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Modelling Enterprise Behaviour in a Food Regulation Environment

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A Decision Support System for Policy Makers

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A Decision Support System for Policy Makers

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Meinen Eltern

Preface

In 2008 I started working as a research associate at the Department for Food and Resource Economics, Chair for Business Management, Organization and Information Management at the University of Bonn. With the end of my PhD thesis a stage of life comes to an end, too, so that I want to say thank you.

Especially I want to thank Prof. Dr. Gerhard Schiefer for giving me the chance of three years experience in research as well as working on my PhD. By participating in an international research project, in national and international conferences and in the teaching assignments I was able to gain much experience. Prof. Schiefer's trust and overall support have helped me a lot. Furthermore I want to thank Prof. Dr. Thomas Heckelei as the second supervisor.

For this research expert interviews and surveys were of high importance. Thanks go to everybody who cooperated and so contributed to the final work.

I want to thank my colleagues, not only for discussing technical questions, but also for the great working atmosphere.

Finally, many thanks go to all my family, who supported me during this time as they did all my life.

Abstract

Modelling Enterprise Behaviour in a Food Regulation Environment – A Decision Support System for Policy Makers

Regulatory frameworks are a common tool in the EU food policy to achieve objectives on the society level, e.g. an increase in the society's health status. Analyses of potential consequences of regulatory frameworks are a basis for policy makers deciding on their implementation. To support policy decision making the thesis builds on an ex-ante approach considering the development path from a regulation via enterprises' behaviour to society consequences. Limiting the thesis' focus on modelling the enterprise behaviour towards regulations its objective is to generate a step-by-step approach for regulatory decision support in food policy and to transform this approach into a computer-based interactive system.

After a theoretical background the thesis presents a basis of an argumentation line that should lead to the requested results, i.e. the enterprise compliance behaviour. This hypothesis is specified and validated according to a decision scenario defined by two regulatory frameworks. A step-by-step approach for regulatory decision support is generated composed of two knowledge areas. (1) A sequence of arguments relying on expertise, and (2) a knowledge base backing up the arguments with modular data, relying on various sources. Of importance for decision aiding is transparency improvement and complexity reduction which is considered by the step-by-step procedure and the filter concept of each argument reducing the model scope.

The utilization of the step-by-step approach through field tests in the cereals industry of several EU countries approved the desired outcome and identified improvement potential. The improved model is translated into a decision support system. The user interface supports the utilization of the model by guiding the interaction between the sequence of arguments, the knowledge base, and the analyst, who has to make the specifications necessary to go from one step to the next. The decision support system presents to the policy maker the status quo of the compliance level, the potential increase through the regulatory framework and the lack in compliance based on the estimated behaviour of affected enterprise classes. The transparency of the system enables recommendations of specific changes in the regulatory framework or corrective policy actions.

Kurzfassung

Modellierung von Unternehmensverhalten im Umfeld von Lebensmittelrichtlinien - Ein Entscheidungsunterstützungssystem für Entscheidungsträger der Politik

Rechtliche Rahmenbedingungen sind ein gebräuchliches Instrument in der Lebensmittelpolitik der EU um Ziele auf Ebene der Gesellschaft zu erreichen, z. B. eine Verbesserung des Gesundheitszustandes. Analysen möglicher Folgen rechtlicher Rahmenbedingungen sind eine Grundlage für Entscheidungsträger bezüglich deren Umsetzung. Zur Unterstützung der politischen Entscheidungsfindung baut die Arbeit auf einem ex-ante Ansatz auf, der den Entwicklungspfad von einer Richtlinie über das Unternehmensverhalten hin zu gesellschaftlichen Konsequenzen berücksichtigt. Die Arbeit ist begrenzt auf das Modellieren von Unternehmensverhalten gegenüber Richtlinien mit dem Ziel einen Schritt-für-Schritt-Ansatz zur Entscheidungsunterstützung bezüglich Richtlinien in der Lebensmittelpolitik zu entwickeln und diesen in ein EDV-gestütztes interaktives System zu transformieren.

Anschließend an den theoretischen Hintergrund zeigt die Arbeit die Grundlage einer Argumentationskette, die zu dem gewünschten Ergebnis führen soll, d.h. das Umsetzungsverhalten von Unternehmen. Diese Hypothese wurde spezifiziert und bestätigt bezogen auf eine durch zwei Richtlinien definierte Entscheidungssituation. Ein Schritt-für-Schritt-Ansatz zur Entscheidungsunterstützung wurde entwickelt, bestehend aus zwei Wissensbereichen. (1) Eine Argumentationskette basierend auf Expertise, und (2) eine Wissensbasis, die die Argumente mit modularen Daten, beruhend auf unterschiedlichen Quellen, unterstützt. Zur Entscheidungsfindung sind eine Verbesserung der Transparenz und eine Reduktion der Komplexität von Bedeutung, was durch die Schritt-für-Schritt-Vorgehensweise und das Filterkonzept der einzelnen Argumente, das den Modellumfang verringert, berücksichtigt wird.

Die Anwendung des Schritt-für-Schritt-Ansatzes durch Feldtests in der Getreideindustrie verschiedener EU-Länder bestätigte das gewünschte Ergebnis und zeigte Verbesserungspotenziale auf. Das verbesserte Modell wurde in ein Entscheidungsunterstützungssystem übertragen. Die Benutzeroberfläche unterstützt die Anwendung des Modells durch Steuerung der Interaktion zwischen der Argumentationskette,

der Wissensbasis und dem Analysten, der die Angaben machen muss um von einem Schritt zum nächsten zu gelangen. Das Entscheidungsunterstützungssystem zeigt dem politischen Entscheidungsträger den gegenwärtigen Umsetzungsgrad, den potenziellen Anstieg durch die rechtliche Rahmenbedingung und die mangelnde Umsetzung auf, anhand des voraussichtlichen Verhaltens der betroffenen Unternehmensklassen. Die Transparenz des Systems ermöglicht Empfehlungen für spezifische Veränderungen in der rechtlichen Rahmenbedingung oder korrigierende politische Maßnahmen.

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List of Abbreviations

BRC	British Retail Consortium
DSS	Decision Support System
EC	European Commission
EU	European Union
EVA	Economic Value Added
FAO	Food and Agricultural Organization
GMP	Good Manufacturing Practice
ha	Hectare
HACCP	Hazard Analysis Critical Control Point
IFS	International Food Standard
ISO	International Organisation for Standardisation
IT	Information Technology
NACE	Nomenclature statistique des activités économiques dans la Communauté européenne
PDO	Protected Designation of Origin
PGI	Protected Geographical Indication
PI	Performance Indicator
SCP	Structure-Conduct-Performance
SME	Small and Medium Enterprise
TSG	Traditional Speciality Guaranteed
UK	United Kingdom
WHO	World Health Organization

1 Introduction

1.1 Introduction to the Research Problem

The increasing globalization of food trade and the harmonization of food standards and food safety measures have led to significant changes in the international and national regulatory frameworks for food. There is an increasing recognition of the need to integrate and improve regulatory activities among national and international bodies to protect human health and environment (VAPNEK, SPREIJ 2005). On the other hand, food policies are expanding to take account on food safety, food security and the human right to food. Therefore, an information system providing decision support is highly needed to increase success for food policy making.

The implementation of policy regulations is a common tool used to exert influence on the food safety status of society. In order to make decisions on the formulation and implementation of food safety regulations it is essential to have appropriate information on the possible effects regarding costs, benefits, impacts and similar indicators. The analysis of effects would need to focus on those issues that are of interest to policy involving broad topics like, e.g. public welfare, the environment, or the economy. In addition the analysis can also focus on effects related to specific groups like, e.g. enterprises or consumers. Different approaches for the provision of information for policy decision support have been carried out, such as e.g. cost-benefit analysis (TEVFIK 1996; BOARDMAN 2006; BRENT 2006) and impact assessment (RAU, WOOTEN 1980; DE VRIES 1999; OECD 2001; JACOBS 2007). All of them have been developed and discussed extensively in literature. The variety of approaches signals difficulties in the analysis and in the provision of information for policy decision support (FRITZ, SCHIEFER 2008). However, independent of the intensive discussion in literature and the huge need for policy decision support, there is little use of these approaches for ex-ante but more for ex-post policy decision support.

Instead this research elaborates a new framework for an ex-ante evaluation considering regulations' effects on enterprises and their behaviour as the basis of the regulations' effects on the society.

1.2 Multi-Level Approach and System Dynamics Thinking

In this context it is of specific relevance to differentiate between different levels of analysis, e.g. between the levels of society, the level of individual actors which might include enterprises, consumers, and others, and at a medium stage a level of sectors identified as the relevant groups of individual actors. On the lower level the focus is usually on individual enterprises, on the level of society the focus is on impact domains. Critical points are relationships between levels. Cases in point are activities in food safety and quality where consumers expect policy to guarantee food safety and at least a baseline quality, but where enterprises are responsible for food safety and quality. Each of the levels has different objectives and so requires a different approach of modelling the cause-and-effects relationships. The level of society builds on the classical analysis of monetary and non-monetary costs and benefits. Instead at the level of enterprises, the main focus is a monetary one. In the long run, for enterprises monetary benefits have to exceed monetary costs. The different views may have consequences for development paths. A classical cost-benefit study ignores the path towards the realization of policy objectives or the barriers that might prevent their realization, i.e. actions on the enterprise level. (FRITZ, SCHIEFER 2008)

To visualize the problem situation one can consider an example of tracking and tracing in the food industry. Policy inserts food regulations to meet the demands of the society for safe food, in this case by assuring tracking and tracing capabilities. For the individual enterprise, there can be major benefits from investment in tracking and tracing capability. But, it might consider potential benefits as low if it assumes that the probability of food safety failures in its own value chain is also low so that the investment cost outweighs the potential benefits, which creates an investment barrier for individual enterprises. However, at the sector level the view might be different. The probability of a food safety failure somewhere in the sector is much higher than that for an individual chain. For the sector as a whole the cost-benefit relationship is, therefore, different. If the sector as a whole is not able to act actively according to its interests, the individual investment barriers will prevent the sector to reach its objectives (FRITZ ET AL. 2008). Furthermore, as consequence of investing in tracking and tracing or any other requirement enterprises can entry new markets or exit markets. The number of enterprises in a sector can increase or decrease, as the balance of SMEs and large international enterprises may change. Taking a supply chain view, dominant chain stages may change into weak ones or they get even stronger. These changing situations may lead enterprises to re-think their decisions and take other actions. The actions taken by the

enterprises determine if the regulation's requirements are complied with or not. Consequently the demands of the consumers are met, partly met, or not at all met. Again the consumers have demands on the food and again it is policy's responsibility to speak up for the consumers.

This example demonstrates the importance of considering the multi-level approach as well as the dynamic interactions for analysing the problem situation. Following a short review on the multi-level approach as well as to system dynamics is given.

1.2.1 Multi-Level Approach

According to KLEIN ET AL. (1999) multi-level theories encompass the micro – macro divide. Multi-level theories describe some combination of individuals, businesses, corporations and industries. While the micro domain focuses on individuals and groups, the macro domain's focus is on organizations and the environment. The goal of multi-level research is to achieve a deeper and richer portrait of organizational life, e.g. the influence of individuals' actions and perceptions on the organizational context and vice versa. Referring to the research problem, here the modelling framework has to account for three different levels: (1) the level of society, which is called the macro level, (2) the level of individual actors, which includes mainly enterprises and which is denominated the micro level and additionally (3) the meso level which serves as a kind of link between the level of society and the level of enterprises. The meso level can be represented by an individual sector, e.g. the milk sector, or a given region within a country. If the sector level is seen as an aggregate of enterprise activities a separate sector analysis does probably not provide additional information. However, if the sector is seen as a group of enterprises its interests might be different from an individual enterprise and so have to be analysed separately (FRITZ, SCHIEFER 2008). Figure (1-1) underneath illustrates the multi-level approach, the level relationships and their effects.

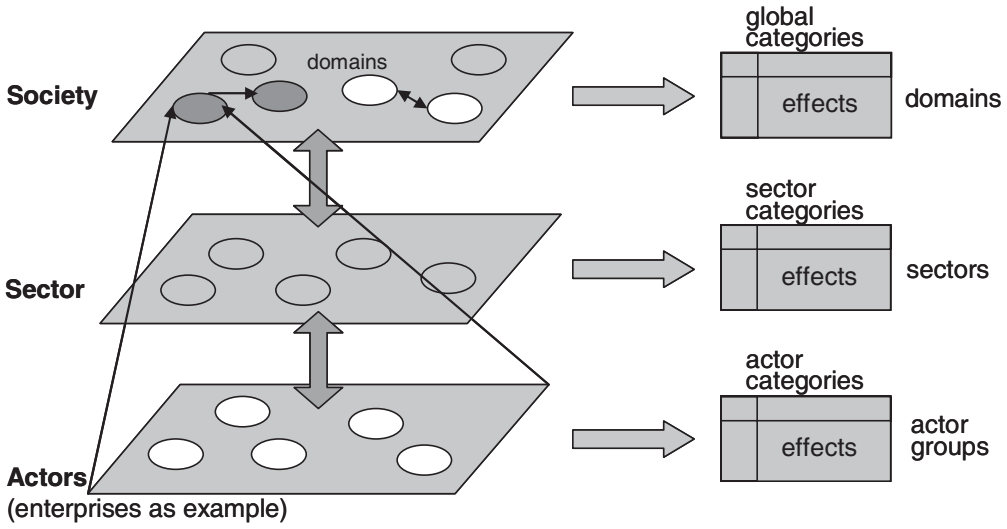

Figure 1-1: The multi-level approach (FRITZ, SCHIEFER 2008)

A theory spanning these levels of the organizational disciplines presents certain challenges. KLEIN ET AL. (1999) mention the following three main barriers. The first barrier of multi-level theory is the mass of potentially relevant theory available. There is a question of identifying what are the core elements to focus on. The second barrier is more subtle. It is a problem of interests, values, and heuristics. A multi-level approach asks for multi disciplinary knowledge. Nevertheless, micro-trained scholars may set priorities in a different way than macro theorists. The third barrier to the development of multi-level theory is the appropriate scope. Elaborating the interlinkages between the different levels it may make it difficult to find the appropriate middle ground to draw the right conclusions; i.e. neither overly simple arguments, nor overly complex arguments.

