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Supply Chain Control Principles in Local Food Production: A Norwegian Case Study

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ABSTRACT

Based on an analysis of the supply chain of four producers of local specialty foods, we explore how planning and control principles can be applied to align supply chain capabilities and market requirements. It has been shown that local food struggles with market access, and that the supply chain is one of the obstacles preventing local food producers from gaining a solid market position. We identify a number of features of the local food chain, analyse the obstacles and develop generic designs and control principles for local food producers.

Keywords: Local food production; Norwegian food artisans; Supply chain design; Control principles

1 Introduction

Local food has gained significant market interest. By offering high-quality food products, local food producers have managed to create a niche in the traditional food sector and to widen the sector's product range and diversity (Hingley et al., 2010; Visser et al., 2013). Local food based on milk, fish, shellfish, meat, fruit and berries often includes specialty features, either from the raw material itself, its origin, or from the processing method. The processing method is often artisan and manual; the food is produced in small quantities and delivered in close to "one-of-a-kind" batches to different categories of customers. Several terms are used when addressing these products such as specialty foods, local food or small-scale food (Ilbery and Maye, 2006; Abatekassa and Peterson, 2011; Pearson et al., 2011; Duram and Cawley, 2012). Here, we use the term "local food" as the joint term for products that typically are produced in small-scale production facilities, with a specific recipe, production processes based on craftsmanship and where raw materials and final products have a specific quality and uniqueness that add value.

Despite the growing market interest, local food producers find it difficult to access the market. Bringing products into the market and, in particular, the distribution of local food has been identified as a challenge (Abatekassa and Peterson, 2011; Visser et al., 2013; Kvam and Magnus, 2014). Local producers tend to perceive traditional market channels such as retailers and food service as less profitable (Hingley et al., 2010) and many producers prefer to sell their products through alternative market channels such as farmer markets, co-operatives, farm outlets and local food schemes. Local food that is sold, for example, through retailers have to compete in an industrialised market arena where industrial actors have turned into a highly efficiently and powerful systems by adapting to volume and low cost as competitive strategies. In the industrial food chain, production facilities, warehouses and inventories, terminals and transport networks have all been designed and developed according to efficiency criteria based on volume benefits where cost, time and availability are the primary performance indicators. Given the artisan and small scale features of local food production, the producers must compete on different criteria than the industrial players do. Small-scale producers also cannot compete with well-recognized brands, high demand and turnover, or a solid logistical infrastructure. The competitiveness of local food producers needs to be found elsewhere such as in the products, location or production processes.

In order to succeed in the market, a company's competitive features (the customers' requirements) and the supply chain strategy need to be aligned (Chopra and Meindl, 2013). For local food producers, this means that the competitive features should be reflected in the way that the supply chain is planned and controlled (Hingley et al., 2010). In this paper, we argue that the reason why distribution is a challenging task for local food producers is the misalignment in how local food products are controlled in the supply chain and the way local food products should be controlled according to the market requirements. The aim of this study is to analyse the supply chain of local food producers in order to propose ways to control the supply chain of local food products. The main contributions include a description of the planning and control models of the case companies and propositions of how the control models could be developed in order to be aligned with the market requirements. Furthermore, the study gives managerial insights into the local food sector by investigating the features of the existing practices and how these features could be altered in order to strengthen the position of local food producers.

The following sections present an analytical framework on planning and control. The methodology is presented in Section 3 and the paper presents four case studies of local food supply chains in Section 4. The data are analysed in Section 5 and discussed in Section 6 before a set of supply chain design and control principles are developed in Section 7. The conclusions follow in Section 8.

2 The planning and control model analytical framework

In general, the supply chain of food consists of agricultural and primary production, processing and production of raw material, and the delivering and selling the products through intermediates, retailers or food services (Romsdal, 2014). Compared to other industries, the food sector faces specific characteristics, which impact the supply chain and the planning and control of the operations (Entrup 2005; Shukla and Jharkaharia, 2013; Ivert et al., 2014). Seasonality and long throughput times of raw materials, among other aspects, lead to a risk of imbalances in demand and supply (Aramyan et al., 2007). In addition, the perishability of raw materials, intermediates, and final products constrains possibilities of storage (Van der Vorst, 2000). Moreover, the food production process is designed for economy of scale, which is in conflict with the requirements emanating from trends of increased product variety and demand uncertainty (Nakhla, 1995; Romsdal et al., 2014).

It is the localness of the production, the artisan production, the size and the uniqueness of the products that separates specialty foods from the more conventional and industrial-made products. While the traditional market channels for specialty foods have been farm stores, farmer markets and local food schemes, the trend now is to sell specialty foods in retail stores, hotels, restaurants and other food service channels (Ilbery and Maye, 2006). The producers of specialty foods see the potential of selling their products through these channels because of broader market access in wider geographical areas that will increase the volume of sales. From the market point of view the retailers, restaurants and hotels see this product segment as attractive because it broadens the product range with a set of products that is demanded by consumers. In order to be a supplier, retailers require that the suppliers fit into their supply chain, which is highly industrialised and characterised by scale benefits, consolidation of product flows, high turnover and rotation speed, and availability and high service levels. A small producer of specialty foods, which lacks the volume needed to gain scale benefits, will find it difficult to adapt to the premises set in the industrialised food supply chains (Martikainen et al., 2013). The problem for the specialty producer becomes how to plan and control the supply chain so that the product successfully can enter the market, which relates to the challenge of configuring and defining the right supply chain (Fisher, 1997; Naylor et al., 1999; Mason-Jones et al., 2000).

