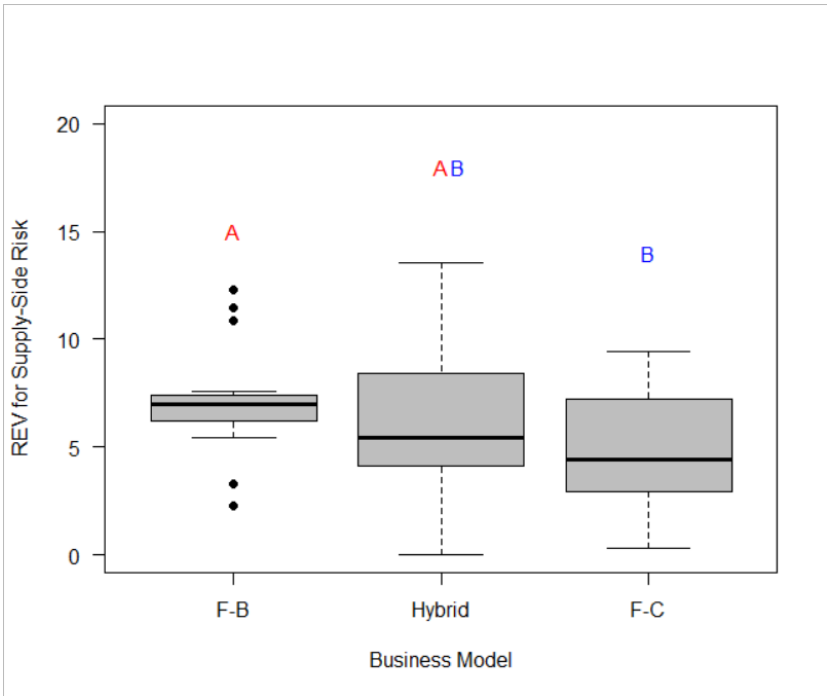
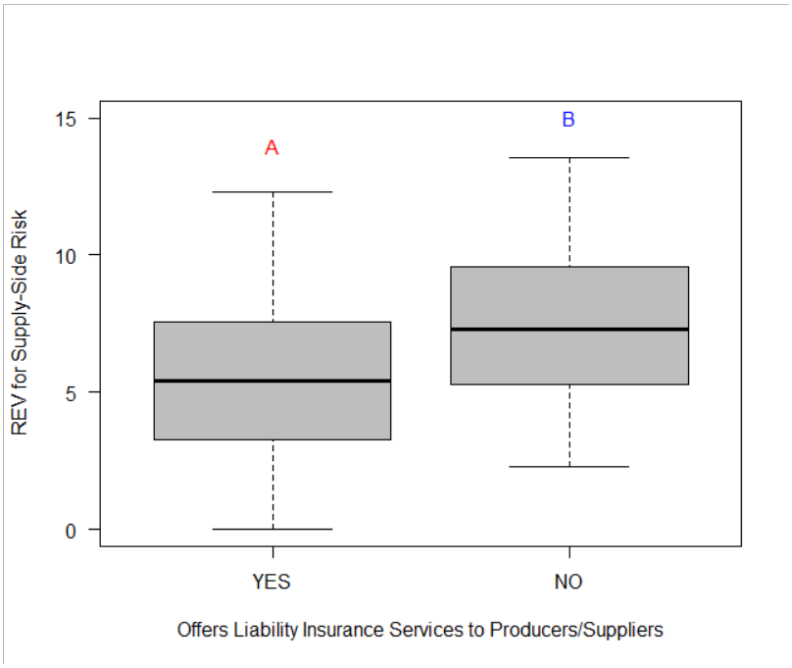


Figure 2.4: Boxplot of supply-side risk exposure value and offering liability insurance services to suppliers



2.5.2.2 Association between internal risk and food hub characteristics

As mentioned above, ANOVA tests were completed to examine association between internal risk and food hub characteristics. The ANOVA test results show that food hub characteristics that were statistically significant in terms of explaining variation in internal risk REV are the following: providing liability insurance services to suppliers (at five percent level) and number of employees and volunteers (at 10 percent level) (see Table 2.10).

As can be seen from Figure 2.6, food hubs providing liability insurance services to suppliers perceive to face lower internal risk (i.e., internal REV) when compared with food hubs that do not provide these services. The Tukey HSD test results also show that this difference is statistically significant (see Table 2.11). One possible explanation for this finding is that offering liability insurance services to suppliers, in essence, is a risk mitigation strategy. This result

suggests that incorporating supply chain risk mitigation strategies in food hubs might be of critical importance for their operations.

Number of employees and volunteers is another variable that was marginally significant (at 10 percent level) in terms of explanining variation in internal risk exposure value (see Table 2.10). Figure 2.5 shows that food hubs working with less than 15 employees and volunteers perceive to face less internal risk when compared with food hubs working with 16-30 or "more than 30" employees and volunteers. However, as can be seen from Table 2.11, the Tukey HSD test results did not identify these differences between the pairs to be statistically significant. Therefore, the pairwise comaprison results for this variable will not be part of drawing conclusions in this study.

Table 2.10: Association between internal risk (REV) and food hub characteristics

Variables	p-value
Business model	0.311
Number of employees/volunteers	0.095˙
Facility	0.200
Food safety certification	0.996
Offers liability insurance services to suppliers	0.036*
Number of observations	73

Note: ˙, *, **, and *** represent significance at 10, 5, 1, and 0.1 percent level resepectively. P-values are from the results of ANOVA test.

Table 2.11: Tukey HSD test pairwise comparison for internal risk

Variable	Pairwise comparison	p-value
Number of employees/volunteers	1-0	0.127
	2-0	0.432
	2-1	0.976

Note: Number of employees/volunteers is codes as: 0="Less than 15", 1="16-30", 2="More than 30"

Variable	Pairwise comparison	p-value
Offers liability insurance services to suppliers	1-0	0.049*

Table 2.11 (cont'd)

Note: Offers liability insurance services to suppliers is codes as: 1="Yes", 0="No"

Note: ˙, *, **, and *** represent significance at 10, 5, 1, and 0.1 percent level, resepectively. P-values are from the results of Tukey HSD test.

Figure 2.5: Boxplot of internal risk exposure value and number of employees/volunteers

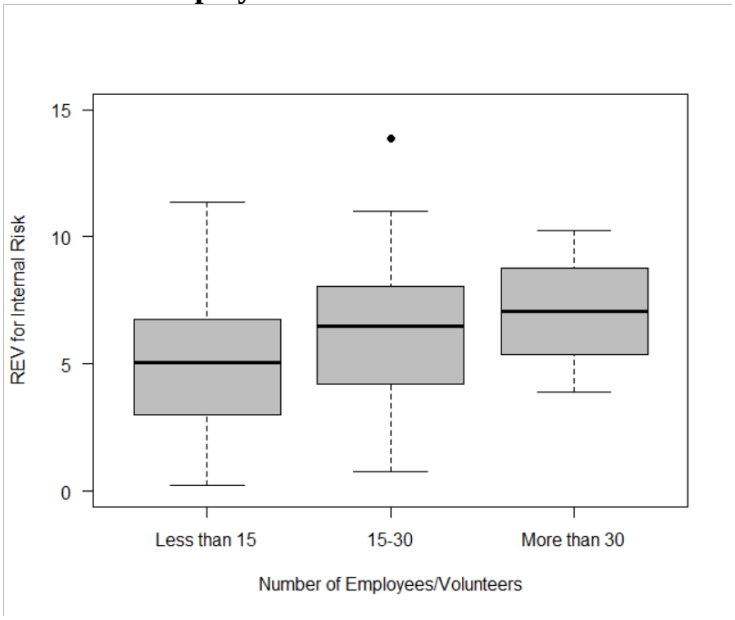
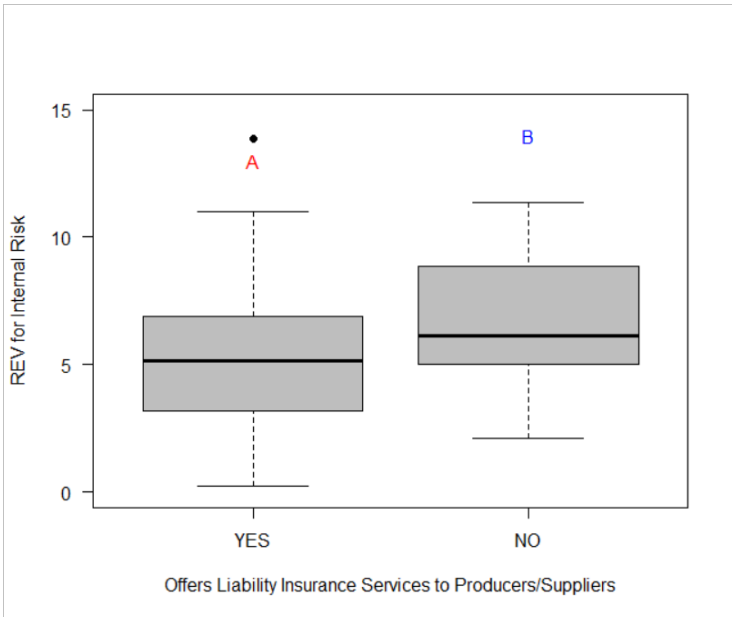


Figure 2.6: Boxplot of internal risk exposure value and offering liability insurance services to suppliers



2.5.2.3 Association between demand-side risks and food hub characteristics

As mentioned above, ANOVA tests were completed to examine association between demand-side risk and food hub characteristics. The ANOVA test results show that food hub characteristics that were statistically significant in terms of explaining variation in demand-side risk (i.e., demand-side REV) are the following: gross sales, business model, and number of employees and volunteers (see Table 2.12).

Table 2.12: Association between demand-side risk (REV) and food hub characteristics

Variables	p-values
Gross sales	0.006**
Organizational model	0.925
Business model	0.000**
Number of employees/volunteers	0.013*
Provides outbound logistics services	0.813
Number of observations	73

Note: ˙, *, **, and *** represent significance at 10, 5, 1, and 0.1 percent level, resepectively. P-values are from the results of ANOVA test.

As can be seen from Table 2.12, gross sales of a food hub is statistically significant in terms of explaining variation in demand-side REV. Figure 2.7 shows that food hubs generating gross sales of less than $500,000/year have lower REV when compared with food hubs generating more than $1,500,000/year. The Tukey HSD test results show that this difference is also statistically significant (see Table 2.13). Additionally, Figure 2.7 shows that food hubs generating gross sales of $500,000-$1,500,000/year perceive to face higher demand-side risk when compared to the food hubs generating gross sales of less than $500,000/year. However, the Tukey HSD test results did not identify this difference to be statistically significant (see Table 2.13). Similarly, Figure 2.7 shows that food hubs generating gross sales of $500,000-$1,500,000/year perceive to face lower demand-side risk when compared with food hubs

generating more than $1,500,000/year. However, the Tukey HSD test results did not identify this difference to be statistically significant (see Table 2.13). Thus, for the gross sales variable, the difference that is statistically significant in terms of demand-side risk (i.e., demand-side REV) is between food hubs generating gross sales of less than $500,000/year and food hubs generating more than $1,500,000/year suggesting that food hubs generating higher gross sales perceive to face higher demand-side risk. One possible explanation for this finding might be that food hubs generating higher sales manage the flow of larger volumes of products which suggests that they most likely work with a higher number suppliers and employees/volunteers. Each of these areas has its own disruptions; therefore imposing a higher risk on the organization.

As can be seen from Table 2.12, the second variable that was statistically significant in term of explaining variation in demand-side risk (i.e., demand-side REV) is food hub's business model. The results of Tukey HSD test also show that there is a statistically significant difference between REVs of F-B and F-C models, as well as between REVs of Hybrid and F-C food hub models (see Table 2.13). As can be seen from Figure 2.8, F-B food hubs have significantly higher REV when compared to F-C food hubs. Similarly, Hybrid food hubs have significantly higher demand-side REV when compared to F-C food hubs. Additionally, Figure 2.8 shows that Hybrid food hubs have lower REV when compared to F-B food hubs. However, the Tukey HSD test results did not indicate a statistically significant difference between Hybrid and F-B models (Table 2.13). Overall, these results suggest that F-C food hubs perceive to face lower demand-side risks when compared to hubs that operate as F-B or Hybrid. These results have two main implications. First, there might be a tradeoff between diversifying customer base and demand-side risk exposure for hybrid food hubs. That is, if a food hub is structured as a hybrid business, it has access to both wholesale buyers (i.e., businesses and/or institutions) and end-consumers.

This allows it to accomplish a social mission of increasing local food access as well as potentially generating higher sales through its access to larger market segments. In turn, this also suggests that hybrid food should expect to be facing higher demand-side risk. Second, structuring a food hub as a farm-to-business/institution model suggests higher demand-side risk.

As can be seen from Table 2.12, the third variable that was statistically significant (at 5 percent level) in terms of explaining variation in demand-side risk (i.e., demand-side REV) is food hub's number of employees and volunteers. Figure 2.9 shows that food hubs that have smaller number of employees and volunteers (i.e., less than 15) have lower demand-side REV when compared to food hubs that have more than 30 employees and volunteers. The results of Tukey HSD test also show that this difference between REVs of food hubs that have less than 15 employees and volunteers and the ones having more than 30 employees and volunteers is marginally significant (at 10 percent level) (see Table 2.13). A possible explanation for this result may be that a higher number of employees and volunteers may be a result of larger operations/size of a food hub. This, in turn, may suggest a higher volume of sales and/or higher number of customers. Interactions with a larger customer base may be more demanding. This has underlying implications for food hub growth strategies.

Table 2.13: Tukey HSD test pairwise comparison for demand-side risk

Variable	Pairwise comparison	p-value
Gross sales	1-0	0.489
	2-0	0.004**
	2-1	0.194

Note: Gross sales coded as: 0="Less than $500,000", 1="$500,000-$1,500,000", 2="More than $1,500,000"

Variable	Pairwise comparison	p-value
Business Model	2-1	0.120
	3-1	0.001**
	3-2	0.049*

Note: Business model coded as: 1="Farm to Business", 2= "Hybrid", 3="Farm to Consumer"

Table 2.13 (cont'd)

Variable	Pairwise comparison	p-value
Number of employees/volunteers	1-0	0.383
	2-0	0.068 ˙
	2-1	0.304

Note: Number of employees/volunteers coded as: 0="Less than 15", 1="16-30", 2="More than 30"

Note: ˙, *, **, and *** represent significance at 10, 5, 1, and 0.1 percent level, resepectively. P-values are from the results of Tukey HSD test.

Figure 2.7: Boxplot of demand-side risk exposure value and gross sales

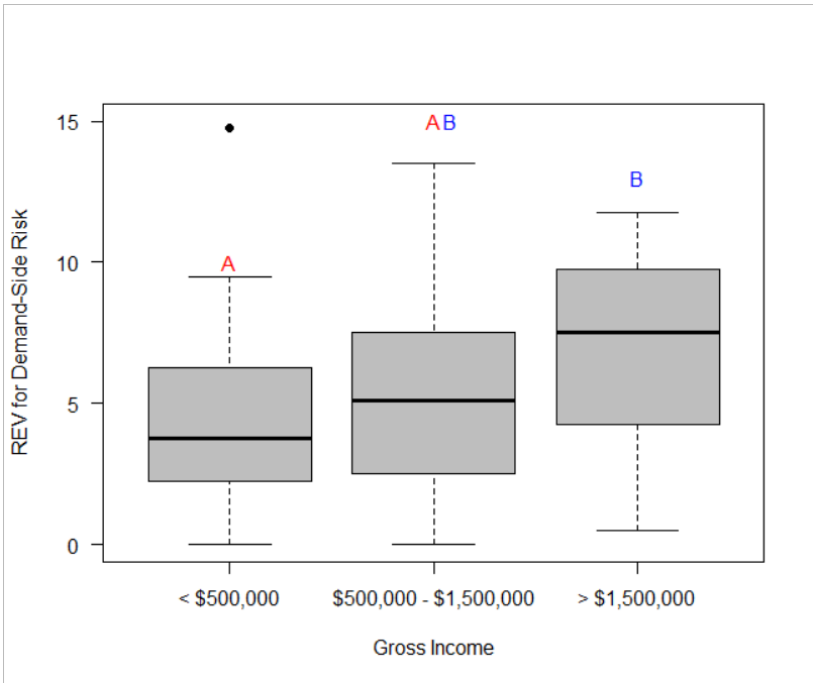


Figure 2.8: Boxplot of demand-side risk exposure value and business model

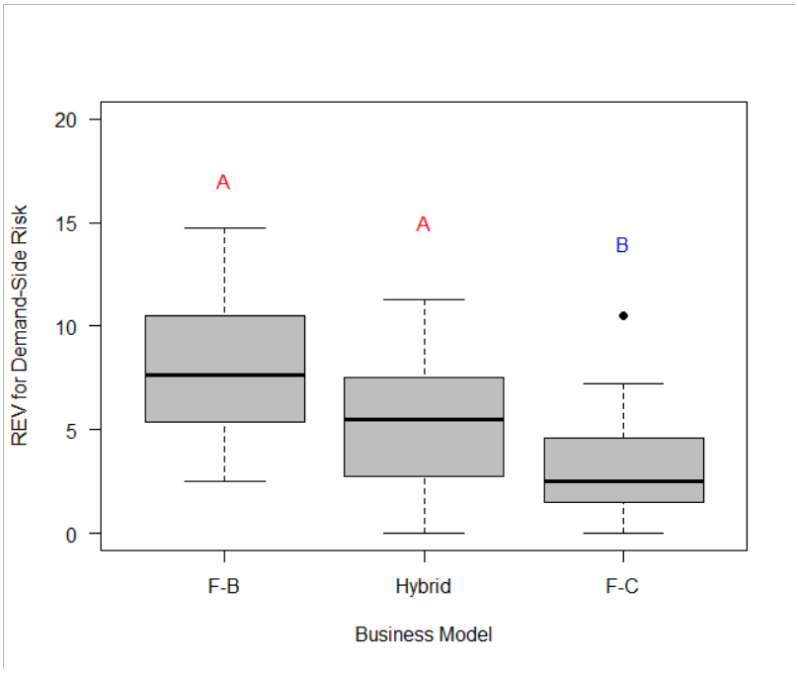
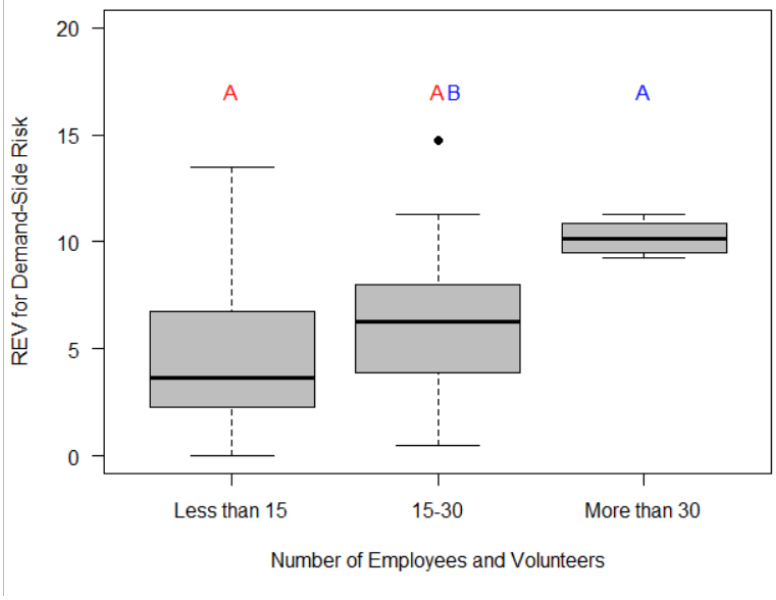


Figure 2.9: Boxplot of demand-side risk exposure value and number of employees/volunteers



2.5.2.4 Association between external risk and food hub characteristics

As mentioned earlier, ANOVA tests were completed to examine association between external risk and food hub characteristics. The results of the ANOVA test show that the business model of food hubs is statistically siginificant in terms of explaining variation in external risk exposure value of food hubs (see Table 2.14). Figure 2.10 shows that F-B food hubs have higher REV when compared to F-C food hubs. The results of Tukey HSD test also show that the difference between REVs of F-B and F-C food hub business models is statistically significant (see Table 2.15). Additionally, Figure 2.10 shows that Hybrid food hubs have higher external REV when compared to F-C food hubs. However, the Tukey HSD test results did not indicate a statistically significant difference between Hybrid and F-C models (Table 2.15). Thus, statistically significant difference in terms of external REV is found only between F-B and F-C food hubs.