1.2.2 System Dynamics Thinking

System dynamics is an approach for analysing and solving complex problems with a focus on policy analysis and design. Initially called 'Industrial Dynamics' FORRESTER (1961, in ANGERHOFER, ANGELIDES 2000, p. 342) defines it as "the study of the information feedback characteristics of industrial activity to show how organizational structure, amplification (in policies), and time delays (in decision and actions) interact to influence the success of the enterprise. It treats the interactions between the flows of information, money, orders, materials, personnel, and capital equipment in a company, an industry, or national economy". LANE (1997, p. 1037) states that "social systems should be modelled as flow rates and accumulations linked by information feedback loops involving delays and non-linear

relationships. (…) The purpose is to learn about their modes of behaviour and to design policies which improve performance".

According to STERMAN (2000) a common tendency is to interpret experience as a series of events following each other one by one. In the event-oriented view every event has a cause, which in turn is an effect of some still earlier cause. As the problem is not isolated, but a system in a system it is not as simple as it seems. The system reacts to solutions, i.e. there is feedback. The results of an action define the future situation. Furthermore there are other agents in a system which may react to actions and so restore the upset balance. Actions can activate side effects, effects that are not anticipated in advance. Figure 1-2 visualizes the complexity of a non-isolated system with feedback of actions, so called side effects and other agents affecting the system.

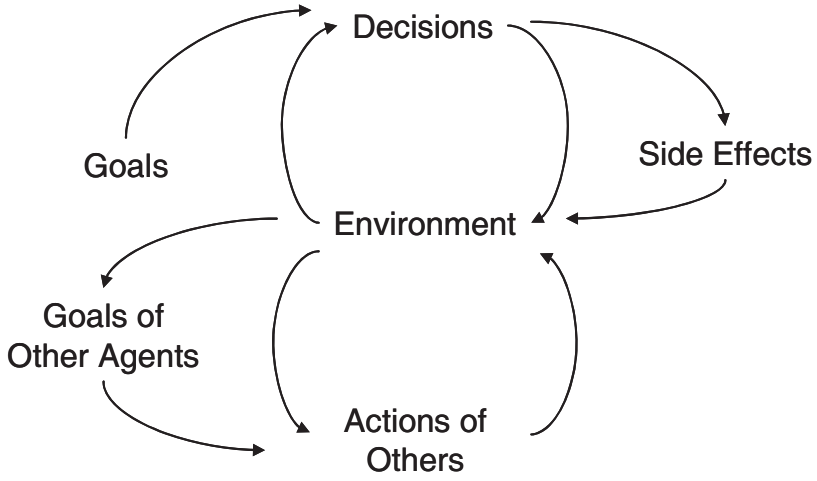

Figure 1-2: The feedback view (STERMAN 2000)

Complexity is often thought of as the number of components in a system or the combinations that has to be considered taking a decision, i.e. combinational complexity. Dynamic complexity instead does not have to have lots of different components. Dynamic complexity arises from the interactions of different agents over time (STERMAN 2000).

In this work the intention is not to present a detailed simulation model, but to understand the idea of System Dynamics, to project it onto the research problem and so to better understand the complexity of the interactions within and between the different affected levels. Based on the example given on tracking and tracing and the continuum of interactions between enterprises, chain stages, sectors and other actors, figure 1-3 visualizes the complexity of the research problem.

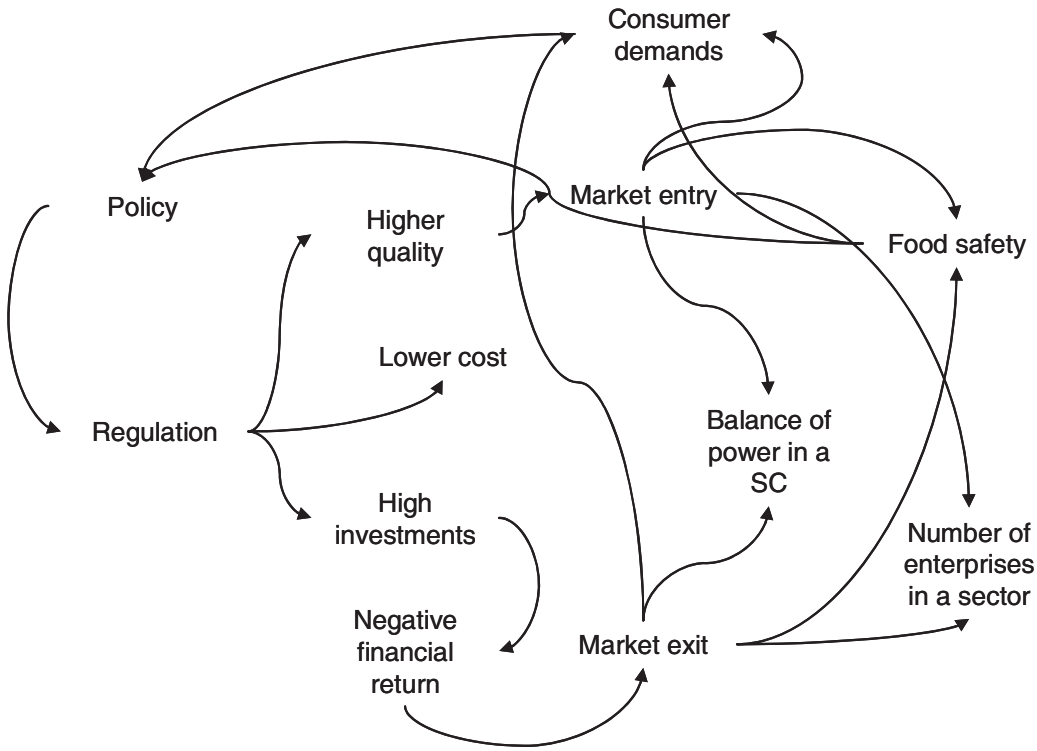

Figure 1-3: Example of system dynamics view

Because of these interrelated and dynamic relationships SPECTOR (2008) highlights this kind of problem scenario as 'dynamic, ill-structured problems'. These problems are characterised by their lacking well defined and complete specifications of outcome states, input conditions, and the processes involved in transforming the input to a possible output. The problem situation may change over time in ways that are not easily projected because there are often many interrelated time dependent factors and non linear relationships. Current conditions and problem constrains may not be completely specified or known (SPECTOR 2008).

1.3 Research Design

1.3.1 Research Objectives

As already explained in the research problem, evaluating a decision support system should help to increase the success in food policy making. Here there is the potential of the thesis.

In discussing the overall research problem the multi-level approach explained in section 1.2 can be build on by a model which distinguishes between a so-called horizontal process and a vertical process (figure 1-4).

- The horizontal process involves the arguments that describe the activities of enterprises within the scenario determined by the regulation.
- The vertical process involves the arguments that link enterprise activities with macro-economic impact domains like e.g. health, environment, trade and others.

So the logical pathway of the model moves from the regulation's requirements on the enterprise level to consequences on different domains at the society level by following the cause-and-effect relations. Underneath figure 1-4 adds to a simplified version of figure 1-1 the policy passing a regulatory framework to meet its objective on the society level.

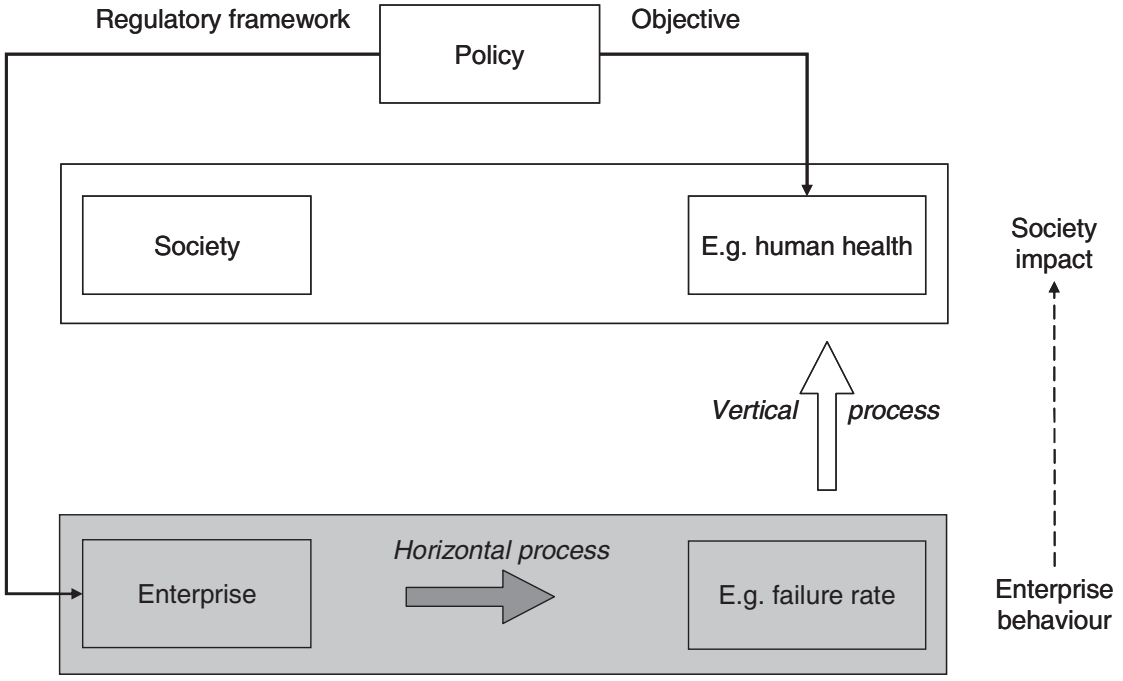

Figure 1-4: Differentiation of the horizontal and the vertical process

To define a clear boundary of the thesis the research is limited to the so-called horizontal process shown in figure 1-4; i.e. the enterprise level. The cause-and-effect relations caused by a food safety and quality regulation on enterprises in the European agri-food industry are under consideration.

The so called vertical process of the overall problem is the subject of another research, which works on a model calculating the impact on the society level as a consequence of the enterprise behaviour. The outcome of the model is a qualitative impact on several domains, e.g. public health, labour, and firm competition, in different levels of aggregation. To reach that goal the operational procedure consists on three steps for each single domain. First,

quantifying the magnitude factor, which correspond to the number of enterprises acting in the system. Second, finding the impact direction by analysing if the main causes, which affect each domain, will change positively, negatively or will not change in the future and so come up with a result for each domain. Third, aggregating the results of the single enterprise classes to the supply chain stage level, thereafter to the entire supply chain level, thereafter to the country level and finally to the EU level. (NOVELLI ET AL. 2011)

The research of this thesis focuses on developing an approach to model enterprise compliance behaviour in a food regulation environment. The **research objectives** are:

(1) to generate a step-by-step approach for regulatory decision support in food policy, and
(2) to transform this approach into a computer-based interactive system for decision support.

The basis should be a sequence of arguments that leads to the requested results. The different arguments are backed up by a knowledge base, which consists of available information linked to the arguments. Furthermore a computer-based interactive system presents the interface between the sequence of arguments, the knowledge base, and the user. The development of a computer-based scheme guides experts in the utilization of the model in decision support.

1.3.2 Research Method

The research method describes the actions taken from identifying the research problem to getting to the final conclusion. It guides through the research by explaining the logical steps following each other.

According to the sections above the overall problem is identified and the objective of the research is defined. It indicates the qualitative approach of this work. To gather theoretical background on the main points, literature was consulted in the fields of food quality and safety requirements and their relation to enterprises, strategic management dealing with enterprise behaviour, and enterprise performance measurement.

Based on the main theoretical ideas, i.e. an argumentation line explaining enterprise behaviour and the cause-and-effect relations between requirements, enterprise performance and enterprise compliance behaviour, the working hypothesis was elaborated: a preliminary framework of a step-by-step approach for decision support.

The working hypothesis was specified and validated by a case study. For developing the preliminary framework further to an implementable step-by-step approach for decision support a specific decision scenario had to be defined. This was done by an EU research project the research of the thesis is connected with. Next desk research, reviewing available studies, regulatory frameworks, etc., built the basis for intensive expert interviews. By discussions with experts in the field of food economics, food law, and food policy a sequence of arguments specific for the decision scenario was defined. Given knowledge connected to the arguments was gathered via desk research to support the decision aiding concept.

To test the usability and identify improvement potential of the step-by-step approach for decision support two field tests were carried out. Herein the step-by-step approach was implemented to the decision scenario by several in-depth interviews with industry associations of different industry sectors in different countries.

Finally the step-by-step approach was transferred to a computer-based decision support system. The technical realization was supported by an IT expert.

1.4 Outline of the Thesis

Figure 1-5 visualizes the outline of the thesis. Chapter 2 presents an overview of food safety and quality requirements and their relation to enterprises. Following chapter 3 gives an introduction to the field of strategic management explaining enterprise behaviour. Furthermore performance measurement and performance measurement systems are introduced. Chapter 4 presents the idea of decision aiding and explains a baseline of arguments leading to the enterprise compliance behaviour. It concludes with a preliminary framework of a step-by-step approach for decision support. Chapter 5 includes the case study, generating a step-by-step approach for decision support. For further specifications first a study on the cereal industry in the EU is presented. The main findings are the sequence of arguments and the knowledge base which result in the step-by-step approach. Chapter 6

implements the step-by-step approach to two field tests and presents the working procedure including improvement potential. Chapter 7 translates the improved step-by-step approach into a computer-based decision support system. Chapter 8 presents the general conclusion of the thesis and an outlook.