Given the features of the traditional food supply chain and the need for the suppliers to offer a high service level at a low cost level in order to meet market requirements, the main strategy in food production is to produce to stock (make-to-stock; MTS) based on forecasted expectation of demand and market trends (Entrup, 2005; Ivert et al., 2014). There is a push of raw materials and products all the way from the agricultural step to where the supply chain meets the end customer (Romsdal, 2014). The raw materials must be harvested and processed when they are mature, and they must be consumed within a given time frame. Customers such as retailers and food service companies replenish products based on forecasted and actual sales in stores. The wholesaler buy large quantities based on forecasted sales in stores, while each store replenished based on actual sale in store and keep only a minimum stock level as a security for variable demand. The supply chain control model is a typical MTS (producer and wholesaler) and make-to-order (MTO) from the wholesaler to the store. Products are buffered at several stages in the supply chain.

In order to analyse how the local food supply chain is designed and controlled, we apply the control model framework, which is a methodology for analysing manufacturing and supply chains (Strandhagen et al., 2010). From the perspective of product, market and production process characteristics, the control model framework provides a structured way to define the customer-order decoupling point (CODP), control principles and control areas, as well as more detailed and specific planning and control issues. The control model framework stems from the manufacturing planning and control literature and is deeply rooted in the production models for planning and control of materials, resources and capacity such as in material requirements planning (Jacobs et al., 2011). The control model framework adapts the conceptual thinking of Toyota production system and Flow-oriented Manufacturing of the early 1980s (Jacobs et al., 2011). A basic tenant of the control model framework is that every system (production unit or supply chain) has an operations platform or configuration that specifies *how, when* and *where* products and information should flow. This configuration is the specification of the control principles. The performance of the model should be measurable and important indicators are throughput time and lead time, stock level and work in progress, service level and cost. A high-performing model is one that is aligned with the competitive strategy and that is characterised by a short throughput time, a small amount of work in progress, distinct areas of responsibility, uniform material flow and flexibility (Alfnes and Strandhagen, 2000).

The configuration and the control principles are context dependent, which means that the specific characteristics of the system that determine how the model should be composed, the overall control strategy and the various control principles (Alfnes, 2005). The location of the CODP is the key decision followed by selecting between MTS, make to order (MTO) and assembly to order (ATO) strategies. The lower-level control principles such as the decision of the signals trigger actions such as serving an order, production start, stock replenishment and delivery frequency. When analysing a system using the control model framework, the following key characteristics should be mapped (Strandhagen et al., 2011) (Table 1):

Table 1.
Key characteristic of a supply chain control model (Strandhagen et al., 2011)

Characteristics	**Description**
Product	The product features such as quantity, value, level of uniqueness, perishability and variety
Market	The type of customers and customer categories, customer requirements (order fill rate, availability, order lead time), demand variability, seasonality, geographical location and type of demand information exchanged
Distribution	The configuration of the distribution channels; direct sale to customers or through intermediates, delivery time, delivery frequency, dispatch principle
Production	The production strategy (MTS or MTO), production frequency, planning and control principles, CODP, type of production process, level of automation, flexibilities, capacities, bottlenecks, level of buffers, type of planning information, frequency of supply

Additionally, the type of company and size, the main function and processes, the order qualifying and winning criteria and the current performance (delivery, lead time, delivery frequency, stock level) level should be studied (Strandhagen et al., 2011). The content of the control models developed is illustrated by the case model discussed in Section 5.

3 Research methodology

We aim to explore the supply chain control model of locally produced specialty foods. Since no theoretical concepts or frameworks exist that can suggest solutions to the phenomenon, the correct research strategy is early theory building through exploratory multiple case studies (Yin, 2014; Eisenhardt, 1989). The case study answers the “how” and “why” questions (Yin, 2014), while a design science approach have been used to propose a To-Be control model (Holmström et al., 2010). Design science focuses on the creation of propositions and suggestions of how problems can be solved and is suitable for exploring and explaining emerging operations and management practices. In this study, the approach is appropriate because our aim is not only to understand how the supply chain currently is controlled but also to propose how the supply chain could be controlled. Access to detailed knowledge through several case studies was necessary in order to obtain in-depth knowledge of the phenomenon in different contexts (Barratt, 2011). The case study described here has been accompanied by a literature study, which contributed by identifying the key characteristics that should be analysed.

The case environment is the region of Mid-Norway, which is a large food-producing region. The number of small- and medium-size food producers in the region is about 150 ("Handlingsplan for lokale matspesialiteter for Trøndelag," 2012-2015). Four cases of specialty foods (producers (the focal company) and the main supply chain partners and customers) in this region were selected in this study. First, in order to analyse the producers, we decided to study comparable producers with respect to size, rural location, level of value added to the products (processing of raw material must be one of the main processes in the company) and customer categories. We also made sure that the span regarding product shelf life, geographical market and type of distribution channels is present. Even if one of the cases is a food hub, the individual producers in the hub are similar to the other producers. Second, the majority of the producers of specialty foods in Norway are small- to micro-sized companies and we decided to focus on companies with fewer than 10 employees since these companies represent the largest population. Third, what the customer selected should be within the retailer, restaurant and hotel segment and the companies selected should be the ones who have direct contact with the specialty food suppliers. The cases are presented in Section 4.

In accordance with Yin (2014), an interview guide was designed and used during the data collection (see interview guide in appendix 1). Since several researchers were involved in the study, the guide helped to ensure that all of the researchers had the same understanding of the basic concepts, terminology and issues. Facts and findings about the companies were collected before the case visit. The visits resulted in two types of data: explanation and observations of the main activities and operations, and quantitative and qualitative interview data and other documents from the companies. In each case we interviewed several companies in the supply chain. In the mussels case we did 2 interviews at the producer. In the cheese case we interviewed 2 people at the producer and one at the distributor. In the food hub we interviewed 5 producers and 2 people in the hub company. The distributor used in this case is the same as in the cheese case and we did one interview and several discussions and meetings with this distributor. In the meat case we interviewed 2 people. All together we interviewed 5 of the producers customers (stores, restaurants and hotels).

