On data and connectivity in complete supply chains

Per Engelseth and Judith Molka-Danielsen
Hogskolen i Molde, Molde, Norway, and
Brian E. White
Complexity Are Us Systems Engineering Strategies, Sudbury, Massachusetts, USA

Received 15 September 2017
Revised 27 July 2018
Accepted 3 October 2018

Abstract

Purpose – The purpose of this paper is to question the applicability of recent industry-derived terms such as "Big Data" (BD) and the "Internet of things" (IoT) in a supply chain managerial context. Is this labeling useful in managing the operations found in supply chains?

Design/methodology/approach – BD and IoT are critically discussed in the context of a complete supply chain organization. A case study of banana supply from Costa Rica to Norway is provided to empirically ground this research. Thompson's contingency theory, Alderson's functionalistic end-to-end "marketing channels" model, Penrose's view of supply purpose associated with service provision, and particularities of banana supply reveal how end-to-end supply chains are complex systems, even though the product distributed is fairly simple.

Findings – Results indicate that the usefulness of BD in supply chain management discourse is limited. Instead its connectivity is facilitated by what is now becoming commonly labeled as IoT, people, devices and documents that are useful when taking an end-to-end supply chain perspective. Connectivity is critical to efficient contemporary supply chain management.

Originality/value – BD and IoT have emerged as a part of contemporary supply chain management discourse. This study directs attention to the importance of scrutinizing emergent and actual discourse in managing supply chains, that it is not irrelevant which words are applied, e.g., in research on information-enabled supply process development. Often the old words of professional terminology may be sufficient or even better to help manage supply.

Keywords Collaboration, Food industry, Information exchange, Logistics, SCM, Big Data, Internet of things

Paper type Case study

Introduction

The more recent wide-spread dissemination of the computer-industry founded icons BD and IoT demands scrutiny regarding the applicability of these terms as concepts in the context of supply chain management (SCM). Taking an end-to-end perspective of the production process, in this case of bananas, where actors and production facilities are dispersed around the globe, importantly demands quality information to support quality production. This information must also be dispersed around the globe as part of an international, long-linked, production process. The entire supply chain from "food to fork," what conceptually and explicitly constitutes the organizational entity known as "the complete supply chain," is studied as production process. How can this huge entity be better managed through improving information quality and connectivity as a "chain" configuration within its system borderlines?

This chain metaphor essentially implies integration as well as connectivity and nonlinearity rather than linearity. When integrated, a supply chain acts as a tightened, more cohesive network, and as such may be studied as a system of well-interconnected parts: people, devices and documents. The question remains, what is the role of BD and IoT in this supply chain inter-organizational structure?

Clearly, the notion of integrating a complete end-to-end supply chain is a formidable challenge, mainly due to its sheer scope (Chen *et al.*, 2009, p. 39). This also implies potentially increased complexity. Alderson (1950, 1957, 1965) was one of the earliest management scholars to view supply as an end-to-end process. His contributions involved modeling

Business Process Management Journal
Vol. 25 No. 5, 2019
pp. 1145-1163
© Emerald Publishing Limited
1463-7154
DOI 10.1108/BPMJ-09-2017-0251

marketing channels that included reasoning of the predominant sequential interdependencies of the physically distributed production operations. His most influential contribution is the principle of postponement involving extending an order-based flow of service to as far downstream in the supply chain as possible. This implies risk-reduction since the final service configuration then takes place at the closest time possible to consumption (Alderson, 1950). Pagh and Cooper (1998) further elaborated on this as a supply chain strategy from an end-to-end perspective discerning between different configurations of order-driven and plan-driven parts in a supply chain. The work of Alderson (1965) culminated in his conceptual modeling of an end-to-end supply chain structure. This represented characterizing supply operations as logistical flows supported by information flows in the context of what at the time of its writing was termed a marketing channel.

Attia (2018) demonstrates, through a survey approach yielding respondents viewpoints, how a firm's inbound supply competitive performance in the food industry is positively affected by supply logistics integration. This suggests that in a market setting, the extent to which supply chain agents collaborate is important. Information is a key, strategic, supply chain integration resource and an inter-organizational boundary spanner. To consider the role of information connectivity in a complete supply chain scope, recent trends within information technology (IT) need to be considered. An important change in recent management thinking is associated with applying the concept of BD to improve management practices in general. In this study, we consider BD in the supply chain context, specifically broadening the research scope to involve an end-to-end supply chain structure. Analyzing a complete supply chain entity entails increasing the number of actors and activities involved, and increases the associated coordination challenges. The complete supply chain is big and understandably complex. Currently, BD has grown past being a buzzword in various IT environments, practice-oriented as well as academic, and is gradually gaining presence in SCM terminology (Fosso Wamba *et al.*, 2015). BD analytics is increasingly considered a driving force of business change, harnessing the power of recent technological advances to improve business processes. BD is associated with managing information in a supply chain, including its analysis, capture, curation, search, sharing, storage, transfer, visualization, querying and information privacy. Fosso Wamba and Mishra (2017) provide a literature review of 49 published papers on BD revealing that the issue of BD has well established itself within academia. "Process mining" represents a variation of BD analytics seeking to discover information regarding processes (Thiede *et al.*, 2018). However, little critical thought is set forth regarding the business sector roots and applicability of BD; the notion that we are possibly only trading apples for pears and following the compelling music of flutes played by the IT industry rather than establishing a rigorous and sound research-based classification of information resources and processes.

IoT is complementary to BD. IoT helps conceptualize supply issues involving data capture and seamless data transmission in a supply chain and represents a way of designing the information flow to support the logistical flow of goods and services. In essence, BD and IoT engender the emergence of information complexity through the seamless and rapid provision for data use in production processes. This includes issues such as IT advances linked with BD to enhance real-time and seamless boundary spanning goods tracking (Gubbi *et al.*, 2013). Furthermore, BD is associated with the analytics of complex data sets. Such analytics may be used for a range of purposes, including marketing (Erevelles *et al.*, 2016), new product development (Xu *et al.*, 2016), retailing (Aloysius *et al.*, 2016), manufacturing management (Dutta and Bose, 2015) and SCM (Hazen *et al.*, 2014).

Through a literature review, Thiede *et al.* (2018) point to the limited application of process mining to cover the inter-organizational aspect of production. The present study, however, discerns a particular SCM-influenced view of BD; one of BD representing not merely analytics to transform large amounts of obscure stored data into information, but rather on the key aspects of information use associated with logistics in the supply chain. From a SCM perspective, this involves focusing on information sharing to assist how different firms align goods supply through multiple sequentially interdependent tiers of actors (Lambert and Cooper, 2000). This evokes what we believe characterizes relevant knowledge, with the supply chain explicitly understood as an end-to-end structure. Furthermore, we seek to elaborate on the type of information in the complete supply chain that reflects process complexity.