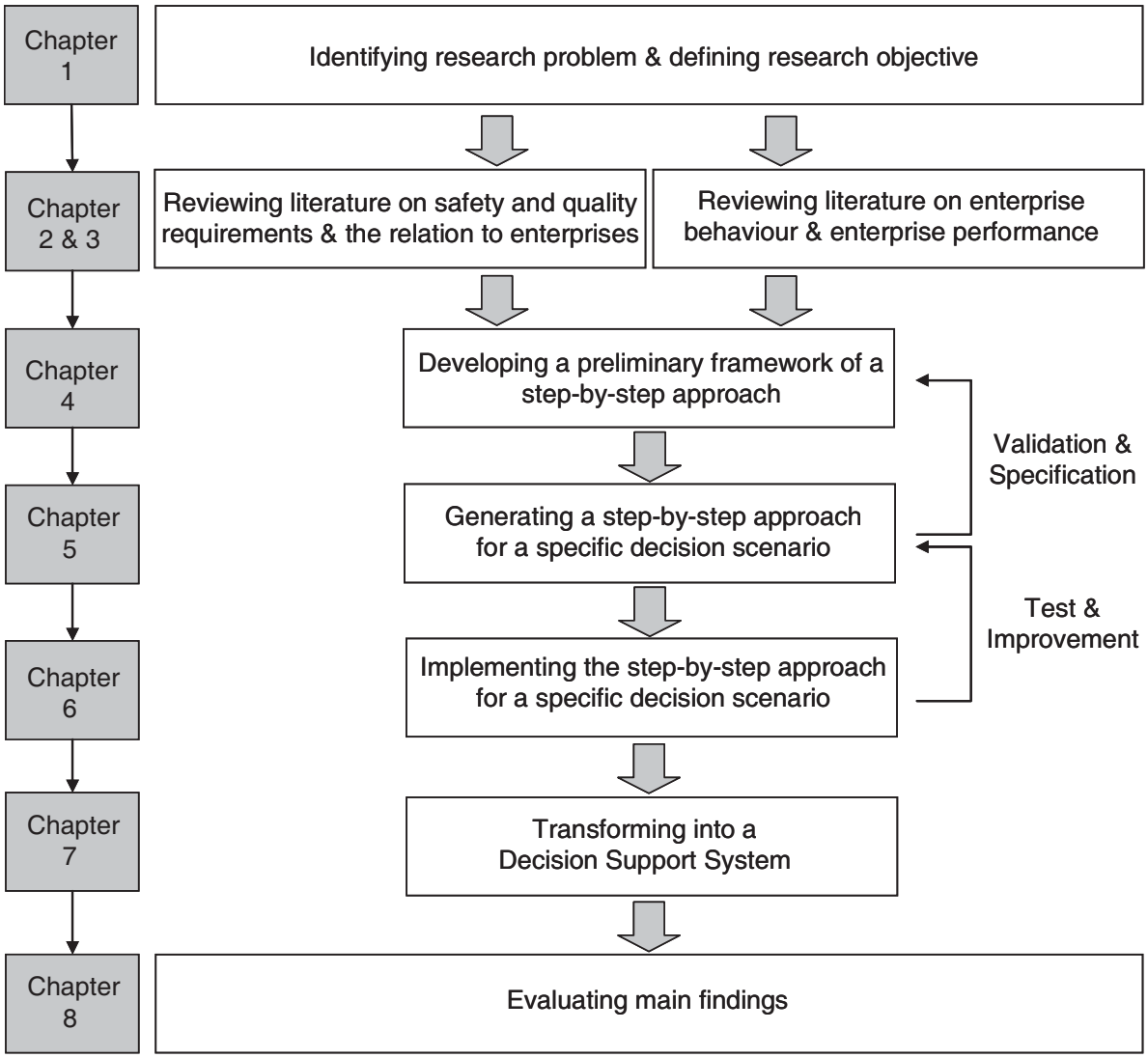

Figure 1-5: Outline of the thesis

2 Food Safety and Quality Requirements and the Enterprise

To work on the first objective of the thesis, the step-by-step approach for regulatory decision support in food policy, a literature review on relevant topics is necessary. This chapter focuses on food safety and quality requirements and the relation to enterprises. The main contribution of this chapter is:

- an introduction to quality management and related terms,
- an explanation of the main differences of public and private regulations, and
- an understanding of the general relation between regulations and enterprises focusing on the intervening character and the effects on enterprises.

Underneath figure 2-1 presents the structure of chapter 2.

Figure 2-1: Overview of chapter 2

2.1 Quality Management

The term 'quality' related to a product or process means that this product or process meets the expectations of the respective customer or user (EARLY 1995; LUNING ET AL. 2002). For this reason no generally accepted understanding of quality exists. For example, talking about quality a consumer thinks about the sensory characteristics of a product and its individually appraised value. In contrast a food manufacturer focuses on factors like the processing ability of food and quality-determining sizes (KOLB ET AL. 1995).

According to DIN EN ISO 9000 (2000) the term 'quality' can be defined as the degree to which a set of inherent characteristics fulfils requirements. In addition to this broad and generic definition, following the concept given by GARVIN (1984) is presented. He differentiates between five approaches: the transcendental, the product-based, the user-based, the manufacturing-based and the value-based approach.

Transcendental approach - The transcendental approach regards quality as a timeless characteristic. Quality is regarded as absolute, and is subjectively evaluated by each person. For this reason, quality can neither be clearly defined nor measured.

Product-based approach - The product-related approach sees quality as a clearly measurable unit, which is classified by product-related characteristics. This approach is mostly based in economic-theoretical approaches of the simple premise 'product A is better than product B, if ingredient A is more valuable as ingredient B'. The weakness of this approach lies in the purely physical aspect of product quality. The individual appraisal of the customer is not considered. As a consequence, contradictions in quality evaluation occur.

User-based approach - This approach evaluates the quality of the product in relation to its usability. Representatives of a market-focused aspect prefer this approach. An issue however is that this approach equals optimal need satisfaction with quality.

Manufacturing-based approach - The manufacturing based approach refers to the production process of a product. If production takes place exactly according to the given specifications, the final product is evaluated as being of high quality.

Value-based approach - In the value based approach the product quality is closely linked with its price. A higher price would induce higher quality estimation.

Certainly a combination of these quality approaches is necessary for developing and implementing holistic quality management. However, according to BRÖCKELMANN (1995) two of the above mentioned approaches tend to have the largest influence on quality management: the user-based approach, which is preferred by marketing specialists, and the manufacturing-based approach, which is important for engineers to minimize reworking and failures.

Quality management can be discussed from different angles, a focused view or a more general one. The focused view is linked to the standard ISO 9000 and deals with all activities around process management including process control. However, quality management can be also viewed as a more general approach which includes the systematic planning, implementation and documentation of activities, which may have an influence on the safety and quality of products (KRIEGER ET AL. 2008). This more general view is introduced in this chapter.

Quality management is an all-encompassing approach, which cannot be limited to any individual functional area within enterprises. It needs to integrate all areas with relevance for product quality and quality guarantees. Furthermore, it is important that the quality management approach is an integrated one. It should cover the whole food value chain of enterprises reaching from the primary producers via the processors and retail to the final customers. This requires efforts on coordination inside enterprises as well as between enterprises. Consequentially, quality management activities of individual enterprises are influenced by the structure of the industry sector and business relationships with suppliers and customers. (KRIEGER ET AL. 2008)

Interests and objectives of implementing quality management might vary. Still, SCHIEFER (2003) differentiates three principal driving forces for improvements in food quality and safety shown in figure 2-2: (1) society which is interested in people's health and the safety of food, (2) enterprises which are interested in market success, and (3) consumers which ask for guarantees on food quality and safety (see also WEINDLMAIER 2005). Consumers have direct influence via their purchasing decisions. Here quality management is an important tool for enterprises for marketing their products. Consumers have indirect influence via legislation. As consumers have difficulties in identifying all expected quality characteristics they depend on the guarantee of others. Regulatory frameworks contain requirements on process organization and process management in enterprises.

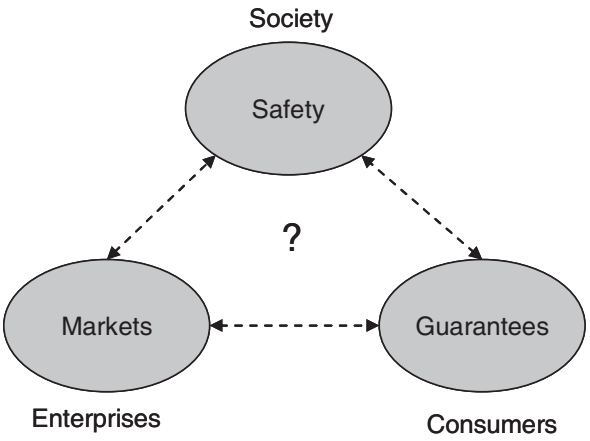

Figure 2-2: Driving forces of quality (SCHIEFER 2003)

2.2 Food Safety and Quality Control

A broad range of food safety and quality control systems is evolved in the agri-food industry (HENSON 1997; CASWELL 1998; CASWELL, JOHNES 1991). Efforts to ensure food quality and safety build on a twofold approach with (1) public infrastructures for food safety control as well as (2) private initiatives of enterprises implementing individual quality management systems (SCHIEFER 2003).

Public		Private	
Direct regulation	Product liability	Self-regulation	Certification

Figure 2-3: System of food quality control (HENSON, CASWELL 1999)

Figure 2-3 gives a clear overview of different systems (HENSON, CASWELL, 1999). Looking at the public side as the initiator of control systems, there ex-ante regulations in the form of standards, inspections, product testing and other actions are specifying how a product has to be produced or are defining its final quality to ensure food safety and quality. Companies which are not meeting the requirements are punished by e.g. monetary penalty. The other public system of control is the one of product liability. It is an ex-post control system which penalises enterprises producing products of insufficient quality through damage awards to the customers harmed by their products. Furthermore there are private control systems which can be differentiated by self-regulation and certifications. Self-regulation can be described by enterprise internal control systems helping the enterprise to set, monitor and self-certify control parameters and so assure product quality. Certification systems include the definition

of product quality standards and their monitoring and certification by external parties, e.g. customers, industry trade associations or certification bodies such as e.g. the International Organisation for Standardisation (ISO). (HENSON, CASWELL 1999)

A further distinction of public and private standards is made by HENSON (2006) on the extent to which enterprises have freedom of choice and actions regarding compliance. In general standards can be mandatory in a legal sense, they can be required in practice because the predominant number of customers asks for it, or they can be voluntary in a way that enterprises can freely chose if they comply or not. HENSON (2006) mentions mandatory standards, which are set by public institutions, in particular regulatory agencies. These standards contain requirements which are mandatory in the legal sense. Thus, the freedom of action for enterprises is very low. On the other side there are voluntary consensus standards which are developed by parties within a market with or without the participation of government, e.g. standards developed by ISO, or the British Retail Consortium (BRC). The compliance with these standards is generally voluntary and thus they are attended by a high degree of freedom for enterprises. The third group is the one of de facto mandatory standards. They are given if a particular set of products or specifications gains market share such that it acquires a huge influence. Table 2-1 sums up the main differences among public and private regulations.

Table 2-1: Differences among public and private regulations (HENSON 1997)

	Public regulation	**Private regulation**
Motivation	Public interest	Private interest
Responsibility of implementation and enforcement	Public sector bodies	Market itself or dominant actors within the market
Discretion in compliance	Firms are legally compelled to comply with regulation, otherwise they face prosecution or other enforcement actions	Firms are not legally compelled to comply with regulation

Following sections give first a deeper introduction to public regulations and subsequent to private regulations.

2.2.1 Public Regulations

The focus of legal authorities is primarily the assurance of food safety for the consumer. Among others, following institutions are mainly involved in the implementation of food legislations and the monitoring of food safety: The European Food Safety Authority, The European Commission (Directorate General for Health and Consumer Affairs), and The Food and Veterinary Office in Dublin.

In general, legislation places extensive and stringent requirements on quality and safety of agricultural and food products. A broad range of laws, acts, regulations, norms and directives exist that refer to the production of food and agricultural products, to the minimization of negative environmental effects and to the prevention of unfair trade. Such legislations contain a variety of different aspects such as food hygiene, traceability, reduction of pesticides, animal feed hygiene, product-related requirements and control-systems. These regulations may act on different regional levels: global (e.g. Codex Alimentarius), continental, national or sectoral (e.g. guidelines for dairy products). (LUNING ET AL. 2002)

On the international level of food safety legislations, the Codex Alimentarius plays an important role. The Codex-Alimentarius-Commission was founded in 1963 by the Food and Agricultural Organization (FAO) and the World Health Organization (WHO) with the objective to develop international standards for food safety on a scientific basis, to facilitate food trade as well as to increase the level of health related consumer protection. Currently all EU member states adhere to the Codex-Alimentarius. Governments, food industry representatives and consumers are included in the development of standards and advices. Up to now the Codex-Alimentarius-Commission developed a multitude of standards (FAO 2002):

- 237 food norms for commodities,
- 41 norms for hygienic and technological practices,
- 185 evaluations of plant protection agents,
- 3274 residual maximum values,
- 25 guidelines for contaminants,
- 1005 evaluations of food additives,
- 54 evaluations of veterinary medicines.

Food safety guidelines given at EU level serve to harmonize the national legislation in the EU member states. The objective is to provide homogeneous directives in food legislation, product liability and safety. Nevertheless, due to differences of historically grown national regulations in the EU member states, the harmonization process takes time. The primary objective of the European Commission is to achieve the highest standard of food safety in the European Union. To reach that goal, a lot of regulations regarding food safety, also including quality management aspects, were implemented in recent years. (KRIEGER ET AL. 2008)

White Book on Food Safety – In 2000, the European Commission published the White Book on Food Safety, which is the basis for the development of legal structures. The main issues of the set of rules are: (1) Establishment of the European Authority for Food Safety (as done formally in Regulation (EC) 178/2002), (2) consequent monitoring of the entire food chain, from primary production to the consumer (traceability), (3) creation of a new legal framework for food safety, (4) regular control in EU member states by Commission controlled inspection services and (5) transparency in food policy. (KRIEGER 2002)

Regulation (EC) 178/2002 – This regulation has become compulsory for all companies active in the agri-food sector on the first day of 2005. Here general principles like the precautionary principle, traceability of food and feed as well as the requirements of food and feed safety are provided. It stresses the measurement of health protection including crisis management, an extension of the rapid alert system and a procedure to avoid that unsafe food and feed finds its way to the market.

Food hygienic package – The EU Commission has re-structured the food hygiene law by publishing the food hygienic package to create a transparent and comprehensible hygiene policy for comprehensive consumer health protection (STÄHLE 2003). This hygienic package consists of following new regulations: Regulation 852/2004 on the hygiene of foodstuffs, Regulation 853/2004 laying down specific hygiene rules, Regulation 854/2004 laying down specific rules for the organization of official controls on products of animal origin intended for human consumption, Regulation 882/2004 on official controls performed to ensure the verification of compliance with feed and food law, animal health and animal welfare rules. This package was published in the Official Journal of the EU in April 2004. Since the beginning of 2006 it is compulsory in all EU member states. Core elements of the EU food hygiene law are the extension of hygiene rules on primary production, the documentation and

verification of self-control measures, and the increased importance of Good Hygiene Practice (GHP; STÄHLE 2004).