The interviews were conducted with key personnel, such as a CEO, sales and operations manager, store manager, and the distribution manager. Each interview lasted from 2–4 hours. These interviews were supplemented with reviews of archival data (such as blueprints and PowerPoint presentations), annual reports, and visits to the production sites. Between two and four researchers were present at each visit. The interviews were recorded and notes were taken during the interviews. Directly after the visit, the interview was documented and summarised by the researchers before being sent to each company for approval and verification (Yin, 2014).

The case analysis procedures followed the qualitative data analysis procedures described in grounded theory (Miles and Huberman, 1984) and have helped us to understand the nature of the individual cases, but also the variety among the supply chains (Eisenhardt, 1989). The characteristics of the current supply chain control models have been presented and discussed in workshops with the case companies. This methodology helped us to specify the existing control principles and strengthen the quality of the findings. This technique has furthermore provided the input for proposing new supply chain control principles. The procedure used for formulating the new control principles is Context-Intervention-Mechanism-Outcome (CIMO), logic as proposed by Denyer et al. (2008). The CIMO logic instructs how to make the design propositions and the recipe follows the format "if you want to achieve outcome O in context C, then use intervention I." The intervention is how to solve the problem in question, but the intervention needs to be combined with mechanisms that will generate the outcome. The CIMO logic was operationalised as follows: first, we determined that a local food supply chain's ability to respond to the market requirements (Context) can be strengthened (Outcome) by designing new supply chain control principles (Intervention) that decides how, when and where products should flow (Mechanism).

4 Local food producers

An overview of the cases is given in Appendix 2. The **mussels case** is a small producer of living mussels, which is a high-quality fresh product that needs to be kept alive before cooking. Value is added to the product through the specific breeding method and the water conditions. The customers are a few specialty food wholesalers, who resell the product to high-end stores and restaurants. Demand varies with a peak season in the summer. Production process includes harvesting, cleaning, sorting and packing. Forecasts decide the harvesting; the rest of the operations are initiated by customer orders. After harvesting, the mussels are put into re-watering tanks where they can be kept alive for up to two days. Orders are packed from these tanks and shipped on the same day. A freight provider delivers the shipment to a regional transit cross-docking terminal for the final shipment to customers. The challenge in this case is to being able to maintain a high-quality and shelf-stable product throughout the supply chain. The producer sees these challenges as problems caused by the short product shelf life and a mismatch between the volumes purchased by the intermediates and the end-customer demand.

The ***cheese case*** is a small producer of award-winning quality cheese. It is the quality of the raw material, the recipe and the production methods that add value to the products. The customers are a range of selected fine restaurant and stores. Production is initiated from the availability of sufficient quality milk combined with forecasted demand of the different varieties. Dependent on availability of mature cheeses, orders are picked from stock and shipped based on the requested delivery date. Distribution services are sourced from a diary distributor and the products are shipped within a national transport and terminal network directly to customer. The problems identified in this case are the length of the delivery time to national customers and the lack of information regarding the shipment and what the customer's future demand will be. The delivery time can be over one week to some locations, which reduces the time left to sell the product in stores before the cheese's shelf life expires. Additionally, the lack of demand and stock level information restrict the planning flexibility and service level of the producer.

The ***meat case*** is a small producer of quality mutton and venison. Venison is produced from farmed and hunted deer. Mutton is made from a special Norwegian breed of sheep. The producer slaughter and butcher the animals. The availability of animals is highly seasonal and fresh products are sold only within the season and the local region. Venison is mostly sold frozen while mutton is salted, cured and smoked according to a specific recipe. It is the quality of the raw materials and the production processes that adds value to the products. The products are sold fresh, dried or frozen to a broad range of customers such as retailers, restaurants and private consumers. Products also are sold directly to a retailer and is mainly used as an outlet for the meat left on the deer when the fillets and steaks are removed. This is sold in thin frozen slices. Most of the products are shipped within the local area. The demand varies and is highly seasonal. Production is limited by the availability of animals. Thus the stocks of finished products are built up within the season based on forecasts and plans. The rest of the year customer orders are picked from the inventory of finished goods subject to availability. The delivery time is at most one week, the frequency is quite flexible and the company often delivers the products themselves due to the lack of transport alternatives. If the company was to buy regular transport services, they presume that the total cost would be too high and that the service level would diminish.

The ***food hub case*** consists of a set of small local food producers and a hub company that sells and consolidates a range of high-quality products, which are fresh, frozen, or preserved. Value is added by the quality of the raw materials, the production processes, the recipes and the geographical and cultural conditions of the region. All products are labelled and sold under a common product brand, but with the identity of the producer added. The customers are local, regional and national retailers, restaurants and hotels. Demand varies and most products are seasonal. Products are produced to stock and are delivered by the producer once a week to the consolidation hub for storing and dispatching. Customer orders are served from the hub. Distribution is operated by a national distributor, which collects at the hub 2-3 times per week. The delivery time varies depending on the location of the customer. Several challenges are identified in this case. First, due to the distribution network, the delivery time to national customers are too long. Second, some of the dispatches are a mix of chilled and frozen products and few distributors can actually operate such a service with small volumes. Third, in order to provide a high service level (availability) and short order lead time, the hub sees the need for having better control of its stock level, incoming orders and future demand and knowing more precisely what, when and how much the producers will supply.

5 Analysis and thoughts on the current supply chain strategy

The characteristics of the planning and control characteristics in the cases are summarised in Table 2.

