Development of Industry-Wide IS Integration Model in the Agri-Industry

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Abstract his paper presents a model explaining industry-wide information systems (IS) integration in the agri-industry. Using a theoretical frame of value configuration analysis and IS integration extent we study 15 organizations. We find that product sensitivity, continuous production, value chain captains, and value creation logic explain the industry-wide IS integration. Incompatible value creation logic among stakeholders and the lack of presence of "value chain captains" – powerful actors dominating the entire industry - has and negative impact on industry-wide integration. On the other hand, product sensitivity and continuous production process led to higher levels of integration.

Keywords Agri-industry, Information systems integration, Value configuration analysis

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1 Introduction

The purpose of this paper is to develop a model explaining the existence, and absence, of industry-wide information systems (IS) integration. The theoretical foundation is an extension of IS integration extent (Massetti & Zmud, 1996), which we combine with value configuration analysis (Stabell & Fjeldstad, 1998). With its foundation in production technology and work process interdependency (Thompson, 1967) we believe that it will be especially suitable to explain why and how the actors integrate their IS. The interdependency frame enables us to identify potential information exchanges and value creation logic that explain integration. We draw upon a multiple-case study from the agri-food industry. This is a suitable industry for exploring integration issues, since it poses some unique characteristics, including crucial technology (Hamprecht, Corsten, Noll, & Meier, 2005), specific market structure (Wier, O'Doherty, Andersen, & Millock, 2008), elaborated industry-specific regulations (Ménard & Valceschini, 2005; Salin 1998) and limitations in the current IS integration (Aghazadeh, 2004; Akridge, 2003; Alfaro & Rábade, 2009).

IS integration is one of persistent business issues that since the 1960's continuously has reappeared on the manager's agenda (Adelberg, 1975; Blumenthal, 1969). Existing research has, in general, found a positive relationship between integration and organizational performance (Barki & Pinsonneault, 2005). Studies reporting on business benefits associated with IS integration are numerous (Bhatt, 2000; Henningsson & Carlsson, 2011). Nevertheless, despite the importance of IS integration the topic is sparsely developed. The IS integration concept itself is limited explored. Conceptualizations of aspects such as integration intensity and integration type are still not developed and explored (Markus, 2000). Exceptions include integration levels (Linthicum, 1999) and integration architecture (Markus, 2000).

Apart from the development of the IS integration concept, there is also a need to address IS integration on other analytical levels than the one of a single company or a two-part collaboration. Previous research addressing IS integration has focused on intra-organizational (Alsene, 1999; Konsynski, 1993) or two-part inter-organizational integration (Massetti & Zmud, 1996). Less is, however, known about integration of business activities that spans over industries or business networks (Konsynski, 1993). The agri-food industry context introduces issues of inter-organizational collaboration among several actors, as well as an increased multitude of IS, and organizational objectives. Although the technical challenges of IS integration may be similar regardless of intra- or inter-organizational context, the organizational and managerial challenges in industry-wide integration needs special attention as they presents a different integration context (Neureuther & Kenyon, 2008).

2 Information Systems Integration

Integration of IS has showed that integration of business activities can improve both efficiency and effectiveness of business activities. It can also lead to greater dependencies among participants and decrease organizational flexibility. It has been acknowledged that dependent business activities exist also across organizational borders (Barki & Pinsonneault, 2005). Studying two-part information integration has doubtlessly led to important knowledge contribution, but only recognizing the dependency of two parts is like only study integration of two activities of intra-organizational integration and not recognizing the advantages, disadvantages, and difficulties of integrating the whole organization. Much of the benefits created by intra-organizational integration are directly dependent on not only two activities becoming integrated, but on the orchestrating and harmonizing of all related activities. The same should logically be true for integration of industries, but the decision making business units have different requirements on the information-integration of the supply chain. Much of the benefits can only be gained if all activities are integrated, meaning that the integrated information flows should also be studied on an industry level.

The IS of industries are integrated to very different degrees, and the knowledge of why this is the case is limited (Bhatt, 2000). Financial institutions can carry out real time electronic transactions with almost any other institution in the world (Rhee & Mehra, 2006). In the automotive industry the use of EDI has led to decreased inventories and faster production cycles (Childerhouse, Hermiz, & Mason-Jones, 2003). Other more fragmented industries, such as construction and agri-food, seem to present IS integration that is only marginal in comparison (Tatari, Castro-Lacouture, & Skibniewski, 2007).

There is a dearth of concepts for describing, explaining, categorizing and differentiating IS integration. Nevertheless, in the literature we find three dimension to describe IS integration: by IS type (Weill & Broadbent, 1998), by level of integration (IT-, IS-, and Business-level) (Alsene, 1999), and by integration extent (Massetti & Zmud, 1996). In this paper we limit our study to the last category, even though it would doubtlessly be valuable if possible to relate IS type and level of integration to value configuration. However, as argued in previous research (Markus, 2000), integration extent is one important concept that needs to be applied and tested in new contexts.