As a consequence, enterprises along the entire food chain must take responsibility for food safety to fulfil the "from farm to fork" concept (LANGMACK, CLAUSSEN 2003).

Product Liability Law – The product liability law was published in 1990 and issues requirements regarding product liability. In 2000 agriculture was included and the burden of proof was reversed. Now in case of a complain companies are committed to proof the safety of the products sold.

This short overview of legal regulations shows that politics have influence on the food safety level by making demands on enterprises, their quality management and thus on the entire production and distribution processes from the producer to the final consumer. Besides the legal requirements und sector specific laws like the package law, slaughter hygiene regulation and the livestock transport regulation, enterprises also have to deal with private regulations, which also issue requirements on food safety and quality.

2.2.2 Private Regulations

Private regulations deal with several different requirements regarding quality management and food safety as well as their integration within enterprises and food chains. In the context of private regulations following terms are used.

Quality standards – Quality standards are a documented set of rules, which must be consulted as basis for the realization of a quality system (KRIEGER 2002).

Quality systems – The implementation of quality standard requirements in enterprises results in a quality system within the company. Depending on the specific requirements, the quality system may be referred to as quality control, quality management or quality assurance system. (DIN EN ISO 9000:2000 2000)

Quality programs – Quality programs mostly possess a regional character and try to develop independent product quality value added and profiles, usually in a closed food chain structure, in order to differentiate the product (KAGERHUBER, KÜHL 2002).

Protected designation of origin (PDO) / Protected geographical indication (PGI) / Traditional speciality Guaranteed (TSG) – In the context of the Community law for revaluation and protection of agricultural products and food in the European Union a law is passed, which contains community brands with a combined indication of quality and origin. The core points are: The protected designation of origin means that production, processing and manufacturing of a product in a certain geographical area must take place according to an approved and fixed procedure. With the protected geographical indication, a connection between at least one of the production stages, the production, processing or the manufacturing, and the origin area exists; it may also concern a product with special reputation. The traditional speciality guaranteed does not refer to a geographical origin, but to a traditional composition of a product or a traditional manufacturing and/or processing method. (EUROPEAN COMMISSION 2009b)

Certification marks – Certification marks are logograms and/or pictograms for the marking of a certain quality of goods or services. A legal regulation is missing, but they can be registered as a collective brand into the register of trademarks led by the patent office. (BROCKHAUS 2002)

Label – Labels are declarations, which link goods with information about its characteristics to improve, e.g. quality transparency (GABLER 2000).

In the last years numerous quality standards have been established. One can differentiate between universal and product independent basic quality systems on the one hand (e.g. GMP, HACCP) and national or product specific quality standards on the other hand (e.g. IFS, BRC) (KRIEGER 2002). These standards may include and build on requirements given in basic quality systems and add further more specific requirements. Underneath figure 2-4 shows that legal requirements present the base of food safety and quality requirements, thereupon there are basis quality systems with a slightly higher level of requirements and based on that there are specific advanced quality systems.

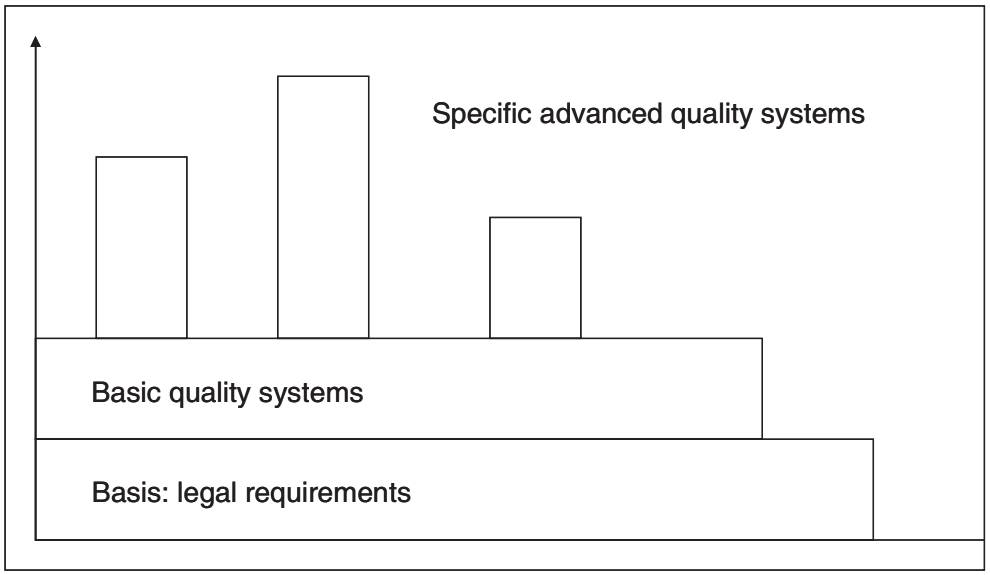

Figure 2-4: Development framework and hierarchy of quality levels (SCHIEFER 2003)

A further differentiation of quality standards can be made by so called horizontal and vertical quality standards. They differ regarding the requirements for specific stages of the food value chain. Horizontal quality standards contain requirements for one single stage of the value chain, e.g. quality standards for primary production, ISO, and HACCP. Vertical quality systems cover several or all stages of the supply chain from feed industry via farmer and processing to retail, e.g. QS-quality scheme. (KRIEGER 2008)

2.3 Food Safety Regulations and Enterprises' Behaviour

Food safety regulations can take various forms which differ in their requirements and thus in their degree of intervention into the freedom of activity of enterprises. According to OGUS (2004) figure 2-5 visualizes the differences in intervention of several types of food safety regulations. At one extreme there are information measures which require suppliers to communicate certain information about their products, but do not include further restriction of the behaviour. The degree of intervention is very low. At the other extreme enterprises may require prior approval of a product from an official agency before selling the product. This can bee seen as a very high degree of intervention. In between there are standards, which allow to sell products without any prior control but not complying with certain criteria means that the enterprise commits an offence. Food safety standards can take three main forms: (1) target standards, which "do not prescribe any specific safety standards for the supplier's products or the processes by which they are produced, but impose criminal liability for pre-specified harmful consequences which arise from their products" (HENSON, HEASMAN 1998,

p. 10); (2) performance standards, which "require certain levels of safety to be achieved when the product is supplied, but leave suppliers free to choose the mechanisms through which they meet such conditions" (HENSON, HEASMAN 1998, p. 10); and (3) specification standards, which "are applied both to products (product standards) and the processes by which those products are made (process standards) and can take both positive or negative forms; either compelling products to contain particular ingredients or the use of particular production methods, or prohibiting the use of particular ingredients or production methods" (HENSON, HEASMAN 1998, p. 10).

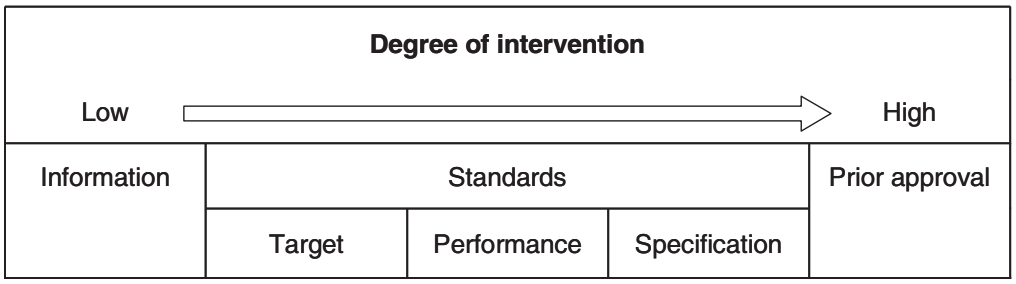

Figure 2-5: Forms of public regulation (OGUS 2004)

As there are differences in the intervention of regulations into the enterprise activities there are differences in the enterprise compliance behaviour, too. Figure 2-6 conveys an impression of differences in enterprise compliance behaviour presenting basics options. In general enterprise compliance behaviour depends on expected benefits, i.e. either improvements in business performance or avoidance of sanctions associated with non-compliance (HENSON, CASWELL 1999). According to the effects on business performance and the driver of complying with regulations the figure underneath differentiates the enterprise behaviour: performance driven compliance, non-compliance, enforcement driven compliance, and conditional non-compliance.

		Driver of compliance behaviour	
		Contribution to industrial performance	Administrative Enforcement
Net economic benefits of compliance	High	Performance driven compliance	Enforcement driven compliance
	Low	Non-compliance	Conditional non-compliance

Figure 2-6: Enterprise compliance behaviour (RUGMAN, VERBEKE 1998)

2.3.1 Enterprise Perspective

In identifying the relation of food safety and quality regulations and the stakeholders of the enterprise level it is important to define the scope of the analysis. In the following the analysis is differentiated according to the perspectives of different stakeholders. This section discusses some of the interests and viewpoints of individual enterprises. Hereafter chains of vertically cooperating enterprises are on focus.

In the context of environmental regulations, literature presents some insight regarding the regulations' impact on the enterprises. There are in general two oppositional perspectives of the regulations' impact on enterprise's strategy and performance.

On the one hand, regulations are watched in a positive way. In the context of environmental regulations PORTER (1990, 1991) and PORTER, VAN DER LINDE (1995) argue that a well designed regulation may lead to 'first mover advantages'. By an early adoption of standards, the enterprise has potential for 'innovation offsets' that lead to lower costs and higher quality and so finally to net benefits for the enterprise. Regarding quality systems, MAZZOCCO (1996) and BREDAHL, ZAIBET (1995) show that most of the firms that adopt quality systems have seen not only declines in the cost of transactions but also have experienced improvements related to their production processes and final product. Among these benefits there are increases in productivity, better management, improvements in consumer relations, elimination of deficiencies in production processes, better adaptation of new personnel, and the conservation of current customers. BREDAHL, ZAIBET (1995) show in their study that for enterprises the total cost of implementing quality systems is less than the benefits acquired directly or indirectly. Consequently, they argue that the adoption of a quality system could be an important strategy for enterprise development.

On the other hand, there is the negative perspective. WALLEY, WHITEHEAD (1994) argue that enterprises rarely benefit from environmental regulations because such investments mostly yield a negative financial return. A key issue in quality assurance concerns the control of the production cycle during the manufacturing of agrifood products. According to LUNING ET AL. (2002) the following components are part of this control cycle and, in consequence, contribute to its cost: a measurement or inspection unit, the comparison of actual results with a target value (i.e. norm, standard, goal or specification) within tolerances, the assessment of the direction of corrective action (i.e. regulation) and the actual corrective actions.

However, there might be a high variance between enterprises regarding costs and benefits of quality regulations. KRIEGER ET AL. (2007) state, that costs and benefits for an enterprise depend on the internal and external conditions under which an enterprise operates. They refer to a study, which shows a high variance of costs among enterprises (DEROANNE ET AL. 2002 in KRIEGER ET AL. 2007). In this study the cost for one enterprise is up to 15 times as much than for another enterprise. There are explanations for higher costs, including: (1) A quality philosophy may be present in the company and there is a specific focus on quality in general and food safety in particular. (2) The enterprise is acting in a sector characterised by higher food safety risks, which requires higher efforts for food safety and quality control. (3) Food safety efforts in small enterprises are relatively more expensive than in larger ones, which can benefit from scale effects (GELLYNCK ET AL. 2004).

The relation of the regulation's impact on the enterprise and the enterprise behaviour of compliance are given by HENSON, HEASMAN (1998) and HENSON, CASWELL (1999). They state that corporate response on a regulation in terms of compliance depends on the expected economic benefit. That means that if an enterprise expects a negative economic effect of the regulation, it is not going to comply with the regulation.

In this context REARDON ET AL. (2001) refer to the enterprise size as an important factor of the compliance behaviour. They hypothesize that the compliance of an enterprise with food quality and safety requirements is correlated with its size. Large enterprises show a tendency to engage in the development of quality regulations in their own interest. They adopt and even intensify public regulations as part of their own individual quality activities. Examples are the quality standards developed by retailers as a strategy for better chain control. In contrast, in international trade, small or medium-sized enterprises are typically 'standard-taker' that will likely expect assistance from the public sector in the adjustment process to comply. SEDDON ET AL. (1993) support this point. They indicate that large firms introduce the ISO 9000 quality system standard primarily for internal reasons, while small ones comply with such standards mainly because of external factors. Small firms adopt quality assurance systems mainly in the expectance to acquire new customers and maintain their existing customer base, rather than decreasing costs of production. Although the enterprise size may affect the enterprise compliance behaviour it still needs much more to understand it. According to HENSON, HOOKER (2001) the compliance decision of an enterprise is viewed as a black box with little attempt to explore and understand the way of compliance.

Enterprises are the core units in the implementation of quality systems. If they participate in agreements along the vertical value chain regarding quality issues, they become part of a chain, where vertical cooperation can involve a wide range of alternatives. The enterprise and chain view could be reconciled, but it is not necessarily the same.

2.3.2 Chain Perspective

The food industry is strongly dependent on horizontal and vertical cooperation, a characteristic which is of specific importance in the case of food quality and safety regulations. The concept of the value chain, introduced by PORTER (1985), recognises that the individual activities within the sequence of activities in the overall production process determine costs and quality of the end product.

In this scenario, quality system standards supporting transactions in enterprises as well as between enterprises in the chain assist in achieving efficiency gains. HOLLERAN ET AL. (1999) state that especially large firms may have strong internal incentives to adopt quality assurance schemes as a means to increase the efficiency of their operations. External incentives are due to e.g. the problem of information asymmetry between sellers and buyers. Sellers know the quality and safety attributes of their products much better than buyers do, and it is hardly possible for buyers to fully assess these attributes during the transactions. As a consequence, buyers may end up with lower quality food than expected. This situation increases the transaction costs for market participants due to increases in costs for information search, negotiation costs, and monitoring and enforcement costs (HOBBS 1996). This generates private incentives to decrease such costs (HOLLERAN ET AL. 1999) through, e.g. the adoption of quality assurance systems.