Table 2.14: Association between external risk (REV) and food hub characteristics

Variables	p-values
Years in operation	0.847
Number of suppliers	0.474
Business model	0.019*
Insures against supply chain risks, if possible	0.801
Region	0.521
Number of observations	73

Note: ˙, *, **, and *** represent significance at 10, 5, 1, and 0.1 percent level resepectively. P-values are from the results of ANOVA test.

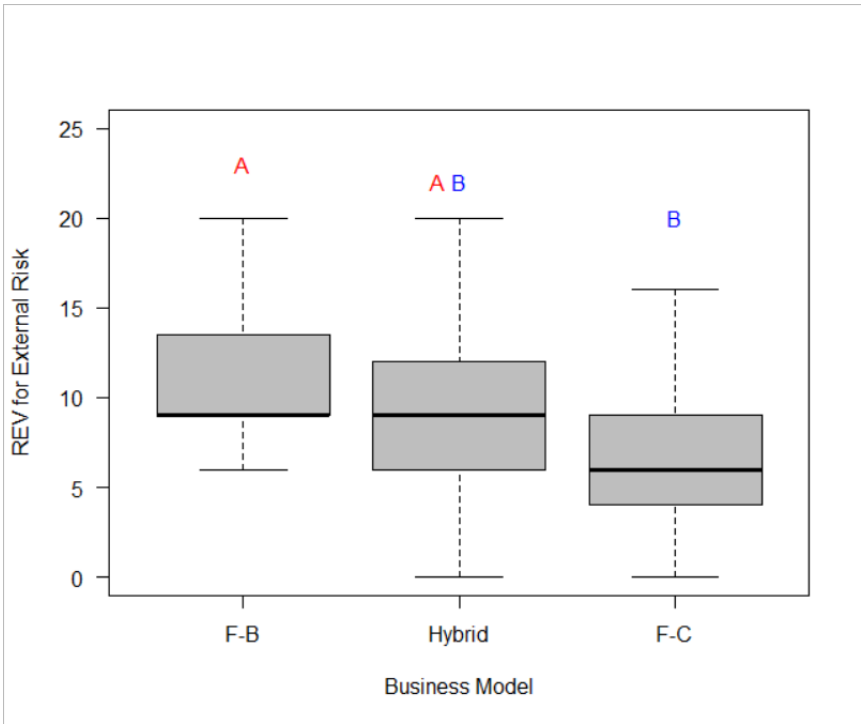
Table 2.15: Tukey HSD test pairwise comparison for demand-side risk exposure value

Variable	Pairwise comparison	p-value
Business model	2-1	0.237
	3-1	0.023*
	3-2	0.297

Note: Business model coded as: 1="Farm to Business", 2="Hybrid", 3="Farm to Consumer"

Note: ˙, *, **, and *** represent significance at 10, 5, 1, and 0.1 percent level resepectively. P-values are from the results of Tukey HSD test.

Figure 2.10: Boxplot of external risk exposure value and business model



2.5.2.5 Discussion of association between food hub characteristics and risk

The results of ANOVA and Tukey HSD tests showed that business model of food hubs regarding its market focus—farm-to-business/institution, direct-to-consumer, and hybrid—is associated with supply-side, demand-side, and external risk. Specifically, food hubs working with only businesses/institutions perceive to face higher supply-side, demand-side, and external risk when compared with direct-to-consumer food hub models. Additionally, regarding supply-side and external risks, there were no statistically significant differences, ether between hybrid and direct-to-consumer models or between hybrid and farm-to-business/institution models. However, hybrid food hubs perceive to face higher demand-side risk when compared with direct-to-consumer food hub models. These results have direct implications for market diversification strategies of food hubs. It might be beneficial for food hubs to structure their organization as a

hybrid model (instead of farm-to-business/institution) not only for diversifying their customer base and expanding their reach for community food access considerations, but also in terms of being exposed to lower risk when compared to farm-to-business/institution models.

The results of ANOVA and Tukey HSD tests showed that food hubs working with a greater number of suppliers face higher supply-side risk. Also, food hubs working with a greater number of employees/volunteers (marginally) face higher demand-side risk. Finally, food hubs having greater annual gross sales face higher demand-side risk. These findings suggest that growth in food hub operations in terms of gross sales, number of suppliers, and number of employees/volunteers implies higher supply chain risks. This, in turn, suggests that incorporating supply chain risk mitigation strategies into a food hub's growth strategy may be of critical importance for its long-run viability.

Finally, the results of ANOVA and Tukey HSD tests showed that food hubs offering liability insurance services to their suppliers face lower risk when compared to the food hubs not offering these services. One explanation for this finding is that offering liability insurance services to suppliers, in essence, is a risk mitigation strategy. It mitigates the possible financial losses internally. This finding reinforces the importance of incorporating risk mitigation strategies into a food hub's core business strategy.

2.5.3 Association between assessed risk and risk preferences of food hub managers

This section focuses on examining association between risk type and risk preferences of food hub managers. The following parameters of risk preferences were examined: the parameter of risk aversion, σ, the parameter of loss aversion, λ, and the parameter of non-linear probability-weighing function, α. In order to investigate if risk preferences of food hub managers played a

role in their risk assessment process, four generalized linear regression models were built (see the Methods section). In each case the independent variables of interest are the measures of risk preferences—σ, λ, and α. The dependent variable for each regression model was the score for the following risk categories: supply-side risk, internal risk, demand-side risk, and the external environments, respectively.

Table 2.16 shows the summary statistics of risk preference parameters of food hub managers. As can be seen from Table 2.16, the average value of σ=0.609 suggests that food hub managers in the sample are risk averse, in general. The average value of λ=3.470 suggests that food hub managers in the sample are not highly loss averse, in general. The average value for α=0.343 suggests that food hub managers tend to overvalue smaller probabilities of high impact gains or losses.[6]

Table 2.16: Summary statistics of measures of risk preference parameters

Variable	Mean	Standard deviation
Risk aversion (σ)	0.609	0.363
Loss aversion (λ)	3.470	3.661
Probability weighting (α)	0.818	0.343
Number of observations	61	

[6] The parameter of risk aversion, σ, is interpreted as follows: σ < 1 indicates the person is risk averse, σ =1 indicates the person is risk neutral, and σ > 1 indicates the person is risk loving. As σ decreases, risk aversion increases, and vice versa. The parameter of loss aversion, λ, captures the extent to which individuals overvalue losses over gains. If λ >1, this means a person is more risk averse to loses than to gains. That is, as λ increases, loss aversion increases. λ takes values from 0.065 to 11.300. The non-linear probability weighting measure, α, "captures the degree to which less likely events are disproportionately weighted when valuing risky prospects" (Ray, 2018: 22). If α<1, this means a person overweighs low probabilities of larger losses or gains and underweights higher probabilities (Ray, 2018).

As can be seen in Tables 2.17, 2.19, and 2.20, there is no statistically significant association between risk preferences of food hub managers and their assessed level of supply-side, demand-side, and external risks. This suggests that food hub managers' risk preferences did not affect their assessment of risk. That is, assessed risk may be considered as more objective.

The regression results in Table 2.18 show that there is statistically significant association between loss aversion of food hub managers and their assessed internal risk for food hubs. The negative sign of the coefficient indicates that the association between these variables is negative. That is, as loss aversion increases (i.e., the value of the parameter λ), the assessed value of internal risk decreases. This suggests that more loss averse food hub managers tend to assign lower values for internal risk.

Table 2.18 also shows that there is statistically significant association between non-linear probability weighting function, α, and assessed internal risk. The negative sign of the coefficient indicates that the association between these variables is negative. That is, as the parameter of non-linear probability weighting function, α, increases, the assessed value of internal risk decreases. Smaller values of α indicate a person's tendency to overweigh lower probabilities. This suggests that food hub managers that overweigh lower probabilities of larger losses tend to assign lower values for food hub internal risk.

As can be seen from Table 2.18, the parameter of risk aversion, σ, is not statistically significant which means that risk aversion of food hub managers did not play a role in their food hub internal risk assessment process.

Table 2.17: Association between supply-side risk (REV) and parameters of risk preferences

Variables	Estimate	Standard error	p-value
(Intercept)	9.224	3.565	0.012 *
Risk aversion (σ)	-1.904	1.984	0.341

Table 2.17 (cont'd)

Variables	Estimate	Standard error	p-value
Loss aversion (λ)	-0.130	0.181	0.473
Probability weighting (α)	-2.111	2.341	0.370
Number of observations	61		

Note: ˙, *, **, and *** represent significance at 10, 5, 1, and 0.1 percent level resepectively. Adjusted R-squared: -0.035.

Table 2.18: Association between internal risk (REV) and parameters of risk preferences

Variables	Estimate	Standard error	p-value
(Intercept)	11.648	3.392	0.001 **
Risk aversion (σ)	-2.783	1.888	0.145
Loss aversion (λ)	-0.414	0.172	0.019 *
Probability weighting (α)	-4.527	2.227	0.046 *
Number of observations	61		

Note: ˙, *, **, and *** represent significance at 10, 5, 1, and 0.1 percent level resepectively. Adjusted R-squared: 0.054.

Table 2.19: Association between demand-side risk (REV) and parameters of risk preferences

Variables	Estimate	Standard error	p-value
(Intercept)	10.879	4.230	0.012 *
Risk aversion (σ)	-3.328	2.357	0.163
Loss aversion (λ)	-0.396	0.215	0.070 ˙
Probability weighting (α)	-3.048	2.781	0.277
Number of observations	61		

Note: ˙, *, **, and *** represent significance at 10, 5, 1, and 0.1 percent level resepectively. Adjusted R-squared: 0.019.

Table 2.20: Association between external risk (REV) and risk preferences

Variables	Estimate	Standard error	p-value
(Intercept)	10.612	5.517	0.059 ˙
Risk aversion (σ)	-2.729	3.071	0.377
Loss aversion (λ)	-0.033	0.280	0.906
Probability weighting (α)	0.222	3.623	0.9513
Number of observations	61		

Note: ˙, *, **, and *** represent significance at 10, 5, 1, and 0.1 percent level resepectively. Adjusted R-squared: 0.002.

Overall, the results show that food hub managers' risk preferences did not play a role in their assessment of supply-side, demand-side, and external risk. The results also suggest food hub managers' risk preferences played a role in their food hub internal risk assessment. It is important to note that these results regarding risk preferences are not definitive as the regression specifications included only the parameters of risk preferences. Ideally, the parameters of risk preferences would have been included in the regression specification that also included other food hub specific variables as predictors of risk. However, due to sample size limitations, that is, only 44 observations with risk preferences, supply chain risks, and food hub characteristics (see Table 2.3), estimating such specification would not be less feasible. Therefore, the results of risk preferences are more explorative in this study than definitive. However, this is an important methodological step in terms of trying to incorporate risk preferences of individuals while collecting supply chain risk related data. Future research may incorporate the parameters of risk preferences as control variables in regression models examining the association between risk type and food hub characteristics.

2.6 Conclusion

Effective supply chain risk management requires planning and investment. However, not investing in supply chain risk management can be more costly (Griffis and Whipple, 2012). The broader literature on supply chain risk management emphasizes that supply chain risks can be both harmful and costly in areas such as finances, supply chain disruptions, underperforming competition, losing customers, and negatively affecting reputation (Griffis and Whipple, 2012; Juttner, 2005;Christopher and Peck, 2004; Zsidisin et al., 2000). Griffis and Whipple (2012) propose a supply chain risk priority continuum in which they differentiate between low priority,

mixed priority, and high priority risks (see Figure 2D.1 in Appendix 2D). Therefore, identification, assessment, and ranking of supply chain risks are key steps in supply chain management process for identifying high priority risks that would serve as a reference point for developing and implementing risk mitigation strategies for food hubs.

This study systematically identified, assessed, and ranked food hub supply chain risks. Additionally, it examined the association between risk type and food hub characteristics as well as the association between assessed risk and risk attitudes of food hub managers. The results showed that the top ten risks are related to imbalances in supply and demand, logistical delays, human resources and infrastructure capacity limitations. First, six of the top ten risks are related to product quantity shortages. Specifically, food hubs experience product quantity-related disruptions that stem from the supply-side (i.e., suppliers' own production capacity constraints and high volatility of supply due to seasonality of production), internal processes (i.e., poor planning or forecasting due to reliance on a limited number of suppliers for a given product, and inadequate forecasting of demand by the hub), demand-side (i.e., unexpected or very volatile customer demand) and external environment (i.e., weather-related production issues). Five of these disruptions (except for high volatility of supply due to seasonality of production) were also perceived to be difficult to detect before they occur. The product quantity-related disruptions stem from all locations of the supply chain suggesting that an enhanced level of supply chain coordination with producers, customers, and internal processes would be needed to mitigate quantity-related shortages. For example, in cases when organizations face high supply-side and demand-side risks, some of the strategies found in literature include flexibility, postponement, visibility, transparency, multiple sourcing, flexible contracts, redundancy (inventory), and collaboration (Kilubi, 2016).

Second, two of the top ten risks are related to logistical arrangements. Specifically, one of the risks stems from the supply-side (i.e., product delivery delays by suppliers) and the second risk stems from the demand-side (i.e., customer delivery failures or delays). Both risks were also perceived to be difficult to detect before they occur. These risks are related to each other in a sense that if a producer delivers products late, it will affect to a large extent the food hub's ability to deliver products to customers on time. There could also be food hub internal capacity-related reasons for a customer delivery's delay or failure (e.g., shortage of transportation, product is not packaged/repackaged for delivery, etc.). This is where visibility, transparency, and collaboration strategies (Speier et al., 2011; Thun and Hoenig, 2011) might be helpful for food hubs. According to Rajesh et al. (2015), when the operations of two entities are well-coordinated, supply-side risks are reduced. Additionally, improved capability of suppliers helps the continuity of supply.

Third, the results showed that food hubs experience disruptions in the physical flow of the products, which are related to human resources (i.e., underperformance of volunteers and employees) and infrastructure capacity limitations (i.e., poor food handling practices due to a lack of adequate infrastructure such as storage facilities). Both of these disruptions that stem from internal processes and control mechanisms. Example strategies for mitigating the risk of underperforming are scheduling 120 percent capacity for volunteers and integrating incentive programs for employees. The second risk, poor food handling practices due to a lack of adequate facilities and infrastructure, is a more complex issue, as it requires financial resources from the food hubs. To mitigate this risk, food hubs might need some support from external stakeholders to build capacity and significantly reduce this risk.

The study also examined association between food hub characteristics and risk type. The following factors were found to have statistically significant association with risks: (a) food business model regarding market focus (i.e., farm-to-business/institution, direct-to-consumer, and hybrid), (b) size in terms of annual gross sales, number of suppliers, and number of employees and volunteers, and (c) offering liability insurance services to suppliers.

First, the results showed that the business model of food hubs regarding its market focus—farm-to-business/institution, direct-to-consumer, and hybrid—is associated with supply-side, demand-side, and external risk. Specifically, food hubs working with only businesses/institutions face higher supply-side, demand-side, and external risk when compared with direct-to-consumer food hub models. One possible explanation for this might be that wholesale buyers (i.e., businesses and institutions) have stricter standards (e.g., food safety), expectations, and larger-scale orders. For example, delivery delays by suppliers is likely to have less impact on the relationship with end-consumers when compared to wholesale buyers. The latter have their own customer base, therefore the negative impact of delivery delays, for example, is much higher. Additionally, regarding supply-side and external risks, there were no statistically significant differences, either between hybrid and direct-to-consumer models nor between hybrid and farm-to-business/institution models. However, hybrid food hubs perceive to face higher demand-side risk when compared with direct-to-consumer food hub models. These results have direct implications for market diversification strategies of food hubs. It might be beneficial for food hubs to structure their organization as a hybrid model not only for diversifying their customer base and expanding their reach for community food access considerations, but also in terms of being exposed to lower risk when compared to farm-to-business/institution models.

The results also showed that food hubs working with a greater number of suppliers perceive to face higher supply-side risk. Also, food hubs working with a greater number of employees/volunteers (marginally) perceive to face higher demand-side risk. Finally, food hubs having greater annual gross sales perceive to face higher demand-side risk. These findings suggest that growth in food hub operations in terms of gross sales, number of suppliers, and number of employees/volunteers implies higher supply chain risks. This, in turn, suggests that incorporating supply chain risk mitigation strategies into a food hub's growth strategy may be of critical importance for its long-run viability.

Third, food hubs offering liability insurance services to their suppliers perceive to face lower supply-side and internal risk when compared to the food hubs not offering these services. One explanation for this finding is that offering liability insurance services to suppliers, in essence, is a risk mitigation strategy. It mitigates the possible financial losses internally. This finding reinforces the importance of incorporating risk mitigation strategies into a food hub's core business strategy.

Finally, the results also showed that food hub managers' risk preferences did not play a role in their rating of supply-side, demand-side, and external risk. The results did suggest that food hub managers' risk preferences played a role in their food hub internal risk assessment. Specifically, more loss averse individuals tended to assign lower values for internal risk. Food hub managers also tended to disproportionately over weigh low probabilities of larger losses while assessing food hub internal risk. It is important to note that these results regarding risk preferences are not definitive as the regression specifications included only the parameters of risk preferences. Ideally, the parameters of risk preferences would have been included in the regression specification that also included other food hub specific variables as predictors of risk.

However, due to sample size limitations, that is, only 44 observations with risk preferences, supply chain risks, and food hub characteristics (see Table 2.2), estimating such specification would not be possible. Therefore, the results of risk preferences are more explorative in this study than definitive. However, this is an important methodological step in terms of trying to incorporate risk preferences of individuals while collecting supply chain risk related data.

The findings suggest that incorporating risk mitigation strategies into food hub growth strategy is critical for their viability in the long run. While some disruptions may be more difficult to detect before they occur due to their inherent nature (e.g., quantity shortages due to catastrophic events or pandemic), others may be difficult to detect because of lack of appropriate risk mitigation mechanisms. These findings reinforce the importance of transparency and information sharing among food hubs and their suppliers and customers to balance demand and supply. Additionally, coordination mechanisms that would allow food hubs to effectively create practical databases and frequently share with suppliers and customers, for example. Additionally, food hub managers may benefit from training related to strategies for more effectively balancing demand and supply.

Second, this work is the first one in the field of food hubs to systematically identify and assess supply chain risks. It also adds to the empirical literature within the supply chain management filed where there is a call for more empirical work. The systematic risk identification, assessment, and ranking is important for increasing awareness among practitioners, policymakers, and other stakeholders about main risks faced by food hubs to help develop scale-appropriate risk mitigation strategies for food hubs.

