Effective Coordination in Regional Food Supply Chains

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Disciplines
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Effective Coordination in Regional Food Supply Chains

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Abstract

Regional food hubs help to promote social, economic, and environmental sustainability by helping small-scale farmers distribute food to regional customers. To satisfy the diverse requirements of their entire customer base, food hubs must often work with a large number of farmers, resulting in prohibitive transportation costs. However, if they limit their supply base, they risk gaps in their offerings. To address this challenge, food hubs that are located in the same region can coordinate with one another to increase their supply base and reduce fuel consumption through shared infrastructure. In this paper we assess the value of coordination among four Iowa food hubs by examining their logistics networks and their customers’ product preferences. By analyzing their sales data, we demonstrate how cross-listing different regional products can result in increased business opportunities for the food hubs and farmers, as well as providing customers with greater variety. We propose the implementation of a standardized inventory tracking mechanism, which will enable efficient and effective supply chain coordination among the food hubs.

Keywords
Local food, coordination, supply chain management, demand management, sustainability

1. Introduction

Consumer demand for regionally-produced food has grown significantly over the past decade, in response to consumers’ concerns about the serious environmental, social, and economic issues associated with conventional food distribution systems. Many consumers prefer to buy food that is produced in the region where they live, and they are often willing to pay higher prices for it [1]. By purchasing regionally-produced food, many consumers believe that they are contributing not only to their own health and well-being, but also to the welfare of their community. Regional food systems promote social sustainability by providing consumers the opportunity to connect with local producers, visit their farms, and learn about their farm stories [2]. They promote economic sustainability for small and mid-sized producers by valuing them as strategic business partners in the food supply chain and by providing them with fair trade opportunities. This is very different from conventional food systems, in which producers are often exploited by large-scale buyers and are forced to bear an unfair share of the risks [3]. Regional food systems also support environmental sustainability, by reducing transportation distances between producers and consumers and encouraging sustainable production methods [4].

A recent development in regional food systems is the addition of an intermediary to connect producers and consumers. Intermediated marketing channels provide producers with an alternative to farmers’ markets and other direct-to-consumer channels, which can potentially reduce their marketing and transportation costs [4]. One type of intermediated channel that has experienced tremendous recent growth in popularity is the regional food hub. The USDA defines a food hub as “a business or organization that actively manages the aggregation, distribution and marketing of source-identified food products primary from local and regional producers to strengthen their ability to satisfy wholesale, retail and institutional demand” [2]. Food hubs enable producers to access larger-volume markets and provide a single pick-up and drop-off point for food distribution. They can make regional food profitable for producers and affordable for consumers. However, on average, food hubs in the United States are not profitable. Difficulties in balancing demand and supply and high distribution and transportation costs have proven to be major challenges for food hubs [5]. One strategy for addressing these challenges is through the development of a collaborative network among multiple food hubs within a region. Coordination among a network of food hubs has
the potential to improve the quality of life of small and mid-sized producers by providing them access to larger markets, to enhance overall transportation efficiency by reducing the number of producer and food hub deliveries, and to provide consumers with convenient access to a greater variety of local and healthy food products.