Other cost and benefit aspects within the chain view include traceability, transparency, product liability and the organization of controls. A core issue in the organization of vertically oriented quality systems is indeed traceability. A well developed traceability capability could reduce the product liability exposure of enterprises. Food quality systems in the supply chain can provide a supportive basis for product liability cases and thus reduce product liability risks. The certification systems allow the reduction of controls at the end of the value chain and transfer costs of control down the value chain. Retailers' incentives to require quality system investments by suppliers and further upstream the value chain set small and medium

sized enterprises at a disadvantage, as compared to larger enterprises, as already mentioned in the foregoing chapter. (KRIEGER, SCHIEFER 2007a)

3 Enterprise Behaviour and Enterprise Performance

Before presenting a preliminary framework of a step-by-step approach for decision support in chapter 4, the third chapter is the last one providing theoretical background. The main contribution of this chapter is:

- an introduction to strategic management explaining enterprise behaviour and enterprise performance, and in this connection
- a description of the structure-conduct-performance paradigm,
- an introduction to performance measurement and related terms, and
- a description of the Balanced Scorecard.

Underneath figure 3-1 presents the structure of chapter 3.

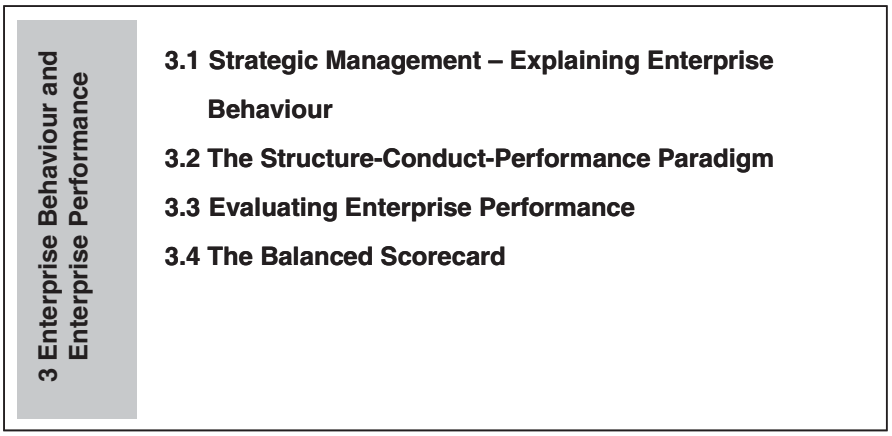

Figure 3-1: Overview chapter 3

3.1 Strategic Management - Explaining Enterprise Behaviour

In the strategic management field the strategic behaviour of enterprises is a key subject as it deals with the investigation of firm behaviour and its interrelation with competitive performance.

> "Strategic management is the interdisciplinary field that studies the behavior of companies and other market parties, in terms of their strategic behavior, the choices they make with regard to organizing their production, their interrelationships, and their competitive positioning. All of this is set against a thorough understanding of the broader environment in which companies have to operate" (NAG ET AL. 2007, p. 946).

An important goal of strategic management is the explanation and investigation of differences in business performance among enterprises.

Strategic management is a relatively young discipline of business studies and has its origin in the 1960s and 1970s. Against the background of a rapid changing environment and the increasing complexity of it, strategic management becomes more and more important to enterprises. An ongoing globalization and an advancing technological change are enhancing competition within industries and challenging enterprises with the adaption of new lifecycles to products, markets and customers. Therefore a future orientated way of managing firms and the implementation of strategies are essential to achieve high performances. (CAMPHAUSEN 2007; MEFFERT 1988)

A general definition of the term strategy has not yet found acceptance neither in scientific discussions nor in practice. The traditional approach to strategy is process-orientated and places emphasis rather on how to develop a strategy than on the strategy's content. These aspects still are important components of defining strategy nowadays. (LOMBRISER, ABPLANALP 2004)

Strategy can be defined as e.g.:

- "The determination of the basic long-term goals and objectives of an enterprise." (CHANDLER 1962, p.5)
- "A set of decision-making rules for guidance of organizational behaviour." (ANSOFF, MCDONNELL 1990 in LOMBRISER, ABPLANALP 2004 p. 22)
- "Rational actions being proactive and planned for long-term achievements." (LOMBRISER, ABPLANALP 2004, p. 22)

PORTER (1991, p. 95) indicates "the reason why firms succeed or fail is perhaps the central question in strategy". This approach is based on the assumption that a firm's success is predominantly determined by the position it takes in the marketplace and the attractiveness of the industry in which it competes. A strategy aims at achieving a competitive advantage (LOMBRISER, ABPLANALP 2004).

Here the structure-conduct-performance (SCP) paradigm is to mention. A transfer of theory from industrial organization economics to strategic management took place. In the main, the

field of industrial organization analyses empirical data and develops theories to explain the behaviour and performance of firms and the industries to which they belong (SCHMALENSEE 1988). Specifically the SCP paradigm of traditional industrial organization economics has been transferred to and builds on strategic management. (MCWILLIAMS, SMART 1993) Also PORTER (1981) states that industrial organization offers much to the analysis of strategic choices by enterprises within industries. Although establishing strategic management is controversial and a wide range of theories exists. The economic perspective of strategic management includes the traditional SCP paradigm of the industrial organization economics, further developments by Michael Porter, the new industrial organization economics, approaches in game theory and the resource-based view (SYDOW, ORTMANN 2001).

Since the 1970s, industrial organization economics has provided the main theoretical foundation for strategic management research into the determinants of enterprise performance and the evaluation of industries (HAWAWINI ET AL. 2003). Its main argument is that the structural characteristics of an industry are the preliminary determinants of performance. A number of studies examined factors explaining the performance differences among industries. In the end, the theoretical framework of the structure-conduct-performance paradigm was most accepted in industrial organization economy (HAWAWINI ET AL. 2003; ALLEN ET AL. 1999). The tenet of the SCP paradigm is that the economic performance of an industry is a function of the conduct of buyers and sellers which, in turn, is a function of the industry's structure (MASON 1939; BAIN 1956). The essence of the SCP paradigm is that the performance of an enterprise depends critically on the characteristics of the industry environment in which it competes (PORTER 1981; HAWAWINI ET AL. 2003; ALLEN ET AL. 1999).

Due to limitations that researchers have revealed in the traditional SCP paradigm, in the 1980s a more dynamic perspective of the paradigm has been developed which considers the possibility of feedback effects from firm conduct to market structure. In industrial organization economics, the unit of analysis shifted from the industry to the firm itself, and emphasis was now placed on the intra-industry heterogeneity to explain firm differences in performance. In this line of research the focus is on how firm behaviour affects the market structure and market performance (CHURCH, WARE 2000; HAWAWINI ET AL. 2003).

In the 1980s Porter refined and further developed the SCP paradigm. Porter's model of five forces emphasizes the different aspects of industry structure and helps to evaluate the attractiveness of an industry and facilitates competitive analysis. Porter improves the SCP paradigm and enriches the strategic management field by defining the competitive structure of an industry more precisely and by highlighting the importance of formulating competitive strategies to reach outstanding performance (HOSKISSON, HITT 1999).

More recent approaches to strategic management assume that the success of an enterprise does not depend on the market but rather on the creative utilization of resources. Thriving companies pursue objectives that go beyond the existing resources and capabilities. Therefore strategies become the enterprises' goal or a strategic intention. These objectives are achieved by targeted resource development and endowment as for example the set-up of core capabilities or the accumulation of resources (LOMBRISER, ABPLANALP 2004). This way of defining strategy has an important impact on the strategic management field as it refers to the resourced-based view which is a central issue in the research field nowadays.

In this work emphasis lays on the key concept of the SCP paradigm as an approach to argue enterprise behaviour and enterprise performance. Following section explains the main idea behind the SCP paradigm.

3.2 The Structure-Conduct-Performance Paradigm

Essential contributions in the field of industrial organization were done by MASON (1939, 1949) and BAIN (1951, 1956, 1959), who are credited with the development of the SCP paradigm. It has enhanced the study of industrial organization by adopting basic approaches from microeconomic analysis. The paradigm is characterized by a market-orientated view and considers in particular external aspects of the firm as the structure of the industry and its competitive chances (HOSKISSON 1999; CARLTON, PERLOFF 2005). A firm that can best attune to the external environmental conditions is able to gain the best market position and be the most successful firm in the industry (RAFFLER 2005).

The fundamental idea of the SCP paradigm implies a stable, causal relationship between its three components (figure 3-2):

- the structure of a market,

- the firm conduct, and
- the market performance.

The three components of the paradigm are related to each other in a way that the success of an industry in producing benefits for their consumers (performance) is determined by the behaviour of its enterprises (conduct), and that in turn is determined by the industry's market structure (factors that constrain the competitiveness of the market; BESTER 2004; CARLTON, PERLOFF 2005).

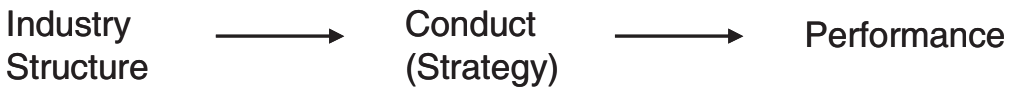

Figure 3-2: The traditional Bain/Mason SCP paradigm (PORTER 1981)

The traditional Bain/Mason paradigm, of the 1950s and 1960s implies that the structure of a market determines the behaviour of firms and that, in turn, determines the joint performance of these firms in the marketplace. This approach suggests that the main driver of performance is the industry structure in which an enterprise competes. Therefore a final argumentation of the Bain/Mason paradigm states that the industry structure can be considered as the crucial determinant of performance and that conduct can be ignored completely. Behaviour only represents the market conditions. A static relationship among its three components is suggested. Thus it is assumed that all firms within an industry are homogeneous, except for their size. In order to explain performance differences among firms this paradigm indicates that the structural characteristics of an industry determine the behaviour of its component enterprises, and that in turn leads to industry-specific performance differentials between enterprises. (PORTER 1981; HAWAWINI ET AL. 2003)

Whereas in the traditional industrial organization economics the unit of analysis has been the industry, the focus shifted to the firm itself to explain performance differentials in the 1980s. The unilateral and static relationship between the three components of the paradigm has met criticism. The reason for this change was due to the fact that the traditional industrial organization theory did not offer a decisive explanation of intra-industry heterogeneity in performance. The question that arose was why enterprises within an industry, operating under identical conditions of supply and demand and facing the same market structure still performed differently, although they were competing in the same industry. (HAWAWINI ET AL. 2003)

For the same reasons, PORTER (1981) developed a refined model of the SCP paradigm to overcome the limitations of the traditional paradigm. He argues that from a strategy point of view, the industry structure being the central factor to determine performance is a limitation of the traditional paradigm. From a strategy perspective, the critical factor that structures the industry is the enterprise and thus that should be analyzed as it leads to the conduct which determines structure and performance in return. In the SCP paradigm, further developed by Michael Porter, the structure of an industry can be influenced or even changed by the actions of single firms and also by the behaviour of all firms competing in that industry. A feedback effect of conduct and performance on industry structure is suggested (THU, AKINTOYE 2005). For example, enterprise innovations may increase or reduce entry barriers. Empirical studies have given evidence that strategic behaviour of firms can affect or even inhibit entry into industries by appropriately choosing their strategies. This shows that there is a linkage between firm conduct and market structure. Similarly a firm may not perform well and hence exits the market. Here performance influences market structure (PORTER 1981; CABRAL 2000). Figure 3-3 highlights the feedback effects by dotted arrows: from performance back to conduct, from conduct to structure, and from performance to structure.

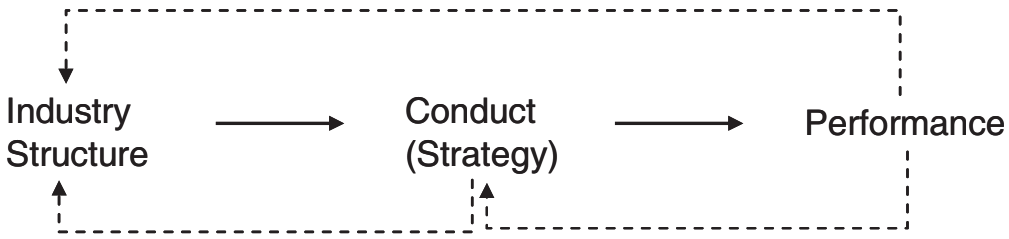

Figure 3-3: The SCP paradigm with feedback (PORTER 1981)

Following the main components of the structure, conduct and performance categories are discussed.

Structure

Market structure is defined as the characteristics that determine competition and pricing within markets (THU, AKINTOYE 2005). The characteristics tend to change relatively slowly and can be regarded as fixed in the short run. Some more important structure variables are:

The number and size distribution of buyers and sellers – It is an important determinant of the market power exercised by leading enterprises in an industry. For example in consumer goods industry it is often the case that there are large numbers of small buyers, so that the main focus is on the number and size distribution of sellers. (LIPCZYNSKI ET AL. 2005)

Entry and exit conditions – It includes barriers to entry a market, which can be anything placing a potential entrant at a competitive disadvantage to an established enterprise. Of importance is the ease or difficulty for enterprises entering an industry, i.e. if entry is difficult, than established firms are sheltered from outside competition (NEVEN 1989). By barriers to exit a market an established firm has to fight to preserve its market share against potential entrants. (LIPCZYNSKI ET AL. 2005)

Product differentiation – It refers to the characteristics of the firm's product, to what extent it is similar to others. Changes in product characteristics of one firm may affect the shares of the total market demand of the other firms dealing with this product. (LIPCZYNSKI ET AL. 2005)

Vertical integration and diversification – It refers to the extent to which a firm is involved in different stages of the production chain. Vertically integration and diversification is likely to have implications for conduct and performance. Here it is to think of better relations to raw material supply and product distribution as well as economies of scale. (LIPCZYNSKI ET AL. 2005)

Conduct

Market conduct describes the behaviour of enterprises, or more explicitly the behaviour of sellers and buyers, in order to earn profit and enhance their market share in relevant markets based upon the underlying supply and demand condition (THU, AKINTOYE 2005; CARLTON, PERLOFF 2005). Examples of conduct variables are the following:

Business objectives – The objectives of firms often derive from structural characteristics of the industry, e.g. the firm size distribution. Typical objectives are e.g. the maximization of sales revenue, growth or managerial utility. (BAUMOL 1959; MARRIS 1964; WILLIAMSON 1963)

Pricing policy – The degree to which a firm can determine its own pricing policy depends to a large extent on the industry's structural characteristics (LIPCZYNSKI ET AL. 2005).