Engelseth and Felzensztein (2012) point out that the use of such a complete chain perspective is still limited in marketing and supply-related research. Supply chain definitions, such as the one provided by the Council of Supply Chain Management Professionals (CSCMP) are explicit in describing the supply chain as an entity that encompasses actors organized in a linear chain structure from raw materials producers to consumers. The chain metaphor points to integration as an objective across this long-linked supply structure but isn't it likely the associated process is nonlinear? Advantages of taking a complete view of this type of supply system were argued by Mesa and Galdeano-Gómez (2015). Their quantitative end-to-end study of a horticulture chain in Spain found that cooperation strategies encompassing a complete supply chain has positive effects on performance involving market creation, promotion, quality, training, joint supply purchases and research ventures. Furthermore, Yao *et al.* (2009) revealed performance improvement measured by order cost reduction, inventory reduction and customer satisfaction. Information in this long-linked supply structure is the colloquial glue that binds operations resources together to coordinate this flow through multiple tiers of actors. One reason to focus on the complete supply chain perspective is that despite the successful dissemination of the term SCM in academia and business, performance in integrated business networks has yet to live up to the expectations created since SCM was first coined as a term by Oliver and Weber (1992) in the early 1980s. Lambert *et al.* (1998) and Giunipero *et al.* (2008) point out that this limited progress is associated with equally limited conceptual modeling of the supply chain as an organizational structure. In accord, Lambert and Cooper (2000) state that: "There is a need for building theory and developing normative tools and methods for successful SCM practice." This study contributes by conceptually pointing out the relevance and use of BD and IoT as empirically grounded in the case study provided. Scrutinizing BD and IoT is critical quest. Do we really need the full-blown aspects of BD and IoT to develop supply chain processes? Likewise, we address how business practitioners may improve their use of information. Do they need to include the terms BD and IoT in management terminology? Or, are can management discourse handle the changes in IT using more established SCM terminology?

This study bases arguments on the contemporary role of information in SCM on a case study of Costa Rica bananas imported in Norway. In line with Meredith (1998), we seek theoretical generalizability by discussing concepts at a higher level of abstraction. It is not the particularities of banana supply that are researched, but principles of data transformation and their role in supporting goods supply. The studied banana flow starts at the plantation in Costa Rica, ends at the retailer in Norway, and is associated with the dynamics of logistical complexity (Engelseth, 2012) as well as a managerial challenge of aligning this flow of goods through a series of markets (Engelseth, 2016).

The complete supply chain structure

First the nature of the supply chain structure needs to be considered to lay grounds for a conceptual framework to guide analysis. This includes revealing how interdependency, the reasoning for interaction, shapes the structure of a supply chain. Enlarging the scope of inquiry from a single firm, and its relationships, to a sequentially interdependent and typically physically distributed chain of actors represents a formidable task as pointed out by Chen *et al.* (2009). It is useful to examine how interdependency affects other SCM-related supply structures to thereafter understand why we study the complete supply chain. It is useful to conceive the chain itself as an organizational body with a similar nature. Supply chains are concerned with what may be termed "production." This is in line with Parsons (1960) who classified organizations as having three distinct levels or layers of responsibility and control: technical, managerial and institutional. The technical layer is most closely associated with production while the management layer oversees and directs this production. Both the management and production layers are subservient to the institutional layer, what may be characterized as including the culture of learning how to produce successfully. This study involves the institutional layer in learning how actors in the supply chain should utilize information from an end-to-end supply chain perspective. The production layer involves variations in interdependency. Power is the source of interdependency (Emerson, 1962). Pfeffer and Salancik (1978) express reasons why agents carry out exchanges in a supply chain. Thompson (1967) classifies interdependencies as either sequential, reciprocal, or pooled, to describe particularities of various industries. All three types of interdependencies co-exist, but only one, namely, pooled, is dominant. In food supply, interdependencies are mainly sequential, meaning the essence of production is coordinating activities that follow one another over a timeline. Reciprocal interdependency is a step up in that two directly connected actors try to interact with mutual benefit. In pooled interdependency resources are combined more broadly based on collective mediations and mutual adjustments to combat uncertainties in an effort to economize production, visualized as the flow of goods, for all.

In the inter-organizational context of the global banana supply case study, our aims are to tighten the coupling among the supply chain actors, to facilitate their seamless collaborations, supported by IT, and thereby to better integrate them in the overall production process. In supply chain structures, such as food chains, uncertainty is associated with production process emergence (Surana *et al.*, 2005). Production in the complete supply chain may be characterized as being demarcated by sequentially interdependent events that guide (decision making) operations, what Alderson (1965) terms as "sorts." This represents a way to model a complete supply chain. During these sorts, the human actors interface and interact with each other using information tools. Accordingly, a food chain may be considered a complex system consisting of a series of sequentially determined transformations. Our main purpose is to see that these transformations provide significantly increased utility, as perceived by end-users. Modeling the flow of goods and how information supports this flow can follow the marketing channels model, coined by Alderson (1965) as the "transvection." The sorts represent the events where people not only interact with each other, but also with the computer. Figure 1 illustrates the fundamental piecemeal reasoning, the supply chain understood as sequentially interdependent organizing events; as a transvection with respect to the time, place, and form transformations in a flow associated typical of physical distribution.

Manageability is attained in an end-to-end supply chain, through what may seem to individual people in the supply chain, as small portions of sequentially interdependent production phases where integration levels may vary, as described by Frohlich and Westbrook (2001). A string of information-using events directs the flow of goods.

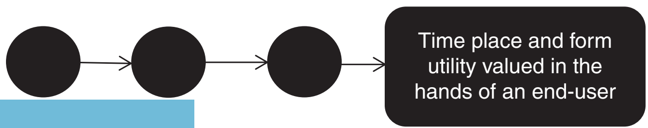

Figure 1.
Goods supply modeled as a transvection

The question arises as how to perceive this complicated supply chain for reasons of inquiry. Instead of climbing the mountain to find a complete top-level perspective of what goes on in supply chains, in line with the previously referred to CSCMP SCM definition, we rather consider managing in the "valley," through a bottom-up perspective in understanding these piecemeal processes each agent can see and reflect upon. We believe the more detailed process workings, process inter-connections, and the role of information in these processes, does more to help us understand what constitutes progress in current complicated global supply chains. The institutional level of production is associated with the supply purpose and therefore conceptually represents a higher level view of what supply means. The institutional aspect includes what can be termed as discourse, routines, culture, etc., found within supply chains. One form of integration can be expressed as shared meanings among professionals working in a common supply chain. The food chain includes a structure, a cornerstone leading to discourse that may be labeled SCM which embraces the culture and ideology that influences food supply operations. This institutionalised discourse legitimizes, through using the provided information, what actors in the supply chain may perceive as rational choices in production.

Supply chain scope and proximity is associated with its structure, understood as the "internal differentiation and patterning of relationships" (Thompson, 1967, p. 51). A complete supply chain is one such analytical structure. From this perspective, Croom *et al.* (2000) pointed out that SCM is associated with different levels of analysis, including "chains," "dyads" and "networks." This is analogous to the sequential, reciprocal, and pooled interdependencies, respectively, mentioned earlier. Analysis at these different levels implies different research issues and the need to adapt the frame of reference that guides data collection and analysis. SCM varies regarding the system boundaries that are chosen to be researched. The dyad is the structure associated with collaboration, or the lack thereof, in relationships between two organizations. Following Thompson (1967, pp. 101–102), a supply chain dyad interaction involves two entities: an organization bringing collective "[…] aspirations, standards and knowledge of or beliefs of causation;" and the situation, representing opportunities and constraints. The situation involves the other firm in the dyad, but also the contingencies of the relationship. Following Croom *et al.* (2000), the immediate context of the dyad is the "chain." This entity may be assigned as sets of relationships analyzed as having systemic properties, most importantly, common functionality and system borders. To start with, the "environment" may denote everything else that is not within the boundaries of what is perceived as manageable within and by the firm. Therefore, the network, following Croom *et al.* (2000), implies an outer layer "task environment." Dill (1958, p. 424) states that the task environment is composed of customers, suppliers, competitors, and regulatory groups. This network structure is associated with connectedness involving multiplicity of purpose and (sometimes) loose coupling (Orton and Weick, 1990). The looser the coupling, the less systemic the nature of interconnectedness. This study focuses on systemic information used at various sequentially interdependent events in the context of the supply chain as an inter-organizational structure; a more tightly coupled, and thus, also systemic (functional) network.