Horizontal coordination via shared infrastructure can yield significant savings in transportation and warehousing costs, enabling participants to work together to create a more economical and sustainable transportation system [6, 7]. For example, a study of eight different food distribution companies in Uppsala City, Sweden, indicated that coordinating their deliveries could reduce the number of vehicles, number of routes, and total distance traveled by 42%, 58%, and 35%, respectively. These kinds of efficiency gains can significantly reduce environmental impacts, via decreased fossil fuel consumption and greenhouse gas emissions [8]. Therefore, organizations should place considerable importance on networking and building collaborative relationships [9]. Because regional food systems tend to be highly interdependent, a strategy of “coopetition” (i.e., cooperation with competitors) is often employed to expand markets and support prices. Faced with a challenging economic climate, many food hubs have taken a collaborative approach to logistics [10]. Utilizing existing infrastructure, sharing delivery routes, and developing shared IT platforms are examples of collaborative strategies that food hubs could use to improve the efficiency and effectiveness of their logistics systems [11,12]. For example, Driftless Organics, an organic vegetable farm in Wisconsin, has streamlined its distribution through its relationships with nearby farms and supply chain partners. Without these strategic partnerships, Driftless Organics would only be able to sell to markets that it could access efficiently on its own [13]. Full Circle, a food hub based in Seattle, works with two Northwest-based organic produce distributors to provide long-haul trucking, and it uses its own trucks and drivers for all local delivery services [14]. Although collaborations between regional food system participants can be beneficial, they should be carefully designed such that they do not hinder smooth and efficient operations [15]. It is important that all participants are honest and realistic about their schedules, and that they are able to balance available time with the work of maintaining and building the relationship [16]. Though coordination activities can increase food hubs’ operational efficiency, the resulting interdependence can make each participating food hub more vulnerable. Therefore, it may make sense to place coordinating food hubs under a single management structure [11].

This paper describes collaborative efforts that have developed among four food hubs in Iowa, including the problems associated with their current processes and potential methods of making these processes more effective and efficient. Through the application of industrial engineering methodologies, we will work to improve this non-traditional supply network, thereby improving the overall sustainability of the food system in Iowa.

2. Case Study
There are four food hubs involved in coordinated logistics efforts in Iowa. Each is located in a different region of the state, and they all have different business models. Food Hub 1 (FH1) is an online grocery store with a distribution center that is located in an urban area in eastern Iowa. This food hub sells products to consumers and wholesale customers. FH1 does not own a truck and relies on producers and customers to provide their own transportation. Food Hub 2 (FH2) also sells directly to consumers through a website, but it has no wholesale customers. It distributes food from an urban area in central Iowa, and it does not own a truck. Food Hub 3 (FH3) operates much differently than FH1 and FH2. It provides transportation services for local farmers, moving their products to restaurants, grocery stores, and other food hubs throughout Iowa via its refrigerated truck. FH3 also operates a warehouse in western Iowa and sells products to its own customers. Food Hub 4 (FH4) purchases food from local farmers and sells it to both wholesale customers and consumers. FH4 uses its own truck to transport products, and its warehouse is located in northeast Iowa. The mapped location of all four food hubs is shown in Figure 1.

![Figure 1: Location of four food hubs on the map of Iowa](image)
The four food hubs have not always coordinated with one another. The idea of coordination was motivated by a shortage of dairy producers in central Iowa, where FH2 is located. Most dairy producers in Iowa are located in the eastern region of the state, where FH1 and FH4 are located. In the summer of 2014, the manager of FH2, unable to efficiently fill his customers’ demand for dairy products, discussed the problem with the managers of FH1 and FH3. Although FH3 had at that time only been transporting food for farmers, the FH3 manager offered to incorporate FH2’s dairy products into her existing route from eastern Iowa to central Iowa. This coordination effort grew to include FH1, which volunteered to make temporary refrigerated storage space available for FH2’s dairy products, as well as other eastern Iowa products that were en route to FH2. This saved several eastern Iowa producers from having to make a trip to central Iowa to deliver their products to FH2.

The coordinated logistics effort started informally, and although it adheres to a regular schedule (operating biweekly), it remains mostly informal today. It begins on Tuesday, when FH4 drops off products at FH1 and central Iowa producers drop off products at FH2, for temporary storage. On Wednesday morning, FH3’s truck leaves western Iowa and heads toward FH2 in central Iowa. On the way to FH2, the truck stops at Producer 7 (P7) and picks up products that are destined for FH1, FH2, and FH3. At FH2, the truck picks up products for FH1 and FH3 and continues on to FH1, stopping at producer locations along the way to pick up more products. One of these stops is at the warehouse of Producer 10 (P10, an organic dairy producer), which acts as a cross-dock for FH3 and Producer 9 (P9, a conventional dairy producer) to exchange products. P10 provides this space in exchange for P9 backhauling its organic dairy products to FH4. The truck then arrives at FH1. During the FH1 stop, FH3 drops off products from western Iowa and picks up the products dropped off by eastern Iowa producers and FH4. FH3 then returns to central Iowa and makes a second stop at FH2, where the products from eastern Iowa are delivered. After this stop, the only products remaining on FH3’s truck are the products destined for its own warehouse in western Iowa, where it completes its journey. The movement of products through this coordinated network is shown in Figure 2. The producers have circles that correspond to the food hub(s) that they sell to. Each arrow represents the transportation of food to/from a food hub or a producer. The corresponding number above each arrow shows the order of events, and the brackets indicate which producers’ goods are being transported.