Product design, branding advertising and marketing – Although product differentiation is listed above as a structural characteristic, the extend of product differentiation can be also influenced by specific strategies focusing on product design, branding, advertising and marketing (LIPCZYNSKI ET AL. 2005).

Research and development – The extent and effectiveness of investments research and development are critical determinants of technological progress (LIPCZYNSKI ET AL. 2005).

Merger – Horizontal mergers have effects on seller concentration, vertical mergers affect the degree of vertical integration, and conglomerate mergers affect the degree of diversification. Each merger is an example of feedback effect on industry structure (LIPCZYNSKI ET AL. 2005).

Performance

Market performance is defined by the economic success of a market in producing benefits for its consumers. The performance of a market can be seen as a multi-dimensional concept comprehending effectiveness, productivity, efficiency, equity, profitability, quality, pricing and technological process of the firms in an industry. In addition to that job opportunities and employment are relevant factors (THU, AKINTOYE 2005; CARLTON, PERLOFF 2005). Important indicators of performance, the third component of the SCP paradigm, are for example:

Profitability – Abnormal profits may be the consequence of e.g. the market structure, an abuse of market power, or the consequence of a pricing policy and thus the consequence of the components structure and conduct. Furthermore profitability influences firm's decision to continue or exit from a market and thus this indicator has implication on future structure. (LIPCZYNSKI ET AL. 2005)

Quality of products and service – This might be a more important indicator for consumers, regulators, or government (LIPCZYNSKI ET AL. 2005).

Technological progress – The indicator is a consequence of investments in research and development and in turn it can give feedback by impacting basic conditions on demand and supply (LIPCZYNSKI ET AL. 2005).

Productive and allocative efficiency – Productive efficiency describes to which extent a firm is able to achieve the maximum technological feasible output from a given combination of inputs. Allocative efficiency refers to whether social welfare is maximized at the market equilibrium. (LIPCZYNSKI ET AL. 2005)

Government policy

Figure 3-4 shows a more complex version of the SCP paradigm. Beside the basic conditions here government policy is added as a component of the paradigm and can operate on structure, conduct and performance. Following examples are given representing possible situations for government or regulatory intervention to promote competition and prevent the abuse of market power.

Competition might be assisted by avoiding a horizontal merger of two large firms, or by forcing the break-up of a large producer into two or more smaller firms. Such actions effect

directly industry structure. Instead regulatory interventions might be targeted directly at influencing conduct. Price controls can prevent a firm with lots of market power from setting a profit maximizing monopoly price. Legal restrictions on forms of collusion might be strengthened, or punishment might be increased. A wide range of government policy measures (e.g. environmental requirements) may have direct effects on firm's performance, measured by indicators such as e.g. profitability or productivity. (CARLTON, PERLOFF 2005; LIPCZYNSKI ET AL. 2005)

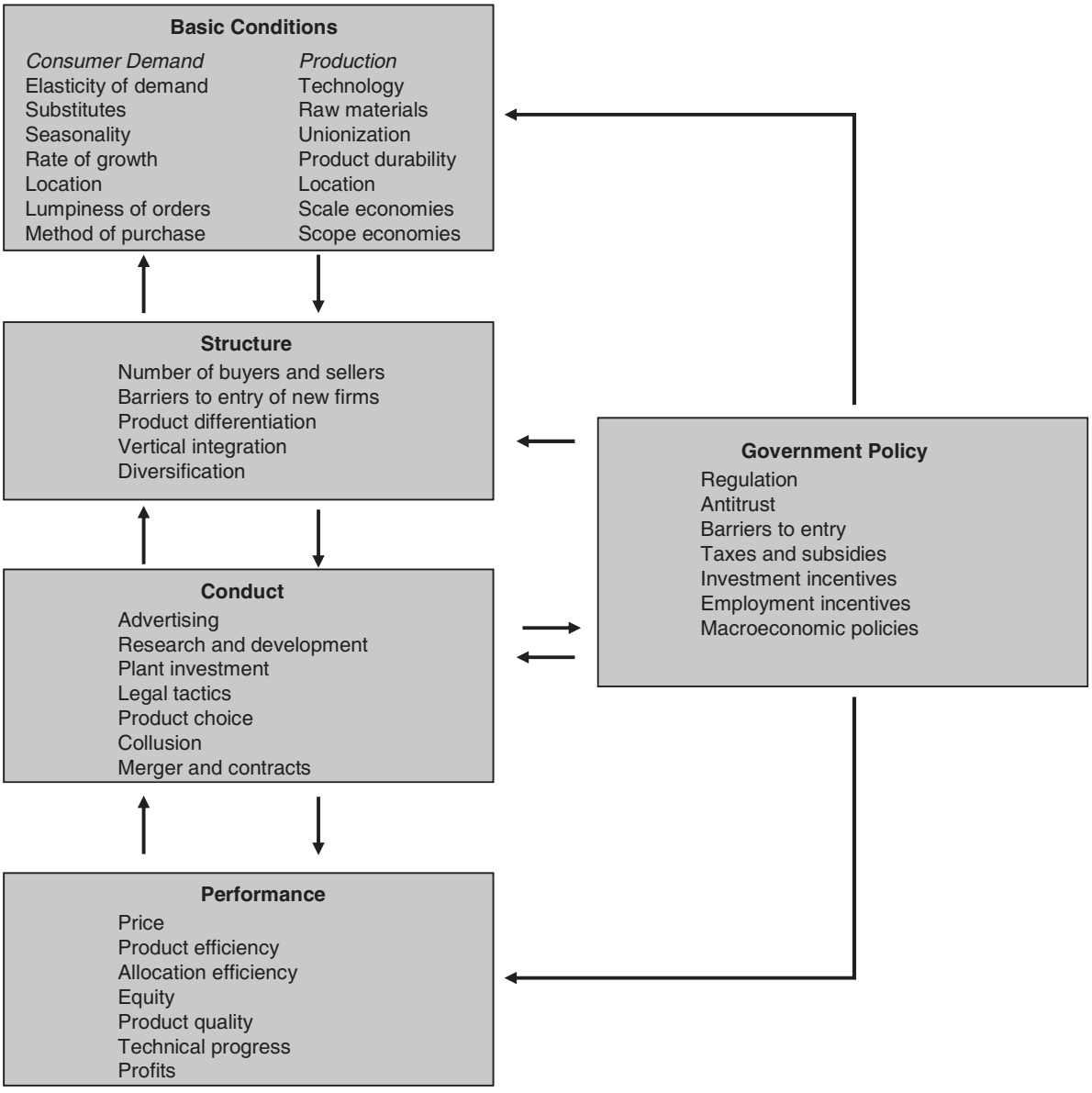

Figure 3-4: The SCP paradigm - a more complex view (CARLTON, PERLOFF 2005)

3.3 Evaluating Enterprise Performance

Since the first part of chapter 3 deals with analyzing enterprise behaviour and explaining enterprise performance, this part focuses on performance measurement enabling to evaluate changes in the enterprise business performance. Measuring performance serves to control the processes within enterprises referring to its objective and strategy (MARTEN ET AL. 2007).
Although there is a huge amount of literature about measuring performance there is no general definition. NEELY ET AL. (1995, p. 80) refer to performance measurement as "a topic often discussed but rarely defined". The following definitions related to performance measurement are based on the assumption that the level of enterprise performance depends on the efficiency and effectiveness of the underlying actions (NEELY ET AL. 1995; BOURNE, NEELY 2003):

> *Performance measurement* can be defined as the process of quantifying the efficiency and effectiveness of action.
>
> *A performance measure* can be defined as a metric used to quantify the efficiency and/or effectiveness of an action.
>
> *A performance measurement system* can be defined as the set of metrics used to quantify both the efficiency and effectiveness of actions.

Considering that nowadays the application of a multi-dimensional and balanced set of performance measures is highlighted and that performance measures should be derived from firm's strategy, the following definitions can be given:

> "Performance measurement refers to the use of a multi-dimensional set of performance measures. The set of measures is multi-dimensional as it includes both financial and non-financial measures, it includes both internal and external measures of performance and it often includes both measures which quantify what has been achieved as well as measures which are used to help predict the future". (BOURNE, NEELY, 2003, p. 3-4)

Looking at performance measurement systems traditionally they focused on cost and financial accounting measures as e.g. return on investment and earnings per share. Thus they attracted

considerable criticism for being constraint by relying on financial and accounting methods in assessing enterprise performance or, more correct, assessing their profitability (METAWIE, GILMAN 2005). Often mentioned shortcomings are the following: Traditional performance measures ignore non-financial aspects like e.g. lead time reduction, customer service or quality improvements. Quantifying performance is difficult if softer and less measurable indicators should be taken into account. Furthermore traditional measures are blamed for their backward looking view on performance. The measures report the effects of decisions and actions made in the past and are not designed to ensure the long-term success of an enterprise. (TANGEN 2004; BOURNE, NEELY 2003; METAWIE, GILMAN 2005)

Due to the mentioned shortcomings the utilization of traditional performance management systems is not satisfactory. Solely relying on financial aspects tends to lose sight of strategic objectives and the organization as a whole (TANGEN 2004; BOURNE, NEELY 2003). Thus the focus of performance measurement shifted to an external and future looking view on measurement by developing more balanced and multi-dimensional performance measurement frameworks (BOURNE et al. 2000; BOURNE, NEELY 2003).

According to KENNERLY, NEELY (2007) an effective performance measurement system enables informed decision making because it quantifies the efficiency and effectiveness of past actions through acquisition, collation, sorting, analysis, interpretation and dissemination of appropriate data. A successful balanced and multi-dimensional performance measurement system should consider the following characteristics (TANGEN 2004; KENNERLEY, NEELY 2007):

Promote strategic objectives – A performance measurement system should be deduced from an enterprise's strategic objective. As strategies may change over time it is important to be able to adapt performance measures to these changes.

Provide an appropriate balance – A performance measurement system should comprise a set of different measures covering all important aspects representing the success of an enterprise.

Preservation against sub-optimization – Choosing a set of performance measures it is necessary to consider assessing the performance of an organization as a whole, i.e. the performance measurement system has to provide a clear linkage from the top of a company all

the way to the bottom. Hence, a supporting infrastructure needs to be established that enables data to be acquired, collated, sorted, analyzed, interpreted and disseminated.

An appropriate number of performance measures – A performance measurement system should consist of a limited number of performance measures, to avoid an information overload. Otherwise it might be difficult to decide which measures should be preferred.

Simple to understand – A highly important element of designing a performance measurement system is that it is easy to grasp. The required information have to be easy understood, presented and received to those that are involved in the implementation process.

Precise and specific about what has to be measured – The performance measures should be defined in a clear way and have a clear purpose so that a correct use of all measures by affected persons is assured. A specific target has to be set for each specific measure and the timeframe has to be determined in which that target has to be met.

This development effected the formulation of new methods and frameworks for performance measurement. An early framework is the DuPont framework. Representing the criticized traditional accounting based frameworks it uses a pyramid of financial ratios. It has an explicit hierarchical structure and links measures at different organizational levels (KENNERLEY, NEELY 2002). Literature of new measurement methods presents numerous approaches. On the one hand there are approaches still focusing on the financial perspective of an enterprise but trying to overcome the limitations of former methods. An important example is the corporate financial performance measurement method, the economic value added (EVA), which attempts to quantify value created by an enterprise, basing it on operating profits in excess of capital employed (YENIYURT 2003; ARAMYAN ET AL. 2006). For the use of this research these kinds of methods are judged as too financial focused and thus not further described. On the other side there are measurement methods stressing the importance of non-financial performance measures, which should be further considered in this research. According to KENNERLY, NEELY (2002), YENIYURT (2003) and NEELY (2005) examples of common balanced measurement methods are. (1) The performance pyramid (LYNCH, CROSS 1995), which supports the need to include internally and externally focused measures of performance. It adds the idea to connect measures in line down to the organization to reflect the corporate vision as well as all business unit objectives. (2) The

results determinant framework (FITZGERALD ET AL. 1991) classifies the measures into those related to results (e.g. financial performance) and those focusing on the determinants of the results (e.g. quality). It considers the causality that results are a function of past business performance in relation to specific determinants. (3) The Balanced Scorecard (BSC; KAPLAN, NORTON 1996a), which identifies and integrates four different perspectives of performance (financial, customer, internal business, and innovation and learning). In literature the BSC is often judged as the most popular method of the balanced measurement methods (e.g. YENIYURT 2003; KENNERLY, NEELY 2002; ARAMYAN ET AL. 2006). NEELY (2003) confirms the dominance of the BSC by studying the most cited articles in the field of performance measurement from 1995 to 2004.

According to that the following section gives a more detailed insight into the BSC and prepares for identifying an appropriate way of measuring and evaluating enterprise performance in this research.

3.4 The Balanced Scorecard

According to BISCHOF (2002) the most well-known performance management system is the BSC that has been introduced by Kaplan and Norton in the 1990s and has been attracting considerable attention in business practice as well as in strategic management literature. The objective of the BSC is to offer an extensive framework that converts an enterprise's mission and strategy into an appropriate set of measurements. To overcome shortcomings of traditional measurement systems, already discussed above, the BSC propose to complement financial measures with operational measures of future financial performance. The multi-dimensional approach, also explained above, is considered by assess business performance from four different perspectives: the financial perspective, the costumer perspective, the internal business perspective and the learning and growth perspective. All measures should be derived from the enterprise's business strategy and are linked to the financial objectives by a cause and effect relationship. (KAPLAN, NORTON 1996a)

In the following figure (3.5) the four perspectives of the BSC are presented that serve as a tool to translate an enterprise's strategy into appropriate objectives and measures.

