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ABSTRACT

One of the primary outcomes of this thesis has been to develop an assessment model of the operational and organisational structure with regard to the AMOR approach (**A**lliances for the **M**utual **O**rganisation of **R**isk oriented inspection strategies). The AMOR model comprises the formation of an alliance between suppliers and customers in the supply chain for mutual benefit. Collaboration in the alliance is realised by jointly organising inspections which are performed in a risk oriented manner.

To advance AMOR principles, it has been necessary to understand typical actors and their tasks in relation to intercompany quality and risk management. A fundamental contribution of this work has been an extensive investigation of the structures of pork producing chains to determine the key actors coordinating quality management strategies. Based on the results, a novel chain coordination model has been developed. With respect to risk management systems, this thesis has contributed an assessment of their fitness in relation to the key aspects of AMOR, including risk orientation and collaboration with suppliers and/or customers. It has been ascertained that more than half (55%) of the 119 surveyed companies of all industry sectors already use a risk management system to perform risk oriented inspections. Furthermore, it has been established that collaboration on risk management takes place: 56 companies collaborate with suppliers, 47 with customers.

The thesis expatiates on three forms of AMOR alliances and contributes a complete characterisation of the four principles underpinning the concept: (1) inspection design, (2) tasks and responsibilities, (3) information and communication structure, (4) costs/efforts and benefits to all parties. Regarding the three forms of alliance differentiation can be made between an alliance a) amongst one or more suppliers and one or more customers; b) complemented by a private sector third-party or c) by a public (or semi-public) sector third-party.

Further results of empirical studies and interviews with industry professionals have discovered a strong willingness on the part of supply chain actors for AMOR inspections to become more widespread in industry as well as concrete examples of implementation.

In consideration of the four aforementioned principles a scoring model has been proposed to determine the extent of AMOR adoption amongst companies of the agri-food supply chain. The model consists of 20 statements regarding the organisation of inspections within an alliance, which are assessed each on a scale from 0 to 5 points. In the model a maximum score of 100 can be achieved, implying implementation of the principles to their full extent. Based on the obtained score, five categories of AMOR adoption can be differentiated: AMOR professional, expert, beginner, uncoordinated, non-AMOR. Depending on the category, the proposed strategies for improvement of the respective operational and organisational structure varies. The effectiveness of the proposed scoring scheme has been evaluated utilising four alliances. Two alliances have achieved a high degree of adoption (84 and 80 points), none of the cases have achieved the maximum score, offering ample room for improvement.

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Kurzfassung

Ein Hauptziel der Arbeit war es, bezogen auf den AMOR-Ansatz (**A**llianzen für die **M**utuale **O**rganisation **R**isikoorientierter Prüfstrategien) ein Bewertungsmodell der Aufbau- und Ablauforganisation zu entwickeln. Der Ansatz beinhaltet die Bildung einer Allianz zwischen Kunden und Lieferanten der Wertschöpfungskette zum gegenseitigen Nutzen. Die Zusammenarbeit in der Allianz erfolgt durch die gemeinsame Organisation von Prüfungen, die risikoorientiert gestaltet werden.

Um die AMOR-Prinzipien in den Kontext konkreter Wertschöpfungsketten zu setzen, wurden typische Akteure und deren Aufgaben in Bezug auf überbetriebliches Qualitäts- und Risikomanagement untersucht. Es wurden Strukturen in der Schweinefleisch erzeugenden Kette erforscht, um die Hauptakteure für die Koordination von Qualitätsmanagementstrategien zu ermitteln und um auf Basis der Ergebnisse ein neuartiges Kettenkoordinierungsmodell zu entwickeln. Bezüglich des Risikomanagements erfolgte insbesondere die Betrachtung von AMOR-Schlüsselaspekten, inklusive Risikoorientierung und Zusammenarbeit mit Lieferanten oder Kunden. Bereits mehr als die Hälfte (55 %) von 119 befragten Unternehmen aller Sektoren der Branche nutzt das Risikomanagementsystem, um Prüfungen risikoorientiert durchzuführen. Auch überbetriebliche Zusammenarbeit hinsichtlich des Risikomanagements erfolgt schon häufig: 56 Unternehmen arbeiten mit Lieferanten, 47 mit Kunden zusammen.

In der Arbeit wurden drei AMOR-Varianten im Detail definiert sowie die wesentlichen vier Prinzipien des Konzeptes festgelegt und beschrieben: (1) Gestaltung der Prüfung, (2) Aufgaben und Verantwortlichkeiten, (3) Informations- und Kommunikationsstruktur, (4) Kosten/Aufwand und Nutzen. Bei den drei Formen wird unterschieden zwischen einer Allianz a) zwischen Lieferant/en und Kunde/n; b) ergänzt durch einen dritten unabhängigen Partner aus der Privatwirtschaft oder c) durch einen dritten staatlichen oder halbstaatlichen Partner.

Weitere Ergebnisse empirischer Erhebungen und Experteninterviews ergaben, dass eine hohe Bereitschaft besteht, eine Aufbau- und Ablauforganisation im Sinne des AMOR-Ansatzes zu gestalten und dass bereits konkrete Umsetzungsbeispiele vorhanden sind.

Unter Berücksichtigung der zuvor genannten vier AMOR-Prinzipien wurde ein Bewertungsmodell entwickelt, um den Anwendungsgrad in konkreten Situationen in der Praxis zu beurteilen. Das Modell besteht aus 20 Aussagen bezüglich der Organisation von Prüfungen innerhalb einer Allianz, die jeweils auf einer Skala von 0 bis 5 Punkten bewertet werden. Insgesamt kann eine maximale Punktzahl von 100 erreicht werden, was für eine vollkommene Umsetzung der Prinzipien steht. Basierend auf der erzielten Punktzahl werden fünf Kategorien der Umsetzung unterschieden: AMOR Professional, Expert, Beginner, Uncoordinated, Non-AMOR. Je nach Punktzahl ändern sich die vorgeschlagenen Strategien zur Verbesserung der jeweiligen Aufbau- und Ablauforganisation. Das Bewertungsschema wurde mit vier Allianzen validiert. Zwei Allianzen erzielten einen hohen Umsetzungsgrad (84 und 80 Punkte). Da keine Allianz die volle Punktzahl erreichen konnte, besteht Raum für Verbesserungen.

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Content

List of abbreviations

%	percent
Ø	mean value
~	approximately
acc.	according
AMOR	Alliances for the Mutual Organisation of Risk oriented inspection strategies
APP	actinobacillus pleuropneumoniae
BfR	Federal Institute for Risk Assessment (Bundesinstitut für Risikobewertung)
BLL	Federation of Food Law and Food Science (Bund für Lebensmittelrecht und Lebensmittelkunde)
BMELV	Federal Ministry of Food, Agriculture and Consumer Protection (Bundesministerium für
today:	Ernährung, Landwirtschaft und Verbraucherschutz)
BMEL	Federal Ministry of Food and Agriculture (Bundesministerium für Ernährung und Landwirtschaft)
BRC	British Retail Consortium
BVE	Federation of German Food and Drink Industries (Bundesvereinigung der Deutschen Ernährungsindustrie)
BVL	Federal Office of Consumer Protection and Food Safety (Bundesamt für Verbraucherschutz und Lebensmittelsicherheit)
c	company
ca.	circa
CAC	Codex Alimentarius Commission
CCP	critical control points
cf.	lat. confer, compare
DBV	German Farmers' Federation (Deutscher Bauernverband)
DFHV	German Fruit Trade Association (Deutscher Fruchthandelsverband)
e.g.	lat. exempli , for example
EC	European Commission
EDI	electronic data interchange
EGF	producers‘ association for quality piglets Osnabrück (Erzeugergemeinschaft für Ferkel Osnabrück)
EGO	producers‘ association Osnabrück (Erzeugergemeinschaft Osnabrück)
EHEC	enterohemorrhagic Escherichia coli
ERP	enterprise resource planning
et al.	lat. et alii, and others
etc.	et cetera
EU	European Union
EU-27	European Union, 27 members
FAO	Food and Agricultural Organization of the United Nations
FAPRI	Food and Agricultural Policy Research Institute
FCD	French Retail Federation (Fédération des Entreprises du Commerce et de la Distribution)
ff.	lat. folio, and following pages
FMEA	failure mode and effects analysis
FMECA	failure mode, effects and criticality analysis
FSDS	feed safety data sheet
FSSC	food safety system certification
GlobalGAP	good agricultural praxis
GMP(+)	good manufacturing practice
ha	hectare

HACCP	hazard analysis and critical control points
HAZOP	hazard and operability study
HDE	German Retail Federation (Hauptverband des Deutschen Einzelhandels)
i.e.	lat. id est, that is
IBM	International Business Machines Corporation
IFS	International Featured Standards
IKB	Integrated Chain Control (Integrale Keten Beheersing)
ISO	International Organization for Standardization
IT	information technology
IVA	German Industrial Asscociation for Agriculture (Industrieverband Agrar)
kg	kilogramme
KPI	key performance indicators
LAVES	Lower Saxony State Office for Consumer Protection and Food Safety (Niedersächsisches Landesamt für Verbraucherschutz und Lebensmittelsicherheit)
LZ	Food magazine (Lebensmittelzeitung)
n	number
n.i.	not indicated
NGO	non-governmental organisation
No	number
n_{total}	total number
ON	Austrian Standards Institute (Österreichisches Normungsinstitut)
p_C	probability using Chi^2-test
p_F	probability using Fisher test
POS	point of sale
PRRS	porcine reproductive and respiratory syndrome
QMSs	quality management strategies
Q-PorkChains	Improving the quality of pork and pork products for the consumer: Development of innovative, integrated, and sustainable food production chains of high quality pork products matching consumer demands
QS	Quality and Safety GmbH (Qualität und Sicherheit GmbH)
QSG	quality and safety guarantee
RASFF	rapid alert system for food and feed
RPN	risk priority number
S	Statement number
SCC	supply chain coordination
SCM	supply chain management
SGS GmbH	Société Générale de Surveillance Holding
SPSS	Statistical Product and Service Solutions
SWOT	strengths - weaknesses - opportunities - threats
TiGA	Animal Health Organisation (Tiergesundheitsagentur)
TQM	total quality management
UK	United Kingdom
veg.	vegetable
WHO	World Health Organization

1. Introduction

1.1 Problem statement

To ensure food safety and quality a plethora of requirements have to be fulfilled by the relevant businesses and a growing number of inspections have to be integrated throughout the agri-food supply chain. There are vast amounts of regulations and laws pertaining to food legislation. These regulations cover a wide spectrum from the mutual recognition of rules of member states regarding production and marketing of food products to the obligatory labelling elements of food packaging (Leible et al., 2014).

The particular provisions of the European and the German national food legislation set two main goals (Leible et al., 2014):

(1) protection of health
(2) consumer protection against fraud and deception

In addition, there are countless private standards initiated, for example, by industry aiming at the fulfilment of legal obligations but which impose supplementary requirements on agri-food companies. The resulting obligations present a considerable burden to the agri-food businesses.

A number of crises in recent years has shown that greater improvement in risk prevention and the organisation of risk management is needed. Recent crises have included the dioxin incidence which has resulted from contamination of feed fat with dioxin and which has been fed to chicken and pigs (contamination of eggs and meat) in 2011. Other examples include the EHEC outbreak in sprouts, also in 2011, and again dioxin findings in eggs in 2012. However, the propagation of defective products through the supply chain can be effectively prevented using a scheme of internal checks in the frame of a risk management system (Schmitz, 2006). Therefore, agri-food businesses have to intensify risk management efforts to prevent negative effects for human and animal health.

In agri-food supply chains there are uneven levels of trust between the different chain stages (Leat et al., 2010). This unevenness hinders information exchange, collaboration and coordination of the supply chain. However, it is increasingly apparent that for good food quality and food safety, verifying information that identifies positive and negative practices along the supply chain should flow unobstructed (Hobbs, 2006). Information from throughout the food chain (including agriculture) enables transparency (Schiefer and Deiters, 2013). Transparent information depends on the activities of all supply chain actors and on the design of appropriate systems (Schiefer and Sebök, 2013). The information flow requires cooperation and coordination from within the sector and a suitable IT infrastructure is an enabling feature (Schiefer and Sebök, 2013; Revoredo-Giha and Leat, 2010). Information exchange and communication allow chain participants to learn about and to react to changes in the requirements and expectations of other chain actors (Revoredo-Giha and Leat, 2010). At the

same time proper communication mechanisms can assist in the rapid identification of defects thereby reducing the risk of creating a more serious crisis.

The fulfilment of legal and industrial food quality and safety requirements, the management of risks, and the need for information exchange, all demand a greater scientific understanding to enable a robust and risk-manageable agri-food supply chain.

To achieve a robust supply chain which can react immediately to errors and which can take measures to reduce and/or avoid risks would signify a major advancement in supply chain coordination. Such a model would be greatly valued in the current dynamic environments of international trading and sourcing, different national and international regulatory standards and at a time when the threat space is growing increasingly complicated. Achieving a supply chain capable of functioning in a complex and dynamic environment with an enhanced ability to withstand crises requires meaningful collaboration between chain stages and also needs the joint organisation of inspections in a risk oriented manner. A coordinated and risk oriented supply chain aims at delivering products as demanded by multiple quality and safety requirements. The new model enables better planning and better use of available resources.

1.2 Research objectives

The primary objective of this thesis has been to investigate a concept of collaboration in alliances between supply chain stages with particular regard to jointly organised quality inspections: AMOR (**A**lliances for the **M**utual **O**rganisation of **R**isk oriented inspection strategies). In this context the inspections shall be risk oriented based on risk analysis and management in the companies. In the course of the thesis the AMOR model shall be defined and its principles established. The application of AMOR and the extent to which AMOR principles are implemented will be investigated in case studies.

A secondary objective of the PhD research has been to study structures in an agri-food supply chain to determine the actors coordinating quality management strategies in the chain and their activities on supply chain level. The results will feed into a model of chain coordination which is intended to support stakeholders of the chain in achieving a high level of coordination for joint quality management strategies with a supply chain-wide focus. This study forms an essential foundation from which to extensively and appropriately adopt AMOR principles.

Moreover, risk management systems in agri-food companies shall be analysed to determine their connection with quality management systems and to evaluate the organisational structure of risk management systems. Knowledge shall be obtained if risk management systems are used for risk oriented inspections in the industry and if collaboration with other supply chain stages regarding risk management takes place.

In the scope of the thesis the following research questions have been pursued:

I. Do structures in the pork supply chain exist which facilitate the coordination and spread of quality management strategies in the supply chain? How can they be characterised?
II. Are risk management systems in the supply chain connected to quality management systems? Are these systems used for the risk orientation of inspections and does collaboration with other supply chain members regarding risk management take place?
III. How can AMOR be appropriately defined in the agri-food sector? To what extent do AMOR principles already exist throughout industry?
IV. What are the key parameters that need to be considered when developing a scoring scheme to determine the extent of AMOR adoption? How might the scoring scheme work in practice?

Subsequently, background information is given to provide a research framework before the detailed thesis outline is presented.

1.3 Background

1.3.1 Agri-food supply chain

The agri-food supply chain

The food industry is one of Europe's most important and dynamic industrial sectors (EC, 2013). This reflects in Germany where the stages of the food industry, and associated stages, account for around 2.55 million employees (BVE, 2013a; Destatis, 2013; IVA, 2013). The largest market branch of the food industry is meat and meat products, accounting for roughly 24% of the total turnover in the German food industry in 2012 (BVE, 2013b). The second largest market is dairy with a share of 15%; bakery products have a market share of 9% of the total turnover (BVE, 2013b). Table 1.1 depicts figures of the core stages of the agri-food supply chain in Germany.

Table 1.1: Characterisation of agri-food businesses in Germany (BVE, 2013a/b; Destatis, 2013; IVA, 2013; Statista, 2013)

Supply chain stage	Full- and part-time employees (year)	Further characteristics (year)
Agricultural production: Agriculture	1.25 million (2013)	• 370.000 companies (2013)
First and second processing stages: Food industry	555.000 (2013)	• 6.000 companies (2013) • 95% small- and medium-sized companies (2013) • Fourth biggest branch of industry in Germany (2013) Branches: o Meat and meat products: biggest and economically most relevant branch of food industry: ~24% of the total turnover of food industry (2012), o Milk and milk products: share of ~15% of the total turnover (2012), o Bakery products: ~9% of the total turnover (2012)
Food trade:		
Food wholesale	340.170 (2011)	• —
Food retail	374.809 (2011)	• 38.866 shops (2012)

The agri-food supply chain starts with upstream suppliers to agricultural production providing goods such as seeds, fertiliser, machinery or feed that go into agricultural production. The subsequent stage is divided into different production areas such as animal husbandry, plant cultivation or fishing industry. Following this primary production is wholesale where purchase, marketing, import and export of grains, livestock, fruit and vegetables are organised. Processing of the agricultural products takes place in two stages. The first processing stage processes agricultural raw products in mills, slaughterhouses, fruit and vegetable processing plants, etc. In the second processing stage the intermediate products are further manufactured in industrial production or crafts to products such as confectionery, meat products, bread and bakery products or pasta. The products are traded by food wholesale and retail companies and reach the final consumer directly or via bulk consumers (such as gastronomy, hotel business, caterers). Different services like consulting, logistics and research are offered to agri-food businesses. The supply chain is embedded in different markets influencing the chain and creating vast connections and networks in an international context. Figure 1.1 shows a generalised agri-food supply chain, which varies depending on the food product manufactured.

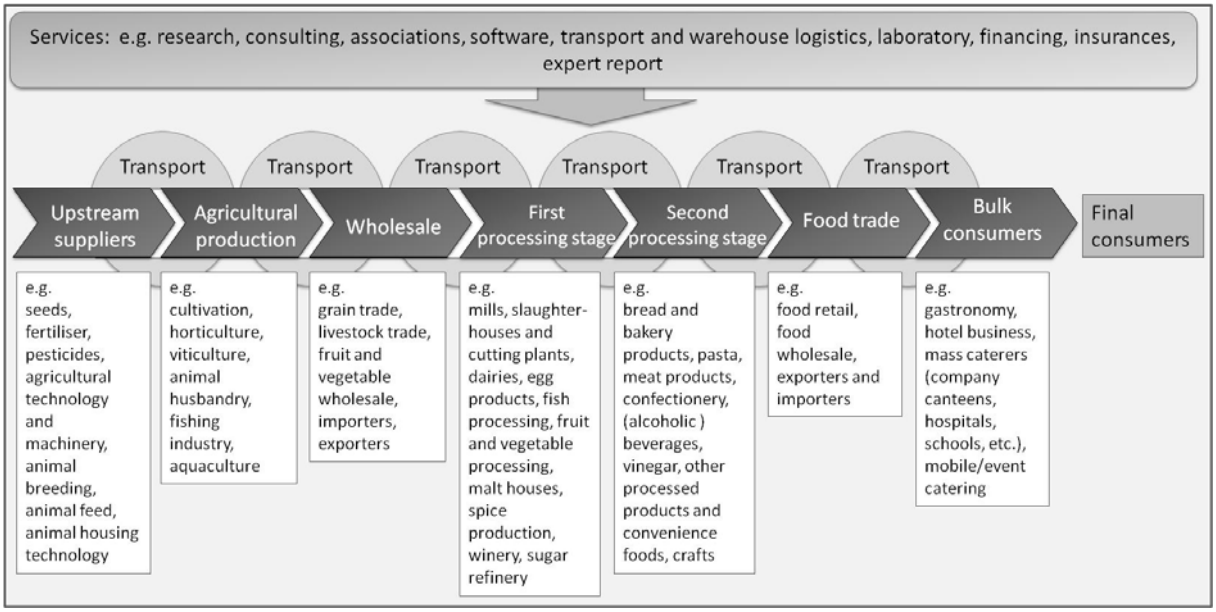

Figure 1.1: Agri-food supply chain

The differences between the agricultural sector and the rest of the industry are getting smaller. Increasing farm sizes result in a more industrialised way of operating such processes (Huirne et al., 2009) and in an increasing specialisation process in agricultural primary production (Karge et al., 2002). In Germany the number of companies in the agricultural production stage has almost halved from 1991 to 2010 (541.000 to 272.000) while the size of the companies has almost doubled (31 to 61 ha) in the same duration (BMELV, 2012). The number of food manufacturing companies in comparison has only increased slightly in the same time-frame (5606 to 5853) (BMELV, 2012). This shows that a significant concentration process has taken place in the last decades in primary production, meaning that fewer, but larger, firms exist. The concentration is even higher when it comes to food retail. The five largest trade groups (Edeka, Rewe, Metro, Schwarz, Aldi) account for around 80% of the turnovers in German food retail (LZ, 2012; Lademann and Heinen, 2011).

While the entire supply chain is more concentrated, the individual stages vary in size and market power. Many agricultural businesses deliver to fewer manufacturers and processors which mainly deliver to only five retail groups. At the same time supplier-buyer relationships and cooperation has become more international (Van der Vorst, 2006), as sourcing takes place in a world-wide context. The situation of processors in agribusiness is different from those in other sectors as they are working with a large number of small-scale suppliers, that is, the farmers, who all deliver the same product (Schulze et al., 2006). Additionally, in the modern food industry high raw material intensity is predominant (purchase of raw material for more than half of the turnover) increasing customer dependency on suppliers and making effective supplier management necessary (Wegner-Hambloch, 2008).

Agri-food supply chains have particular properties in contrast to other supply chains, because of (Aramyan et al., 2006):

(1) the nature of production, which is to some extent based on biological processes, thus increasing variability and risk,
(2) the nature of the products, which have specific characteristics like perishability and bulkiness with low product price that require a particular type of supply chain, and
(3) the societal and consumer attitudes towards issues like food safety, animal welfare and environmental friendliness.

More concrete, the fact that food products perish makes transport, handling, processing and storage critical at each stage of the supply chain and limits shelf-life. Moreover the supply chain is rather slow in reacting to changes in demand as, for example, vegetables and animals need time to grow. Produced foodstuff that is no longer in demand can not be stored beyond its natural shelf-life. If the product is of low quality, it can normally not be reused or recycled as might be the case in other, non-food, industries.

Furthermore, as food is a product of daily use, its quality and safety have a direct effect on the population so there is a public interest in agri-food supply chain production. For the same reason, tracking and tracing is of paramount importance. Whenever food crises occur it is essential to find the source of the hazard (e.g. contaminant) and to locate where contaminated food has been distributed to and to eliminate it from the food chain. The implementation of tracking and tracing capabilities as well as the fulfilment of quality expectations depend on activities throughout the supply chain and involves chain and sector efforts and agreements on who does what, when, where and how (Schiefer, 2006). Therefore, challenges arising in the agri-food supply chain have to be mutually solved.

Promoters in the supply chain

The concept of ‘promoters’ exists in different application areas. In the realisation of strategies a promoter is seen as an actor who is, due to a key position, an important pulse generator and as a result, influences substantially the process of strategy realisation (Anwander, 2002). Promoters help to spread newly developed strategies in order to widely reach the actors (Anwander, 2002). Promoters qualify for resolving occurring conflicts and challenges during implementation of a new strategy (Tavasli, 2007).

The idea of a promoter can also be found in the application area of quality management. Promoting teams in this context are usually responsible for the planning, structuring and performance of quality management projects and activities in a company. In Six Sigma as part of quality management the belt system has been established with different belt levels representing a promoter’s skills, qualifications and responsibility level. For each of these promoters the tasks with rights and duties are clearly defined prior to the start of a project.

According to Anwander (2002) an ideal promoter is characterised by the fact that his opinion is in demand by the actors. The author suggests that the reason for this might be due to the promoter’s credibility, openness, enthusiasm, reliability, acceptance and function as a role

model. The promoter has to be fully convinced by the project and has to be able to project this positive message so as to convince others. Furthermore, a promoter must have extensive knowledge of the companies involved in the processes.

In agri-food supply chains netchain coordinators can act as promoters. Netchain coordinators are “organisations with bundling functions and offering services to reduce interfaces for the farmers by coordinating and supporting product and information flows” (O’Hagan et al., 2013). Netchain coordinators may be partners from within the netchain or may be external institutions which professionally offer the adoption of coordination services (Wohlgemuth, 2002). These can be livestock traders, livestock marketing corporations, farming cooperatives, meat companies and/or retailers and producers' associations assuming diverse services in the meat supply chain (Brinkmann and Petersen, 2010).

Businesses acting as netchain coordinators require contextual knowledge and a good organisational overview of the mechanisms of the existing network, which is why they perfectly fulfil the requirements for being promoters.

Collaboration and alliances in the supply chain

The specific market characteristics of agricultural food chains as previously described, especially perishability, present strong motifs for collaboration between chain stages (Den Ouden et al., 1996). When collaborating, effective coordination of transactions, and interactions between organisations, needs to be provided to make the partnership successful (Hartmann et al., 2010). Coordination describes provisions to jointly agree on areas of responsibility which are mutually fulfilled by different entities (Schmitt and Pfeifer, 2007). In light of globalisation high quality and intercompany coordination of processes becomes increasingly important (Schmitt and Pfeifer, 2007).

The necessity of coordination and success stories of coordination have been discussed and shown in studies in all kinds of industries (Arshinder et al., 2008). Complex supply chains, such as that of the agri-food chain, must be coordinated to be effective and to allow smooth functioning of included processes (Brinkmann et al., 2011).

A specific form of collaboration is strategic partnering and the formation of alliances. Both forms are a response to the more challenging and complex environment of firms in the agri-food supply chain (Sporleder, 2006). A strategic alliance is defined as “a close, long-term, mutually beneficial agreement between two or more partners in which resources, knowledge, and capabilities are shared [...]” (Spekman et al., 1998). The aim is to realise a competitive advantage of the alliance partners (Das and Teng, 2000) as well as to create synergies and added value beyond what an individual firm may be able to achieve (Sporleder, 2006). To achieve these goals, commitment to the strategic alliance has to be given from both sides (Devlin, 1988). The formation of an alliance requires the willingness to collaborate and to exchange information.

Some specific features of supply chain alliances are (Duffy and Fearne, 2004):

- high interdependence
- open communication
- coordination of work processes
- shared information
- engagement in joint activities
- mutual trust
- action for mutual benefit
- win-win orientation

Alliances are characterised by mutual interdependence, which means that each party is vulnerable to its partner(s) (Ireland, 2002). To handle this vulnerability carefully and to prevent failure and disappointment, the expectations of each partner are formulated and fixed in an agreement at an early stage. This is important to assure that all partners are "on the same page". Within the alliance, specific terms and conditions are negotiated, the contribution of each partner is assessed, and the resultant benefits can be determined (Spekman et al., 1998). Existing alliances have to be kept alive and managed, and the capability of doing so is a multidimensional construct which comprises skills to address three main aspects: coordination, communication, and bonding (Schreiner et al., 2009).

Problems arise when expectations differ and/or are unrealistic as well as when partners do not agree on the level each partner commits to, or takes from, the relationship (Spekman et al., 1998). Furthermore, tension can result from poor planning, poor execution, or boundary definitions and/or management difficulties (Spekman et al., 1998). To prevent these problems responsibilities, objectives and framework conditions have to be clarified early.

In the classical approach the objective of an alliance is to improve the competitive position of the partners by sharing resources or the joint product development (e.g. Walter et al., 2008; Ireland, 2002; Spekman et al., 1998). In agri-food supply chains the objectives for alliances can also be to reduce costs for controls by reducing the amount or frequency of inspections, to improve the collaboration between the stages and to jointly act towards quality and safety of food products.

A mutually beneficial relationship between supplier and customer in general and in alliances in particular enhances the ability of the partners to create value (Ireland, 2002), which shall be shared amongst the partners. All partners should receive benefits proportional to their investments over the life of the alliance (Spekman et al., 1998). One of the primary benefits of alliances is the access to previously unavailable resources and the joint development of new resources (where resource refers to all assets, capabilities, processes, information and knowledge) (Ireland, 2002). With an alliance, tighter relationships are created between the partners with higher information exchange and a foundation of trust is built which makes a contribution to align the entire supply chain.

1.3.2 Quality inspections

Customers mostly insist on zero-defect deliveries and many products, especially cheap mass products, are sorted out when they are of unsatisfactory quality and not reworked (Pfeifer, 2001, 1993). It has already been remarked that the reworking of foodstuff is not possible

and the production of high quality products is a primary goal. Another peculiarity of food products is that food safety and quality can not be guaranteed by inspecting the end product, but needs to build on appropriate inspections throughout the food supply chain (Fritz and Schiefer, 2009). Therefore, the efficient design of inspections is indispensable.

An inspection is defined as: “conformity evaluation by observation and judgment accompanied as appropriate by measurement, testing, or gauging“, where conformity is the fulfilment of a requirement (ISO 9000, 2005). During inspection a measurement value is compared with a target value or an object or material is compared with a reference object or material, which may lead to a result good or bad (Starke and Brückner, 2013). With the inspection it is determined whether the inspected entity fulfils set requirements such as quality stipulations (Weckenmann and Werner, 2007; Leohnhard and Naumann, 2002). The aim of inspections is the identification of quality (Linß, 2011) and as part of quality: food safety.

By inspections quantitative and qualitative information can be gained, where the former present values that can be assigned to scales with determined distances (Linß, 2007; Weckenmann and Werner, 2007). The latter are non-numeric and decisions can only be made between “good/acceptable” or “bad/unacceptable” or based on classifications in certain groups (Linß, 2007).

Some qualitative characteristics can be arranged according to a specific system so that it is possible to make a rank order according to ordinal scales (e.g. quality grades of food products) (Weckenmann and Werner, 2007). Other characteristics, the so-called nominal properties have no such relation between different possible values of the characteristic, which means that only an assignment to a certain group can be determined, for example the assignment according to colour (Weckenmann and Werner, 2007).

Quality inspections

For the implementation of inspections in most companies, a quality management department is created (Starke and Brückner, 2013). Quality inspections include the initial sample inspection, incoming (goods) inspection, (intermediate) inspections accompanying production, final inspection and outgoing (goods) inspection as well as reliability inspection (Starke and Brückner, 2013). Due to the importance for food supply chains the incoming, intermediate and final inspections are described more detailed:

- **Incoming inspections:** Ensure that specifications and acceptable quality levels agreed with the customers are complied with. Incoming inspections can be performed as sample inspections. In cases where the quality level and quality assurance of the supplier are well known, and assuming a strong supplier-buyer relation, the purchaser can opt to forgo an incoming inspection on the strength of the trust which is placed in the outgoing inspection of the supplier. Such a procedure requires a certified quality management system at the supplying company as well as close collaboration with the purchaser (Starke and Brückner, 2013).

Examples for incoming inspections are checks on temperature (of the lorry or the front pallet), optics and colour, best before date, quantity comparison, declarations, weight check, pesticide residues in vegetable, fruit or tea, undamaged packaging, labelling, correct product compliance with specifications (size, shape, etc.). Checks can be performed per pallet or per article using spot checks.

- **Intermediate inspections:** Selected quality related characteristics are inspected to prevent errors. Intermediate inspections have to be performed early on and at vital points in the process. Results from intermediate inspections shall have a regulatory effect on process control (Starke and Brückner, 2013).
  Examples of intermediate inspections are sensory inspections of the product, compliance of the products with specifications (e.g., herbs and spices on fish fillets spread evenly and amount as in specification), acceptable packaging, pH in product as required, test on potential pathogens (e.g. salmonella in fish products, baby tea), heating/cooling temperature have been met as intended, heat treatment has been performed as intended, storage temperature is correct.
- **Outgoing inspection:** Is the last quality inspection before delivery to the customer, which is why this inspection is usually the proof of quality for the customer. This final inspection can be identical to an inspection accompanying production. In any case the final quality inspection has to be complemented by: identity inspection, provision of examination documents of previous inspections, approval after final inspection, completeness of the delivery according to type, quantity and packaging (size), compliance with the shipping papers (Starke and Brückner, 2013).
  Examples are product inspection in a metal detector, temperature checks, correct labelling, clean/hygienic truck for food transportation, compliance with specification.

Quality inspection comprises different steps which vary between authors (e.g. Linß, 2007; Seghezzi et al., 2007; Weckenmann and Werner, 2007; Pfeifer, 1993), but have principally the same pattern. According to the aforementioned authors, three steps can be identified:

(1) Inspection planning
(2) Inspection performance and inspection data capturing
(3) Inspection data evaluation and documentation

Within inspection planning the framework conditions and strategy of the control are set. The task of this step is to plan inspections for the different phases of the production of products or the provision of services (Linß, 2007). Inspection stages, procedures, inspection methods and inspection instructions for the inspection are developed (Linß, 2007; Pfeifer, 2001) and responsibilities determined (Starke and Brückner, 2013). Table 1.2 shows the different determinations that have to be made.

Table 1.2: Determinations to be made during inspection planning (modified according to Linß, 2007; Weckenmann and Werner, 2007)

Determination	Question
Which characteristic shall be inspected (description of inspection characteristic and necessary parameters)	what?
In which way shall inspection of the characteristics take place:	
• location	• where?
• time	• when?
• performer of the inspection	• by whom?
• specifications and instructions regarding procedure of the inspection	• how?
• inspection resources and measuring instruments to be deployed	• with what?
• planned evaluation of the results (record, collect, analyse, distribute, condense, consider use of results)	• inspection data?
• number of objects to inspect	• how many?
• way how they should be chosen	
• the inspection frequency	• how often?
• way of data documentation	
Basis of decision making (limiting values, tolerances, etc.)	
Decision rules according to objective criteria to ascertain conformity	

Inspection planning results in an inspection instruction. The instruction contains the complete and comprehensive description of the inspection procedures, the inspection instruments which have to be used and the description of the inspection object as well instructions for inspection data capture and processing (Starke and Brückner, 2013).

Step two, carrying out the inspection according to the inspection instruction includes capturing actual values of the test characteristics, which is why it is also called inspection data capturing (Linß, 2007). Data capturing is made on receipts, inspection protocols, quality control charts and data entry into the computer is made manually or automatically (Starke and Brückner, 2013). The inspection values have to be captured in a way that an inspection data aggregation and processing is possible in the subsequent step (Starke and Brückner, 2013).

In the third step the collected information is evaluated and the measurement result is determined. This includes the preparation, aggregation, representation and documentation of the captured data, so that a decision about the conformity of the values of the inspection characteristics with the requirements can be made (Starke and Brückner, 2013; Linß, 2007). The overall result is received by comparing the measurement finding against the quality requirement (Weckenmann and Werner, 2007). The result has to be reproducible, within a measurement uncertainty threshold, so that enclosed information is useful as a basis for decisions (Weckenmann and Werner, 2007).

The inspection has to be documented within the company, from planning to results. Documents of the quality inspection are inspection plans, inspection instructions, protocols (original data), inspection evaluation according to protocols, inspection reports, calibration instructions of measuring and testing equipment, results of calibrations, inspection results of acceptance from the supplier (Starke and Brückner, 2013). A comprehensive documentation of the inspection result and how it was obtained is the prerequisite for usability within qual-

ity management (Weckenmann and Werner, 2007). The documentation, therefore, should be meaningful and accessible.

Risk oriented and mutual inspections

Inspections can be adapted according to the objective and purpose of the product under consideration. Furthermore, inspections can be adjusted in intensity to achieve a specific inspection goal whilst continuing to satisfy standard criteria. This type of intelligent-inspecting satisfies the quality and safety requirements at the lowest intensity level, which is intended to be cost-effective for the companies.

According to the ISO 2859 standard a change between tightened, normal and reduced inspection is possible (ISO 2859, 2009). Higher intensity inspections requires higher inspection costs (personnel costs, space required, measurement equipment), that is why only as much as is necessary shall be inspected (Starke and Brückner, 2013). Reduced inspection intensity, whilst conserving resources and limiting financial costs, comes at the expense of risk to a company, because fewer products are actually being inspected (Kamiske and Brauer, 2008).

A risk oriented inspection is a tightened or relaxed inspection according to sampling instruction, of which the inspection accuracy (intensity of inspection) is greater or smaller than in normal inspections. Risk oriented inspections start with the analysis of the surrounding and its risks. Risk is either high because of the type of product, the origin of the product, methods of processing or because internal controls by which the risks are either prevented or at least detected early do not prove effective. In cases of high risk, the inspection is intensified by increasing the extent of the inspection (sample size) or the frequency of the inspection (Leonhard and Naumann, 2002).

Examples of risk orientated inspections in European legislations are the following:

- According to Regulation (EC) No 882/2004 the official control of food producing companies is risk oriented and is based on the risk classification of the company (EC 882, 2004). Control frequency of the companies and intensity of the control is adapted based on product risk, results of the last inspection, self-control of the company, etc. (Colbert and Alderman, 1995).
- The official meat inspection is risk oriented since entry into force of the Regulations (EC) No 853/2004 and 854/2004 in 2006. This means that not every carcass is inspected by adspection, palpation and incision but according to the risk of the batch for food safety: visually (low risk), increased or traditional (high risk) (Blaha et al., 2007).

In line with the idea of risk oriented inspections is the statement of Pfeifer (1993) that, if a product is bought for a longer time period in larger quantity an adaption of the amount of control to the actual quality situation is profitable. The sample size in this case is either reduced or increased depending on the previous control results. Pfeifer (1993) calls this con-

trol dynamisation which shall reduce the inspection effort. Additionally, in case of long-term delivery of large amounts of goods it is beneficial to jointly perform inspections with the supplier during production. For example the outgoing goods inspection of one party can be combined with the incoming goods inspection of the other, which is planned and performed in joint action between supplier and customer. The incoming goods control in this case can be limited to a check on the identity of the delivered goods and of the provided shipping documents. Without these close agreements the customer has to perform an incoming goods control, which due to reasons of liability alone, consists of checking the critical characteristics of a product (Pfeifer, 2001, 1993).

Both aspects, mutual as well as risk oriented inspections which are performed between suppliers and customers are discussed in detail as novel inspection approaches in the main chapters of the thesis.

1.3.3 Quality management and risk management

Quality management

The standard ISO 9000:2005 defines the term quality management as “coordinated activities that organisations use to direct and control quality” (ISO 9000, 2005). An important goal of quality management is the fulfilment of various food laws, product liability, the satisfaction of customer demands as well as enhanced efficiency through increasing productivity and systematic error avoidance (Dunkhorst and Pfaff, 2009; Hahn and Pichhardt, 2008). The main focus of food quality management is on assuring product and process quality in the company. Quality characteristics of food products can be classified as internal and external quality. Internal characteristics are taste value, ecological value and non-material value (Huyskens, 1996). Characteristics which influence the external quality are market value, on such features as shape, colour, size, freshness, consistency, and practical value, on parameters such as shelf-life, transport capabilities, suitability for storage, kitchen-technological suitability and processing (Huyskens, 1996).

Integrated in the quality management system of the company are food safety and risk management systems (Kamiske, 2008; Alli, 2003). Food safety is an essential quality characteristic in the agri-food supply chain which has to be ensured within a risk management system (Alli, 2003).

Already existing quality management and assurance systems as well as systems for hygiene management can be used for finding sources of potential risk areas (Lendle, 2008). Furthermore, management tools and techniques such as HACPP, FMEA, fault tree analysis, Ishikawa-diagram, brainstorming, and checklists can be applied as cross-section method within risk and quality management systems in agri-food companies (Mack et al., 2006; Schmitz, 2006). The integration of risk management systems in existing management systems can significantly influence its effectiveness (Dunkhorst and Pfaff, 2009; Winter, 2008).

Quality and risk management show mutual objectives and values. Within quality management values are created to satisfy customers and other stakeholders and which are assured through systematic risk prevention and error minimisation in the companies. Because of the mutual influence both systems show a feedback effect towards each other. Moreover the effectiveness of risk and quality management systems can only be evaluated in the future and advantages only become obvious indirectly. The relationship can be summed up as: good quality management decreases risks and good risk management improves quality (Romeike, 2008). Figure 1.2 shows the links between risk and quality management.

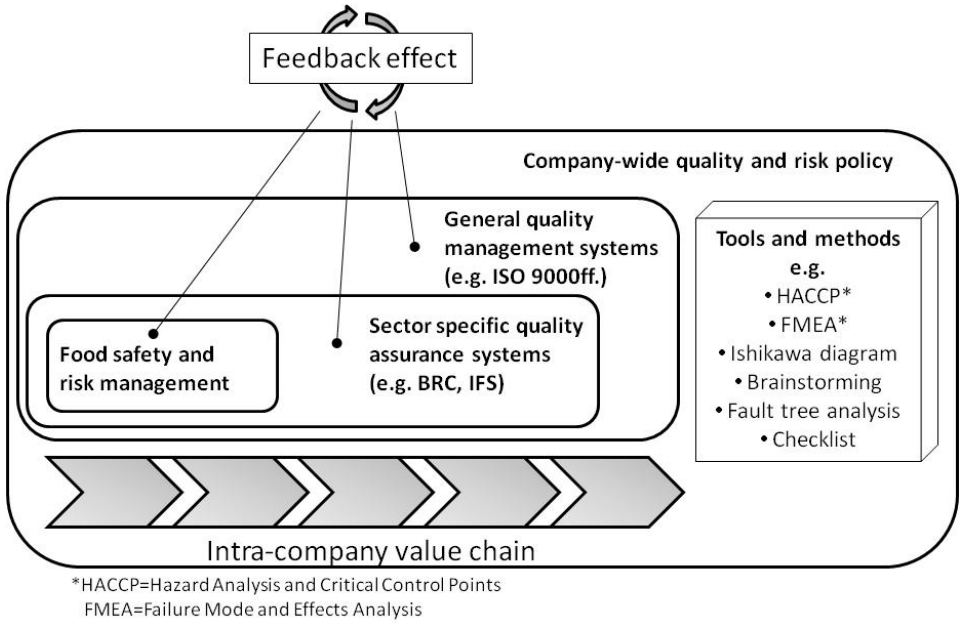

Figure 1.2: Integration of quality and food safety and risk management in agri-food companies (modified according Jouve et al., 1998)

Risk management

In the agri-food sector risk is related to the safety of food in order not to impact negatively on human health. But also a food product that does not comply with general quality requirements poses a risk for agri-food enterprises as it leads to customer rejection and loss for the company.

