The implications of EU food safety legislation and consumer demands on supply chain information systems

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Abstract

The European consumer has become increasingly concerned about the safety of food and the negative effects of bio-industrial production. This concern has been strengthened by several sector-wide crises in the last decade (such as the BSE crisis, the dioxine crisis, classical swine fever and hoof and mouth disease in Europe). Governments, both national and international, respond by imposing new legislation and regulations. Retailers react by imposing new demands on their suppliers. In this paper, retailer demands and legislation on product labeling, quality assurance and product liability are related to three cases: a meat chain, a fresh produce chain and a food industry. To comply with the new demands, companies are forced to introduce sophisticated information systems that focusing on identification, registration and tracking and tracing.

Key words: EU-legislation, food supply chains, tracking and tracing, information systems

1 Introduction

Crisis in the European food sector

A research project carried out in Januari 1998 by the European Commission. showed that 11% of all food products that are controlled in the European Union (EU) do not comply with the demands of EU legislation. It is estimated that millions of Europeans get sick every year from food contamination. Important causes are salmonella, campylobacter and E-coli O 157. Consumers can find recall announcements almost weekly in any newspaper.

Since the discovery of BSE, in cattle as the probable cause of the deadly for humans variant Creutzveldt-Jacob, there has been a large-scale crisis in the European cattle sector. Between 1990 and 1999 there was a reduction in sales of cattle meat in the EU of 6% (with peaks and falls). The British meat sector suffered the most from the crisis in this period. In 2000 several new discoveries of BSE were made in other European countries, like France and Germany. By mid-Februari 2001, the consumption of cattle meat had dropped by as much as 80% in Germany.

Increasing complexity of the global food system

New consumer demands, combined with increased international competition and new technologies have had a great impact on the complexity of the global food system. Demand and supply are no longer confined to local, or regional, supply. This has spurred an enormous growth of product assortment in the supermarkets (in most supermarkets in the 1990s the number of articles more than doubled from 10,000 to more than 25,000).
We see on the one hand an increasing concentration in the agribusiness sectors and on the other hand an enormous increase in cross-border flows of livestock and food products (which stimulates the spread of infections). These developments seem to increase the chances for crises such as described above to repeat themselves.

In the next section demands related to food safety are discussed. In sections 3, 4 and 5 implications of these demands on the level of the supply chain and on the level of the company

are described in three cases. Section 6 gives the implications for company and supply chain information systems. Sections 7 concludes the paper.

2 EU government and retail demands

To describe demands to information systems related to food safety in the supply chain we must make a distinction between governmental demands and retail demands, in which the retailer represents consumer demands.

Demands from retailers to companies in the food chain

Demands regarding food safety from (EU) retailers are best represented by two examples: Eurep-gap demands and demands from the British Retail Consortium.

Eurep is an organization of more than 20 large European retailers and purchase organizations (e.g. AHOLD, TESCO). GAP stands for Good Agricultural Practice. It is a package of norms aiming to guarantee environment-friendly, safe and high-quality products. The demands are gradually increased. For example the fruit and vegetables suppliers of Albert Heijn (AHOLD) in the Netherlands must comply with the Eurep-Gap demands as of the end of 2002. This means that growers delivering to Albert Heijn must further decrease their use of pesticides. (Anonymous 2000). The norms of the Eurep-gap retailers are more rigid than (EU) governmental demands.

The norms of the British Retail Consortium (BRC) regard hygiene and safety. As in the above example, companies delivering to Albert Heijn must be certified according to these norms starting on 1 January 2002 (Anonymous 2001). Furthermore, the leading retailers want to achieve complete traceability for vegetables and fruit before the end of 2001.

Within Europe we see also important differences in the demands of retailers. An example is the policy of British retailers to only buy bacon originating from pigs that have been raised in group-housing. This demand is a translation of the wish of the British consumer to pay attention to animal welfare.

EU legislation

EU governmental demands focus on three areas: product labeling, product quality and safety assurance, and product liability.