2.1 IS Integration Extent

IS integration refers in general terms to creation of some sort of linkage between two or more previously separated IS that originally were not intended to work together (Markus, 2000). It can also be defined as the extent to which information through different communication networks can be shared and accessed for organizational use (Bhatt, 2000). We broadly define IS integration in industry as the extent to which IS are used across the entire industry. However, such a broad definition is not sufficient for the ability to collect data and say anything about to which extent an industry is integrated.

When it comes to integration extent there is a rough distinction between loose and tight integration (Themistocleous, Irani, & Love Peter, 2004). Loose integration refers to the distribution of data through asynchronous communication and low mutual dependability of business processes. Tight integration refers to high level of business process dependence and sharing of information through homogenous infrastructures with synchronous communication. An alternative is to adopt the four proposed EDI usage measurement (Massetti & Zmud, 1996): volume, breadth, diversity, and depth. We are tentatively extending these concepts into the industry-wide application area and define integration extent as:

• IS integration volume represents the extent to which an industry's information processing is integrated. A measure of IS integration volume is useful since it illustrates an industry's progress towards integration of information processing.
• IS integration breadth represents the extent to which an industry has integrated IS along with its actors. The IS breadth gives an idea about whether industry try to get rid of bottlenecks in the information flow.
• IS integration diversity represents the extent to which an industry has integrated different types of business processes through IS. This measurement is connected to the different functionality an IS support.
• IS integration depth represents the extent to which an industry's business processes are supported by IS at different

hierarchical levels. The IS depth lets us know if the industry uses IS as operational, tactical and strategic tool.

2.2 Value Configuration Analysis

The ways companies create value is similar across industries, but what activities distinguish companies is industry dependent (Porter, 1985). Value configuration analysis aims at understanding what activities drives cost and value (Stabell & Fjeldstad, 1998). The value chain framework provides us with an approach that, in principle, de-composes a company into strategic important activities and analyses the activities impact on cost and differentiation (Porter, 1985). The value chain analysis seems to be applicable and useful starting point to understand how cost and value relates to IS integration. However, criticism has merged over the years. "It is not only difficult to assign and analyze activities in terms of the five primary value chain categories, but the resulting chain often obscures rather than illuminates the essence of value creation (Stabell & Fjeldstad, 1998, p 414)". For example, consider software companies, banks or telecom operators that do not transform raw material into final products. Besides being difficult to apply, Stabell & Fjeldstad (1998) also claimed that different technology lead to fundamentally different ways of creating value, for example in telecom value is co-produced in the actual linkage or the mediation of parties (Ramirez, 1999). This is a different view than the classical industrial logic. Therefore is value configuration analysis proposed as a complement to value chain analysis and it draws upon three types of organizational interdependencies (Thompson, 1967):

• Pooled interdependency, meaning that each activity performed is interrelated and contributes to the final product.
• Sequential, the output of one activity is the input for next activity, i.e. each activity is a prerequisite of the following activity.
• Reciprocal, the output of one activity is the input for another, which in turn, directly or via proxy, is the input for the first activity.

With these three types of interdependencies as basis, three sets of value configurations emerge: the value chain, the value shop, and the value network. The basic idea is that these value configuration display different patterns of interdependencies and different value creation logics. The configurations may coexist within a company or within an industry with actors operating by different value creation logics.

The Value Chain assumes that conversion of raw material into final products creates value. In the process of converting inputs to final products long-linked technology is used. This is done through five primary activities: Inbound logistics, Operations, Outbound logistics, Marketing and sales, and Service (Porter, 1985). The primary activities are mainly sequentially interdependent and managed through coordination, i.e. the output of one activity is the input of the next. In addition, there is four support activities of the value chain model: procurement, technology development, human resource management and firm infrastructure. The drivers of cost and value are scale, capacity utilization, linkages, interrelationships, vertical integration, location, timing, learning, policy decisions, and government regulations.

The Value Shop, such as consultancy, software development, medicine, and design, creates value by solving customer problems. The value shop uses intensive technology to solve customer problems (Thompson, 1967) and drivers of differentiation are much more important than cost drivers (Stabell & Fjeldstad, 1998). Identifying resources that matches the requirements of the problem is the key process. One could describe value creation as "moving from one state to a desired state". Problem solving creates value in the process between customer and provider. The activities are sequential and reciprocal interdependent. The primary activities of a value shop are: Problem-finding, Problem-solving, Choice, Execution, and Control and Evaluation. Learning is the most important driver of long-term value.