The origin of risk management lies in the finance and insurance sectors (Binner, 2012). Risk management in the food sector is a more recent development. The FAO and WHO held a first consultation meeting on the application of risk management to food safety matters in 1997, after having discussed risk analysis in a consultation meeting two years prior (FAO/WHO, 1997). With the onset of the new European food legislation, agri-food companies have to perform a risk analysis according to articles 6 and 7 of the EU basic regulation (EC) No 178/2002. An integral part of each system in conformity with the EU hygiene regulation (EC) No 852/2004 - 854/2004 has to be a food safety procedures-method according to HACCP-principles (hazard analysis and critical control points).

A comprehensive risk management system is helpful for the early detection and control of potential risks and to maintain continuity in the company (Romeike, 2005). Risk management, based on Vanini's (2012) definition, comprises all of the elements of the organisation structure, legal regulations, support instruments and methods to systematically implement company-wide processes to handle and control risks.

The task of efficient risk management is the systematic and comprehensive identification, collection and assessment of potential risks, and of already known risks, the control of responses and measures according to the detected risks and constant monitoring of the risks, as well as a continuous risk communication and documentation (Werdich, 2011; Mack et al., 2006). According to this, operational risk management comprises the elements of risk identification, assessment, control and monitoring, with the supporting elements of risk documentation and internal and external risk communication.

Strategic risk management provides the risk policy of the company. Within risk policy the framework conditions of the risk management system in the company are set. Risk policy deals with the basic approach of the company to risks, determines the strategy regarding risks, and the objectives and organisational structures of the risk management system. Within risk policy, measures and instruments should be determined to avoid, reduce or externalise risks (Romeike, 2005; Gleißner et al., 2004). A structure with determined tasks, responsibilities and reporting channels has to be established under the premise of least possible impairment of business operations (Schramm, 2008).

For risk management, a risk manager or a risk management team should be appointed for clear allocation of responsibilities in risk management. A risk management team might be composed as follows: company executive(s), a determined risk manager, employees from departments such as quality management, controlling, production management, procurement, storage and sales (Elles, 2008; Lorenz, 2008; Winter, 2008).

Risk identification

In the first step of operational risk management potential risks have to be systematically captured, characterised and recorded in a risk description to gain understanding of the risk situation (Elles, 2008). This process has to allow for the creation of a robust risk management system which is capable of coping with known and currently unforeseen risks. With risk identification, uncertainty shall be reduced to enable a rational, science-based regulation process for the management of risks (Roosen et al., 2009).

For identifying as well as for assessing risks several tools and methods are available (e.g. Binner, 2012; Schuchardt, 2012; Brühwiler, 2008; Elles, 2008; Kamiske, 2008) (Figure 1.3).

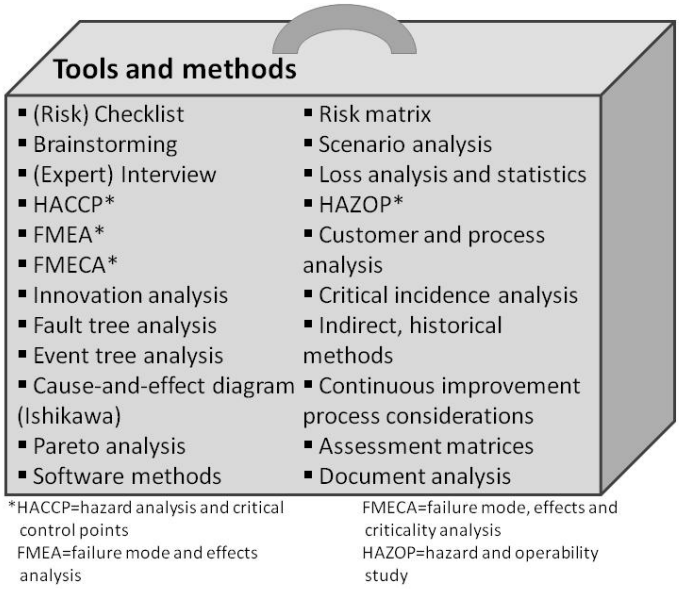

Figure 1.3: Tools and methods for risk identification and assessment

Many of the tools and methods in Figure 1.3 are known from quality management where they already have been applied.

Risk assessment

In the following step identified risks are systematically assessed regarding potential exposure so that risk management measures can be realised (Schuchardt, 2012). That is, risks are examined to determine the extent of their danger to the individual processes and products in the company (Dustmann, 2004) and thus potentially to the end-consumer.

In practice the biggest problem is the realistic assessment of risks because they are often based on subjective assumptions (Binner, 2012). For this reason it is important that the assessment is performed as objectively as possible. For the assessment of food safety risks, no clear guidelines exist (Lendle, 2008). Depending on the type of production and company size, the companies can chose from various tools and methods as has been shown in Figure 1.3.

European food legislation has made HACCP mandatory for food business operators (not including those in primary production). Other standards such as the ISO 31010:2009 „Risk assessment techniques“ and the ON Rule 49000 “Risk management for organisations and systems” from the Austrian Standards Institute (ON) additionally might require further assessment methods (Werdich, 2011).

A three-dimensional Risk Priority Number (RPN), which is e.g. part of the FMEA tool (failure mode and effects analysis), can be used to determine the potential risk impact and scale of damage. The RPN is composed of the probability of occurrence of the cause (e.g. low=1 point to high=10 points), the probability of detection of the cause, or the defects in the process before delivery to the customer (e.g. low=10 to high=1), and the importance or severity of the defect consequences from the customer’s point of view (e.g. low=1 to high=10). RPN=Occurrence x Detection x Severity. Depending on the detected RPN an evaluation and

weighting of the risks can be performed (Theuvsen et al., 2013; Dunkhorst and Pfaff, 2009; Schmitz, 2006).

The assessed risks can be presented in a risk matrix with the dimensions probability of occurrence versus importance/severity of the defect consequences (Figure 1.4) to provide an overview of the risk profile of a company and to allow risk comparison and prioritisation. From the example in Figure 1.4, the risks can be assigned to five different categories, shown in the matrix in different colour shades such as: no risk (food product is safe), acceptable risk, justifiable/tolerable risk, unacceptable risk (further measures are urgently required) and non-calculable risk (Hahn and Pichhardt, 2008).

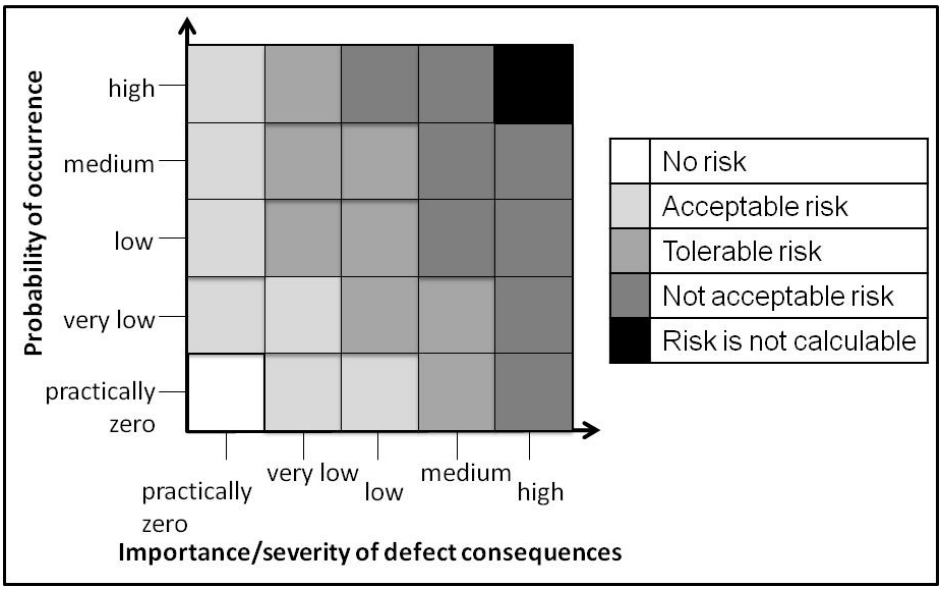

Figure 1.4: Risk matrix (modified according to Hahn and Pichhardt, 2008)

The risk matrix can give a rough and clear overview of the risks. However, some aspects can not be seen. For example in FMEA the probability of occurrence is divided into occurrence and detection and therefore is more suitable for the production process (Werdich, 2011).

Risk control

During risk control practical measures are defined for the prioritised risks to prevent or minimise existing risks regarding their hazard potential, the probability of occurrence and the extent of damage (Schuchardt, 2012). Guidelines concerning the acceptable risk, which is appropriate to different types of food hazards, have to be developed and procedures to ensure that the risks are kept within the limits set by those guidelines have to be established (FAO/WHO, 1997).

In general, there are four strategies to control risks (Werdich, 2011):

(1) risk avoidance
(2) risk reduction or limitation
(3) risk devolving
(4) risk acceptance

Within the risk avoidance strategy risks are completely evaded, for example specific business areas, products, alternative production methods are selected. Risk avoidance works only with strategic decisions.

Risk reduction aims to lower the probability of occurrence of the revealed risks and/or to limit the severity of the damage when risks are present, for example through organisational and technical measures such as emergency and crisis planning.

Risk devolving comprises the transfer of the risks to another company such as insurance companies and/or by contracts to suppliers, customers and other parties.

Risk acceptance by a company means that risks are accepted and covered by that company.

The goal of risk control for the company is that unacceptable risks are avoided and unavoidable risks are limited to an acceptable level and then responsibility for the risk is taken (Seidel, 2002). The selection of the action alternatives should be oriented towards the risk policy of the company and should conform to the aims that have been developed within the risk strategy (Romeike, 2005).

Risk monitoring

Risk monitoring aims to continuously supervise the control and preventive measures. In the context of continuous improvement of surveillance and the determination of new potential risk sources, internal and external surveillance systems should be considered. HACCP and quality management systems, complaint management as well as supplier and customer audits can be used as surveillance and internal early warning systems (Elles, 2008). As external early warning systems the Rapid Alert System for Food and Feed (RASFF) of the EU, the Federation of German Food and Drink Industries (BVE), the Federation of Food Law and Food Science (BLL), the Federal Institute for Risk Assessment (BfR), the Federal Office of Consumer Protection and Food Safety (BVL) and the Robert Koch Institute in Germany are important institutions to identify internal and external risks (Elles, 2008). Moreover, as sector specific early warning system e.g. for the pig and poultry industry functions the salmonella database (QS, 2012), for the fruit and vegetable wholesalers a residue monitoring system (DFHV, 2013). Each monitoring system provides insight to the current risk situation of the tested products regarding the potential for disease and contamination which could impact on human health.

Risks and preventive measures have to be verified regarding implementation and the effectiveness of the whole risk management system with respect to the intended goals (Schuchardt, 2012). This can be performed as internal audits or as checks by independent third parties.

Documentation and communication

The whole risk management process has to be documented including all steps and the results of risk management and the detected risks have to be communicated internally and

externally. It is important to coordinate the risk management process with internal and external stakeholders (Brühwiler, 2008) and the rationale has to be transparent to all parties (FAO/WHO, 1997). Only when all stakeholders know about the risk policy as well as of acute risks in the company they can act accordingly.

Figure 1.5 provides an overview of the steps for the implementation of a company-wide risk management system with each step that a company ideally performs as well as tools and methods supporting risk identification and assessment.

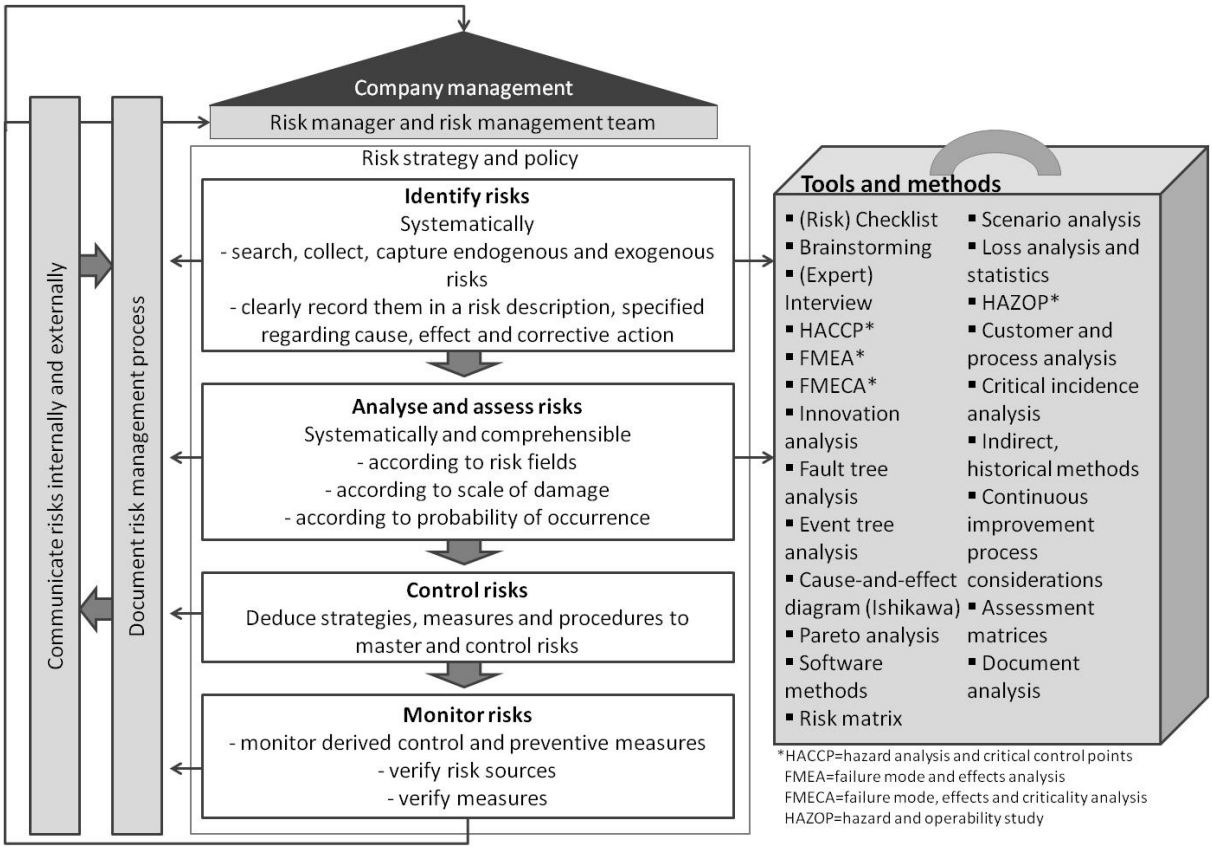

Figure 1.5: Idealised company risk management system

For reasons of cost and effort, not all the risks can be covered, and “black swans” (Taleb, 2008) will always occur. For these cases occurring, a company should have emergency plans ready (Schuchardt, 2012).

Not least, proper risk management should be understood as a continuous improvement of processes which ultimately leads to a risk management system that is dynamic and reacts to changes (Brühwiler, 2008; Romeike, 2007).

1.4 Thesis outline

The thesis is divided into seven chapters presenting the research framework to test the research questions posed (see Figure 1.6).

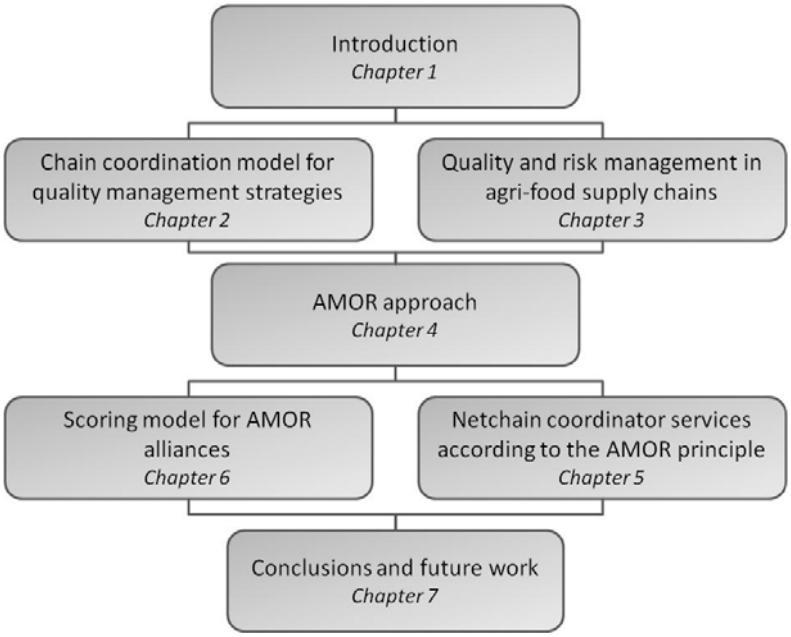

Figure 1.6: Outline of the thesis

Chapter 1 provides a general introduction into the research problem and provides background information on a number of themes relevant to the thesis. **Chapter 2** elaborates an example of how supply chains can be coordinated regarding quality management strategies in pork supply chains and introduces a coordination model. **Chapter 3** presents results from a survey on the organisation of quality and risk management in agri-food companies. **Chapter 4** presents an approach for organising inspection strategies in agri-food supply chains, called AMOR (Alliances for the Mutual Organisation of Risk oriented inspection strategies). Within this approach alliances between partners of the supply chain are formed and inspection strategies jointly designed and performed in a risk oriented manner. **Chapter 5** presents more details of the approach and describes its principles using the example of health monitoring provided as a service by netchain coordinators. **Chapter 6** shows a means of scoring alliances performing inspections according to AMOR principles to demonstrate the implementation degree of the principles. Four examples will be presented and scored. **Chapter 7** will summarise the work and draw conclusions on the research.

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2. Towards a chain coordination model for quality management strategies to strengthen the competitiveness of European pork producers[1]

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Abstract

This paper presents a new chain coordination model for quality management strategies of European pork supply chains. It is a result of qualitative research into intensive and extensive pork production in seven selected countries consisting of a literature review, country-specific expert interviews and case studies. The model defines strategic roles and responsibilities for quality management actors on normative, strategic and operational levels and groups these actors into the categories certification, coordination and control. New actors have been defined for the category "coordination of quality management strategies": the chain quality board (normative), the network coordinator (strategic) and the quality broker (operational level). The proposed concept of a quality broker represents an innovative approach to facilitate implementation of coordination mechanisms in pork supply chains. In addition, coordination mechanisms have been defined and classified under the headings contracts, information technology, information sharing and joint decision making. The model represents an organisational concept applicable to a broad diversity of pork supply chains. It is intended to facilitate the establishment and management of quality management strategies to strengthen the competitiveness of European pork producers.

Keywords: pork supply chain, quality management, coordination

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2.1 Introduction

Food supply chains incorporate organisations that are responsible for the production and distribution of products of vegetable or animal origin (Zuurbier et al., 1996). In the European pork sector, quality management strategies (QMSs) have had a major impact on the competitiveness of supply chains. New framework conditions in the EU markets and an increasing export orientation of pork production recently instigated a shift towards supply-chain-oriented coordination of such strategies. Brinkmann and Petersen (2010) have emphasised that actors in pork supply chains should assume more responsibility for QMSs on supply chain level.

Supply chain management itself arose from the perspective of inventory management in the 1980s (Oliver and Webber, 1982). Another view is highlighted by Porter (1985), who created the value chain concept as a framework for value-adding activities of firms with the three competitive forces cost leadership, differentiation and focus. Since that time some authors have concluded that businesses will compete as supply chains and not as single autonomous entities (Zhang, 2006; Christopher, 1998). In addition, Arshinder et al. (2008) have pointed out that research is more and more shifting towards supply chain coordination and the implementation of coordination mechanisms. An approach to select appropriate coordination mechanisms for supply chains, like supply chain contracts, information technology, information sharing and joint decision making, has been proposed by Xu and Beamon (2006) as well as by Arshinder et al. (2008).

Bowersox et al. (2002) and Lin et al. (2005) have noted that quality and operational efficiency can be seen as the two largest supply chain challenges. However, in the current state of the art in pork production, the role of QMSs in the design and organisation of pork supply chains has not been taken into account. The hypothesis of this paper is that chain-wide coordination of QMSs is a critical success factor for the competitiveness of supply chains in the pork sector.

The goal of this paper is to describe the main elements of a chain coordination model for QMSs. The model design is based on four main steps: literature review (1), inventory of pork production chains through expert interviews and case studies (2), creation of the model design (3), and initial validation (4).

The derived chain coordination model focuses on the definition of:

- actors coordinating QMSs, and
- their activities – the coordination mechanisms – on supply chain level.

The model is intended to support stakeholders of pork production in achieving a high level of coordination for joint QMSs with a supply chain-wide focus.

2.2 Literature

In this section, the first step of the model design process, the literature review, is presented. In the following paragraphs, the quality management challenges for the EU pork sector are described; the generic value chain concept is briefly explained; followed by a description of a three-level management model. This section ends with an overview of current coordination of supply chains as can be found in the literature.

2.2.1 European pork production

Pork is a very popular meat product in the European Union (EU), with more than 42 kg consumed per person per year (EC, 2008). Pork production in high-density pork production regions all over Europe fulfils the demand of 501 million people in the EU market (EUROSTAT, 2010). A productive livestock of 145 million pigs yielded 22.5 million metric tons of pork (FAPRI, 2010; Marquer, 2010) in the EU-27 member states in the year 2009. A degree of self-sufficiency of 106.9% (EC, 2008) indicates a need to export to non-EU countries. On a global level the EU is the second largest pork producer behind China (FAPRI, 2010). Production statistics of the FAO (2010) indicate that China produced 49.9 million metric tons of pork with a pig livestock of 451 million in 2009. FAPRI (2010) expects that mainland China will become a net importer in 2014. Hong Kong is traditionally a large importer of pork, produced in the EU member states, for example.

Quality management processes of pork supply chains have changed significantly in the EU in recent years. On the one hand, the general objectives of the EU food law have been adjusted to create a system of self-control among firms and precaution as well as self-responsibility among producers (Schulze Althoff et al., 2005; Urlings, personal communication). Producer liability for quality and safety of products has increased based on these new legal framework conditions fixed in 2002 (EC, 2002) and later years. Consequently, more intensive cooperation of stakeholders is needed to coordinate and promote QMSs in a collaborative way (Van der Vorst, 2000). On the other hand, EU member states have strongly increased their production and are now promoting export activities to global markets (Schloeder, personal communication). To support access strategies and achieve competitive advantage in new markets, QMSs need to be adapted to specific export requirements.

2.2.2 Generic value chain concept

Porter (1985) created the value chain concept as a framework for value-adding activities of firms with the three competitive forces cost leadership, differentiation and focus. Porters' generic value chain concept consists of primary and support activities. The author has stated that "every firm is a collection of activities that are performed to design, produce, market, deliver and support its products". Inbound logistics, operations, outbound logistics, marketing and sales as well as services are defined as primary activities. In addition, four generic categories of support activities have been identified: firm infrastructure, human resources

management, technology development and procurement. Each activity is performed to generate additional value and finally to realise an acceptable margin.

A pork supply chain can be described, according to the generic value chain concept of Porter (1985), as a "chain of firm value chains" that are often described as production stages (see e.g. Trienekens et al., 2009).

2.2.3 Three-level management model

Dubs et al. (2009) defined a company as a system. The "company system" has some special traits: it is an economic system to achieve a return on investment, it is purposeful and multifunctional, and it has relationships with other systems to generate mutual benefits. It is also a socio-technical system, in which humans use technical facilities to fulfil tasks. The authors designed a management model (the "St. Gallener Management Model") that distinguishes three process categories within a company: management processes (1), business processes (2) and support processes (3). Within the management processes three dimensions of management have been differentiated: normative, strategic and operational. Normative management has the objective of building up entrepreneurial processes of agreement and legitimation; strategic management focuses on sustaining competitive advantage and operational management warrantees efficient processes and routines of problem solving within the boundaries set by the normative and strategic levels. More specifically:

- the normative level is where goals, principles and rules are defined,
- the strategic level is where approaches are determined and implemented to achieve the goals and principles as well as to comply with the rules, and
- the operational level is responsible for the execution of these approaches.

These levels can be suitable from the perspective of coordination of supply chains to interlink the management of single companies, as described below.

2.2.4 Coordination of supply chains

In the industry there has been a shift from competition between companies to competition between supply chains (Nair, 2006). A supply chain consists of collaborating organisations, each of which is dependent on the performance of the others in the chain (Xu and Beamon, 2006). Supply chains must therefore be coordinated in order to be effective.

Principles of supply chain coordination

Supply chains can be governed by supply chain management (SCM), which can be defined as "the integrated planning, coordination and control of all business processes and activities in the supply chain to deliver superior consumer value at lower cost to the supply chain as a whole whilst satisfying requirements of other stakeholders in the supply chain (e.g. government and NGOs)" (Van der Vorst, 2004). According to this definition coordination of supply

chains can be seen as part of SCM, but the importance of coordination cannot be over-emphasised (Xu and Beamon, 2006). Coordination in supply chains is referred to as supply chain coordination (SCC) in this paper.

Complex supply chains like the pork-producing chain require a certain extent of coordination to allow smooth functioning of supply chain processes. Supply chains generally can be managed as a single entity through the dominant member or through a system of partnerships requiring well-developed cooperation and coordination (Van der Vorst, 2004). SCC is a strategic response to the problems that arise from inter-organisational dependencies within the supply chain (Xu and Beamon, 2006). Supply chain members need to be coordinated by efficiently managing dependencies between them (Arshinder et al., 2009).

The necessity of coordination and success stories of coordination have been discussed and shown in studies in all kinds of industries (Arshinder et al., 2008). Performance improvements can be obtained in almost all activities of a supply chain, like online ordering, production planning, inventory management and the ease of task completion (Arshinder et al., 2008). The other benefits are reduction in costs, inventory and lead time, improvement in responsiveness, and resolution of conflicts (Arshinder et al., 2008). Another important dimension to consider in SCC is how to allocate the benefits arising from coordination and which actors should absorb the risks (Xu and Beamon, 2006).

Coordination mechanisms

Coordination mechanisms are necessary to motivate or force actors to achieve coordination (Arshinder et al., 2009). A coordination mechanism is a set of methods for managing interdependence between supply chain actors (Xu and Beamon, 2006). Each organisation seeks to implement coordination mechanisms that increase benefits and reduce risks. The challenge for an organisation is to select appropriate coordination mechanisms to manage organisational interdependencies (Xu and Beamon, 2006).

According to Arshinder et al. (2008) the use of coordination mechanisms results in improved supply chain performance. The most common coordination mechanisms can be described as heuristics (Gaudreault et al., 2009). Arshinder et al. (2008) consider four mechanisms that have been extensively discussed in literature:

- **Supply chain contracts**: Supply chain actors use contracts to better manage supplier-buyer relationships and risk. The contracts establish parameters, like quantity, price, time and quality, which are the conditions buyers have to specify when placing orders and suppliers have to satisfy. The authors differentiate between types of contracts, such as buyback, revenue-sharing, and quantity flexibility. The coordination achieved by contracts provides incentives to all supply chain members and improves the service level. Contracts are expected to modify the profits of all supply chain members (Arshinder et al., 2009). They can be a useful mechanism to resolve conflict and risk-related problems.

- **Information technology** (IT): IT helps to seamlessly link locations in the supply chain. It allows planning, tracking and estimating the lead times based on real-time data. The use of IT in handling transactions online between supply chain members reduces response time. Members can plan their operational activities by sharing data with or retrieving data from each other. It helps in streamlining processes and reduces supply chain costs.
- **Information sharing**: Supply chain actors coordinate their activities by sharing information regarding demand, orders, inventory, POS (point of sale) data, etc.
- **Joint decision making**: Coherent decision making helps to resolve conflicts among supply chain members and anticipate any future uncertainty. Supply chain members might have different technologies, skills and knowledge about the market. To handle any future exceptions, members may jointly plan supply chain activities like ordering, replenishment, forecasting and product design.

Figure 2.1 gives an overview of the coordination mechanisms for SCC.

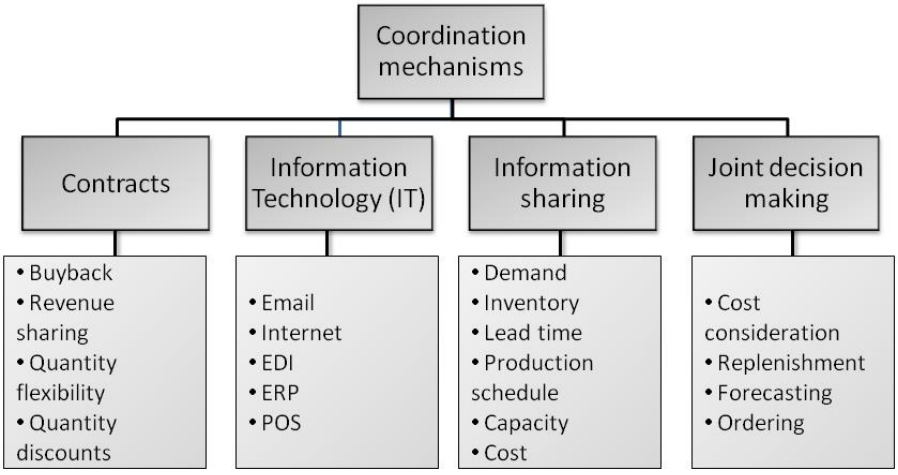

Figure 2.1: Coordination mechanisms (modified, according to Arshinder et al., 2008)

It can be assumed that if a coordination mechanism is applied properly, it will help in achieving SCC. There is bound to be conflicts and problems in the traditional supply chain, as it involves human beings. There is thus an urgent need to implement coordination mechanisms in supply chains (Arshinder et al., 2008).

However, some characteristics of relationships between partners tend to limit the effectiveness of a coordination mechanism (Gaudreault et al., 2009):

- Exchange of information: the information that actors are willing to exchange may be limited.
- Roles and responsibilities of actors: their business relationship and responsibilities may have been established a priori.
- Planning capabilities: the actors' planning capabilities may have been defined a priori.

In other words, the design of a coordination mechanism must be compatible with the business context (Gaudreault et al., 2009). To illustrate how business and market conditions in the pork sector may influence the coordination of quality management strategies, a short explanation of the pork sector will be given in Section 2.3.

2.3 Justifying the need for coordination of pork supply chains

Pork production in Europe can be characterised by a strong division of labour typically in four main stages of the product life-cycle from breeding to meat products (Figure 2.2). This structural feature can be roughly described as follows.

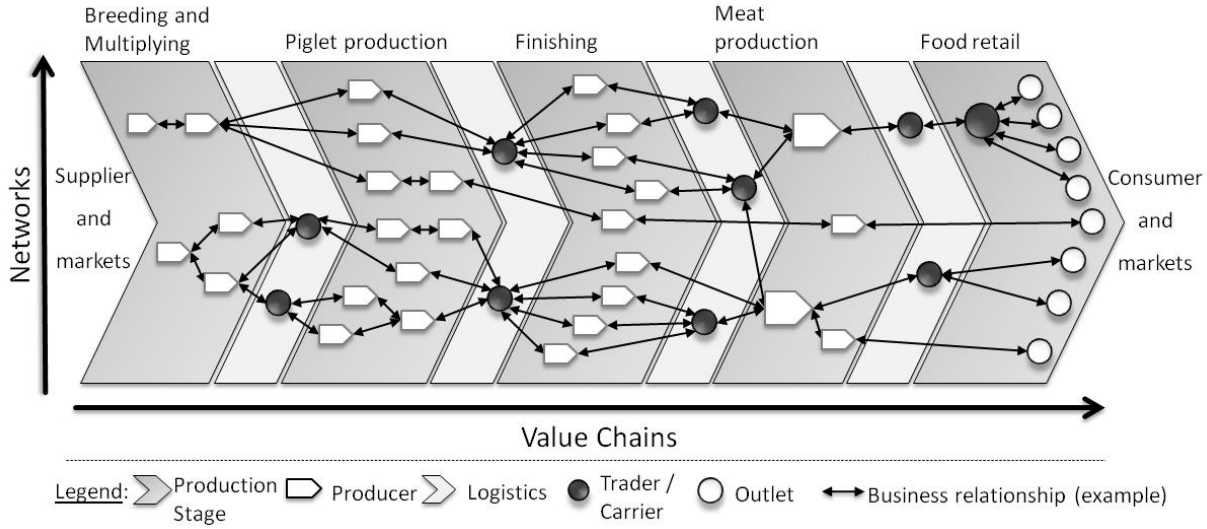

Figure 2.2: Modern pork production from "breed to meat" – value chains and networks

At the start the breeding stage covers the pure breed nucleus and cross-breed multiplying herds. The main product, cross-breed gilts, is distributed to piglet producers. Sow keeping and piglet rearing livestock are specific for piglet production. After a defined growth period for piglets (life weight 25-30 kg), the finishing of pigs takes place on specialised farms.

Further on in the supply chain, meat production covers slaughtering and the meat processing industry. Hansson (2003) noted that, in The Netherlands, Denmark and Spain for example, pigs traditionally are slaughtered at a lower average slaughter weight (ca. 78-80 kg) than in Belgium and Germany (ca. 93-95 kg). One important reason for regional deviations in the EU is that market demands for pork products differ among regions. Usually the weight and lean meat content of pig carcasses are together used as a main quality criterion for farms and meat producers, because this criterion is highly correlated to the weight of valuable pork products (Tholen et al., 2004; Branscheid et al., 2003). Officially required classification systems (EC, 1985) deliver this information about carcass quality, based on online measurements in the slaughter process. In general, such classification systems generate quality information that can be used to support coordination mechanisms for quality management strategies in pork supply chains up- and downstream.

The final pork products (mainly fresh meat, sausages or convenience products) are transferred to consumers and markets via distributors like food retail or via the traditional channel of butcheries (Recke, 2007).

However, in pork production the term ”chain” does not fully describe the complex structural coherences, especially on farm level. Pork supply chains are not linear (Trienekens and Wognum, 2009; Schulze Althoff, 2006), because various actors perform manifold activities in several production stages. Trienekens et al. (2009) proposed the term “net-chains” to describe these network-like structures, which can be found especially on the farming level and require additional coordination levels. The high need for coordination, especially of the farming network, has been underlined by Petersen et al. (2007). Figure 2.2 visualises the complexity of modern pork chains.

Distribution of intermediary products in farming stages of pork chains can be supported by livestock traders or carriers, as described by Theuvsen et al. (2010). These marketing hubs (trader/carrier in Figure 2.2) coordinate the quality of intermediary products between supplier and buyer networks. In that way, they support the organisation of business-related forward and backward quality information flows to generate additional value.

Various figures from the German pork sector can help illustrate the great need for coordination of farming networks: in total 87,700 producers (DBV, 2011; DESTATIS, 2010) are potential “decision makers” affecting QMSs of pork supply chains. A comparatively low number of feed suppliers (1.6% of the producers) and meat-producing customers (0.7%) are related to the farming network (97.7%). Other EU member states have similar structures in the pork sector. Branscheid (2008) has indicated that special efforts are necessary to coordinate the farming stages of pork production. This makes the application of coordination mechanisms even more relevant.

QMSs of pork supply chains should take into account that in this context intensive chain coordination (Wever et al., 2010; Bahlmann and Spiller, 2009) or integration of stakeholders on farm level (Petersen et al., 2007) may be required.

2.4 Research approach

The research approach for developing a model for supply chain coordination followed a cyclic design (Figure 2.3).

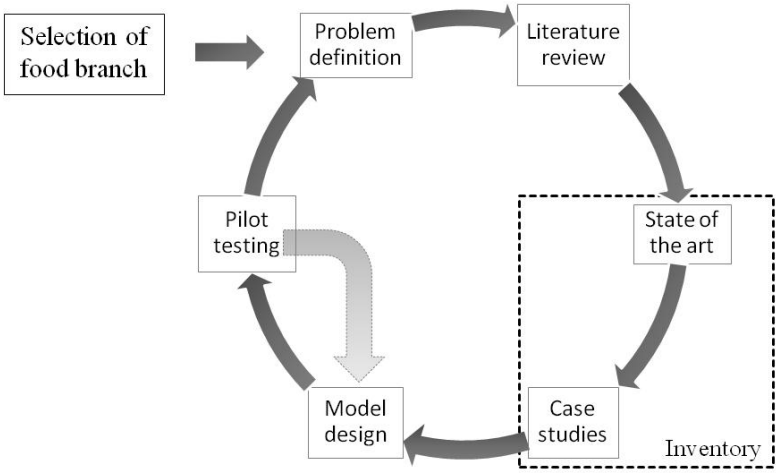

Figure 2.3: Cyclic design approach

Box 1. Examples of quality management strategies.

Some driving companies in the pork sector have designed QMSs that include the quality objectives, key processes and quality standards of their pork supply chains. Examples are "Partnership for Quality" (Westfleisch eG, a farming and meat cooperative), "Gutfleisch Transparency" (EDEKA North, a retailer with integrated meat processing) and "Good Farming" (VION Food Group, a large meat producer).

To design a chain coordination model for QMSs in pork production a research approach has been defined to answer the following questions:

- What is an effective structure of actors for the coordination of QMSs in complex business relationships of pork supply chains?
- What are suitable designs for coordination mechanisms of QMSs?

Problem definition

A QMS includes the quality objectives, key processes and quality standards of supply chains. It is assumed that, in addition to costs, QMSs have a major impact on the future competitiveness of pork supply chains. Suitable models for chain-wide coordination of QMS are not yet available, even though they are needed to achieve competitive and effective pork supply chains.

This paper is a result of the chain management module of the EU Integrated Project Q-PorkChains (FP 6 IP no 130.226.170.72), in which about 20 researchers from China, Germany, Greece, Hungary, the Netherlands, South Africa and Spain collaborated to optimise quality and information management as well as logistics from a supply chain perspective. The re-

searchers analysed pork supply chains in several countries, and recently reported the results to the EU as deliverables or milestones. This paper is based on these results as well as deeper analyses performed to get more detailed information about supply chain coordination and coordination mechanisms.

Analysis framework

The cyclic research approach guided the drafting of an analysis framework, which consisted of two main steps (Figure 2.4).

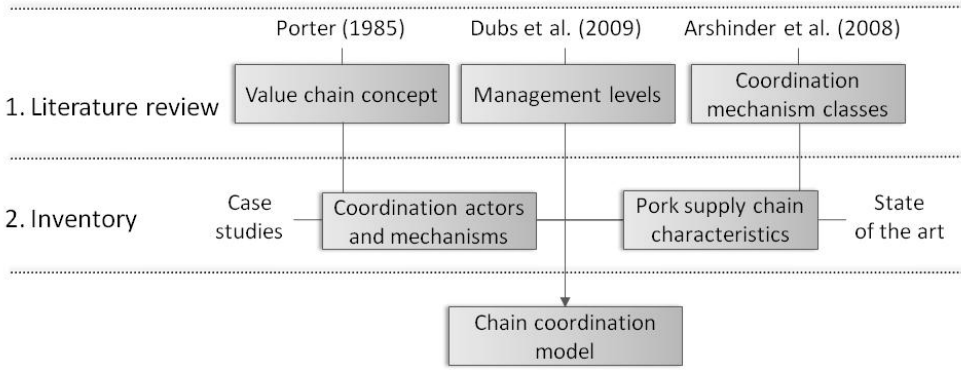

Figure 2.4: Analysis framework

Based on the literature review (step 1; see Section 2.2), the value chain concept (Porter, 1985), management levels (Dubs et al., 2009) and coordination mechanism classes (Arshinder et al., 2008) were identified. In the second step, characteristics of "state of the art" pork supply chains were determined based on expert interviews. Case studies provided information about coordination of quality management strategies – i.e. the coordinating actors and the coordination mechanisms used. These two activities in the second step are together referred to in this paper as an "inventory" of existing pork supply chains.

Results of the first two steps were combined to design the elements of a chain coordination model. For instance, the value chain concept and the pork supply chain characteristics were used to define a typical pork supply chain (described in section 2.5 as a first step of the model design).