EU legislation with regard to product labeling

In the last decade there has been extensive new legislation regarding labeling of products (Anonymous 2001a). The aim of labeling is to inform the consumer about characteristics such as composition and origin.

Table 1. Typical information provided on product labels

Name and type of product	Special instructions for storage or use
List of ingredients	Name and address of producer or packer
Amounts of most important ingredients	Place of origin
Net weight or volume	Instructions for use
Best-before date	Percentage of alcohol

In the last years a discussion has arised between the EU and the USA on labeling of GMOs. Labeling of GMOs is obligatory in the USA only if the product differs essentially from the "original"; if the nutritional value differs; or if the product contains an allergen that is not present in the original. The EU demands that all GMO products must be labeled as such. Another difference between the EU and the USA is reflected by the following example: the US dairy industry may label milk of cows not treated with the bST hormone as such only if the label also states that there is no indication of significant differences in milk from cows treated with bST. (Folbert and Dagevos, 2000)

EU legislation on product quality and safety assurance

Legislation regarding product safety focuses primarily on the required organizational measures needed to guarantee product quality and safety. Food safety systems now generally refer to HACCP or related systems. Hazard Analysis of Critical Control Points aims for identification, evaluation and control of significant and potential dangers related to food safety. HACCP systems identify a number of critical control points in business processes for which critical values must be defined. Measurement in these control points must lead to prevention of problems.

Application of the HACCP concept is obligatory for most links in the food chain. An exception is the primary sector (the farm), where the HACCP concept is still being developed.
A next step will be the supply-chain-wide implementation of HACCP.

EU legislation on product liability

The starting point of this legislation is that the legal entity that puts a product on the market is liable for all damages caused by deficiencies of that product. So, a manufacturing company is always liable for the products it puts on the market, even if the company is not at fault. It is possible, however, to 'pass the buck' to other actors in the supply chain if a manufacturer is able to prove that the necessary procedures were carried out according to the dictated standards. Other links that can be held responsible are the EU importer, the legal unit responsible for the product's brand name, or the legal unit that trades the product under a generic brand name. (Commission of the European Union, 1999)
Under new guidelines, 99/34/EG, producers of agricultural products will be subjected to the same liability requirements that have been in force for other producers under current guidelines 85/374/EEG. Among these requirements is the rule that the injured party has to prove the damage, the product's deficiency and the causal link between these two.

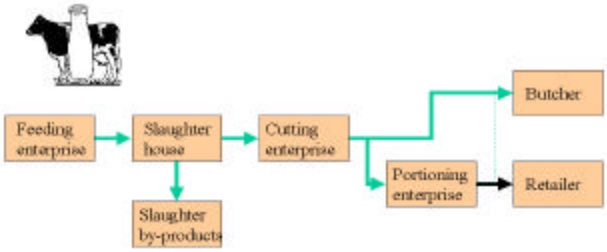
A major difference between legislation and consumer concern in the EU and the USA seems to be that the EU consumer and EU legislation are much more directed at the prevention of problems, i.e. how a product is produced. The main concern in the US has up to now been the safety of the end-product. This could explain why in Europe much more attention is paid to social, ethical and ecological issues than in the US (Folbert and Dagevos, 2000).

In the next three sections implications of legal and retailer demands will be described.

3 Implications on supply chain level; case of the meat chain.

Figure 1 shows the veal and beef chain from farmer to retailer.

Figure 1 structure of veal and beef chain



Since last year, new labeling rules for beef products have come into effect in the EU to improve the traceability of beef and to provide more information to the farmers and consumers. As of 1 September 2000 the following items have to be included in beef labeling: a reference number corresponding to the animal or group of animals, the country in which the animal was slaughtered, the country in which the animal was cut, and the reference number of the cutting enterprise. As of 1 January 2002, the country in which the animal was born, and in which it was raised have to also be indicated. It is interesting to note that this regulation emphasizes the place of origin and not the manner in which the product is produced. One could question whether it is so helpful to know if the animal was born in country a or b.