Table 2.
Characteristics of the case companies

Variable	Aspect	Characteristics
Product	Quantity	Low number of items per order (mussels, cheese and meat), medium order size (food hub)
	Uniqueness	High price, high value, restricted shelf-life and temperature restrictions (all cases)
	Perishability	Varies between very short shelf-life (mussels, food hub), medium (cheese) to long shelf life (meat and food hub)
	Variety	Low number of stock-keeping units, SKUs (mussels and cheese), medium number of SKUs (food hub and meat)
Market	Customer	Products are sold to retailers (cheese, meat, food hub), intermediates (mussels), food service (cheese, meat and food hub) and private (all)
	Geographical distance	Local (all), regional (all) and national (cheese, food hub and mussels)
	Service level	Retailers require a high service level (over 97%) (availability, delivery time/frequency, product range). Food service customers also have high service level demand, but they are more flexible than the retailers
	Demand uncertainty	High level of uncertainty (all cases) and seasonal demand pattern (all cases)
Distribution	Distribution model	Direct to customer through a freight forwarder (mussels), to customer through distributor (cheese and food hub) and direct to customer through own transport (meat)
	Lead time	Long lead time (mussels, meat and cheese), medium (meat)
Production	Production strategy	MTS (cheese, meat and food hub), pack on order (mussels). Production is initiated on forecast in all cases. CODP in finished goods inventory (cheese, meat and food hub) and CODP in packing lines (mussels)
	Size and capacity	All cases have a small volume capacity
	Demand information	Only orders are exchanged among the producer, customer and distribution service provider (all cases). No exchange of plans, forecast, stock level or demand variation

Table 2 shows that the products are mainly produced to stock. The exception is the mussels producer, where the final stage of production is made to order. All producers plan production based on historical sales information and expectation of incoming orders. The size and frequency of incoming orders vary and information about future demand is rarely exchanged between the producers and the customers. Orders are dispatched from stock and the lead time is largely affected by the delivery frequency and the choice of consolidating volumes and the structure of the logistics service providers distribution model. Only the meat producer delivers products directly to the customer. The customers require a service level above 97%, with the order fill rate being the most important service. Figure 1 summarises the cases of a local food producer in a generic current state, AS-IS, control model (

Figure 1). HORECA (hotel/restaurant/café) refers to the food service industry.

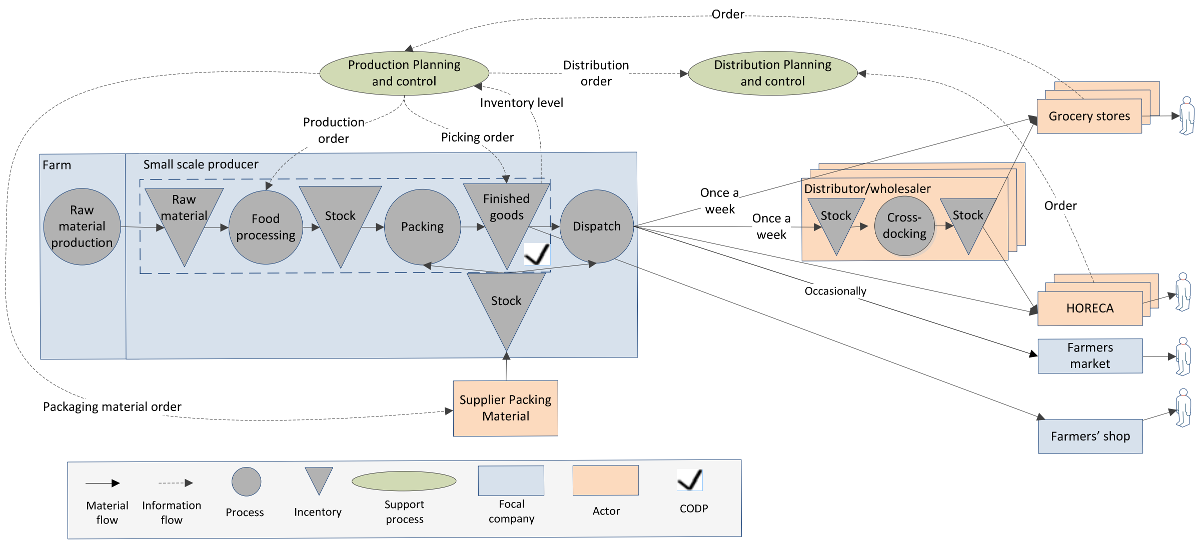

Figure 1. Generic AS-IS control model for small-scale food producers

There are several aspects related to the current ways of designing and controlling the supply chain that deserve reflection.

First, the low volume and capacity restrictions have a significant impact on the control principles, and the local food producers try to adapt to the scale principles of the industrialised food chain. This fact can be seen in the ways that deliveries, frequencies and distribution services are consolidated. Orders are mainly accumulated during the week and shipped once or maybe twice a week. For customers that are located very close to the supplier, deliveries can be arranged more frequently, such as in the services offered in the meat case.

Second, the main production and operations strategy is MTS, which, together with capacity limitations, restricts the flexibility in the system. The CODP typically occurs at the inventory of finished goods, which means that the connection between customer orders and individual products is made at this stage in the supply chain. This affects the responsiveness of the local food producers and the length of the lead time.

Third, the producer manages the production with limited insight into the demand situation. Except from orders, there is no exchange of demand-related information such as plans, forecast, stock level, or demand changes between the producer and the customers. This fact has implications for the planning and control of production and sales since forecasts are based on historical sales data combined with intuition and previous experience. It is difficult to capture changes in demand when information is not shared in the supply chain. This situation is of special importance for the case companies since their demand varies.

Fourth, the supply chain operations are controlled separately without considering the trade-offs among parameters such as demand, delivery frequency, stock-level and delivery time, transport and cost. This fact affects the product throughput time, the product quality, the volume of products being wasted and makes it difficult for the producers to realise the real product demand. Additionally, the level of collaboration (horizontally and vertically) in order to reduce the scale limitations in the supply chain is limited. This fact is especially evident for transport and access to physical distribution services. Since each producer sources transport individually, the terms and conditions achieved are poor regarding availability, price level and frequency.

Fifth, the principle of "one size fits all" is the dominant operations model for the production and supply chain. We did not determine that any of the producers differentiated based on product or customer in the ways that they operated their production. Despite this fact, the market approach is broad (all types of customer segments and geographical regions) and is not precisely defined regarding how to fulfil the market requirements. The customer segments in the study have different service requirements. Retailers are preferred because of their long-term contracts and volume. However, retailers are also the most demanding and the ones with the most concerns regarding the service level provided by the local producers. For the retailers, availability, product range and delivery frequency are extremely important; restaurants are more flexible regarding availability but not on product quality.