Finally, food hubs can use the risk identification and assessment framework and processes presented in this study to implement regular assessment of their own risks to revise,

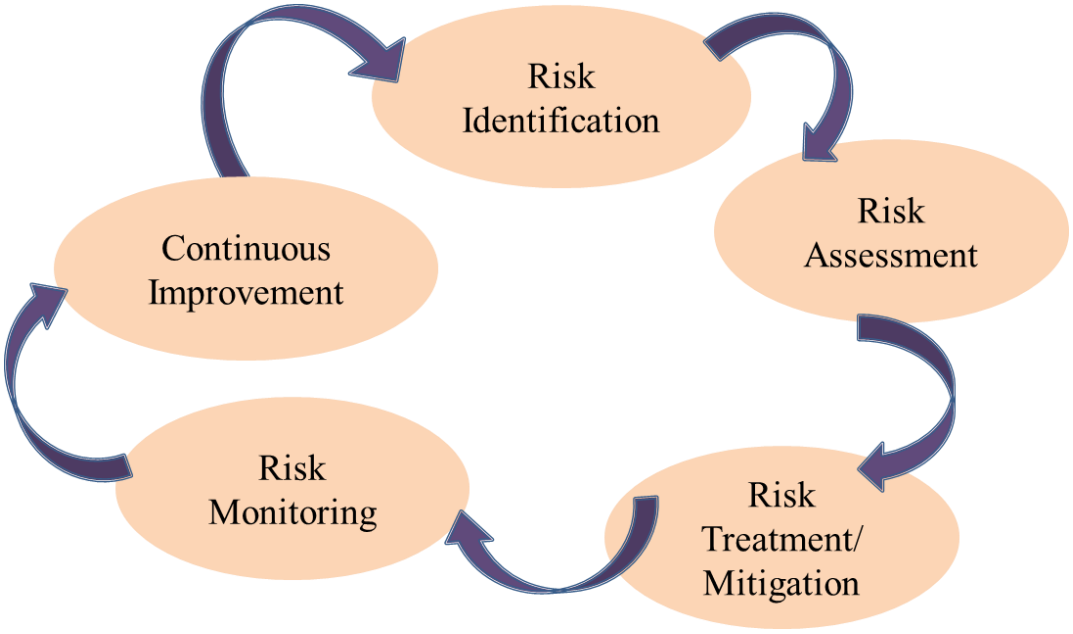
refine, and/or introduce new risk mitigation strategies in their food hubs. Regular assessment of risks in food hubs will also allow them to generate historical data that will help to enhance risk knowledge and management in their enterprises. It will also serve as a tool to monitor risks over time as the environment in which food hubs operate changes and new risks are presented. The risk identification and assessment framework and process presented in this study can also be customized in other organizational settings, such as food banks and other food-related organizations.

One limitation for this study is not incorporating risk preferences of food hub managers into the regression models examining the association between risk type and food hub characteristics. Future research may incorporate the parameters of risk preferences as control variables in these models. Additionally, future research may empirically explore risk mitigation strategies for risks identified in this study.

APPENDICES

APPENDIX 2A: Food hub supply chain risk management process

Figure 2A.1: Supply chain risk management process



Source: Louis and Pagell (2019)

APPENDIX 2B: Food hub risks

Table 2B.1: Risks faced by food hubs

Category	Open coding	Individual examples
Liability risks[7]	Contractual liability risk	N/A
	Operational liability risk	▪ In non-profit food hubs, people using their own vehicles ▪ In non-profit food hubs, executive director rents a car to go to the conference and stops off at his brother-in-law's, and he has a cocktail on the way home. ▪ Lack of verification that things such as the scales and weights are inspected twice annually at the facility where animals are being slaughtered.
Food safety risks	Food safety risk	▪ Lack of Good Agricultural Practices (GHP) certification
Quantity risk	Quantity risk	▪ Entering into contracts and not being able to deliver quantities promised to customers
Recall risk	Recall risk	N/A
Financial risk	Financial risk	▪ Loss of investments (in case of for-profit food hubs) ▪ Lack of insurance for the Board of Directors (in case of non-for-profit food hubs)
Employee risk	Employee risk	▪ Lack of knowledge about food handling issues ▪ Lack of knowledge about food safety issues ▪ Lack of knowledge about warehouse keeping ▪ Lack of knowledge about purchasing food

[7] There are other potential unknown externalities that other food hubs may face

APPENDIX 2C: Example question and risk experiments

Figure 2C.1: Example question in the survey

Food hub operations may be disrupted when food products are improperly handled in your facility. Two possible reasons why a food hub may improperly handle food products include: a) a lack of adequate facilities and infrastructure, and/or b) employees or volunteers that lack adequate knowledge and/or training on food safety and food handling standards. Please answer the following two questions related to these types of disruptions.

a) Food hub operations may be disrupted in cases when food products are not handled properly due to a lack of adequate facilities and infrastructure (e.g., lack of proper climate-controlled storage facilities, etc.).

Q1. Does this type of risk apply to your food hub?

- o Yes
- o No

Q1a. How often does this type of issue occur in your food hub?

- o Weekly
- o Monthly
- o Several times a year
- o Once a year
- o Almost never

Q1b. How severe is the impact on your operations if this type of issue occurs?

- o Operations close to shutdown
- o Serious disruption
- o Definite disruption
- o Minor disruption
- o No direct effect

Q1c. How detectable is this type of issue before it occurs?

- o Very detectable
- o Considerable warning before occurs
- o Some warning before occurs
- o Little warning before occurs
- o Almost undetectable

Table 2C.2: Risk experiments - Series 1

Task 1:

Please choose between Option A and Option B for **each of the 14 decisions** in this table. After you make your choices/decisions, please indicate at which decision number you switch from Option A to Option B by selecting the Decision No. using the slider below.

Decision No.	Option A		OR	Option B	
	30% chance	70% chance		10% chance	90% chance
1	$8	$2	OR	$13.6	$1
2	$8	$2	OR	$15.0	$1
3	$8	$2	OR	$16.6	$1
4	$8	$2	OR	$18.6	$1
5	$8	$2	OR	$21.2	$1
6	$8	$2	OR	$25.0	$1
7	$8	$2	OR	$30.0	$1
8	$8	$2	OR	$37.0	$1
9	$8	$2	OR	$44.0	$1
10	$8	$2	OR	$60.0	$1
11	$8	$2	OR	$80.0	$1
12	$8	$2	OR	$120.0	$1
13	$8	$2	OR	$200.0	$1
14	$8	$2	OR	$340.0	$1

Decision No. where you switch from Option A to Option B

(e.g., 0 indicates always choose Option A; 3 indicates switch from Option A to Option B at decision No.3; etc.)

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

Table 2C.3: Risk experiments - Series 2

Task 2:

Please choose between Option A and Option B for **each of the 14 decisions** in this table. After you make your choices/decisions, please indicate at which decision number you switch from Option A to Option B by selecting one of the answers listed on the slider belowby selecting the Decision No. using the slider below.

Decision No.	Option A		OR	Option B	
	90% chance	10% chance		70% chance	30% chance
1	$8	$6	OR	$10.8	$1
2	$8	$6	OR	$11.2	$1
3	$8	$6	OR	$11.6	$1
4	$8	$6	OR	$12.0	$1
5	$8	$6	OR	$12.4	$1
6	$8	$6	OR	$13.0	$1
7	$8	$6	OR	$13.6	$1
8	$8	$6	OR	$14.4	$1
9	$8	$6	OR	$15.4	$1
10	$8	$6	OR	$16.6	$1
11	$8	$6	OR	$18.0	$1
12	$8	$6	OR	$20.0	$1
13	$8	$6	OR	$22.0	$1
14	$8	$6	OR	$26.0	$1

Decision No. where you switch from Option A to Option B

(e.g., 0 indicates always choose Option A; 3 indicates switch from Option A to Option B at decision No.3; etc.)

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

Table 2C.4: Risk experiments – Series 3

Task 3:

Please choose between Option A and Option B for **each of the 7 decisions** in this table. After you make your choices/decisions, please indicate at which decision number you switch from Option A to Option B by by selecting the Decision No. using the slider below.

Decision No.	Option A		OR	Option B	
	50% chance	50% chance		50% chance	50% chance
1	$5	-$0.8	OR	$6	-$4.2
2	$0.8	-$0.8	OR	$6	-$4.2
3	$0.2	-$0.8	OR	$6	-$4.2
4	$0.2	-$0.8	OR	$6	-$3.2
5	$0.2	-$1.6	OR	$6	-$3.2
6	$0.2	-$1.6	OR	$6	-$2.8
7	$0.2	-$1.6	OR	$6	-$2.2

Decision No. where you switch from Option A to Option B

(e.g., 0 indicates always choose Option A; 3 indicates switch from Option A to Option B at decision No.3; etc.)

0 1 2 3 4 5 6 7

APPENDIX 2D: Supply chain risk continuum and strategies

Table 2D.1: Supply chain risk priority continuum

Risk Category	Low Priority	Mixed Priority	High Priority
Likelihood of occurrence	Low	At least one risk category exists	High
Severity of impact	Low		High
Likelihood of detection	Easy		Difficult
Examples of potential risk mitigation strategy	▪ Monitor ▪ Take	▪ Imitate ▪ Flexibility ▪ Postpone ▪ Speculate	▪ Avoid ▪ Control

Source: Griffis and Whipple (2012)

Table 2D.2: Supply chain risk mitigation strategies framework

	low — Demand-side risks — high	
	Ante disruption state	*Post disruption state*
low Supply-side risks	**Proactive Strategy Approach** • Visibility & Transparency • Partnerships/Relationships	**Reactive Strategy Approach** • Postponement • Visibility & Transparency • Redundancy (Inventory) • Multiple Sourcing & Flexible Contracts • Collaboration • Flexibility
high	**Proactive Strategy Approach** • Joint Planning & Coordination • Redundancy (Inventory) • Visibility & Transparency	**Reactive Strategy Approach** • Flexibility • Postponement • Visibility & Transparency • Multiple Sourcing & Flexible Contracts • Redundancy (Inventory) • Collaboration

Note: Adapted from Kilubi (2016)

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3. EMERGENT ORGANIZATIONAL NETWORKS: THE CASE OF FOOD HUB MANAGERS' ADVICE NETWORK

3.1 Introduction

Food hubs are enterprises that actively manage the flow of food products primarily from small- and medium-sized local farm and food entities to retailers, institutions (e.g., schools and hospitals), and foodservice companies. The main business practices of food hubs include: (1) Recruiting producers and developing producer networks, (2) identifying, branding, and marketing differentiated farm products, (3) managing infrastructure to transform, package, and transport farm products, and (4) negotiating with buyers to secure a fair return for the producers (Diamond and Barham, 2012). Food hubs carry out these activities through a network of allied partners such as their suppliers (e.g., small- and medium-sized farm and food entities), customers (e.g., retailers, institutions, and foodservice companies), as well as other institutional partners such as government support organizations and organizations supporting local food initiatives.

The heterogeneous legal business structures and primary markets food hubs serve (Barham et al., 2012) result in ties with multiple diverse stakeholders and networks. The formation, maintenance and/or resolution of network ties require resources (e.g., human and financial) (Monge and Contractor, 2003). Having limited resources (Fischer et al., 2013), food hubs seek to manage these networks effectively and efficiently in order to enhance their performance. However, food hubs are a new type of enterprise in the U.S. food system and there are limited experiences to draw upon for strategic action. Little is known about specific networks that are critical to support food hub performance.

The literature on food hubs is developing and network analysis has been identified as an important area of study. For example, both the 2015 and 2017 National Food Hub Survey (Hardy et al., 2016; Colasanti et al., 2018) results showed that the top three sources utilized by food hubs to gather information useful for their food hubs include networking with food hubs, formal communities of practice networks, and annual meetings and conferences. Additionally, the 2017 National Food Hub Survey (Colasanti et al., 2018) results showed that food hubs ranked peer-to-peer information sharing as *the most common* (94 percent) way of receiving useful information. Furthermore, peer-to-peer information sharing was *perceived by food hubs as the most useful* (66 percent) way of receiving information. These findings point to the important role networks play in food hub performance as well as the role of peer-to-peer information sharing for food hubs.

While these findings are useful, there is still a lack of knowledge about the factors that are associated with the information provided and received by food hubs. In general, previous research on social networks shows that network ties are a result of individual or collective action (Bourdieu, 1986; Spillane et al., 2012). Information is a specific form of social capital that is also closely related to advice, another form of social capital. While the aforementioned studies on food hubs did not make an explicit distinction between *information* and *advice* received through food hub networks, the social network studies, in general, make a distinction between the two. As a step forward, this study differentiates *general information* from *advice* useful for food hubs in their operations and thus focuses on a specific network—the food hub managers' advice network. This study intentionally focuses on advice because it is one of the strategic resources critical for knowledge development (Spillane et al., 2012; Choo, 1998). It is accessed through social relationships. New knowledge can be developed when people receive new advice or when they mobilize different pieces of advice (Spillane et al., 2012; Choo, 1998).

Advice embedded in social networks is a form of social capital that serves as a fundamental component of new knowledge development. Factors that might account for the development of social capital, including advice, are understudied. In order to enhance the level of social capital in food hubs, in this case receiving advice on how to operate a food hub enterprise, for example, it is important to investigate factors that are associated with the development of this social capital. Identifying factors that might account for the development of, or the differences in, social capital among actors at different levels (i.e., individual, group, or organizational) is important for changing the level of social capital. However, there is a lack of both theoretical and empirical scholarship that identifies factors associated with the development of social capital (i.e., causes of social capital) (Spillane et al., 2012; Small, 2010; Coburn, 2001). In their efforts to take a step forward in this direction, Spillane et al. (2012) proposed that understanding factors associated with the *existence* of a social tie among actors provides a step forward in the process of understanding/identifying factors that might account for the formation of, or the differences in, social capital among actors. This is based on the assumption that social ties among actors are "a necessary condition for social capital because in the absence of such ties, individuals do not have access to social resources" (Spillane et al., 2012: 1114). That is, absent social ties, individuals do not have access to social capital. Therefore, this study follows Spillane et al.'s (2012) approach to identifying factors associated with advice-receiving by food hub managers from their professional network members as a way of finding implications for the development of, or differences in, advice-receiving in food hubs.

This study focuses on a specific network—food hub managers' advice network—and develops a model on how food hub managers choose from whom to get advice about operating a food hub enterprise. According to Wellman and Frank (1991:1), "the explanation of who gives

what to whom may be in the nature of the giver and receiver, the relationship, or in the composition and structure of the network in which people and ties are embedded." Therefore, this study examines the role of individual-, relationship-, and network-characteristics in shaping receiving advice about operating a food hub enterprise. This study draws from both theoretical and empirical literature on social capital and social tie formation in general as a reference point in the process of formulating working hypotheses. Hence, it is located within the empirical literature on social capital as well as social networks. Based on this, the working hypotheses guided data collection and analysis of the study.

The contribution of this study is twofold. First, identifying factors that are associated with the development of social capital offers further guidance on how to enhance the level of social capital—in this case advice—for food hub managers. This, in turn, will foster the design of networking strategies both by food hub managers and organizations aimed to support the development of food hubs to more effectively achieve valued organizational outcomes such as food hub enhanced performance. For example, if a variable, such as a food hub manager providing advice to a network member in the past, turns out to be a significant factor in the likelihood of getting advice, food hub managers may be incentivized to invest more proactively in their social networks which, in turn, will potentially serve as a source of resource flows for themselves. Also, organizations supporting food hub development initiatives may be incentivized to organize specific webinars, one-on-one or group sessions with food hub managers who are more experienced in specific topic areas regarding operating a food hub enterprise. Second, this study contributes to the broader empirical literature on social capital and social networks, as a step forward in the direction of filling the gap in the empirical literature on social capital.

This paper is organized as follows: Section two frames a case for food hub networks. In Section three the theory of social capital and advice as a form of social capital are discussed. Section four presents the empirical framework of the study. Section five presents the methods employed in this study. In section six the results of the study are presented. The final section of the paper discusses the results and makes concluding remarks.

3.2 Framing the Work: A Case for Food Hub Networks

The emerging literature on food hubs has no explicit studies exploring or examining food hub networks. There are a limited number of studies that mention some aspects of food hub networks. This section will present the aspects of these studies focusing on food hub networks.

Both the 2015 and 2017 National Food Hub Surveys (Colasanti et al., 2018; Hardy et al., 2016) included a section on sources utilized by food hubs to gather information useful for food hubs. The surveys included a list of sources food hubs could potentially utilize to gather information. The list includes the following sources: Informal networking with food hubs, formal communities of practice, annual meetings or conferences, university's educational resources, the federal government's educational resources, nonprofit organization's educational resources, state government's educational resources, food policy councils, and local government's educational resources. The results of both surveys show that some of the information sources utilized by food hubs are more common than others and that the importance of these sources greatly varies. Specifically, from the abovementioned list, both the 2015 and 2017 survey results showed that the top three sources utilized by food hubs to gather information useful for their food hubs are directly related to networks and include the following: "informal networking with food hubs" (52

and 63 percent, respectively), "formal communities of practice" (47 and 49 percent, respectively), and annual meetings or conferences (44 and 66 percent, respectively).

Additionally, both the 2015 and 2017 surveys asked the respondents to rank the sources they indicated to be important. The results show that the most important source was "formal communities of practice"[8], followed by "informal networking with food hubs." It is important to notice that "annual conferences or meetings" were ranked as the third most important source in the 2015 survey, whereas in the 2017 survey the rank dropped to number five for this category (Colasanti et al., 2018). Colasanti et al. (2018: 58) also mention that "this finding points to continued challenges for meeting and conference organizers to ensure that their content is relevant and useful to participants. It also suggests that informal networking opportunities within meetings or conferences would be valuable."

The 2017 National Food Hub Survey (Colasanti et al., 2018) also asked the respondents to specify the means that were used for information delivery. The following means were listed as potential means of information delivery: peer-to-peer, webinars, listserv group emails, workshops, one-on-one with experts, and tours. The survey results show that food hubs ranked peer-to-peer information sharing as *the most common* (94 percent) way of receiving information useful for their food hubs. Furthermore, peer-to-peer information sharing is *perceived by food hubs as the most useful* (66 percent) way of receiving information.

Thus, both formal and informal networks play an important role in food hubs managers' actions of gathering information useful for their food hubs. These findings highlight the

[8] According to Colasanti et al. (2018), there are at least eight formal networks, such as the Michigan Food Hub Network, Iowa Food Hub Managers Working Group, a California network coordinated by the UC Sustainable Agriculture Research and Education Program at the University of California-Davis, and the Tap Root Collaborative on Colorado. There are also at least two emerging networks.

important role of networks, their members, and food hub manager's role in pursuing information useful for their food hubs by utilizing these networks. These findings also reinforce the notion that the food hub sector is still evolving; therefore, food hubs might seek the most recent knowledge and expertise important for strategic action and/or day-to-day operations through these networks. This also suggests that there might be insufficient resources available for food hubs to draw for strategic action and/or day-to-day operations. The dynamic nature of food hubs, their heterogeneous business structures, and multiplicity of markets they serve, make the importance and relevance of dynamic and network-drawn knowledge and expertise vs. existing resources available through more traditional means, such as websites and printed material, more apparent.

While these findings are useful, there is still a lack of knowledge about the factors that are associated with information received by food hubs through their networks. As a step forward, this study differentiates *general information* from *advice* useful for food hubs in their operations and thus focuses on a specific network—the food hub managers' advice network. This study draws from the social network theories, with an emphasis on the theory of social capital, to better understand the dynamics of advice-receiving in food hub managers' professional networks.

3.2.1 The role of knowledge and expertise for food hubs

A new firm's survival and growth is highly affected by its access to key strategic resources. Two specific strategic resources are knowledge and expertise in a firm's respective activity sector. Knowledge and expertise are important to manage the firm, and assess the reliability of its suppliers and buyers, etc. Firms gain expertise through their in-house activities and human capital. They also get access to knowledge through external sources such as peers, customers,

suppliers, organizations conducting research and development activities, etc. (McDermott et al., 2009). Firms in any industry gain access to knowledge and expertise in three major ways: (1) By hiring a competent workforce; (2) by outsourcing their services in the key functional areas of their organization, or (3) by utilizing their social networks. Often the first two approaches require firms to make considerable financial investments in order to access strategic resources. However, there are situations when firms do not have sufficient financial capital to invest in these key strategic resources in all functional areas of their business. Therefore, they rely on their social networks in order to get access to key strategic resources such as knowledge and expertise. Additionally, there might be situations when existing knowledge on a given phenomenon is still evolving and/or is not easily available.