Information connectivity

The second issue covered in this analytical framework addresses information connectivity. This focuses on how information supports interactions to create value. Consumer awareness of market supply is increasing due to globalization and the increasing use of social media (Liu *et al.*, 2012). This means that customer-responsive supply is increasingly vital for firms to survive in the marketplace. Achieving customer value is therefore a key objective in achieving quality supply systems (Christopher, 2016). In this picture, "value is benefit, an increase in well-being of a particular actor" (Lusch and Vargo, 2014, p. 57). "Customer value" is a normative construct; it should therefore be the prominent driver of production. In this picture, complete supply chain complexity is at least two-fold, namely, in production transformations and customer valuations. This latter form of complexity is clearly expressed by Holbrook (1994) who describes customer value as "an interactive relativistic preference experience" (Holbrook , 1994, p. 27). Thus, in food chains end-user values do not emerge in isolation from within the heads of consumers in isolation, but through their interactions, in the wider environment of the supply chain including the relevant market. With the results of a survey of cold chicken supply, Schiavo *et al.* (2018) provides how consumers demand quality expressed as seven factors: product quality and flexibility of delivery; supply flexibility; responsiveness to market changes and product assortment; measurements of the inventory and competitiveness; product specificity; product availability and specificity cost; and delivery frequency. Sensitivity to the supply chain consumers and being responsive to their demands, which may be experienced as uncertain by food producers, increases supply chain complexity. This increases the need for information connectivity. Information, given this customer-responsive perspective, helps tame supply uncertainty associated with how to transform the goods in supply by increased grounds for rational decision making to coordinate production.

Throughout its history, SCM has tended to be from a managerial perspective predominately production-oriented, concentrating on technical aspects and their costs, more than a customer value focus (Arlbjørn and Halldorsson, 2002; Gripsrud *et al.*, 2006). From a resource-based view of the firm, Penrose stated as early as 1959 (p. 25) that – moving away from applying the term production factor, such as technical and cost factors, which was commonplace in economics – "it is never resources themselves that are the 'inputs' of the production process, but only the services that the resources render." Penrose used the plural, services, and did not denote the type of industrial sector. Using the term "service" implies taking the customer perspective in supply chains. Information connectivity therefore facilitates information exchange, manual and automated, to support the attainment of both production (technical, managerial and institutional) value but also customer value.

Customer value, being environmentally contingent, is associated with uncertainty, and may vary due to interactions within the supply chain as well as changes in the environment. From a supplier's point of view, it is therefore a moving target. The cognitive nature of customer value may vary from relatively stable to extremely volatile depending on a range of factors, including features of the product such as the availability of its technology and the current market. In a supply chain customer value is associated with production output. Following the transvection model (Alderson, 1965), production information is also transformed, as goods and the production processes are transformed. During sorts, the decision-making events demarcating the supply chain, perceived as a timeline configuration, actors interface customer value information with production information. In addition, a wide array of other information sources is available to support decision making at a sort. In taking a complete supply chain perspective, when production is predominately sequentially interdependent, customer values also have a sequentially interdependent aspect if, as goods are produced and managed at sequentially interdependent sorts, currently measured or estimated customer values are uniquely tied to these sorts. Customer value is then local and transient in nature. So, in cases of predominately sequentially interdependent production, as in food chains, customer values are "negotiated" at each sort. In the supply chain, not only is information about the goods transforming, but also changing customer values transform production properties that need to be understood. During a sort the transformation of goods may be associated with their past, present, and future characteristics (Engelseth, 2012). The goods past is associated mostly with traceability, the present mostly with tracking, and the future mostly with plans based on orders and/or the anticipation of orders, often expressed as forecasts. IoT encompasses improving human–machine and machine-machine interfaces to reduce, e.g., labor costs and human error. Accordingly, information supports quality interaction in cases of reciprocally interdependent more manual interactions, and standardization in cases of more automated pooled interdependencies. Regarding IoT, unstructured data can be sourced in large volume and rapidly acquired, e.g., from Global Positioning System (GPS)-enabled or social-media-enabled applications during sorts. While the characteristics of volume and mode of acquisition present challenges for harnessing and use of data in the supply chain, recent approaches in visualization and geo-analytics have allowed data generated outside of the main enterprise, as part of the long supply chain, to contribute to knowledge-sharing activities, collaboration, and integration of the supply chain network. Taking a complete supply chain perspective, information as a resource involves a layered, continuum picture of more controllable internal data through intermediately controllable supply chain data to less controllable environmental data. This leads us to the next topic, associated with the role of IT in facilitating information connectivity to produce supply chain products valued by the end-user.

Information technology

The third and last issue covered in the analytical framework addresses the potential of technology to enhance information connectivity and information use to create value in a supply chain. This involves scrutinizing both BD and IoT and providing thereby three research issues directing the structuring of the case narrative as well as its analysis. Within IT, process-driven BD analytics including process mining (Van Der Aalst, 2011) has emerged lately as a widely discussed topic of research. BD is associated with technology for transforming the volume, velocity, and variety features of data into useful information. Fosso Wamba *et al.* (2015) point to BD consisting of: data policies; technology and techniques; organizational change and talent; access to data; and related issues. This approach makes use of event logs in supply chains and enables conformance checking and thereby new process discovery and is different from applications used in marketing, where the search has been for data associated with customer behavior. In many cases, such sources need to be data-mined. A study by Rozados and Tjahjono (2014) produced a list of 52 mainstream sources of BD across supply chains. These data vary by degree of structure, volume, and velocity. The dimension of "structured-ness" indicates three types of data: core transactional data, internal systems data and other data. They indicated in their paper that greater enterprise resources are generally spent on the preparation, management, and use of the core transactional data. Wang *et al.* (2016) depicts, based on a literature review, three main categories of studies associated with big data analytics: descriptive analytics; predictive analytics; and prescriptive analytics. However, there is little empirical evidence regarding the effect of management and use of the unstructured big data in SCM, and little guidance regarding the strategy for expenditure of enterprise resources to utilize this category of information. This includes complex information provision and use in supply chains.

