Reconfiguration of food value chains – between logistics and traceability

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The rise of digitalisation is fueling a dynamics of reconfiguration of food value chains. This article explores two rising challenges: Logistics and traceability. These issues are crucial for food value chains because of the very specific characteristics of food products, such as perishability, shelf life constraints, quality variability, sanitary risks, market uncertainty, and the increasing distance between producer and consumer due to the markets' globalization.

Introduction

Since the 1990s, food safety crises and large-scale frauds have reduced consumer confidence, and their perception of safety has considerably declined (Trienekens and Vand Der Vost, 2006). As a consequence, the demand for high-quality products, safety guarantees, and transparency regarding food products is increasing (Koss and Kloppenburg, 2019). Therefore, food product traceability, safety, and sustainability issues have become crucial concerns to food retailers, distributors, processors, and farmers (Kittipanya-Ngam and Tan, 2020), and is now a driving force for producers and companies to improve traceability of products along the value chain, but also to create new value.

Traditionally, the creation of value within food chains results from the relationships between actors-producers, transporters, processors, distributors, customers – that organize all the stages allowing them to obtain a competitive advantage, each link carrying value needing to be optimized. Digital technologies have introduced two major disruptions in this well-organized structure. First of all, disintermediation/remediation has made it possible to modify the historical positions of distributors, in particular because products and services carry a higher information intensity. Now, it becomes easier to aggregate products and services previously purchased separately (remediation) and to distribute them without necessarily going through historical circuits (disintermediation). Digital technologies also facilitate the development of network mediation, which make it possible for several actors to join forces to co-create offers through cooperation and the use of real-time information, pooling of skills, and optimization of distribution circuits.

Due to food scandals, sanitary or geopolitical crises, the fear of supply disruptions has become a real issue and has reinforced the need for a segmented massification of supply. In particular, it has led to the development of value chains' functioning in hybrid modes, where logistics and traceability play a transformative role and carry both complexity and resilience to adapt to consumer demand, market uncertainties, and sanitary and

supply risks. In this context, logistics and traceability systems are increasingly implemented using digital technologies, as a tool allowing the control of food quality and safety within value chains and supporting the enhancement of consumer confidence (Bosona and Gebrensenbet, 2013). The transformation of logistics and traceability systems is thus driven by an increase demand for services, which are becoming strategic in value chains to support both product flows and transparency regarding their quality attributes (safety, nutritional value, freshness…), the origin of the products as well as the conditions of product delivery.

Increasingly hybrid value chains

From the consumer side, digital innovations have radically transformed the way consumers look for information, buy, consume, talk about products and services, and share their experience. From the corporate perspective, digital innovations offer a new way to reach, inform, engage, sell to, learn about, and provide services to customers. As pointed out by Brandt and Henning (2002), the digital change of our society has enabled people to communicate across boundaries of time and space, access an array of information around the world, and make multiple real-time transactions. This breakthrough means that customers are not just searching for information about products and services, but that they are also able to create and share their own content across a large online network. This growing presence of consumers in value chains is leading value chain actors to increasingly diversify their contact points with consumers, breaking down walls that were previously prevalent between the different sales channels (short *vs.* global chains, online *vs.* offline sales…). For value chain actors, it is now essential to place the customer/consumer at the core of their strategic decisions. Indeed, the power of the latter is becoming preponderant, especially when they ensure a role of consumer-actor.

Nowadays, the creation of value depends on customer satisfaction. The more the supply of goods and services meet the uses and values of customers, the greater the value created. Providing a solution (products plus services), rather than just selling a product, becomes a source of strong competitive advantage, based more and more on the concept of usefulness and functionality of the product rather than on its intrinsic characteristics. Digital transformation supports, and even accelerates, these observed changes. In particular, it facilitates the (re)location of the value created, which consists in bringing value chains closer to customers. In this process, the challenge is to locate the value – and not only or not necessarily the production – with the objective of enabling a better match between supply and demand. As offers are becoming more personalized, transformations of value chains are required to develop new proximities – physical, relational, or functional – with customers.

As exchanges are more and more based on interactions that become virtual, new proximities can be created that are no longer limited to geography or territory, but also based on shared values, sharing of information on practices, the quality of the products, or the conditions of production and transport (zero carbon, zero pesticides, fair remuneration...). These needs of proximity find answers in many digital solutions (platforms, apps...), but also require a need for increased transparency on products, production and distribution processes, and a demand for better knowledge of the actors of the supply chains that goes beyond their sole activities to encompass their values and positioning regarding, for instance, the protection of the environment, or their contribution to ethical and societal challenges.

However, the shift from a context of commercialization and exchange based on physical products to a context of virtual proximity with a new role for consumers in value chains pushes the traditional operating structures of the value chains, and leads to the development of value chains that become multiple, more segmented, and hybrid.