The Value Network is the based on mediating technology (Thompson, 1967). This supports the process of creating links between customers who share a common interest. Mediating technology manages time and space for customers. By enabling linkage between actors, e.g. in a telecom company how links phone calls between parties or a bank how creates links between depositors and borrowers, creates value. Formal contracts govern the relationship between network participants. Value increases with the number of participants, i.e. network effects. Value networks entail three distinct primary activities: Network promotion (marketing) and contract, Service, and Network infrastructure. The activities are often simultaneous and lead to strong reciprocal interdependency between them. Standards are the main principle to control and coordinate reciprocal activities. Scale is bot a cost and value driver.

3 Research Methodology

The research presented in this paper was carried out as a structured case study framework (Carroll & Swatman, 2000). The structured case study approach includes guidelines for the process of developing knowledge and theory based on empirical data, but does not prescribe specific data collection techniques or ways of analyzing the data. The main steps are to develop an initial conceptual framework, to collect and analyze empirical evidence, and to reflect upon the result in order to induce knowledge.

To populate the theoretical framework, we centered around four product flows in the food industry: Milk, Pork, Peas, and Sugar. These four flows are embedded cases of the larger food industry case. They were selected due to their importance and since they present a variation in product characteristics. To achieve variation within the case, we started the investigation with farmers producing output representing different production technologies and market structure. Milk and meat are produced through continuous processes, while the other two flows are based on batch production. Peas are very sensitive, while sugar beets are not sensitive at all. A variation within the embedded cases were also considered to increase possibilities for valid theoretical generalization (Eisenhardt, 1989).

Data collection began with the first field visits. During the field visits we collected data through 27 semi-structured conversations guided by an interview guide. The visits lasted between 90 to 120 minutes. The interviews were taped and field notes were taken. After the field visit, the field notes were used to write a case story. The recordings were mainly used for supporting the field notes when writing up the case story. Interviewees were initially asked to explain and show the main activities of their organization. Whenever possible, we probed the respondents with questions about their main business activities, customers, suppliers, and use of IS in the businesses. In addition, public available documents, such as annual reports and web pages, were used to enrich the picture and to triangulate findings (cf. Yin, 1994). The individual respondents were owners of the firms (farmers), chief information officers, or financial officers. For customers, suppliers, and collaborators the data collection was repeated until the most important actors, according to the respondents, were identified. In total, we interviewed representatives from seven farmer units, four food processors, two grocery chains and two retailers. We also interviewed four organizations that influenced the IS integration among the actors in the food industry: one agriculture consulting company, one information system integrator who had developed several of the integration solutions in the industry, the Swedish Agricultural Agency, and the Swedish Customs. Based on the data eleven rich case stories focusing on the primary actors of the industry of about 2000 word each were written. These were then used as input for first round of analysis and reflection.

The first round of analysis and reflection was mainly done to capture the individual actors and the main forces shaping the IS integration. Since the focus of this paper is on the industry level and not the individual actors the case description and analysis in this paper is the study's second analytical phase, focused on the industry level and the integration of this. The industry level analysis followed a second empirical phase in which complementary data on the relations between identified actors were gathered. When gathering data special concern was given to the preliminary IS integration shaping factors and their explanation in the value configuration.

4 IS Integration in the Food Industry

The number of end consumers in the Swedish food industry is just above ten million consumers. Three large grocery chains, with a total market share of 72%, dominate the Swedish market. ICA and Axfood are private companies, whereas Coop is a cooperative owned by the consumers.

There are several food producers in the area, such as Procordia Food AB, Findus Sverige AB, Skånemejerier, and Pågen AB. Skåne is the most important agricultural area of Sweden with some 8700 farmers. The main food products from Skåne are different types of crops, dairy products, rapeseed oil, sugar beets, and meat. In addition to the companies directly involved in food production, there are several other actors in the food industry. These actors have a control and quality function, and the potential to influence the production and the end customers and their preferences, such as KRAV (certifier of organically produced food), European Union (EU) and its Common Agricultural Policy (CAP), National Food Administration, Consumers in Sweden, customs, service providers, and Agricultural Universities. In particular, CAP is influential, since it comprises a set of rules and mechanisms that regulate the production, trade and processing of agricultural products in the EU

4.1 Milk Flow

The milk production utilizes milk robots and automatic feeding machines. The data collected by the milk robots (for example amount and quality) is linked trough an IS to the Diary Association, which makes analysis provides feedback, e.g. on quality and what to feed the cows with.

The farmer sells its entire production to the dairy, and the price is based on quality (fat and protein) and quantity of the milk. When the dairy receives the milk, it is pumped into storage silos. Taste and quality are checked upon arrival to the dairy. Thereafter the milk is cooled down and the cream is separated from the milk. Before the milk is packed it is homogenized. The origin of the packaged milk is kept track of by the dairy, which has about 900 dairy farmers delivering milk. Using an identification number, makes it possible to trace each package to a specific milk batch. The farmer use the shipment id to identify, which cow delivered the milk and can thereby provide the full medical history of a specific cow. The dairy delivers its products to the local grocery stores or to central storage facilities of the large grocery chains. The end-consumers then buy the product from the grocery.