6 What's the right supply chain for specialty foods?

This section discusses the features of the current control models in the cases and relates these features to supply chain planning and control theory. Emphasis is placed on the pull and push strategies, the level of efficiency versus responsiveness in meeting customer requirements, the aspects of differentiation and different market aspects, and the level of integration and collaboration in the supply chain.

Efficiency versus responsiveness configuration principles**:** Looking at the characteristics of the local food system, the environment can be thought as a responsive supply chain strategy (Fisher, 1997), with its variable and unpredictable demand, and the added high-value and high-quality specialty features (innovative products) (Chopra and Meindl, 2013). Responsiveness is the ability to react on request and, in particular, the speed with which a supply chain can adjust its outputs to an external request such as a customer order (Reichhart and Holweg, 2007). Responsiveness is characterised by short time-to-market, the ability to scale up (or down) quickly and the rapid incorporation of consumer preferences into the design process (Christopher et al., 2004). Considering the producers' actual situation, what they do is to adapt into an efficiency supply chain configuration scheme defined and designed by the industrial food actors. The efficiency configuration is suited for high volume, stable demand, repetitive operations, and economics of scale benefits, which is hardly the case for local food producers. According to Hingley et al. (2010), this disjoint should not be considered to be a disadvantage but instead a change to a profitable differential. Thus, given the characteristics of the volatile demand, specialty and perishable products, and customers that request high levels of service, the creation of responsive supply chains is the key to survival in turbulent and volatile markets where shortened life-cycles and global economic and competitive forces create additional uncertainty (Christopher, 2000).

Pull versus push control principles: Specialty foods are produced based on planned sale and MTS schemes, and orders are dispatched from stock. This situation represents a typical push system, which leaves little room for flexibility and responsiveness regarding customer requirements and internal needs for more flexibility in production and inventory. Push systems are typically preferred in situations where demand is stable and economics of scale benefits could be gained. Given the characteristics of the local production system, the system is better aligned with a pull system where operations are based on customer orders and driven by demand. For local food producers, given the restrictions in production capacity and the long production lead times, a combination of push and pull principles could be applied in order to be both efficient and responsive (Simchi-Levi et al., 2008). The CODP, where the product is connected to a specific order, could either be in the production before the quality level is decided, according to customer request, or later in the supply chain and closer to the customer (Olhager, 2010). Rather than focusing primarily on speed or cost, best-value supply chains are designed to deliver superior total value to the customer in terms of speed, cost, quality and flexibility (Ketchen et al., 2008).

Differentiation criteria: The food producers apply the "one size fits all model" where products, shipments and customers all follow the same routes and are controlled by the same principles, even if they have different characteristics in terms of value, shelf life, order volume and demand pattern, requests by different customers, etc. Aitken et al. (2005) argue that supply chains should be designed differently and specify the model for how flow segments should be controlled based on the specific product/market context. One supply chain can thus consist of a number of different flows, each with the aim of achieving higher levels of responsiveness to the different needs of the customer. The CODP plays a key role in differentiating supply chain operations, by ensuring a distinct decoupling of the operations upstream and downstream of the CODP, the boundary between MTO and MTS (Olhager, 2010).

Integration and collaboration**:** The operations in the local food supply chain are disintegrated (vertically and horizontally) and each echelon is separately controlled based on signals from the next or previous echelon. This methodology weakens the position of the producers and makes them vulnerable in terms of operating a small-volume system and meeting service requirements. Integration, both information and material flow, is strongly connected to operational and business performance, and internal and customer integration are more strongly related to improving performance than supplier integration (Flynn et al., 2010; Prajogo and Olhager, 2012). For local food producers, two aspects are of vital importance: collaboration and information sharing (Abatekassa and Peterson, 2011). These aspects are important in order to compensate for scale benefits and for providing high customer service.

Only in the food hub case did we find that integration and collaboration were used to consolidate products for dispatching. Several collaboration concepts on the fast moving consumer goods sector, for example, vendor-managed inventory (VMI) and collaborative planning, forecasting and replenishment initiatives have emerged during the last decades. The basic principles of the models are to integrate and make processes and operations seamless in order to reduce lead time, inventory level, cost, etc. The models build on process and procedure alignment and require a stable and long-term partnership. There are several variants of how supply chain members can collaborate on planning and inventory including, for instance, information exchange, VMI and synchronized supply (Holweg et al., 2005).

Except for the orders and order confirmation, there is no regular exchange of demand information with regard to quantity and types of products that will be produced, stock level and customer demand, and expected demand and planned ordering. Information is not sent to the distributors regarding needed transport capacity and time. Both effective information sharing and effective supply chain practices are critical to achieving good supply chain performance (Zhou and Benton, 2007; Abatekassa and Peterson, 2011). It is widely accepted that the creation of a seamless and synchronized supply chain leads to increased responsiveness and lower inventory costs. Reducing uncertainty via the transparency of information flow is a major objective in external supply chain collaboration (Ryu et al., 2009). Both strategic information exchange and operational information exchange are required to enhance supply chain performance (Ramayah and Omar, 2010). Information and communications technology (ICT) has major positive implications for supply chains and is associated with large potential benefits (Simchi-Levy et al., 2008; Chopra and Meindl, 2013).

7 Generic control models for local food

From the analysis and by applying the control model analytical framework, we have used CIMO logic to develop three propositions for generic models for local production of food. The first proposition deals with market and product strategies, the second proposition contains some generic control principles, and the third proposition relates to the control principles for the products that are delivered to retailers.

Proposition 1: The first proposition dealing with market and product strategies suggests:

In order to score high on service level and delivery performance (O), local food producers (C) should focus on market and product scope (I) by deciding which customers to sell to, what products to offer and where (location) to sell the products (M).