Literature review

A literature study about pork production was undertaken to obtain information about supply chain management, supply chain coordination and quality management strategies of pork supply chains. This review was presented in Section 2.2.

Inventory

State of the art in pork production: As part of the EU Q-PorkChains project, seventy qualitative expert studies were performed in China (16 experts), Germany (12), Greece (6), Hungary (20), the Netherlands (9), South Africa (8) and Spain (19) to gain country-specific information

in face-to-face interviews guided by a semi-standardised questionnaire about quality management, supply chain management, supply chain coordination and coordination mechanisms. The information resulting from these studies was analysed to provide input for the model design.

Case studies: Also within the EU Q-PorkChains project, in-depth case studies of two pork supply chains per each of the above-named countries (one fresh-pork chain and one specialised supply chain) were conducted, focusing on the following topics: governance structures in the supply chain, quality management methods and standards, use of information and information exchange, performance in the pork chain (key performance indicators), value chain analysis focusing on costs and margin, innovations (product, process, market and organisational), regulations, production as well as resource use and waste treatment in the pork chain. At the end of each case, a SWOT analysis was performed.

An overview of the supply chains investigated in the case studies is presented in Table 2.1. Based on the results, a chain coordination model for quality management strategies was designed, as described below.

Table 2.1: Overview of pork supply chains investigated by in-depth case studies (n=14)

Country	Type of chain	
Germany (D)	Fresh-pork chain (1 per country)	Eichenhof chain
The Netherlands (NL)	Fresh-pork chain (1 per country)	Organic pork chain
Spain (E)	Fresh-pork chain (1 per country)	Iberian cured ham chain
Greece (GR)	Fresh-pork chain (1 per country)	Imported pork chain
Hungary (HUN)	Fresh-pork chain (1 per country)	Mangalica chain
China (CN)	Fresh-pork chain (1 per country)	Integrated pork chain
South Africa (SAF)	Kanhym chain	Eskort chain

Model design

The first step in the model design process was to define the model framework based on the literature review, analysis of the state of the art in pork production and case studies. Such a model would represent a typical pork supply chain that demands quality from suppliers and subsequently satisfies the quality demands of consumer markets. Production stages of a pork supply chain were determined based on the value chain model of Porter (1985).

The results of the state of the art analysis and the case study analysis were used to define coordination levels, coordinating actors and their tasks. Coordination levels were differentiated according to Dubs et al. (2009).

However, a definition of coordinating actors alone is not sufficient to realise a chain-wide QMS. In relation to the coordinating actors, adequate coordination mechanisms were defined that support or facilitate the compliance of the entire pork supply chain to a QMS. The coordination mechanisms were categorised as proposed by Arshinder et al. (2008).

A further requirement for the design of the model was to comply with principles of total quality management (TQM) (Sousa and Voss, 2002; Pfeifer, 2001).

Pilot testing

The model was tested and evaluated in selected pilot chains of the Q-PorkChains project. Only the results of an initial test are included in this paper.

2.5 Towards a chain coordination model

Based on the interviews performed in the Q-Porkchains project, we identified the main common characteristics of current pork supply chains. These characteristics will be presented in the next paragraph, followed by the coordinating actors and coordination mechanism as found in the cases studied according to the multi-level coordination model.

Defining a typical pork supply chain

A typical pork supply chain was defined based on our analysis of the state of the art in pork production (see Figure 2.5). The model takes the value chain concept of Porter (1985) into account and is logically adjusted to transformations in the life-cycle of a pork product: feed, pigs and pork. It also involves the intermediary stages of distribution and is linked to supplying and consuming markets.

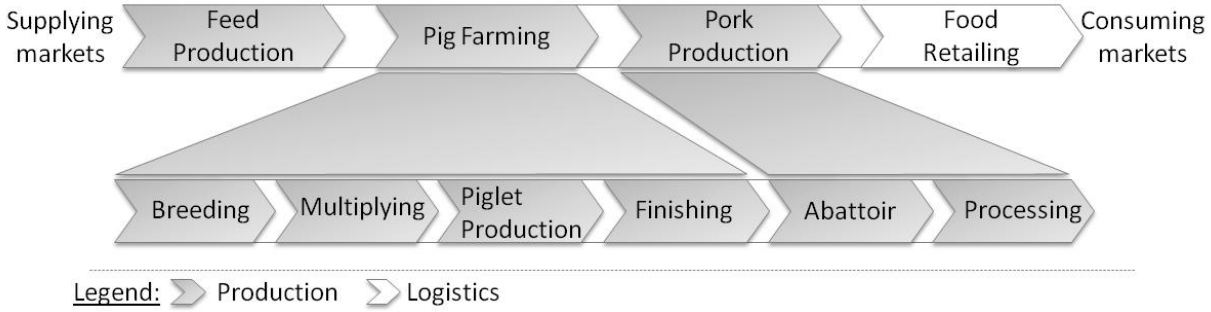

Figure 2.5: A typical pork supply chain for food retailing

The supply chain includes feed production as the main supplier to pig farming (breeding, multiplying, piglet production and finishing). Abattoir and processing stages are aggregated to pork production. Food retailing is an important marketing channel to consumers and was therefore selected as a customer of the pork supply chain.

The production stages depicted in Figure 2.5 are found in every pork supply chain, but their organisational forms can differ, as identified in the inventory. For example, piglet production and finishing can be performed by one farm, while slaughtering and processing are also often done within the same meat plant. Some retailers have backward integrated meat processing; and an entire supply chain can be fully integrated under the roof of a pork-producing company. The need for coordination can thus vary in relation to the supply chain's form of organisation. The case studies were analysed to find out more about this.

Section 2.6 presents the coordinating actors of QMSs included in the model.

Chain coordination model for quality management strategies

To achieve a successful QMS for the entire pork supply chain, different actors are required to align individual efforts. Actors in this context are organisations which take over responsibility for quality management of a pork supply chain.

We start by applying the three management levels (management, business and support processes) used by Dubs et al. (2009) to the pork chain. Besides coordination of QMSs in the pork supply chain, which is the focus of this article, two other elements of a chain quality management model should be distinguished: certification according to production and quality standards and control of production regarding compliance with these standards (e.g. Wever et al., 2010).

Actors responsible for certification (Box 2) and official control are already well established in pork production. Coordinating actors, however, are a relatively new feature in European pork production.

Box 2. Examples of certification systems.

To assure a standardised quality of processes in pork production, certification systems are used, often initiated by retailers (Brinkmann and Petersen, 2009). Important examples of certification systems are GlobalGAP (farming), IFS (pork processing), QS (from feed production to retail) and IKB (from farm to meat processing). In many cases today, pork supply chains need such certificates to get access to important customers

These three categories are not independent – they are linked on each management level. Quality certification standards, for example, influence the orientation of the quality management of a supply chain, thus also affecting activities of the coordinating actors and vice versa: representatives of retailers, meat producers and farmers' associations, for example, are involved in the decision-making bodies of the German QS certification system. Additionally, the category control influences the category coordination as every legal entity of the pork supply chain is officially controlled, while legal decisions affect the operations of the coordination actors.

Figure 2.6 shows the actors on the three levels; the already well-established actors in the areas certification and control as well as the actors in the category coordination (light grey). The coordinating actors are the core components of the model. They facilitate the implementation and promotion of a QMS along the whole pork supply chain. Heading the model are quality requirements of the markets in which the pork supply chain is acting, as they represent framework conditions for QMSs and thus directly influence the actors. These requirements are transformed by supply chain actors into a QMS. The activities of all actors of

the model finally lead into the quality management of the pork supply chain and influence the pork supply chain members.

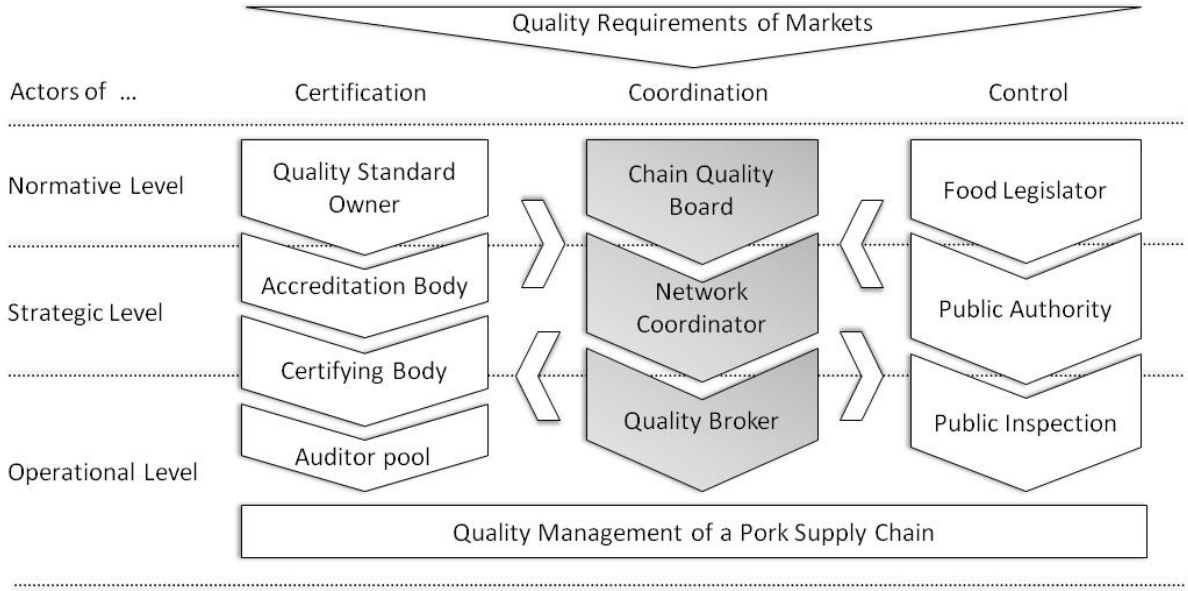

Figure 2.6: Chain coordination model to encourage quality management strategies of pork supply chains

The normative level in the categories certification and control is occupied by actors who are responsible for the establishment of requirements for official controls and quality standards. At present, existing normative actors are quality standard owners or food legislators. Current examples of strategic actors are certifying bodies or public authorities. In between the normative and strategic level in the certification category is the accreditation body, which guarantees that the certification follows certain standards. Examples for the operational level are auditor pools and public inspection. They promote quality standards and controls amongst the supply chain members. The actors are brought together via different coordination mechanisms.

In the remaining part of the chapter we will focus on the coordinating actors. Both the actors and the coordination mechanisms will be described below.

Coordinating actors on the normative level top the QMS. These actors are in charge of setting requirements for these strategies and for strategic quality objectives of the supply chain. In our model these actors are together called the “chain quality board” according to their distinguished position. The position can be occupied by actors who also have an outstanding position in the pork supply chain.

The strategic level is covered by one or more actors who set up, implement and support coordination mechanisms strategically. Based on their function of coordinating the network of the pork supply chain we named them “network coordinators” in the model. Brinkmann and Petersen (2010) proposed this term for an organisation that is responsible for quality in a pork supply chain. Focal companies (Bowersox and Closs, 1996) that are driving QMSs in

chains are good candidates for the position of network coordinator, e.g. farming cooperatives, meat companies or retailers (Brinkmann and Petersen, 2010).

The operational level aggregates actors who perform the controls of a QMS and who promote the strategy amongst the members of the supply chain to make these QMSs work. In the model they are represented as “quality brokers”, because of their function to mediate between the supply chain members. Quality brokers can be companies that are naturally in an intermediary position with access to supply chain members.

In short, the defined coordinating actors in a supply chain are:

- a chain quality board
- one or more network coordinators
- one or more quality brokers

The main tasks and responsibilities of the actors in the coordination category are outlined in Figure 2.7 and described in more detail subsequently.

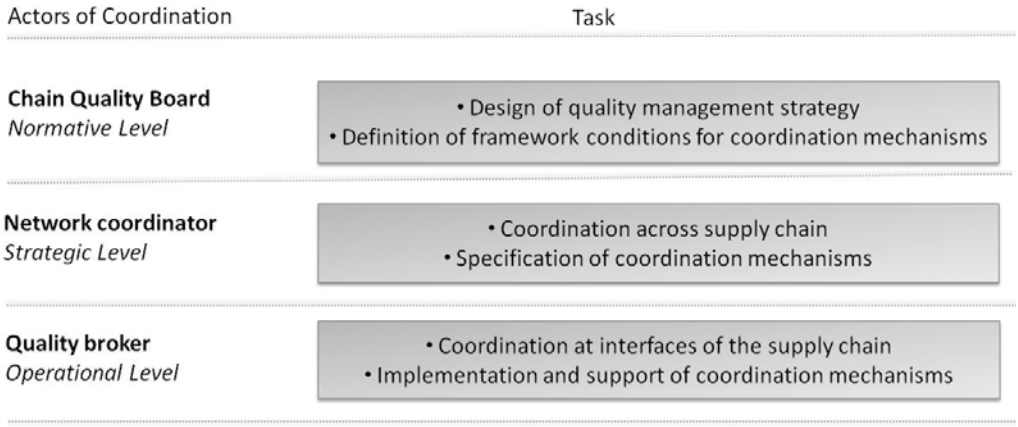

Figure 2.7: Main tasks of coordinating actors

The chain quality board is responsible for designing a QMS, by setting quality standards, key processes and strategic quality objectives in the supply chain. It should consist of a representative group of strategic decision makers in the supply chain. External support should be generated through research and quality consulting. Furthermore, the board defines framework conditions for coordination mechanisms by setting roles and principles.

The network coordinator is the promoter of the quality management strategy. In addition it defines, specifies (through the addition of detailed requirements) and initiates coordination mechanisms. It furthermore performs compliance control and manages quality across the supply chain. A focal company in the pork chain could fulfil this role.

A quality broker is responsible for implementing and supporting coordination mechanisms between the stages of pork supply chains. This actor is in an intermediary position between the production stages and coordinates at the interfaces of the supply chain.

The quality broker is considered to play an important role, when quality management is not managed on a chain-wide level incorporating all actors in the supply chain. Below we will more explicitly explain the concept of a quality broker.

Identifying coordinating actors in the investigated case studies

Each case study was analysed in-depth with respect to the existence of actors on a normative, strategic and operational level (Dubs et al., 2009) who coordinate quality management in the pork supply chains.

The management levels were used to categorise identified actors. Results of this investigation are shown in Table 2.2.

Table 2.2: Coordinating actors of pork supply chains investigated in the case studies

Country	Case	Normative level	Strategic level	Operational level
CN	1	Group corporation (slaughterhouse and distributor)		
	2	Food processing corporation (slaughterhouse and processor)		
D	1	Eichenhof board	EGO meat plant management	EGF - Erzeugergemeinschaft für Ferkel eG
	2	Gutfleisch board	EDEKA meat plant north management	Vermarktungsgemeinschaft für Zucht- und Nutzvieh eG
GR	1	n.i.	n.i.	Intermediary company
	2	n.i.	Pig-producing company	n.i.
HUN	1	n.i.	Pig producers	n.i.
	2	n.i.	n.i.	n.i.
SAF	1	PIC Board	Kanhym estate	n.i.
	2	TOPIGS Board	ESKORT bacon factory	n.i.
E	1	n.i.	Integrator companies	
	2	Control Board PDO Guijuelo	Integrator companies	
NL	1	VION Quality Directorate	VION west meat plants	Feed industry, producer cooperatives
	2	The Groene Weg (VION Quality Directorate)	VION west meat plants	Operations supply manager

n.i.=not indicated/no equivalent actor

Table 2.2 illustrates that in some supply chains actors on the three levels have already been introduced in the chain to coordinate quality management. Pioneers in this respect are supply chains in Germany and the Netherlands, which have implemented QMSs and are coordinated by actors on all three levels. Most of the actors can also be found in Spain, with the additional characteristic that the strategic and operational levels are represented together by the respective integrator companies. In the other chains studied, actors have not been indicated on one or more levels or do not exist in such a way that they can be allocated to a level. Thus, these supply chains have one or two of the actors and lack the others. In one case, in Hungary, no actor was found on any of the levels. These results are not surprising, as many of these chains can be characterised as very traditional, fragmented and not well coordinated. The supply chains in China represent special cases as the chains are fully inte-

grated and hence, the normative, strategic and operational levels are allocated to one actor or organisation that owns the whole pork supply chain.

Analysis of the state of the art in pork production and of the case studies provided support for the usability of the chain coordination model for quality management.

The quality broker concept

The concept of a quality broker has been developed to facilitate implementation of coordination mechanisms in pork supply chains, because of an important problem in many (not vertically integrated) pork supply chains.

A strong division of labour with many production units, especially in pig farming, requires supportive organisations to implement and support coordination mechanisms at interfaces of the supply chain. In practice, livestock traders often hold this position. But as a consequence, intermediary trade in the supply chain can provoke opportunistic behaviour to realise a margin (income of a trader). This behaviour can have a negative influence on the implementation of coordination mechanisms in supply chains (Arshinder et al., 2008) and is a big problem from the perspective of chain-wide quality management.

To solve this problem the "quality broker" concept (Figure 2.8) is proposed and incorporated in the coordination model. It helps relate business activities and monetary returns more to actors' contributions to coordination mechanisms and a QMS, respectively.

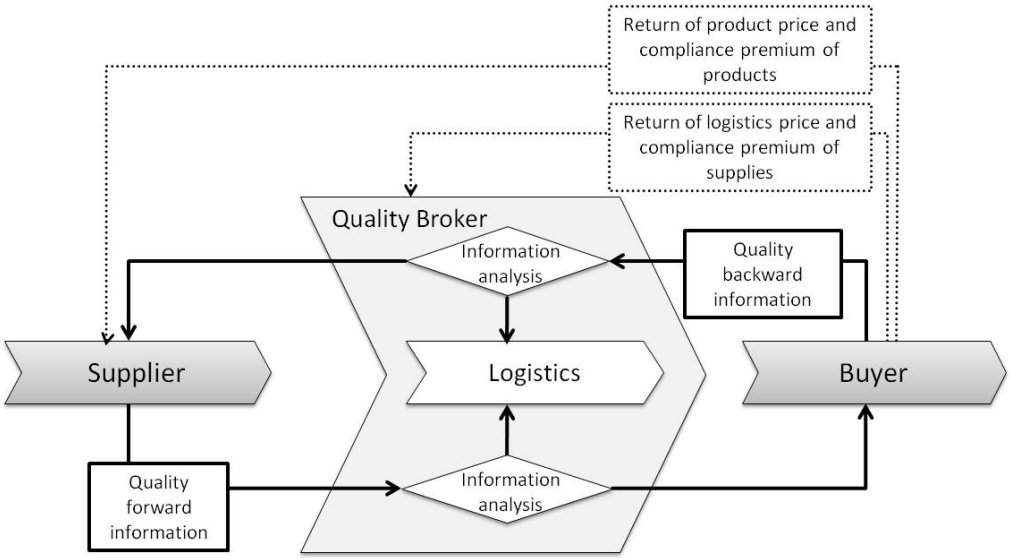

Figure 2.8: The quality broker concept

For example, a negotiable market-oriented product price and a compliance premium of the products could be the return for the supplier. However, the quality broker could get a logistics price and a compliance premium for his support of coordination mechanisms. In this way both are stimulated to improve compliance to their tasks in regard to the QMS. This is a new way of thinking with respect to how business relationships can become more strongly related to QMSs along the chain on the operational level.

Figure 2.8 shows the concept in the context of perfect market competition. If markets are not balanced (oligopoly or oligopsony), a marketing office of suppliers as well as a buying agency of buyers respectively should be integrated into the concept.

The coordination model includes not only actors, but also coordination mechanisms, which will be described in Section 2.6.

2.6 Coordination mechanisms

As shown in Figure 2.7, responsibilities for coordination mechanisms have been allocated to the three levels. Now the coordination mechanisms themselves will be described. Types of coordination mechanisms, such as those proposed by Arshinder et al. (2008), have been selected and aligned with quality management in pork supply chains.

The proposed coordination mechanisms (Figure 2.9) cover quality management activities along the chain with relevance to general quality requirements, animal health or welfare, food safety, certification and supply chain performance.

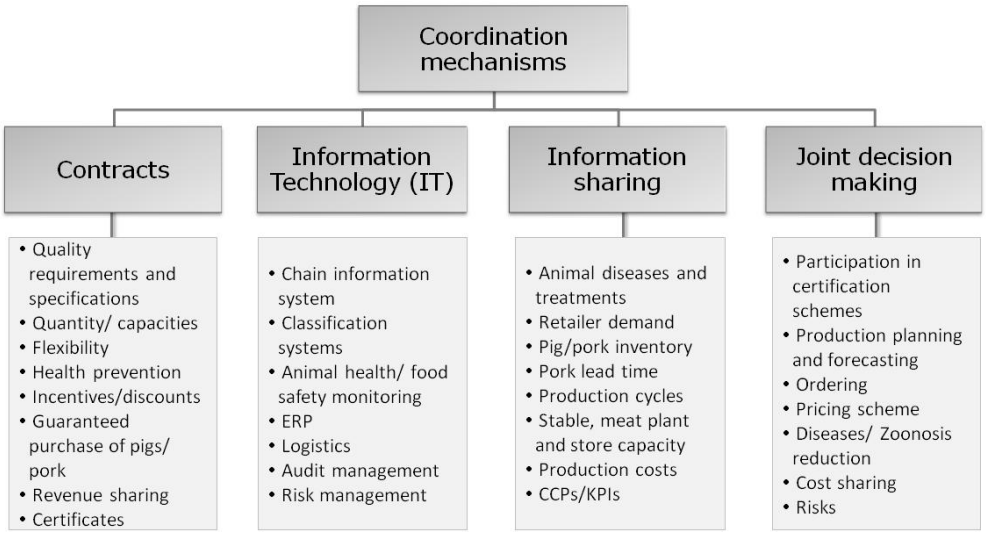

Figure 2.9: Coordination mechanisms of quality management in pork supply chains

Contracts are necessary to lay down the general principles of a quality management strategy and to define (product and process) quality requirements as well as specifications. In addition, they should cover quantities and capacities in the supply chain, but also the flexibility of production to minimise “bull-whip” effects (Forrester, 1958) within the chain. Another important aspect is health protection clauses that specify participation in animal health and food safety monitoring schemes to avoid hazards for the animals and consumers, respectively.

Incentives and discounts should be part of contracts to control the behaviour of producers and to motivate them to reach defined quality requirements for each production stage. Important from the perspective of good collaboration in the supply chain are guarantees for the purchase of pigs and pork, because storage capacity for growing pigs is very limited and

stock keeping of pork often increases cost and reduces quality. Revenue sharing is a very promising coordination mechanism, but requires a quality-management-oriented design of business processes and close collaboration.

Furthermore, today's markets often require certification as an approval of process quality on a defined basis. Thus, participation in a certification scheme should be fixed in contracts.

Information technology helps to facilitate communication along the pork supply chain. A chain information system supports the chain-wide coordination of information. To generate objective information about intermediary products, automated classification systems are very helpful at value-determining (neuralgic) points in the chain, like the inbound area of a meat plant for instance. They facilitate forward control processing (product quality flows) and motivate the supplier to improve their process backwards.

Animal health and food safety monitoring generates respective information. The objective of this coordination mechanism is to avoid hazards to animal and human health as well as to promote prevention supported by information and communication platforms with user-defined access. Such monitoring is strongly linked to risk management (risks to animal and human health), which should also be part of the coordination mechanism information technology.

Enterprise resource planning (ERP) should be integrated into chain information technology to achieve a high alignment of supply and demand within the chain. It is a challenging coordination mechanism especially on the farm level, because of the relatively small number of production units in different production stages (up to four) and because the pig's life cycle has a variation of growth of up to 8% (coefficient of variation: final weight of healthy finished pigs). In relation to ERP, logistics IT is a very important coordination mechanism to deliver intermediary products at the proper time to meet demand.

Audit management should facilitate the coordination of and compliance with certification standards within the chain. Approaches to risk management in a pork supply chain are of increasing importance in modern QMSs. For example, the supply chain meat inspection (initiated by the EU Hygiene Package) integrates quality and risk management and enforces collaboration at the farming level.

Modes and principles of information sharing should be further defined. Important from the health and safety point of view is sharing of information about animal diseases and treatments. To coordinate production along the supply chain, information about retailer (customer) demand, pig and pork inventory, production (especially farm) cycles as well as stable, meat plant and storage capacity should be communicated.

Against the background of realising revenue sharing, information exchange about production costs is also relevant.

Critical control points (CCP) of the HACCP concept and key performance indicators (KPI) will allow controlling of compliance with quality management requirements. Of importance in regard to food safety is that CCPs along the chain be interlinked and adjusted to avoid hazards as early as possible.

Good collaboration in a supply chain is based on essential conditions for joint decision making. An important point is participation in certification schemes (e.g. GlobalGAP, IFS, BRC), which should be decided upon jointly to obtain chain-wide certification. Ordering and pricing schemes affect the main interests of the supply chain actors and thus the choice of scheme should also be part of joint decision making.

Furthermore, animal diseases, zoonoses and risks related to food origin are new integral parts of supply chain meat inspection. These risks threaten the safety of pork meat, and it is therefore in the interest of the whole supply chain to decide jointly how to minimise them.

Coordination mechanisms facilitate the diffusion of a QMS from the normative level into the operational level, represented by quality management of a pork supply chain. They are an integral part of a QMS. Framework conditions and specifications of coordination mechanisms should be defined within the QMS.

2.7 Application of the model to a specific case

To validate the developed model of supply chain coordination and determine whether it is applicable under realistic conditions, it was applied to one of the supply chains studied in the Q-Porkchains project, namely the German Eichenhof chain.

Figure 2.10 presents the individual actors identified in the different categories and levels in the studied chain. Eichenhof is a meat brand program of a pork supply chain coordinated by a farmers' cooperative that has its own meat plant. The chain quality board of this chain is represented by an executive board of the cooperative and the chief executive officers of the meat plant, together called the Eichenhof board. The network coordinating position is occupied by the management of the meat plant that enforces the QMS. The position of quality broker is occupied by the pig livestock broker "EGF", which acts as an intermediary between the farming stages and which implements and supports coordination mechanisms.

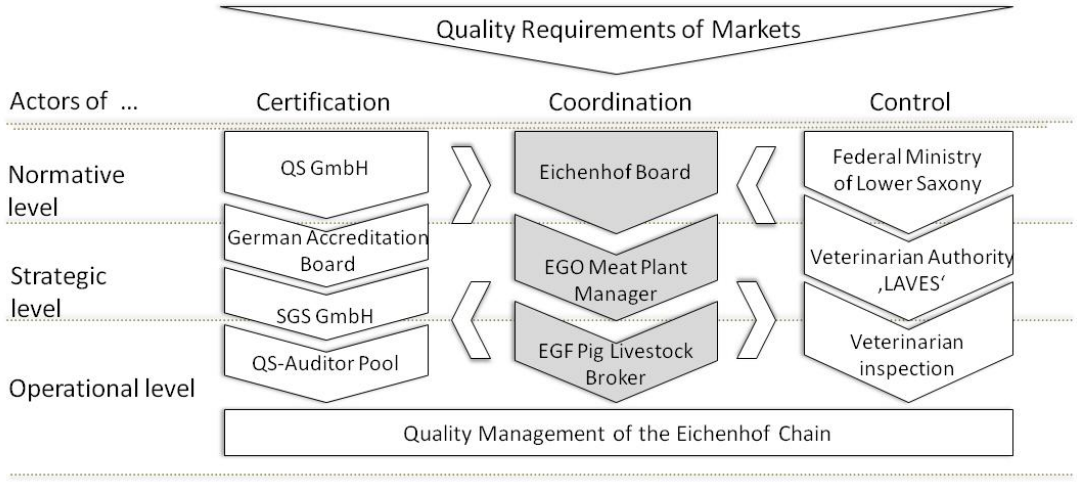

Figure 2.10: Chain-wide coordination of QMS – the example of the Eichenhof chain in Germany

In 2004 the chain quality board decided to acquire certification from the German "QS" standard (QS GmbH, Germany). The actors of the QS standard on the different levels are shown as certification actors in the figure. As Eichenhof is located in the federal state of Lower Saxony, the control actors fall under the federal ministry for food, farming, consumer protection and state development of Lower Saxony.

Application of the developed model to the Eichenhof chain shows that the model indeed reflects reality in this pork supply chain and individual actors can be found for each level and category. Additionally, looking back to the aggregated results for the three management levels in the case study pork supply chains shown in Table 2.2, more conclusions can be drawn on the existence of coordinating actors in pork supply chains. The existence of coordinating actors on the three levels varies between the chains. Mostly they are present in the more advanced and modern supply chains, whereas in the traditional supply chains coordination has not yet been fully achieved. In fully integrated supply chains owned by one company, we observed that coordination is performed by just one organisation acting as the chain quality board, network coordinator and quality broker on all three levels of the model.

It is expected that the variance in the presence of coordinating actors in the case studies depends on the organisational forms (integration) in the chain, the presence of quality management strategies, the need for certification to get access to consumer markets and the official food control system in each country.

2.8 Discussion and next steps

Quality certification standards and food legislation (EC 2002) have been in flux in recent years (Velthuis et al., 2010; Bahlmann and Spiller, 2009). These changing framework conditions have tremendously stimulated coordination efforts of pork supply chains to simultaneously comply with several certification standards on international, national, and regional level, different regulations in home and export markets and new approaches for meat control (Van Wagenberg, 2010). Additionally a stronger focus of QMSs on ecologic (e.g. carbon

footprint) and societal (e.g. animal welfare) demands can be recognised (Wognum et al., 2011). Together these facts significantly increase the need for coordination of QMSs of the entire pork supply chains. Chain-wide coordination of QMSs can be seen as a big challenge for the future competitiveness of complex pork supply chains in Europe.

To design QMSs in the pork supply chain and to coordinate individual activities concerning quality management in a balanced way, a chain coordination model has been proposed. Three levels of coordination roles and responsibilities have been defined – normative, strategic and operational – to allocate actors according to their roles and responsibilities, categorised into certification, control and coordination activities.

Results of empirical analysis of the case studies have shown that the existence of the coordinating actors (chain quality board, network coordinator and quality broker) in the different supply chains varies. This variation can be related to:

- the degree of integration in the chain: in fully integrated chains, like in China, one actor occupies normative, strategic and operational positions
- the presence of quality management strategies in pork supply chains

For the efficient coordination of quality management strategies of pork supply chains, as described in the proposed model, producer network integration (Petersen et al., 2007), information management models (Lehmann et al., 2010; Schulze Althoff and Petersen, 2004) and chain governance strategies (Wever et al., 2010) can be conducive. The proposed coordination mechanisms – within the categories contracts, information technology (IT), information sharing and joint decision making (Arshinder et al., 2008) – reflect and support the following key aspects of successful quality management of pork supply chains:

- sustainable satisfaction of consumer and market demand
- compliance with legal requirements and private certification standards
- structured improvement of process and product quality along the chain
- prevention of animal diseases and zoonoses to achieve a high level of animal health (welfare) and food safety as well as to minimise associated risks
- effective and open communication of quality between production stages

A challenge for the implementation of coordination mechanisms is the high division of labour with highly specialised (pig and pork) producers. Opportunistic behaviour among producers, as analysed in several studies (e.g. Dubois and Giraldeau, 2007; Schramm et al., 2004; Kagerhuber and Kühl, 2002), can cause information asymmetries in food supply chains. This can negatively influence implementation of coordination mechanisms in supply chains (Arshinder et al., 2008). The quality broker concept has been proposed to facilitate implementation of coordination mechanisms and promotion of QMSs on the operational level. Only very few studies highlight the potential of farmer cooperatives in this context (Theuvsen et al., 2010; Voss et al., 2010; Petersen et al., 2007; Schulze Althoff, 2006).

The proposed chain coordination model for QMSs is intended to strengthen the competitiveness of European pork chains by making them more compatible with various market conditions and relationships in pork supply chains. Furthermore, it can help chains structure coordinating actors and implement coordination mechanisms for QMSs.

In a next step, the model will be tested and evaluated in pilot chains to further improve it, following the cyclic research approach. In this context, scientific methods will be reviewed to identify a suitable method to test the validity of the established model as well as to identify and further develop the actors and coordination mechanisms in various pork supply chains.

Furthermore, guidelines will be designed for using the model to substantiate the tasks and responsibilities of the individual actors. A literature review of strategic management, quality management and information management will be performed, e.g. to find rules for composing a quality board.

The quality broker concept will also be tested and simulated. Various supply chain scenarios will be identified and then analysed with respect to this role.

In addition, further research will be conducted on coordination mechanisms in the pork supply chain. In this paper the authors identified coordination mechanisms of quality management of pork supply chains based on a literature search, interviews and case studies. In the next steps these coordination mechanisms will be further specified and presented to experts. For this purpose suitable scientific methods have to be identified and selected. One method would be to query specialists in pork supply chains through expert interviews to evaluate and assess the proposed mechanisms. Results will be quantitative as well as qualitative. A quantitative analysis will aim to rank the mechanisms according to their relevance for QMSs of pork supply chains and to further align them based on the estimation of experts. The objective of the qualitative analysis will be to develop implementation and application criteria for coordination mechanisms.

In conclusion, this chain coordination model for QMSs will serve as the foundation for extensive further research.

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3. Practical implementation of quality and risk management systems in agri-food supply chains

Abstract

Due to the continued occurrence of food crises, quality management and risk management procedures are of prime importance to the agri-food sector. For this reason a survey has been performed on contemporary food quality and risk management systems in companies throughout Germany. The objective of the study has been to determine the current design of quality and risk management systems, their practical implementation and to determine connections between both systems. The results confirm that quality and risk management systems are highly interconnected and that the responsibility for the execution of both is normally undertaken by the same department. Furthermore, it has been found that quality management standards and methods are mostly also used for risk management. A two dimensional risk management assessment plot has been formulated, which clusters companies according to their methodical competence and international trade orientation.

Keywords: risk management, food safety, quality management, agri-food industry

3.1 Introduction

Quality management is crucial in agri-food supply chains and a key element of the agri-food business model, not least to comply with legal and customer obligations. Whilst the principles of quality management are firmly established in agri-food companies, those of risk management are more recent. Risks are inherent to almost any activity and hence their management is essential.

In agri-food supply chains the management of risk is particularly important as the chain directly impacts on the human population (in terms of produce consumed) on a daily basis. In addition, the products are perishable and have limited shelf-life, which require careful and appropriate handling, storage and transportation. Ignoring the potential risks in food supply chains can cause widespread public illness and in turn can damage the reputation and livelihood of companies, as well as entire sections, of the agri-food industry and can lead to severe crises (Horst and Strecker, 2006). To help safeguard against crises, the European Union has established risk management as a strategic priority in legislation.

Food legislation requires the analysis of risks (Regulation (EC) No 178/2002). Good risk management practices help to ensure that crises can be prevented or at least minimised (Kamiske, 2008). The legal requirements as well as the obligation to mitigate harmful risks pose a formidable new challenge to the companies of the agri-food industry. The management of these demands on the agri-food sector has prompted the establishment and implementation of a proactive risk management system, which represents an important success factor for companies of the agri-food sector. The risk management system aims to mitigate serious risks for consumer protection, to comply with current regulations and to increase company efficiency as well as to maintain competitiveness.

There is a tendency in agri-food companies to implement combined systems where for example quality and risk management are integrated in one system (Slütter et al., 2014; Theuvsen et al., 2013). The interconnections between quality and risk management, as well as the actual status of quality management systems and the prevalence of risk management systems in the agri-food supply chain present research questions of huge importance. Heretofore, sparse evidence has existed as to how risk management was actually implemented in practice in the agri-food sector. Therefore, a survey has been conducted on quality and risk management systems in agri-food companies based on the following hypotheses:

I. Risk management is interconnected with quality management and similar standards and methods are used in the agri-food industry.
II. The risk management system is based on varying definitions of risk management in the industry.
III. The two dimensions of methodical competence and international trade orientation are two categories according to which companies can be classified into typical clusters.

With particular reference to hypothesis III, it has been anticipated that those companies with a strong international trading element are also likely to have a sophisticated and well developed risk management competency.

3.2 Background

3.2.1 Quality management and links to risk management

Food quality management is the extent to which the established requirements relating to the characteristics of a food are met. Food safety is the extent to which those requirements relating specifically to characteristics or properties that have the potential to be harmful to health or to cause illness or injury are met (Alli, 2003).

The international standard ISO 9000:2005 defines quality management as “coordinated activities that organisations use to direct and control quality” (ISO 9000, 2005). The main focus of food quality management is on assuring product and process quality in the company through the fulfilment of various food laws, product liability, and customer demands (Dunkhorst and Pfaff, 2009; Hahn and Pichhardt, 2008).

There are more than one hundred food safety and quality standards in the global food supply chain and the number is constantly growing (Simmons, 2010). Standards can be general, such as the ISO (International Organization for Standardization) 9000ff. or ISO 31000 aiming at cross-sector applicability or can be specific to the agri-food sector such as the BRC Global Standard for Food Safety (British Retail Consortium) or IFS (International Featured Standards) for the food sector. The bottom line is that companies’ adherence to a particular standard is open to their individual interpretation and preference. Adherence is largely based a company’s obligations to its customers. For example, a customer may require an agri-food company to follow the IFS standard.

Important standards in Germany are the international standards ISO 9001, ISO 22000, ISO 31000, IFS Food, BRC, the national standard QS (Qualität und Sicherheit, Quality and Safety). Table 3.1 gives an overview of these standards.

Table 3.1: Comparison of the standards ISO 9001, BRC, QS, IFS Food, ISO 22000, ISO 31000 in chronological order according to release

Standard / Criterion	ISO* 9001	BRC*	QS*	IFS* Food	ISO* 22000	ISO* 31000
Initiator	International association of standardisation bodies ISO*	British retailers	Companies from agri-food industry	German and French retailers (HDE, FCD)*	International association of standardisation bodies ISO & CAC*	International association of standardisation bodies ISO*
Release	1987	1998	2001	2003	2005	2009
Application	International	International	National (Germany)	International	International	International
Target group	Branch neutral for all kinds of companies	Food manufacturers	Initially for meat and meat products, since 2004 for fruit, vegetable, potatoes	Food manufactures	Agri-food companies	Branch neutral for all kinds of companies

*ISO=**I**nternational **O**rganization for **S**tandardization
BRC=**B**ritish **R**etail **C**onsortium
QS=**Q**uality and **S**afety (Qualität und Sicherheit)
IFS=**I**nternational **F**eatured **S**tandards
HDE=German Retail Federation (**H**auptverband des **D**eutschen **E**inzelhandels)
FCD=French Retail Federation (**F**édération des Entreprises du **C**ommerce et de la **D**istribution)
CAC=**C**odex **A**limentarius **C**ommission

In the early 1990s the first certifications of quality management systems were granted according to ISO 9001 in the food industry sector (Schulze and Spiller, 2008). Certification according to ISO 9001 forms the entry-level and is the foundation of quality management for participating companies (Pöchtrager, 2011). Ten years later specific food quality assurance systems have been developed (Schulze and Spiller, 2008). These include ISO 22000, IFS, BRC or QS, which build mainly on ISO 9001 principles.

The international **ISO 9000ff.** standard family represents the most important and branch-neutral norms for quality management and sets a framework for quality management systems. ISO 9001:2008 describes how quality management systems should be established and refined laying down the requirements of quality management systems.

BRC is a retailer initiative and represents the majority of British retailers. In 1998 the BRC developed a standard nowadays known as BRC Global Standard – Food. Originally developed for the supply of retailer branded products it became widely used across other sectors of the food industry, also outside the UK, and provides certification for food manufacturers in general (BRC, 2011, 2004).

BRC is a horizontally oriented quality standard. This means that it does not set overlapping requirements for subsequent stages of the value chain as it applies only to own-brand product suppliers of retail groups (Krieger and Schiefer, 2007). For horizontally oriented quality

systems the main focus is on process quality whereas vertically oriented quality systems focus on product liability and cross compliance (Gellynck and Kühne, 2007).

The standard **QS** is the biggest quality assurance system organised by the private sector in Germany, founded in 2001 by associations and organisations of the food industry. QS standards exist for meat and meat products since 2001 and for fruit, vegetables and potatoes since 2004. The QS system is mainly used in Germany as the national standard and regulates all steps involved in the meat, fruit/vegetable/potatoes production and functions both in a horizontal and vertical cross-linking. For example, for the meat chain, the QS standard starts to regulate practices at the level of feed producers, then covers primary production, abattoirs and cutting plants, then the meat industry at the connection point to the consumer and food retailing. QS has established agreements with quality standard regulators in other countries, such as IKB (the Netherlands), Certus (Belgium) and QSG (Denmark) so that the systems are mutually recognised and one audit is sufficient (Nienhoff, 2008).

The international standard **IFS Food** was developed by the German retail federation HDE and its French counterpart FCD in 2003. IFS Food is a quality and food safety standard which intends to allow the assessment of suppliers' food safety and quality systems. Initially IFS was for retailer branded food products and is now applied to all the post-farm gate stages of food manufacturing (IFS, 2011).