To support the process between farmers and grocery stores the dairy uses two ISs. The ERP-system is used to handle logistics, purchasing, resource management, financial assets, maintenance, supply chain management and data warehousing. While the EDI/Link-XLM system is used to manage the electronic information flow (order, invoicing, and payment) to and from farmers and customers. The EDI/Link-XLM system is fully integrated with the ERP system.

The local grocery collects data through their sales terminal and customer loyalty card, but this data is not pushed down to the dairy or the farmer. The local groceries employ an automated inventory control system, which communicates the supply need to the dairy. End consumers have no automated information integration with any other actor than their local grocery. The data that is passed on from the local grocery to the retail chain is of transactional reporting on amounts sold and needed.

4.2 Sugar Flow

A web portal provided by the sugar mill supports the sugar production. The amount of sugar beets that the farmer is allowed to grow and deliver to the sugar mill is regulated in a contract between the parties. In order to control the flow of sugar beets to the sugar mill there are strict delivery plans that the farmer has to follow. Most of the information exchange between the farmer and the sugar mill is done through the portal. The information consists of invoices and dates for seed distribution. The information flow is one-way, from sugar mill to the farmer.

The sugar mill has a regional monopoly an ERP-system to support its core activities, internally as well as externally. The modules used in the sugar beet information flow are: Agri, Sales & Distribution, and Logistics. The Sales & Distribution module is used to handle the information exchange between sugar producer and their customers, while the Logistics module aids the transportation of the processed product (feed and sugar). Agri is used to control the delivery of beets from farmers by creating delivery plans. The module is connected to the web portal www.sockerbetor.nu. The sugar producer aims to guide the farmer on how to best cultivate sugar beets by providing information, for example appropriate PH levels, protecting against erosion, balanced fertilization and numerous hints and tips on how to protect and salvage parasite infected crops and soil. After the sugar beets have been harvested and transported to the sugar mill, the raw sugar is extracted from the beets. For processed and packaged sugar the relation to the grocery store is similar to the relation between dairy and grocery store.

4.3 Pea Flow

The pea processor controls the entire production. The planning process has an 18-month time horizon, i.e. the foundation that is laid in March should produce a harvest in August the following year. To support this pea processor has developed a concept called LISA (Low Input Sustainable Agriculture), which aims to structure the process and minimize the weaknesses. The base in LISA is the selection of fields for growing peas by analyzing the soil in different fields, picking the most suitable fields and monitoring the development of the crops while looking for signs of harmful organisms. The subsequent harvest and processing of the peas is also a highly controlled and automated process. It is pea processor who controls the information gathering, and they more or less tells the farmer what and where to grow the peas. In addition, the processor does the actually harvesting. What can be said is that the farmer more or less only gives access to its field and make sure that the soil is prepared as it should be before the sowing.

The pea processor uses ERP-systems from both SAP (R3 for financials and administration) and Lawson (Movex for logistics and production). They supply the farmers with information about which fields are suitable for pea cultivation, when to plant seeds, how much and what kind of fertilizing. Information is extracted from databases, which are based on soil samples from the farmers' fields. This means that in many cases the processor knows more about a field than the farmer who owns it. In addition, the processor harvests the peas with their own machines. In the production at pea processor's plant, data about peas, such as quality and origin, is gathered enabling feedback to the farmer. Today the information flow is broken when the peas are packaged for consumers. There is no integration between the pea processor production system and the packaging system.

The relation between pea processor and the local grocery stores are similar to those for the milk and sugar producers. However, most of the pea production is frozen and exported abroad, mostly to Italy who is the worlds' largest consumer of peas. The peas are then sold on an open market to any willing buyer. However, using a printed code on the package peas can still be traced manually to a specific batch if necessary.

4.4 Pork Flow

The pork farmers are specialized on pig breeding and have one single costumer. Scan. The farmers make yearly agreements on production quotes. Pork quality is based on percentage of fat in the meat. Low percentage of fat increases the value, making slaughter easier. However, low fat percentage affects the taste in a negative way. To benchmark the individual farmer the slaughterhouse provides the farmers with access to a benchmarking system, namely PIGWIN. The farmers use PIGWIN to compare their own productivity with other breeders. They also use a web portal supplied by processor with information such as the quality of the animals they have delivered, and how much the processor are willing to pay for these. In addition, the pig farmers' informs the pork processor about how many animals they will deliver to the slaughter.

The food processor is one of the largest slaughterhouses in Sweden, owned by the breeders. The information flow starts with the communication between the farmer and the food processor. The farmer notifies the pork processor via the Internet, SMS or telephone, on how many and what kind of animal that he/she wants to deliver. The food processor uses several different systems to collect data about the animals, for example their weight, age and origin. All of the information from these systems is sent to the ERP system. The pork processor uses approximately 4-5 systems when interacting with the farmers for handling payment, butchering notifications and so on. They also use a CRM system when collecting the information from the farmers which is used to keep track of all of the 17 000 breeders. Swedish Meats has decreased their client list from over 10 000 customers when almost every super market was their customer, down to a customer basis consisting of 3 grocery chains and 100 industrial customers. Even though the system handles the whole process from the farmer to delivery, no detailed information is passed on to the customer. It is possible to have a continuous information flow from the origin to the end customer, if requested.