When the market, product and geographical decisions are all taken into account, an overall control strategy should guide how products and information flow. This strategy leads us to the

second proposition.

Proposition 2: The control strategy for local food production (C) should be based on principles of coordination, integration and collaboration between planning levels and units in the supply chain (I) by applying the following elements:

- Integrate production planning and demand planning, both on long and short terms
- Key performance indicators must be defined and supported by a measurement system
- Establish an e-based system for administrative as well as planning and control processes in the supply chain, including decision support tools for order management
- Share resources and collaborative arrangements

This will secure that market requirements are met (O).

For each of the specific market segments, control principles should be designed that specify how, when and where products and information should flow. This fact leads us to the third proposition:

Proposition 3: The control principles for the products sold to retailers should adhere to the following:

- Define differentiated expected lead times and delivery frequency for each customer, applying a high turnover and direct delivery for sensitive and high-quality products
- Seek to apply VMI principles where possible, supported by customer access to stock levels and demand in real-time
- Utilise distributor/cross-docking operations and plan production accordingly
- Seek to place CODP in the production supported by pick and pack by order model, differentiated based on product/quality and on customer-order frequency and demand profile
- Apply electronic bidding for transport/logistics and decision support in dispatching model/transport service

The following generic model illustrates the principles (Figure 2).

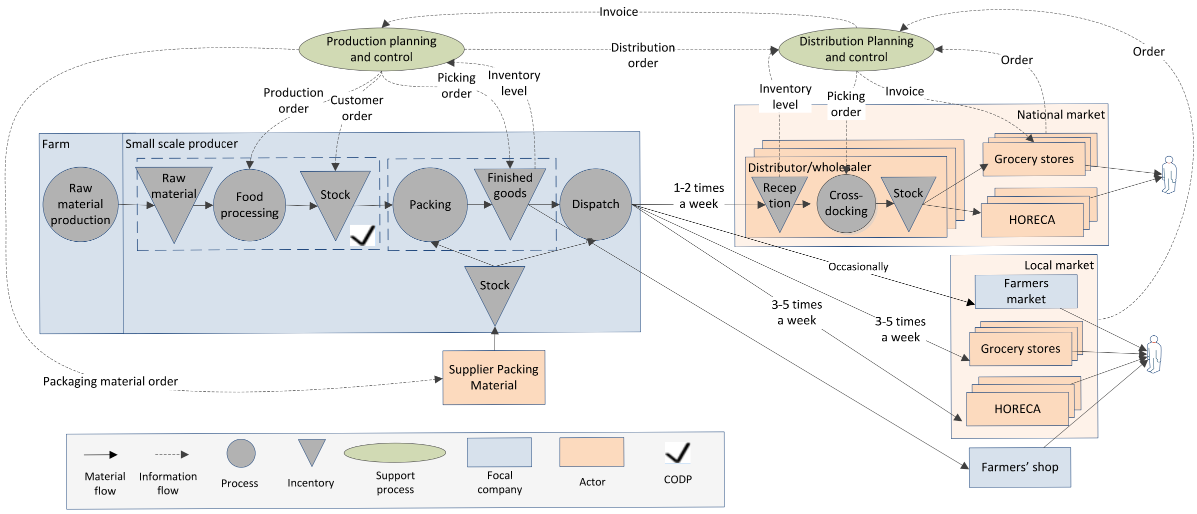

Figure 2. Generic TO-BE control model for local food producers

The main elements in the supply chain of local food producers are the unique and specialty features of the products and the production (Figure 2). These elements should be embedded into a responsive system that utilises scope benefits, creates flexibility in production and distribution, compensates for scale drawbacks, builds on collaboration with partners and shares information with customers.

For the case companies, the TO-BE control model has the ability to increase the flexibility of the production by placing the CODP after production and before packing and utilizing demand and stock level information in the planning. These changes will allow the producers to develop the responsiveness necessary to meet customer requirements. By establishing collaborations with partners on distribution and transport operations, the producers can increase their delivery frequency and shorten their order lead time. The order-winning criteria for producers of specialty foods are the quality and the uniqueness of the products, made possible by a responsive supply chain configuration. Expected impact are summarised in Table 3. Here, the cases are also grouped into three categories: the local meat producer, the national and individual cheese and mussels producers, and the producers in the food hub.

Table 3

Expected impact of the TO-BE control model for the case companies

Case	Impact
The local meat producer	Focus on improving quality and high end customers such as hotels and restaurant in the regional and local market, and some main customers. Continuously receive orders and stock level information from customers via an integrated and e-based system for ordering, production and distribution planning. CODP before packing; products are MTS but packed on customer orders. The delivery frequency is 3–5 times per week, made possible by establishing a cross-docking collaboration with partners.
The national mussels and cheese	Focus on the national market and prioritized customers. Continuously receive orders and stock level information from wholesalers and retailers via an e-based system for ordering and production and distribution planning. CODP before packing; products are made to stock but

producers	packed on customer orders. The delivery frequency is high with a minimum of 3–5 deliveries per week and low stock levels. Develop specialised transport and distribution services in collaboration with partners. Continuously update plans with stock level information from customers.
The collaborative food hub producers	Focus on the national market and customers within the food service industry and selected retail customers. CODP before packing and distribution for the hub and on stock at the food hub. Utilise stock level information from customers to plan production and distribution. Develop distribution solutions with providers that reduce the delivery time in national markets.

8 Conclusions

This paper explores how the supply chain of specialty foods should be designed and controlled in order to fit with the competitive features of local food producers. We identify a number of characteristics of local food chains and analyse the obstacles regarding distributing these products to the market. Furthermore, the paper discusses how the characteristics could be dealt with by adjusting planning and control principles. Based on the ideas presented herein, we develop generic planning and control principles for local food producers.