A disadvantage of this system is that such labeling could inadvertently serve as an advertisement for meat from certain member states (French people would prefer to eat French meat, for example). In addition, non-EU countries would also have to be identifiable. But these countries often lack good I&R (identification and registration) systems and well-functioning controlling agencies.
Another disadvantage according to many cattle farmers is that these regulations will restrict their flexibility and decrease efficiency in various links in the chain, such as in buying, processing, transporting and selling. Groups of animals will have to be separated depending their their place of origin. This will lead in any case to less efficient use of the available

capacity in the chain. For the consumer this may mean that meat will be sold more often pre-packaged with an identified country of origin.

4 Implications for identification and registration of data; case of a fruit and vegetables trader

The figure and table below illustrates incoming and outgoing streams of products and transformation processes for an average fruit and vegetable trader (Ilekhomon-Troost, 2001). An average trader in vegetables and fruit in the Netherlands has between 50 and 100 suppliers.

Figure 2 Suppliers and customers of an average trader in vegetables and fruit

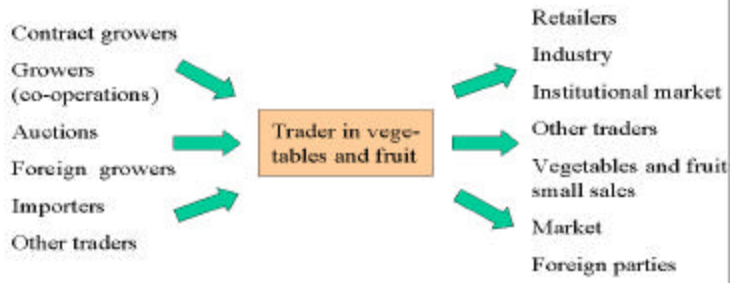


Table 2. Product transformations for a trader in fruit and vegetables

Form at acquisition	Transformation Process	Form at distribution	Product examples
Loose product in bulk container	------	Loose product in bulk container	Box of apples
Packaged product	------	Packaged product	Endive
Loose product in bulk container	Packaging and labeling	Individually packaged product	Broccoli in plastic wrap
Loose product in bulk container	Packaging and labeling	Packaged combination of products	Sweet pepper stop light
Loose product in bulk container	Cleaning, cutting Packaging, labeling	Individually packaged product	Pre-cut endive
Loose (cut) product in bulk container	Cleaning, cutting Packaging, labeling	Packaged combination of products	Salad-mix

Processes are washing, cutting, packaging, and/or labeling. If a product's country of origin is known, then separate handling will be possible. However, if products have to be handled separately by supplier, or even by batch, then this would result in a less than optimal use of labour and machinery capacity. It would also require more extensive administration on the workfloor and in the company as a whole. Support from an information system would then be required. Regarding the demands from government and (especially) retailers a trader in vegetables and fruit should provide for the following information system functions (Ilekhomon-Troost, 2001).

Table 3. Important information system functions at a trader of fruit and vegetables

Supply	Storing of purchase specifications Coupling of lot number to supplier data and production data Coupling of lot number to entry control data
Storage	Coupling of lot number to storage location and conditions (e.g. temperature, time)
Assembly	Registration of new lot numbers linked with preceding lot numbers
Packaging/labeling	Coupling of lot number with label
Sales	Coupling of lot numbers to invoice data Coupling of lot number to distribution data

Only very few companies in the EU comply with these demands. For example, a research conducted amongst 20 average vegetables and fruit traders in the Netherlands showed that none of the companies came even close to an information system that complies with the new demands (DLV advies, 2000).

5 Implications for data registration and production management; case of the food industry

The industry (processing) link of the food supply chain is the most complex one with respect to the identification and registration of data. Registration of process and product characteristics (e.g. composition, storage time, history of products) is essential for these industries, for the purpose of traceability and for production management.