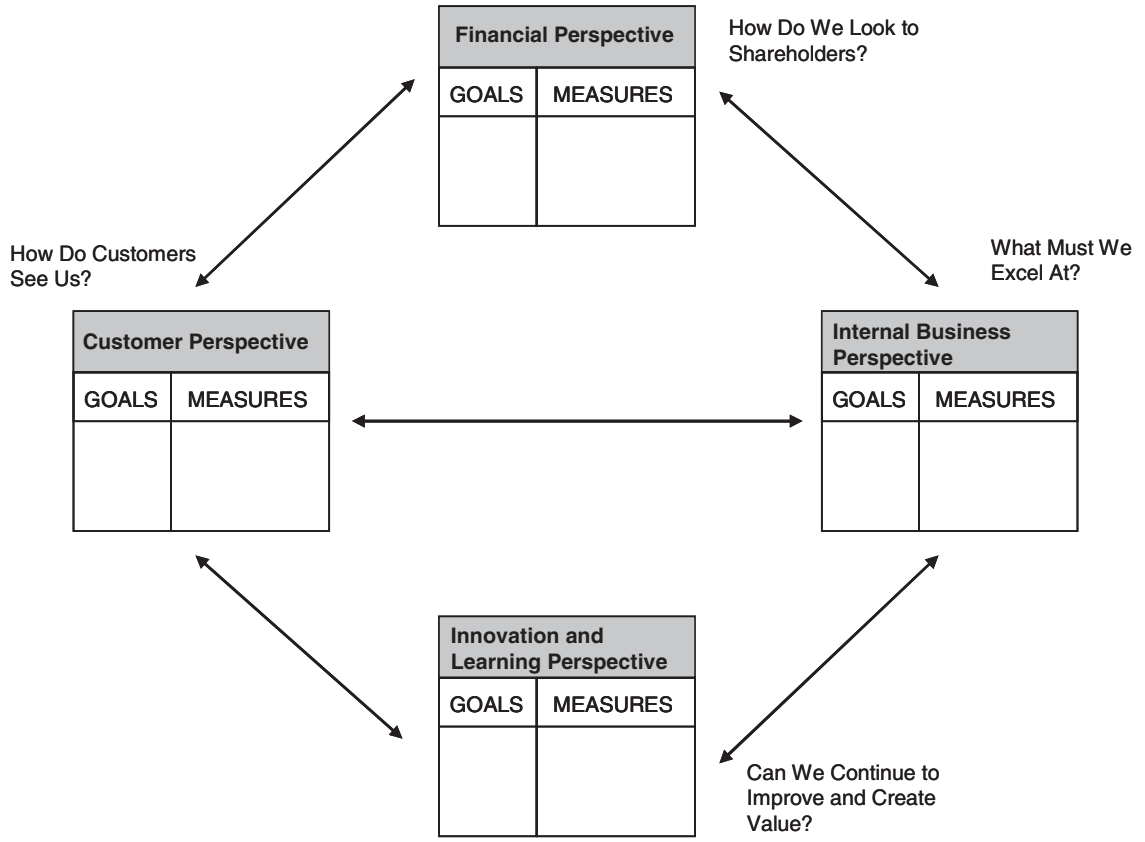

Figure 3-5: The Balanced Scorecard a framework to translate strategy into operational terms (KAPLAN, NORTON 1992)

The four perspectives of the BSC can be described as follows:

The financial perspective – The financial perspective demonstrates whether the implementation and execution of a strategy is successful and leads to profit-oriented improvements. Here the objectives of an organization are determined based on the expectations of a shareholder. The single measures target on the improvement of financial performance based on a cause-and-effect relationship. The financial perspective takes an important role as the financial objective of an enterprise gives direction to the formulation and of objectives and measures in the other perspectives. Examples of measures are: revenue growth, cost reduction, asset utilization. (KAPLAN, NORTON 1996a; KAPLAN, NORTON 1996b; GILLES 2003)

The costumer perspective – This perspective aims at identifying important customer and market segments of the enterprise and determining appropriate performance measures. It comprises general, cross segmental measures that ensure the success of the enterprise's strategy. These measures include for example customer satisfaction, new customer acquisition, and customer profitability (BISCHOF 2002). Furthermore measures referring to the

enterprise value proposition should be considered, too. Value propositions are defined by e.g. product and service characteristics, customer relations, image, and reputation. (KAPLAN, NORTON 1996a; KAPLAN, NORTON 1996b; GILLES 2003)

The internal-business-process perspective – This perspective serves to identify critical business processes essential for internal improvements in order to satisfy the demands of customers and the expectations of stakeholders. The focus of the internal-business-process perspective is not only on the improvement of existing operating processes but also on the development of new processes. Innovations should be identified and initiated along the business value chain to guaranty future financial success. This perspective includes objectives and measures regarding the long term innovation cycle and the short term production cycle. Examples are measures focusing on the process time like lead time, or measures focusing on the process quality like the amount of waste produced. (Kaplan, Norton 1996a; GILLES 2003; WAGNER 2002)

The learning and growth perspective – This final perspective aims in creating the necessary infrastructure the objective of the previous mentioned perspectives and so ensure long-term growth and improvement. Thus the learning and growth perspective is crucial for the current and future success of the enterprise. The infrastructure consists of the three components people, systems and processes. Enterprises have to invest in further education, improving information technology and processes. Examples of basic measures are employee satisfaction, company loyalty, and re-skilling employees. (GILLES 2003; KAPLAN, NORTON 1996a)

The four perspectives of the BSC provide a balance between short-term and long-term goals, leading and lagging indicators, and hard objective and soft subjective measures. An essential aspect of the BSC is that the four perspectives are closely linked to each other based on a cause-and-effect relationship. The success of a strategy depends on the interactions between the identified measures and objectives. Therefore measures should not be considered in isolation. (KAPLAN, NORTON 1996a)

The BSC has met criticism as it does not consider the interest of all stakeholders of an enterprise business. Missing are e.g. suppliers, competitors, and regulators. Another point of criticism is that the BSC hardly gives advice on how appropriate measures can be identified, established and used to manage a business. (METAWIE, GILMAN 2005; TANGEN 2004)

4 A Preliminary Framework of a Step-by-Step Approach for Decision Support

To shortly sum up, so far food safety and quality regulations and their general relations to enterprises has been investigated (chapter 2). As regulations might affect the enterprise behaviour and performance, theory dealing with enterprise behaviour, enterprise performance and performance measurement has been presented (chapter 3). Based on that, chapter 4 presents a preliminary framework of a step-by-step approach for decision support. The main contribution of this chapter is:

- an insight into the concept of decision aiding,
- a preliminary framework of a step-by-step approach for decision support serving as the working hypothesis for the following study, with
    - an argumentation line which presents the enterprise compliance behaviour in general,
    - a concept of combining clusters and tendencies to norms which lead by following through to the desired outcome.

Underneath figure 4-1 presents the structure of chapter 4.

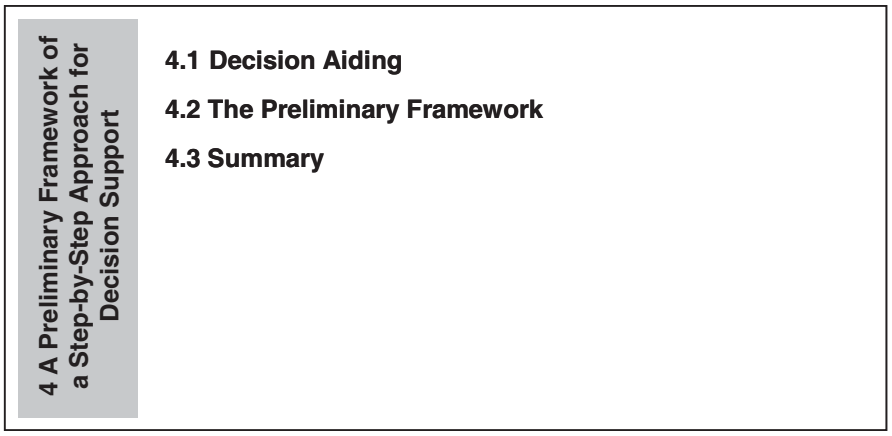

Figure 4-1: Overview of chapter 4

4.1 Decision Aiding

In most cases a decision is not based on a single action. In fact the period leading up to the final action is full of fragments or constraints of this decision. Therefore the concept of a

decision must be seen more as a process whose progress is punctuated by a certain number of critical points. Consequently the final comprehensive decision is mainly determined by these critical points in the decision process (ROY 1996). Because decisions today are increasingly complex and interrelated QUDRAT-ULLAH ET AL. (2008) refer to 'a dynamic decision making'. Dynamic decision making is characterised by the following: a number of decisions is required rather than a single decision, decisions are interdependent, and the environment changes, either as a result of decisions made or independently of them or both (EDWARDS 1962). See also the concept of system dynamic thinking given in chapter 1.2.

In some cases, simple observation is sufficient to reach a decision. However, in the case of a complex and dynamic decision process, a more formal model is necessary to understand the factors affecting decision making. According to ROY (1996, p. 7) a model can be defined as "a schema which, for a certain family of questions, is considered as a representation of a class of phenomena that an observer has more or less carefully removed from their environment to help an investigation and to facilitate communication." The model assists in understanding, reasoning about reality, communicate the results, and so aid the decision. ROY (1996, p. 10) defines decision aiding as the "activity of the person who, through the use of (…) formalized models, helps obtain elements of responses to the questions posed by a stakeholder of a decision process. These elements work towards clarifying the decision (…)".

The method proposed by ROY (1996) to deal with analysis in the context of information acquisition and solution formation can be divided into the following four steps:

(1) The object of the decision is clarified in order to identify the critical points of the decision which should be modelled. Furthermore the impact of the recommendation, which the analyst should present, has to be defined.

(2) The consequences of possible decisions which could be relevant for the objective has to be identified. The question to answer is which of these consequences should be modelled and how.

(3) The criteria, which capture best the essence of the consequences for decision aiding, should be defined. Especially in multi-criteria analysis the challenge is how to aggregate performance measures on various criteria to judge the action positive or negative. In this stage it is pointed out what detailed information will be collected and developed for modelling. Consequently the options taken here will determine the procedure that leads to the recommendation.

(4) The information which leads to the final decision are processed. It can be distinguished between a decision aiding process that should lead to a choice, a sorting or a ranking.

The four levels should not be considered as static ordered, rather more as a guideline. Some steps can start before others are finished, and steps may have to be reconsidered, after the subsequent steps are finished.

The procedure of decision aiding presented above is comparable to the one of QUDRAT-ULLAH ET AL. (2008). Their decision model consists principally of the following three levels:

(1) The objective of the decision authority is defined.
(2) The regulatory framework, i.e. the space of available policy activities, is determined.
(3) A cause-and-effects model is elaborated, which allows for the identification of the effects of intervening regulation.

Looking at the stakeholders of a decision aiding process ROY (1996) distinguishes between three kinds of stakeholders. There is always one stakeholder who is being aided, so it is on his behalf that the decision aid is applied. This stakeholder is called the 'decision maker'. Often the decision maker does not have the background to appropriately manage preconditions to make a decision. For this reason the stakeholder who is performing the aid is generally different from the decision maker. This stakeholder is called the 'analyst', usually an expert or specialist. The analyst's role is to make the model explicit and to enlighten the decision maker about the consequences of a certain type of behaviour. A third type of stakeholder, the 'client', acts as a kind of mediator between the decision maker and the analyst. This is the person who requests the study and who is responsible for the organization of the study, which delivers the input for the decision supporting system. Nevertheless this stakeholder can also play the role of an analyst if he has expert knowledge on an appropriate field. ROY (1996) defines this stakeholder as the 'client'.

4.2 The Preliminary Framework

Based on the previous section the three main steps of a model to understand decision making are applied on the given research problem:

(1) The object of the decision is clarified. – The object of the decision is the enterprise compliance behaviour determining possible consequences. New food safety and

quality regulations are passed in order to make the enterprises act according to the regulations' requirements. Analysing the enterprise compliance behaviour aids policy makers deciding for or against a food safety and quality regulation proposal.

(2) The regulatory framework is defined. – The regulatory framework contains the requirements and the scope; i.e. which enterprises are affected. It is the starting point of the cause-and-effects relations. Thus it is the starting point of the step-by-step procedure, too and considered in the framework at the very beginning.

(3) The cause-and-effect model is elaborated. – To identify the complexity of the problem and to visualize the focal steps the processes are broken down to the most important ones. To reach an objective on the society level (e.g. improving human health), policy imposes regulations (e.g. food safety and quality regulations) on enterprises. The affected enterprises respond by a specific behaviour, i.e. complying with the regulation to a specific degree or not complying. Based on the enterprise's behaviour there might be consequences on the enterprise level (see chapter 2.3) as well as for other institutions in society (see multi-level approach in section 1.2).

Considering the introduction to a multi-level approach in section 1.2 and the research objectives in section 1.3 the modelling framework focuses on the enterprise level.

The preliminary framework of a step-by-step approach for decision support (figure 4-2) serves as a working hypothesis to fulfil the first research objective which is to generate a step-by-step approach for regulatory decision support in food policy. The preliminary framework considers:

(1) an argumentation line which explains the enterprise compliance behaviour in general, and

(2) combinations of clusters and tendencies to norms which lead by following through to an appropriate outcome.