The digital: a driving force behind this hybridization

In the 1980s and 1990s, companies and value chains were starting to face the challenge to create data to get information. Nowadays, data and information are considered as commodities. In this transformation process, those who are able to better use data can get a huge competitive advantage on markets. Indeed, the challenge is no more on how to get or produce data, but on how to use them and transform them into something with a business focus and a potential for value creation. It means, for decision makers, the need to upgrade their information and digital ecosystems to get knowledge and a right understanding of their customers, suppliers, and value chains, in order to create value and get a competitive advantage. This change is transforming the way value chains' actors understand power relationships and use information as a strategic tool for decision-making that support value creation.

The creation of capabilities for leveraging data analytics able to deeper understand value chains and the speed of new technologies appearance can create market disruptions and add continuous pressure to existing markets. The most adaptive and digital companies are often more profitable than their industry competitors, and find ways of creating more and/or new value, beyond their conventional markets. Especially, they try to predict what will happen and they optimize against plan, because the world is not predictable due to the changing nature of the demand curve and elements of uncertainty. Indeed, demands are more and more complex to meet, as companies develop offers that answer the consumer desire for more personalized products and services, delivered when and where they specify, very quickly, and at a low cost. To achieve this, companies digitalize and automate their value chains with the objective to better execute against the unplannable, by making their value chains more adaptable. Moving decisions away from headquarters and out in the field, where managers closest to the action can make rapid adjustments – based on "what if" decision analytics and technologies that provide real-time data –, gives people across the value chain more power to pivot operations, develop gains, deploy more accurate inventory and replenishment strategies, improve reliability and resilience, support more transparency, and, eventually, develop more efficient and sustainable value chains.

Logistics and traceability at the core of the changes

The general European Union regulatory framework (Regulation (EC) No 178/2002) defines traceability as "the ability to trace and follow a food, feed, food-producing animal or a substance intended to be, or likely to be, incorporated into a food or feed through all stages of production, processing and distribution". The most widely used definition considers that "traceability is the ability to follow a product lot and its history through all or part of a production chain, from harvest to transportation, storage, processing, distribution, and sale" (Moe, 1998). Bosona and Gebrensenbet (2013) introduced a new, comprehensive definition of food traceability as "a part of logistics management that capture, store, and transmit proper information about a food, feed, food-producing animal or substance at all stages in the food supply chain so that the product can be checked for safety and quality control, traced upward, and tracked downward at any time required". Furthermore, authors argue that three components are closely linked to traceability: Tracing (backward follow-up products), tracking (forward follow-up of products), and history (information flows associated with each product). As a result, they highlight the link between information and physical flows as a key factor in the implementation of effective and efficient traceability, and the lack of coordination of logistics activities affects the flow of products from farm to fork and therefore the effectiveness of food traceability efforts.

Logistics actors have already been using ICTs (Information and Communication Technologies) and data systems since the 1990s, due to the rise of mass retailing, which

has led to the massification of physical flows and therefore new organizational developments, such as the marginalization of traditional intermediaries (wholesalers) and the rise of new actors (retailers) having as a main strategic objective the optimization of flow management in order to reduce logistics and distribution costs. For example, EDE (Electronic Document Exchange), ERP (Enterprise Resource Planning), WMS (Warehouse Management System), TMS (Transport Management System) are among the best known digital tools that have been developed by the value chain actors. The main objectives of the use of these new technologies were productivity gains, cost savings, reduction of transaction costs throughout the whole value chain, optimal transport conditions to preserve food products (such as freshness of perishable foods, like fruits and vegetables). These technological innovations have enabled logistics to adapt to the emergence of the new organizational models of just-in-time and on-demand flows of mass market products with low differentiation.

However, from the 2000s onwards, digital technologies were mobilized with total different objectives, such as adaptation to market hyper-segmentation and increasing customization of products. In this rapidly changing environment, logistics met several challenges: Complexity of flow management, multimodal transport, urban logistics, and reduction of the environmental footprint. Online purchasing has increased expectations for greater fast delivery, personalized products, flexibility of delivery locations, information in real-time, and new services (return-product). The continuous growth of e-commerce and the development of omnichannel strategies,due to new consumer purchasing trends using simultaneous physical and digital channels as needed, make logistics activities and product traceability increasingly complex, posing a major problem of traceability, fraud, and food safety risks. This requires new technologies, such as smart food packaging technologies with the integration of data capture, to facilitate food traceability and monitor food quality conditions (Yam, 2012). Besides, Vanderroost *et al.* (2017) argue the growing importance of data collected from the Internet of Things (IoT) and Wireless Sensor Networks (WSN) to optimize logistic operations (transport, warehousing, cold chain, waste reduction…), and to develop intelligent food packaging defined as "a food package that in some way provided with one or more intelligent devices (sensors, RFID tags) to identify or locate a food package, or monitor the condition of a food package, its contents, or its environment." Such packages also offer the perspective to facilitate bidirectional interactions for consumers and retailers and/or food companies.