In the case of food hubs, the third approach, tendency to rely on social networks, is particularly critical for two reasons. First, food hubs are a new type of organization in the U.S. food system, hence, there is limited knowledge and experience available to outsource. Second, most food hubs are constrained in terms of their financial resources (Colasanti et al., 2018) and have limited opportunity to hire multiple employees in their key functional areas. Therefore, relying on their social networks to receive advice becomes more important.

3.3 The Theory of Social Capital: Advice as a Form of Social Capital

The construct of social capital has gained much attention in organizational research. The pioneers that started exploring the construct of social capital are Pierre Bourdieu (1986) and James Coleman (1990; 1988). Later on, researchers in various fields such as sociology, education, and organizational studies began to build and extend on the work of these social

capital pioneers. In particular, researchers began to theorize about social capital as well as empirically test the effects of social capital on valued outcomes (Spillane et al., 2012).

The concept of social capital has been defined in various ways. According to Burt (2005: 29), "social capital, as an investment in social relations with an expected return in the marketplace, [is] defined as resources embedded in a social structure that are accessed and/or mobilized in purposive actions." Bourdieu and Wacquant (1992: 119) defined social capital as "the sum of the resources, actual or virtual, that accrue to an individual or group by virtue of possessing a durable network of more or less institutionalized relationships of mutual acquaintance and recognition." Social capital is embedded in social relationships or networks, which leads to individual or aggregate benefits in a given society (Jackson, 2008). Spillane et al. (2012) proposed a definition of social capital that is built on the works of pioneers in the field, including Coleman (1988), Bourdieu (1986), and Lin (1982, 2001). According to Spillane et al. (2012: 1113), "the construct [i.e., social capital] denotes real or potential resources for action that are attained *through relationships.*" These resources take different forms such as trust, goods, services, information, advice, social obligation, social support, and social norms (Spillane et al., 2012; Inkpen and Tsang, 2005; Nahapiet and Ghoshal, 1998; Coleman, 1988).

In general, there are different types of capital such as physical, financial, human, and social capital. Unlike other forms of capital, social capital is embedded in social relationships among actors. Like other forms of capital, social capital fosters productive activity, making it possible to achieve certain outcomes that would not be possible in its absence (Coleman, 1988).

The majority of literature on social capital has studied the type of resources embedded within social networks, the effects of social capital at the individual, group, and organizational level, as well as the nature of the organizations of social relations (Spillane et al., 2012; Lin,

1999). In entrepreneurship research, studies on social networks focus on the entrepreneurs' access to intangible resources (Hoang and Antoncic, 2003). Through network relations, entrepreneurs get access to resources such as emotional support in risk-taking situations (Bruderl and Preisendorfer, 1998), information and advice, problem solving, business information (Johannisson et al., 1994), know-how (Brown and Butler, 1995), and reputation (Deeds et al, 1997). Access to these different forms of social capital, in turn, results in valued entrepreneurial outcomes such as enhancing the level of persistence in an entrepreneur to stay in business in risk-taking situations (Gimeno et al., 1997), acquiring key talent (Freeman, 1999), getting new ideas, recognizing entrepreneurial opportunities (Smeltzer et al., 1991; Birley, 1985), enhanced access to key strategic resources, and mitigating perceived risk through legitimacy (Stuart et al., 1999).

Despite these advances in both theoretical and empirical research on social capital, little is known about factors associated with the development of social capital (i.e., causes of social capital) (Spillane et al., 2012; Small, 2010; Coburn, 2001). Identifying factors that might account for the development of, or the differences in, social capital among actors at different levels (i.e., individual, group, or organizational) is important for changing the level of social capital. Spillane et al. (2012) proposed that understanding factors associated with the existence of a social tie among actors provides a step forward in the process of identifying factors that might account for the formation of, or the differences in, social capital among actors. This is based on the assumption that social ties among actors are "a necessary condition for social capital because in the absence of such ties, individuals do not have access to social resources" (Spillane et al., 2012: 1114). That is, absent social ties, individuals do not have access to social capital.

This study follows the approach of Spillane et al. (2012) in terms of focusing on identifying factors associated with the *existence* of a social tie among actors in a social network.

This, in turn, will have direct implications for potentially understanding factors associated with the development of, or differences in, social capital among actors in a social network—in this case food hub managers advice network.

3.4 The Empirical Framework: The Role of Individual, Tie, and Network Characteristics in Shaping Advice Received by Food Hub Managers

Before turning to the empirical framework of the study, the following two paragraphs will provide brief introduction to some of the key network terms used extensively in the empirical framework.

In general, social network studies are designed to be either whole-network or egocentric. The choice between these two approaches depends on the research questions under study (Hanneman and Riddle, 2005). Since this study focuses on food hub managers' networks, an egocentric network approach is appropriate. In an egocentric network approach, social relations based on an ego (e.g., person, organization, community, classroom, nation, etc.) are considered.

The actors (i.e., nodes) of the network are defined as follows: a respondent food hub manager is an "ego" in this study. Individuals nominated/listed by food hub managers (i.e., egos) as members of their networks are nodes (i.e., "alters") in their network. The type of relation (or "tie") under study is a food hub manager (i.e., ego) receiving advice from their network members (i.e., alters).

As a starting point, this study draws from the work of Wellman and Frank (1999) to structurally set up the empirical part of the study. Specifically, according to Wellman and Frank (1999:1), "the explanation of who gives what to whom may be in the nature of the giver and receiver, the relationship, or in the composition and structure of the network in which people and

ties are embedded." Therefore, this study examines individual-, tie-, and network-specific characteristics in shaping advice receiving about operating a food hub enterprise. Individual characteristics refer to specific attributes of food hub managers (i.e., egos) and people in their social networks (i.e., alters). Tie characteristics refer to specific attributes of a dyad in a network. Network characteristics refer to composition and structure of a given network.

In formulating working hypotheses about individual-, tie-, and network-specific characteristics that may account for receiving advice about operating a food hub enterprise, this study draws from the theory of social capital and theories of tie formation.

3.4.1 Individual characteristics

Individual characteristics refer to specific attributes of food hub managers (i.e., egos) and people in food hub managers' social networks (i.e., alters). Both ego and alter characteristics are important factors in identifying receiver- and giver-effects in social networks, because part of the explanation of who gives what to whom may be in the nature of the giver and/or receiver (Wellman and Frank, 1999). Taking into consideration the small sample size of this study (i.e., seven food hub managers), specific individual characteristics of food hub managers (i.e., egos or advice-receivers) are not hypothesized and examined. Instead, ego characteristics are modeled in this study as a dummy variable which will still allow for identifying the overall effect of individual characteristics of food hub managers in their advice-receiving networks.

This study incorporates only alter characteristics (i.e., giver-effect) as the sample size for alters is much larger (N=64). Alter's expertise is one of the key factors in advice-receiving networks (Nebus, 2006). Ego's perceptions of who the experts are in their social networks are directly affected by the nature of the task being addressed (Nebus, 2006). Experts are individuals

who specialize in a specific domain(s) and present problems within a specific domain(s) at a deeper level (Nebus, 2006; Simon, 2000; Chi et al., 1988). Another distinguishing aspect of experts is that they diagnose and solve problems quickly due to a certain intuition based on their experience (Nebus, 2006; Prietula and Simon, 1989). Within the context of food hubs, there are several domains or functional areas that are particularly important for food hub operations. The broader literature highlights some of these areas including food safety, operations management, product sourcing/producer networks, customer relations, human resource management, and funding. Thus, these areas could be considered critical domains for food hub operations. Therefore, it is expected that food hub managers might have questions or need advice regarding one or more of these functional areas. Hence, it is expected that food hub managers will connect with individuals that they perceive to be experts in one or more of these areas. Following this logic, the following hypothesis is formulated:

> ***Hypothesis 1:*** *Food hub managers are more likely to receive advice from alters who are perceived as experts in domains specific to food hubs.*

Another key attribute of an alter in food hub managers' advice-receiving networks is the number of years the alter has been involved in the food hub or related organization. This notion is directly related to a concept known as *cognitive trust* in a network. Cognitive trust, also known as calculus-based trust, is a specific dimension of trust reflecting an individual's competence, professionalism, ability, and past performance (Nebus, 2006). As Nebus (2006: 628) states, "these traits create a halo effect, which may result in this person's being perceived as desirable, even though he or she is not an expert in the pertinent field of study." Food hubs are a new type of enterprise in the U.S. food system. Therefore, individuals who have been involved in the

process longer will more likely be perceived as more trusted in terms of starting or operating a food hub. They may not necessarily be experts in specific domains, but they might be perceived to be more aware of sources of resources necessary for food hub survival and growth. Thus, these alters will be perceived as trusted and food hub managers will be more likely to receive advice from them. Based on this logic, the following hypothesis is formulated:

Hypothesis 2: *The longer the alter has been in the food hub or related business, the more likely it is the food hub manager will receive advice from the alter.*

According to the theory of social exchange, individuals establish relationships to exchange valuable resources such as information, material goods, skills, and the like (Zhu et al., 2013). One of the ways to identify and explain the dynamics of social exchange in a network is through the degree of reciprocity. In general, a high degree of reciprocity indicates that individuals choose each other in a network (Valente, 2010). Following this logic, egos tend to receive resources from alters with whom they have current or prior exchange relationship. The exchange does not necessarily need to be regarding the same type of resource. In general, in the context of expertise, reciprocity is expected to be lower. The reason is that individuals with less expertise in a given subject will seek advice from those alters who have higher levels of expertise. This implies that alters with higher levels of expertise (compared to the ego) are less likely to seek advice from the ego in the same subject area. On the other hand, if the ego provided advice to the alter in a different subject area in the past, it is expected that the alter will reciprocate and provide advice to the ego about a food hub-related topic. Following this logic, the following hypotheses are formulated:

Hypothesis 3: *Food hub managers are more likely to receive advice from alters to whom they did not provide advice about food hub-related subject area in the past.*

Hypothesis 4: *Food hub managers are more likely to receive advice from alters to whom they provided advice in other subject areas in the past.*

3.4.2 Tie characteristics

Tie characteristics refer to specific attributes of a dyad in a network. As stated earlier, part of the explanation of who gives what to whom in a network may be in the nature of the relationship (Wellman and Frank, 1999). One of the key characteristics of a tie that connects an ego to an alter in an egocentric network is its strength. The higher or lower the frequency and intensity of interaction between an ego and alter, the stronger or weaker the tie is, respectively (Monge and Contractor, 2003). Previous research shows that strong ties provide more social support (e.g., emotional aid, material aid, information, and companionship) than weak ties (Wellman and Frank, 1999; Wellman and Wortley, 1990; Erickson et al., 1988). Weak ties, on the other hand, have shown to provide other benefits such as finding jobs (Granovetter, 1973). In the context of food hubs, it is expected that food hub managers will receive advice regarding a food hub related problem or food hub related decision they have to make from individuals in their professional networks with whom they interact more frequently and communicate with for a longer amount of time during each interaction. This notion is rooted in the assumption that food hub managers would consider reaching out to or share with people in their professional networks while encountering a food hub related problem or when they have to make a food hub related decision (alone or with others). Because of the dynamic nature of the tasks being completed in food hubs, it is expected that food hub managers will receive advice from individuals with whom they have

strong ties because they interact with these individuals more frequently and for a longer amount of time during each interaction. According this logic, the following hypothesis is formulated:

> ***Hypothesis 5:*** *The stronger the tie between the food hub manager and the alter, the more likely it is the food hub manager will receive advice from the alter.*

Another tie-level characteristic that has shown to play a role in advice-receiving networks is homophily. Homophily is a property that refers to the fact that people tend to maintain relationships with people who are similar to themselves. Homophily is measured in various ways, including age, gender, race, religion, profession, and the like. It can have important implications for how the information or behaviors are spread (Jackson, 2008). Burton (1927) was the first author who formalized this property in social networks and framed it as "birds of a feather" (Jackson, 2008). Previous research shows that homophily influences whom a person consults for advice. A greater likelihood of response is expected from individuals with similar demographics. Researchers have also found that individuals seeking technical advice, for example, have a greater tendency to ask others of the same gender, age, and organizational tenure (Nebus, 2006; Zenger and Lawrence, 1989; Ibarra, 1992).

In this study, homophily in terms of common interest is emphasized. Specifically, within the context of food hubs, attendance in common meetings or conferences shows that egos and their alters have common interest. This also provides a venue for potential interactions between egos and alters. Additionally, from the transaction costs perspective (Williamson, 1985), egos spend fewer resources accessing advice from their alters in case of attendance in common meetings. In the context of food hubs, the managers are more likely to get advice directly during the meetings or conferences related to food hubs. Moreover, these meeting and conferences

create a sense of belonging and proximity, which, in turn, fosters the resource flow in the form of advice between egos and alters. Thus, based on the literature, the following hypothesis is formulated:

> ***Hypothesis 6:*** *Food hub managers who attend common meetings with the alter are more likely to receive advice from the alter.*

3.4.3 Network characteristics

Network characteristics refer to the composition and structure of a given network. Network characteristics affect their overall dynamics. A measure of network structure that has shown to play an important role is transitivity. In an egocentric network, transitivity exists when the following combination of links between three nodes exists: Ego chooses an alter 1 (A1), A1 chooses A2, and ego chooses A2. That is, a triad is considered transitive if two of the nodes have the same relationship with the third node (Valente, 2010). According to the Balance theory (Heider, 1958), the ego chooses A2 because individuals prefer having a balanced environment around them. In the case of food hubs, the effect of transitivity is reflected in situations when a food hub manager and one of the alters have a third mutual tie. In this case, the likelihood that the food hub manager will get advice from this alter is higher. Based on the literature, the following hypothesis is formulated:

> ***Hypothesis 7:*** *The greater the number of mutual ties between a food hub manager and the alter, the more likely it is that the food hub manager will receive advice from the alter.*

3.5 Methods

3.5.1 Study design

In general, social network studies are designed to be either whole-network or egocentric. The choice between these two approaches depends on the research questions under study (Hanneman and Riddle, 2005). Since this study focuses on food hub managers' networks, an egocentric network approach is appropriate. In an egocentric network approach, social relations based on an ego (e.g., person, organization, community, classroom, nation, etc.) are considered. The egocentric network approach is used to capture individual social networks, and in situations when the identities of egos (or focal actors) are known. However, the identities of egos' alters are not known to the researcher in advance. Egocentric network studies rely on the egos to provide information about their alters. The primary goal of egocentric network analysis is to capture properties of a focal actor's network and explain phenomena relevant in a particular context (e.g., behavior, economic success or failure) (Henning et al., 2012). This study employed egocentric network design to collect data from food hub managers (i.e., egos).

Egocentric networks are also distinguished according to the way they describe the embedding of actors in social relations. One approach is to describe only direct relations of egos with their alters. The second approach is to describe both direct relations of egos with their alters as well as to capture the structure of the environment of an egocentric network by identifying relations between alters (Henning et al., 2012). In this study, the second approach was employed to incorporate network variables, such as transitivity, into the analysis.

3.5.2 Boundaries of the network, nodes, and ties

Since in social network studies one needs to specify boundaries of a network, this study defines a food hub manager's network to include individuals outside their organization with whom they had business or professional conversations about food hubs. For recall purposes, the managers were asked to include individuals with whom they had professional conversations or discussions during the past 12 months (for a similar approach see Agneessens and Wittek (2012) and Brennecke and Rank (2017)). Individuals outside a food hub with whom the manager had professional conversations or discussions about food hubs are the boundaries of the network under study. That is, food hub managers' egocentric networks were specified in terms of ties of the selected kind—individuals with whom they had professional conversations or discussions about food hubs.

The actors (i.e., nodes) of the network are defined as follows: the respondent food hub manager is an "ego" in this study. Individuals nominated/listed by egos as members of their food hub-related professional networks are "alters" (i.e., nodes in an egocentric network). The type of tie under study is an advice-receiving tie (i.e., ego received advice from an alter).

3.5.3 Population and sampling

This study focuses on food hubs in Michigan. There are ten actively operating food hubs in MI. All 10 food hub managers were contacted via email and were invited to participate in the survey. Once agreement was received, the hard copy of the survey questionnaire was sent to them via mail along with a prepaid return envelope. The mailing of hard copies of the survey questionnaire was due to the nature of the network survey structure. The goal of the questionnaire design was to make the response process as pragmatic as possible for food hub managers. These steps were completed during mid-January to early March of 2020. Participants

received $50 Amazon gift cards as a thank you for their time once the completed questionnaires were received. The gift cards were sent via Amazon.com.

Seven out of ten food hubs in Michigan completed and returned completed surveys. Each of the food hub managers nominated eight to ten alters in their networks resulting in a sample size of 64 for alters. The data was digitized and coded for analysis purposes.

3.5.4 Survey questionnaire and data

Survey research is one of the primary research designs to collect data for network studies. A survey questionnaire was used to collect data from food hub managers about their advice network. In particular, an egocentric network approach was employed in which case both relational and attribute data were collected. The working hypotheses stated earlier served as a basis for data collection (for a summary see Table 3A.1 in Appendix).

Food hub managers (i.e., egos) were first asked to nominate 8-10 individuals outside their organization with whom they had business or professional conversations about food hubs during the past 12 months. This has underlying implications for the boundaries of the ego's network. From this list, managers were asked to specify those individuals from whom they *received advice.* This advice might have been for a food hub related problem or decision that the manager had to make alone or with others during the past 12 months (for a similar approach see Agneessens and Wittek (2012) and Brennecke and Rank (2017)). The questionnaire also included questions about alters that egos would most likely be able to answer (see Appendix 3B for the full survey questionnaire). Ideally, alter characteristics would have been collected directly from alters. However, due to confidentiality reasons egos were asked to specify alter characteristics.

3.5.5 The empirical model, measurement of variables, and analysis

In order to test the working hypotheses of this study, the empirical model (1) was specified. In the model specification, the dependent variable is the likelihood of receiving advice (see Table 3.1). That is, a model for likelihood of receiving advice as a function of individual, tie, and network characteristics is estimated. Since the sample size in terms of egos for this study is small (i.e., seven food hub managers), specific individual characteristics of egos (i.e., advice-receivers) were not examined. Egos were assigned dummy variables to account for ego-specific characteristics associated with advice-receiving.

The empirical model is specified as follows:

$$\begin{aligned}\log\left[\frac{P(Getting\ Advice_{ij}=1)}{1-P(Getting\ Advice_{ij}=1)}\right] = {} & \beta_{0j} + \beta_1\, Strength\ of\ Tie_{ij} \\ & + \beta_2\, Attendance\ in\ Common\ Meetings_{ij} \\ & + \beta_3\, Alter's\ Number\ of\ Years\ in\ Food\ Hub\ or\ Related\ Org_{ij} \\ & + \beta_4\, Alter's\ Area\ of\ Expertise_{ij} \\ & + \beta_5\, Ego\ Provided\ Food\ Hub\ Related\ Advice\ to\ Alter\ in\ Past_{ij} \\ & + \beta_6\, Ego\ Provided\ Other\ Advice\ to\ Alter\ in\ Past_{ij} \\ & + \beta_7\, Mutual\ Ties\ Between\ Ego\ and\ Alter_{ij} \\ & + \varepsilon_j \end{aligned} \quad (1)$$

where the subscript i stands for ego i, and j stands for alter j. Egos were assigned dummy variables and their characteristics were treated as random effects.