This study is the first of its kind to conduct detailed level analyses and identify the logistical challenges in the way that local food chains are designed and controlled. The results of the study reveal that if local food producers reconfigure the main design and adapt new control principles, a better fit could be achieved between the competitive strengths of local food producers (unique products) and the supply chain.

Furthermore, the study illustrates how the deliveries of specialty foods to retailers could be planned and controlled, and likewise how restaurants and private customers could be served. For management, the implications of this research are the identification of strategies and control principles of particular importance in the local food chain; the suggestion of strategies and control principles for different customer categories should be helpful when redefining the strategies and delivery system. The contributions from the study is relevant for other sectors with the same characteristics as food (small scale, high added value, niches, time restrictions) such as textile and healthcare and health products.

This study is based on four cases and further research should continue work on mapping the supply chain characteristics of local food systems to investigate the relation between local food production and the market requirements. Additionally, further research needs to explore and test the strategies and principles proposed in this paper, such as demand information sharing, collaboration and consolidating models, and integrated supply chain control.

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References

Abatekassa, G., Peterson, H.C. (2011). Market access for local food through the conventional food supply chain. *International Food and Agribusiness Management Review*, **14** (1): 63-82.

Aitken, J., Childerhouse, P., Christopher, M., and Towill, D. (2005). Designing and managing multiple pipelines. *Journal of Business Logistics*, **26** (2): 73-96.

Aramyan, L.H., Lansink, A.G.J.M.O., van der Vorst, J.G.A.J., and van Kooten, O. (2007). Performance measurement in agri-food supply chains: A case study. Supply Chain Management: *An International Journal,* **12** (4): 304-315.

Barratt, M., Choi, T.Y., and Li, M. (2011). Qualitative case studies in operations management: trends, research outcomes, and future research implications. *Journal of Operations Management,* **29** (4): 329-342.

Chopra, S., Meindl, P. (2013). Supply chain management : strategy, planning, and operation. Boston: Pearson.

Christopher, M. (2000). The agile supply chain: competing in volatile markets. *Industrial marketing management*, **29** (1): 37-44.

Christopher, M., Lowson, R., and Peck, H. (2004). Creating agile supply chains in the fashion industry. International *Journal of Retail & Distribution Management*, **32** (8): 367-376.

Duram, L., Cawley, M. (2012). Irish Chefs and Restaurants in the Geography of "Local" Food Value Chains.

Eisenhardt, K.M. (1989). Building theories from case study research. A*cademy of management review,* **14** (4): 532-550.

Fisher, M.L. (1997). What is the right supply chain for your product? *Harvard business review*, **75**: 105-117.

Flynn, B.B., Huo, B., and Zhao, X. (2010). The impact of supply chain integration on performance: A contingency and configuration approach. Journal of Operations Management 28 (1), 58-71. doi: http://dx.doi.org/10.1016/j.jom.2009.06.001

Handlingsplan for lokale matspesialiteter for Trøndelag. (2012-2015) Retrieved 31.01, 2014, from http://www.fylkesmannen.no/Nord-Trondelag/Landbruk-og-mat/Mat/handlingsplan-for-lokale-matspesialiteter-for-Trondelag-2012-15/

Hingley, M., Boone, J., and Haley, S. (2010). Local food marketing as a development opportunity for small UK agri-food businesses. *International Journal on Food System Dynamics*, **1** (3): 194-203.

Holmström, J., Främling, K., and Ala-Risku, T. (2010). The uses of tracking in operations management: Synthesis of a research program. *International Journal of Production Economics,* **126** (2):267-275.

Holweg, M., Disney, S., Holmström, J., and Småros, J. (2005). Supply Chain Collaboration:: Making Sense of the Strategy Continuum. *European management journal*, **23** (2): 170-181.

Ilbery, B., Maye, D. (2006). Retailing local food in the Scottish–English borders: A supply chain perspective. *Geoforum,* **37** (3): 352-367.

Ivert, L.K., Dukovska-Popovska, I., Kaipia, R., Fredriksson, A., Dreyer, H.C., Johansson, M.I., Chabada, L., Damgaard, C.M., and Tuoikangas, N. (2014). Sales and operations planning: responding to the needs of industrial food producers. Production Planning & Control, 2014

Jacobs, R., Whybark, C., Berry, W., and Vollmann, T. (2011). Manufacturing planning and Control for Supply chain management. Location, McGraw-Hill.

Ketchen, J.D.J., Rebarick, W., Hult, G.T.M., and Meyer, D. (2008). Best value supply chains: A key competitive weapon for the 21st century. Business Horizons 51 (3), 235-243. doi: http://dx.doi.org/10.1016/j.bushor.2008.01.012

Magnus, T., Kvam, G. (2008). Vekststrategier for lokal mat. Frekvensrapport. Report, 8(08).

Miles, M.B., Huberman, A.M. (1984). Qualitative data analysis: a sourcebook of new methods; Qualitative data analysis: a sourcebook of new methods. Location, Publisher.

Nakhla, M. (1995). Production control in the food processing industry: the need for flexibility in operations scheduling. *International Journal of Operations & Production Management*, **15** (8): 73-88.

Olhager, J. (2010). The role of the customer order decoupling point in production and supply chain management. *Computers in Industry*, **61** (9): 863-868.

Pearson, D., Henryks, J., Trott, A., Jones, P., Parker, G., Dumaresq, D., and Dyball, R. (2011). Local food: understanding consumer motivations in innovative retail formats. *British Food Journal*, **113** (7): 886-899.

Prajogo, D., Olhager, J. (2012). Supply chain integration and performance: The effects of long-term relationships, information technology and sharing, and logistics integration. *International Journal of Production Economics*, **135** (1):514-522.

Ramayah, T., Omar, R. (2010). Information exchange and supply chain performance. *International journal of information technology & decision making,* **9** (1): 35-52.

Reichhart, A., Holweg, M. (2007). Creating the customer-responsive supply chain: a reconciliation of concepts. *International Journal of Operations & Production Management*, **27** (11): 1144-1172.