IFS Food is a horizontally oriented quality standard (Krieger and Schiefer, 2007). IFS and BRC are very similar standards, but not identical (Simmons, 2010). BRC is more process oriented (Branscheid, 2008). Unfortunately there is no mutual recognition of IFS Food and BRC, which means they both have to be audited individually.

The international food safety management standard **ISO 22000**:2005 was developed by ISO and Codex Alimentarius Commission (CAC). This standard provides a framework of internationally harmonised requirements in the food sector and is an advancement of the ISO 9001 standard. The standard incorporates the ISO 9001 standard and combines it with the HACCP (hazard analysis and critical control points) concept to one standard. The main difference between ISO 22000 and ISO 9001 is in scope. The main goal of ISO 22000 is food safety whereas ISO 9001 focuses on general quality management (i.e., not restricted in scope to the food sector). The ISO 22000 standard can be applied in all types of organisations within the food supply chain, independently or integrated in other management systems (Gellynck and Kühne, 2007).

The branch neutral **ISO 31000**:2009 standard relates to risk management. The purpose is to provide universally recognised principles and generic guidelines on risk management to replace the countless sector-specific standards.

The standards alone show that in agri-food companies a number of overlaps exist between risk and quality management. Many sector-specific quality assurance standards have defined the HACPP concept as a basic requirement, in line with the legal requirements, and there-

fore make demands on risk analysis and furthermore food safety management in the companies (Dunkhorst and Pfaff, 2009; Lange, 2007; Gymnich et al., 2006). A food that does not conform to food safety requirements automatically does not conform to food quality requirements; on the other hand, a food can conform to food safety requirements, but not conform to the other quality requirements (Alli 2003). Food safety is an essential quality characteristic which due to its importance and potential impact on consumer health has to be ensured within a wider risk management system.

Quality and risk management show mutual objectives and values as within quality management, values are created through satisfaction of customers and other stakeholders which are assured through systematic risk prevention and error reduction in the companies. The relationship can be summed up as: good quality management reduces risks and good risk management improves quality (Romeike, 2008).

3.2.2 Definition of risk and risk management

In the agri-food sector risk is principally concerned with the avoidance of all potentially harmful entities, which might adversely impact on consumer health. For food companies, it is an obvious risk to distribute food which is unsafe and which does not comply with legal requirements.

An important definition in the area of food is provided by the European Regulation (EC) No 178/2002 which defines risk as “a function of the probability of an adverse health effect and the severity of that effect, consequential to a hazard” (EC 178, 2002). Risk differs from hazard which is “a biological, chemical or physical agent in, or condition of, food or feed with the potential to cause harm” (FAO/WHO, 1997).

To clarify the difference, hazard occurs when an object has a harmful effect. For example, if a substance is toxic, irritating or corrosive. However, a risk only emerges when people have had exposure (either direct and/or suspected) to the hazardous substance. Risk includes the probability that the harmful effect has actually been caused. This means that risk is only present when hazard and potential exposure to the said hazard manifest simultaneously in any given food-supply chain (Ulbig, 2010).

Agri-food companies also have to contend with risks (e.g. of financial loss) that stem from products that are non-threatening to human health, but which are nonetheless rejected by the consumer as the product may fail to comply with certain quality requirements. This work focuses on quality and safety risks that might lead to deterioration of process and product safety, leading to negative impacts on consumer health and financial loss for the company. Potential risk areas are countless, but might typically result from unhygienic practices, false or incorrect documentation, poor and inappropriate internal quality and security controls, mistakes in procurement and supplier selection, inappropriate technology and infrastructure (e.g. no refrigeration during transport).

A comprehensive risk management system is helpful for the early detection and control of potential risks to maintain continuity in the company (Romeike, 2005).

Risk management comprises all elements of organisation structure, legal regulations, support instruments and methods to systematically implement company-wide processes to detect, handle and control risks (modified according to Vanini, 2012).

Risk management includes the elements risk identification, assessment, control and monitoring. Tasks of efficient risk management are the systematic and comprehensive identification and collection, assessment, control and monitoring of potential, and of already determined risks, as well as a continuous risk communication and documentation (Mack et al., 2006).

European guidelines for agri-food companies for the establishment of a risk management system, cover several areas:

- Agri-food companies have to perform a risk analysis according to article 6, 7 of the EU basic regulation (EC) No 178/2002. The exact integration of the risk analysis into the company organisation and management systems is not explained further.
- An integral part of each system in conformity with the EU basic regulation and the supplementary hygiene regulation (EC) No 852/2004 - 854/2004, has to be risk analysis according to HACCP-principles. According to the guidelines of the Codex Alimentarius Commission, HACCP comprises the determination of critical control points (CCP) in production, and determination of critical threshold values for the critical control points as well as the establishment of a monitoring system, the implementation of control measures as well as the documentation and verification of the system (CAC, 2003). The concrete design of the risk management system is not specified.

In addition to the European directives, researchers have identified a number of rules for risk management, which are summarised as follows:

- The focus of the food entrepreneurs needs to be the analysis of risks across all company departments which could endanger the continuity of the business processes and services (Lendle, 2008).
- Risk management straddles all departments and processes in the company and shall be understood as the task of each and every employee (Romeike, 2005; Seidel, 2002; Reh, 2001). A risk management system through a continuous and targeted handling of risk information creates transparency in the company and helps to strengthen risk awareness amongst the employees (Seidel, 2002).
- Operational risk management is not an independent management system, but shall be an integral part of the management and the everyday processes of the company (Winter, 2008; Seidel, 2002). A poorly conceived risk culture and an attitude of the business management that risk management is only a burdensome obligation imposed by legislation can lead to a poor risk assessment, to taking excessive risks and to an insufficient ability to cope with risks (Vanini, 2012).

- Companies which have established a functioning quality management system can easily integrate an equally effective risk management system (Brühwiler, 2008; Romeike, 2008).

The present author suggests that the subject of risk management should not aim exclusively to provide an exhaustive assessment of possible risks (which would always be incomplete), but rather to ensure that risk management procedures are robust to a diverse set of circumstances which could be harmful to health and business.

3.3 Methodology

The empirical study comprises data collected as part of an online survey of companies from the agri-food supply chain in Germany. The survey consisted of a series of closed and open-ended questions, thus allowing the respondents space for elaboration on their individual answers. It was composed and pre-tested by academic reviewers familiar with quality and risk management prior to online release. For the survey the Unipark programme was chosen providing the software EFS Survey of the European company QuestBack. Table 3.2 shows the sections of the questionnaire (the complete questionnaire in German is enclosed in Appendix A).

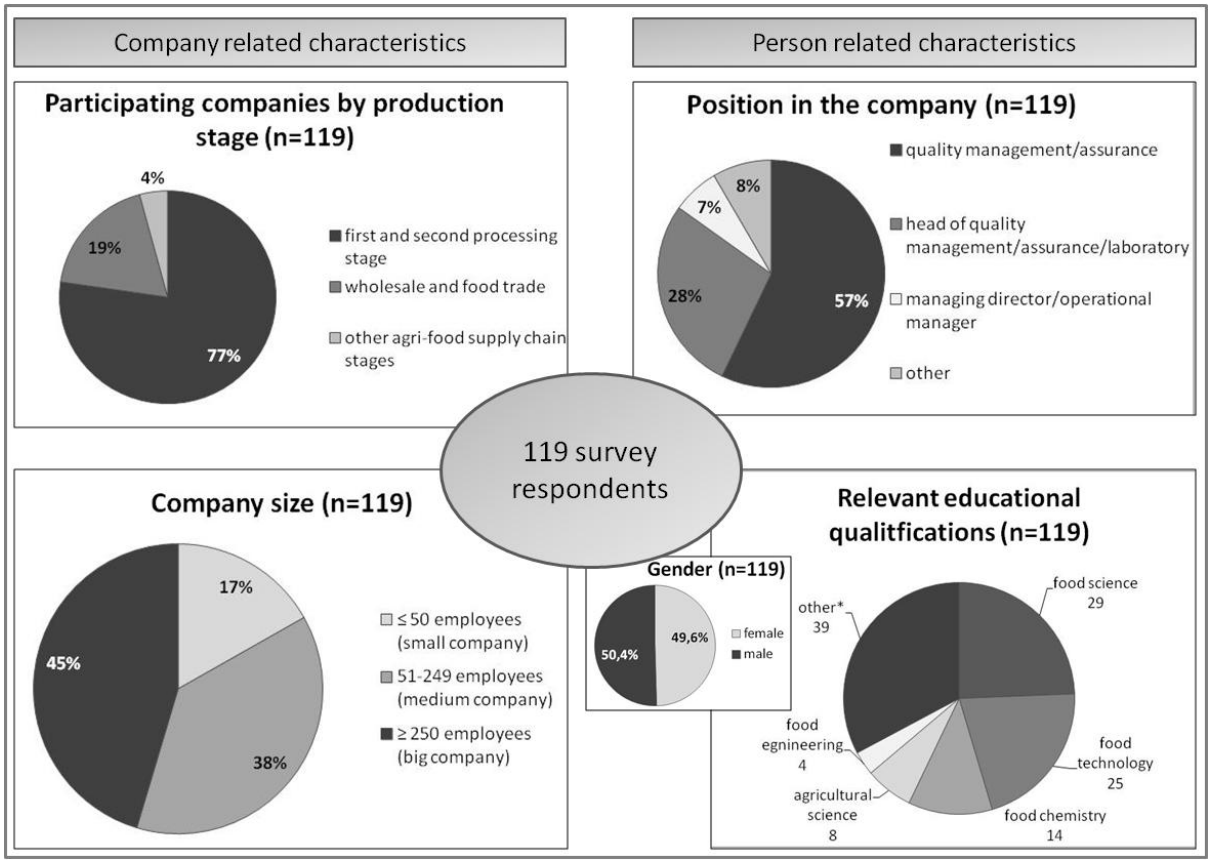
Table 3.2: Sections of the survey questionnaire

Title page	
Sample characterisation	Data regarding the company (2 questions) Data regarding the contact person (3 questions)
Main part	**Questions regarding quality and risk management systems in the agri-food company (13 questions)**
Final pages	
	=total of 18 questions

The survey was announced and distributed by the German Federation for Food Law and Food Science (Bund für Lebensmittelrecht und Lebensmittelkunde, BLL), which notified its members. Furthermore an extensive network of the Preventive Health Management Group has been invited and the survey was posted on relevant professional groups of the social network XING. The study has been live for a duration of 10 weeks (11/2013 – 01/2014).

Quality controls of the survey data have been performed: a certain amount of quality control was necessary to ensure that the survey had been completed as required - the questions were mandatory and had to be answered before proceeding to the next question.

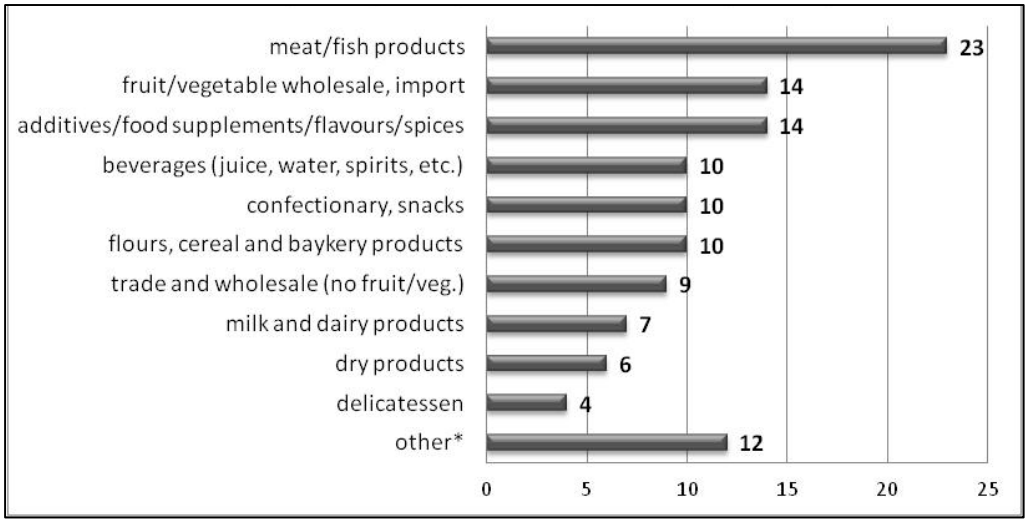
Furthermore, one participant was excluded for completing the survey in under three minutes, indicating that the questions and responses could not possibly have been properly assimilated. In total 119 participants satisfactorily completed the evaluation out of 471 persons who have visited the link (25%). Figure 3.1 provides an in-depth analysis of the characteristics of the participants.



*other educational qualifications are for example business economist, chemist, biologist; some did not specify qualifications

Figure 3.1: Characteristics of participants of the survey (n=119)

In Figure 3.1 it can be seen that most of the survey participants (85%) are employees at various levels in quality management departments (i.e., quality management plus head of quality management) and focus is on the first and second processing stage. The interviewees have been asked to indicate the main product of their company. Based on this, the companies have been assigned to sectors of the agri-food industry, shown in Figure 3.2.



*some products/sectors have not been specified whilst others represent minorities such as frozen products or mixtures for processing.

Figure 3.2: Distribution of the business-line of the participating companies (n=119)

For further evaluation of the data, a statistical analysis has been performed using the IBM Statistical Product and Service Solutions (SPSS) software and Microsoft Excel. The analysis has attempted to discover whether any statistically significant trends and findings can be inferred from the collected data. To determine this, significance testing has been carried out using cross tables and the Chi^2-test (p_C), where the number of cells with expected frequencies of smaller than five must not be more than 20% (Backhaus et al., 2011). In this case, the Fisher test (p_F) has been applied. Significance has been reached when $p<0.05$ (Backhaus et al., 2011).

Based on the survey data the enterprises have been positioned in a cross-diagram to assess the portfolio of the companies regarding their risk management systems (Figure 3.3).

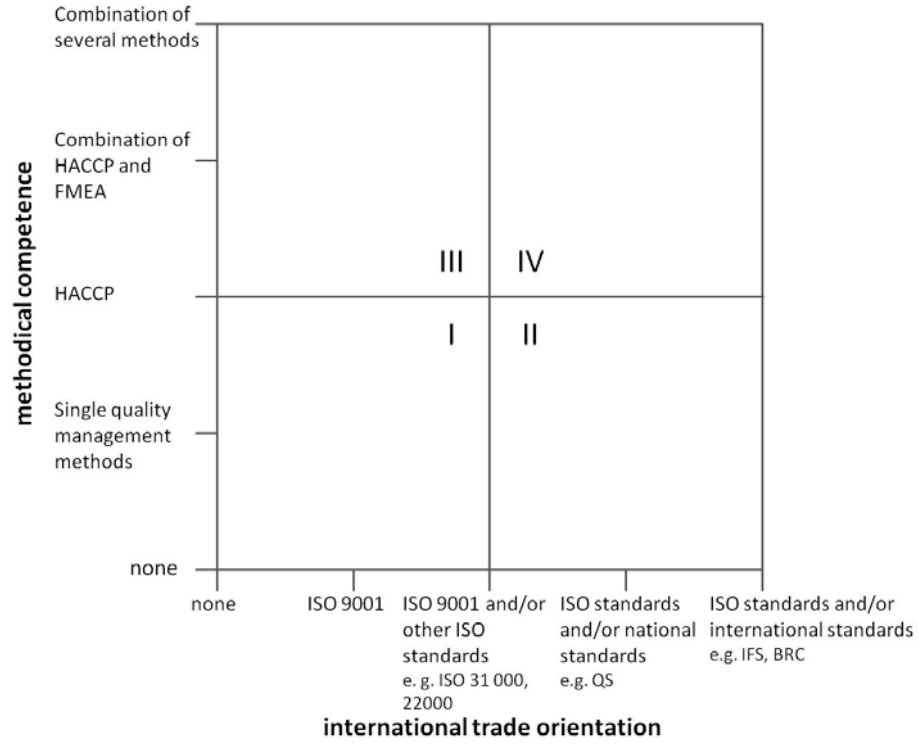


Figure 3.3: Portfolio of methodical competence and international trade orientation in risk management

The x-axis demonstrates the orientation of the company towards international trade, based on the standards adhered to by the respective enterprises. Standards are mostly applied upon customer request. Food traders, wholesalers and/or international customers require different standards than those required by caterers and/or national customers, for example. At the lower end of the x-axis, no standard is used as the company might not have a risk management system; this is followed by the basic ISO 9001, followed by the ISO standard combined with other ISO standards (e.g. ISO 31000, 22000), followed by ISO standards combined with national standards (e.g. QS) or national standards alone. The top end of the x-axis multiple standards plus international standards (e.g. IFS, BRC) indicate the highest degree of international trade orientation.

On the y-axis the methodical competencies for risk analysis and assessment are scaled from no competence at the lower end, followed by single individual quality management methods which are applied in the companies, the team-oriented HACCP method, and a combination of the methods HACCP and FMEA (failure mode and effects analysis). At the top end of the axis companies are positioned if they apply a combination of several methods for risk management. The combination of several methods indicates a level of redundancy, which by default safeguards against the proliferation of risks and subsequent manifestation of hazards. Therefore, companies positioned higher on the y-axis are categorised as having a high degree of methodical competence.

It would intuitively be anticipated that companies with a strong international trade orientation and with multiple customers, would probably also have to adhere to multiple quality standards. Those companies that adhere to multiple quality standards and multiple risk management protocols will be positioned in quadrant IV. The subsequent data analysis will explore the distribution of the companies throughout the quadrants.

The analysis also assesses the two dimensions based on whether the participating companies belong to a sector which has been involved in recent publicised crises (i.e. crisis in the sector, not necessarily the individual company). To accomplish this, the companies have been allocated to one of three classes, as follows, and then plotted in the diagram: companies are from a sector which has been involved in a) multiple publicised crises between 2010-2013, b) one publicised crisis between 2010-2013, and c) no crisis between 2010-2013. The purpose of this analysis has been to determine whether crises have influenced international trade orientation and to discover if companies have altered their methodical competence in response to crisis in their respective sectors.

3.4 Results and discussion

3.4.1 Implementation timeline of quality and risk management systems

The survey participants have indicated the years in which their respective quality management systems and/or risk management systems have been implemented in their companies (Figure 3.4).

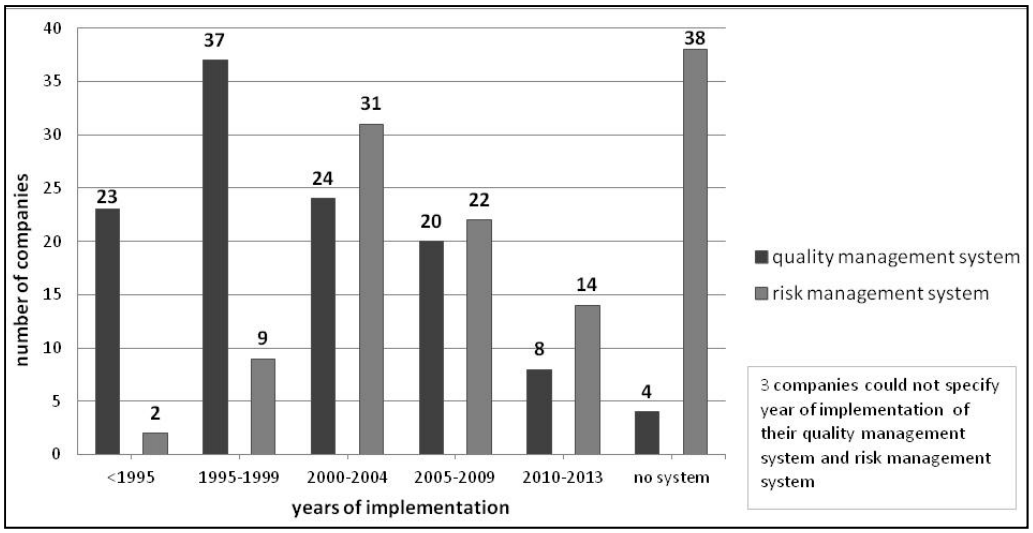


Figure 3.4: Frequency distribution of implementation timelines of quality and risk management systems (n=119)

It can be seen in Figure 3.4 that 52% (60) of the companies having a quality management system have initiated this system prior to the year 2000, whereas most companies (65%; 53) have introduced a risk management system subsequent to their quality management systems, primarily between 2000 and 2009. This finding is unsurprising and reinforces the fact that quality management concerns for agri-food companies preceded concerns related to risk management. The first certified quality management systems started in the 1990s (Lehnert et al., 2014) whereas risk management (for the agri-food sector) was only brought into discussion years later (FAO/WHO, 1997).

Quality management systems

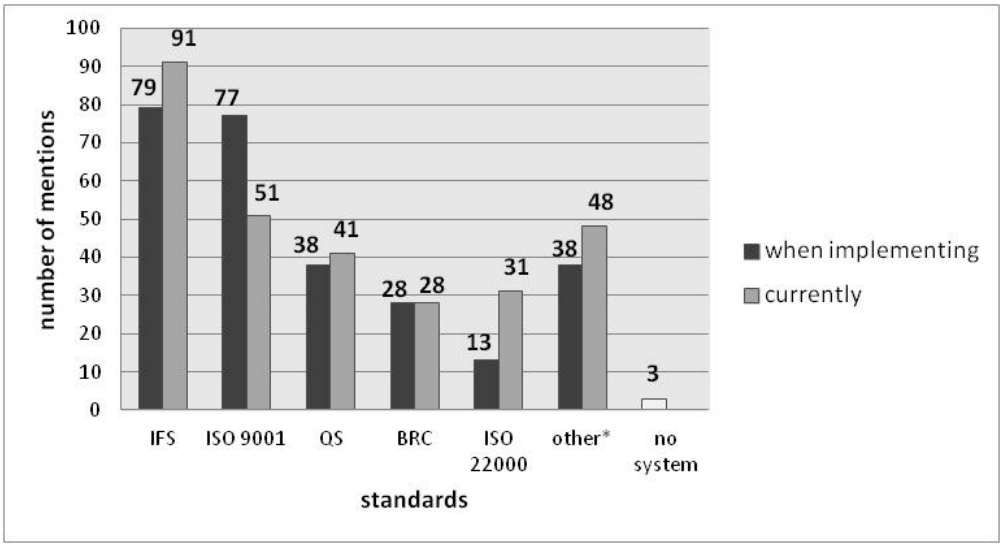
While 94% of the participating companies have a separate quality management department, only 5% operate a separate risk management department (thereof three medium-sized, two large and one small company). In 65% of the companies, risk management is conducted under the quality management department, in 12% of companies, risk management is performed over several company departments (whereof almost half state quality management together with other departments) and 18% of companies do not have their own risk management system (Figure 3.5).

*these are: quality management + other department (6 companies); the department management (4); controlling (2); procurement (1); sales/marketing (1); unspecified department (1)

Figure 3.5: Frequencies of allocation of risk management in the companies (n=119)

The results show clearly that in the agri-food industry risk management and quality management are heavily interconnected and overlapped. This important finding is in contrast to the situation of corporate risk management in finance, insurance and banking where risk management (of mostly financial risks) is normally a separate department or integrated into controlling (Denk et al., 2008). As has been established in this evaluation, in the majority of agri-food companies the basis for the management of product risks is a functioning quality management system where an effective risk management system can be easily integrated and which is mostly an integral element of the quality management system (Brühwiler, 2008; Kamiske, 2008; Romeike, 2008).

Standards that have been reported to be used both when having initially implemented the quality management system and which are currently employed for the establishment and further development of the system are shown in Figure 3.6. The survey participants could choose between five given standards and add additional ones if applicable.



*other: e.g., HACCP, bio/organic farming, special GMP, Food Safety System Certification FSSC 22000, Halal, etc.

Figure 3.6: Frequencies of standards used as basis for quality management systems (multiple replies possible; n=119)

The three most important standards in descending order were IFS, ISO 9001 and QS. 79 interviewees stated to have used the private and sector-specific IFS standard at the time of implementation and 91 currently for further development. The standard significantly gained importance since implementation ($p_C<0.001$).

77 persons have reported to have used the general standard ISO 9001 when implementing the quality management system but currently only 51 have reported to adhere to the same standard, which is a highly significant decrease ($p_C<0.001$). The QS standard has been mentioned 38 times when implementing a quality management system and 41 have indicated it to be in current use, BRC has received 28 mentions (both when implementing and currently) and ISO 22000 has received 13 mentions (used when implementing) whereas 31 have reported to currently follow this standard.

There has been a proliferation of standards in the food supply chain internationally (Julien, 2010) and companies are to a large extent subject to multiple certifications. For this reason requirements of different standards are considered for the implementation and further development of quality management systems, as has been confirmed by this survey.

The more recently introduced standards like ISO 22000, IFS, BRC or QS, have largely replaced ISO 9001, even if companies still comply with ISO 9001 requirements (Pöchtrager, 2011). Nowadays there is a lack of demand by customers for ISO 9001, so certification of ISO 9001 no longer represents an advantage for the company, which explains the decrease of ISO 9001 use in the survey.

Risk management systems

When asked for the definition of risk management in their companies 24 persons referred to the identification, analysis and control of risks/hazards, 14 to HACCP only and 12 to HACCP combined with other systems such as crisis management or the food defense approach (protection of the agri-food supply chain against terrorist acts). Eight have mentioned crisis management alone and seven distinguished between the risk that is addressed, e.g. product risk or business risk. Six each have stated that risk is the prevention of negative impacts and that it is an integral part of quality management. Five participants have defined risk management as assuring food safety and/or product quality and three defined it as a multi-faceted systems for the reduction/elimination of hazards such as crisis, glass and allergens. 14 have given other definitions such as “prevention”, “company specific standards”, “safeguarding of the company, the customer, and the end-consumer”. Details can be seen in Figure 3.7.

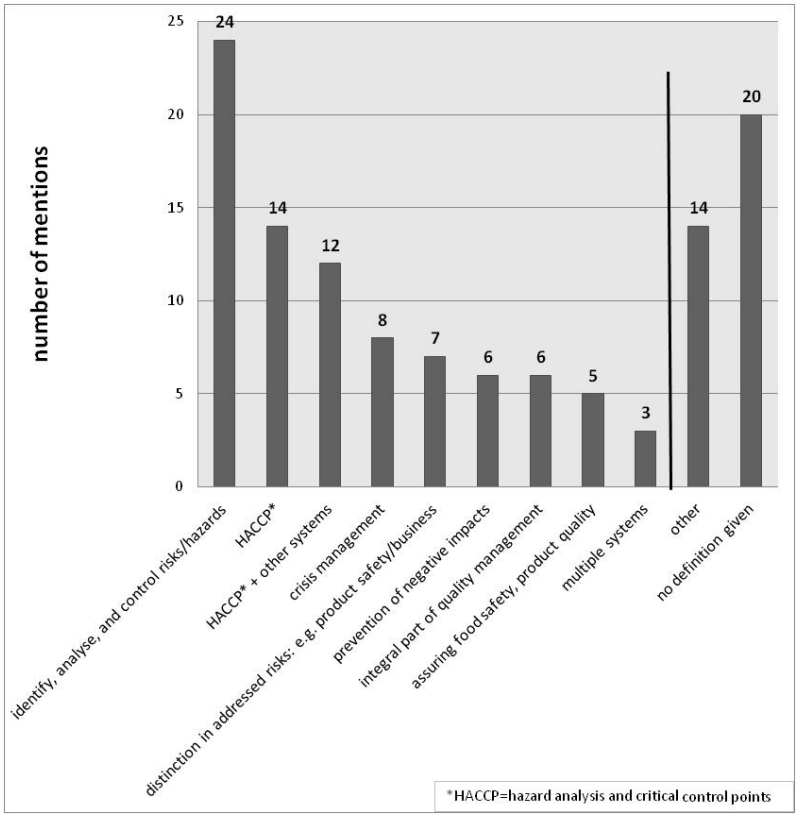
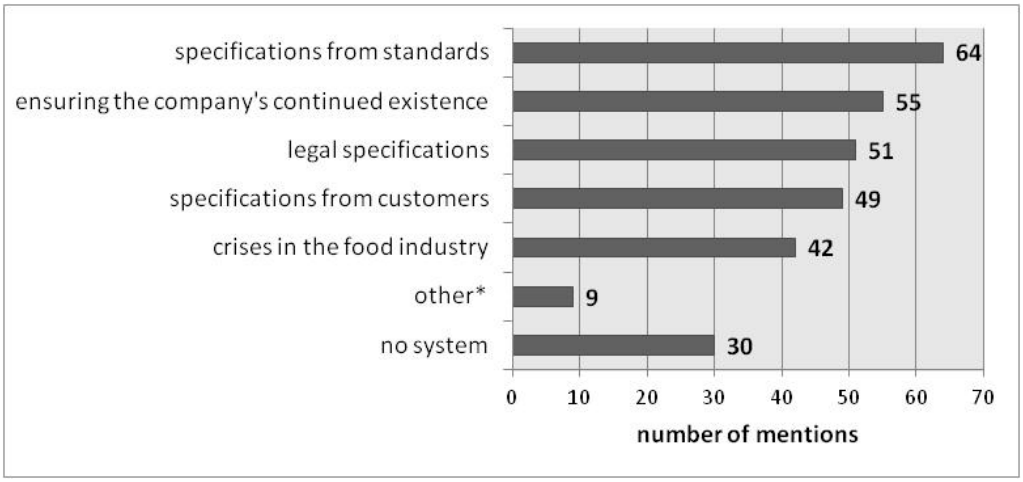


Figure 3.7: Frequency distribution of stated definitions of risk management (n=119)

It is clearly apparent that varying definitions exist for risk management and the focus of each definition is distinctly different. The majority of the surveyed companies focus on where risks come from and on identifying and assessing them. Other companies focus on the possible negative effects that known risks can have.

The reasons for the implementation of a risk management systems have been stated as following: for some it was a general standard requirement (64); to ensure the company's continued existence (55); to fulfill legal obligations of various type (51); specifications from specific customers (49); it was implemented in response to crises in the food industry (42). Additionally other reasons have been given such as insurances (2 mentions), in response to a personal experience, or as a requirements for EU approval (Figure 3.8).



*others mentioned: (1 did not specify other systems)

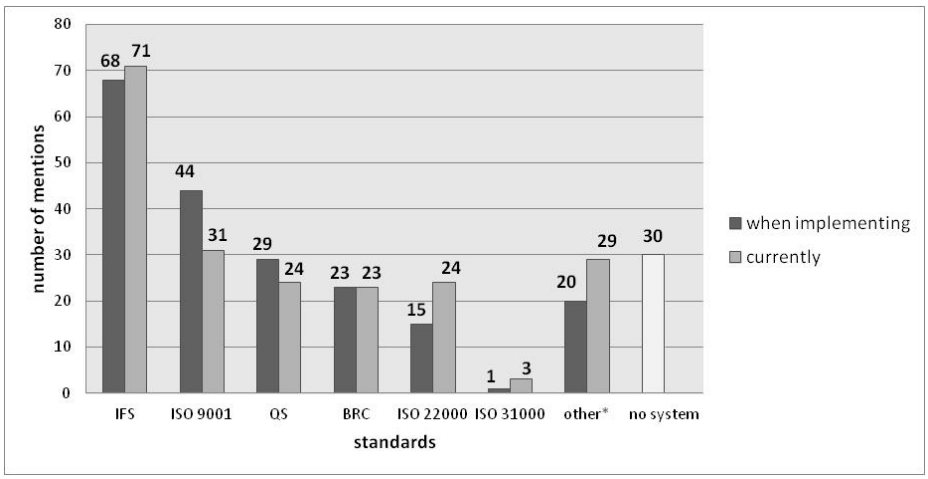
- insurances (2 mentions)
- conclusions from personal experiences
- requirement for EU approval
- optimisation of processes, assurance of quality
- company valuation by financial auditors, investors and analysts
- prophylaxis, helps to reduce probability of occurrence of risks
- integral part of a quality management system in the food industry

Figure 3.8: Frequencies of reasons for introduction of risk management systems (multiple replies possible; n=119)

An attitude of company management that risk management is only a burdensome obligation imposed by legislation can lead to a poor risk assessment, to the taking of high-risk activities and to an inability to cope with risks should they manifest (Vanini, 2012). It is therefore important that companies acknowledge risk management as more than just the fulfilment of legal requirements, which seems to apply for the surveyed companies.

The three most common standards used for the risk management systems are IFS, ISO 9001 and QS (Figure 3.9). IFS has been identified 68 times as a basis for the implementation of a risk management system and 71 have indicated that IFS is currently important for the establishment and further development of the system - signifying a substantial increase (p_C<0.001). ISO 9001 has decreased from 44 mentions for implementation of the risk management system to 31 for further development of the system which is a significant decrease in use (p_C<0.001). QS has been reported 29 times (implementation) and 24 times (currently).

The standards BRC, ISO 22000 and ISO 31000 have been reported less often as foundations for the risk management system.

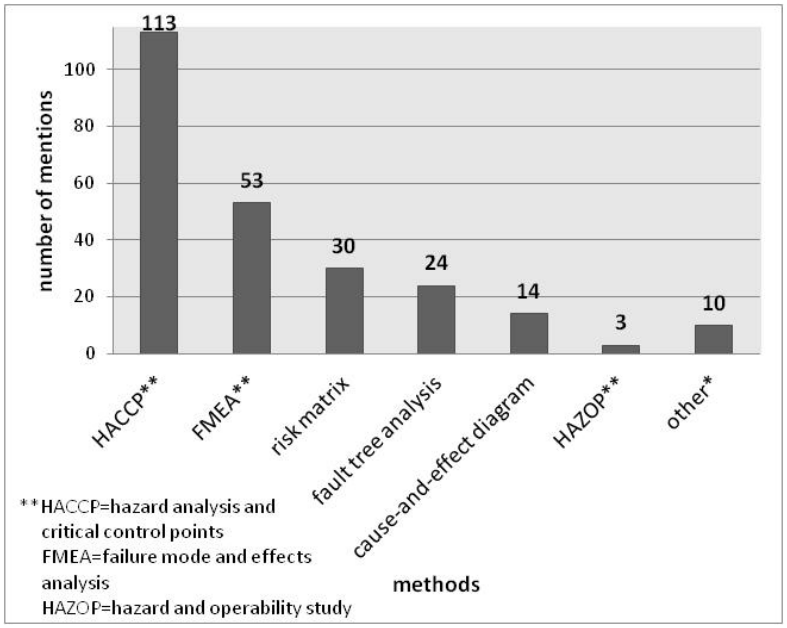


*others mentioned e.g. HACCP, bio/organic farming, special GMP, Food Safety System Certification FSSC 22000, Halal

Figure 3.9: Frequencies of standards used as basis for risk management systems (multiple replies possible, n=119)

Figure 3.9 further clarifies the connection between quality and risk management as mostly the same standards form the foundation for both systems.

To further characterise the risk management systems in the companies, the survey participants have been asked to indicate the methods that are used to analyse and assess risks (Figure 3.10). The most commonly identified method was HACCP with 113 mentions, followed by FMEA with 53 mentions and risk matrix with 30 mentions.



***others mentioned** (3 did not specify other methods):

- company specific systems (3)
- complaint management (1)
- experience (1)
- internal and external information of the industry association (1)
- according to the method defined for the area to be analysed (1)

Figure 3.10: Frequencies of methods used for risk analysis and assessment (multiple replies possible; n=119)

The identification of risks poses major difficulties for many companies in the agri-food industry particularly as potential threats in the environment of companies are constantly changing (Lendle, 2008). Therefore, it is important that companies use efficient tools to identify risks. Most companies apply HACCP which is legally required for most of the surveyed companies. Many companies additionally use other methods for risk analysis, which are mostly known from quality management. It is known that often preventive quality management methods are applied in risk management (Theuvsen et al., 2013).

The companies have been questioned regarding collaboration in the supply chain and risk orientation of inspections to test the prevalence of these aspects. The first question in this regard has been if they use their risk management system to design inspections in a risk oriented manner (Figure 3.11). 55% of respondents have affirmed this. Manifold examples for this have been named, e.g. microbiological inspections, contaminants, pesticides/residues, FMEA/HACCP, analysis plans, risk matrix.

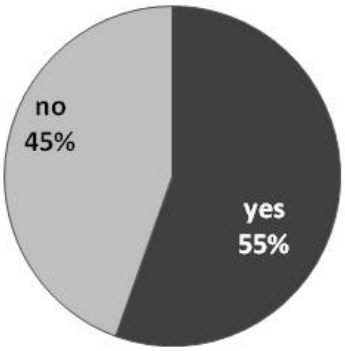


Figure 3.11: Frequencies of use of risk management for risk orientation of inspections (n=119)

Risk oriented inspections start with the analysis of the surrounding and its risks and results in an intensified inspection if the risk is high (Leonhard and Naumann, 2002). Within risk management this analysis is performed and an adaption of inspection intensity (risk orientation) is possible. More than half of the companies regard the chance of using the risk management system as well as risk analysis for the development of a risk orientation of inspections.

Another question has aimed at finding if the companies collaborate with suppliers and/or customers regarding the management of risks (Figure 3.12). 56 companies have affirmed that they collaborate with suppliers and 47 with customers whereas 46 do not collaborate with either. This confirms literature findings that collaborations between supply chain stages varies considerably.

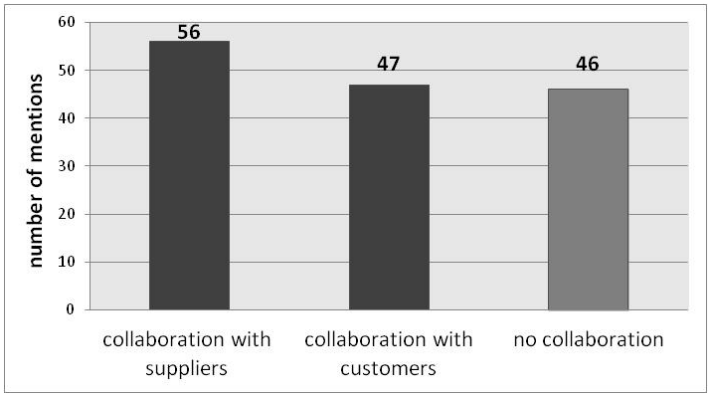


Figure 3.12: Frequencies of collaboration with suppliers and/or customers regarding management of risks (multiple replies possible; n=119)

Collaboration in the supply chain is important as product alert notifications and product recalls (or product complaints) are common incidences in the agri-food production chain which require an inter-company risk management system (Theuvsen et al., 2013). The expansion of risk management beyond individual companies is regarded in literature and in practice as appropriate to confront the vulnerability of global value networks with large distances between network-nodes and the influence of framework conditions (Kersten et al., 2008). Within agri-food chains there generally is a low level of information sharing (Leat et al., 2010). Collaborations between supplier and customer increases the information exchange between the collaborating companies as well as transparency. Regarding risk management this might, for example, help to reduce the likelihood of certain events occurring (i.e., reducing risk), it might also increase the number of identified risks or validate the companies' own risk assessment.

Furthermore, the interviewees have been questioned regarding competences and skills which they feel a risk manager should possess. The interviewees could choose out of nine given characteristics which have been selected according to Quality Austria (2013) and rank the chosen items (Figure 3.13).

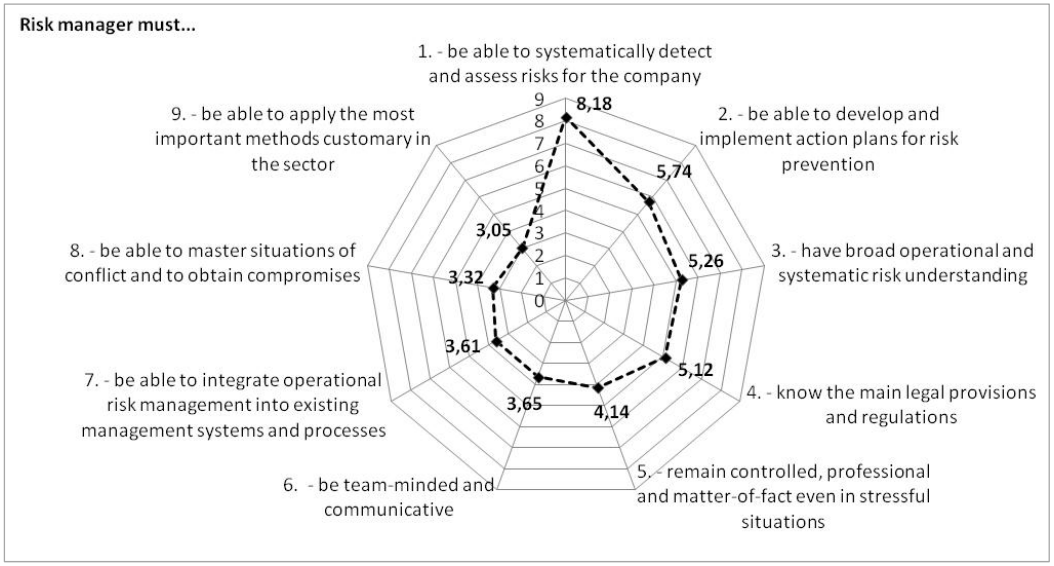


Figure 3.13: Mean value of ranked competences and skills of a risk manager (n=119)

The highest rankings were given to the characteristics “He/she must be able to systematically detect and assess risks for the company”, “….be able to develop and implement action plans for risk prevention”, and “…have broad operational and systematic risk understanding”. The knowledge of the requirements from industry is important for educational institutions which can adapt their focus in courses and trainings to provide capable graduates fit for industry.