The first variable in the model is *strength of tie*. Strength of tie can be measured in various ways. Granovetter (1973: 1361), for example, proposed that tie strength is related to

"amount of time, the emotional intensity, the intimacy (mutual confiding), and the reciprocal services which characterize the tie." In his study, Granovetter measured strength of tie by the number of times respondents had interacted in the past year. The tie was considered weak if the frequency of interaction was once a year or less. It was considered medium if the frequency of interaction was less than a week but more than once a week. Finally, a tie was considered strong if the frequency of interaction was at least twice a week.

Monge and Contractor (2003) suggest taking into account also the intensity of interaction while measuring the strength of a tie. In this study, strength of tie was constructed by taking into account frequency of interaction and duration of each interaction (i.e., a typical duration of conversation each time) between ego and alter. Duration of each interaction was taken into account to operationalize the intensity of interaction component. Frequency of interaction was coded according to the following scale: 1 (once in the past 12 months), 2 (several times in the past 12 months), 3 (monthly), 4 (weekly), and 5 (daily). Duration of a typical conversation was coded according to the following scale: 1 (less than 15 minutes), 2 (15-30 minutes), 3 (31-60 minutes), 4 (1-2 hours), and 5 (more than 2 hours). The tie strength was measured by multiplying the frequency of interaction with the duration of interaction. This scale was built to reflect the notion that the more frequent the interaction between ego and alter, the stronger the relationship. Similarly, the longer the duration of a conversation between the ego and alter each time, the stronger the relationship. Thus, the higher the score, the higher the frequency of interaction and duration of each conversation (see Table 3.2).

The second variable in the model is *attendance in common meetings*. In order to capture the extent to which attendance in common meetings played a role in food hub managers advice-receiving, managers were first asked to indicate which food hub-related professional meetings

and conferences they attended during the past 12 months (see the list of meetings and conferences in Table 3.2). They also had an opportunity to list additional food-hub related meetings and conferences they attended. Then food hub managers were asked to indicate if they saw each of the alters in the meetings or conferences they attended by selecting one of the following categories: no (code: 0); yes, once in the past 12 months (code: 1); and yes, several times in the past 12 months (code:2) (see Table 3.2).

The third variable in the model is *alter's number of years in a food hub or related organization*. This variable was measured by asking food hub managers to provide the number of years each network member has been in food hub business or related organization based on their best knowledge (see Table 3.2).

The fourth variable in the model is *alter's area of expertise* perceived by ego. This variable was specified by asking food hub managers to specify areas of expertise for each alter. Food hub managers were provided a list of areas of expertise. The list was constructed by taking into consideration areas that are important for food hubs. The main business practices of food hubs include: (1) recruiting producers and developing producer networks, (2) identifying, branding, and marketing differentiated farm products, (3) managing infrastructure to transform, pack, and transport farm products, and (4) negotiating with buyers to secure a fair return for the producers (Diamond and Barham, 2012). Therefore, the list included areas capturing these fields: product sourcing/producer networks, operations management, food safety, human resource management, funding, distribution, and customer relations. Respondents also had an opportunity to add other areas of expertise in the category "Other." Since a person may be an expert in multiple areas, respondents had an opportunity to specify more than one area for each alter. That is, the areas of expertise for alters are not mutually exclusive. This variable was measured by

assigning categories of "yes" (coded: 1) or "no" (coded: 0) with respect to each area of expertise for each alter (see Table 3.2).

Reciprocity was measured in the following way: 1) *ego provided food hub-related advice to alter in the past*, and 2) *ego provided advice about other topic areas to alter in the past*. Food hub managers were asked to mark "yes" (coded: 1) or "no" (coded: 0) for each of these categories (see Table 3.2).

The seventh variable in the model is *transitivity (mutual ties between ego and alter)*. One approach for measuring transitivity is to calculate the fraction of mutual ties between ego and alter in an egocentric network (see Jackson (2008) for a similar approach). Following this approach, food hub managers were asked who knew each other in their food hub related professional network. Afterward, a fraction of mutual ties was calculated and then converted to percentage (see Table 3.2).

The eighth variable in the empirical model is the dummy for egos. As mentioned earlier, assigning a dummy variable for food hub managers would allow capturing the overall effects of their individual characteristics on the likelihood if receiving advice from alters.

Finally, the very last term in the model is the error term ε_j. It represents random factors that may account for the variability in the dependent variable that are not controlled experimentally (Winter, 2013).

There were also several other variables included in the questionnaire for descriptive statistics purposes to better understand the network under study. Table 3.3 provides the list and description of variables.

Table 3.1: Dependent variable in the empirical model

Variable	Code and description
Ego received advice from the alter	1=Yes This advice might have been for a food hub related problem or with a food hub related decision that ego had to make alone or with others in the past 12 months.[9] 0=No Ego did not receive advice from the alter. They simply had general professional conversation(s) about food hubs.

Table 3.2: List and description of variables included in the empirical model *and* descriptive statistics

Variable	Code and description
Frequency of communication with alter	1=once in the past 12 months; 2=several times in the past 12 months; 3=monthly; 4=weekly; 5=daily
Duration of a typical conversation with alter	1=less than 15 minutes; 2= "15-20" minutes; 3= "31-60" minutes; 4= "1-2" hours; 5=more than 2 hours
Strength of tie	Frequency of communication x Duration of conversation
Alter's area of expertise	1=Yes; 0=No ▪ Product sourcing/producer networks ▪ Operations management ▪ Food safety ▪ Human resource management ▪ Funding ▪ Distribution ▪ Customer relations ▪ Other
Alter's number of years in food hub or related organization	Numerical value

[9] Note: "In the past 12 months" refers to the time period that respondents would recall at the time of taking the survey (late January-early March, 2020).

Table 3.2 (cont'd)

Variable	Code and description
Homophily Attendance in *common* meetings and conferences: Ego saw alter in these meetings or conferences	0=No; 1=yes, once in the past 12 months; 2=yes, several times in the past 12 moths (see the list of meetings and conferences in Table 3)
Reciprocity a) Ego provided alter with food hub-related advice in the past b) Ego provided alter with other topic-related advice in the past	1=Yes, 0=No
Transitivity: Mutual ties between ego and alter	1=Yes, 0=No Faction of mutual ties converted to percentage according to the following formula: Number of mutual ties in an egocentric network between the ego & the alter/(Total number of alters in the egocentric network -1) x 100

Table 3.3: Variables included in the descriptive statistics

Variable	Code and description
Food hub manager's number of years in food hub	Numerical value
Number of food hub related meetings or conferences attended by ego within the past 12 months	Numerical value calculated by summing up the responses for each ego
Length of relationship with alter	Numerical value
Mode of communication with alter	1=Yes; 0=No · Face-to-face · Phone · Text · Email · Social Media (LinkedIn, Facebook, etc.) · Video-Conferencing (Skype, Zoom, etc.) · Other

Table 3.3 (cont'd)

Alter's age	"66 or older"=5, "56-65"=4, "46-55"=3, "36-45"=2, "26-35"=1, "18-25"=0
Attendance in food hub related meetings and conferences in Michigan	1=Yes; 0=No • Lakes EXPO • Michigan Farm to Institution Network Meeting • Michigan Food Hub Network Meeting • Michigan Food and Farming Systems Family Farms Conference • Michigan Good Food Charter Communities/Meetings • Michigan Food and Agriculture Summit • Northern Michigan Small Farms Conference
Ego intends to collaborate with alter in the future	0=No, 1=maybe; 2=Yes
Alter's organizational affiliation	Food hub, university, Extension service, independent consultant, for-profit enterprise, non-profit, government agency, other
Alter's job title	Description
Usefulness of received advice	0=not at all useful; 1=slightly useful; 2=useful; 3=very useful

Finally, the empirical model was estimated following the generalized linear mixed-effects regression method and using R software. This method allows for taking into account fixed effects (i.e., variables specified in the model) and random effects (i.e., ego characteristics specified by a dummy variable). It also allows for addressing the non-independencies aspect of network data (Winter, 2013). Additionally, descriptive statistics are reported to provide a better understanding of the network under study.

3.6 Results

This section presents descriptive statistics and regression results. First, the descriptive statistics focus on describing the characteristics of food hub managers' professional networks regarding food hubs. As mentioned earlier, food hub managers were asked to nominate 8-10 individuals outside their organization with whom they had business or professional conversations about food hubs during the past 12 months. All seven food hub managers listed a combined total of 64 network members (i.e., alters). The descriptive statistics focus on presenting important aspects of the professional networks of food hub managers regarding food hubs.

Food hub managers are also asked to specify those individuals in their professional network (listed earlier) from whom they *received advice.* This advice might have been for a food hub related problem or with a food hub related decision that the manager had to make alone or with others during the past 12 months. The regression results focus on analyzing the advice-receiving networks of food hub managers by testing the empirical model (1) described earlier. The regression results identify variables that were statistically significant in terms of explaining variation in advice-received in food hub managers' professional networks.

3.6.1 Descriptive statistics

This section focuses on providing context in terms of food hub managers' professional networks by focusing on network member (i.e., alter) characteristics and network communication in general. The results show that food hub managers were involved in food hub businesses for four and a half years, on average (see Table 3.4). Additionally, Table 3.4 shows that food hub managers have known their network members for approximately four years, on average.

Table 3.4: Summary statistics

Variable	Mean	Standard deviation	Standard error	Min	Max
Food hub manager's number of years in food hub (years)	4.57	3.51	1.32	1	11
Number of food hub related meetings or conferences attended by ego	3.71	2.36	0.89	2	8
Length of relationship with alter (years)	3.72	2.92	0.36	1	12
Number of years alter has been in food hub business or related organization (best approximation by food hub managers)	6.10	5.17	0.64	<1	20
Strength of tie (frequency of interaction x duration of interaction)	8.01	4.06	0.50	2	20

Note: For alters, N=64. For egos, N=7.

All network members listed by food hub managers live in the U.S. state of Michigan. Figure 3.1 shows the age of food hub managers' network members. These results are based on food hub managers' perceptions of age for each of their network members. As can be seen from Figure 3.1, most network members are 26-45-years-old (78 percent).

Figure 3.2 shows the organizational affiliation of food hub managers' network members (i.e., alters). The results show that the top three organizations that network members are affiliated with are following: university/college/extension (30 percent), food-related for-profit business (20 percent), and food hubs (14 percent).

Figure 3.1: Alters' age (in years)

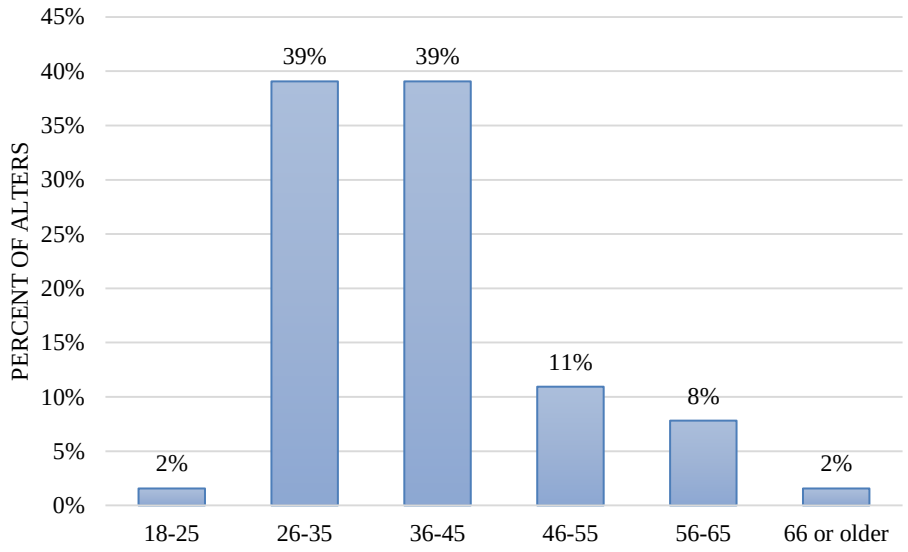
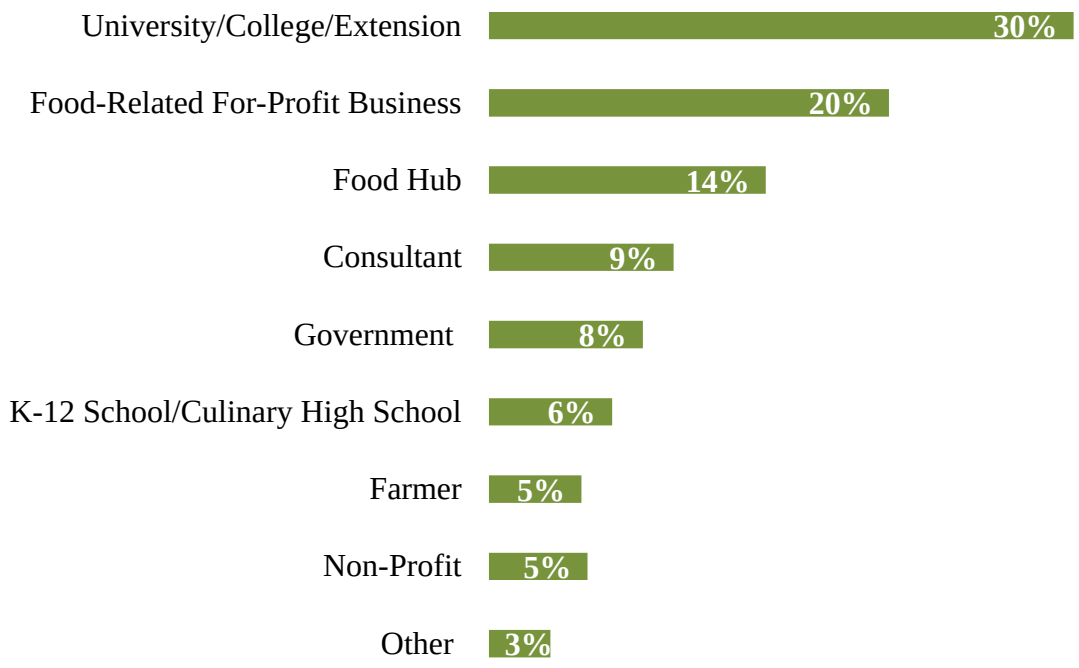


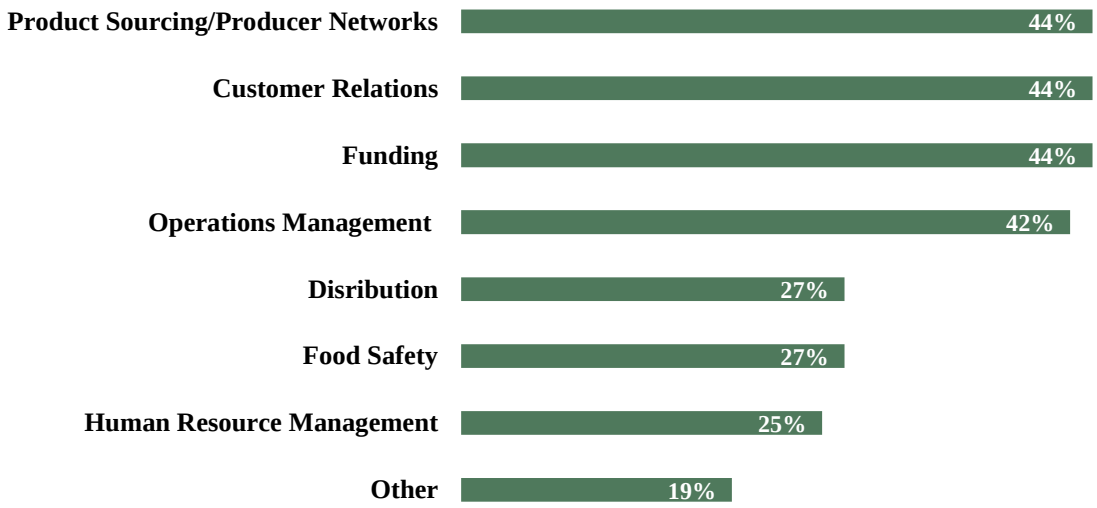
Figure 3.2: Organizational affiliation of food hub managers' professional network members



Note: These categories are constructed based on a qualitative analysis of listed organizational affiliations. The category "Other" includes responses such as a food-related marketing agency.

Figure 3.3 shows perceptions of egos regarding the areas of expertise of their alters. The top three areas include the following: product sourcing/producer networks, customer relations, and funding. It is important to note that these areas of expertise are not mutually exclusive. Overall, these results suggest that managers' food hub-related professional networks consist of individuals who are perceived to be experts in areas important for food hub operations.

Figure 3.3: Network members' area of expertise perceived by food hub managers



Note: The category "Other" included the following responses listed by food hub managers: Education, culinary, diversity and inclusion, business planning, farm-to-school/agriculture education, business assistance to small businesses, agriculture education and food sovereignty, economic development, and development.

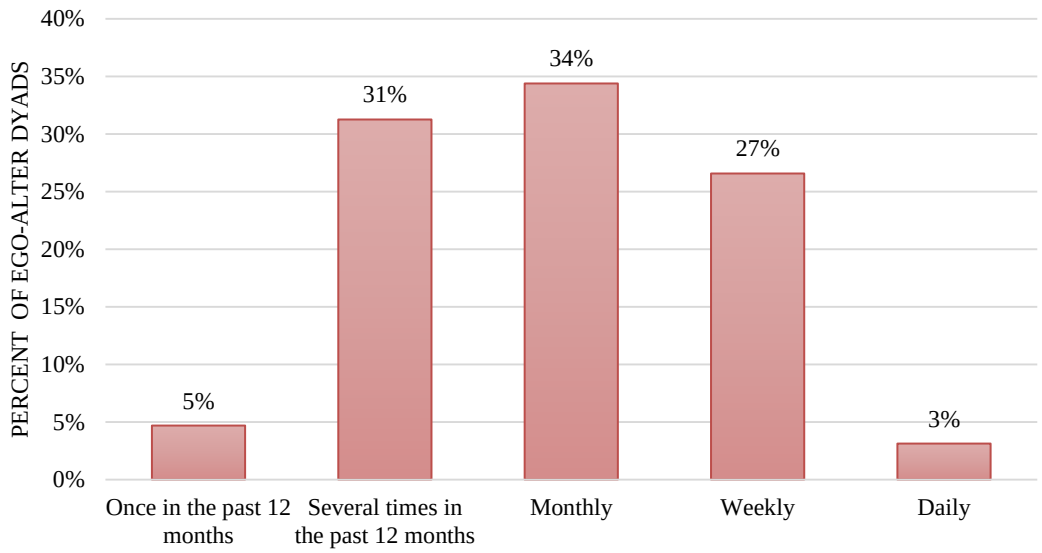
Figure 3.4 shows food hub managers' frequency of communication with each network member (i.e., alter). The top three answers were the following: communication on a monthly basis, several times a year, and on a weekly basis.

Figure 3.5 shows the duration of food hub managers' conversations with each alter when they had an opportunity to converse. As can be seen from Figure 3.5, most food hub manager-alter dyad conversations lasted 15-30 minutes (41 percent), and for 30 percent of the dyads the

conversations typically lasted 31-60 minutes. Thus, 71 percent of ego-alter conversations typically last 15-60 minutes.

Table 3.4 shows summary statistics for the measure of the strength of a tie. As mentioned earlier, the measure was constructed by multiplying the frequency of interaction (taking values from 1 to 5) with the duration of interaction (taking values from 1 to 5). Therefore, the measure could take values from 1 to 25. Table 3.4 shows that the average value of the strength of tie score was 8.01 with a standard deviation of 4.06.