Based on an extensive literature review on BD, Fosso Wamba *et al.* (2015) point out that people continue to struggle to better understand BD as a concept. We concur with Brown *et al.* (2011) that BD, as a concept, points to a resource that expectedly is beneficial in business practice. Rather than viewing BD as "something out there," a competence-based technical driving force of improvement, we turn the picture around to search for its potential use, from a complete supply chain perspective, and thus gain a platform to consider technology options to support improved logistical operations. Thereby, from the SCM perspective in this study, BD is viewed as part of the information flow, one of many contextual factors impacting the supply chain as what Thompson (1967) defines as a form of "long-linked technology" that may be conceptually modeled following the previously described transvection model (Alderson, 1965). BD can have value if it impacts the competitive environment of firms by positively "transforming processes, altering corporate ecosystems, and facilitating innovation" (Brown *et al.*, 2011). As already implied, this value is local when it is associated with any sort event in the supply chain.

In this study, we take a view adapted to the use of this technology in supply operations, namely, how BD, together with IoT, may be understood as supporting the design of information provisions. The following provides a description of how information supports a relatively simple end-to-end international supply chain of banana production. This provides a basis for discussing the nature of food supply from: a complete supply chain perspective; what characterizes the provision and use of information in this supply chain structure; and the potentiality of IT as resource to develop this studied form of food supply. Based on these three considerations, the applicability of what may be perceived as recent IT icons popularly called BD and IoT, are scrutinized.

Method

The directed inquiry research issue was focused on detecting interaction between the banana goods and the actors managing this flow in the multi-tier complete banana supply chain. The data were collected in accordance with the transvection view (Alderson, 1965) described in the preceding analytical framework. We started interviews, not at the retail level but with an informant that we thought had a birds-eye view of the complete supply chain and asked him to describe the bananas chain from the retailer to the origin at plantations in Costa Rica. The study focused on the packaging and goods identification techniques used, essentially how the flow of goods interacts with the flow of information. The analytical focus was more on data complexity than BD *per se*. The information we acquired helped us gain a better understanding of supply chain functionality, especially regarding how and why actors interconnect. This provided an accounting for technical features of goods, their packaging, the information systems utilized, and how these information systems interact with both people and goods through various instruments such as barcodes, scanners, documents and computer screens. In this case study, characterized by long-linked technology, we learned how they produced bananas and how information supported this production.

The case study research strategy was applied in accordance with Yin (2017). This strategy was a means of creating focus and order in a complex supply network research setting consisting of series of mainly complementary banana product transforming activities at a series of different facilities. Eisenhardt's (1989) approach was used to shape a case study research strategy. This was aimed at creating an empirical foundation for future simulations of this part of the fresh seafood supply, and to create a case narrative that could be used to interpret the studied product with focus on responsiveness to customer needs (the market and customer value orientations). This case is based on an overall study of four end-to-end food supply chains. The sub-case presented here is one of several from this study. Some of the interviews in the study were overlapping since it concerned suppliers to common supermarkets and two wholesalers, with distribution of two of the products. Data were derived from a project that also included three other food chains with in total 63 interviews. Data were collected using a semi-structured interview technique by listing the topics, rather than the questions for each interview. Approximately 25 of these interviews provide a relatively direct foundation for constructing the following case narrative. Informants (interviewees) can be grouped into five types: actors directly involved in the chain; supporting actors (e.g. logistics services); packaging suppliers; transport companies; and more generic actors such as information system suppliers, standardization organizations (such as GS1, www.gs1.org) government food quality inspectors, industrial federations and media. The first informant was a manager with a good overview of the entire supply chain. He proposed a limited set of informants to interview, and later individual informants directed the researcher to yet more informants, a "snowballing" form of inquiry. The following table provides an overview covering the 20 interviews directly associated completely, or in part, with the banana case (Table I).

The interviews and observations were both open, which meant that the true intention of the case study was communicated to the informants and persons observed. This openness was also used as a tool to ensure credibility of the research, as discussed later in this paper. All interviews were taped and transcribed. The interviews lasted for an average of one hour, with the longest interview lasting almost four hours and the shortest lasting 15 min. The in-person interviews were followed up by telephone interviews to clarify data and update information. Clarification of data also involved discussing potentially different interpretations of interview transcripts. The applied research strategy followed the research protocol with the aim of gaining new insights. Data collection was directed by an emergent frame of reference that was written down and successively refined. The research protocol directed the formulation of interview guides, each of which was adapted to a specific informant and took preceding findings into consideration. This involved designing the research process, which led to "[…] observations generated new questions on which further interviews could be based" and eventually "added new dimensions to the subject, which eventually resulted in a new view of the phenomenon itself" (Dubois and Gadde, 2002).

Company	Informant function	Overall theme of interview
Norwegian produce Wholesaler trading	Logistics manager	Logistics operations
Norwegian produce Wholesaler trading	Product manager (Apples)	The role of the product manager
Norwegian produce Wholesaler trading	Import manager	EDI systems in BAMA
Software supplier	Marketing manager	Stock replenishment systems
Norwegian produce Wholesaler trading	Leader production planning domestic production	Forecasting at import dept.
Norwegian produce Wholesaler trading	Product manager (potatoes)	Information system
Tracing system software supplier	Manager	Food product traceability
Norwegian produce Wholesaler Dagligvare Oslo	Director	Business relationships of distribution center
Distribution center	Purchasing manager	Business relationships between the distribution center and retailers
Supermarket	Assistant store manager	Ordering products from BAMA and TINE
Logistics consultant	Director	ICT and the materials flow
Norwegian packaging support organization	Manager	Product traceability and retailing
Norwegian produce Wholesaler trading	Product quality manager	Product traceability and BAMA
Norwegian produce Wholesaler, central office.	Project leader	Information systems in BAMA
IT supplier specializing in RFID systems	Product development manager	RFID and tracking materials
Organization supporting quality goods branding	Director	Quality labeling of food products
Norwegian produce Wholesaler import office	Manager of banana ripening facility	The banana ripening facility
Norwegian government food quality inspection	Consultant	Food quality and traceability in Norway
Banana fruits supplier, Hamburg	Operations manager	Supplying and tracking of bananas
Banana fruits Europe, Hamburg	Quality assurance manger	Banana product quality and traceability

Table I. Summary of interviews conducted

Analysis in this single case study is, following Thomas (2011), theory-driven. The following section provides a case narrative. This narrative is constructed following the three sections of the analytical framework describing the structure of the banana supply chain as a flow of goods supported by information. Information is depicted, as involving exchanges to transact ownership as well as guide production as predominately logistics activities. This narrative construct is the basis of analysis. The analytical framework represents a selection of theory elements judged appropriate to shed light on our research problem. It is accordingly used to guide analysis. Concepts covered in the three sections of the analytical framework representing a literature review is applied to compare the empirical findings with theoretical material found thereby creating a qualitative analysis.

Case narrative

Figure 2 shows the supply network involved in supporting the studied flow of bananas.

At the end of each year, the Norwegian fruits and vegetables wholesaler's international trading department provides the Hamburg office of the international fruits company with a week-by-week specified forecast of the expected orders for the coming year. There is no contract regulating the business relationship between these companies. The office in Hamburg compiles orders from all its European customers. These plans are fed into a common information system and sent to the San Jose (Costa Rica) office. Ordering bananas by the retailer involves a daily procedure where a number of boxes are specified on an ordering list together with other products supplied by the Norwegian fruits and vegetables wholesaler. Large shops may be supplied six times a week, while the smaller and less centrally located ones are supplied more infrequently. Bananas are ordered by the number of pallets of boxes. Each day before 3:00 p.m. the person in charge of produce at the supermarket checks the current supply of bananas and can tell by the color of the bananas whether some should be replaced. That person then fills in the order list and sends it using an electronic data interchange (EDI) resource to the distribution center. The distribution center again collects daily orders and, based on these, orders supplies of bananas. These may be supplied on a daily basis if needed. The trading office of the Norwegian fruits and vegetable wholesaler confirms or adjusts orders once a week according to the annual forecast of bananas. Order confirmations or adjustments are placed eight weeks before delivery. They are usually adjusted to within 10 percent of an average of the annual predetermined forecast.