The survey results have shown, that in line with Brühwiler (2008) the design of a risk management system is customised to the concerned company, meaning different definitions of risk management are applied in the companies, different standards and methods are employed as well as different skills required for risk assessment.

3.4.2 Portfolio analysis

For the portfolio analysis the companies are plotted based on methodical competence and international trade orientation regarding their risk management systems. Figure 3.14 shows the 5 main clusters that could be found with the portfolio analysis.

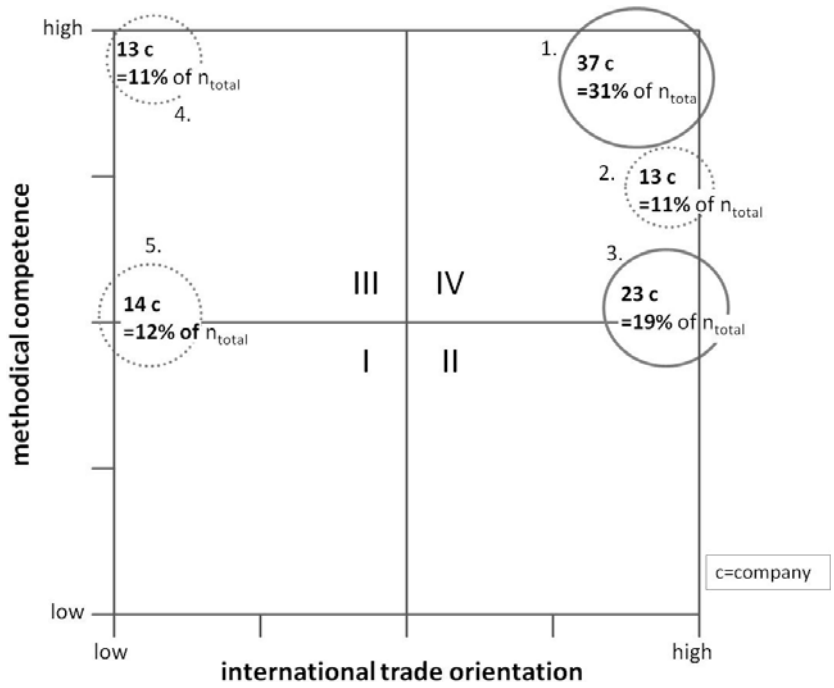


Figure 3.14: Portfolio clustering of participating enterprises according to the dimensions methodical competences and international trade orientation (n_{total}=119)

84% of the companies surveyed can be positioned in the clusters and only 16% are positioned outside of these clusters (not inserted in Figure 3.14). The majority of companies belonging to none of the described sectors (“other”) are not in any of the clusters and are positioned elsewhere in the matrix. There are no clear clusters in the quadrants I and II showing that most companies have a certain degree of methodical competence regarding risk management. Two clusters are visible in quadrant III showing medium to high methodical competence but low international trade orientation. Three clusters are positioned in quadrant IV

with companies having medium to high methodical competence and high international trade orientation. Table 3.3 characterises the five main clusters more detailed.

Table 3.3: Characteristics of the five clusters (n=100)

Number of cluster / Criteria	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Number of companies in cluster					
Absolute number	**37**	**13**	**23**	**13**	**14**
Percentage (%) of total participant number (n_{total}=119)	**31**	**11**	**19**	**11**	**12**
Company size (small companies (1), medium companies (2), big companies (3):					
Mean value (weighted sum of size/cluster sum)	2,5	**2,3**	**2,1**	2,2	2,1
• small (absolute number)	2	**3**	**6**	1	3
• medium (absolute number)	**14**	3	**9**	**9**	**6**
• big (absolute number)	**21**	**7**	**8**	3	**5**
Sector affiliation of companies (absolute number; % of companies in the sector, rounded):					
• meat/fish products (23c)	**9 (39%)**	3 (13%)	**5** (22%)	1 (4%)	**3** (13%)
• fruit/vegetable wholesale, import (14c)	2 (14%)	0	**4 (29%)**	**4** (29%)	**4** (29%)
• additives/food supplements/flavours/spices (14c)	**5 (36%)**	2 (14%)	3 (21%)	1 (7%)	0
• beverages (juice, water, spirits, etc.) (10c)	**5 (50%)**	0	2 (20%)	**2** (20%)	1 (10%)
• confectionary, snacks (10c)	**6 (60%)**	1 (10%)	1 (10%)	1 (10%)	1 (10%)
• flours, cereal and bakery products (10c)	3 (30)	**4 (40%)**	1 (10%)	1 (10%)	1 (10%)
• food trade and wholesale (no fruit/veg.) (9c)	0	0	**3 (33%)**	1 (11%)	2 (22%)
• milk and dairy products (7c)	2 (29%)	1 (14%)	1 (14%)	1 (%)	1 (%)
• dry products (6c)	1 (17%)	1 (17%)	1 (%)	1 (14%)	0
• delicatessen (4c)	1 (25%)	**1 (25%)**	**2 (50%)**	0	0
• other (12c)	3 (25%)	0	0	0	1 (8%)

c=company

The majority of companies from “fruit/vegetable wholesale, import” can be found in clusters 4 and 5 presenting low international trade orientation and medium to high competence regarding methods. These companies lie in an area of the matrix where they fulfil legal requirements of risk management, but not necessarily standards required in international trade. Fruit and vegetable wholesalers are often direct marketers delivering directly to bulk consumers which do not demand international standards.

Enterprises producing “meat/fish products” are mainly positioned in cluster 1 and 3 representing companies with medium to high methodical skills and a high implementation of international standards like IFS or BRC.

The majority of producers of “confectionary, snacks” are located in cluster 1. This sector is not composed by direct marketers, but sales to food trade and wholesale is performed. The trade stages have a high demand for international standards.

Subsequently the companies have been plotted in the matrix based on recent crises (multiple crises, one crisis, no publicised crises between 2010 and 2013), shown in Figure 3.15.

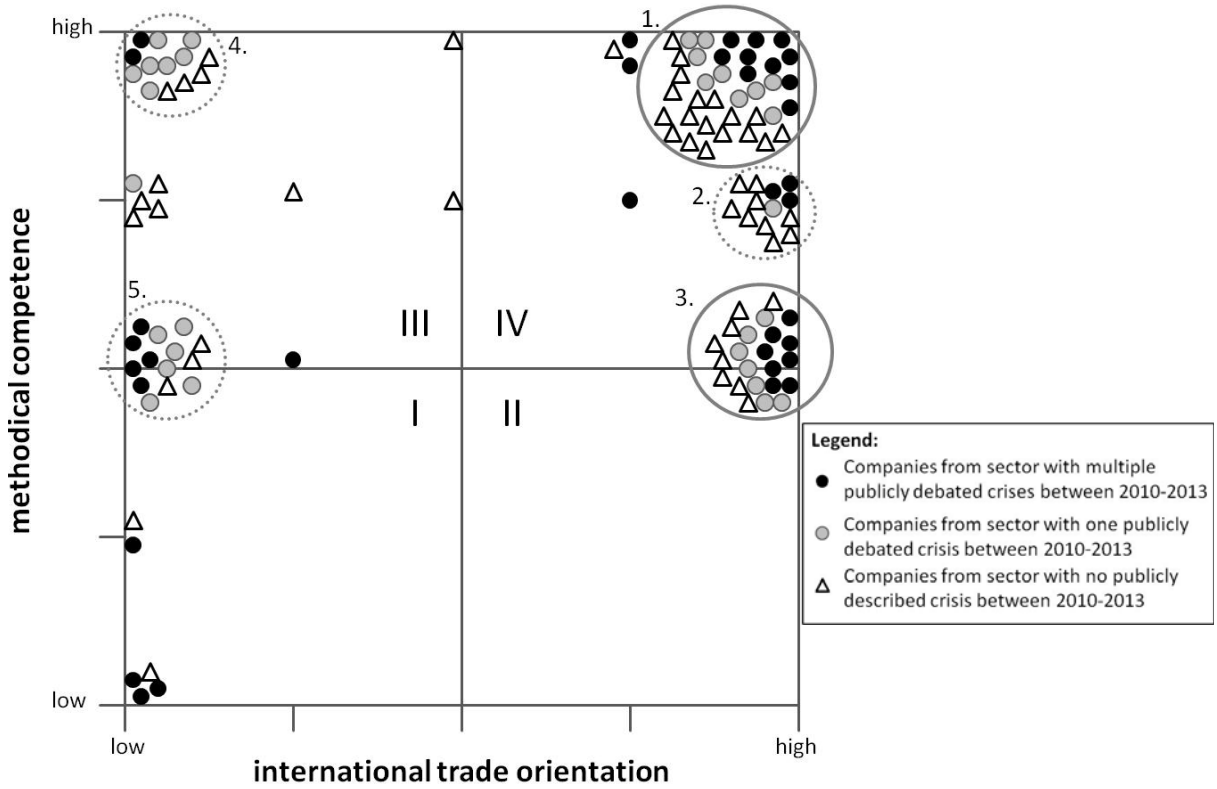


Figure 3.15: Portfolio clustering all surveyed companies (n=119)

The clusters in the portfolio demonstrate that most companies (61%) apply above all sector specific international standards like IFS or BRC and use at least HACCP or multiple methods for risk analysis and assessment. In quadrant I only individual companies can be found. Four of these six companies are not producing, but trading food products. Four are small companies (≤50 employees), one each is medium (51-149 employees) and big (≥250 employees).

Table 3.4 depicts the relation of companies in the clusters based on the number or crises in the last years.

Table 3.4: Relation of companies in the clusters based on recent crises

Number of cluster / Categories	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
a (=d)	10	3	**8**	2	5
b (=d)	9	1	7	**7**	**6**
c	**18**	**9**	**8**	4	3
Relations:					
d:c	1.06	0.44	1.88	2.25	3.67

a: companies from sector with multiple publicly debated crises between 2010-2013
b: companies from sector with one publicly debated crisis between 2010-2013
c: companies from sector with no publicly described crisis between 2010-2013

In cluster 1 the relation of companies from sectors which have had at least one to several crises since 2010 to companies from sectors with no publicly described crisis is almost equal. In cluster 2 almost half of the cluster is composed by companies from sectors that did not have a crisis. The other three clusters are dominated by companies with more than one sector crisis. The results show clearly that crises between 2010 and 2013 seem not to be decision criteria for the application of specific standards or the acquirement of methodical competence in risk management. But without the influence of past crises extended methodical competence and standards like IFS and BRC would not have been established and implemented.

3.5 Conclusion

The survey has shown that the companies to a large extent have already implemented risk management systems and take appropriate measures. The implementation of a systematic risk management system in the companies has been considerably advanced through law and customer demands. This is underpinned by the fact that the implementation of the risk management system is linked with the changed legal requirements such as the General Food Law (EC) No 178/2002.

The survey and evaluation have answered the following:

I. Risk management is strongly linked with quality management. The primary responsibility for risk management is taken by the quality department. Risk and quality management are largely based on the same standards and quality management methods are used as well for risk analysis and management.
II. The definitions used for risk management vary in the companies. Therefore, the focus of risk management could be different among the companies of the agri-food industry meaning that risk-reduction strategies may be misaligned.
III. When applying the dimensions methodical competence and international trade orientation it could be seen that the companies have established HACCP principles for risk management regardless of the sector. It has also been shown that many companies go beyond HACCP and apply multiple methods for risk analysis and assessment. High methodical competence results from the group of interviewed persons, who

were predominantly quality management representatives. Furthermore the results have shown that methods and requirements from trade relations can be combined in most of the companies.

The findings are important not least to adjust educational training for graduates and for integrating skills and competencies required by the industry into new courses. One major consideration in this regard should be to convey the broad definitions of risk management, which include different aspects for a comprehensive understanding of risk management. The practical application of HACCP should be shown but also other methods for risk analysis and assessment should be presented to deepen the competencies and increase the repertoire of methods.

The respondents have been subject to heavy regulation and a battery of rules, laws, and controls, to the point that they have weighed their options with regard to sourcing materials and against whom to distribute to. However, when it comes to what standard should be followed for risk management - that is left open to the companies, so some will follow FMEA, whilst others find other risk analysis models to use. This means that if every company in a supply chain is managing risk according to completely different methodologies and definitions, questions arise as to the consistency of the risk assessment throughout the supply chain. To measure this, one supply chain should be taken as an example and risks assessed for this chain. Then companies along the supply chain should be queried on the risks they consider. Both results should be contrasted and results analysed.

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4. AMOR – improving inspection strategies in agri-food supply chains[1]

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Abstract

A new development in the area of agri-food supply chains is the emergence of inspections according to the AMOR principle. AMOR stands for **A**lliances for the **M**utual **O**rganisation of **R**isk oriented inspection strategies and implies that inspections are organised in a joint collaboration between suppliers and customers. Furthermore these inspections are to be performed more intensively when the perceived risk is high and less intensively when the perceived risk is low. A survey has been carried out in three supply chains: fruit/vegetable, milk and meat. The survey assesses the existence of AMOR inspections in practice. The companies investigated have been plotted in a cross-diagram to indicate their willingness to cooperate with other companies and to establish the risk awareness of the companies. A willingness to cooperate and an awareness of risk are two of the central struts of the AMOR approach. The results show that some AMOR inspections currently exist in practice and also show the degree of willingness to perform AMOR inspections.

Keywords: alliances, inspection, supply chain coordination, quality management, AMOR

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https://www.ifama.org/events/conferences/2012/cmsdocs/Symposium/PDF%20Symposium%20Papers/608_Paper.pdf (20.02.2014).

4.1 Problem statement

Agri-food production chains are exposed to a dynamic environment and have to adapt accordingly (Luning et al., 2006). Producing companies are further challenged by the fact that more critical consumer attitudes towards food production exist (Luning et al., 2006). This consumer influence can lead to fundamental changes in production and processes. As a result, production companies often have to incorporate additional, previously unplanned for, inspections into the supply chain to fulfil consumer demands. Additionally agri-food supply chains are becoming increasingly complex and dynamic (Trienekens et al., 2012; Brinkmann et al., 2011; Fritz and Schiefer, 2009) and include numerous actors with a range of varying customer-supplier relationships (Raab, 2011). However, despite the complexity, food safety and traceability has to be guaranteed at all times from "farm to fork". This is supported and controlled by manifold investigations along the supply chain.

Every stage in the supply chain performs several inspections on the (intermediate) product. But often the customers in the supply chain do not know which inspections have already been performed by the suppliers and to what extent, and vice versa. Information obtained through these inspections is rarely exchanged and therefore is often only available to one stage of the supply chain. The communication is traditionally one-way from producers of raw materials to the users of the end product (Knura et al., 2006). However, a number of authors rate an effective organisation of information exchange consisting of characteristics of products, processes and manufacturing equipment between decision makers in a food producing chain today as crucial to the competitiveness of supply chains to the food retail sector (Trienekens et al., 2012; Petersen et al., 2010; Ellebrecht, 2008; Schulze Althoff, 2006). Until now only few approaches have existed for a coordinated inspection strategy to improve communication between customer and supplier and to achieve a sufficient information flow between the actors of the chain (Petersen et al., 2010).

The **A**lliances for the **M**utual **O**rganisation of **R**isk oriented inspection strategies (AMOR), aims at closing this gap. It aims to create alliances amongst supply chain actors to mutually organise inspection strategies. These inspections are performed more intensively when the perceived risk is high, and less intensively when the perceived risk is low. Information flows in both directions and communication between the stages is assured. With this AMOR moves from a procedure-driven approach (Colbert and Alderman, 1995) towards a risk oriented approach. The principle of risk orientation has been introduced to the agri-food chain by new EU legislation, for example, for the official control and for meat inspection (EC 853, 2004; EC 854, 2004; EC 882, 2004). With a risk oriented approach, limited resources can be utilised more effectively by adapting the inspection intensity to the different levels of risk associated with particular products and batches.

4.2 Objectives

AMOR builds the basis for the development of a new inspection culture where organised inspections are performed among some of the actors of a given supply chain. Such intelligent

inspection strategies permit the exchange of test results as well as risk evaluation and an adjustment of inspection intensity adapted to the associated risk - risk orientation. These fundamental aspects of AMOR may lead to the implementation of more efficient and robust supply chains in the future. Risk orientation effectively means that inspections are adapted to the risk which is associated with a specific batch of a product. If the risk is perceived high then the inspection is performed more intense, if the risk is low, the inspection is also less intense. To determine the risk associated with a particular product requires knowledge of countless variables. It is not an area that produces fixed, constant, values or "risk". Furthermore, random events may dramatically change the risk associated with a particular product. However, inspection intensity can still be based on product risk association. This is especially true for those products where an abundance of historical quality data exists, which exhibits very few (ideally zero) instances of adverse performance/quality and where there is a long-standing relationship of trust between supplier and customer. Of course, a risk-free past is certainly not evidence of a risk-free future. However, a very low risk (ideally risk-free) past can, in some cases, permit a relaxation of inspection intensity. If a new situation (unspecified) results in an increased risk to a product, then the inspection intensity can immediately adjust/adapt to this as the infrastructure to do so is permitted under AMOR. In the case of food production, risks to product quality and especially public health are of paramount concern.

The aim of current empirical and experimental studies is to define this new methodological-theoretical approach, AMOR. In the course of research and prior to going deeper into the formal analysis of how risk oriented inspection strategies can be performed as a mutual effort between partners, the dissemination of this concept in practice in agri-food supply chains is investigated. For this reason a survey has been performed amongst companies of different food supply chains. The results of this survey are presented in this paper.

As the AMOR principle requires collaboration amongst supply chain actors reinforced by mutual risk oriented inspection strategies, this implies that actors must be risk aware in order to orient towards areas of higher risk. Therefore the survey aims to assess these two critical dimensions, collaboration and risk awareness, of the AMOR approach. The companies surveyed have been tested on the grounds of their knowledge and belief in the AMOR principles and displaying a strong willingness for cooperation as well as their simultaneous risk awareness.

4.3 Research approach

The authors have chosen the sectors of meat, milk and fruit/vegetable as a representative research setting of the agri-food sector. In these three sectors trendsetters according to the authors' opinion which are ahead of their peers in terms of quality management and which are perceived as open to new developments have been selected to get information on development trends. The survey has been designed as in-depth expert interviews performed face to face and via telephone.

A questionnaire consisting of a series of closed and open-ended questions has been given to the survey participants. It has been pre-tested by academic reviewers and industry practitioners familiar with quality management and quality inspections and subsequently has been modified and sent out to the interviewees prior to the personal or telephone interview.

A total of 60 German companies have been contacted to participate in the survey: 25 each from the fruit/vegetable and milk sectors and 10 from the meat sector. A total of 22 (out of 60) companies responded to the survey. The respondents comprise: 7 experts from the fruit/vegetable sector, 7 experts from the milk sector and 8 experts from the meat sector. The companies comprise private and cooperative fresh fruit and vegetable wholesalers, dairies, livestock marketing and producers' associations, slaughter and processing companies. The breakdown of the participants as well as further characteristics such as work experience and positions in the company, ranging from managing director to representative or head of quality management is provided in Table 4.1.

Table 4.1: Characteristics of participants in the survey

Characteristics of the sample	Fruit/veg.	Milk	Meat	Total
Number of persons invited to participate in survey	25	25	10	**60**
Companies not participating	18	18	2	38
Number of respondents	**7**	**7**	**8**	**22 (37%)**
Work experience (~Ø) of participants	10 years	20 years	13 years	14 years
Head of quality management*	2	5	3	10
Quality management representative*	5	2	3	10
Managing director*	1	0	4	5

*multiple answers possible

For convenience the seven companies of the fruit and vegetable sector have been designated O1 to O7, the one of the milk sector M1 to M7, and the eight experts of the meat sector F1 to F8.

4.4 Results and discussion

4.4.1 Categories of alliances

From the literature review and according to statements from interviewees of all three sectors, different alliances became obvious in which inspections can be organised mutually. Alliances exist between supplier(s) and their customer(s). Agreements are directly made between both sides. Other alliances include external parties, such as laboratories and/or auditors. It is possible to distinguish alliances with external private or public parties. It has been found that there are three main categories of alliance between the different actors. These alliance categories are shown in Figure 4.1.

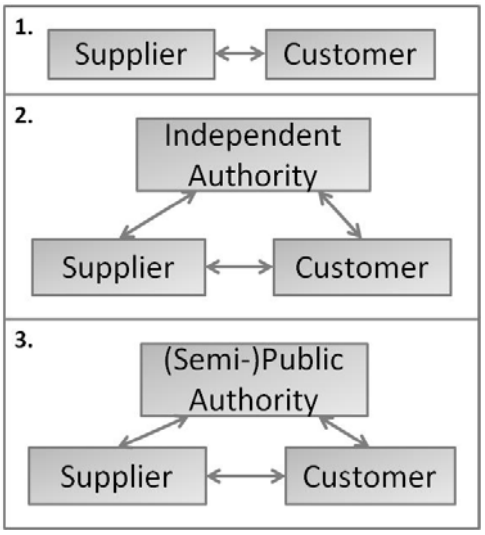

Figure 4.1: AMOR alliance categories

Category 1 applies when inspections are directly organised mutually between one or more customers and one or more suppliers. Both parties determine the inspection strategy with its inherent elements.

Category 2 extends category one by a third party. This is an independent authority which can be a netchain coordinator or an entity which conveys between one or more suppliers with a more powerful customer. The third party functions as a mediator which organises and performs the inspections for the other two parties and which is approved by the other parties. In this constellation it is important that the independent entity also benefits from the inspection.

Category 3 surpasses the private industry and includes a (semi-)public authority. In this alliance the public authority performs the inspection and provides the results to supplier and customer.

In general the alliances have to decide jointly on the inspection strategy. This comprises the organisational structure and risk oriented design of the strategy. Furthermore the alliance has to set mutual responsibilities and tasks and the information and communication structure has to be jointly developed for a successful inspection strategy. The benefits and costs shall be allocated onto the partners to achieve a win-win situation for all participating partners.

4.4.2 Inspections to date and the potential of AMOR

At present inspections in agri-food supply chains are mostly designed in such a way that each company of the chain performs an incoming goods inspection, (at least) one intermediate inspection and one outgoing goods inspection (see Figure 4.2). The information from these inspections is passed with the product from stage to stage. However, information rarely flows back to the preceding production stage. Therefore, primary production stages often do

not know about inspection results. A two-way flow of information is critical to improving product quality, avoid duplication in testing and to increasing chain efficiency.

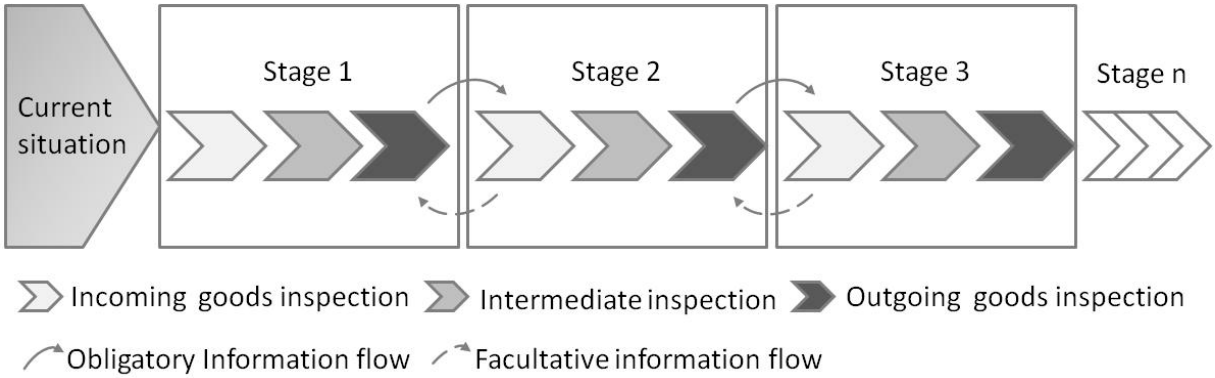

Figure 4.2: Inspections at present in food producing chains

The AMOR approach for instance, applies when an incoming goods inspection by a customer (stage 2) and the outgoing goods inspection of its supplier (stage 1) can be combined into one inspection. Referring to the entire chain inspection frequency, the amount of inspection points in the value creation process can be decreased, as shown in Figure 4.3. Information on safety and quality always flow in both directions due to the mutual organisation of the inspection.

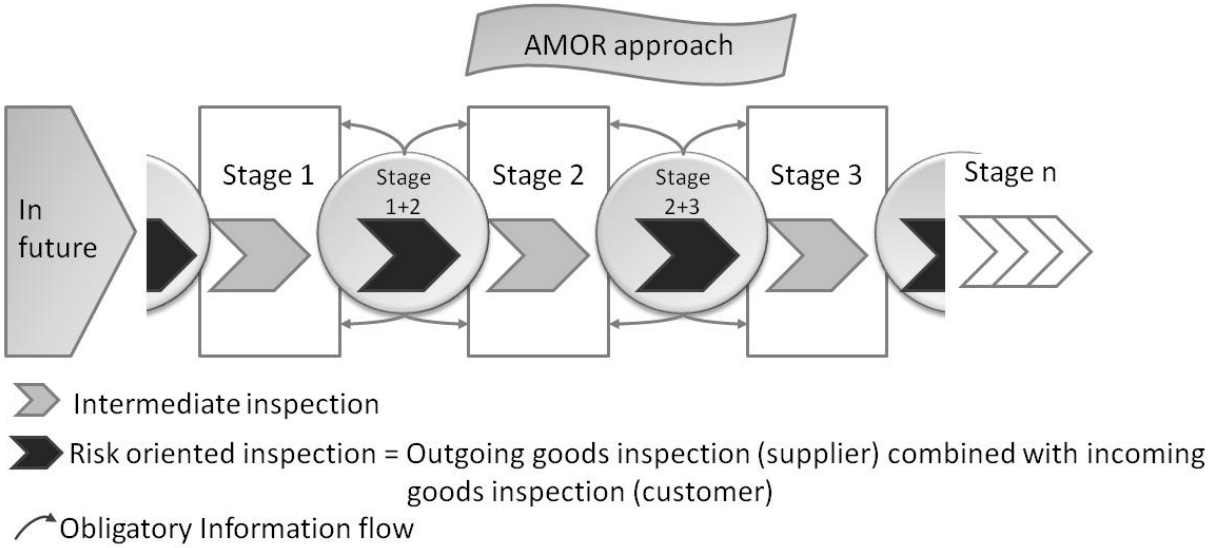

Figure 4.3: Organisation of inspections in food producing chains with the AMOR approach

4.4.3 Benchmarking of the actors

Based on the assessment of the AMOR approach among the companies of the three sectors fruit/vegetables, milk and meat, the enterprises have been positioned in a cross-diagram (Figure 4.4). By modifying the Boston Consulting Group Matrix (BCG, 1968), a benchmarking of the companies based on their competence in adhering to and/or implementing AMOR principles has been performed.

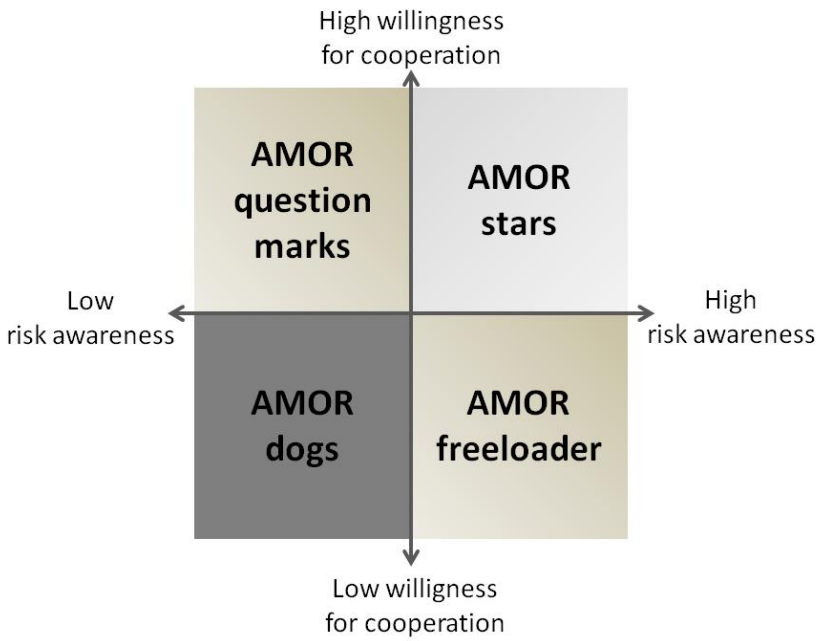

Figure 4.4: Matrix to assess companies' abilities to adhere to and/or implement the AMOR principles

Initially the two axes of the graph have been defined. These are "risk awareness" (x-axis) and "willingness for cooperation" (y-axis). The x-axis shows that a company has a certain mindset regarding risks and that management of risks is more than just fulfilment of basic requirements. The company is flexible regarding risk assessment. Risk awareness is important for applying risk orientation to inspections.

To show the degree of risk awareness, five survey questions were devoted to this topic. The questions are listed in Table 4.2. Each question that has been answered with "yes" results in 1 point for the company, a partial answer results in a ½ point and the answer "no" results in no points, adding up to the highest possible score of 5 points per company on the x-axis.

Table 4.2: Elements of risk awareness

1.	Do you apply more than HACCP (hazard analysis and critical control points) for risk analysis?
2.	Do you rely on external help for the implementation of the risk management system?
3.	Do you want to increase your competitiveness with your risk management system?
4.	Have you been influenced to optimise your risk management system through current food crisis e.g. EHEC?
5.	Is risk orientation conceivable for inspections?

The questions in Table 4.2 have been chosen to achieve a broad sense of the risk awareness of the participating companies.
The y-axis of Figure 4.4 represents the willingness to cooperate with other companies of the supply chain. Five questions from the interview were assigned to this part and the same rules of scoring as for the x-axis have been applied (Table 4.3).

Table 4.3: Elements of willingness for cooperation

1.	Is it conceivable for you to mutually organise an inspection with another company?
2.	Have you already implemented mutual inspections with other companies?
3.	Would you be willing to share relevant information with other companies for an AMOR inspection?
4.	Is it conceivable to organise a mutual inspection with an adjacent partner in the processing chain: For example could you merge your incoming/outgoing goods inspection with that of the incoming/outgoing goods inspection of your immediate supplier/customer?
5.	Do you already perform an inspection that is an outgoing and incoming goods inspection at the same time?

The companies are positioned according to their scores for risk awareness and willingness for cooperation into the cross-diagram. Four different quadrants can be differentiated. Depending on the position in the diagram the companies are referred to as “AMOR stars” (high level of both), “AMOR question marks” (low to medium risk awareness and high willingness for cooperation), “AMOR freeloaders” (high risk awareness, low to medium willingness for cooperation) and “AMOR dogs” (both results low). Figure 4.5 shows the positioning of the companies according to the survey results.

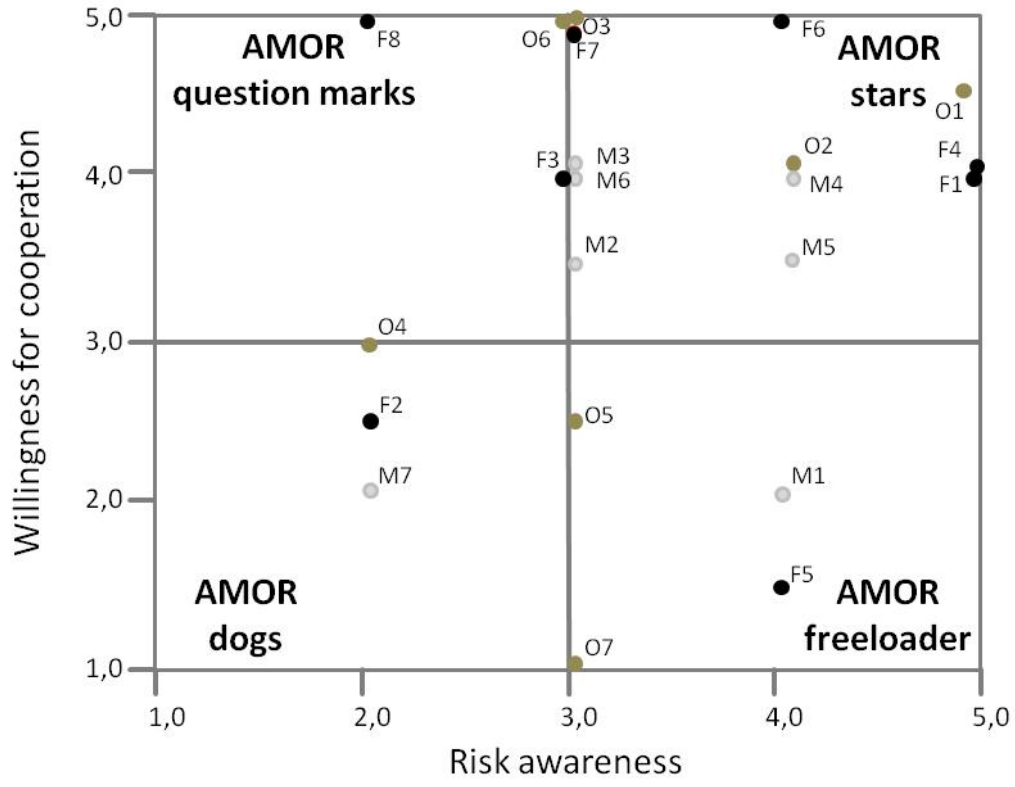

Figure 4.5: Matrix to determine the companies’ competency with AMOR

The matrix shows that the companies are distributed within all quadrants, so there are AMOR dogs as well as AMOR stars. Seven companies are clearly in the stars quadrant, of which three are from the meat sector and two each from the fruit/vegetable and milk sector. Amongst the AMOR stars are many companies organised as cooperatives (O1, O2, M2,

M4, M5 and F1). It has been deduced from the results, that in cooperatives, there already exists a strong foundation of trust and long-term relationships between actors and so these lend themselves well to mutual AMOR inspections. Most stated reasons for not cooperating with other companies for inspection strategies on grounds of lack of trust and reliability as well as often changing suppliers.

The matrix also shows that most of the actors are willing to cooperate with other companies whereas for those companies risk awareness remains low to medium. The willingness to cooperate, however, is crucial for AMOR inspections and provides a good basis on which to build for future AMOR approaches.

From the survey it has been possible to deduce (a) the extent of current mutual inspection areas, (b) the potential for future collaboration, (c) current mutual inspection areas and (d) the desired requirements for future mutual inspections. The survey has shown that the basis for AMOR inspections is given in practice. All three sectors understand the concept of risk oriented inspections and all experts questioned can as well imagine to apply this principle on inspections in their companies. Different needs exist for AMOR inspections in the different sectors. In the fruit/vegetable sector the interviewed wholesalers stated monitoring residues and supplier rating for joint inspections. In the milk sector packaging and microbiological and chemical analysis were identified and in the meat sector animal health, risk oriented meat inspection and livestock inspection as well as additives were named and, in future, also microbiological, chemical and physical tests. In some areas the interviewees already have experience of collaboration for joint investigations.

4.5 Conclusions

The results show that the majority of interviewees regard AMOR inspection strategies with risk orientation and mutual organisation as a possibility for their companies. With this the basis for the AMOR approach is clearly given in practice and examples of AMOR inspections can be found in the companies. The concrete implementation, however, varies due to different risks and different aspects of food production.

Furthermore, forms of alliances have been detected in which AMOR inspections can be mutually organised. Thus, inspections within the different food producing chains can be assigned to three basic alliances.

AMOR can be seen as a new trend in innovative supply chains. The approach forms the basis for further comprehensive research in the course of which it will be important to clarify to what extent the three categories of AMOR alliances can be transferred to inspection strategies in other food sectors and how these inspections can be performed by a mutual effort between partners. Therefore the requirements for AMOR inspections, the responsibilities and tasks, cost and benefit allocation as well as information and communication structures will have to be investigated in detail. This survey provides the starting point for such investigations.

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5. Netchain coordinator services in pork supply chains including inspections according to the AMOR principle[1]

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Abstract

This paper presents a mutual inspection concept between livestock production and processing, coordinated by a netchain coordinator acting as the service provider. The concept is based on an analysis of demand and offer with respect to the coordination of livestock health status certificates. Surveys have been conducted amongst piglet producers and pig fatteners ($n_{farmers}$=206) to reflect the demand for coordination services. Another survey amongst service providers ($n_{providers}$=21) determines the availability of these services. The results show a clear demand amongst farmers for the netchain coordinator services of livestock health status certificates. It has also been found that some service providers offer audit and monitoring procedures to enable certification with highly varying degrees of service quality. Based on the surveys, the joint organisation of livestock health status certificates between producer, fattener and service provider will be presented. It will be shown that for greater efficiency, coordination should be based on the principles of Alliances for the Mutual Organisation of Risk oriented inspection strategies (AMOR). To enable the mutual organisation of inspections, four key steps have been identified to develop and test AMOR as an innovative form of cooperation: (i) inspection design, (ii) responsibilities and tasks, (iii) information and communication structures, and (iv) shared cost and benefit model.

Keywords: AMOR, intercompany health management, livestock health status certification

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5.1 Introduction

Animal health is inextricably linked to food safety and consumer health (EC, 2007). Therefore, in the meat production chain, which aims to deliver safe food and high-quality products to the consumer, animal health management is of paramount importance. A vital aspect to help assess animal health records would be the participation in health monitoring initiatives for the collection of animal health data. Such monitoring schemes are also intended to improve the health of the livestock by focusing on husbandry practices, farm management, and disease surveillance (Knura et al., 2006). Participation in these schemes is expected to deliver animal health certificates which mainly attest the health status of a pig producing company. The health status is based on the occurrence of pathogens in the animals and on the results of farm audits regarding farm health management.

In recent years a multitude of monitoring programmes have been developed in Germany with a high number of participating agricultural companies. This indicates the growing importance of monitoring programmes amongst piglet producers, fatteners and marketing organisations (Seybold et al., 2009). Despites its significance, the implementation of animal health management, and appropriate measures in primary production, require great organizational efforts. Farmers, too, face greater challenges and require assistance beyond the primary level from actors of the respective value creation network (Blaha, 2004; Petersen, 2003). Support for piglet producers and fatteners can be provided by netchain coordinators. The netchain coordinator can function as a service provider by facilitating, amongst other things, an animal health management scheme and by awarding health status certificates.

Up to now the actual demand from farmers for support in relation to the specific coordination service “health status certification” for piglets has not been recorded. The extent and terms of reference of the coordination service, as set by service providers, are critical unknowns. Furthermore, in relation to the implementation of mutual inspections, there currently exists no framework as to how these inspections for determining the animal health status should be conducted.

The objective of this paper is to address these known unknowns and to answer the following research questions:

I. What are the specific demands of farmers compared to the services offered by service providers?
II. Which gaps exist in this regard?
III. Which aspects have to be considered to mutually organise an inspection strategy between producer, fattener and netchain coordinator to determine animal health status?

The investigation is focused particularly on the demand for, and offer of, services in health status determination connected with monitoring activities. Furthermore, research concentrates on how inspections for determining the livestock health status can be efficiently designed and mutually organised between piglet producer, pig fattener and service provider.

5.2 Literature

5.2.1 Pork supply chain

The typical European pork production chain comprises the stages: supplying markets (e.g. feed production), breeding and multiplying, piglet production and rearing, finishing, slaughtering, processing, retailing, and consuming markets (e.g. private consumers) connected by intermediate traders/carriers. These production stages can be found in every pork supply chain, however, the organisational structures can differ between countries. The transport of pigs for example from producers to fatteners and further to slaughtering and retailing can take place within one country, but more often takes place from one country to another, and then possibly to a third. This applies in particular as regional specialisation on certain production stages of pig rearing has evolved, with piglet production mostly in the Netherlands and Denmark whilst in Northwestern Germany predominantly pig fattening takes place (Haxsen, 2010). This convenient regional distribution results in an active trade of pigs beyond national borders where Northwestern Germany plays an important role as a pig importer and where trade in Denmark and in the Netherlands concentrates on the export of piglets (FAO, 2011; BMELV, 2010).

5.2.2 Netchain coordinators

Many activities in health management can only be realised through the support of third parties. Inter-enterprise coordination in complex production chains is beneficial to the smooth functioning of the integrated processes (Brinkmann et al., 2011). In pork supply chains, due to their structure, coordination tasks are often performed by so-called netchain coordinators (Petersen et al., 2010). Potential netchain coordinators in the pork supply chain include farmers' cooperatives and slaughterhouses performing the tasks of selection, control and development of suppliers and customers (Ellebrecht, 2008).