This coordinated logistics system has demonstrated the potential of shared warehousing and transportation for improving efficiency for all participants and increasing the volume of regionally-produced food that can be distributed throughout the state. However, as the participants seek to add more nodes (i.e., food hubs and producers) to their network, their inadequate physical and information infrastructures will present challenges. In particular, there is currently no formal platform to track the movement of products throughout the system. Communication between the food hubs typically occurs via informal means (i.e., phone calls and text messages). The absence of a systematic information-sharing mechanism in this coordinated system has already led to a number of problems. For example, labeling inconsistencies have caused FH3’s truck driver to pick up the wrong products during a stop. FH1 often unexpectedly receives volumes of refrigerated goods that exceed its storage capacity, which can have consequences for product quality and safety. FH2 has also begun to receive larger-than-expected volumes, and the manager has expressed concerns that the cross-docked items could be mistakenly comингled with the products it is storing for its own customers. This lack of structured information sharing has led to suboptimal system-wide logistics and frequent delivery errors. Additionally, the food hub managers lack a systematic method for allocating and tracking the costs of shared physical infrastructure and warehousing services, which is necessary for successful and sustained collaboration.

### 3. Recommended Approach
To address these challenges, we propose that the four food hubs implement an inventory tracking system through the use of a shared IT platform, using RFID or barcoding tools. This system will make inventory data available to all supply chain participants during transit and storage, providing visibility of shipments between food hubs and allowing for real-time updates on their locations. Giving the food hub managers’ information about inbound shipments with enough lead time for them to respond will help to alleviate problems involving insufficient temporary storage capacity. Using RFID or barcoding will improve the accuracy and speed of data capture, thereby requiring less labor from food hub employees. Additionally, having all food hubs and their producers use a consistent labeling scheme will help to ensure that the correct products and quantities are transported. The shared IT platform will enable the food hubs to accurately and fairly allocate transportation and storage costs, which will help them to maintain and grow the coordination effort with clear expectations of each participant.
Besides facilitating effective coordination among the four food hubs, the common IT platform will also allow coordinating hubs to share information about supply, demand, and product availability. Food hubs can use this information to support production planning with their producers and to facilitate the cross-listing of products among the food hubs. This will allow each food hub to offer their customers a wider variety of products. As an example of how this could work, a detailed analysis on the dairy sales of FH1 and FH2 was performed. According to the data on milk sales from May to September, dairy sales for FH2 have declined in 2015 as compared to that in 2014 (Figure 3). On average, only 48 gallons of milk were sold in each order cycle. Based on USDA data on per capita milk consumption, the potential sales of milk in an order cycle for FH2 is around 329 gallons. The manager of FH2 was concerned about this and suspected that offering organic milk might increase sales. However, this would require that FH2 begin purchasing milk from FH1’s organic producer (P10), and the manager was concerned that this could damage his relationship with his current producer, P9. This is a serious concern for FH2, which currently relies on P9 as its sole supplier of fluid milk.

To help the FH2 manager make a data-driven decision, a comparative analysis of dairy sales data for FH1 (which offers organic and conventional milk) was performed for 30 order cycles between June 2014 and October 2015. The statistical analysis (summarized in Figure 4) indicates that organic milk is preferred over regular milk by the customers of FH1. This suggests to the manager of FH2 that offering organic dairy products from P10 could be a good strategy for satisfying his customers and increasing sales. This will also eliminate FH2’s complete dependency on P9 for their entire milk supply. However, the manager has no way of knowing how much volume he can sell, and organic milk is both perishable and expensive. To mitigate the risks of carrying insufficient or too much inventory, FH1 and FH2 are now considering pooling their organic milk inventory and cross-listing it through a shared IT platform.