The customers of the international fruits supplier strive, according to its representative in Hamburg, to place orders as close to the annual plans as possible. The order is coordinated with orders from other customers of the global fruits supplier (Hamburg office) and adjusted in the information system resource. This new, adjusted total demand for bananas is then sent to the San Jose office, where data are coordinated with orders from other sales offices around the world. Based on this information, harvesting plans for each plantation are created, giving them the information they require in order to have the

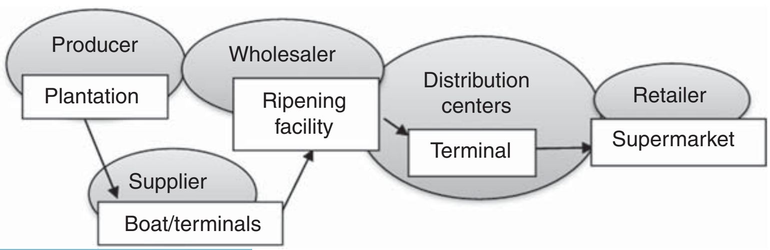

Figure 2.
The transformation of bananas as a goods flow

necessary amount of packaging materials and create transport plans within Costa Rica for the designated week. Based on the eight-week order adjustment from the different importers, including the Norwegian fruits and vegetables wholesaler, bananas are first earmarked with ribbons at the plantation where they are harvested. Many vessels sail from Costa Rica to various world-wide destinations with banana cargo on different days of the week. Therefore, harvesting and transport in Costa Rica are carried out continuously.

Approximately 24 hours prior to sailing, the bananas designated for transport are harvested, packed and transported to the port. The San Jose office also supplies the Hamburg office with documents containing the necessary product and logistics information. The ship bound for Hamburg sails every Wednesday from the Caribbean-side Moin port in Costa Rica. The ships are reefer (climate-control-facilitated) ships. The transport by ship generally takes 12 days but may be delayed due to weather. The temperature is set at 13.3 C, and the oxygen level is reduced from the normal 20 percent to 2–3 percent. A representative of the fruit producer described this process of reducing the level of oxygen as "putting the banana to sleep." Four documents are created for the transport: a bill of lading, a manifest describing the goods in further detail, a document stating the fruits' sanitary condition, provided by the Costa Rican Government, and a document proving the country of origin of the bananas. These documents are faxed to the Hamburg office and copies are sent to the global fruits supplier at Moin to follow the vessel. The original documents are sent by the San Jose office to the global fruit supplier and are also this company's responsibility upon arrival. During transport, these bananas may be traded among different actors in the international fruit supplier's global industrial network of customers; this also includes the quantities earmarked for specific customers. The exact amount of bananas registered in specific sizes of boxes combined into pallets is then sold to various importers. Customers may adjust orders within three days of the ship's departure in order to alter harvest volumes of bananas. Every Thursday and Friday, while the goods are at sea, the international fruits supplier has its sales days for these bananas.

During transport, the temperature in the storage compartments is continuously registered and controlled and the bananas ripen gradually. The vessel arrives at the Hamburg terminal about 7:00 a.m. every Monday. Upon arrival, the pallets are registered by scanning the bar-coded labels on the pallet and a temperature control test is carried out. At the global fruits supplier terminal in Hamburg, quality control is carried out of samples from this shipment. All the pallets of bananas on the arriving ship are considered interchangeable and no destination information is provided on the pallets or boxes. The transport from Hamburg to the banana ripening facility in Oslo takes one day and starts each Monday in Hamburg. The fruit and vegetable wholesaler orders complete truckloads or containers provided by a Norwegian ferry operator on the Kiel-Oslo line. Thirty percent of the order is in truckloads that take the road across bridges through Denmark and Sweden; the rest is put into containers used on the ferry route. Upon arrival at the banana ripening facility, the products are temperature-controlled and the volume is checked against documents. Transportation damage is registered and may be used as a basis for a complaint to the global fruit supplier in Hamburg. (The latter is very rare.) Information about the received volume of bananas is registered in the information system of the Norwegian fruit and vegetable wholesaler, including the temperature log and product damage. At this facility, the bananas ripen within an average of six days. The ripening process may be shortened or prolonged by two days depending on the temperature applied. The incoming supply of bananas is registered in the Norwegian fruit and vegetable wholesaler's information system and coordinated with orders recorded in its sales system. These orders, measured in boxes of bananas, represent aggregate retail demand and are communicated by the distribution centers. Then goods are sent to the distribution centers spread around Norway where they may be stored for less than a week. They are then distributed to the retailers as a part of a mixed consignment of different fruits and vegetable products loaded onto pallets. Bananas are usually unpacked for the first time at the supermarket by a person responsible for produce, and are then placed on a display shelf.

Analysis of the banana flow

Analyses is driven by the issues described toward the end of the analytical framework provided above: first a complete supply chain perspective is considered as context for production followed by what characterizes the provision and use of information in this supply chain in this structure. Finally, the potentiality of IT as a resource to develop this studied form of food supply is considered.

The complete supply chain structure

The banana is a simple and well-known product retailed mainly in supermarkets. Its service is associated with the features of this type of goods upon placement in the hands of an end-user. It is still not problematic, following Penrose (1959), to call this banana provision a "service." However, as we see it, this mainly represents a terminology change since, in the case of bananas, service perception by consumers is predominantly associated with goods features. Therefore, banana supply as a "service" mainly conceptually enhances the importance of the goods' recipients. Integration to coordinate in a complete supply chain is associated with achieving customer value. Value orientation is associated with, in this case, reaching a relatively stable aim of customer value. Following contingency theory, customer value, especially in cases of high uncertainty and reciprocal interdependency, is environmentally contingent. This view renders customer value a slowly moving target, only somewhat increasing supply chain system complexity.

Uncertainty is associated with production and transactions. Production is described as stepwise sequentially interdependent banana product transformation in line with the transvection (Alderson, 1965) model. The case also describes how transactions are associated with complexity. Orders are never secured before a few days prior to delivery in Hamburg, and the goods may also be traded on a commodity market prior to that. To support handling complete supply chain complexity, competence, including mutual trust, is important. Three aspects of variation in uncertainty are registered which influence information needs in the studied complete supply chain. This also impacts the nature of interdependency, providing the reasoning for interaction associated with supply (Pfeffer and Salancik, 1978), as indicated in Table II.

Table II shows that uncertainty combined with type of interdependency, the form of interaction founded on the particular nature of need to interact, helps to define the information use of the actors in the complete supply chains. Since customer value is a simple factor, interdependence is pooled, and a simple sales auditing which may be automated is required. Regarding transactions, uncertainty is higher, but given the stability of the business relationships supporting the flow of goods, uncertainty is only moderate while still reflecting reciprocally interdependent relationships. The main effort of the collective of supply chain actors is to plan and control a sequentially interdependent production of food products.