Figure 3.4: Frequency of interaction between food hub managers and network members



The study results also show that the average number of food hub managers' modes of communication with each alter was 2.89 (see Table 3.4). That is, egos, on average, used at least two modes of communication with each of their alters. Figure 3.6 shows modes of communication listed in the survey. The results show that the top three modes of communication are face-to-face meetings, email, and texting. Specifically, 89 percent of ego-alter dyads use

Figure 3.5: Duration of conversation between food hub manager and network member

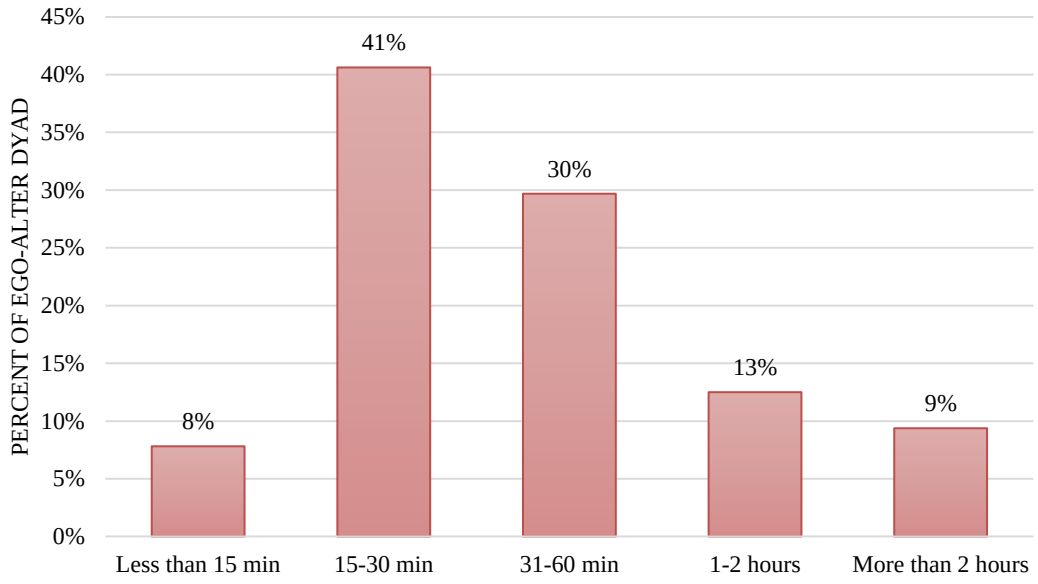
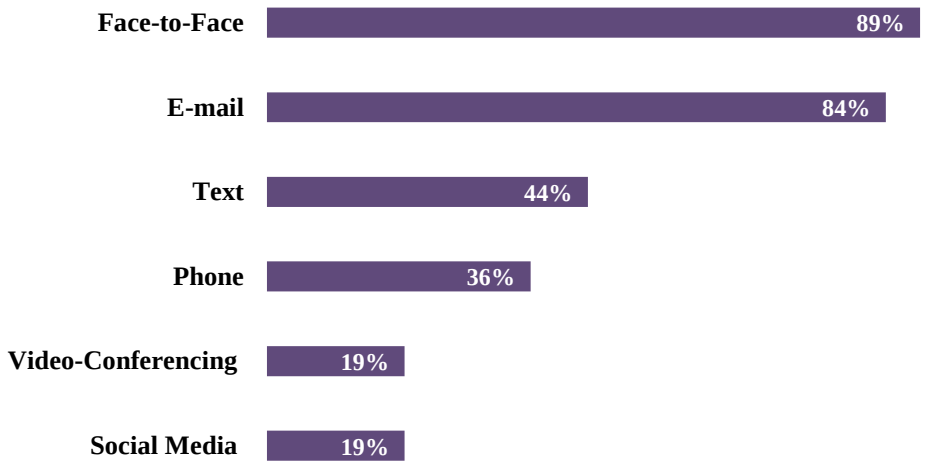


Figure 3.6: Food hub manager-network member modes of communication



Note: The questionnaire also included a category "Other" to allow respondents list additional modes of communication. There were no other modes of communication added by food hub managers.

face-to-face meetings, 84 percent of ego-alter dyads use email, and 44 percent of ego-alter dyads use texting as a mode of communication. These modes of communications are not mutually

exclusive, meaning that an ego-alter dyad may have been using more than one mode of communication with each other. These result reveal not only the most common modes of communication utilized by food hub managers but also emphasize that it might be beneficial to use more than one mode of communication with network members.

Food hub managers were also asked about the professional meetings and conferences related to food hubs they attended over the past 12 months. The questionnaire included a list of meetings and conferences in Michigan.[10] The food hub managers also had an opportunity to add other food hub related meetings and conferences that they attended.

Further calculations also showed that the average number of meetings and conferences attended by food hub managers was 3.71, which means that each manager attended at least two meetings or conferences related to food hubs within a year.

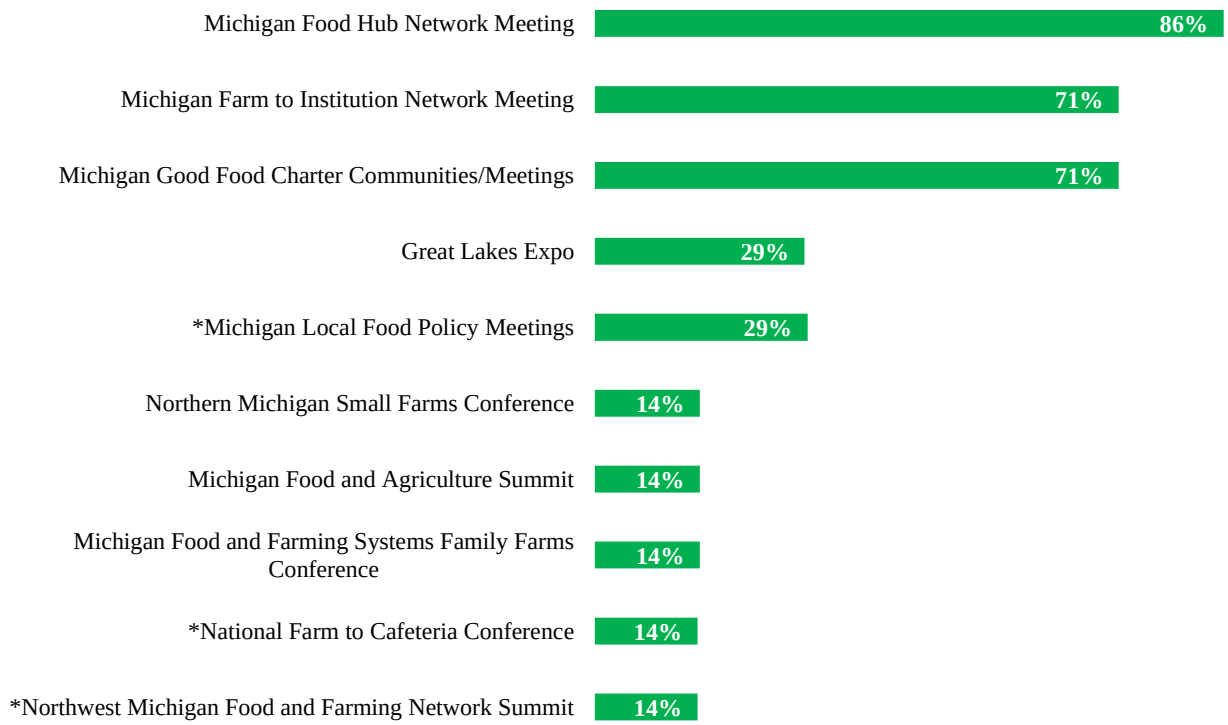
Food hub managers were also asked to indicate if they saw each of their network members in any of these meetings or conferences they attended. Figure 3.8 shows that the majority of the alters (55 percent) were not seen in those meetings.

Food hub managers were also asked if they intended to collaborate with each of the alters in near future. Figure 3.9 shows that 86 percent of the ego-alter dyads were indicated by food hub managers to be as "intend to collaborate in near future."

The results show that 61 percent of ego-alter dyads were indicated by food hub managers to be advice-receiving ties. Thirty-nine percent of the dyads, on the other hand, were indicated to

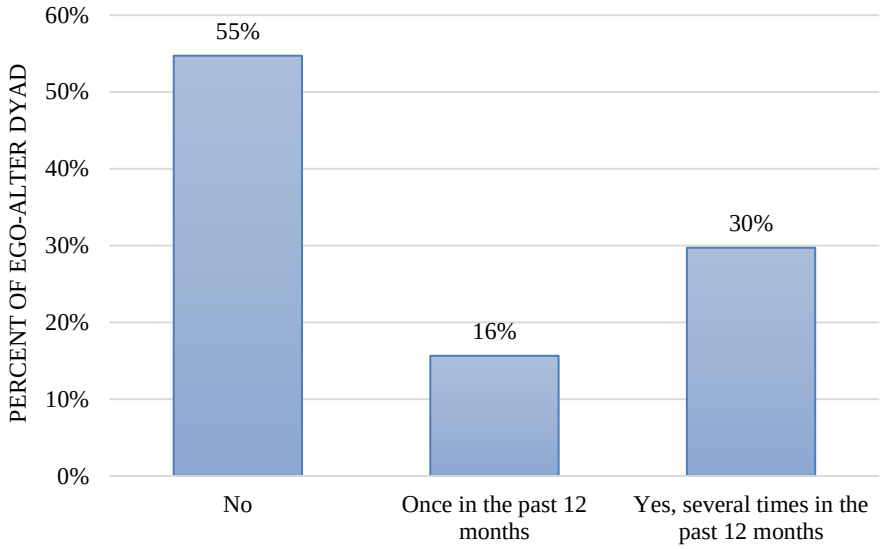
[10] It is important to note that one of the nationally recognized conferences related to food hub is the National Good Food Network (NGFN) conference which takes place every other year. Since the questionnaire asked the respondents to reflect on the past 12 months (i.e., late-January-early March 2019 to late-January-early March 2020), it would not include the time period when the NGFN conference took place (the year of 2018).

Figure 3.7: Percentage of food hub managers attending food hub-related meetings



Note: "*" denotes meetings listed by food hub managers in the category "Other."

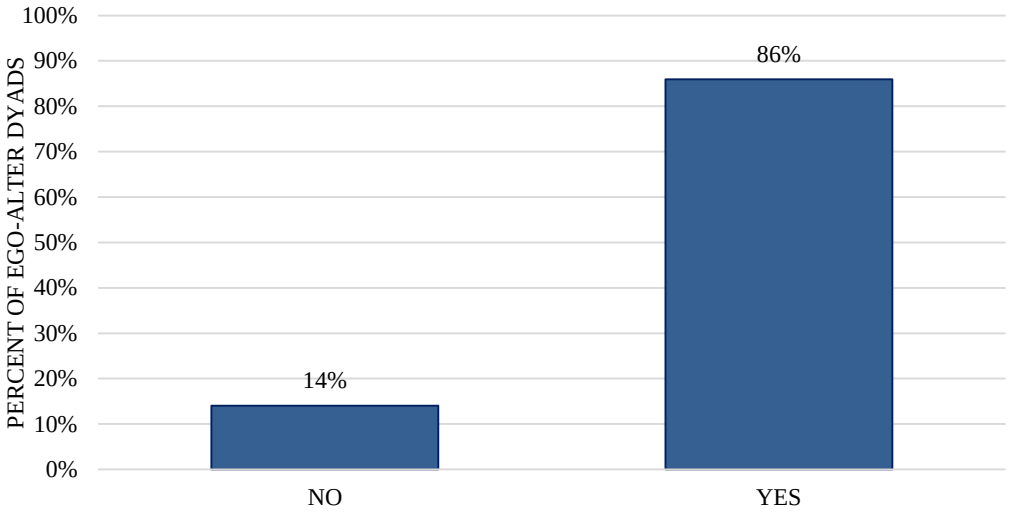
Figure 3.8: Whether food hub managers saw network members in meetings they attended



be no advice-receiving ties—they were simply general professional conversations about food hubs.

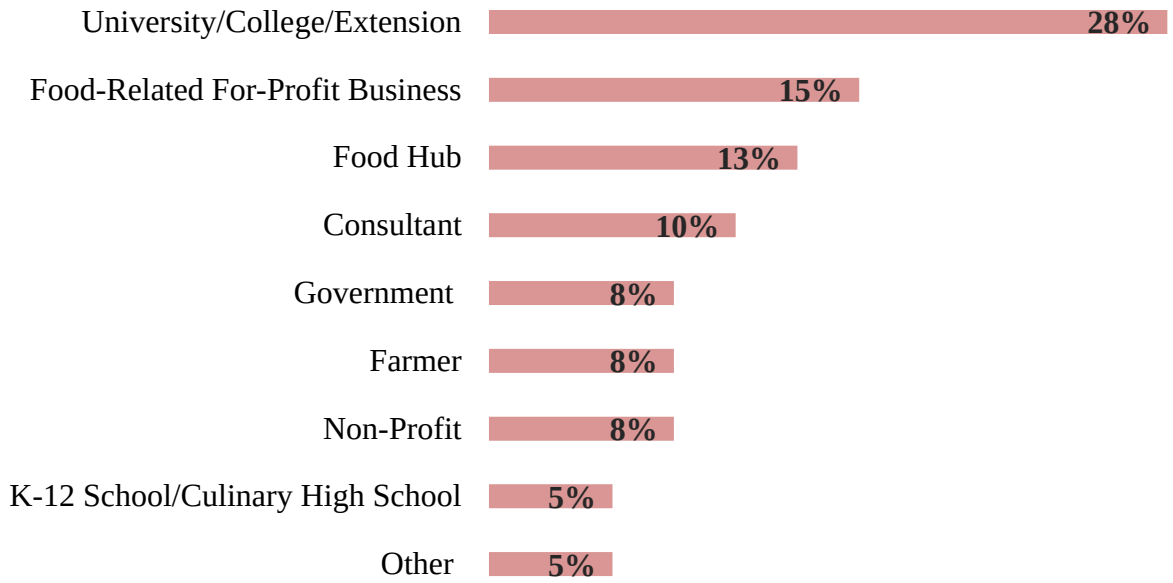
Figure 3.10 shows organizational affiliation of network members from whom food hub managers received advice. As can be seen from the results, the top three affiliations are with university/college/extension (28 percent), food-related for-profit business (15 percent), and food hubs (13 percent).

Figure 3.9: Intend to collaborate with each alters in near future



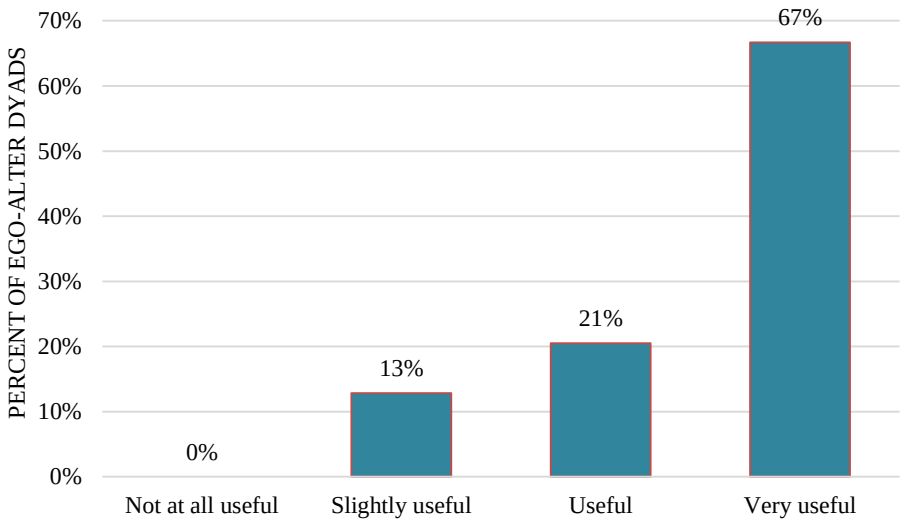
Food hub managers were also asked about usefulness of advice they received from alters. As can be seen from Figure 3.11, food hub managers perceived most of the advice received from the alters as very useful (67 percent), 21 percent was perceived as useful, and 13 percent was perceived as slightly useful. It is also important to note that the "not at all useful" category was not selected for any of the advice received from alters.

Figure 3.10: Organizational affiliation of alters from whom managers received advice



Note: [1]The category "Other" included responses such as a food-related marketing agency. [2]Of the 64 network members, 39 were indicated to be individuals from whom food hub managers received advice. Therefore, in this figure N=39.

Figure 3.11: Usefulness of advice received by food hub managers



3.6.2 Regression results and discussion

The results of the generalized linear mixed effects regression show that some of the variables had effects on the log odds of the ego receiving advice from the alter (see Table 3.5). Specifically, strength of tie, transitivity, reciprocity, and an alter's area of expertise have a statistically significant effect on the log odds of the ego receiving advice from the alter (see Appendix 3C.1 in Appendix 3C for collinearity check). It is important to note that this study originally included eight different areas of expertise of alters to be tested (see Table 3.2). Figure 3.3 shows descriptive statistics for alters' area of expertise (perceived by egos). However, due to the sample size restrictions, only one specific area was included in the model specification. In order to decide which area of expertise to include in the model, eight separate specifications of the empirical model with each area of expertise were tested. The specification with the lowest AIC was selected for final reporting (see Appendix 3C.2 for model selection check).

Table 3.5: Generalized linear mixed-effects regression results for fixed effects

Variable	Estimate	Standard Error	P-value
Intercept	-0.546	1.081	0.613
Strength of tie	1.846	0.914	0.043 *
Attendance in common meetings (met once)	1.774	1.907	0.352
Attendance in common meetings (met several times)	-0.090	1.264	0.942
Alter's number of years in food hub or related org.	0.045	0.755	0.952
Transitivity (mutual ties)	1.739	0.748	0.020 *
Ego provided food hub-related advice to alter in the past	2.914	1.268	0.021 *
Ego provided advice to alter about other topics in the past	-1.264	1.550	0.414
Alter's area of expertise (in operations management)	3.228	1.227	0.008 **
Number of observations	64		

Note: ˙, *, **, and *** represent significance at 10, 5, 1, and 0.1 percent level respectively. AIC=58.4; BIC=80.0. The table reports standardized parameter estimates. Ego characterisitcs were treated as random effects.

Additionally, Table 3.6 shows supported and refuted hypotheses along with the hypothesized sign of the relationship for each variable.

Table 3.6: Supported and refuted hypotheses

Variable	Estimate	P-value	Hypothesis	Hypothesized relationship (sign)	Supported (S)/refuted (R)
Intercept	-0.546	0.613			
Strength of tie	1.846	0.043 *	H5	+	S
Attendance in common meetings (met once)	1.774	0.352	H6	+	R
Attendance in common meetings (met several times)	-0.090	0.942	H6	+	R
Alter's number of years in food hub or related organization	0.045	0.952	H2	+	R
Transitivity (mutual ties)	1.739	0.020 *	H7	+	S
Ego provided food hub-related advice to alter in the past	2.914	0.021 *	H3	-	S
Ego provided advice to alter about other topics in the past	-1.264	0.414	H4	+	R
Alter's area of expertise (in operations management)	3.228	0.008 **	H1	+	S
Number of observations	64				

Note: ˙, *, **, and *** represent significance at 10, 5, 1, and 0.1 percent level respectively. AIC=58.4; BIC=80.0. The table reports standardized parameter estimates. Ego characterisitcs were treated as random effects.

3.6.2.1 Strength of tie

As can be seen from Table 3.5, strength of tie has a significant positive effect (at five percent level) on the log odds of receiving advice from the alter. This result suggests that the odds of the ego receiving advice from the alter tend to be higher as the strength of the tie between the ego and alter increases. Thus, hypothesis five is supported. This result is consistent with the literature that strong ties provide support in social networks (Wellman and Frank, 1999). Within the context of food hubs, this finding suggests that food hub managers are more likely to receive advice from alters with whom they interact more frequently and for a longer amount of time during each interaction.

One explanation for this finding could be that when food hub managers face a food hub-related problem or decision, they are more likely to discuss it with individuals in their professional networks with whom they meet more frequently and spend longer amounts of time during each interaction. This could also point to the reality that food hub operations are dynamic and food hub managers need faster turnaround in terms of finding solutions for problems. Therefore, strong ties tend to provide advice useful for food hubs.