Ryu, S.-J., Tsukishima, T., and Onari, H. (2009). A study on evaluation of demand information-sharing methods in supply chain. *International Journal of Production Economics*, **120** (1): 162-175.

Romsdal, A. (2014). Differentiated production planning and control in food supply chains. Doctoral thesis at Norwegian Univeristy of Technology and Science (NTNU), 2012:16.

Simchi-Levi, D., Kaminsky, P., and Simchi-Levi, E. (2008). Designing and Managing the Supply Chain. Concepts, Strategies, and Case Studies. Boston, McGraw-Hill/Irwin.

Strandhagen, J., Dreyer, H. C., and Romsdal, A. (2010). Control Model for Intelligent and Demand-Driven Supply Chains. *Managing global supply chain relationships*: 49-71.

Shukla, M., Jharkharia, S. (2013). Agri-fresh produce supply chain management: A state-of-the-art literautre review. *International Journal of Operations and Production Management,,* **33** (2):114-158.

Van der Vorst, J., van Dijk, S.J., and Beulens, A.J.M. (2001). Supply chain design in the food industry. International *Journal of Logistics Management*, **12** (2): 73-86.

Visser, J., Trienekens, J., and van Beek, P. (2013). Opportunities for Local for Local Food Production: A case in the Dutch Fruit and Vegetables. Proceedings in Food System Dynamics: 417-437.

Yin, R.K. (2014). *C*ase study research: *Design and methods*, (**5**): Location, Sage.

Zhou, H., Benton Jr, W. (2007). Supply chain practice and information sharing. Journal of Operations Management, **25** (6).1348-1365

Appendix 1

Case company			
Address			
Contact person	*Name:*	*e-mail:*	*Phone:*
Sector:			
Turnover:	2011:	2012:	2013:
Man-year:			

Product	
Product description	
Level of uniqueness	
Variety	
Volume	
Shelf life	
Value	
Company's growth ambition	
Market	
Customer categories	
Market strategy	
Geographical area and distance	
Demand pattern and variability	
Service level	
Order information and ordering method	
Market activities and promotions	
Production	
Main production principle	
Production strategy	
Production technology and level of craft work	
Production lead time	

Capacity and restriction, bottlenecks	
Stability of supply and raw materials	
Distribution	
Distribution channel	
Transport and way of distributing	
Delivery terms	
Distribution lead time	
Delivery frequency	
Distribution collaboration	

Appendix 2

Case	Characteristics		
	Product	**Production**	**Market**
Cheese	**Value:** The products value is high and the price varies between 300-500 NOK/kg. **Perishability:** The shelf life can be up do 12 months, but if chees is cut up in smaller items then the shelf life is reduced to one month. **Product range:** 6 different products with one counting for 50-60% of the turnover.	**Capacity:** The maximum production volume is 20.000 kg/year. **Production strategy:** MTS based on forecast and plans. Semi like production line. The processing is a mix of manual and automated operations. **Production time:** It takes 3 days to produce the chees, 1 month refrigerated storage, packing and 1-12 months curing.	**Service level requirement:** High regarding availability, frequency and quality. **Geography:** Customers are located in the local, regional and national market. **Demand uncertainty:** The demand is higher than the capacity. Demand varies and is seasonal. **Lead-time:** Long due to maturing processes. Varies between 6-52 weeks. **Delivery frequency:** Regular deliveries once a week. **Quantity:** Low number per order. App. 300 kg/week.
Meat	**Value:** High product value with a cost between 100-500 NOK per kg. **Perishability:** The fresh products expires within a framework of 2-4 weeks while the frozen product have a shelf life up till one year. **Product range:** Produces 33 different products (SKU).	**Capacity:** The capacity is restricted to 10.000 kg/year. **Production strategy:** MTS based on forecasts. Takes place in a combination of lines and cell based environment. They combine manual and automated operations and the level of workmanship is high? **Production time:** The times vary and is some few days for some of the products and weeks for other.	**Service level requirement:** High regarding availability and delivery time. **Geography:** The main marked is the local and regional. **Demand uncertainty and variability:** A fairly high variation in demand, in addition to the seasonal variations. **Lead-time:** Short lead-time in the local. Longer in the regional market. **Delivery frequency:** Continuously on customer request. **Quantity:** Low number per order but varies. Appr. 20-500 kg/week.
Shell	**Value:** High value with at price at over 50 NOK/kg **Perishability:** 10 days after packing. **Product range:** Only one type of product.	**Capacity:** The production volume is 650 tons/year. **Production strategy:** Harvesting is done on plans, while products are packed on order. One main production and packing line. The processes are mainly automated with mechanical washing, cleaning and packing operations. **Production time:** The time from harvesting start to finishing packing is 1-6 days. The shell can stay for 2 days in water tanks. The production takes 1 day.	**Service level:** High requirements regarding quality and availability. **Geography:** A small volume is sold to local and regional customers. The majority of customers are intermediates located south in Norway. **Demand uncertainty:** Seasonal variations. Sales doubles in the summer when it's high season. **Lead-time:** Varies but is normally between 15-48 hours. **Delivery frequency:** Daily on order. **Quantity:** Low volume/order.
Food hub	**Value:** All products add some sort of value but the price level varies from fairly medium to high priced products. **Perishability:** Varies from one week to several weeks depending on product type. **Product range:** The product range is broad and covers different type of products.	**Capacity:** Each production site has restricted capacity for the products they provide. **Production strategy:** All products are produced to stock. They are packed and consolidated on order. **Production time:** The production time varies from some few days to weeks. Delivery time to the hub is 1 day.	**Service level:** High requirements regarding availability, delivery frequency and quality. **Geography:** The products are sold in the local, regional and national market. **Demand uncertainty:** Demand varies and are seasonal. **Lead-time:** Varies but normally 1-3 days to the local and regional customers, and 1 week to national customers. **Delivery frequency:** Once a week. **Quantity:** Low volume per order.