	Uncertainty	Interdependency	Information use
Customer value	Low	Pooled	Simple auditing
Transactions	Moderate	Reciprocal	Collaboration
Production	Moderate	Sequential	Planning and control

Table II.
Uncertainty and interdependencies of banana supply

The studied banana chain, however, involves a well-developed set of dyadic relationships that repeatedly work together. The dynamics is associated to a limited degree with who participates in this supply chain system. Given the number of actors, primarily complexity and stability characterise this network structure. This is a large scope global network that is organizationally flexible to a large extent due to some degree of loose coupling. However, overall the complete supply chain is rather tightly coupled and relatively stable, so, uncertainty is predominately associated with the degree of flexibility within the complex system, and the technical dynamics associated primarily with how transactions are carried out at the operational level. Uncertainty emerges through spontaneous indeterminate processes (Gouldner, 1959) involved in the logistics operations of flowing bananas from Costa Rica to Norway. These processes, associated with the flow of bananas, are supported by information, enabling flexibility in a predominately closed system where the major actors are constant members implying a tightly coupled system. Rationality in this supply system is clearly bounded, since pure rational choice is simply impossible in the complex context that each described individual actor perceives. A functional, common and quite abstract aim of business survival keeps these actors integrated and trading with each other. This reveals a form of prominent deterministic supply chain discourse involving the planning and guiding of production operations that is an integrated part of supply chain structure, at the supply chain overall system level. These plans are, however, fragmented and local at the dyadic and process level. This implies that in practice it is difficult to plan goods transformation in detail due to the sheer scope of the system. Planning is vital but local and fragmented; sorts need to be provided with quality information.

Information provision and use in complete supply chains

In the described case, the Norwegian fruits and vegetables wholesaler is only one of many customers of the international fruit supplier, which indicates that, in this case, a task environment or "network" is better than the "supply chain" in explaining features of operations. In this study, a linear view of supply is taken, following the product from final delivery upstream. This modeling is, however, a simplification, since in reality the banana supply chain involves numerous interacting flows, e.g., flows for different plantations in different countries, competing national market customers, manifold retails, etc., i.e., the complete supply chain should be viewed as nonlinear and very complex. In this case, the supply chain represents an abstraction of the interactions of the many and different individual actors. This is exemplified by a lack of formal contracts that might help regulate the relationships between the international fruit supplier and the Norwegian fruit and vegetable wholesaler, for example. On the other hand, cooperative discourse is strong since the two companies are and have been loyal to each other for many years. Following Parsons (1960), the institutional level of responsibility and control is decisive in making this supply chain work. Information is provided to support the effective flow of bananas. This support takes place through sets of dyadic relationships, although these relationships are apparently strongly embedded in well-developed institutional controls found in a wider task environment of networked chains of service supply. They are not all directly interlinked, rather, following Thompson (1967), they are "long-linked." This means that connective coupling between any two entities is typically through intermediaries. Information in the sequentially interdependent supply chain reflects issues predominantly concerning who owns the bananas and how the bananas are transformed. Informing about production, including who is responsible for this production through transactions, is the core feature of coordination.

The transvection (Alderson, 1965) sheds important light regarding the big picture of the studied supply chain, namely, how production is technically organized. The various actors are sequentially interdependent in managing goods flows supported by information flows.

Coordination involves influencing the detailed timing this flow. In the case of seasonally-independent banana supply this is a continuous form of production, a never-ending set of reciprocally interdependent and mutual minor adjustments supporting the flow of bananas, and thereby the overall production. This flow is coordinated through stepwise emergent information provision that is rooted in banana transformation as well as changes in other important externalities such as the demand. The transvection helps reveal the complexity of production, as local management of flows and the need to coordinate among these sort events with varying impressions and assessments of uncertainty. This model also helps illustrate banana production as an emergent process, guided through a series of intermittent sorts with emergent properties.

The banana supply case reveals a routine practice of updating of logistics information held by the international fruits supplier, coordinated with the demand information held by the Norwegian fruit and vegetable wholesaler. This interaction engenders supply process emergence, but fortunately, thanks to coordinated operations, this emergence is coupled with a rather limited uncertainty. At present, the banana flow is managed manually. Given that most of the features of reciprocal interdependency are associated with routine interaction, this implies that these interdependencies are, although managed as sequentially interdependent sorts, these sorts are predominately pooled as interdependent regarding information provision and use. Enhancing connectivity of the sorts through standardization will reduce the need for mutual adjustment, thus reducing interaction costs. The sorts provide analytical lenses to discern more precisely how operations proceed and are coordinated. Information is predominately concerning the present and future of the goods. Traceability is a latent resource since it is seldom used and mainly in place because it is demanded by authorities where the bananas are to be sold. The importance of information visualization emerges at this operational level. Focus should be directed to enhancing the connectivity of people, devices, and documents. This connectivity involves management and production, and follows Parsons (1960). This connectivity facilitates the development of important institutionalised behaviors, in particular, the supply chain's networked discourse. The supply chain should aim to become a community where how development is to be carried out is widely agreed upon. In technical terms, information connectivity is mainly associated with tracking and logistics operations to supply the goods.

Developing information connectivity in a food supply chain

The case describes how supply in the chain structure is demarcated by sorts; following Thompson (1967), a long-linked form of technology characterized by predominate sequential interdependency. Therefore, these events demand more than planning to improve production sequencing supported by intensive technology in cases of high uncertainty, as shown in the case. The sequential decision-making events in the flow demand mediating technology to interconnect humans with the computer, and thereby interconnect different supply chain actors. This illustrates, in line with Thompson (1967), that any form of industry will reflect different types of interdependencies, but one is dominant, the analytical point of departure. In this case it is the sequential interdependency that instigates the model of the banana supply chain.

The banana case also involves considerations of pooled interdependencies, the use of mediating technology, more specifically to develop IT use. In the scope of the supply chain, information may be considered as a service element supporting production, and can therefore be analyzed following interdependencies different from that of the food chain itself. When using this mediating technology, the use of people to inform also suggests considering in further detail the human-information system interface. This is because full automation is still not possible due to limited technology and total IT investment costs. Visualization of BD can be applied in real-time fresh-food supply chains to improve customer value and reduce interaction costs. However, visualization tools and technologies need to be placed within a framework that can integrate the essential elements in a co-created SCM plan.

In the case of complex global banana supply, it may be possible to consider sources of data that are less structured in the analysis of the quality and value of the product. For example, a system might employ GPS BD telematics technologies to collect data about the durations of exchange periods at the handover control points between organizations in the supply chain. Additional information might be collected, such as the temperature of the pallets at the start and end of the exchange periods. A monitoring system might contain a choropleth geographic map of the supply chain and colors can indicate system values for temperature at the control points. That is, if there is an unacceptable temperature rise at a control point, the cloud-based system would note an alarm (e.g. red color) at the control point. This could be historically linked with later reports of customer satisfaction or dissatisfaction. This implies that IT represents a means of economizing the complete supply chain. Through increasing the relevance of pooled interdependencies, through IT investments, the costly mutual adjustments may be toned down. This implies considering IoT (including people, devices and documents) technology to increase information connectivity to increasingly automate how sorts are carried out, and how they are organized sequentially in relation to each other. The tranvection represents a tool to map how IoT may be implemented, focusing the sequentially interdependent nature of the managed sorts. Accordingly, using IT to develop this supply chain may be facilitated through conceptually modeling the chain founded on transvection logic and methodology.