Schütz (2009) suggests that the scope of duties of netchain coordinators varies and concentrates mainly on servicing four key areas: supply management, audit, process and crisis management. Within the key areas, support of the individual farmers for inter-enterprise animal health and hygiene management is provided. Specifically, consulting, auditing and monitoring activities, assistance for data processing, issuing of certificates, and inter-enterprise information exchange are offered, which encompass basic offers for the customer groups, piglet producers and fatteners. Potential netchain coordinators are livestock traders in their position as mediators in the pork supply chain (Schütz, 2009).

In accordance with the tasks of service organisation, netchain coordinators can be defined as organisations with bundling functions and offering services which reduce interfaces for the farmers by coordinating and supporting product and information flows.

Brinkmann et al. (2011) have allocated the responsibility for coordination tasks in pork supply chains on three levels: normative, strategic and operational, with the respective chain

actors “chain quality board”, “netchain coordinator”, and “quality broker”. Organisations assuming coordination tasks for pork supply chain actors in connection with quality management position themselves within these three levels and adjust their services accordingly. These can be livestock traders, livestock marketing corporations, farming cooperatives, meat companies and/or retailers and producers' associations assuming diverse services in the meat supply chain (Brinkmann and Petersen, 2010). Wohlgemuth (2002) stresses that netchain coordinators may be partners from within the netchain as well as external institutions which professionally offer the adoption of coordination services. Enterprises acting as netchain coordinators require contextual knowledge and a good organisational overview of the mechanisms of the existing network.

A current example of the offer of coordination services relates to health status certificates for piglet-producing enterprises. Piglet health certificates are issued as a means to increase transparency regarding piglet health to the customer (Nathues et al., 2011). The health status of piglets is an important purchasing criterion for fatteners (Petersen et al., 2010). This is emphasised by the end-customer, that is, the consumer who increasingly demands high animal health and welfare (Moynagh, 2000).

5.2.3 Services, service providers, and customers

A service can be defined as a function performed/offered by a service provider and utilised by a customer, to benefit that customer. The provision of a service can be connected to a real material product or not (Kotler et al., 2011; Böhle, 2010;). However, almost every company comprises a service component. Product offers without an accompanying service component, or service components without an associated product, are rare (Kotler et al., 2011).

To realise the integral elements of inter-enterprise health management repeatable activities have to be performed. Coordinators monitor the degree of implementation of measures concerning animal health and help to work on suggestions for improvement and help to facilitate the realisation of defined optimisation protocols. The following service activities are frequently offered in combination by netchain coordinators to service users to achieve high product and process quality:

– organisation of an inter-enterprise information exchange
– organisation and realisation of monitoring activities
– organisation and realisation of audits and consultations
– support with data processing
– issuing of health status and company compliant certificates

The present means of issuing health certificates is a complex coordination service consisting of local farm audits and monitoring activities comprising laboratory investigations on pathogens, and, based on the results, status classification and communication (Petersen et al., 2010). This health status certification process includes different criteria depending on the certificate-issuing service provider. However, the analysis of health status including auditing

has to be based on nationally and/or internationally standardised analytical methods, cut-off points or management practices. The service provider will judge a company's performance in meeting the predefined criteria and will subsequently assign a health status certificate to that piglet producing company. For the certification, a systematic sampling for performing the laboratory investigations is a necessary precondition in the producer's company.
There are numerous service providers capable of issuing health certificates. The certificates include different criteria since universally accepted methods and values are lacking. The different criteria make it difficult for a fattener company and piglet trader to compare the health status that the different certificates assign to the livestock. This lack in comparability aggravates the compilation of homogenous fattener groups regarding animal health.

5.2.4 The AMOR-approach

AMOR stands for "**A**lliances for the **M**utual **O**rganisation of **R**isk oriented inspection strategies" and is a novel concept to mutually organise inspection strategies between several supply chain actors in a risk oriented manner. With this, AMOR aims at achieving a mutual benefit in a win–win situation for all participating alliance partners. Risk orientation means that there is no uniform inspection for all product batches, but an adaption of the degree of inspection intensity according to the risk to consumer health or quality. The concept has two main dimensions: the collaboration between two or more chain actors for mutual benefit and the risk orientation of the jointly organised inspections. With this approach resources can be allocated to areas of greatest risk. Furthermore, information exchange and communication between the involved supply chain actors, which often is limited, could be facilitated through the joint organisation of inspections. Motivation and structures are given so that information flows in both directions (Lang and Petersen, 2012a, 2012b).

Against the background of the aforementioned international trade with pigs and supplier–buyer relationships across borders, the AMOR concept includes national as well as international cross-border cooperation.

In general, the requirements for an AMOR inspection can be divided into four aspects identified by Lang and Petersen (2012a):

(1) inspection design
(2) tasks and responsibilities
(3) information and communication structures
(4) cost distribution and benefits to all parties

These aspects should be decided upon jointly by the alliance partners. First, the participants decide together about the procedures and parameters which shall have to be considered and the associated information structures. Therefore the participants are aware of the necessity of the inspections and the different information they have to convey which often is lacking if one party just gets dictated which information to deliver. With this the compliance and the validity of information increases when correct data are transferred. Furthermore,

the realisation of an animal health strategy requires good communication as well as the development of an effective long-term collaboration between all stages of the value chain (Aumüller et al., 2010).

In commercial relations between supplier and customer a number of commercial and economic aspects will restrict information flow between partners in the chain. However, AMOR aims at limiting these restrictions while improving general communication and communication of inspection results as well as improving information sharing and exchange between the alliance partners. Consequently, trust shall increase and the basis for long-term and close collaboration between the partners is laid. In turn, this shall help to reduce inefficiencies as the pork supply chain becomes streamlined and a relationship of trust has been established between partners.

Also, joint inspections reduce costs compared to inspections performed separately (Trienekens and Zuurbier, 2008). The studies of several authors have shown that primary producers, carriers and processors require forward and backward information regarding the quality of products, to better plan, perform and to optimise their production process (Schütz, 2009; Ellebrecht, 2008; Mack, 2007; Schulze Althoff, 2006).

Three categories of alliances can be differentiated in which inspections according to AMOR can be performed (Lang and Petersen, 2012a):

(1) alliance between customer/s and supplier/s
(2) alliance between customer/s, supplier/s and independent authority
(3) alliance between customer/s, supplier/s and public authority

Alliances in these categories are of a vertical nature; that is, between an upstream and downstream partner whereof the former stage supplies the next with some input and the latter uses this input to manufacture and/or market products downstream the supply chain (Chaddad and Rodriguez-Alcalá, 2010). The alliances can be based on legally binding contracts, which makes them more obligatory for the partners. However, collaboration and trust are always balanced by the need for commercial success and competitiveness, which might restrict the will to engage in formal agreements between different partners in the production chain. An alternative in this case could be an open and looser network without contractual obligations which are more flexible (Duffy and Fearne, 2004). There are numerous examples from many disciplines of where loose regulation works extremely well.

Category 1 applies when inspections are directly and mutually organised between one or more customer/s and one or more supplier/s (Lang and Petersen, 2012a).

Category 2 extends category one by a third party. In this case an independent authority can be a netchain coordinator or an entity which conveys information between one or more supplier/s and a more powerful customer. The third party functions as a mediator to organise and perform the inspections for the other two parties and which is approved by the other

parties. In this constellation it is important that also the independent entity benefits from the inspection (Lang and Petersen, 2012a).

Category 3 surpasses the private industry and includes a (semi-)public authority where the public authority exerts the inspection and provides the results to supplier and customer (Lang and Petersen, 2012a).

It is important to state, that competencies of the different entities are not diluted through the alliance and that the authority is independent and stands free to provide a framework of rules and guidelines.

An important aspect for the AMOR approach is the relation between service/consultation on one side, and auditing/inspection on the other. It is essential that the service-giver is not the auditor, and that auditing is performed with total independence from the partner to be inspected. Organisations performing several of these services have to be organised in a way that guarantees independence.

A study conducted within the meat sector has shown that inspections according to AMOR-principles would be a realistic option for netchain coordinators such as livestock marketing and producers' associations, slaughter and processing companies (Lang and Petersen, 2012a). Therefore, as the health status of piglets is an important purchasing criterion and customer specification for fatteners the paper is based on questions regarding a process of conformity auditing and monitoring effectively organised between the actors “netchain coordinator”, “piglet producer” and “pig fattener” according to AMOR.

5.3 Methodological approach

Two empirical studies in the form of surveys have been conducted based on a literature analysis. These surveys form the basis for an AMOR case study. Figure 5.1 shows the research framework, comprising three main steps.

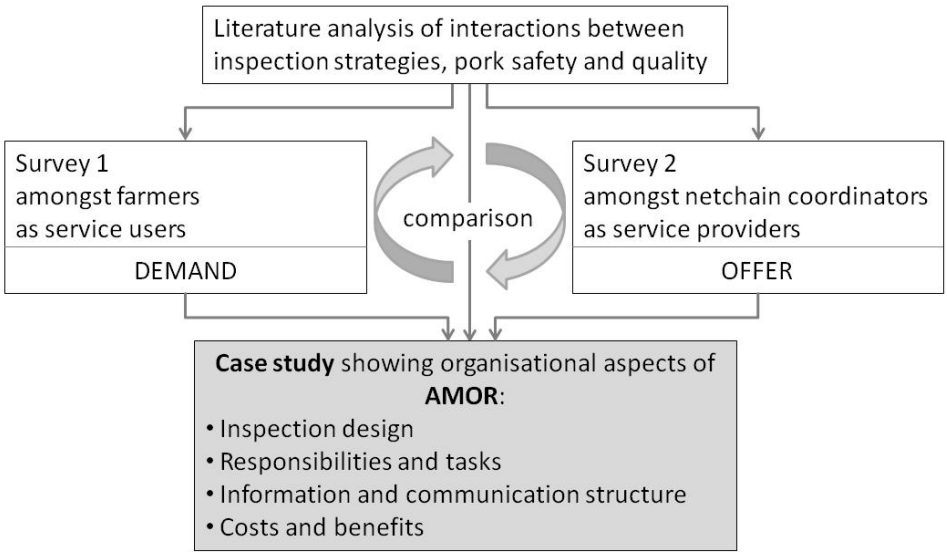


Figure 5.1: Research framework

Survey 1 has been conducted amongst farmers like gilt rearers, piglet producers and pig fatteners as the relevant target group to avail of services offered in relation to animal health management. The aim of survey 1 has been to determine the extent of the demand amongst farmers for coordination services related to animal health management. The survey has been performed in two stages, sub-survey 1.1 and 1.2. The companies participating in sub-survey 1.1 were located in Northwest Germany, companies in sub-survey 1.2 in South and Central Germany. The questionnaires, which have been pretested, were circulated by mail with a cover letter and stamped addressed envelopes for ease of return. The surveys incorporated mainly closed questions with predetermined answers including answers on Likert scales and blank spaces for individual answers. 102 farmers participated in sub-survey 1.1 and 104 participants in sub-survey 1.2.

Table 5.1 shows the participants of surveys 1 and 2 and their characteristics.

Table 5.1: Characteristics of participants in the survey

Survey number / Sample description		Survey 1		Survey 2
		Survey 1.1	Survey 1.2	
Target group		Farmers	Farmers	Service providers
Total number of persons		213	512	30
Response rate in absolute (%)		102 (48%)	104 (20%)	21 (70%)
Characteristics of participants	**Piglet producer**	61	13	
	Piglet rearer	-	6	
	Piglet fattener	41	64	
	Closed system	-	14	
	Gilt rearer	-	7	
	Producers' association			14
	Advisory service organisation in health management			3
	Abattoir			2
	Livestock trader			1
	Research institution			1

Table 5.2 gives an example of the scale used in the questionnaire. It presents the scales used to assess the interest amongst piglet producers and fatteners in information exchange between these two stages regarding two facets. Facet one was the interest in receiving information, and two, the willingness to provide this information to both groups.

Table 5.2: Scales to assess interest in receiving information and willingness to provide information

Interest in receiving information	Scale value	Willingness to provide information
Generally yes	4	Generally yes
Not on a regular basis	3	Upon agreement
To a limited extent (only in case of acute problems)	2	To a limited extent (only in case of acute problems)
Generally no	1	Generally no

Survey 2 has been performed amongst service providers, such as pig traders, farmers' cooperatives and consulting organisations to determine the offer side for coordination services related to animal health management. The survey has been an online expert interview launched amongst service providers in Europe who have existing or future planned functions as netchain coordinators to investigate the range of services provided for farmers and the extent to which these organisations are already coordinating activities in animal health management. As various types of companies can adopt the role of netchain coordinator, a range of service-centred organisations have been targeted.

The survey, pretested by experts prior to survey release, has been initiated by sending a cover letter containing the link leading to the online questionnaire by mail to the participants. The dynamic questionnaire with automated forwarding depending on the given answers, contained mostly closed questions with predetermined answers, but blank boxes enabled the entry of individual additional information. Overall 21 firms participated (Table 5.1), whereof 18 are located in Germany, two in Denmark, one in France, and one in the Netherlands.

The overall aim of surveys 1 and 2 has been to compare the demand for services amongst farmers with the offers provided by the service providers. Therefore, the results of both surveys will be analysed and compared.

Following the surveys an AMOR case study has been set up to show how the livestock health status certificate can be successfully organised in a mutual approach and risk oriented manner between netchain coordinator, piglet producer and fattener. For this purpose preexisting certification procedures for attesting livestock health status have been viewed and processed and structured in a way that they fulfil the general AMOR requirements (see 5.2.4).

The analysis of both surveys will highlight the dual significance to farmers and service providers of health status certificates.

5.4 Results and discussion

A first step in the evaluation of **survey 1** has been to detect the interest of piglet producers and fatteners in an information exchange between each other. Based on the scaling system of Table 5.2 the willingness to receive information ranks at 3.1, which is the average value calculated from the response of each participant (famer). Furthermore, the response relating to the participants' willingness to provide information ranks at 3.4, meaning that willingness for the provision of information exists in almost all cases after a corresponding agreement between entities. The two values show a requirement for inter-enterprise information exchange by both piglet producers as suppliers and pig fatteners as customers. This reinforces the recommendation of Petersen et al. (2010) to include health data as quality and performance criteria into the regular communication between business partners. An exchange of relevant measurement data during primary production up- and downstream the supply chain, respectively, between two stages lowers the risk of trading in animals that fail to meet

the health criteria. Information exchange, therefore, improves food safety and product quality (Klauke et al., 2011).

Further analysis of **survey 1** has revealed that more than 75% of pig fatteners attach the attributes “important” and “very important” to piglet health certificates for the purchasing of piglets. On the other hand, only 42% of piglet producers have stated that they consider a piglet health certificate as “important” or “very important” for their marketing purposes. Moreover, only 21% of piglet producers, and only about 12% of fatteners, have indicated that health certificates for piglets are “not important”. The clear statement by fatteners that piglet health certification is very important, confirms earlier research (Petersen et al., 2010). The requirement of fatteners determines their purchase decision and thus, has a major impact on the demand of this coordination service. For piglet producers it results in competition and they increasingly take part in voluntary monitoring programmes so that they do not suffer any disadvantages when marketing their piglets. Most of the netchain coordinators questioned have organised the marketing of piglets and are therefore directly aware of the requirements of fatteners.

In **survey 2**, eleven service providers have been identified to coordinate audits leading to health status certification. Furthermore, two providers plan to integrate this service offer in their portfolio while 17 do not offer this service at all. This shows that audits concerning health status are in the portfolio of a significant number of service providers, but that also a large gap exists in the offer. The service offer of one-third of the respondents includes the preparation of certificates regarding the use of antibiotics, participation in monitoring sessions, transport times, adherence to waiting times, genetic origin and health status. It has been found that three companies even certify the health status for pig fatteners in addition to pig producers.

The validity of the certificates issued varies. With nine providers, the certificate remains valid for six months. Three respondents have linked certificates with delivery batches. That is, health status certificates are issued on the outgoing product and remain valid only for the duration of delivery. Two netchain coordinators only renew the certificates once a year. One respondent has stated that certificates in basic rearing and in multiplying of piglets expire after one month and in production after three months. This shows that there are large variations regarding certificate issuing and validity and that no standardised procedure is available. Here a regional or national authority should step in with clear guidelines based on practical science, experience, and risk assessment, to establish homogenous monitoring routines and implement uniform validity periods of the certificates.

Eight participants believe that the netchain coordinator has the responsibility for the procedure of determining the health status and carrying out monitoring sessions. A further five netchain coordinators believe that the guidelines should be established by a regional body. One participant believes responsibility rests with a national body and another one suggests an external service organisation to be responsible for the specifications. Ten of the 14

netchain coordinators who have commented on this, issue the certificates themselves and for three service companies, an external enterprise issues their certificates.

To further assess the current situation regarding offer and demand for services in animal health management, subsequently two concrete examples are given where the offers of the service providers are compared with the demand by farmers, and their significance to farmers.

5.4.1 Contrast of demand and offer regarding monitoring activities of diseases

For determining the health status, it is necessary to carry out monitoring activities on a regular basis to determine the status of diseases that are included in the certification process. Therefore the first example compares the importance of information concerning the health status of piglet producers for pig fatteners with respect to the following pathogens: PRRS (porcine reproductive and respiratory syndrome), Brachyspira, Salmonella, Pasteurella, Mycoplasma, and APP (actinobacillus pleuropneumoniae). Results are shown in Figure 5.2.

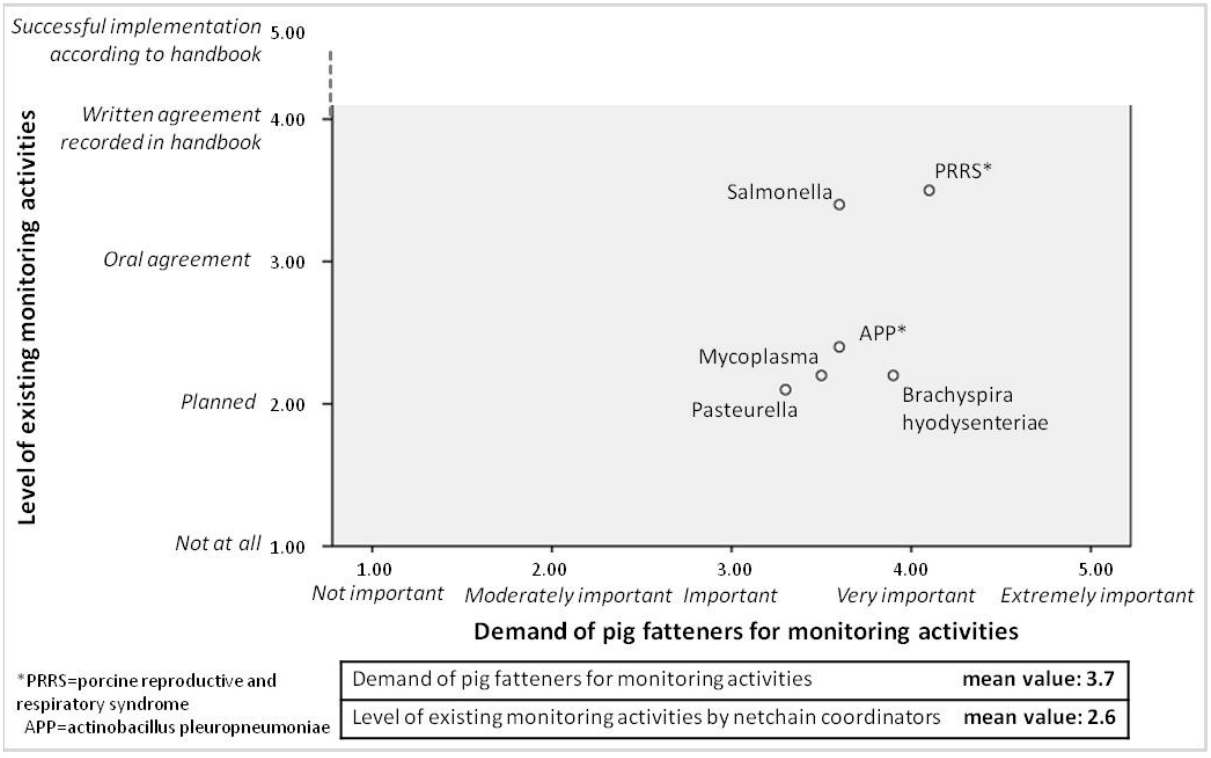


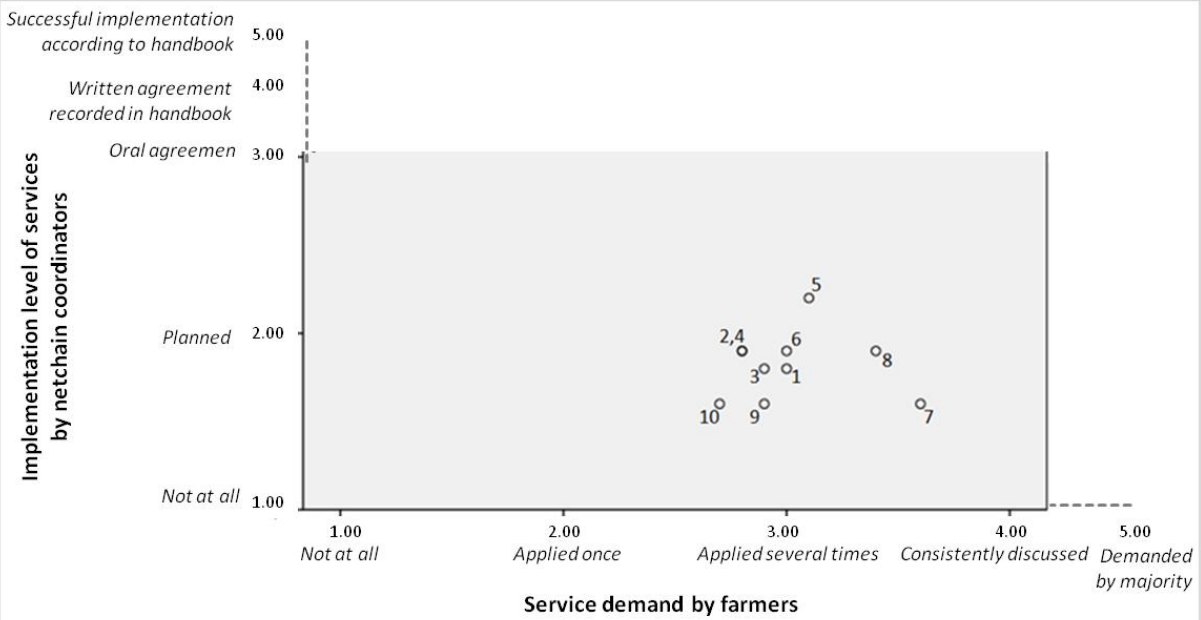
Figure 5.2: Meaning of health status information of producers for fatteners and coordination offer of corresponding monitoring activities by netchain coordinators (n=15)

Figure 5.2 illustrates the importance of the relevant status information regarding defined monitoring activities by netchain coordinators. It can be seen that the surveyed pig fatteners rank “medium” to “high” as regarding monitoring activities, whereas the coordination offer of the netchain coordinators varies depending on the investigation parameters. Offers regarding PRRS and Salmonella monitoring cover a large extent of the demand, therefore offer

and demand can be rated as balanced. Legal requirements for quality assurance programmes require Salmonella monitoring in piglet production. The great importance of the PRRS status and the monitoring offer already geared to this, can be ascribed to the fact that PRRS is considered as one of the diseases causing the greatest economic loss to farmers. In contrast, monitoring activities in connection with other diseases lag behind. For example for APP, Mycoplasma, Pasteurella and Brachyspira hyodysenteriae, there is a large difference between offer and demand. The higher demand suggests that in this regard there is a need for action, which has already been taken into consideration within the framework of the current TiGA (animal health agency) initiative in Germany aiming at a uniform nation-wide health status certificate for piglet producers (Petersen et al., 2010).

5.4.2 Contrast of demand and offer regarding the determination of health status

The second example contrasts offer and demand for services which are directly linked with the determination of the health status. Results are shown in Figure 5.3.



Service No.	Description
1	Information from farmers about procedure when determining the health status
2	Information from veterinarians about procedure when determining the health status
3	Cooperation between veterinarians and laboratories for health status determination
4	Organisation of sample taking
5	Organisation of farm visits with veterinarians and farmers
6	Administration of sample results
7	Information from farmers about samples and farm checks
8	Advice for farmers on the basis of their results
9	Preparation and handover of health status certificates to farmers
10	Investigation and consideration of new customer demands

Figure 5.3: Representation of offer and demand for services within the framework of determining the health status for farmers by netchain coordinators (n=19)

From Figure 5.3, the demand for services is between 2.7 and 3.6 on a scale of 1 to 5. In contrast to this, however, the implementation level of the relevant services resides between 1.6

and 2.2 on the offer scale. This means that the relevant service offers are quite often still in the planning phase. The greatest divergence between offer and demand exists in relation to the "information of the farmers regarding results of monitoring and farm visits". While this service is requested increasingly by the farmers, the service is not even considered in the plans of some coordination organisations.

5.4.3 Customer expectations and service providers' offer

The overall result of the conducted surveys and the most important aspects regarding the demands by farmers (i.e. piglet producers and fatteners) and the relevant offer by netchain coordinators are shown in Table 5.3.

Table 5.3: Customer (farmers) expectations and offer (netchain coordinators) of coordination services

Subjects	Customer expectations	Service offer
Health status of piglet producer	Health certificate for piglet producer: - **High** (fatteners) - **Medium** (piglet producers)	Monitoring sessions for piglets: - **Medium** (salmonella, PRRS) - **Low** (only about 1/3 of providers are offering monitoring sessions regarding brachyspira, pasteurella, mycoplasma, APP)
		Certification/attestation (of additional information regarding health status): - **High**
		Health certificates (preparation, organisation of issuing as well as handing over to farmers): - **Low**
Preparation of health management-relevant issues	Support with preparation of health-relevant issues: - **High** (piglet producers)	Execution of health management-relevant audits: - **Medium**
		Advisory services for farmers on the basis of results: - **Medium**
		Information of farmers on results of monitoring sessions/visits: **- Low**
Inter-enterprise information exchange	Support of information exchange between piglet producers and fatteners: - **High**	Information of farmers and veterinarians on procedures for status determination: **- Medium**
Assignment of the results to three categories (low, medium, high) on basis of percentage of positive mentions for demands or offers: low (0-20%); medium (>20%-50%); high (>50%)		

Table 5.3 shows that piglet producers place a "medium"-level demand for the service of health status certification for their own industry. On the other hand, fatteners have a "high" demand for services offering health status certification of piglet producers. This demand by producers and fatteners is contrasted by varying service offers in piglet production for defined monitoring activities. Offer is "low" for B Brachyspira hyodysenteriae, Pasteurella, My-

coplasma and APP resulting in a gap between offer and demand. Regarding Salmonella and PRRS where the service offer is provided on a medium scale, offer and demand are more balanced. Furthermore, there is a low offer for health certificates including preparation, organisation of issuing as well as handing over to farmers and a high offer for certifications/attestations of additional information from internal inspections regarding the health status. The gaps which exist between those services demanded by farmers and those offered by providers, to determine animal health status, require closing. However, many netchain coordinators have stated that planning activities exist so that an extension of these coordination services can be expected in the future.

In the topic of "preparation of health management-relevant issues", the piglet producers have a high demand for support from the netchain coordinators whereas the service providers offer little information on monitoring and audit results. A medium-level offer of farm audits exists as well as advisory services based on monitoring and audit results. This shows another gap where expansion of service offers is required.

The high demand for inter-enterprise information exchange amongst farmers is in contrasts to a medium information offer on the part of the netchain coordinators. This is obviously another gap which requires filling through an extension of relevant services.

Comparing offer and demand of selected coordination services in inter-enterprise health management, it has been revealed that on the whole there are large gaps in this respect. A medium to high demand is often confronted with a low to medium range of offers.

The outcomes have shown that an extension of activities in inter-enterprise health management like the determination of health status and certification is necessary, and that piglet producers and pig fatteners require the support of netchain coordinators in these activities. A breach of, for example, cross-compliance regulations leads to subsidy cuts and thus has direct financial disadvantages for farmers. This background information implies a great demand amongst farmers for support to be able to comply with legal requirements. The need for coordination between farmers, veterinarians, laboratories, slaughterhouses and specialist advisors on many services in inter-enterprise health management requires regular and targeted cooperation on the basis of an organised exchange of information between all parties. Many netchain coordinators, however, have stated that planning activities exist so that an extension of these coordination services can be expected in the coming years. An extended monitoring scheme can contribute to improvements in the health status of piglet producing companies (Lehnert, 2009; Seybold et al., 2009).

The literature study has already shown that farmers demand support for their activities in health management and an inter-enterprise coordination of monitoring and audit processes. The results of the surveys on inter-enterprise information exchange and the coordination of services in the health management of pork supply chains show a unique need for action concerning the expansion of coordination services for primary production in the pork supply

chain. The study results therefore confirm findings from literature analysis. As a consequence, these customer demands are made to netchain coordinators who provide services in response to demand. However, services need to be streamlined between demand and offer. To achieve this, a mutual organisation of the inspections for livestock health certification between demand and offer-side is a suitable approach. For this reason, the service offer concerning health certificates is described in more detail as a case study in the framework of the AMOR approach.

5.4.4 Organising health status certificates according to AMOR principles

AMOR proposes a centrally organised method of company auditing and monitoring for certification. To apply the AMOR concept to animal health certificates, it is important to discover how inspections leading to a certificate could be mutually organised between the respective parties (producer, fattener and netchain coordinator). In this regard the characteristic aspects of the design of AMOR inspections including responsibility and tasks, information and communication structures, and cost analysis for the individual parties will be explored.

The inspection strategy resulting in a health status certificate adheres to the following general procedures: The piglet producer registers for the programme with a netchain coordinator. The netchain coordinator then commissions a veterinarian to conduct animal testing and sampling. The veterinarian collects all relevant samples and sends them to an accredited laboratory for standard analysis according to (inter)nationally recognised methods. The veterinarian conducts an audit to assess the general conditions of the farm and to determine the state of animal health and animal health management. With the aid of the laboratory test results, the netchain coordinator issues a health status certificate to the piglet producer. The producer can take appropriate measures according to these results and furnish the health certificate to the fatteners.

Inspection design

The inspection falls under alliance category 2 of the AMOR approach (cf. Section 5.2.4) where the inspection is organised between supplier–customer and a private third party. The participants of the alliance mutually decide on inspection priorities, the extent to which they each execute a given task and the commitment to the exchange of results and information with partners. In practice, the service provider sets the strategy, however full participation involving all partners should be aimed at.

Once formed, the alliance decides on an inspection plan for sampling and regular farm audits, which both shall be based on exterior (inter)nationally recognised guidelines as far as these are available. The inspection plan comprises the decision on which parameters to include for determining the health status, which pathogens have to be monitored and how often inspections have to be performed. For the sample analyses, the type of test kits used by the laboratory have to be chosen, for comparability of the results, and other specifica-

tions for the analyses have to be made (e.g. tests on antibodies or directly on pathogens; test medium). For risk orientation of the inspections a regular risk analysis of pathogens has to be performed to regularly reconsider pathogens included for the health certificate. Inspections need to be adaptable quickly to prevent a threat to human health.

The frequency of each test and the sample size have to be set. This is also best decided in a risk oriented manner, which means that the sample size taken after a first status classification of a farm and the frequency of sampling vary depending on the health status of the farm. The respective vaccination regimes in the piglet producing company have to be included into the assessment and therefore have to be documented as they influence the traceability of pathogens. Otherwise false positive results can lead to misinterpretation.

In addition to inspections, checklists have to be compiled jointly for the monitoring of additional parameters in the farm audits, besides pathogens, including the management of production, farrowing, occupancy, stable climate, epizootic diseases, hygiene, etc., to judge the health conditions of the animals. Vaccination protocols, parasite control, feeding regimes and medication must also be assessed.

Overall a clear decision structure for assigning farms in accordance with their inspection results to different health status categories has to be developed. This means that after the choice of the parameters, different status categories have to be set up and a structure for relating the results to the respective category must be devised. This could be by means of points and possibly weighting factors for the individual parameters which sum to form an overall index per company. However, to create a health status index for each company it is essential to have a thoroughly specified and agreed testing and scoring regime. The nature of the data and information collected must lend itself well to indexing to eliminate human biases, false inference and anchoring effects. Clear regulations must stipulate exactly what is measured, how it is measured, and an infallible method of transforming measurement results into numbers (on the index scale) must be found. This is an area that demands intensive research and which will require a new style of data to be gathered as current data cannot be transformed to a number scale without bias and anchoring.

Responsibilities and tasks

Table 5.4 gives an overview of the responsibilities and tasks of the alliance partners.

Table 5.4: Responsibilities and tasks of the alliance partners

Netchain coordinator	Piglet producer	Pig fattener
• Provides database, data collection, saving, evaluation and processing • Storage of master data • Preparation of work instructions • Editing of inspection plans • Assignment of health status and issuing of health certificate • Support of piglet producer and fattener regarding health management	• Participation in the programme • Provision of master data • Complete and regular sampling • Measures of internal health management	• Feedback of animal health • Animal health management in fattening

The netchain coordinator represents the steering board and offers risk oriented inspections on a supraregional service. The coordinator is responsible for providing the database and for gathering, saving, evaluating, and processing the data as well as for storing the master data of the piglet producers and the veterinarian. Furthermore, the coordinator prepares work instructions for sampling, shipping and analysis and edits an inspection plan for sampling and site audits. For the veterinarian the netchain coordinator provides guidelines for the minimum size of the sample and the minimum number of samples per year, which are dependent on the stock size and the specific pathogen. Checklists for the farm visits are also issued by the coordinator. By informing farmers and veterinarians in advance, they can prepare for upcoming activities such as site visits or sampling, and thus can be supported with their individual preparations.

Based on the laboratory results and farm audits, the service provider assigns an animal health status to the piglet producer and issues a certificate about the participation in the monitoring programme.

The piglet producer is responsible for communicating the master data set of his business such as current contact data, address, information on trade relations, stable places, animal numbers, vaccination scheme and the farm veterinarian. The producer is responsible for participation in the programme and especially the complete and regular sampling of the piglets. The piglet producer decides the animal health management measures as, for example, which vaccinations to give and decides on improvement processes to be taken.

According to the test results, the piglet producer takes measures concerning the internal animal health management to improve or maintain the health status.

For the pig fattener, information on the health status of the producers is important in deciding if any countermeasures are necessary. A typical example is the prophylaxis at reception and placement of piglets: if enough useful pre-information is available, prophylactic measures might be unnecessary, however, without this information, the fattener would routinely treat the piglets. The fattener should give feedback information regarding animal health to the respective piglet producer to provide the producer with the possibility to improve performance. This step is not yet performed in practice.

The veterinarian is accountable for farm audits on animal health and animal health management. The responsibility for sample taking and shipping of the samples to the laboratory also rests with the veterinarian.

The laboratory performs the analysis of the samples and inserts the test results into the database.

Information and communication structure

For simplified information and communication the use of a joint database is advantageous for all sides. A web database is a critical success factor to apply management methods in food supply chains (Oskam et al., 2010) and may in the long run aid improvements to animal health management procedures. A database permits timely information flow between different entities as data are directly introduced into the database such as laboratory results and can be seen immediately by the other parties (depending on the respective access authority). Additionally, the provision of information enables targeted risk management adapted to the relevant risk and allows a risk oriented inspection strategy.

The database to handle data concerning animal health status potentially can be used for other purposes. In the milk production and dairy chain attempts exist to use health-related and similar data from primary production to predict functionality and quality in the end product, e.g. in cheese production (e.g. Allen et al., 2009; Klei et al., 1998). Accordingly further research could investigate whether the data stored from pig producers can be related to meat and product quality in any way. Possibly with multivariate approaches correlations can be detected in the huge data set that can be valuable in an unexpected way to give added value to meat production, for instance to monitor and also control the production process so that specifications of pig health can be used to improve quality through the whole chain.

Figure 5.4 shows the structure of the database including the data comprised.

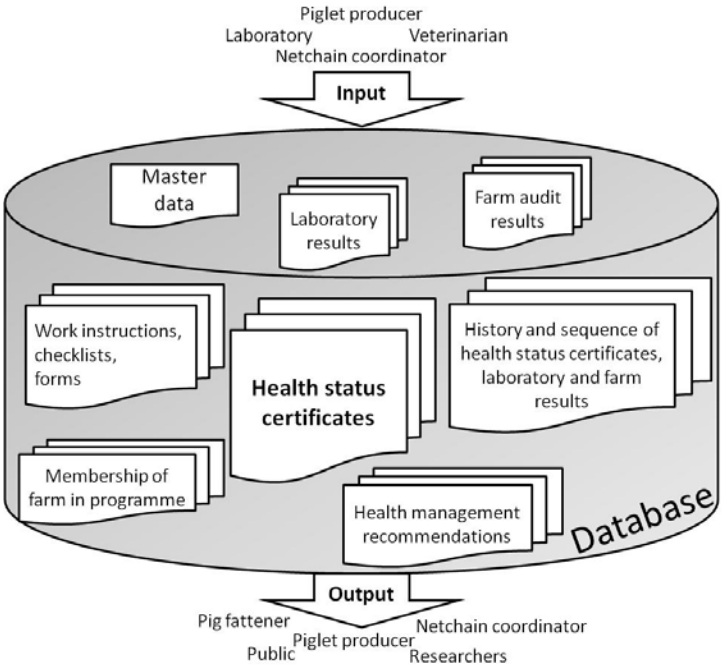


Figure 5.4: Database structure

The database with individual access data can store and administer data and provide targeted information for each participant as well as limited access to particular data. Presentation of the information can vary according to the target group. The data stored comprises data on samples and test results and, for example, instructions for sampling, sample marking and sample shipping as well as instructions for interpretation, documentation and communication of the test results and various forms for the participants. With the data stored and documented a history of the health status and its parameters can be generated.

Table 5.5 illustrates the input in and output of the database of different stakeholders and shows the data comprised in the database.

Table 5.5: Database input and output

Actor	Input	Output
Netchain coordinator	- Administration of master data - Work instructions - Forms - Checklists - Data collection and storage - Data evaluation - Data processing - Health management recommendations	- Farm audit results - Laboratory results
Piglet producer	- Master data entry	- Master data - Work instructions - Forms - Checklists - Farm audit results - Health status certificates - Health status history and sequence - Health management recommendations - Laboratory results
Pig fattener	—	- Health status certificates
Veterinarian	- Farm audit results - Potentially advice on health management recommendations	—
Laboratory	- Laboratory results	—
Public	—	- Membership of farm in programme - Potentially other authorised data (e.g. certificates, anonymised results)
Science	—	- Potentially anonymised data for research on connection between animal health and food product quality

The netchain coordinator in the health status determination therefore does the actual data collection, storage and data processing and keeps the database running.

The piglet producer provides master data and can adapt them in the database in case of changes. The producer also has access to master data, a detailed overview of results from farm audits and laboratory test and the health status certificates. Continuity and completeness of the sampling of the producer can be controlled via the database. Evaluation and clear display of results and the ensuing recommendations help the participants to detect weak points early and to quickly react to possible negative results to improve the internal animal health management. Moreover documentation of vaccinations have to be performed which is important as tests on specific pathogens can be forgone if the piglets are vaccinated against it. The producer, as data owner, decides if the certificate and the individual results can be published.

The pig fattener who is going to receive the piglets obtains information about the health status and the vaccination status of the producer's company. This database allows piglet buyers access to findings which are documented and therefore to additional information for their purchase decision.

Costs and benefits

Inspection strategies according to AMOR have to be beneficial to all participants. This section offers a hypothesis of how the different entities might arrange themselves to conform to AMOR principles. The actual arrangement may differ on a case-by-case basis. However, it is constructive to consider these aspects of AMOR initially in general terms.

To participate in activities of inter-enterprise health management requires a high level of service quality. A high service quality attracts customers and secures the existence of the service providers, which is a beneficial outcome for the service provider. Furthermore, the provider obtains information about animal health to optimise marketing of the piglets and to improve the supplier–buyer information exchange.

The piglet producers pay for participation in the monitoring programme, which includes the certificate, and for the use of the database. They also bear the cost of laboratory analyses and the veterinarian farm audits and sampling. The animal health status is a communication tool targeting fatteners and is a supporting tool to achieve good animal health management on the farm. Therefore, the producer receives a higher competitiveness and a competitive advantage in the marketing of piglets on a national and an international scale. This has been confirmed by the surveys, where it has been shown that fatteners require a certificate. Additionally it helps to minimise risk through determination and elimination of potential disruptive factors and by guaranteeing process transparency internally and externally. With the health status certificate the producer does not only satisfy the demand of the fatteners but meets requirements from changed regulations for product liability in primary production. With this it provides the possibility to prove the quality capability of the agricultural company and to ensure control and improvement of the production quality.