5 IS Integration Extent and Value Configuration

5.1 IS Integration Industries

Table 1 presents a summary of IS integration extent. Generally, the extent of IS integration is closer between farmers and food producers then between food producers and grocery chains and their retailers. The IS integration between food producers and the grocery chains relates mainly to the demand for order and delivery. There is also a flow of information governing invoicing and payment for the products. To this end EDI solutions are de facto standard for all involved parties. There is little or no IS integration dealing with, for instance, sales data from the grocery to the food producers. Thus, the grocery chains keep the producers in uncertainty by not sharing sales data. The business logic between retailers and food producers is based on market mechanism without any overall governance. The final link between retail chain and end-customer IS integration through the use loyalty cards and cash register data. Nevertheless, not to precede the analysis we begin with the four facets of IS integration extent: Volume, Breadth, Diversity, and Depth.

Table 1 Operational Definitions and Indicators

Extent	Milk	Meat	Pea	Sugar
Diversity	High	Moderate	High	Low
Depth	Moderate	Moderate	High	Low
Breadth	High	High	Moderate	Low
Volume	High	Moderate	Low	Low

IS integration volume refers to the extent an industry's information processing is integrated. Looking at the entire food chain, we can see that parts of the information processing are integrated. For instance, between farmers and food producers there is a high degree of information processing to make the farmers more efficient (e.g. optimize the use of fertilization and pesticides) and effective (e.g. quality of the products. The information processing entail feedback loops where the farmers receive feedback on quality of the products and suggestion of how to improve their internal activities. The integration is based on collaboration between the farmers and the food producers governed by contracts. The farmers also have vertical information processing with external quality agencies, e.g. milk and pork production. When looking at the information processing from the food producers' point of view and up-ward the food chain to the grocery chains and the retailers another picture emerges. The integration is not as tight. It is mainly concerns order, delivery and payment. However, between the grocery chain and retailers the integration becomes tight again. The end customers are also integrated through loyalty cards.

IS integration breadth refers to the scope of purposes for which IS are integrated. The farmer's use IS to control their core activities, such as harvesting, fertilization and feeding. IS are in most cases embedded in the production technology, such as tractors with GPS navigation and smart boxes, and automatic feeding for cows and pigs. Looking at the relationship between farmers and food producers there is high degree of IS integration breadth. The food producers largely provide these systems to the farmer. Different IS solutions supports production planning, delivery planning, and quality assurance. There are also IS support for administrative processes, such as invoicing and payments. Except for the pea flow, which is ran by the food producer. Continuing up the food chain the IS integration breadth decreases as only the functional and not operational activities are integrated. When it comes to the grocery chains and retailers the IS integration breadth increases again. The grocery chains provide their retailer with integrated IS for all their activities including cash terminals and loyalty cards.

IS integration diversity, i.e. the degree of IS utilization in different types of business processes. Staring with the pea flow, the fertilization and weed control (the only activities performed by the farmer) is fully integrated with the tractors GPS supported smart card. Data on soil quality and weeds is continuously updated into the smart box, which then controls the fertilization and the use of pesticides based on current data and historical data. The smart box actually controls the tractors when it is out on the fields. The sowing date determines harvest and the closer the harvest the closer the food producer monitors the quality of peas. When it is time the food producer harvest and freezes the peas. The pork and milk flow has similar IS based integration. Feeding of the animals is done through computer support and the process is transport to the food producers and the external quality agencies. Input from the food producers and the external agencies directly influence what the animals are fed. Traceability of both milk and pork seem to be the main drivers. Delivery plans are written in the contracts between the farmer and the food producer. The farmer gets reminders through SMS. Sugar on the other hand is one of the few crops that the farmer actually has some own control off. The business processes integrated here are the same as for the pea flow, but the delivery is supported by a web-based system. The batch production mode with low product sensitivity explains the low need for stronger integration. Upwards the IS integration stops except for order, delivery and payment processes, expect between the grocery chain and the retailer.

IS integration depth, i.e. the use of IS on different hierarchical levels. The farmers' just use IS for transactional support on an operational level. However, the food producers' and the grocery chains utilize ISs at all levels (operational, tactical and strategic).

5.2 Value Configuration in Industry

Analyzing the food chain from a value configuration perspective two main value configurations emerge. In the beginning of the food chain, we can identify a value chain model, but looking at the end, we have a value network. The two value configurations are not ideal, but they both have characteristics that correspond to other value configurations. This is in line with that any real world cluster of actors will have features of several value creation logics (Stabell & Fjeldstad, 1998).