Conclusion

The banana supply case shows that when taking an end-to-end perspective not only are sequential interdependencies predominant, production is also emergent. In line with Thompson (1967), some form of planning must be implemented to coordinate these sequences of production. The transvection model highlights how decision-making event, the sorts, demarcate the flow of bananas, helping to direct this flow. This sequencing of decision-making renders production an emergent process. This complete supply chain can therefore be characterized as a complex system founded on "transformation" as the key feature of production. As Alderson (1965) states, transformation involves changes in the time, place, and form features of a service. In this case, the provided service is visualized as banana production.

Rendering every daily banana supply to BD analytics is hardly called for. Information complexity is, as discussed, predominantly associated with the observations: pooled interdependencies are the constantly evident variation in production resource combinations in the context of sequentially interdependent sorts; and the effective core goods transformation depends on this pooling, as substantiating by positive customer value experiences. The case exemplifies limited reciprocal interdependency. It is a simple, albeit large in scope, production system. Following Thompson (1967), complexity in the case study is associated with process emergence contingent with the supply chain system context as well as a wider non-systemic environment. The supply chain in this end-to-end banana supply case mainly needs to be integrated through enhanced information connectivity supporting information exchange to cope with uncertainty principally associated with business-to-business transactions leading to changes in production. However, founded on enhanced information connectivity the production system is flexible, and can adapt. This relatively routine state of production may be improved through enhanced IT; increasing pooled interdependency using mediating (standardizing all production resources including information) technology to automate information connectivity. Connectivity is predominately associated with sorts, where humans interface with each other through the computer and other communication devices such as the telephone (as long as this technology can be assumed independent from IT) implying a persistent need to also enhance reciprocal interdependencies and the customer value cocreation effort.

BD as it is used in professional terminology may obscure what needs to be done to enhance quality supply in the studied food supply chain. It is possible that BD may somehow be a resource that may be applied in marketing to better understand consumer behavior. It is also possible that in some supply chain contexts little is known about the actors or environment. In this case consumption is simple and the supply chain is relatively tightly coupled. Uncertainty is mainly associated with complexity found within the supply chain system. Most management literature on BD is found in operations-related research and focuses on technical aspects of creating and using BD in operations. BD is a broad term but implies no IT-related magic wand (except perhaps in the imagination of the IT industry) that can improve how the described information flow may better support production. The need for electronic connectivity (EC) is more appropriate in suggesting that information flow may be improved using advances in IT. A process-focused view of handling data "volume, velocity, and variety" is called for. There are many interesting features of EC involving, e.g., IoT: people; devices; and documents, and EC may be used to classify operational changes in the realm of SCM. Thus, a view emerges that rather than talking about BD to develop supply chains, focus should be in integration, coordination and enabling technologies exemplified by IoT.

In the case, current banana supply activities are coordinated predominately through manual mechanisms. This suggests increasing the degree of automation through increasing pooled interdependencies in this supply chain now predominately characterized by long-linked planning technology. In the complete supply chain picture, these predominately indirect manual costs are often cloaked in obscurity within accounting systems that weakly interlink management costs with production costs. Visualization of complex and dynamic supply information represents a mindsight that may increase the efficiency in trading bananas, improving the efficiency of the human-computer interface.

This study is related to only one particular case. Hence, these findings and views should be further investigated in different types of supply chains. Further studies may also focus on IT-enabled process development in supply chain contexts, taking into consideration the current situation of ever increasing data complexity. Such studies may involve both IT-based improvement of the information flow to support banana production, and production understood as a purposeful transformation rendering service. Such research should also involve how people interact, including how they use the IT focusing on developing visualization which we regard as a core feature when considering enhanced data complexity.

References

Alderson, W. (1950), "Marketing efficiency and the principle of postponement", *Cost and Profit Outlook*, Vol. 3 No. 4, pp. 4-24.

Alderson, W. (1957), *Marketing Behavior and Executive Action*, Richard D. Irwin, Homewood, IL.

Alderson, W. (1965), *Dynamic Marketing Behaviour. A Functionalist Theory of Marketing*, Richard D. Irwin, Homewood IL.

Aloysius, J.A., Hoehle, H. and Venkatesh, V. (2016), "Exploiting big data for customer and retailer benefits: a study of emerging mobile checkout scenarios", *International Journal of Operations and Production Management*, Vol. 36 No. 4, pp. 467-486.

Arlbjørn, J.S. and Halldorsson, A. (2002), "Logistics knowledge creation: reflections on content, context and process", *International Journal of Physical Distribution and Logistics Management*, Vol. 32 No. 1, pp. 22-40.

Attia, A. (2018), "Supply logistics integration ion the Saudi food industry", *Business Process Management Journal*, Vol. 24 No. 4, pp. 1007-1022.

Brown, B., Chul, M. and Manyika, J. (2011), "Are you ready for the era of 'big data'?", *McKinsey Quarterly*, No. 4, pp. 24-27, 30-35.

Chen, H., Daugherty, P.J. and Landry, T.D. (2009), "Supply chain process integration: a theoretical framework", *Journal of Business Logistics*, Vol. 30 No. 2, pp. 27-46.

Christopher, M. (2016), *Logistics and Supply Chain Management*, 5th ed., FT Press, London.

Croom, S., Romano, P. and Giannakis, M. (2000), "Supply chain management: an analytical framework for critical literature review", *European Journal of Purchasing and Supply Management*, Vol. 6 No. 1, pp. 67-83.

Dill, W.R. (1958), "Environment as an influence on managerial autonomy", *Administrative Science Quarterly*, Vol. 2 No. 4, pp. 409-443.

Dubois, A. and Gadde, L.-E. (2002), "Systematic combining: an abductive approach to case research", *Journal of Business Research*, Vol. 55 No. 7, pp. 553-560.

Dutta, D. and Bose, I. (2015), "Managing a big data project: the case of Ramco cements limited", *International Journal of Production Economics*, Vol. 165, pp. 293-306.

Eisenhardt, K.M. (1989), "Building theories from case study research", *Academy of Management Review*, Vol. 14 No. 4, pp. 532-550.

Emerson, R. (1962), "Power-dependence relations", *American Sociological Review*, Vol. 27 No. 1, pp. 31-41.

Engelseth, P. (2012), "Modelling transformations in a complete fresh food value network", in Jodlbauer, H., Olhager, J. and Schonberger, R.J. (Eds), *Modelling Value. Selected Papers of the 1st International Conference on Value Chain Management*, Physica-Verlag, Berlin, pp. 373-391.

Engelseth, P. (2016), "Aligning end-to-end seafood supply through a series of markets", *International Journal of Production Economics*, Vol. 173, pp. 99-110.

Engelseth, P. and Felzensztein, C. (2012), "Intertwining relationship marketing with supply chain management through Alderson's transvection", *Journal of Business and Industrial Marketing*, Vol. 27 No. 8, pp. 673-685.

Erevelles, S., Fukawa, N. and Swayne, L. (2016), "Big Data consumer analytics and the transformation of marketing", *Journal of Business Research*, Vol. 69 No. 2, pp. 897-904.