From the linear value chain to the value grid/network

The concept of value chain, defined by Porter (1998), establishes a standard in the economics science by explaining the systematic structure of the set of activities needed to provide value-added products or services by companies. Porter also defined the value of information has a fundamental infrastructure to achieve efficient models, by helping optimize and support core activities of each enterprise in the value chain. However, in today's world, business transactions are no longer made in traditional ways (supplier, transformer, distributor, customer), but can be seen as a set of possible value connections and/or networks.

In this new way of rethinking value chains, organizations can overcome uncertainty and risk in the stages that are the most susceptible to disruption or to carry the most significant negative impact. For instance, when a company decides to serve a new market, launch a new product, or develop new distribution channels, it can turn volatility and unpredictability, which are overwhelming challenges, into sources of competitive advantage, by developing a flexible value chain and embracing digital advancements. However, these new technologies can be leveraged only if business partners are ready to these

changes as well. It becomes crucially important to work with value-chain partners, as they could facilitate and hinder technology advances. Nowadays, all value chain actors need to develop a wide view of their market landscape to catch the benefits and overcome the challenges of new digital technologies, as the imperative of being more agile is pressing.

However, doing so involves breaking free of linear thinking and viewing value creation from a multi-dimensional value grid perspective that provides great opportunities for developing value-enhancing activities in and outside the traditional, linear value chain, for managing risks, and responding to new threats. In order to develop a value network or grid approach, three dimensions can be explored for enhancing value creation: the vertical, horizontal, and diagonal directions (Pil and Holweg, 2006). Companies expand vertically, by looking beyond directly connected partners upstream or downstream, and by exploring opportunities in both directions from their adjacent partners in the value chain. In doing so, companies develop a nonlinear approach, as they seek new ways to interact with demand, obtain critical information, or penetrate the value chain at multiple points. Another way out of the linear approach is to develop horizontally, by identifying opportunities in parallel value chains through the spanning of similar partners in different value chains. By looking at multiple value chains, companies can leverage economies of scale across multiple sources of demand. However, it also enables companies to manage risks, sustain value creation, and explore novel ways of value creation. Finally, the diagonal direction deals with a more integrative approach, where companies explore more widely partners and value chains for opportunities to create value by offering packages built upon their own products and services with additional products and services coming from other companies, either in their value chain or across value chains. This strategy allows companies to mitigate risk by operating in value chains with orthogonal demands and risk patterns (Pil and Holweg, 2006).

Today, logistics is adapting to this dynamic of reconfiguring value chains by modifying their business models and their positioning in value chains. In particular, it participates in the phenomenon of product disintermediation by allowing delayed differentiation, in order to facilitate the offer of personalized products and meet the demand for agility and flexibility of the consumer, who increasingly adjusts their demand to their needs. The services thus offered by logistics allow it to position itself on different segments of the same value chain (*e.g.* fast delivery and in small quantities to the distributor or the consumer), on several value chains (*e.g.* delivery of fresh products and non-perishable products), or on integrated offers (*e.g.* delivery with packaging recovery), while at the same time positioning itself as a major actor in the need for traceability of products in real time.

Thinking non linearity within value chains can also be seen as a strategy that focuses on power dynamics between a company and other actors in its own value chain (vertical dimension). By assuming multiple positions through multiple entry points in a value chain in order to diversify demand, supply more than one partner, or limit a buyer's power, companies are less vulnerable to specific changes in demand and more able to capture value as it emerges. After initial opportunities have been exploited, the potential landscape for identifying new opportunities can be continuously enlarged. Not thinking linearly about demand helps companies identify customer solutions that fall outside their traditional value chain, allowing them to operate smaller, with more flexibility, and to produce at lower costs. In addition to helping companies create value propositions that would be impossible within a traditional, linear value chain, supplying several value chains provides access to more information and can help identify potential rivals. By reaching outside their established value chains, companies can create new threats to competitors in the market, or leverage their understanding to strategically lock competitors.

Conclusion

Digital changes are nowadays having a real impact on the organization of value chains and the creation of value within these chains, leading to a redefinition of the very notion of value, which is now co-created, co-transformed and co-captured by all actors: Consumers, competitors, strategic partners... Value-creating activities are recomposed within each company and between companies. This has implied a shift from a system where the same company provided all the stages of a value chain, to a system in which this value chain unfolds in several directions, with increasingly specialized actors and expanded partnerships, sometimes far beyond the value chain or sector of origin. Supported by digitalization, these changes are driven by a need for increasingly meeting consumer expectations, shifting value creation to a network system in order to bring out new opportunities and reduce uncertainty and risk. Moving from a linear value chain focus to a value grid focus requires managers to rethink the organization's value proposition and associated structures within and outside their existing operational spheres. Obviously, thinking in a nonlinear way is inherently complex as it requires companies to continually explore, evaluate, and map the broad competitive landscape, rethinking value creation and monitoring emerging dangers from other actors in the value network. Due to the specificities of food products, logistics is strongly linked to traceability. The ongoing development of new digital innovations, such as digital twins, will enable the design of more sophisticated logistics and traceability networks, where data is transformed into a valuable resource to create specific services, with traceability being one of them to meet the strong requirements of information and transparency of the consumers.

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