Production processes in food industries have special characteristics (Den Ouden, 1996; Trienekens, 1999; Hvolby and Trienekens 1999):

- Production processes usually consist of divergent processes combined with convergent processes (e.g. a pig is composed of more than one product; after decomposition for a number of products other ingredients are added). Splitting and mixing of lots are common activities in many food industries, which need control.
- Production yields are often uncertain. This can be explained by variations in composition, form, color, etc. of raw materials and semi-manufactured products. Materials often have dynamic characteristics (e.g. changes in composition of dairy products, shrinking of meat products). This implies that product characteristics change over time. When (and where) to control processes is an important issue in these industries.
- Recipes are often variable (one product can be based on more than one recipe and different raw materials can lead to similar products) and multi-level (one recipe can lead to more than one product: for example identical products in different packaging). Recipe management is a critical activity.
- Recycling of products or semi-finished products is common in food processing industries. In many cases end-products that do not meet quality standards and, in part, waste or by-products can be recycled. Also, waste products have to be accounted for, because of environmental regulations, among other reasons.

- Many final products are perishable (although to a lesser extent than produce), and therefore have a limited shelf-life. When to control raw materials and products is, as was stated before, an important issue in these industries.

These typical characteristics have typical implications for food industries regarding the use of data (on products and processes) in various management processes. A research project in the food industry in the Netherlands showed the following relationships (Trienekens 1999, Twillert 1999).

Table 4 Use of product and process data in various management processes in food industries

Production planning	- Detailed production planning on the basis of lot characteristics - MRP on the basis of lot characteristics
Order-management (purchasing)	- Registration of data during order entry (supplier, delivery data, delivery time, etc.) - Having insight into the location of the ordered goods in the supply chain - Registration in case of purchasing raw materials for the production of samples in R&D
Warehouse management	- Links between batch numbers of suppliers and lot numbers of food industry - Registration of data on lot characteristics during receipt - Lot traceability in case of splitting or mixing lots - Location control per lot Reverse logistics: identification of raw materials lots that are returned from production
Manufacturing	- Registration of actual lot numbers that are used in production - Registration of process variables per ‘’batch’’ - Lot traceability in case of using more batches for one packaging order
Order management (sales)	- Using shelf-life restrictions in sales - Registration of actual lot numbers that are sent to the customers - Registration of complaints
Freight management	- Registration of data during order picking and truck loading (employee who picked the order, actual lot numbers per sales order line, departure time, departure temperature, etc.) - Being able to have insight into the distribution of trays over retail outlets - Tracking of pallets (or other returnable packaging materials) for finished goods

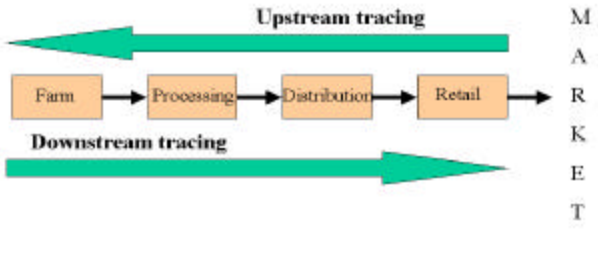
6 Implications for information systems

Given the demands of governments and retailers, it is extremely important for companies in the food chain to be able to guarantee the composition and origin of their products and to be able to trace the origin and cause of the problems when problems occur.

The following demands can be made of information systems :

- Identification of produce and products throughout the food chain. Identification aims at recognizing an item as a unique set of data. The identification function in a company provides items with unique codes (barcode, label, tag, etc.).
- Tracking of items. Tracking aims at registration of (and/or adding data to) (unique) items as they make their way along the supply chain.
- Traceability of items throughout the food chain. Tracing aims at defining the composition and the treatments an item has received during the various stages in the production life cycle. Chain upstream tracing aims at determining the history of items and is used to determine the source of a problem of a defective item. Chain downstream tracing aims at the determination of the location of items that were produced using, for example, a contaminated batch of raw materials.