At the top of the food chain, including grocery chains, retailers, and end customers the value configuration primarily corresponds to a value network. The value creation logic is actually about orchestrating the network of customers and suppliers. The grocery chains and retailers are providing a market, where suppliers of food meet consumers of food. In that sense, it is about linking customers. In relation to the primary activities, network promotion and contract management, service provision, and infrastructure operation, a core activity is attracting potential customers and suppliers to participate in the network. The service-provisioning concept (associated with establishing, maintaining, and terminating links between customers and billing for value received) needs to be interpreted in a slightly different by viewing the retail stores opening hours and location as service provision where links between customers are established maintained and terminated. The final primary activity, infrastructure operations is the running of retails stores (the market) and keeping the cash registrar working. In addition, for the grocery chains and the retail stores a key activity is inbound and outbound logistics. However, there is no conversion of inputs to outputs. When considering the relationship between the activities they are carried out simultaneously and in parallel, which is consistent with the value network. The interdependency of activities is pooled and sequential. The inbound and outbound activities are sequential in nature. The last and final point is related to the cost and value drivers that are both based on scale and capacity utilization.

At the start of the food chain from farmers to food producers, we find several similarities and some differences. The four food chains are all based on a value chain logic converting inputs (seeds and food) through feeding, fertilization, and harvesting into final products (peas, sugar beets, milk, and pigs). The relationship between the activities is sequential, but there are also a number of iterations and feedback loops between the farmers and food producers. The interdependency is pooled, and sequential. Scale and capacity utilization drive cost and value. The food producer relies on value chain logic and traditional primary activities, such as inbound logistics, operations, outbound logistics, sales, and marketing. The relationship between inbound logistics (harvesting) and operations (freezing) is sequential and the interdependency is sequential. Cost drivers are based on scale and capacity utilization. Value on the other hand is based on reputation.

Peas and sugar flows are produced in batch production with harvest ones a year. Sugar beets are not as sensitive as peas regarding when to harvest them or where to store them before final sugar refinery process. The value creation logic is also based on refining inputs (seeds) to output (sugar beets). Milk and pork production, on the other hand, is different in that the production mode is continuous which creates high degree of interdependency with the customer. A continuous process is built on a tight integration between the involved actors, which is supported by IS integration. The interdependency between activities is sequential. The sequential flow is also vertically integrated with external agencies. The external agency supports the milk farmer with information to improve the quality. In addition milk farmers are the farmers that are most advanced in their use of IS, the entire process is monitored and controlled with the assistance of IT. IS integration between farmers and food producers are mainly related to "production" data, with complementary support of secondary processes. The farmers and the food producers are tied to each other with long-term contracts. Thus, farmers and food producers collaborate with each other to reach mutual benefits and thereby have a tight integration. The milk producers have contracts with different local grocery chains and larger retailer. They deliver different milk products on a regularly basis.

In summary, the industry-wide food chain has the shape of a sandglass (Figure 1). At the beginning, a great number of farmers create the raw material for the industry. For each of our empirical subcases it can be claimed that one major actor dominates the food chain. In addition, each of the food flows has just one major food producer – leading to an almost monopolistic position situation, cf. the milk flow. The theme has been noticed being typical for the food industry (Salin, 1998), starting with a large number of farmers and suppliers, in the middle a small number of producers and distributors, ending with a large number of consumers. The farmers and food processors have relations ranging from almost pure value chain logic (sugar) to more co-creation logic (pea). Together the production cluster forms a unit in the value network dominated by the grocery chains.