Fosso Wamba, S., Akter, S., Edwards, A., Chopin, G. and Gnanzou, D. (2015), "How 'big data' can make big impact: findings from a systematic review and a longitudinal case study", *International Journal of Production Economics*, Vol. 165, pp. 234-246.

Fosso Wamba, S. and Mishra, D. (2017), "Big data integration with business processes: a literature review", *Business Process Management Journal*, Vol. 23 No. 3, pp. 477-492.

Frohlich, M.T. and Westbrook, R. (2001), "Arcs of integration: an international study of supply chain strategies", *Journal of Operations Management*, Vol. 19 No. 2, pp. 185-200.

Giunipero, L.C., Hooker, R.E., Joseph-Matthews, S., Yoon, T.E. and Brudvig, S. (2008), "A decade of SCM literature: past, present and future implications", *Journal of Supply Chain Management*, Vol. 44 No. 4, pp. 66-86.

Gouldner, A. (1959), "Organizational analysis", in Merton, R. (Ed.), *Sociology Today*, Harper & Row, New York, NY.

Gripsrud, G., Jahre, M. and Persson, G. (2006), "Supply chain management – back to the future?", *International Journal of Physical Distribution & Logistics Management*, Vol. 36 No. 8, pp. 643-659.

Gubbi, J., Buyya, R., Mausic, S. and Palaniswami, M. (2013), "Internet of things (IoT): a vision, architectural elements, and future directions", *Future Generation Computer Systems*, Vol. 29 No. 7, pp. 1645-1660.

Hazen, B.J., Boone, C.A., Ezell, J.D. and Jones-Farmer, L.A. (2014), "Data quality for data science, predictive analytics, and big data in supply chain management: an introduction to the problem and suggestions for research and applications", *International Journal of Production Economics*, Vol. 145, pp. 72-80.

Holbrook, M.B. (1994), "The nature of customer value", in Rust, R.T. and Oliver, R.L. (Eds), *Service Quality, New directions in Theory and Practice*, Sage Publications, Thousand Oaks, CA, pp. 21-71.

Lambert, D. and Cooper, M. (2000), "Issues in supply chain management", *Industrial Marketing Management*, Vol. 29 No. 1, pp. 65-83.

Lambert, D.M., Cooper, M.C. and Pagh, J.D. (1998), "Supply chain management: implementation issues and research opportunities", *The International Journal of Logistics Management*, Vol. 9 No. 2, pp. 1-19.

Liu, Z., Anderson, T.D. and Cruz, J.M. (2012), "Consumer environmental awareness and competition in two-stage supply chains", *European Journal of Operations Research*, Vol. 218 No. 3, pp. 602-613.

Lusch, R.F. and Vargo, S. (2014), *Service-Dominant Logic, Premises, Perspectives, Possibilities*, Cambridge University Press, Cambridge.

Meredith, J. (1998), "Building operations management theory through case and field research", *Journal of Operations Management*, Vol. 16 No. 4, pp. 441-454.

Mesa, J.C.P. and Galdeano-Gómez, E. (2015), "Collaborative firms managing perishable products in a complex supply network: an empirical analysis of performance", *Supply Chain Management: An International Journal*, Vol. 20 No. 2, pp. 128-138.

Oliver, R.K. and Weber, M.D. (1992), "Supply-chain management: logistics catches up with strategy", in Christopher, M. (Ed.), *Logistics: The Strategic Issues*, Chapman Hall, London, pp. 63-75.

Orton, J.D. and Weick, K.E. (1990), "Loosely coupled systems: a reconceptualization", *The Academy of Management Review*, Vol. 15 No. 2, pp. 203-223.

Pagh, J.D. and Cooper, M.C. (1998), "Supply chain postponement and speculation strategies: how to choose the right strategy", *Journal of Business Logistics*, Vol. 19 No. 2, pp. 13-34.

Parsons., T. (1960), *Structure and Processes in Modern Societies*, The Free Press of Glencoe, New York, NY.

Penrose, E. (1959), *The Theory of the Growth of the Firm*, John Wiley, New York, NY.

Pfeffer, J. and Salancik, G.R. (1978), *The External Control of Organizations*, Stanford University Press, Stanford, CA.

Rozados, I.V. and Tjahjono, B. (2014), "Big data analytics in supply chain management: trends and related research", *6th International Conference on Operations and Supply Chain Management, Bali.*

Schiavo, G., Korzenkowski, A.L., Batista, E.R.S., de Souza, D.L. and Scavarda, A. (2018), "Customers' quality demands as directions to the cold chicken supply chain management", *Business Process Management Journal*, Vol. 24 No. 3, pp. 771-785.

Surana, A., Kumara, S., Greaves, M. and Raghavan, U.N. (2005), "Supply-chain networks: a complex adaptive systems perspective", *International Journal of Production Research*, Vol. 43 No. 20, pp. 4235-4265.

Thiede, M., Fuerstenau, D. and Bezerra Barquet, A.P. (2018), "How is process mining technology used by organizations? A systematic literature review of empirical studies", *Business Process Management Journal*, Vol. 24 No. 4, pp. 900-922.

Thomas, G. (2011), *How to do Your Case Study*, Sage Publications, London.

Thompson, J.D. (1967), *Organizations in Action*, McGraw Hill, New York, NY.

Van Der Aalst, W. (2011), *Process Mining: Discovery, Conformance and Enhancement of Business Processes*, Springer Science & Business Media, Berlin.

Wang, G., Gunasekaran, A., Ngai, E.W.T. and Papadopoulos, T. (2016), "Big data analytics and supply chain management: certain investigations for research applications", *International Journal of Production Economics*, Vol. 176, pp. 98-110.

Xu, Z., Frankwick, G.L. and Ramirez, E. (2016), "Effects of big data analytics and traditional marketing analytics on new product success: a knowledge fusion perspective", *Journal of Business Research*, Vol. 69 No. 5, pp. 1562-1566.

Yao, Y., Drener, M. and Palmer, J.W. (2009), "Impact of boundary-spanning information technology and position in chain on firm performance", *Journal of Supply Chain Management*, Vol. 45 No. 4, pp. 3-17.

Yin, R.K. (2017), *Case Study Research: Research and Applications*, Sage, Thousand Oaks, CA.

Further reading

HKSAR (2002), *How to Implement A Food Safety Plan. Risk Communication Section*, Food and Environmental Hygiene Department, Hong Kong, available at: www.cfs.gov.hk/english/programme/programme_haccp/programme_haccp_7requirement.html (accessed March 1, 2016).

Lao, S.I., Choy, K.L., Ho, G.T.S., Tsim, Y.C., Poon, T.C. and Cheng, C.K. (2012), "A real-time food safety management system for receiving operations in distributions centers", *Expert Systems with Applications*, Vol. 39 No. 3, pp. 2532-2548.

Molka-Danielsen, J. (2011), "Exploring the role of virtual worlds in the evolution of a cocreation design culture", in Salmela, H. and Sell, A. (Eds), *Lecture Notes in Business Information Processing, "Nordic Contributions in IS Research – Second Scandinavian Conference on Information Systems", SCIS 2011*, Springer, Berlin, pp. 3-15.

Corresponding author
Per Engelseth can be contacted at: peen@himolde.no