This finding has important implications for food hub managers. Specifically, the results point to the importance of the strength of tie in food hub-related professional networks. Food hub managers that invest time and effort to build relationships in the field are shown to benefit from them. That is, allocating time to meet up with network members regularly and spending a longer amount of time during each interaction can have positive effects on food hub managers' advice-receiving process. This reinforces the notion that in order to increase the level of social capital—in this case advice—in food hub managers professional networks, they would need to

be intentional about the frequency of interaction and duration of meetings with network members.

3.6.2.2 Transitivity

Table 3.5 shows that transitivity also has a significant effect (at five percent level) on the log odds of the ego receiving advice from the alter. The positive value of the coefficient indicates that as the number of mutual ties between the ego and alter in an egocentric network increases, the odds of the ego receiving advice from the alter increase.

Thus, hypothesis seven is supported. This finding suggests that food hub managers whose food hub-related professional networks have high levels of transitivity are more effective in terms of receiving advice from network members. That is, the likelihood of receiving advice from network members is higher in transitive networks. This finding is consistent with the broader literature on trantivity which states that high level of transitivity in a network is indicative of cohesiveness as well as effectiveness in a broader sense (Valente, 2010). This finding is also consistent with the balance theory (Heider, 1958), according to which people prefer a balanced environment with the people around them. Accordingly, having a mutual tie with an alter increases a food hub manager's likelihood of getting advice from an alter.

This finding has important implications for food hub managers in terms of designing or revising their food hub-related networking strategies. As mentioned earlier, the formation, maintenance, and/or resolution of network ties require resources such as human and financial capital (Monge and Contractor, 2003). Therefore, for food hub managers, part of the effective management of resources is to assess their own food hub related networks to be able to manage these networks effectively and efficiently. The findings of this study show that high levels of

transitivity in food hub managers' egocentric networks increase the likelihood of receiving advice from alters.

3.6.2.3 Reciprocity

As can be seen from Table 3.5, "ego provided food hub-related advice to alter in the past" is statistically significant (at five percent level). The positive value of the coefficient indicates that a food hub manager's likelihood of receiving advice from a network member increases if the manager provided food-hub related advice to the network member in the past. This means that hypothesis three is supported, but the coefficient is, contrary to expectations, positive instead of negative. Specifically, hypothesis three claimed that if a food hub manager provided food-hub related advice to an alter in the past, then it would be less likely that this specific resource flow would be reciprocated due to the nature of the resource under study—advice. That is, it was hypothesized to see a negative association between advice received by food hub managers and them providing advice about food hub-related topics to the alter. However, as can be seen from the regression results, advice-receiving about food hub-related topics is reciprocated.

One possible explanation for this result could be that in the field of food hubs, there are no "defined experts" where the flow of the advice is one-sided in most cases. Rather, these results might point to the reality that most people in the field are learning from each other; therefore, advice about food hub-related topics is reciprocated.

Hypothesis four, on the other hand, claimed that if food hub managers provided advice to alters about other topics (unrelated to food hubs) in the past, then the likelihood of a food hub manager receiving advice from the alter would be higher. That is, it was expected to see positive association between the two variables. However, as can be seen from Table 3.5, the negative value of the coefficient for this variable indicates that if a food hub manager provided advice

about other topics (unrelated to food hubs) to an alter in the past, then the odds of receiving advice from the alter decreases. This result, however, is not statistically significant.

3.6.2.4 Alter's area of expertise (in operations management)

As can be seen from Table 3.5, an alter's area of expertise in operations management has a significant and positive effect (at one percent level) on the log odds of the ego's receiving advice from the alter. This result suggests that the likelihood of a food hub manager receiving advice from the alter tends to be higher if the alter is perceived to be an expert in operations management. Thus, hypothesis one is supported. Operations management is one of the key functional areas of food hubs. This result is consistent with the literature that people who are experts in specific domains play a key role in advice-receiving networks in these specific domains. Within the context of food hubs, one possible explanation for this result could be that alters perceived to be experts in operations management play a critical role in these advice-receiving networks. Additionally, this result might point to the possibility that operations management is one of the areas in which food hub managers needed advice when they faced a problem or decision that they had to make alone or with others. That is, in-house expertise might have not been sufficient to solve the problem(s) or make the decision(s). Food hub managers thus sought advice from within their professional networks.

This finding has important implications for increasing the level of social capital under study—advice—for food hubs. According to the findings, operations management is one of the key functional areas of food hubs and the managers have benefited from external advice. Therefore, food hub managers might benefit from training or other capacity-building initiatives regarding operations management to help food hubs become more successful.

3.6.3 Random effects

Table 3.7 shows the generalized linear mixed-effects regression results for the random effects. The standard deviation is a measure of the variability for each random effect added in the model. As can be seen from the results, the ego dummy's variability is 0.831. That is, there are idiosyncratic differences between egos. This result suggests that there are differences in individual characteristics of food hub managers that play a role in their likelihood of receiving advice.

Table 3.7: Generalized linear mixed-effects regression results for random effects

	Variance	Standard Deviation
Ego Dummy (Intercept)	0.690	0.831
Number of observations	64, groups: Ego Dummy, 7	

3.6.4 R-squared of the empirical model

Table 3.8 shows the R-squared value of the model. In Table 3.8, *R-squared marginal (m)* is the proportion of the variability in the dependent variable that is explained by only the fixed effects in the model. The *R-squared conditional (c)* is the proportion of the variability in the dependent variable that is explained by the fixed effects *and* the random effects in the model.

As can be seen from Table 3.8, the fixed effects in the empirical model explain 78.8 percent of the variability in the data. As can be seen from Table 3.8, when adding in the random effects, there is 3.6 percent increase of the variability, which suggests that the random effect of ego characteristics account for 3.6 percent variability in the dependent variable (i.e., ego's likelihood of receiving advice). This result suggests that the random effect of individual characteristics of egos (i.e., food hub managers) plays a role in the likelihood of receiving advice

from network members. As mentioned earlier, this study did not specify individual characteristics of food hub managers due to small sample size. Assigning a dummy variable for the egos still allows accounting for the overall effect of ego-specific characteristics.

Table 3.8: R-squared of the generalized linear mixed-effects regression model

	R-squared m (fixed effects)	R-squared c (fixed effects *and* random effects)
Theoretical	0.788	0.824

Note: *R-squared m* is the proportion of the variability in the dependent variable that is explained by only the fixed effects in the model. The *R-squared c* is the proportion of the variability in the dependent variable that is explained by the fixed effects *and* the random effects in the model.

These results have two important implications for future research. First, an R-squared of 78.8 percent for the fixed effects suggests that there are other alter-, tie-, and/or network-specific variables that may account for the variability in the dependent variable that were not included in the empirical model. Identifying and incorporating more factors would potentially allow better understanding the advice-receiving networks of food hub managers. Second, an R-squared of 82.4 percent for the fixed *and* random effects suggests that food hub managers' individual characteristics affect variability in the data. Therefore, future research can also identify and empirically examine specific characteristics of food hub managers as predictor variables in the likelihood of receiving advice.

Taking into consideration the novelty of this study and the fact that it is the first one in the field of food hubs to empirically examine food hub-related networks, these results will serve as a basis for future research to build on more empirical studies in this field.

3.7 Discussion and Conclusion

This study examined food hub managers' advice-receiving networks. The results show that food hub managers' advice network members are individuals affiliated with various organizations. The top three organizational categories are universities/colleges/extensions, for-profit food businesses, and food hubs. Additionally, food hub managers perceived most of the advice received from alters as very useful; none of the received advice was characterized as not at all useful.

The regression results showed that network, tie, and individual characteristics played a role in food hub managers' likelihood of receiving advice. First, as the number of mutual ties between the food hub manager and an alter in an egocentric network increases, the likelihood of the ego receiving advice from the alter increases. This may suggest that food hub managers whose network members know each other are more effective in terms of receiving advice.

Second, a tie-level characteristic that played a role in food hub managers' likelihood of receiving advice was strength of tie. Specifically, the stronger a tie between a food hub manager and an alter, the more likely it is the food hub would receive advice from the alter. As tie strength in this study was defined in terms of frequency and duration of communication, this result suggests that food hub managers receive advice from individuals they interact more frequently and for a longer amount of time.

Third, an alter-specific characteristic that played a role in food hub managers' likelihood of receiving advice was the alter's area of expertise (perceived by egos) in operations management. This result reinforces the notion that operations management is a critical part of food hub operations and food hub managers received advice from individuals who were

perceived as experts in this area. This also suggests that operations management is an area that food hub managers may need additional capacity building.

Finally, the results show that if a food hub manager provided food hub-related advice to the alter in the past, the likelihood the food hub manager receiving advice about food hub-related topics from the alter increases. That is, advice-receiving about food hub-related topics is reciprocated. One possible explanation for this result could be that in the field of food hubs, there are no "defined experts" where the flow of the advice is one-sided in most cases. Rather, these results might point to the reality that in the field of food hubs most people are learning from each other; therefore, advice about food hub-related topics is reciprocated.

These findings have important implications for increasing the level of social capital—in this case advice—in food hub managers' professional networks as well as for designing or revising their strategies. As mentioned earlier, the formation, maintenance, and/or resolution of network ties require resources such as human and financial capital (Monge and Contractor, 2003). Therefore, for food hub managers, part of the effective management of resources could be assessing their own food hub-related networks to be able to manage these networks effectively and efficiently. The findings of this study show that high levels of transitivity in food hub managers' egocentric networks increase the likelihood of receiving advice from alters. Second, food hub managers that invest time and effort to build relationships in the field are shown to benefit from them. That is, allocating time to communicate with network members regularly and spending more time during each interaction can have positive effects on food hub managers' advice-receiving process. This reinforces the notion that in order to increase the level of receiving advice in food hub managers' professional networks, they must be intentional about the frequency and duration of interaction with network members. Third, it might be helpful to have

capacity building efforts for food hub managers in the form of organizing training or other capacity-building initiatives in the area of operations management to help food hubs become more successful. Fourth, food hub-related advice was shown to be reciprocated suggesting that proactively investing in food hub-related professional networks will potentially serve as a source of resource flows for food hub managers.

One limitation of this study is not identifying and incorporating specific characteristics of egos (i.e., food hub managers) into the model. Part of the reason for this is the relatively small number of food hubs in the state of Michigan which was the scope and focus of the study. Taking into consideration the novelty of this study and the fact that it is the first one in the field of food hubs to empirically examine food hub-related networks, these results will also serve as a basis for future research to build on more empirical studies in the field. For example, increasing the sample size (which would allow incorporating specific characteristics of food hub managers into the empirical model) would further enhance the understanding of advice-receiving networks.

Finally, this dissertation is the first attempt in the field of food hubs to model and examine social capital in the form of advice in food hub managers' professional networks. It informs practitioners about the key factors that play a role in receiving advice in food hub managers' professional network. It also reinforces the importance of the professional networking strategies in the field of food hubs based on the food hubs in Michigan. Future research can use this approach and test this model with a larger sample size of food hub managers, which would also allow including food hub manager-specific characteristics.

APPENDICES

APPENDIX 3A: Hypotheses

Table 3A.1: List of hypotheses

Hypothesis 1: *Food hub managers are more likely to receive advice from alters who are perceived as experts in domains specific to food hubs.*
Hypothesis 2: *The longer the alter has been in the food hub or related business, the more likely it is the food hub manager will receive advice from the alter.*
Hypothesis 3: *Food hub managers are more likely to receive advice from alters to whom they did not provide advice about food hub-related subject area in the past.*
Hypothesis 4: *Food hub managers are more likely to receive advice from alters to whom they provided advice in other subject areas in the past.*
Hypothesis 5: *The stronger the tie between the food hub manager and the alter, the more likely it is the food hub manager will receive advice from the alter.*
Hypothesis 6: *Food hub managers who attend common meetings with the alter are more likely to receive advice from the alter.*
Hypothesis 7: *The greater the number of mutual ties between a food hub manager and the alter, the more likely it is that the food hub manager will receive advice from the alter.*

APPENDIX 3B: Survey questionnaire

Question 1: **Please list 8-10 individuals outside your organization (ex. other food hub managers, independent consultants, university, etc.) with whom you had business or professional conversations about food hubs over the past 12 months. (**You do not need to provide full names if you do not wish to do so. The most important aspect here is to keep consistency with the numbers when referring to these individuals throughout the survey. For rest of the survey, you will refer to these individuals by the assigned numbers.)

	Individuals (First name and last names OR initials OR nicknames)*	**Job title**	**Name of the Organization**
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

Question 2: **Thinking about the individuals you listed in Question 1, please complete the following questions related to each of them.**

	Age *(best guess)*	**Does this individual live in Michigan?** *(Check all that apply)*	**How long have you known each individual?** *(Best approximation in years)*	**Organizational affiliation** *(ex. food hub, university, Extension service, independent consultant, for-profit enterprise, non-profit, government agency, other (please specify))*
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

Question 3: **Reflect on your relationships with the individuals you listed in Question 1. How often, on average, do you communicate with each of them?** *(Check a box for each individual)*

	Daily	Weekly	Monthly	Several times in the past 12 months	Once in the past 12 months
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

Question 4: **When you had an opportunity to converse with each of these individuals, how long, on average, did your conversation last each time?** (Check a box for each individual.)

	Less than 15 min	15-30 min	31 - 60 min	1-2 hours	More than 2 hours
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

	Question 5: **Do you intend to collaborate with each of these individuals in the near future?**			Question 6: **To your best knowledge, how long has each individual named in Question 1 been involved in food hub business or related organization?** *(Best approximation in years)*
	No	Maybe	Yes	
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

Question 7: **Which professional meetings or conferences related to food hubs did you attend over the past 12 months?** *(Check all that apply.)*

Meeting	**Attendance**
Great Lakes EXPO	
MI Farm to Institution Network Meeting	
MI Food Hub Network Meeting	
Michigan Food and Farming Systems Family Farms Conference	
Michigan Good Food Charter Communities/Meetings	
Michigan Food and Agriculture Summit	
Northern Michigan Small Farms Conference	
Other (please specify):	

Question 8: **Thinking about the professional meetings in Question 7, have you seen any of the individuals mentioned in Question 1 in any of these meetings you attended?**

	Yes, Several times in the past 12 months	Yes, Once in the past 12 months	No
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

Question 9: **How did you typically communicate with each of these individuals (Check all that apply.)**

	Face-to-Face	Phone	Text	E-mail	Social Media (Facebook/ LinkedIn/ etc.)	Video-conferencing (Skype/ Zoom/ etc.)	Other (please specify)
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							

Question 10: **For each of the individual mentioned in Question 1, please indicate those individuals from whom you *received advice.* This advice might have been for a food hub related problem or with a food hub related decision that you had to make alone or with others over the past 12 months. Also, please indicate the extent to which the advice was useful.** *(Filling this question out fully is very important for having complete answers!)*

	I did NOT receive advice from the individual; we simply had general professional conversation(s) about food hubs	**or I received advice & the advice was:**			
		Not at all useful	**Slightly useful**	**Useful**	**Very useful**
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

	Question 11: Please indicate whether or not **you provided each individual listed in Question 1 with an *advice*** about operating a food hub enterprise in the past?		Question 12: Please indicate whether or not **you provided each individual listed in Question 1 with an *advice* in other subject areas** (i.e., other than food hubs) in the past?		Question 13: Please indicate whether or not **you received any *advice* from each of the individuals listed in Question 1 prior to the past 12 months?**	
	YES	**NO**	**YES**	**NO**	**YES**	**NO**
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						

Question 14: **Thinking about each of the individuals listed in Question 1, from your perspective, what are their areas of expertise?** *(Check all that apply.)*

	Food safety	Operations management	Distribution	Customer relations	Producer networks/ Product sourcing	Human Resource Management	Funding	Other (please specify)
1.								
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								
10.								

Question 15: **Number of years you have been working in your food hub: _____**

Question 16: **Your age:**

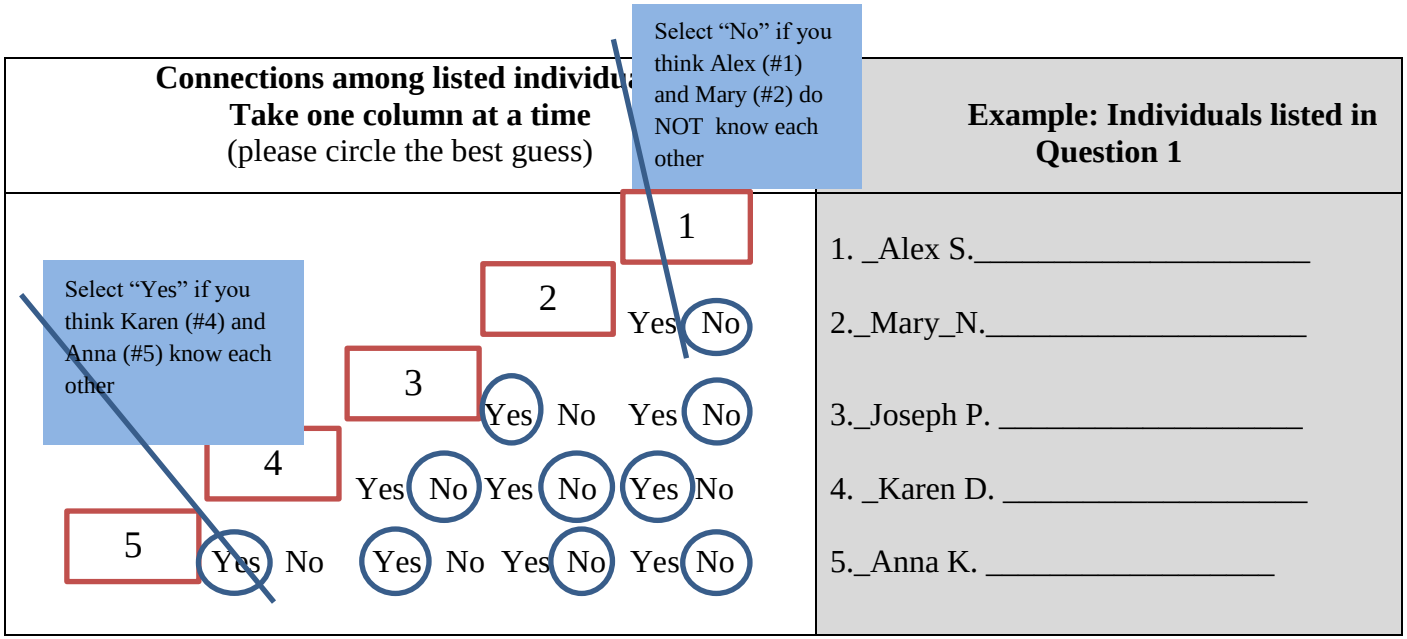
___ 18-25 ___26-35 ___36-45

___46-55 ___56-65 ___66 or older

Filling this question out fully is very important for having complete answers! Please be patient with us, and see an example below where it is explained how to easily fill out the answers!

To your best knowledge, please indicate whether or not the individuals named in Question 1 know each other (ex. you have seen them talking to each other)? Indicate each individual's connection with each of the other 8-10 individuals you have listed by circling Yes or No.

Here is an Example for how to fill out the answers:
To fill out the answers below, please take one column and row at a time.



Question 17: **To your best knowledge, please indicate whether or not the people named above know each other (e.g., you have seen them talking to each other, etc.)?** To fill out the answers below, please take one column and row at a time. Indicate each individual's connection with each of other 8-10 individuals you have listed by circling Yes or No.