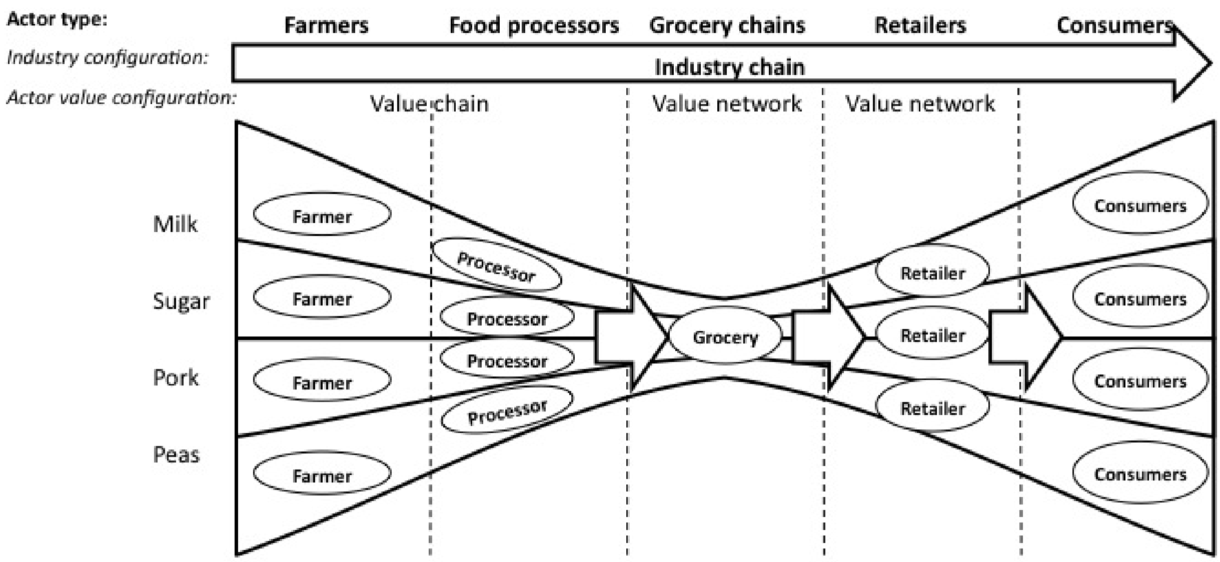

Fig. 1 Industry-wide food chain integration

6 Discussion: Drivers and Inhibitors for Industry IS Integration

Our analysis of the relations between farmers and food processors showed that extent of both organizational and informational integration varied from minor (between sugar farmers and processor) to almost fully integrated (between pea farmers and processor). Consolidating this finding with the value configuration analysis shows that the level of integration corresponds well to the actor's position on a continuum between ideal value chain logic and ideal value network logic. In other words, the more network like the production, the more integrated. Most integrated is the milk production. Thereafter follow peas, pork, and fourthly the production of sugar beets. Interestingly there are two "incompatible" value creation logics, value chain and value network, in the same industry. This change of value creation logic is at the heart of the rupture in IS integration.

The value configuration analysis showed that dependency between the actors relates to the sensitivity of what was produced. Food products are sensitive to heat, coldness, time, and sun. The sensitivity of food products is one of the key distinguishing features of the food industry. Compared to milk and peas are more sensitive than pork and sugar. The need for tight monitoring of sensitive products has made the food producers to develop and diffuse IS to their suppliers – who do not have the resources to develop their own information systems.

Dependency between farmer and producer relates to the production mode, i.e. whether the production is in batches or continuous process. A continuous production poses different requirements on IS integration than batch production, since there is a need for a frequent communication between farmers and food producers to track delivery and quality.

In particular, the milk farmer needs quick feedback on the quality – especially if the milk contains certain hazardous bacteria. Arranging the four products in terms of batch/continuous production mode gives that milk followed by pork are the products closest to a continuous flow, while peas and sugar are close to an ideal batch mode production with harvest and processing once a year. Thus, through the mediating state of increased dependency product sensitivity and production mode are drivers of IS integration in the food industry. This conclusion is in line with it resembles the general conclusion that the unique features of an industry drives the IS integration (Bhatt, 2000).

The analysis of the relations between food producers and grocery chains showed that there was a significant rupture in the IS integration between these actors. The farmers and food processors are to some degree integrated, and likewise were the grocery chains and the retailers on their side. Previous research had shown that different value creating logics have different cost and value drivers according to the type of activities involved and the interdependencies between them. Where multiple logics coexist, the different cost and value drivers may generate tensions (Bygballe & Jahre, 2009). We see that the different value creation logics of the food industry affect the IS integration extent by the dimension of integration depth; the only information exchanged digitally between producer and grocery chains are orders and invoices as the actors only share the functional and not the operational processes.

A fourth important influencing factor is the presence of what we have labeled as value chain captains. This concept refers to the none-existence of an overarching control organization that looks out for the entire chain's best interest. Farmers and food producers seem to benefits mutually from their IS integration collaboration, but the retail store and retail chains do not perceive benefits to themselves by collaborating with the food producers. Therefore, there is only IS integration on administrative level for order, invoicing and payment – aiming at efficiency gains. Thus, comparing IS integration in internal supply with information in an industry-wide supply chain there is besides the lack of common management level described above, logically also the issue of asynchronous savings by integration efforts. Therefore, in the light of the disjoint economic responsibility and asynchronous gains and costs, we see the role of the value chain captains. The captains are using their dominant positions to enforce IS integration that lays in their direct interest. Very often, the costs have to be carried by the smaller actor in the supply chain, while savings mainly are made within the realm of the captain. Backward integration is also more prominent than forward integration in the four cases. Backward integration is associated with efficiency gains in for example reduced inventory, faster time to market, and more reliable output (Hedman & Kalling, 2003). Forward integration is associated with decreased demand uncertainties, development of market specific strategies, quality assurance and lock-in effects (Childerhouse, Hermiz, & Mason-Jones, 2003). Problems with proving positive financial impact of forward integration may make companies further down the supply chain more reluctant to IS integration than companies near the end customer. The question to ask is thus whether this is due to benefits of forward integration are fewer or just harder to proof in numbers.