The health status shall reflect the health condition of the piglets and helps the fattener and/or piglet traders to compile homogenous batches with animals of similar health status. They receive a proof of origin and certainty as to the origin of the animals and can plan logistics when buying piglets as well as plan and prepare vaccinations when they buy piglets with known status. It is obvious that improved and known health status is beneficial for the fattener as he can purchase piglets with unsuspicious findings on the tested pathogens. The fattener receives additional information about the animals which are valuable to the company. For this the fattener would be expected to pay higher purchase prices and regularly purchase pigs from certain piglet producers. With a health status certificate the fattener can prove transparency in the production process as well as a high and stable product quality towards his customer.

Fig. 5.5 summarises the case study and the previously described characteristics of the inspection strategy according to the AMOR approach.

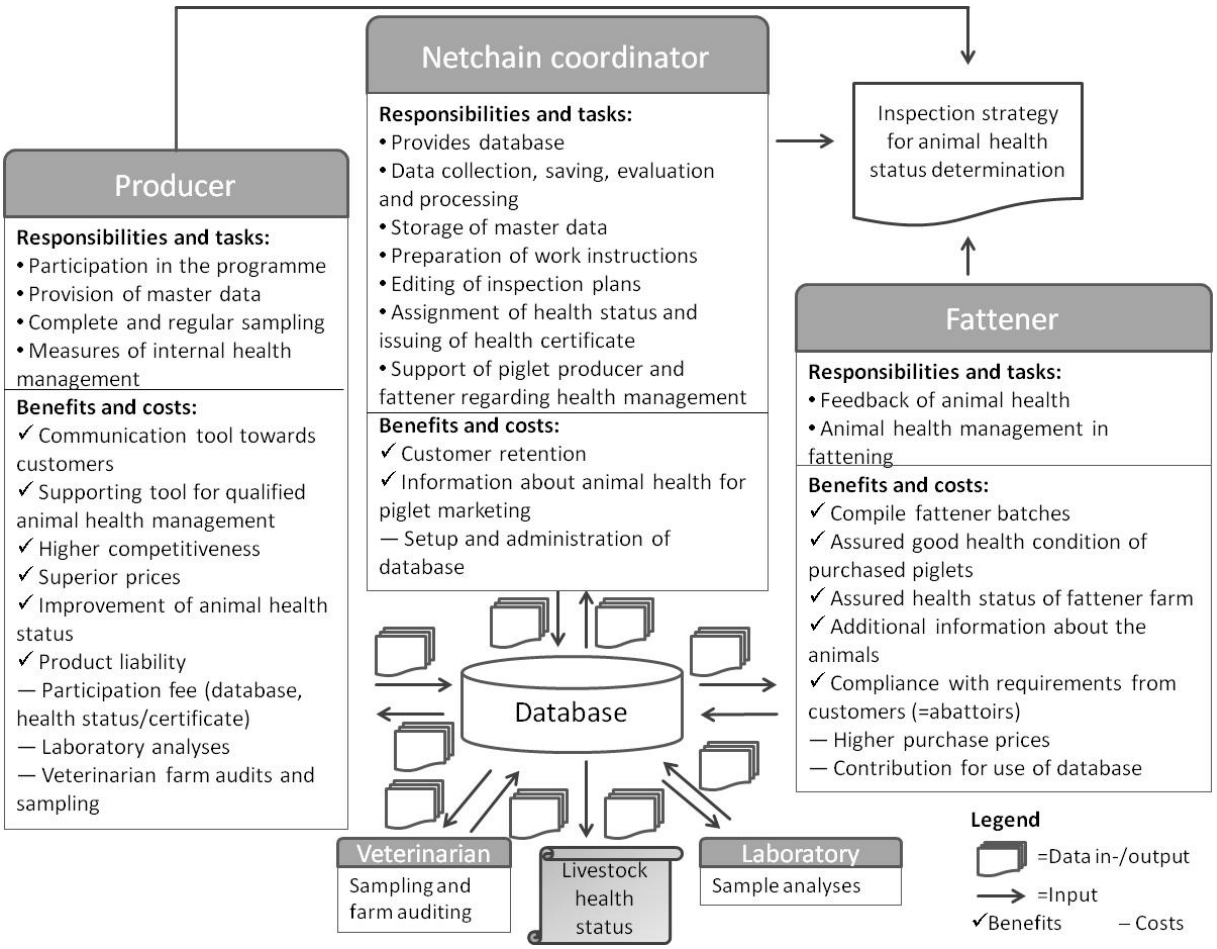


Figure 5.5: Characteristics of the AMOR inspection "livestock health status"

These mutual inspections are clearly beneficial aspects of AMOR because each participant can benefit from the resources of its partner. Furthermore, in a time of crisis (e.g. food contamination affecting public health) the usual sense of a company's "isolation in time of crisis" can be avoided. Other positive aspects of the mutual approach are for example that with monitoring activities a piglet producer obtains information if hygiene and prevention measures are successful. The producer can better control production processes and conditions and at the same time can pass on pre-information on the health status of the group of animals to the fattener (Gymnich, 2001). Furthermore, this pre-information allows the fattener to detect potential subclinical diseases early on and to take counter-measures such as further examination or quarantine measures (Gymnich, 2001). Moreover, close cooperation between piglet producers and fatteners has the advantage that feedback on health disorders, and the associated animal performance, can be jointly discussed and a mutually beneficial method to improve animal health can be achieved (Gymnich, 2001).

The survey has shown that 10 of the 14 netchain coordinators issue the health certificates themselves. However, for the competitiveness of German piglets on the world market a more standardised and uniform procedure would be valuable. The German TiGA (animal

health agency) offers a supraregional and uniform system for health management in pig herds for Germany and attempts an accreditation regarding a livestock health certificate.

5.5 Conclusion

The surveys have clearly shown that farmers require coordination services regarding livestock health management for marketing (producers) as well as purchases (fatteners) and that the netchain coordinators, as service providers, already offer some of these services. This means that the netchain coordinators have the necessary structures for this offer and possess the possibility to organise this kind of services. However, gaps exist when this demand is compared to concrete service offers of netchain coordinators regarding livestock health management. Service gaps exist because of a lack of awareness and lack of communication between the respective sectors (i.e. the demand side and the offer side). It has also been found that in some cases services are offered by the service provider, but which the farmers had no knowledge of. Since information often is valuable for advising several production stages, the extension of such offers and their combination with further offers in health management becomes obvious. Therefore services need to be extended to satisfy the demand and fulfil the coordination tasks for piglet producers and pig fatteners.

The case study has provided a template for closing the gap between demand and offer by describing in detail how inspections of livestock health can be successfully organised in a mutual effort between netchain coordinator, piglet producer and fattener.

For future work in this direction and to extend the use of the service offer, the netchain coordinators with their key position in the pork supply chain can function as a promoter. Promoters help to spread newly developed strategies to achieve wide acceptance (Anwander, 2002). Thus, the netchain coordinators can spread the health status certificate as well as information conveyed with them so that all actors know what the certificate means and what the underlying principles are.

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6. A scoring system to rank alliances performing mutual and risk oriented inspections

Abstract

A limited set of resources coupled with the necessity for improved information exchange and transparency has resulted in a novel means of organising inspections between several alliance partners in agri-food supply chains. This novel approach has been presented as the AMOR model, which is based on the collaboration between companies regarding mutual risk oriented inspections. In this chapter, a method of scoring is proposed which aims to determine the degree of AMOR implementation in existing alliance inspections and to highlight those areas requiring improvement. The scoring model has been tested using four separate and independent examples from the agri-food sector. The proposed checklist comprises 20 statements and has been composed such as to contain a degree of redundancy to ensure the accuracy and integrity of responses. With the checklist each alliance achieves a score which places it in a particular category. From there a set of strategies and recommendations are provided to assist an alliance to advance to a greater level of AMOR adoption.

Keywords: scoring model, AMOR, alliance, inspection

6.1 Introduction

Legal regulations, consumer requirements, food crises and global sourcing pose persistent challenges for agri-food supply chains. These challenges increase pressure on food business operators whose most important duty is to provide the final consumer with safe food products at the end of the supply chain. To meet their responsibility the companies have to perform product inspections at the different production and processing stages, to ensure quality and safety of the food products. Thereby, scarceness of resources and a necessity for improvement of information exchange and transparency between the stages have resulted in a novel way of organising inspections between several alliance partners in the agri-food supply chain. This approach is represented as AMOR model: **A**lliances for the **M**utual **O**rganisation of **R**isk oriented inspection strategies (Petersen and O'Hagan, 2014; O'Hagan et. al., 2013; Lang and Petersen, 2012a, 2012b). The AMOR principles include collaboration between different stages, joint inspection strategies and risk orientation of the inspections as well as information exchange of results.

The AMOR approach has been presented to industry (Lang et al., 2012a, 2012b) and several practical case studies have been analysed. These studies have been of a descriptive nature owing to the fact that until presently, no concept has been available to investigate the degree of AMOR in existing inspection strategies. Therefore, in this chapter a scoring system is proposed to examine the adoption of AMOR principles in existing alliance inspections and to highlight areas for improvement. The scoring model has been tested using four concrete cases from the agri-food sector.

The following alliances have been chosen as inspection settings to be scored:

a) an alliance between farmers, slaughterhouses and producers' association with their risk oriented inspection health monitoring
b) an alliance between raw material producers, feed producers and the coordinating office with the risk oriented inspection supplier rating of raw material producers
c) an alliance between animal suppliers, slaughterhouses and a semi-private service provider and the risk oriented meat inspection
d) an alliance between food manufacturer, food trade company and intermediate storage regarding temperature monitoring inspections

The settings will be shown and contrasted. The key points for improvement will be explained and strategies to advance the adoption of AMOR principles will be recommended.

6.2 Background

The AMOR model is described based on Lang and Petersen (2012a, 2012b), O'Hagan et al. (2013) as well as Petersen and O'Hagan (2014):

The concept comprises the mutual organisation and implementation of inspection strategies between several supply chain actors in a risk oriented manner. With this, AMOR aims at

achieving a mutual benefit for all participating alliance partners to reduce the effort and workload expended by an individual company when performing an inspection in isolation, whilst simultaneously ensuring a superior quality management through risk-oriented inspections. Risk orientation means that there is no uniform inspection for all product batches, but an adaption of the degree of inspection intensity according to the risk regarding consumer health or quality. The concept has two main dimensions: collaboration between two or more chain actors for mutual benefit and risk orientation of the jointly organised inspections. With this approach resources can be allocated to areas of greatest risk. Furthermore, information exchange and communication between the involved supply chain actors, which often is limited, should be facilitated through the joint organisation of inspections. Motivation and structures are given so that information flows in both directions.

In general, the requirements for an AMOR inspection comprise four aspects:

(1) inspection design
(2) tasks and responsibilities
(3) information and communication structures
(4) cost/effort distribution and benefits to all parties

These aspects should be decided upon jointly by the alliance partners. The alliance can be composed of different supply chain actors, as shown in Figure 6.1.

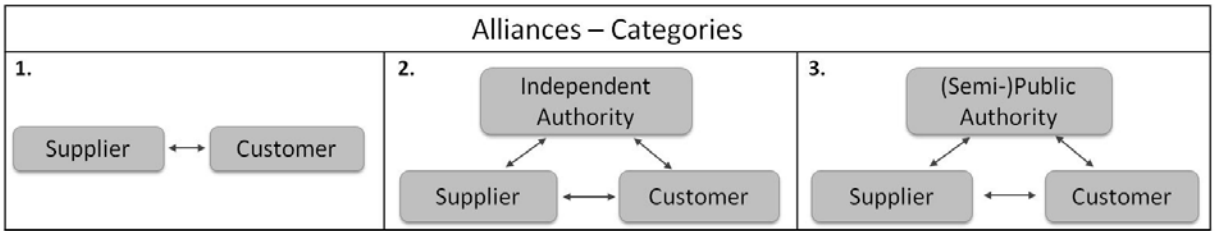


Figure 6.1: Categories of AMOR alliances

Basically the alliance can be formed by two partners or several partners in a supplier-customer relationship. The inspections are directly and mutually organised between these alliance partners.

The alliance between the stages supplier and customer can be extended by an independent third partner approved by the other alliance partners. The third party can be a netchain co-ordinator or an entity which conveys information between supplier(s) and customer(s). The third party functions as a mediator to organise and perform the inspections. In this constellation it is important that the independent entity also benefits from the inspection.

In the extended alliance the third partner can also be a semi-public or public authority, which represents the third form of an alliance. The public authority exerts the inspection and provides the results to supplier and customer.

6.3 Methodological approach

In the first step a rating system for alliances performing mutual and risk oriented inspections has been chosen: the scoring model.

With a scoring model, an assessment takes place based on partial judgements, which are summed up to a total score to form the basis for the decision on how to further proceed (Tilman, 2000). The advantages of a scoring model include:

- the assessment is transparent and comprehensible (Koppelmann, 2004; Przygodda and Ferreras, 2004)
- the model is adaptable, the judgment systematic and objective (Przygodda and Ferreras, 2004; Tilman, 2000)
- the model is flexible in terms of applications (Chen et al., 2004)

The scoring system has been developed in detail based on the principles previously described for these inspections by O'Hagan et al. (2013): inspection design, responsibilities and tasks, information and communication structure, and cost/effort and benefits.

In the next step the scoring model has been tested by interviewing alliance partners of four alliances of the agri-food industry performing mutual and risk oriented inspections within a particular alliance.

Background to four testing case studies

Example a): Alliance between farmers - slaughterhouses – producers' association

The alliance between farmers, slaughterhouses and producers' association (Figure 6.2) is an AMOR alliance according to category 2 between supplier (partner 1), customer (partner 2) and third partner (partner 3).

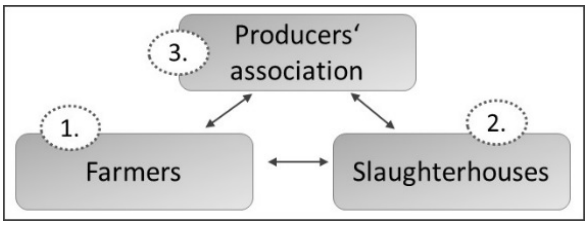


Figure 6.2: Example of alliance between farmers, slaughterhouses and producers' association

The third partner, in this case producers' association, acts as the netchain coordinator bundling around 2500 members on the primary production stage in pork production and holds shares of three slaughterhouses. Together with its members in pork production and with the slaughterhouses, the netchain coordinator organises a herd health monitoring based on pathogen monitoring and on-farm audits as risk oriented and mutual inspection of this alliance.

The inspection strategy for pig health monitoring can briefly be described as follows: the farmer subscribes to the monitoring activity for which he pays an annual fee. The slaughterhouse performs sampling of a set number of samples per year which are tested on a defined number of pathogens. The netchain coordinator calculates an index upon which the health of the pigs can be based.

The alliance applies a central database through an external organisation with defined access rights for information exchange regarding the health monitoring.

Table 6.1 presents the responsibilities and tasks as well as efforts and benefits for this example.

Table 6.1: Distribution of responsibilities/tasks as well as efforts/benefits in example a)

Responsibilities and tasks	
Farmers: - proactive in recommending improvements to the monitoring system **Slaughterhouses:** - organise sampling and shipment - assure that sampling and shipment performed on time, quality and budget - proactive in recommending improvements to the monitoring system **Producers' association:** - calculates health index, documents it and makes it available in database - coordinates and controls success of inspection strategy - assures that e.g. sample evaluation, coordination of veterinary farm audits are on time, quality and budget - defines work processes (sampling, shipment, on-farm audit) and create work instructions - maintains sample plans, ensures quality assurance of results, administers changes - encompasses coordinated decisions in the alliance	
Cost/efforts	**Benefits**
Farmers: – fee for monitoring – costs for veterinary farm audit **Slaughterhouses:** – time for sampling and sample shipment **Producers' association:** – data management – effort for calculation of health index – cost for external database	**Farmers:** ✓ reduced pathogen pressure in the herd ✓ reduced costs for quality and pre-vaccinated piglets ✓ targeted health measures like vaccinations ✓ sustainable improvement of animal health **Slaughterhouses:** ✓ receive payment for sampling and shipment ✓ healthier animals for slaughter, less lung lesions **Producers' association:** ✓ customer retention and winning of new customers ✓ reputation ✓ active strategy for reducing antibiotics

Example b): Alliance between raw material suppliers - feed producers - coordinating office

An alliance between raw material suppliers, feed producers and the coordinating office has existed since almost three years and has been founded after the dioxin crises resulting from dioxin contamination of feed and consequential dioxin residues in food products. The alliance combines 560 raw material suppliers delivering to 17 medium-sized as well as cooperatively organised compound feed manufacturers and the central coordinating office organising as well as administering the alliance comprises two employees (Figure 6.3; Table 6.2).

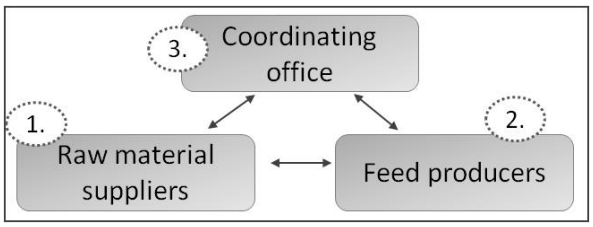


Figure 6.3: Example of alliance between raw material suppliers, feed producers and a coordinating office

The aim of the alliance is to achieve an even closer surveillance of the quality capability of suppliers in the feed industry to ensure feed safety. The inspections of the alliance include risk oriented supplier rating of the raw material suppliers, specification of the listed products and on-site supplier audits.

A key element of the system is the database which bundles information on compound feed manufacturers, raw material suppliers and product as well as trade relations. The complete capture of product and supplier relations in the database enables a rapid response of the alliance members in cases of emerging problems. In the database the coordinating office and feed manufacturers have access rights, however, the suppliers do not currently have access. The compound feed manufacturers insert information about their suppliers regarding their processes, products and problems as well as rejections of deliveries into the database. Around 270 products are registered and listed in the system.

A risk oriented evaluation of listed products in the system is performed by the advisory board comprising ten feed producers. The basis for this evaluation is a product data sheet, the Feed Safety Data Sheet (FSDS). FSDSs are send (per Email/mail) to the raw material suppliers listed in the system. The suppliers complete the forms for their products which they deliver to compound feed manufacturers and return them to the coordinating office.

The suppliers submit detailed information on the risk oriented aspects of their products. Besides presenting the in-house HACCP concept, the raw material suppliers shall provide details of their product specific hazard identification and risk assessment as well as their substantiated control measures in the FSDS. These include identification of product, a description of the manufacturing process, the feed materials and the logistical path, information on shelf-life and product labelling. Depending on the recorded product, product specific monitoring parameters regarding chemical, physical and microbial hazards have to be presented.

The risk oriented assessment of the suppliers which are listed in the system is done by a daily check of the GMP+ certificate status, the capture and evaluation of complaints as well as the conduct of on-site supplier audits by means of a self-organised risk oriented checklist. The check of the QS certificate status is planned. Currently members use the information provided via database for their individual supplier assessment and the selection of raw material suppliers in their companies.

Based on the aforementioned information, suppliers are audited in a risk oriented way, auditing first suppliers with high risk class products and conspicuousness in deliveries.

Table 6.2: Distribution of responsibilities/tasks as well as efforts/benefits in example b)

Responsibilities and tasks	
Raw material suppliers: - complete feet safety data sheet (FSDS) and send it to coordinating office **Compound feed manufacturers:** - insert information into database (product- and supplier relations, informations regarding raw material suppliers and purchased raw materials; complaints; rejected deliveries) **Coordinating office:** - coordinates collaboration with raw material suppliers regarding FSDS (sends sheet via Email/mail; inserts sheet information into database) - manages maintenance of database, administers data and disseminates data to compound feed manufacturers - organises supplier audits - checks on GMP$^+$ certificates, acquired complaints, notifications of rejected deliveries	
Cost/efforts	**Benefits**
Raw material suppliers: – time for audit and FSDS sheet **Compound feed manufacturers:** – fee for AFS membership – time and personnel to insert data into database **Coordinating office:** – organisational effort for audits – maintenance of data base	**Raw material suppliers:** ✓ fewer customer audits **Compound feed manufacturers:** ✓ extended information on suppliers and supplier rating ✓ fewer audits at supplier companies ✓ Increased safety of purchased products **Coordinating office:** ✓ membership fees ✓ product safety

Example c): Alliance between animal suppliers - slaughterhouses - semi-public service provider

The alliance in this case jointly performs the risk oriented meat inspection for health and safety marking of the carcasses intended for human consumption. The risk oriented meat inspection implies a simplified inspection of meat carcasses without incision, also called visual meat inspection. Only animals and carcasses from diseased animal populations with potential risks for food safety are inspected in an extended way.

In this alliance the farmers register for the risk oriented meat inspection and provide food chain information for risk assessment of the risk situation. The official veterinarian at the slaughterhouse performs the ante- and post-mortem inspections. Data collection, management and provision of work instructions are performed by a service provider. The service provider is semi-public as it falls under the charge of a German ministry and functions as coordinator (Figure 6.4, Table 6.3).

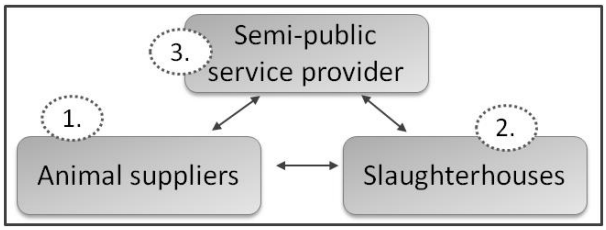


Figure 6.4: Example of alliance between animal suppliers, slaughterhouses and a semi-public service provider

Compared to the previously described cases a) and b) this inspection is prescribed by European legislation: mainly directed by Regulation (EC) No 854/2004 as well as by Regulation (EC) No 2074/2005 amended by Regulation (EC) No 1244/2007. It is facultative to participate in the risk oriented meat inspection, but if the farmers register, they as well as the slaughterhouses and the service providers (if applicable), have to fulfil certain requirements.

The basis for the decision about the approval for the risk oriented meat inspection requires the participation of the farmers in a quality assurance system like QS, provision of food chain information by the animal suppliers, results of previous meat inspections of the last six months, provision of results of the salmonella categorisation, provision of the results of animal inspections.

The service provider is partially funded by state resources. Costs are proportionally paid through carcass classification by slaughterhouses and service provider. The slaughterhouse pays a fee for visual examination according to specific cases. Farmers have no direct costs, but least benefit as well.

Table 6.3: Distribution of responsibilities/tasks as well as efforts/benefits in example c)

Responsibilities and tasks	
Animal suppliers: - register for risk oriented meat inspection - provide food chain information **Slaughterhouses:** - validate food chain information, perform risk assessment, adapt inspection procedure according to the risk - slaughter in a risk oriented way **Semi-public service provider:** - performs data capture, processing, storage and data provision - provides work instructions for e.g. veterinarian at slaughterhouse - provides modules for e.g. delivery management	
Cost/efforts	**Benefits**
Animal suppliers: – effort to provide food chain information **Slaughterhouses:** – pay risk oriented meat inspection **Semi-public service provider:** – provides database – coordinates inspection – data management – partially pays database	**Animal suppliers:** ✓ receive valuable information on quality parameters for improved animal management ✓ can build pools of slaughter animals for targeted delivery ✓ potentially incentives from slaughter house for low risk animals **Slaughterhouses:** ✓ better planning of slaughter as risk of animals is known and batches are separated according to risk (high risk animals are slaughtered after low risk ones) ✓ in the long run improved health of animals for slaughter ✓ use of provided work instructions, delivery management ✓ potential cost advantages by succeeding stage for more safe products **Semi-public service provider:** ✓ improved quality of meat and meat products ✓ availability of valuable product data

Example d): Alliance between food manufacturer – food trade company – intermediate storage

The alliance of the cold chain between a food manufacturer, a food trade company and an intermediate storage firm (Figure 6.5), performs inspections of temperature monitoring of meat. As a result, the specific temperatures of meat products have to be adhered to, as otherwise the shelf-life and quality of the meat products would deteriorate.

Temperature monitoring is performed by the food manufacturer in company-internal processes until the point of intermediate storage. Information regarding this temperature control is not transferred to the storage or to the food trade company. Starting from there the storage-stage assumes temperature monitoring of the ambient temperature. For the last transportation step from intermediate storage to the food trade company an external logistics company is commissioned assuming responsibility for the product and temperature monitoring. During this transport step the temperature is documented with temperature recorders ("data loggers") integrated in the delivery vehicle. The temperature record of the loggers, the data log, is printed upon arrival at and handed over to the trade company. The product temperature is inspected in spot checks at the incoming goods control of the food trade company. In case of elevated temperature, the sample size for measuring the product tem-

perature is adapted. The logistics company receives notification in this case. Generally information is not transferred back to storage and manufacturer.

The food trade company can better plan distribution using temperature profiles. Responsibilities and tasks are distributed between partners as required by law to maintain specific temperatures in particular cold chains. However, proper collaboration does not take place in this particular alliance as every partner tends to perform individual inspections without data exchange.

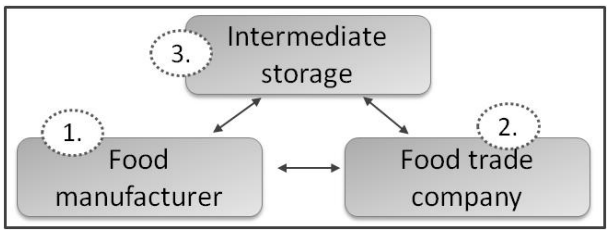


Figure 6.5: Example of alliance between food manufacturer – food trade company – intermediate storage

Table 6.4 depicts distribution of the responsibilities, tasks and efforts, costs and benefits for example d).

Table 6.4: Distribution of responsibilities/tasks as well as efforts/benefits in example d)

Responsibilities and tasks	
Food manufacturer: - precooling of products and shipping to intermediate warehouse, temperature control within this step **Food trade company:** - order, storage, selling of products, distribution, delivery to end customer, temperature control during storage and transportation **Intermediate storage:** - cold storage of meat, distribution, keeping product temperature	
Cost/efforts	**Benefits**
Food manufacturer: – temperature monitoring of chilling rooms (data loggers have to be read out manually – time consuming, data management), temperature monitoring during transportation to intermediate storage (monitoring system of cooling truck) **Food trade company:** – costs for infrared thermometer (for product temperature, time consuming) and for monitoring of environmental temperature **Intermediate storage:** – temperature monitoring of whole storage (including other products)	**Food manufacturer:** ✓ proof of temperature control towards storage and customer and official food control **Food trade company:** ✓ improved planning of distribution according to temperature profiles ✓ with data loggers information that temperature has been controlled and cold chain has been uninterrupted during delivery **Intermediate storage:** ✓ proof of temperature control towards customer and official food control

An overview of the four case studies is given in Table 6.5, where the cases are further characterised.

Table 6.5: Characteristics of the individual case studies used for testing the proposed scoring model

Characteristics / Example	Sector	Number of firms	Company form	Inspections
Example a) **Alliance partners:**	Pork production			Voluntary inspections: health monitoring, on-farm audits, blood tests on pathogens
1 Piglet producers, pig fatteners		900, 1600	Cooperative	
2 Slaughterhouses		3	Private, cooperative	
3 Producers' association		1	Cooperative	
Example b) **Alliance partners:**	Feed production			Voluntary inspections: supplier rating, on-farm audits
1 Raw material suppliers		560	Private, cooperative	
2 Feed manufacturers		17	Cooperative	
3 Coordinating office		1	Cooperative	
Example c) **Alliance partners:**	Meat production			Obligatory inspections: meat inspection
1 Animal suppliers		30.400	Private, cooperative	
2 Slaughterhouses		40	Private, cooperative	
3 Semi-public service provider		1	Semi-public	
Example d) **Alliance partners:**	Meat cold chain			
1 Food manufacturer		1	Private	Obligatory inspection: temperature monitoring
2 Food trade company		1	Private	
3 Intermediate storage		1	Private	

Each alliance differs in the amount and type of the companies forming the alliance partners. Some partners are exclusively private companies, some cooperative and in example c) a semi-public partner is involved. Furthermore, the inspections vary with respect to obligatory or facultative forms.

6.4 Results and discussion

6.4.1 Scoring model for alliances implementing mutual and risk oriented inspections

At the top of the scoring sheets the main principles of the AMOR approach are described briefly as an introduction to the scoring procedure. The scoring system itself comprises two parts. The first section provides space to insert the partners of the assessed alliance and the kinds of risk oriented inspections that the alliance performs. The sheet also allows space to state the position held by the interviewee (position 1: supplier, position 2: customer or position 3: third partner). Furthermore, the interviewee shall insert a self assessment of the AMOR capability of their particular alliance, expressed as a percentage.

The second part of the score sheet comprises 20 statements which the alliance has to rate on a scale from 0 to 5, indicating their assessment of the competence of their alliance with regard to AMOR (Table 6.6).

Table 6.6: Scoring system rating scale and statements

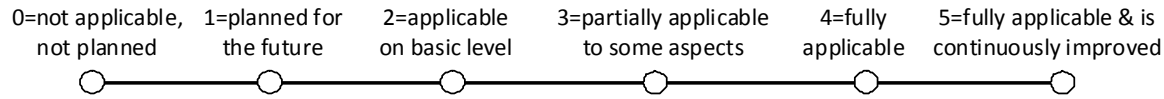
0=not applicable, not planned	1=planned for the future	2=applicable on basic level	3=partially applicable to some aspects	4=fully applicable	5=fully applicable & is continuously improved
					

1. The inspection is jointly organised between supplier and customer (and third partner)
2. Partners of the alliance mutually decide on inspection details (e.g. test parameters, type of sampling, inspection frequency, location, plan, allocation of inspection costs, interpretation of inspection data)
3. Commitment of all alliance partners to exchange results and product information with each other is given
4. Inspection frequencies and sample size are adapted on a case-by-case basis
5. Risk status of the product is assessed before the inspection
6. Adjustments to inspections in response to different hazards
7. Each alliance partner has defined responsibilities regarding the inspections
8. Each alliance partner has defined tasks regarding the inspection and implements these in the interest of the alliance
9. All alliance partners are actively involved in the implementation of the mutual inspection strategy
10. Responsibilities and tasks are laid down in written agreements
11. There is a joint database which the alliance partners use
12. Timely information is available to the necessary extent for all partners of the alliance
13. Product information flows from supplier to customer (and third partner)
14. Product information flows from customer to supplier (and third partner)
15. All partners obtain the inspection results
16. Defined pre-information about products/company of origin is available prior to inspection
17. Inspection results improve planning of business and production processes in the companies of the alliance
18. Each alliance partner has efforts related to the mutual inspection strategy (e.g. time, fees, personnel, material)
19. Each alliance partner has benefits from the mutual inspection strategy
20. Correspondence between effort versus benefit to each partner is identifiable

The rating points (0 to 5) are further characterised for each statement to enable the interviewee to unambiguously allocate points for each statement and to allow comparability between different results. Additionally, to characterise the organisation of the alliance inspections as well as identifying strong and weak points regarding AMOR aspects, the interviewees shall justify their allocated rating for each statement. An example of the scoring system is shown in Table 6.7. The complete scoring form is attached in Appendix B.

Table 6.7: Example of the scoring system

1. The inspection is jointly organised between supplier and customer (and third partner)



0=not applicable
1=is planned for the next 12 months
2=some individual aspects of the inspections are jointly organised
3=most inspections are to a good extent jointly organised
4=the inspections are jointly organised, the alliance partners are involved in equal parts
5=the joint organisation is fully implemented and follows a continuous improvement process (CIP)

Justification: _

With this scoring scheme a total score of 100 points can be achieved. Based on the overall score a classification of the alliance into five categories has been established providing measures for further improvement of the alliance inspections regarding AMOR principles (Table 6.8).

Table 6.8: Categories of alliances based on overall score

Categories	Category name	Strategies for advancement
1. 81-100 points	AMOR professional	AMOR principles are fulfilled and additionally integrated in a continuous improvement process.
2. 61-80 points	AMOR expert	AMOR principles are to a great extent implemented. Points where AMOR principles are only weekly adhered to shall be improved and a continuous improvement process started.
3. 41-60 points	AMOR beginner	The organisation of the inspection has to be revised and points where AMOR principles are only weekly adhered to have to be viewed and reorganised.
4. 21-40 points	AMOR uncoordinated	The inspection has to be restructured and planned aspects have to be implemented and the alliance newly scored.
5. <20% points	non-AMOR	The inspection has to be newly organised to full extent according to AMOR principles in four areas to become an AMOR inspection.

According to the presented scoring system the four previously described alliances have been scored to investigate where, and to which extent, AMOR procedures can be found in these alliances.

6.4.2 Four examples of alliance assessment using the scoring system

Alliance between farmers, slaughterhouses and producers' association as netchain coordinator

First the alliance between farmers, slaughterhouses and producers' association has been scored (Figure 6.6). Weak points exist regarding the frequency of inspection and sample size on a case-by-case basis as both aspects in the example are determined and are then effective for a certain period. Only in exceptional cases frequency and sample size are changed from the plan. Another weak point is the effort-benefit relation which is unequally distributed between partners.

Alliance between raw material suppliers, feed producers and the coordinating office

The second testing case involved an alliance between raw material suppliers, compound feed manufacturers and a coordinating office. The scoring of this particular alliance is shown in Figure 6.6. The overall weakness of the alliance is the poor integration of raw material suppliers into the system resulting in a very low score in questions 18 and 20, as cost and effort lie mainly with the compound feed producers and the coordinating office as well as the benefits. A low score is also achieved in questions 6, 10 and 14. These low scores reflect that raw material monitoring is only being planned, inspection frequency and sample sizes will be adapted and responsibilities and tasks will be laid down as well as product information flow from customer to supplier.

The alliance plans to open up towards suppliers in the near future and is developing a new inspection task, raw material monitoring. For these reasons, the alliance should be reassessed after restructuring has been performed and after the implementation of the new material monitoring task.

Alliance between animal suppliers, slaughterhouses and semi-public service provider

The alliance between animal suppliers, slaughterhouses and a semi-public service provider is in contrast to the other examples. This alliance is dominated by legal regulation making precise and strict provisions on the organisation of the inspection. With this precondition, most AMOR principles are fulfilled, e.g. tasks, responsibility and information management as required by law. The continuous improvement process is limited and unclear as the alliance is not fully guided as to procedures for improvement (improvements only takes place if demanded by legal requirements). The slaughterhouse is the dominant actor in this alliance due to its active involvement in performing the actual inspection.

Alliance in the cold chain between food manufacturer, intermediate storage and food trade company

The alliance in the cold chain between food manufacturer, food trade company and intermediate storage only weakly adheres to AMOR principles as inspections on temperature monitoring are not mutually well organised. Furthermore, information exchange between alliance partners rarely occurs. A more intensive collaboration is intended for the future, but has yet to be developed.

An overview of the distribution of points in the scoring scheme of all cases is given in Figure 6.6.

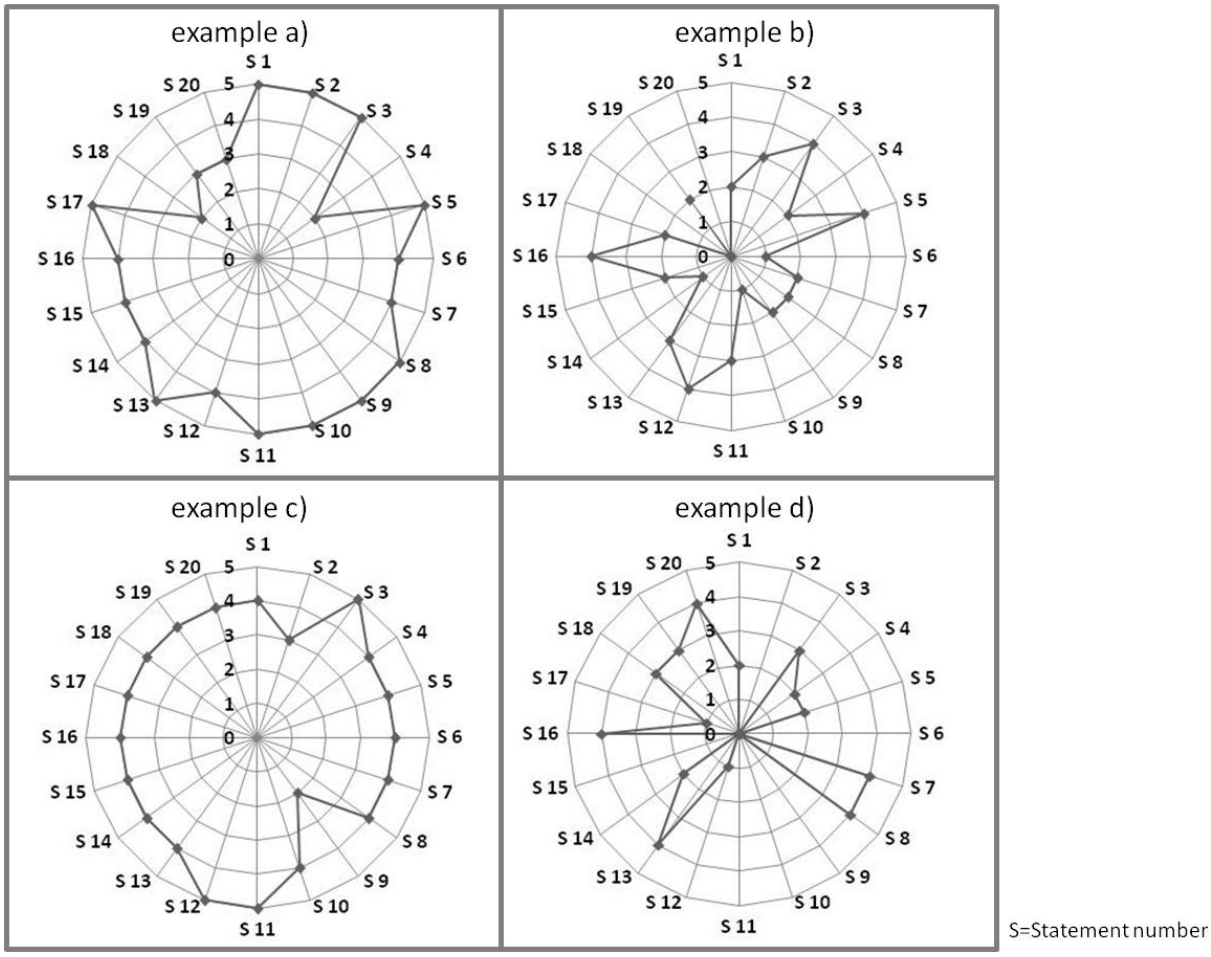


Figure 6.6: Scoring of alliances a, b, c and d based on interviews with alliance partners

Figure 6.6 clearly reveals the difference in the level of adherence to AMOR principles in the different cases which have been investigated. Example a) and c) have a relatively stable adherence at a high level whereas example b) and d) vary significantly in the implementation of different principles.

Table 6.9 provides information on the self-estimate of the interviewees on the “AMOR ability” of the alliances, the achieved total scores and scoring categories.

Table 6.9: Achieved categories of the scored alliances

Results / Example	Self-estimated score [%]	Achieved total score[points]	Scoring category [1-5; category name]
a)	100	84	1 AMOR professional
b)	35	44	3 AMOR beginner
c)	70	80	2 AMOR expert
d)	30	39	4 AMOR uncoordinated

Self assessment of the interviewee regarding ability of the alliance in adopting AMOR principles prior to answering the question has been assessed. The alliances all have estimated their level reasonably accurately, knowing their weak points in the implementation. The alliance of example a) could be scored as an AMOR professional and c) as an AMOR expert. The weaker alliances are b) as beginners and d) as uncoordinated.

Strategies and recommendations

Based on the scoring results of the four case studies different strategies have to be pursued to advance AMOR adoption regarding inspection design, tasks and responsibilities, information and communication structure as well as the distribution of costs/efforts and benefits:

Alliance a)

An AMOR professional ranking generally can focus on continuous improvements to processes. The alliance shall especially aim at advancing adaption possibilities of inspection frequency and sample size and achieve a more equitable distribution of effort and benefits between the partners.

Alliance b)

An AMOR beginner rating requires much greater effort for restructuring the inspections. The partners shall particularly concentrate on the distribution of the efforts on all alliance partners and the correspondence between effort versus benefit of each partner. Additionally the planned activities: the adjustment in response to hazards, written agreements of responsibilities and tasks and product information flow from customer back to the supplier shall be implemented as planned.

Alliance c)

An AMOR expert rating shall integrate the efforts into a continuous improvement process and shall more actively integrate all partners into the implementation of the mutual inspection strategy and enforce a mutual decision on the inspection details. Information flow and cost/benefit distribution needs to be continually monitored to ensure the alliance achieves greater efficiency.

Alliance d)

An AMOR uncoordinated ranking indicates a very low adoption of AMOR principles in the alliance. Such an alliance has a very limited flow of information. The alliance is likely to be inefficient through such practices as not aligned product inspections between successive stages. For an AMOR uncoordinated alliance to advance it requires a committed strategy to revise the organisation of the alliance and to reinforce stronger collaboration and mutual decisions as well as to implement planned activities.