The effectiveness of the proposed coordination mechanism will be evaluated by determining the return on investment of the shared IT platform and the RFID or barcoding system. The proposed system will facilitate movement of greater food volumes between the food hubs due to cross-listing of products among each other, result in fewer errors in coordination with respect to delivery of wrong products, and increase customer participation due to fewer errors in customer orders and product variety being offered at individual hubs. The system will also enable faster and more efficient communication between the food hubs and will decrease the food hub’s dependency on manual labor due to reduced number of steps and time required to perform the tasks.
4. Anticipated Challenges
Although the proposed coordination mechanism will benefit the producers, food hubs, and their customers, there are several anticipated challenges. The most apparent limitation of the proposed solution is the cost of developing and implementing the inventory tracking system and the shared IT platform. Since the food hubs already struggle to make a profit, such costs can be prohibitive. IT platforms are particularly expensive upfront and require maintenance for continued use. To use RFID or barcoding technologies, the food hubs will require scanning and labeling equipment, which is yet another expense. Also, because the business models of the participating food hubs are distinct, it will be difficult to develop a single IT system that can address all of their operational issues adequately. Another significant challenge with the implementation of a shared system relates to the involvement of the food hub managers and employees in consistently using and updating the inventory tracking system. Once the food hubs begin using the system, they all must continue to actively participate. If one food hub stops using the system, the inventory information on the IT platform will become inaccurate, which spoils the overall coordination efficiency as the information becomes unusable for the participating food hubs.

The use of a shared inventory management system is common in conventional supply chains, where large corporate retailers connect their stores through a single tracking system. However, the four Iowa food hubs are not owned by an umbrella organization – they are autonomous business entities. Right now, the food hubs are not directly competing for customers, since their delivery regions are fairly small and do not overlap. However, as coordinated logistics increases the distribution radius of each food hub, this may change. For example, FH1 and FH4 are both located in eastern Iowa. FH1 has customer pickup locations in two eastern Iowa cities, and FH4 delivers consumer food boxes to these cities. Since many consumers in eastern Iowa have equal access to both hubs, it can create a competitive environment instead of a collaborative one. Similarly, cross-listing products among the food hubs can lead to competition among the producers and could potentially affect their sales. For example, if FH2 adds the organic milk from P10, the sales of conventional producer P9 could decrease. This might lead to producers’ ending their participation with the food hubs because of inadequate sales. Placing all participating producers and food hubs under one management structure would not only streamline the coordination process but could potentially reduce the problem of competition among them. However, this will also reduce producer and food hub autonomy, which is problematic since farmers and food hub managers typically value their independence very highly [17].
5. Conclusion
In this paper we have shown how horizontal coordination among regional food hubs could help them better meet demand for sustainably-produced food while reducing their overall costs, fossil fuel consumption, and greenhouse gas emissions associated with transportation. Coordination between the food hubs will not only impact their own profits, but it also has the potential to improve economic sustainability and quality of life for small and mid-sized food producers in Iowa, by enabling them to reach new customers and reducing the amount of time that they must spend on making deliveries. Although coordination via a shared inventory management system is quite common in conventional supply chains, it is almost unheard of in regional food systems, and effective implementation will require overcoming multiple financial, technical, and cultural barriers. Implementing a shared inventory management system will facilitate cross-listing of products among food hubs, transparency of inventory flow during transit and storage, vehicle scheduling, and fair cost allocation among the participating food hubs. Employing a RFID or barcoding system will be an efficient way to capture the inventory data, instead of relying on manual entries by each food hub manager. Future work will include developing the proposed IT platform and cost allocation mechanism to be used as a pilot study with the four food hubs.

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References