Connections among listed individuals	**Take one column at a time** (please circle the best guess)									**Individuals You Listed in Question 1**
									1	1.
								2	Yes No	2.
							3	Yes No	Yes No	3.
						4	Yes No	Yes No	Yes No	4.
					5	Yes No	Yes No	Yes No	Yes No	5.
				6	Yes No	Yes No	Yes No	Yes No	Yes No	6.
			7	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	7.
		8	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	8.
	9	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	9.
10	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No	10.

APPENDIX 3C: Collinearity check and model selection

Table 3C.1: Collinearity check

	Model specifications with one variable at a time							
	(1)	(2)		(3)	(4)	(5)	(6)	(7)
	Strength of tie	Attendance in common meetings (met once)	Attendance in common meetings (met several times)	Alter's number of years in food hub or related org.	Transitivity (mutual ties)	Ego provided food hub-related advice to alter in the past	Ego provided advice to alter about other topics in the past	Alter's area of expertise in operations management
Estimate for intercept [std. error]	0.651 [0.616]	-0.006 [0.742]		0.601 [0.831]	0.857 [0.712]	0.198 [0.636]	0.728 [0.719]	-0.367 [0.710]
Estimate for the variable [std. error]	1.133 [0.458]	1.610 [1.098]	1.001 [0.857]	1.230 [0.625]	1.864 [0.591]	0.052 [0.691]	-0.352 [0.686]	2.391 [0.818]
P-value (intercept)	0.290	0.993		0.470	0.228	0.755	0.311	0.605
P-value (variable)	0.013 *	0.143	0.243	0.049 *	0.001 **	0.128	0.608	0.003 **

Note: ˙, *, **, and *** represent significance at 10, 5, 1, and 0.1 percent level respectively. The table reports standardized parameter estimates. Ego characterisitcs were treated as random effects.

Table 3C.2: Generalized linear mixed-effects regression results for fixed effects with alter's area of expertise

Model specifications with alter's area of expertise	Intercept	Strength of tie	Attend common meetings (met once)	Attend common meetings (met several times)	Alter's number of years in food hub or related org.	Transit. (mutual ties)	Ego provided food hub-related advice to alter in the past	Ego provided advice to alter about other topics in the past	Alter's area of expertise	Model measures
(1) Product sourcing/ producer networks									Product sourcing /producer networks	
Estimate	0.111	1.710	2.093	-0.789	-0.244	1.556	2.460	-0.717	2.505	
Std. error	0.817	0.643	1.496	1.206	0.507	0.602	0.948	0.944	1.048	
P-value	0.891	0.007 **	0.161	0.513	0.629	0.009 **	0.009 **	0.069 ·	0.016 *	
AIC										63.300
BIC										84.900
R-squared m										0.748
R-squared c										0.748
(2) Operations management (OM)									OM	
Estimate	-0.546	1.846	1.774	-0.090	0.045	1.739	2.914	-1.264	3.228	
Std. error	1.081	0.914	1.907	1.264	0.755	0.748	1.268	1.550	1.227	
P-value	0.613	0.043 *	0.352	0.942	0.952	0.020 *	0.021*	0.414	0.008 **	
AIC										58.400

Table 3C.2 (cont'd)

Model specifications with alter's area of expertise	Intercept	Strength of tie	Attend common meetings (met once)	Attend common meetings (met several times)	Alter's number of years in food hub or related org.	Transit. (mutual ties)	Ego provided food hub-related advice to alter in the past	Ego provided advice to alter about other topics in the past	Alter's area of expertise	Model measures
BIC										80.000
R-squared m										0.788
R-squared c										0.824
(3) Food safety									Product safety	
Estimate	0.135	1.055	1.334	0.439	0.403	1.644	1.821	-0.295	0.528	
Std. error	1.201	0.639	1.580	1.199	0.832	0.789	0.958	1.555	1.383	
P-value	0.910	0.098 ·	0.398	0.713	0.627	0.037 *	0.057 ·	0.849	0.702	
AIC										68.400
BIC										90.000
R-squared m										0.537
R-squared c										0.732
(4) Human resource management (HR)									HR	
Estimate	1.195	1.098	0.874	-0.139	0.530	1.661	2.123	-0.652	-1.725	
Std. error	1.389	0.684	1.537	1.335	0.837	0.793	1.089	1.429	1.055	
P-value	0.389	0.108	0.569	0.917	0.526	0.036 *	0.051 ·	0.648	0.102	
AIC										65.500
BIC										87.100
R-squared m										0.560

Table 3C.2 (cont'd)

Model specifications with alter's area of expertise	Intercept	Strength of tie	Attend common meetings (met once)	Attend common meetings (met several times)	Alter's number of years in food hub or related org.	Transit. (mutual ties)	Ego provided food hub-related advice to alter in the past	Ego provided advice to alter about other topics in the past	Alter's area of expertise	Model measures
R-squared c										0.773
(5) Funding									Funding	
Estimate	0.286	1.093	1.409	0.510	0.390	1.686	1.887	-0.276	-0.290	
Std. error	1.246	0.638	1.572	1.238	0.815	0.774	0.977	1.502	0.948	
P-value	0.759	0.086 ·	0.370	0.680	0.631	0.029 *	0.053 ·	0.853	0.759	
AIC										68.500
BIC										90.100
R-squared m										0.534
R-squared c										0.738
(6) Distribution									Distr.	
Estimate	0.173	1.329	1.231	-0.418	0.200	1.475	1.598	-0.588	2.022	
Std. error	1.110	0.714	1.552	1.321	0.733	0.723	1.001	1.452	1.222	
P-value	0.876	0.062 ·	0.427	0.751	0.784	0.041 *	0.110	0.685	0.098 ·	
AIC										65.500
BIC										87.100
R-squared m										0.591
R-squared c										0.731
(7) Customer relations									Customer relations	

Table 3C.2 (cont'd)

Model specifications with alter's area of expertise	Intercept	Strength of tie	Attend common meetings (met once)	Attend common meetings (met several times)	Alter's number of years in food hub or related org.	Transit. (mutual ties)	Ego provided food hub-related advice to alter in the past	Ego provided advice to alter about other topics in the past	Alter's area of expertise	Model measures
Estimate	-0.072	1.212	1.874	0.606	0.178	1.444	1.312	-0.850	1.388	
Std. error	1.183	0.729	1.585	1.258	0.742	0.718	0.994	1.729	0.982	
P-value	0.951	0.0964 ·	0.237	0.629	0.809	0.044 *	0.186	0.622	0.157	
AIC										66.600
BIC										88.200
R-squared m										0.582
R-squared c										0.700
(8) Other									Other	
Estimate	0.404	1.214	1.586	0.237	0.560	1.647	1.905	-0.051	-1.770	
Std. error	1.379	0.685	1.531	1.314	0.874	0.748	1.026	1.563	1.510	
P-value	0.769	0.0766 ·	0.300	0.856	0.521	0.027 *	0.063 ·	0.973	0.241	
AIC	67.000									67.000
BIC	88.500									88.500
R-squared m	0.504									0.504
R-squared c	0.775									0.775

Note: ·, *, **, and *** represent significance at 10, 5, 1, and 0.1 percent level respectively. The table reports standardized parameter estimates. Number of observations: 64. Ego characterisitcs were treated as random effects.

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CONCLUSION

The first paper of this dissertation examined key similarities and differences between different types of food hubs from the perspective of entrepreneurial processes by which they were formed. Based on the results of the comparative case study analysis, the study developed a new empirical framework of food hub models aimed to capture key similarities and differences in entrepreneurial processes in food hubs. The results showed that food hubs have a primary mission of creating social value or catalyzing social change by providing solutions to social problems in local communities through local foods. Social value is created by addressing the needs of small- and medium-sized farmers to access larger markets and rely on farming for their livelihoods, establishing scale-appropriate local and regional food infrastructure and food safety procedures, involving youth in farming, improving access to healthy food in local communities, preserving family farms, maintaining farm identity, and strengthening local and regional systems as a whole. This suggests that the social value proposition differs by food hub type. The nature of social value creation may be multifaceted or single depending on a particular case. Therefore, there is not a defined set of social mission goals food hubs aspire to. But social value creation is fundamentally rooted in meeting a need(s) or catalyzing social change in a local community, which has a ripple effect in the region.

Second, food hubs meet one or more of these social needs or catalyze social change in local communities by engaging in economic activity within the context of local and regional food markets. They actively pursue revenue-creation and capacity-building strategies to build economically viable enterprises. Economic value creation is an integral part of their strategy. Diversifying customer base, funding sources and strategies that align with food hub social value proposition are critical for food hub survival and growth.

Third, the key differences in food hub models stem from their legal business structure, the market they serve, level of involvement in the supply chain (e.g., only aggregation; aggregation and distribution, etc.) and the scale and scope of mobilized resources.

The results of the first paper have two main implications. First, the study helps to shed light on the ongoing debate among practitioners and researchers about whether food hubs primarily pursue a social mission, monetary goals, or both simultaneously. From the perspective of the existing and potentially emerging food hub practitioners, the empirical framework of food hub models developed in this study can serve as a tool for strategy development or refinement purposes such as developing and implementing scale-appropriate resource mobilization strategies, defining organizational boundaries, opportunity recognition, and achieving and maintaining strategic alignment with social value proposition. From the perspective of policymakers and other stakeholders interested in the advancement of food hubs, the study can serve as a resource to help develop scale-appropriate infrastructure, instruments, and resource allocation strategies to help food hubs achieve strategic alignment with food hub priorities. Finally, the study contributes to the emerging empirical literature on social entrepreneurship and food hubs where there is a huge gap.

The second paper systematically identified, assessed, and ranked food hub supply chain risks. Additionally, it examined the association between risk type and food hub characteristics as well as the association between assessed risk and risk attitudes of food hub managers. The results showed that the top ten risks are related to product quantity shortages, logistical delays, human resources and infrastructure capacity limitations. First, six of the top ten risks are related to product quantity shortages. Specifically, food hubs experience product quantity-related disruptions that stem from the supply-side (i.e., suppliers' own production capacity constraints

and high volatility of supply due to seasonality of production), internal processes (i.e., poor planning or forecasting due to reliance on a limited number of suppliers for a given product, and inadequate forecasting of demand by the hub), demand-side (i.e., unexpected or very volatile customer demand) and external environment (i.e., weather-related production issues). Five of these disruptions (except for high volatility of supply due to seasonality of production) were also perceived to be difficult to detect before they occur. The product quantity-related disruptions stem from all locations of the supply chain suggesting that an enhanced level of supply chain coordination with producers, customers, and internal processes would be needed to mitigate quantity-related shortages. For example, in cases when organizations face high supply-side and demand-side risks, some of the strategies found in literature include flexibility, postponement, visibility, transparency, multiple sourcing, flexible contracts, redundancy (inventory), and collaboration (Kilubi, 2016).

Second, two of the top ten risks are related to logistical arrangements. Specifically, one of the risks stems from the supply-side (i.e., product delivery delays by suppliers) and the second risk stems from the demand-side (i.e., customer delivery failures or delays). Both risks were also perceived to be difficult to detect before they occur. These risks are related to each other in a sense that if a producer delivers products late, it will affect to a large extent the food hub's ability to deliver products to customers on time. There could also be food hub internal capacity-related reasons for a customer delivery's delay or failure (e.g., shortage of transportation, product is not packaged/repackaged for delivery, etc.). This is where visibility, transparency, and collaboration strategies (Speier et al., 2011; Thun and Hoenig, 2011) might be helpful for food hubs. According to Rajesh et al. (2015), when the operations of two entities are well-coordinated,

supply-side risks are reduced. Additionally, improved capability of suppliers helps the continuity of supply.

Third, the results showed that food hubs experience disruptions in the physical flow of the products, which are related to human resources (i.e., underperformance of volunteers and employees) and infrastructure capacity limitations (i.e., poor food handling practices due to a lack of adequate infrastructure such as storage facilities). Both of these disruptions that stem from internal processes and control mechanisms. Example strategies for mitigating the risk of underperforming are scheduling 120 percent capacity for volunteers and integrating incentive programs for employees. The second risk, poor food handling practices due to a lack of adequate facilities and infrastructure, is a more complex issue, as it requires financial resources from the food hubs. To mitigate this risk, food hubs might need some support from external stakeholders to build capacity and significantly reduce this risk.

The study also examined association between food hub characteristics and risk type. The following factors were found to have statistically significant association with risks: (a) food business model regarding market focus (i.e., farm-to-business/institution, direct-to-consumer, and hybrid), (b) size in terms of annual gross sales, number of suppliers, and number of employees and volunteers, and (c) offering liability insurance services to suppliers.

First, the results showed that the business model of food hubs regarding its market focus—farm-to-business/institution, direct-to-consumer, and hybrid—is associated with supply-side, demand-side, and external risk. Specifically, food hubs working with only businesses/institutions face higher supply-side, demand-side, and external risk when compared with direct-to-consumer food hub models. Additionally, regarding supply-side and external risks, there were no statistically significant differences, either between hybrid and direct-to-consumer

models nor between hybrid and farm-to-business/institution models. However, hybrid food hubs perceive to face higher demand-side risk when compared with direct-to-consumer food hub models. These results have direct implications for market diversification strategies of food hubs. It might be beneficial for food hubs to structure their organization as a hybrid model not only for diversifying their customer base and expanding their reach for community food access considerations, but also in terms of being exposed to lower risk when compared to farm-to-business/institution models.

The results also showed that food hubs working with a greater number of suppliers perceive to face higher supply-side risk. Also, food hubs working with a greater number of employees/volunteers (marginally) perceive to face higher demand-side risk. Finally, food hubs having greater annual gross sales perceive to face higher demand-side risk. These findings suggest that growth in food hub operations in terms of gross sales, number of suppliers, and number of employees/volunteers implies higher supply chain risks. This, in turn, suggests that incorporating supply chain risk mitigation strategies into a food hub's growth strategy may be of critical importance for its long-run viability.

Third, food hubs offering liability insurance services to their suppliers perceive to face lower supply-side and internal risk when compared to the food hubs not offering these services. One explanation for this finding is that offering liability insurance services to suppliers, in essence, is a risk mitigation strategy. It mitigates the possible financial losses internally. This finding reinforces the importance of incorporating risk mitigation strategies into a food hub's core business strategy.

Finally, the results also showed that food hub managers' risk preferences did not play a role in their rating of supply-side, demand-side, and external risk. The results also suggested

food hub managers' risk preferences played a role in their food hub internal risk assessment. Specifically, more loss averse individuals tended to assign lower values for internal risk. Food hub managers also tended to disproportionately over weigh low probabilities of larger losses while assessing food hub internal risk. It is important to note that these results regarding risk preferences are not definitive as the regression specifications included only the parameters of risk preferences. Ideally, the parameters of risk preferences would have been included in the regression specification that also included other food hub specific variables as predictors of risk. However, due to sample size limitations, that is, only 44 observations with risk preferences, supply chain risks, and food hub characteristics (see Table 2.3), estimating such specification would not be possible. Therefore, the results of risk preferences are more explorative in this study than definitive. However, this is an important methodological step in terms of trying to incorporate risk preferences of individuals while collecting supply chain risk related data.

The findings suggest that incorporating risk mitigation strategies into food hub growth strategy is critical for their long-run vitality. While some disruptions may be more difficult to detect before they occur due to their inherent nature (e.g., quantity shortages due to weather-related production issues), others may be difficult to detect because of lack of appropriate risk mitigation mechanisms. These findings reinforce the importance of transparency and information sharing among food hubs and their suppliers and customers to balance demand and supply. Additionally, coordination mechanisms that would allow food hubs to effectively create practical worksheets and frequently share with suppliers and customers, for example. Additionally, some trainings for food hub managers related to strategies for balancing demand and supply might be beneficial.

The third paper examined food hub managers' advice networks. The results show that food hub managers' advice network members are individuals affiliated with various organizations. The top three organizational categories are universities/colleges/Extension, for-profit food businesses, and food hubs. Additionally, food hub managers perceived most of the advice received from network members as very useful; none of the received advice was characterized as not at all useful. The regression results showed that network, tie, and individual characteritics played a role in food hub managers' likelihood of receiving advice. First, as the number of mutual ties beteen the food hub manager and an alter in an egocentirc network increases, the likelihood of ego receiving advice from the alter increases. This may suggest that food hub managers who have networks in which people know each other are more effective in terms of receiving advice. Second, a tie-level characteristic that played a role in food hub managers' likelihood of receiving advice was the strength of the tie. Specifically, the stronger a tie between a food hub manager and an alter, the more likely it is the food hub manager would receive advice from the alter. Third, an alter-specific characteristic that played a role in food hub managers' likelihood of receiving advice was alter's area of expertise (perceived by egos) in operations management. This result reinforces the notion that operations management is a critical part of food hub operations and food hub managers received advice from individuals who were perceived as experts in this area. This also suggests that operations management is an area that food hub managers may need additional capacity building. Finally, the results show that if a food hub manager provided food hub-related advice to the alter in the past, the likelihood of food hub manger receiving advice about food hub-related topics from the alter increases. That is, advice-receiving about food hub-related topics is reciprocated. One possible explanation for this result could be that in the field of food hubs, there are no "defined experts" where the flow of the

advice is one-sided in most cases. Rather, these results might point to the reality that in the field of food hubs most people are learning from each other; therefore, advice about food hub-related topics is reciprocated.

The findings of the third paper have important implications for increasing the level of social capital—in this case advice—in food hub managers' professional networks as well as for designing or revising their networking strategies. As mentioned earlier, the formation, maintenance, and/or resoultion of network ties require resources such as human and financial capital (Monge and Contractor, 2003). Therefore, for food hub managers, part of the effective management of resources could be assessing their own food hub-related networks to be able to manage these networks effectively and efficiently. Also, organizations supporting food hub development initiatives may consider organizing specific one-on-one or small group sessions with/for food hub managers to allow sharing knowledge and expertise in specific topic areas regarding operating a food hub enterprise.

Thus, this dissertation has several main contributions to the field of food hubs and broader academic literature. First, this work provides evidence of systematic comparison of different food hub models and develops an *empirical framework of food hub models* to capture key similarities and differences in food hubs. It can be used as a tool to develop or analyze a food hub model in a given context. Since this is the first attempt in the field to model food hub entrepreneurial processes, future research can test this model by using a larger sample size of case study food hubs. It also adds to the empirical literature within the social entrepreneurship field where there is a call for more empirical work.

Second, this work is the first one in the field of food hubs to systematically identify and assess supply chain risks. It also adds to the empirical literature within the supply chain

management filed where there is a call for more empirical work. Effective supply chain risk management requires planning and investment. However, not investing in supply chain risk management can be more costly. The broader literature on supply chain risk management emphasizes that supply chain risks can be both harmful and costly. Therefore, identification, assessment, and ranking of supply chain risks are key steps in the supply chain management process for identifying high priority risks that would serve as a reference point for developing and implementing risk mitigation strategies for food hubs. The systematic risk identification, assessment, and ranking is important for increasing awareness among practitioners, policymakers, and other stakeholders about main risks faced by food hubs to help develop scale-appropriate risk mitigation strategies for food hubs.

Additionally, food hubs can use the risk identification and assessment framework and processes presented in this study to implement regular assessment of their own risks to revise, refine, and/or introduce new risk mitigation strategies in their food hubs. Regular assessment of risks in food hubs will also allow them to generate historical data that will help to enhance risk knowledge and management in their enterprises. It will also serve as a tool to monitor risks over time as the environment in which food hubs operate changes and new risks are presented. The risk identification and assessment framework and process presented in this study can also be customized in other organizational settings, such as food banks and other food-related organizations.

Finally, this dissertation is the first attempt in the field of food hubs to model and examine social capital in the form of advice in food hub managers' professional networks. It informs practitioners about the key factors that play a role in receiving advice in food hub managers' professional network. It also reinforces the importance of the professional networking

strategies in the field of food hubs based on the food hubs in Michigan. Future research can use this approach and test this model with a larger sample size of food hub managers, which would also allow including food hub manager-specific characteristics.