Figure 3 Upstream and downstream tracing in the food chain



It is obvious that, related to traceability, information regarding product and process characteristics is linked to products in every part of the chain. However, when goods are exchanged between enterprises that are part of a supply chain, in most cases the majority of information that can be linked to products is left at the supplying company. In other words, the information is de-coupled from the products and only aggregated information accompanies the product further through the chain. (In this sense labels on products only represent a potentially small part of the information available).

Traceability, then, is guaranteed via the coupling of aggregated product properties to detailed product properties by codes or certificates. These codes or certificates linked to products must give access to the information left behind at the links upstream the chain. For companies this means that they must implement information systems that are able to identify, register and track the product throughout the chain, while preserving the link between aggregated and detailed product information.

The major advantage of de-coupling information from the product, while preserving a link to detailed product properties, is that exchanging parties prevent an information overload, as detailed data are not exchanged, while these data still remain accessible by means of identification. The point at which this occurs is called the information de-coupling point (Beulens, 1999). Figure 4 depicts the information de-coupling point.

Figure 4 Information Decoupling point

Furthermore, three demands made of companies are important:
In the first place, companies must register product and process information according to certain standards (information must be exchangeable between companies). In Europe EAN (European Article Numbering) standards are now mostly used. In this regard, standards must be used for product and process data. For many of these data new standards will have to be developed (e.g. EAN Europe is working on identification standards in compliance with the new EU labeling legislation for cattle) (www.ean-ucc.org).
In the second place, systems that register these data must on a company level be integrated with administrative (ERP) systems, to simplify the analysis and exchange of data. Also, these data can then be used for the planning and evaluation of production.
The third point of attention is the exchangeability of data in the (international) supply chain. A solution used in different sectors in this regard is a (supply chain) database with product and process data of different links in the chain. Such a database, however, must be easily accessible for users (in many cases including consumers) in the chain. This means that companies must be increasingly transparent with regard to their product and process data. This is not yet the case.

7 Conclusion

This paper shows that legislation related to food safety is an important driving force for organizations to build a sophisticated identification, registration, tracking and tracing system. Data that are gathered in the context of tracking and tracing provide the consumer with information about the product, support quality assurance systems (such as HACCP) and may provide required documentary evidence in debates or lawsuits between customers and suppliers.

Important criteria for a sound identification and registration system are that it must be fraud-insensitive and that data on the origin and history of a certain product must be able to be traced quickly and adequately. Fraud-insensitivity refers to linking an identification code to the product (e.g. ear-marks on pigs and cattle can get lost; in the EU often up to 5%) and to exchanging correct data between chain parties. It must also be noted that as soon as an animal is ‘’decomposed’’ in parts at the slaughterhouse and mixed with other parts and materials in food industries, traceability becomes a very complex issue.

Internationalization of the food chain makes it imperative that identification and registration systems also become internationalized. Possibilities for fast, real-time accessibility to data is, however, restricted because of the large number of different, and sometimes still manual, databases in the different EU countries (e.g. Germany still used more than 200 different databases for cattle registration in 2000). Most countries in the EU still do not have a central database, and there are no automatic coupling systems between national databases yet. Tracing of the origin of a product is, therefore, still a long and difficult effort in many cases.

Although in most current European chains data are related to origin of produce and products, in the future new consumer demands may require the registration of new data. For example, in an animal chain, data such as the food an animal has eaten, medicines it has been given, but also data on the living circumstances of the animal may all have to be registered. In Europe, an increasing number of chains are offering various guarantees to their customers, concerning the use of pesticides or, medicines for animals, animal-friendly production, etc. Free range meat and eggs, and organic vegetables and fruit are just a few examples.

From the previous part in the paper it may be clear that the business community at large faces a great number of challenges. Challenges derived from the need to satisfy consumer demands, to comply with rapidly changing legal requirements and business requirements. This while ensuring low costs. Part of these requirements are of such nature that meeting these results is a ‘’license to produce’’. Not being able to meat them means loosing this license.
Finally it must be noted that changes in information systems alone cannot bring the necessary integrity and auditability of information gathered and provided. These changes must be accompanied by other, organizational, changes in business processes and management.

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