By the value configuration and IS integration extent analysis, we identified four factors explaining industry IS integration. Figure 2 summarizes the explaining factors. High degree of product sensitivity and continuous production mode is positively affecting or demanding IS integration. Differences in value creation logic are influencing negatively IS integration, but the effects are limited by the presence of value chain captains that can enforce integration. Product sensitivity is a unique industry factor. We assume that similar factor exists in other industries industry, c.f. (Bhatt, 2000). Production mode is not an industry specific factor, but it is an influential factor driving IS integration and it is related to the core activities of a business. The lack or presence of value chain captains is a managerial factor applicable to all fragmented industries with differentiated value creation logics.

7 Conclusion

This paper develops an explanatory framework for describing and explaining IS integration in industries, based on value configuration analysis (Stabell & Fjeldstad, 1998) and integration extent (Massetti & Zmud, 1996). We identify product sensitivity, production mode in the form of batch versus continuous production, differences in value creation logic and lack of value chain captain as four factors explaining the current state of integration in the food industry. Applicability to other industries is dependent on the presence of the mechanisms linking factors to impact described in the paper. Extrapolating the findings from this study industries with sensitive products are likely to be more integrated than industries with none-sensitive products. For instance, high-tech products, such as mobile phones and computers, are sensitive to time, since they rapidly lose value on the market. So also, industries with continuous production mode and industries that are centered on one or a few major actors who can decide the terms of doing business, as the automotive industry.

Returning to the outset of this paper, the research was partly founded upon the findings that industries were to a varying degree integrated in their IS (Bhatt, 2000). However, it was not explored further what caused this difference

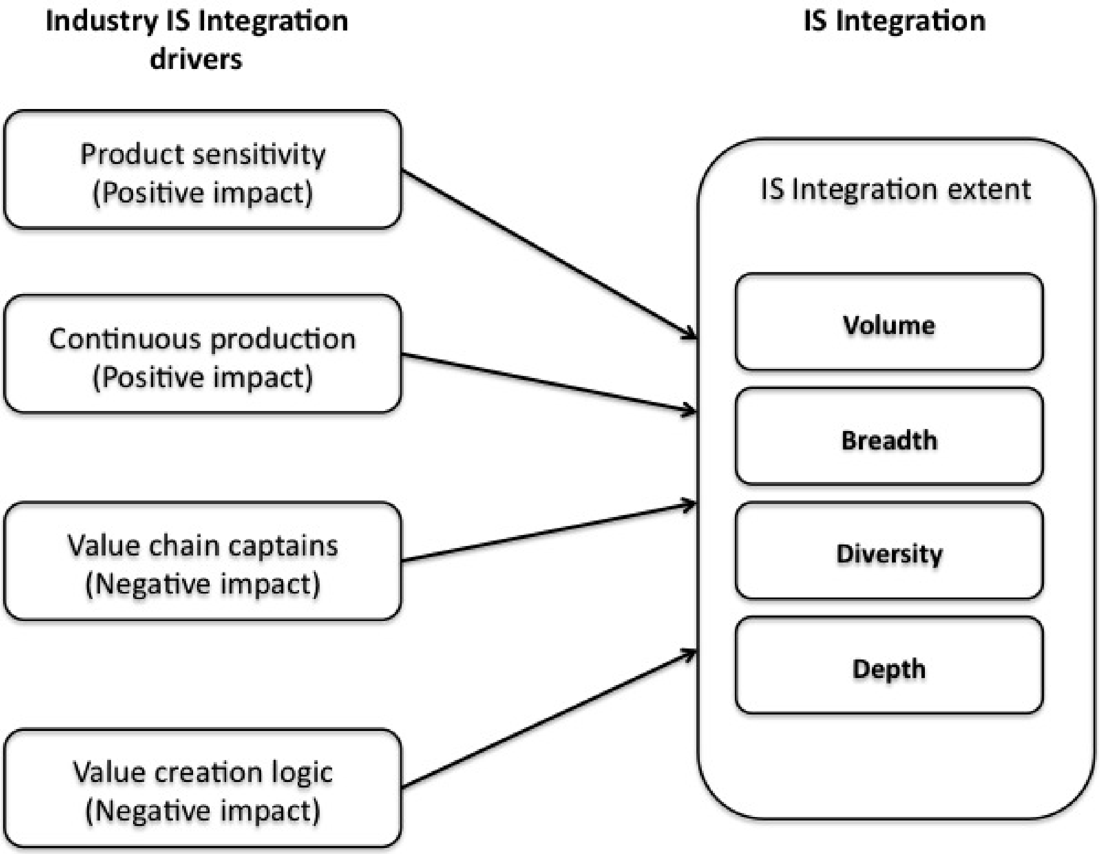

Fig. 2 Explanatory model

and by which mechanisms. We found four industry-specific factors that influence IS integration in the food industry. We have also started to outline how the mechanisms work, which is essential in order to understand if and how the factors influence in other industries.

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