6.5 Conclusion

The scoring system proposed here to assess alliances organising mutual and risk oriented inspections has been established and has been tested on four alliances from the agri-food sector.

The tests have revealed that different degrees of application of AMOR principles exist in the four examples and different areas of weaknesses in implementation could be shown. Based on the achieved scoring category the alliances shall pursue specific strategies to advance the adoption of AMOR principles and to continue to reduce the weak points.

A more extensive investigation of a larger number of alliances should be performed. For example, in the trade of frozen bakery products as well as fruit and vegetable wholesale, examples for the application of AMOR principles are known. A broader scope will widen the perspective of the concept and potentially allows adaption to the principles. By studying more practical examples, the composition of the scoring model could be refined to best categorise particular alliances.

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7. Conclusions and future work

7.1 Introduction

Transparency in agri-food supply chains depends on communication and information exchange (Schiefer and Deiters, 2013). In this context, much of the information required by producers, processors, intermediaries, consumers, and government is already available at some stages. However, up to and including the present, information has not flowed in a closed loop through all of the relevant chain actors (Branscheid, 2002). Data capture is often carried out in parallel to processes in the individual stages, so the collected data is only available horizontally for this stage (Branscheid, 2002). To improve this situation the collaboration and coordination of activities is required between supply chain entities to increase information sharing and accessibility. A method for improving supply chain efficiency and improved information flow is to perform inspections jointly with a greater number of supply chain stages, to enhance the mutual benefit to each stage.

With regard to the mutual inspections, an adaption of the control to match the actual quality situation is valuable if a product is bought for an extended time period in larger quantity (Pfeifer, 1993). In this case the intensity of inspection is greater or smaller than in normal inspections (Leonhard and Naumann, 2002). Adaption of the inspection can be oriented towards risks with greater or smaller likelihoods according to the risk of the product or batch. Risk orientation of specific inspections is anchored in European food legislation, for example regarding the official control of food producing companies according to Regulation (EC) No 882/2004.

A combination of both, collaboration between supply chain stages regarding inspections and risk orientation of these inspections has been proposed with the AMOR model (**A**lliances for the **M**utual **O**rganisation of **R**isk oriented inspection strategies) (Petersen and O'Hagan, 2014; O'Hagan et. al., 2013; Lang and Petersen, 2012a, 2012b). The model describes the collaboration in a dyadic relation between supplier and customer potentially complemented by a coordinating partner for the purpose of a mutual inspection strategy according to risk oriented viewpoints. The approach includes the formation of an alliance between the collaborating partners and the exchange of inspection results as well as product information within this alliance.

7.2 Answers to research questions

The primary outcome of this thesis has been the development of the AMOR model (**A**lliances for the **M**utual **O**rganisation of **R**isk oriented inspection strategies). AMOR has been comprehensively defined and a complete characterisation of the principles of the concept is provided. Furthermore, practical applications of AMOR principles have been investigated and the extent of their implementation has been evaluated through case studies.

The thesis has made an additional contribution to the study of structures in an agri-food supply chain to determine actors coordinating quality management strategies as well as their activities on supply chain level. Based on the insights obtained through this evaluation, a model of chain coordination has been established.

Another goal of the work has been to analyse risk management systems in agri-food companies to determine their connection with quality management systems and to evaluate the organisational structure of risk management systems. This analysis has established whether risk management systems are used for risk oriented inspections in industry and whether collaboration with other supply chain stages regarding risk management is an existing practice. The aspects of risk orientation and collaboration are important aspects of the AMOR concept.

The research presented in this thesis is based on empirical studies including qualitative and quantitative online, personal and telephone interviews as well as focus group meetings with industry professionals. The main findings of the research will be summarised in response to the questions formulated in the Introduction chapter.

I. Do structures in the pork supply chain exist which facilitate the coordination and spread of quality management strategies in the supply chain? How can they be characterised?

In empirical analysis of case studies, structures for the coordination of quality management strategies in the pork producing chain could be found. A chain coordination model has been proposed for the coordination of individual activities concerning quality management. Three levels have been defined – normative, strategic and operational – to allocate actors according to their roles and responsibilities. The actors on the three levels are the chain quality board on the normative level, network coordinator on the strategic level and quality broker on the operational level.

The chain quality board can be occupied by actors who have an outstanding position in the supply chain. These actors are in charge of setting requirements for the quality management strategies and for strategic quality objectives of the supply chain. The network coordinators strategically set up, implement and support mechanisms for coordination. Quality brokers perform the controls of a quality management strategy and promote the strategy amongst the members of the supply chain to assure functioning of the strategies. The brokers mediate between the supply chain members as they usually are companies that are naturally in an intermediary position with access to supply chain members.

Results have shown that the existence of the coordinating actors in the different supply chains varies. This variation can be related to for example the degree of integration in the chain. In fully integrated chains like in China, one actor occupies the positions on normative, strategic and operational level.

The research has shown that the proposed chain coordination model will strengthen the competitiveness of European pork chains by making them more compatible under various

market conditions and relationships in pork supply chains. Furthermore, it can help chains to structure coordinating actors and implement coordination mechanisms for quality management strategies.

II. Are risk management systems in the supply chain connected to quality management systems? Are these systems used for the risk orientation of inspections and does collaboration with other supply chain members regarding risk management take place?

Based on survey results comprising 119 participants from industry it could be shown that quality and risk management systems are interconnected in agri-food companies. It has been found that risk management systems are mainly integrated into the quality management department. Further connections exist as risk management systems are largely based on quality management standards and as quality management methods are applied for risk analysis and assessment. Chronologically, risk management systems have been developed more recently than quality management. The implementation and certification of quality management standards has already occurred. It could be shown that when questioning quality managers, as in the survey, they are well equipped to additionally perform the tasks of risk management.

More than half of the interviewees (55%) stated that in their company the risk management system is used for the risk orientation of inspections. Hence, the majority of the companies perceives the option of risk orientation and takes advantage of their risk management system, including risk analysis for risk orientation of their company inspections.

Additionally 56 companies out of the 119 have affirmed that they collaborate with suppliers, and 47 firms collaborate with customers. These companies perceive that inter-company risk management provides a means of reducing vulnerability and risks in their supply chains.

III. How can AMOR be appropriately defined in the food sector? To what extent do AMOR principles already exist throughout industry?

The concept of AMOR comprises the formation of an alliance between supply chain stages in a supplier and customer relationship for mutual benefits. Collaboration in the alliance takes place through the joint organisation of quality inspections which are performed in a risk oriented manner.

The alliance has to determine the inspection strategy with its inherent elements in a joint effort. Determinations to be made comprise the organisational structure and risk oriented design of the strategy. Furthermore, the alliance has to set and record responsibilities and tasks for each alliance partner. Jointly an information and communication structure on how product information and inspection results are disseminated on time, has to be developed for a successful inspection strategy. Benefits as well as efforts and costs shall be allocated onto the partners to achieve a win-win situation for all participating companies. The entire inspection strategy shall be recorded and shall underlie a continuous improvement process. On a regular basis the strategy shall be mutually revised and improved.

In different food producing chains three basic forms of alliances have been detected in which AMOR inspections can be mutually organised. Category 1 applies when inspections are directly organised between one or more customer/s and one or more supplier/s. Category 2 extends category one by a third partner. The third partner is an independent authority which can be a netchain coordinator or an entity who liaises, for example, between one or more suppliers and a more powerful customer. The third party functions as a mediator to organise and perform the inspections for the other two partners and which is approved by the other parties. In this constellation it is important that the independent entity also benefits from the inspection. Category 3 surpasses the private industry and includes a semi-public or public authority as a third partner. In this alliance the public authority performs the inspection and provides the results to supplier(s) and customer(s).

The AMOR concept has been tested for practical applications in industry based on a survey amongst companies and a focus group meeting with industry professionals. Survey and focus group meetings had the objective of assessing the prevalence of AMOR aspects in practice and to find concrete application examples. It could be shown that the basis for AMOR inspections is given in practice. The majority of interviewees regard AMOR inspection strategies with risk orientation and mutual organisation as a possibility for their companies. The results show that examples of AMOR inspections can indeed be found to exist in the companies, including inspections such as on residues, packaging or animal health. The comprehensive implementation of AMOR, however, varies depending on company and sector and depends on different risk factors, different aspects of food production and dissimilar needs regarding AMOR inspections. It has been deduced from the results that within cooperatives, there already exists a strong foundation of trust and long-term relationship between actors. Both aspects lend themselves well to mutual AMOR inspections. These findings have provided a firm basis for the AMOR approach, which is clearly demanded in practice and can be seen as a trend in supply chains.

IV. What are the key parameters that need to be considered when developing a scoring scheme to determine the extent of AMOR adoption? How might the scoring scheme work in practice?

A scoring model has been developed based on the defined AMOR approach to investigate the extent of AMOR implementation in existing alliance inspections. To gain the necessary insight for this research question, a set of 20 statements has been generated. Scoring is performed by assessing the statements on a scale from 0 (=not applicable, not planned) to 5 (=fully applicable and is continuously improved). For each statement the points on the scale are explained for unambiguous assessment. The concept has been tested using four different examples of alliances in practice performing inspections while adhering to AMOR principles. It could be shown that the degree of implementation varies and different areas for improvement exist. None of the case studies have implemented the AMOR principles to their full extent, thereby offering ample room for improvement.

Figure 7.1 summarises the core research and lists key findings of the PhD thesis.

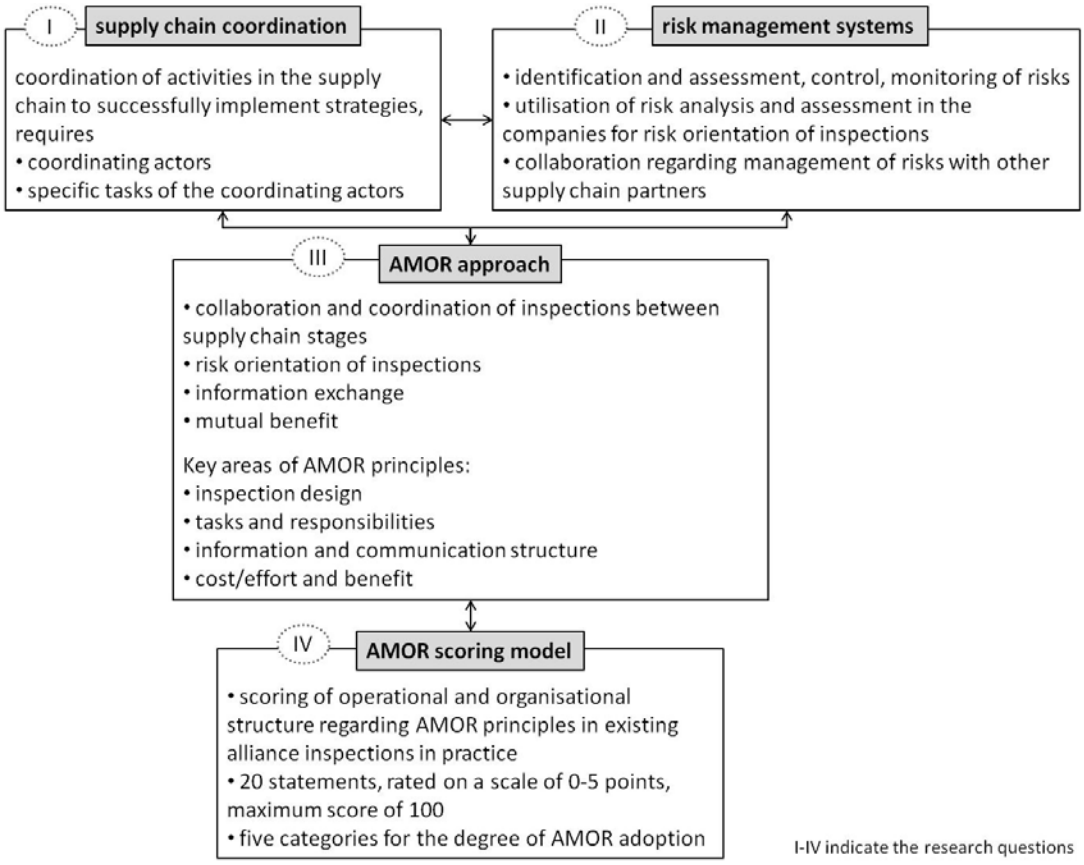

Figure 7.1: Work-flow diagram depicting core research focus and listing key findings

7.3 Recommendations for further research

This thesis has made a novel contribution to the field of supply chain coordination. It has developed a novel alliance framework under AMOR for the creation of a robust supply chain to reflect current industrial demands. AMOR, as has been shown, adheres to and advances supply chain trends, which industry acknowledge as being fit for purpose in a more dynamic and uncertain environment. To corroborate the model and to place it in context with respect to emerging trends, a risk assessment survey of agri-food supply chains has also been conducted. This thesis has contributed to the foundational proofs-of-concept for AMOR and supply chain coordination. However, further work is now required to refine the methodologies that will be required to achieve widespread implementation and adoption of the work proposed here.

Refinement of the model approach

(1) The chain coordination model in the pork supply chain could be tested and evaluated in pilot chains. By doing so the model can further be improved and refined. For example, actors and mechanisms for coordination in various pork supply chains can be further developed and additional actors and mechanisms might be identified. In this context, scientific methods should be revised to identify a suitable method to prove the validity of the established model.

Furthermore, guidelines should be designed to substantiate the tasks and responsibilities of the individual actors for the application of the model. A literature review of strategic management, quality management and information management should be performed, for example to find rules for composing a quality board as one of the coordinating actors. The quality broker concept should also be tested and simulated. Various supply chain scenarios should be analysed with respect to this role.

(2) The AMOR model is the result of case studies performed in a number of companies in Germany. Extensions can possibly be made by studying more companies and companies in other food sectors. Even more valuable would be an investigation of AMOR to other European and non-European countries. A broader scope will widen the perspective of the concept and potentially allows adaption to the principles. By studying more examples in practice, the definition of the comprised elements could be refined. Further examples can be used to good effect to refine the proposed scoring concept.

Varying focus point of alliance setting

During research the first and the final stages of the supply chain have not been studied in detail, namely upstream suppliers, food trade and bulk consumers. Further research should particularly expand in these directions. In the empirical studies and in the focus group meetings, the participants often mentioned specifically food retail as a problematic stage when it comes to information exchange and collaboration regarding inspections. Literature findings confirm that retailers dominate the supply chains in Germany and are trusted least in different agri-food supply chains (Leat et al., 2010). Retail up to this point has only been marginally included into the research of mutual and risk oriented inspections. Extensions in this direction might reveal valuable insights and confirmation of the estimate in literature, or might provide new insight as to the reasons for this. It might reveal applications of the AMOR concept as well for this stage.

Adopting a perspective for small and medium-sized companies

The concept of AMOR could especially be investigated for application possibilities for small and medium-sized enterprises. These companies require particularly supportive approaches and innovative concepts for growth and/or on the existence on the market in competition with bigger companies. Trust seems more pronounced in relationships involving small and medium-sized companies, which are characterised by the existence of personal relationships between the partners (Leat et al., 2010). It is expected that the AMOR model would provide specific chances for small and medium-sized enterprises, which are common in agri-food supply chains.

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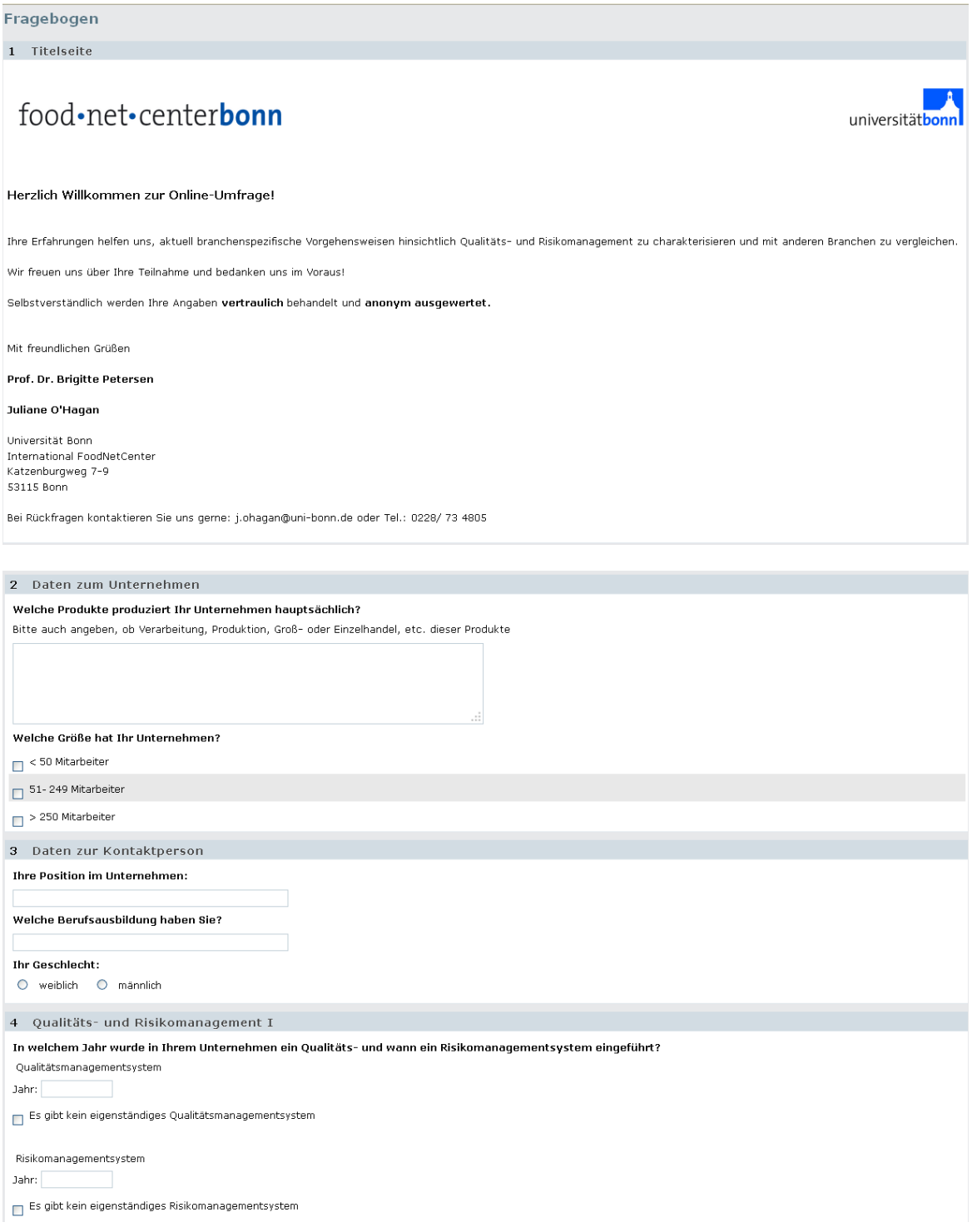
B Scoring scheme assessment sheet

A Questionnaire of the survey on quality and risk management (in German)



Fragebogen

1 Titelseite

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Herzlich Willkommen zur Online-Umfrage!

Ihre Erfahrungen helfen uns, aktuell branchenspezifische Vorgehensweisen hinsichtlich Qualitäts- und Risikomanagement zu charakterisieren und mit anderen Branchen zu vergleichen.

Wir freuen uns über Ihre Teilnahme und bedanken uns im Voraus!

Selbstverständlich werden Ihre Angaben **vertraulich** behandelt und **anonym ausgewertet.**

Mit freundlichen Grüßen

Prof. Dr. Brigitte Petersen

Juliane O'Hagan

Universität Bonn
International FoodNetCenter
Katzenburgweg 7-9
53115 Bonn

Bei Rückfragen kontaktieren Sie uns gerne: j.ohagan@uni-bonn.de oder Tel.: 0228/ 73 4805

2 Daten zum Unternehmen

Welche Produkte produziert Ihr Unternehmen hauptsächlich?

Bitte auch angeben, ob Verarbeitung, Produktion, Groß- oder Einzelhandel, etc. dieser Produkte

Welche Größe hat Ihr Unternehmen?

☐ < 50 Mitarbeiter

☐ 51- 249 Mitarbeiter

☐ > 250 Mitarbeiter

3 Daten zur Kontaktperson

Ihre Position im Unternehmen:

Welche Berufsausbildung haben Sie?

Ihr Geschlecht:

○ weiblich ○ männlich

4 Qualitäts- und Risikomanagement I

In welchem Jahr wurde in Ihrem Unternehmen ein Qualitäts- und wann ein Risikomanagementsystem eingeführt?

Qualitätsmanagementsystem

Jahr:

☐ Es gibt kein eigenständiges Qualitätsmanagementsystem

Risikomanagementsystem

Jahr:

☐ Es gibt kein eigenständiges Risikomanagementsystem

Wie definieren Sie Risikomanagement in Ihrem Unternehmen?

Was war der Grund für die Einführung eines Risikomanagementsystems?

- ☐ Rechtliche Vorgaben
- ☐ Vorgaben aus Standards/Normen
- ☐ Vorgaben von Kunden
- ☐ Krisen in der Ernährungswirtschaft
- ☐ Sicherung des Fortbestands des Unternehmens
- ☐ Sonstiges:
- ☐ Wir haben kein eigenständiges Risikomanagementsystem

5 Qualitäts- und Risikomanagement II

Gibt es eine eigene Qualitätsmanagementabteilung im Unternehmen?

○ Ja ○ Nein

Gibt es in Ihrem Unternehmen eine eigene Risikomanagementabteilung?

- ☐ Ja
- ☐ Nein, das Risikomanagement ist der Abteilung Qualitätsmanagement zugeordnet
- ☐ Nein, das Risikomanagement gehört zu folgendem/n Unternehmensbereich/en:
- ☐ Wir haben kein eigenständiges Risikomanagementsystem

6 Qualitäts- und Risikomanagement IIIa

Die Anforderungen aus welchen Normen und Standards haben Sie bei der Einführung Ihres Qualitätsmanagementsystems berücksichtigt?

Normen:

- ☐ ISO 9001
- ☐ ISO 22000
- ☐ Sonstige:

Standards:

- ☐ IFS
- ☐ BRC
- ☐ QS
- ☐ Sonstige:
- ☐ Wir haben kein eigenständiges Qualitätsmanagementsystem

Die Anforderungen aus welchen Normen und Standards berücksichtigen Sie aktuell beim Aufbau und der Weiterentwicklung Ihres Qualitätsmanagementsystems?

Normen:

- ☐ ISO 9001
- ☐ ISO 22000
- ☐ Sonstige:

Standards:

- ☐ IFS
- ☐ BRC
- ☐ QS
- ☐ Sonstige:
- ☐ Wir haben kein eigenständiges Qualitätsmanagementsystem

7 Risikomanagement IIIb

Die Anforderungen aus welchen Normen und Standards haben Sie bei der Einführung Ihres Risikomanagementsystems berücksichtigt?

Normen:

- ☐ ISO 9001
- ☐ ISO 22000
- ☐ ISO 31000
- ☐ Sonstige:

Standards:

- ☐ IFS
- ☐ BRC
- ☐ QS
- ☐ Sonstige:

- ☐ Wir haben kein eigenständiges Risikomanagementsystem

Die Anforderungen aus welchen Normen und Standards berücksichtigen Sie aktuell beim Aufbau und der Weiterentwicklung Ihres Risikomanagementsystems?

Normen:

- ☐ ISO 9001
- ☐ ISO 22000
- ☐ ISO 31000
- ☐ Sonstige:

Standards:

- ☐ IFS
- ☐ BRC
- ☐ QS
- ☐ Sonstige:

- ☐ Wir haben kein eigenständiges Risikomanagementsystem

8 Qualitäts- und Risikomanagement IV

Welche Methoden nutzen Sie für die Risikoanalyse und -bewertung?

- ☐ HACCP
- ☐ FMEA
- ☐ Ursache-Wirkungsdiagramm
- ☐ Risikomatrix
- ☐ Fehlerbaumanalyse
- ☐ HAZOP (HAZard and OPerability study)
- ☐ Sonstige:

Nutzen Sie Ihr Risikomanagementsystem, um Produkt-Prüfungen risikoorientiert zu gestalten?

- ☐ Nein
- ☐ Ja, zum Beispiel

Arbeiten Sie mit Kunden und/oder Lieferanten bezüglich des Managements von Risiken zusammen?

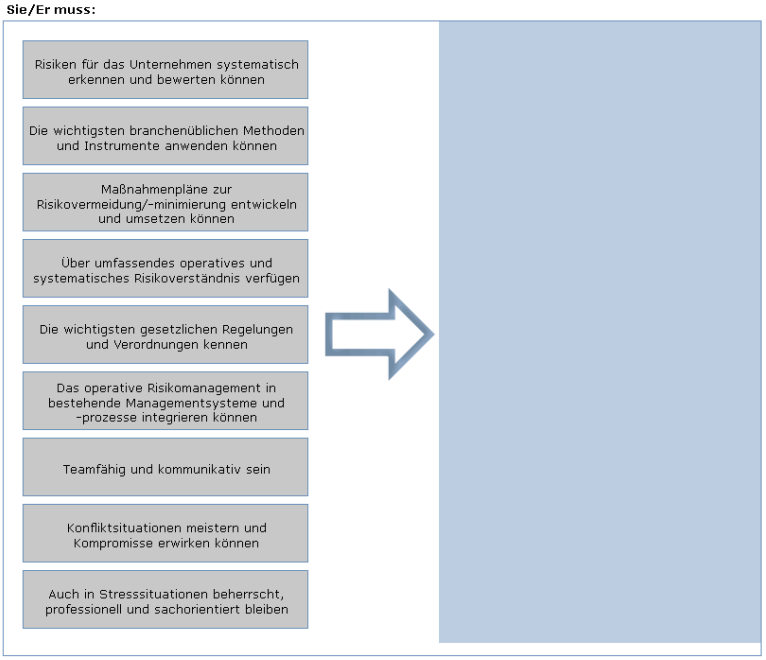
- ☐ Ja mit Lieferanten, zum Beispiel:
- ☐ Ja mit Kunden, zum Beispiel:
- ☐ Nein

9 Qualitäts- und Risikomanagement V

Welche Kompetenzen und Fähigkeiten sollten Personen im Risikomanagement haben?

Bitte wählen Sie aus und rangieren nach Wichtigkeit (oben= sehr wichtig; nach unten hin= abnehmende Wichtigkeit)

Sie/Er muss:



Weitere wichtige Kompetenzen und Fähigkeiten sind Ihrer Meinung nach:

10 E-Mailadresse

Bei Interesse an den Ergebnissen der Umfrage, geben Sie hier Ihre Emailadresse ein

11 Endseite

Herzlichen Dank für Ihre Teilnahme an der Umfrage!

Bei weiteren Fragen zur Umfrage und den Ergebnissen kontaktieren Sie uns bitte:

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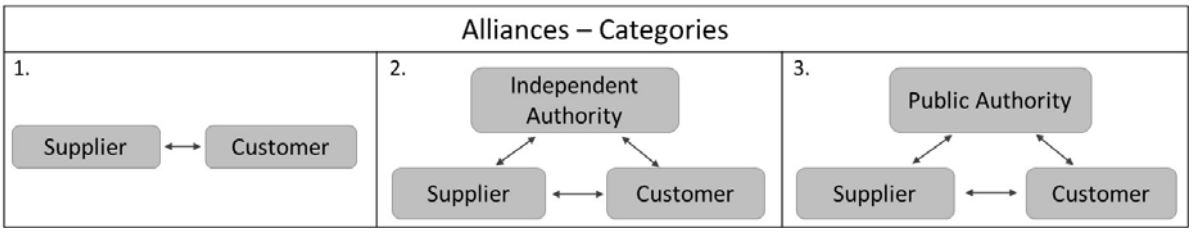
B Scoring scheme assessment sheet

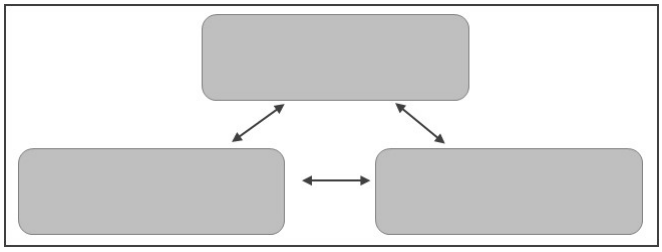
AMOR:

- Alliance (collaboration supplier and customer (and potentially independent third partner/(semi)public entity)
- Mutual organization of inspections in the alliance
- Risk oriented design of inspections
-

Three types of alliances:



The considered alliance:



List any risk oriented inspection which you perform: _____

From which position in the alliance do you answer (supplier, customer, third partner)?

_____

Self-assessment of the AMOR-capability of this alliance: _____%

Please tick the appropriate rating and provide a brief justification:

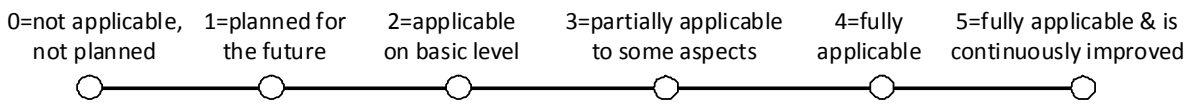
1. The inspection is jointly organised between supplier and customer (and third partner)

0=not applicable, not planned	1=planned for the future	2=applicable on basic level	3=partially applicable to some aspects	4=fully applicable	5=fully applicable & is continuously improved

0=not applicable
1=is planned for the next 12 months
2=some individual aspects of the inspections are jointly organised
3=most inspections are to a good extent jointly organised
4=the inspections are jointly organised, the alliance partners are involved in equal parts
5=the joint organisation is fully implemented and follows a continuous improvement process (CIP)

Justification: _

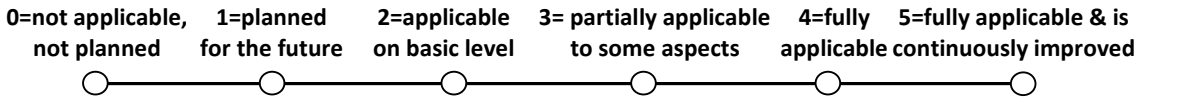
2. Partners of the alliance mutually decide on inspection details (e.g. test parameters, type of sampling, inspection frequency, location, plan, allocation of inspection costs, interpretation of inspection data)



0=not applicable
1=is planned for the next 12 months
2=one partner determines most inspection details
3=part of the inspection detail is jointly determined, part is determined by one partner
4=all inspection details are jointly determined
5=the inspection details are regularly reconsidered and follow a CIP

Justification: _

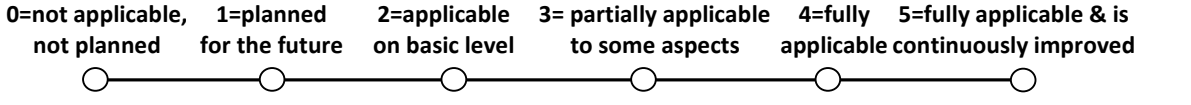
3. Commitment of all alliance partners to exchange results and product information with each other is given



0=not applicable
1=is expected for the next 12 months
2=one partner obtains results and information, but responds only with minimum disclosure
3=the commitment of the partners is evidently variable
4=the partners have the same commitment to pass on results and information
5=the partners continually determine important details and engage in full disclosure of relevant information

Justification: _

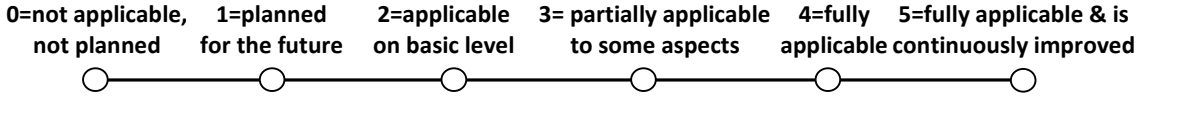
4. Inspection frequencies and sample size are adapted on a case-by-case basis



0=not applicable
1=is planned for the next 12 months
2=frequency/sample size are only adapted in exceptional cases
3=frequency/sample size are adapted for most inspections
4=frequency/sample size are adapted for each inspection
5=the inspection strategy related to frequency and sample size follows a CIP

Justification:_ _

5. Risk status of the product is assessed before the inspection

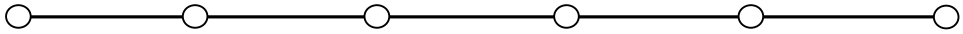


0=not applicable
1=is planned for the next 12 months
2=the risk status is only assessed in case of conspicuousness/crisis
3=the risk status is assessed in case of irregularities
4=the risk status is assessed in all cases
5=risk assessment follows a CIP

Justification:_ _

6. Adjustments to inspections in response to different hazards

0=not applicable, not planned | 1=planned for the future | 2=applicable on basic level | 3= partially applicable to some aspects | 4=fully applicable | 5=fully applicable & is continuously improved

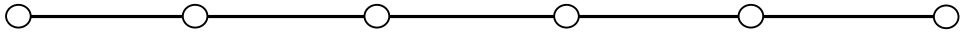


0=not applicable
1=is planned for the next 12 months
2=inspections are only adjusted in case of conspicuousness/crisis
3=inspections are adjusted in case of irregularities
4=inspections are always adjusted and tuned to different hazards
5=the modality of risk adjustment follows a CIP

Justification: _

7. Each alliance partner has defined responsibilities regarding the inspections

0=not applicable, not planned | 1=planned for the future | 2=applicable on basic level | 3= partially applicable to some aspects | 4=fully applicable | 5=fully applicable & is continuously improved

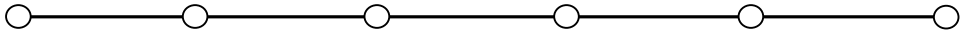


0=not applicable
1=is planned for the next 12 months
2=responsibilities are only defined for one partner
3=responsibilities are defined informally for all partners
4=responsibilities are defined contractually for all partners
5=definition of responsibilities follows a CIP

Justification: _

8. Each alliance partner has defined tasks regarding the inspection and implements these in the interest of the alliance

0=not applicable, not planned | 1=planned for the future | 2=applicable on basic level | 3= partially applicable to some aspects | 4=fully applicable | 5=fully applicable & is continuously improved



0=not applicable
1=is planned for the next 12 months
2=tasks regarding the inspections are partly implemented
3=tasks are mostly implemented
4=tasks are fully implemented reliably by all partners
5=assignment of tasks follows a CIP

Justification: _

9. All alliance partners are actively involved in the implementation of the mutual inspection strategy

0=not applicable, not planned | 1=planned for the future | 2=applicable on basic level | 3= partially applicable to some aspects | 4=fully applicable | 5=fully applicable & is continuously improved

0=not applicable
1=is planned for the next 12 months
2=strategy implementation lies with one partner
3=all partners are to a great extent involved in strategy implementation
4=all partners are involved in strategy implementation
5=planning and implementation of the mutual inspection strategy follows a CIP

Justification: _

10. Responsibilities and tasks are laid down in written agreements

0=not applicable, not planned	1=planned for the future	2=applicable on basic level	3= partially applicable to some aspects	4=fully applicable	5=fully applicable & is continuously improved
○	○	○	○	○	○

0=not applicable
1=is planned for the next 12 months
2=individual written agreements exist
3=main responsibilities and tasks are recorded in a written form
4=all responsibilities and tasks are recorded in a written form
5=the written agreements are documented and continually updated

Justification: _

11. There is a joint database which the alliance partners use

0=not applicable, not planned	1=planned for the future	2=applicable on basic level	3= partially applicable to some aspects	4=fully applicable	5=fully applicable & is continuously improved
○	○	○	○	○	○

0=not applicable
1=is planned for the next 12 months
2=there is a database, but some partners have very limited access rights to results and information
3=there is a database and all partners have access rights to a great extent
4=there is a database and all partners have full access rights to relevant information
5=the joint database is continually improved and extended in its functions

Justification: _

12. Timely information is available to the necessary extent for all partners of the alliance

0=not applicable, not planned	1=planned for the future	2=applicable on basic level	3= partially applicable to some aspects	4=fully applicable	5=fully applicable & is continuously improved
○	○	○	○	○	○

0=not applicable
1=is planned for the next 12 months
2=some relevant information is available in a timely manner information is timely available
3=most relevant information is available in a timely manner
4=all decision-relevant information is available
5=availability of information follows a CIP

Justification: _

13. Product information flows from supplier to customer (and third partner)

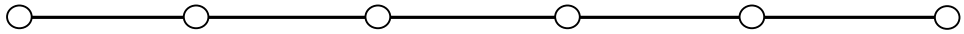
0=not applicable, not planned	1=planned for the future	2=applicable on basic level	3= partially applicable to some aspects	4=fully applicable	5=fully applicable & is continuously improved
○	○	○	○	○	○

0=not applicable
1=is planned for the next 12 months
2=basic information flows from supplier to customer
3=relevant information flows regularly from supplier to customer
4=full information exchange occurs with each delivery from supplier to customer
5=the information exchange follows a CIP

Justification: _

14. Product information flows from customer to supplier (and third partner)

0=not applicable, not planned — **1=planned for the future** — **2=applicable on basic level** — **3= partially applicable to some aspects** — **4=fully applicable** — **5=fully applicable & is continuously improved**

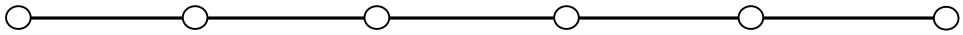


0=not applicable
1=is planned for the next 12 months
2=basic information flows from customer to supplier
3=relevant information flows regularly from customer to supplier
4=full information exchange occurs with each delivery from customer to supplier
5=the information exchange follows a CIP

Justification: _

15. All partners obtain the inspection results

0=not applicable, not planned — **1=planned for the future** — **2=applicable on basic level** — **3= partially applicable to some aspects** — **4=fully applicable** — **5=fully applicable & is continuously improved**

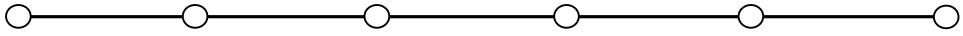


0=not applicable
1=is planned for the next 12 months
2=some inspection results are provided for all partners
3=most decision-relevant inspection results are provided for all partners
4=all decision-relevant inspection results are provided for all partners
5=the determination of the passing on of decision-relevant information follows a CIP

Justification: _

16. Defined pre-information about products/company of origin is available prior to inspection

0=not applicable, not planned — **1=planned for the future** — **2=applicable on basic level** — **3= partially applicable to some aspects** — **4=fully applicable** — **5=fully applicable & is continuously improved**



0=not applicable
1=is planned for the next 12 months
2=a basic minimum of pre-information is available
3=most relevant pre-information is available
4=all relevant pre-information is available for all partners

Justification: _

17. Inspection results improve planning of business and production processes in the companies of the alliance

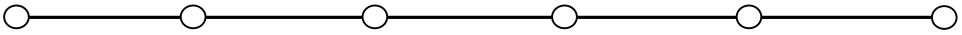
0=not applicable, not planned — **1=planned for the future** — **2=applicable on basic level** — **3= partially applicable to some aspects** — **4=fully applicable** — **5=fully applicable & is continuously improved**

0=not applicable
1=exploitation of inspection results for process improvement is planned for the next 12 months
2=process planning of the partner companies is slightly improved
3=process planning of the partner companies is substantially improved
4=process planning of the partner companies is definitively improved
5=the exploitation of inspection results for process improvement follows a CIP

Justification: _

18. Each alliance partner has efforts related to the mutual inspection strategy (e.g. time, fees, personnel, material)

0=not applicable, not planned — **1=planned for the future** — **2=applicable on basic level** — **3= partially applicable to some aspects** — **4=fully applicable** — **5=fully applicable & is continuously improved**



0=not applicable
1=is planned for the next 12 months
2=one partner contributes considerably greater efforts for the inspection
3=the partners generally have efforts which are variable in extent
4=all partners have benefit-related efforts (i.e., effort is proportional to benefit)
5=the definition of efforts for each partner follows a CIP

Justification: _

19. Each alliance partner has benefits from the mutual inspection strategy

0=not applicable, not planned — **1=planned for the future** — **2=applicable on basic level** — **3= partially applicable to some aspects** — **4=fully applicable** — **5=fully applicable & is continuously improved**

0=not applicable
1=is planned for the next 12 months
2=one partner achieves considerably lower benefits from the inspection
3=the partners generally have variable benefits
4=all partners have effort-related benefits
5=the statement of benefits of each partner follows a CIP

Justification: _

20. Correspondence between effort versus benefit to each partner is identifiable

0=not applicable, not planned — **1=planned for the future** — **2=applicable on basic level** — **3= partially applicable to some aspects** — **4=fully applicable** — **5=fully applicable & is continuously improved**

0=not applicable
1=is planned for the next 12 months
2=one partner has considerably more efforts than benefits with the mutual inspection
3=efforts do not correspond completely to the respective benefits
4=the efforts of all partners correspond to the benefits
5=the mutual effort-benefit estimation follows a CIP

Justification: _