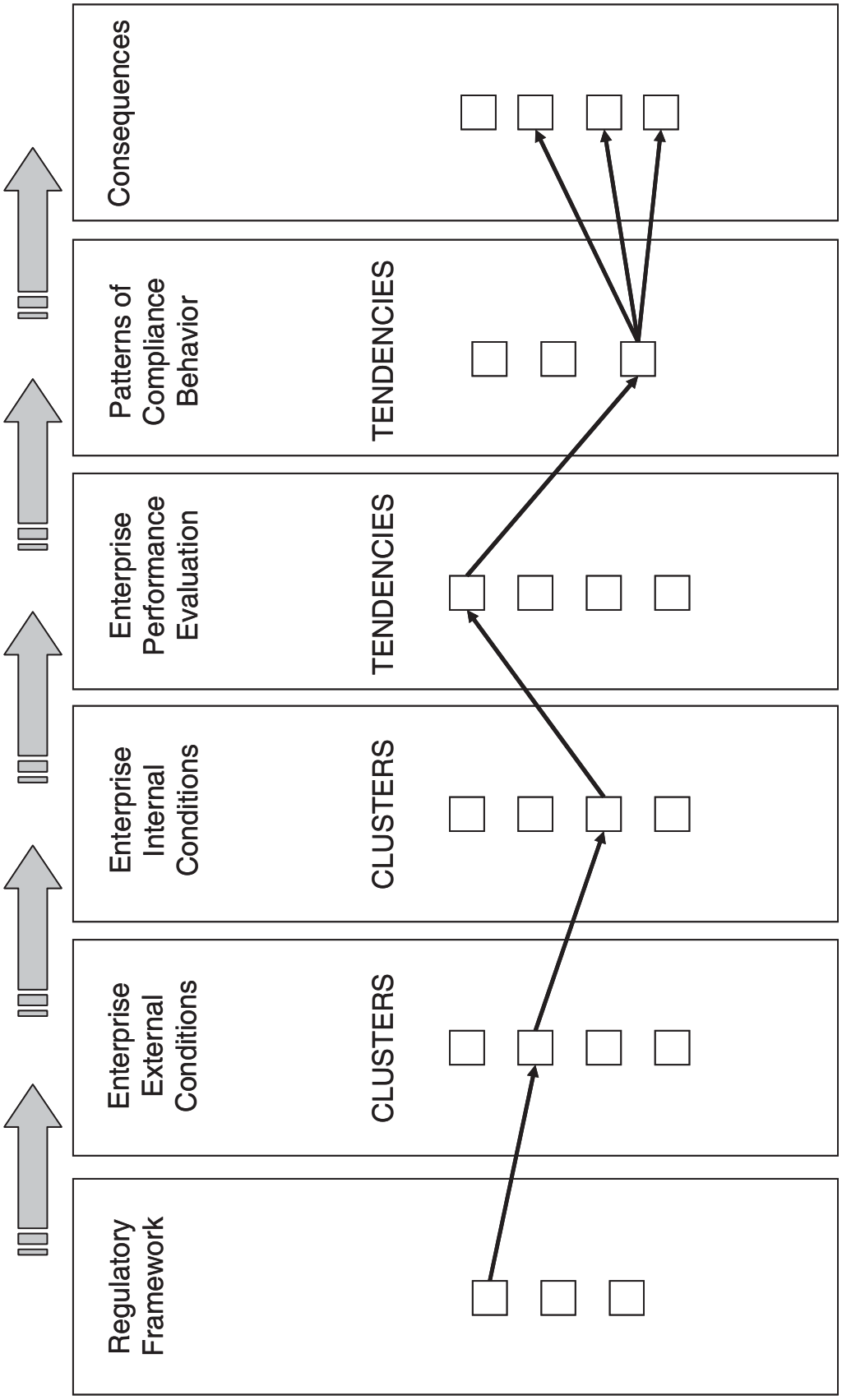

Figure 4-2: The preliminary framework

The steps of the argumentation line shown in figure 4-2 are:

(1) Regulatory framework,
(2) Enterprise external conditions,
(3) Enterprise internal conditions,
(4) Enterprise performance evaluations,
(5) Patterns of compliance behaviour, and finally
(6) Consequences.

The argumentation line is based and enhanced on theoretical background given in the literature review of chapter 2 and 3. The general argumentation line can be shortly explained as follows:

The regulatory framework (1. argument) includes the requirements and defines the scope of the regulation and thus it is the starting point of the argumentation line.

Industry structure determines the conduct of an enterprise (chapter 3.2). That means that the external conditions (2. argument) of an enterprise, e.g. the overall situation in a country or the industry sector, affect the actions of an enterprise, e.g. production processes. In addition to the external conditions, internal conditions (3. argument) like enterprise size affect the enterprise actions, too (chapter 2.3).

In turn, the conduct determines the performance of a firm (chapter 3.2). To fulfil regulation's requirements an enterprise has to take actions which can have positive, e.g. higher quality, or negative effects, e.g. increase in cost, on the enterprise performance (chapter 2.3). In addition, the principles of performance measurement are used to see the effects of action taken within the enterprise on the enterprise performance (chapter 3.3). The argument enterprise performance evaluation (4. argument) considers the actions taken within an enterprise and their effects on the enterprise performance.

There has to be at least a non-negative effect on the enterprise performance to act according to the food safety regulations (chapter 2.3). Thus, based on the outcome of the argument enterprise performance evaluation the patterns of compliance behaviour (5. argument) are judged.

Finally there are several consequences a policy decision maker might be interested in. The consequences can be on different levels (chapter 1.2). Independent on the interest of the decision maker all possible consequences (6. argument) depend on the enterprise compliance behaviour. Possible consequences for an enterprise itself are represented within the previous argument in terms of changes in the enterprise performance. Other consequences are not considered in the further elaboration of the framework.

Furthermore in figure 4-2 different items are indicated below each argument mentioned as clusters or tendencies. The combination of different clusters and tendencies, each related to one argument, describes a norm that by following through leads to the desired outcome. The arrows in figure 4-2 indicate a possible norm to follow through. To each argument a limited number of clusters and tendencies are assigned. The huge amount of different combinations allows considering different situations. In addition this procedure constitutes the idea of a filter concept. Following a norm means including some clusters and others not. Thus several clusters are not further considered in following through the norm. For example a regulation is made for specific enterprises with defined external conditions, e.g. enterprises in the cereal industry. Because of the filter concept the following steps would consider only enterprises in the cereal industry, all others are filtered out. This concept reduces the complexity of the decision situation by focusing only on critical points and breaking the overall decision down to several smaller decisions (compare section 4.2).

4.3 Summary

The preliminary framework of a step-by-step approach for decision support presents a baseline of a norm that states if an enterprise in a specific situation, defined by external and internal conditions, facing a food safety regulation with given requirements will behave in a causal way. The framework considers a key point of decision aiding, i.e. breaking down complexity, by concentrating only on a few critical steps and by thinking in terms of clusters and tendencies.

The framework distinguishes a variety of areas that need further consideration through research. First it involves the identification and definition of the single arguments in the step-by-step approach. Second it is necessary to gather knowledge that enables the analyst to take each small decision linked to the single steps, combining clusters and tendencies to an

appropriate norm. These challenges will be approached in the following chapter implementing and further developing the preliminary framework according to a defined scenario.

5 Case Study: Generating a Step-by-Step Approach for Decision Support

Chapter 4 presented and discussed the preliminary framework of a step-by-step approach for decision support. To fulfil the first research objective, i.e. to generate a step-by-step approach for regulatory decision support in food policy, further consideration through research is necessary. In this chapter the preliminary framework will be validated and specified based on two decision scenarios. The aims of the study are to:

- identify the structure of the cereal industry in the EU specifying the decision scenarios,
- decide on a sequence of arguments appropriate for the decision scenarios,
- collect given knowledge backing up each argument, and finally
- present a step-by-step approach for decision support adjusted to the decision scenarios.

Underneath figure 5-1 presents the structure of chapter 5.

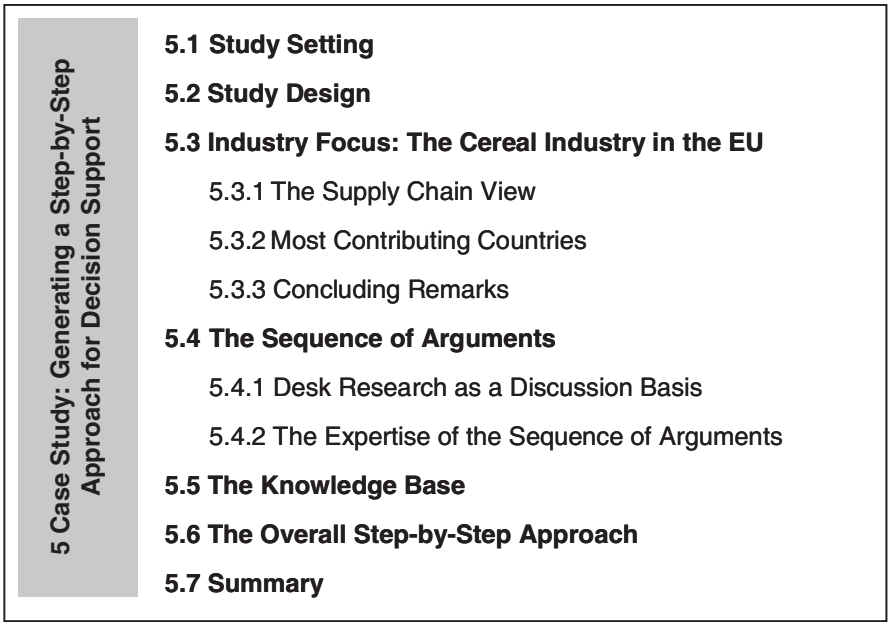

Figure 5-1: Overview of chapter 5

5.1 Study Setting

The study is done in connection with a European Union research project called MoniQA. The MoniQA project was established as a network of excellence for considering quality and safety control strategies for food. Its objective is to contribute to the harmonization of analythical methods for monitoring food quality and safety. The focus of MoniQA are the technologies and processes available or under development for tracing hazardous substances in food. For more information see www.moniqa.org.

Within this project there is a working group with the subject of wider socio-economic implications of existing and future food safety regulations. Its aim is to design a framework that allows the identification and systematic impact assessment of food quality and safety regulations at different levels. This work discussed already the approach of taking different levels into account while explaining the overall problem situation in chapter 1.2. Chapter 1.3, the research objective, arranged this work in the overall problem situation and thus in the task of the working group, too. As the following study is done in connection with the mentioned EU project, the study setting conforms to the specifications of the EU project.

The operationalisation of the preliminary framework (chapter 4) has to be based on specific decision scenarios. The scenarios under consideration involve:

(1) a new regulation on the exposure to allergens in food, and

(2) a new regulation on the use of pesticides.

Within this scenarios the following regulation respectively directive have been selected by the project to build on the study. According to the possible scenarios mentioned above the focuses lay on (1) allergens and on (2) pesticides.

(1) *Proposal for a Regulation of the European Parliament and the Council on the provision of food information to consumers* - The draft proposal consolidates and updates two areas of labelling legislation, the general food and nutrition labelling respectively covered by Directive 2000/13/EC and 90/496/EEC. Directive 2000/13/EC lays down common labelling requirements applicable to all foods to be delivered to the final consumer, and to food supplied to mass caterers. Directive 90/496/EEC introduces mandatory labelling of key nutritional elements in the principal field of

vision. In the study the focus is on labelling of certain substances causing allergies or intolerances. (EUROPEAN COMMISSION 2008)

As most of the proposal's content is out of the study's scope the full version is not added to the thesis. The main excerpts of the proposal affecting the study are added to the appendix of the thesis (appendix A).

(2) *Directive 2009/128/EC of the European Parliament and the Council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides* - The directive covers only pesticides which are plant protection products. Core areas of the Directive's requirements are e.g. training for professional users, inspection of pesticide application equipment, protection of the aquatic environment, drinking water, and sensitive areas. (EUROPEAN COMMISSION 2009a)

The main excerpts of the Directive affecting the study are added to the appendix of the thesis (appendix B).The full version is not added to the thesis.

Furthermore the project opts for the EU cereal industry as a possible addressee of the given regulations in this exemplary decision situation. Here a further detailed analysis of the industry structure is necessary to identify the main stakeholders.

5.2 Study Design

The study design describes the steps followed in the research to arrive at the outcome, i.e. the step-by-step approach for decision support. The steps consider the study setting as well as the two-sided structure of the preliminary framework.

The study's course of actions is as followed:

(1) As mentioned in the previous section the underlying EU project decided to apply the model on the cereal industry in the EU. Thus a detailed analysis and understanding of the cereal industry is necessary. Literature, statistical data, and a given case study in a German flour mill supply chain have been analysed to get an insight into the cereal supply chain and to identify the dominant EU member states (section 5.3).

(2) According to the preliminary framework first arguments have to be identified and brought in a defined sequence which determines the norm to follow. To reach that goal first desk research was done (section 5.4.1). Already existing information have been gathered by analysing food safety regulations, case studies and surveys in that field. This information built the bases for further intensive expert discussions (section 5.4.2). Several experts in the field of food economics, food law, and food policy have been interviewed to identify appropriate arguments and to generate a sequence of these arguments fitted to the given decision scenario.

(3) In the next step knowledge has been developed to back up the arguments. For this reason already given information is gathered from statistical data, case studies, surveys, etc. Furthermore a survey targeted on identifying the compliance level of quality management systems has been addressed to several certification bodies in the EU. Another survey has been prepared to identify cost related information in the use of methods to identify allergens, which should back up the process of enterprise performance evaluation. Detailed information is presented in section 5.5.

5.3 Industry Focus: the Cereal Industry in the EU

In the EU-27, the main crops grown on arable land are cereals. According to the harvested production in the EU, the main crops are (in 1000 tonnes in 2009): cereals (ca. 296000), sugar beet (ca. 111000), rape (ca. 21000), and sunflower (ca. 7000). These crops are produced in almost all EU member states. However, a small group of four countries is responsible for the bulk of the production. Looking at cereals the main producers are France, Germany, Poland, and the United Kingdom (UK). (EUROSTAT 2010)

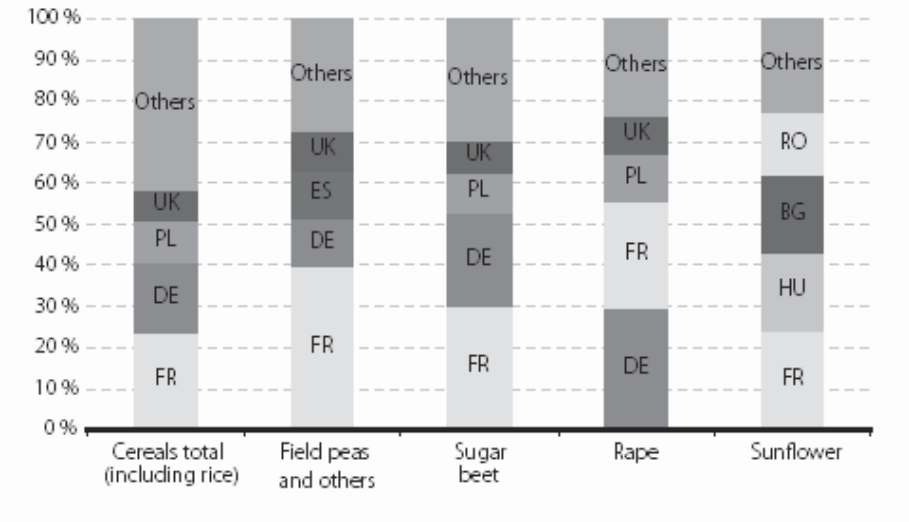

Figure 5-2: Share of crop production between main EU countries, 2009 (EUROSTAT 2010)

The most important cereal in the EU is wheat with a production level of about 139 million tones. The production of barley and grain maize is much less (62 and 58 million tons). Underneath, figure 5-3 highlights the importance of wheat, which represents almost half of the cereals production. In line with the cereal production, the production of wheat is concentrated in a few countries, too. France, Germany, UK, and Poland account for more than 60% of the production. France and Germany are producing even 46% of the total EU production. (EUROSTAT 2010)

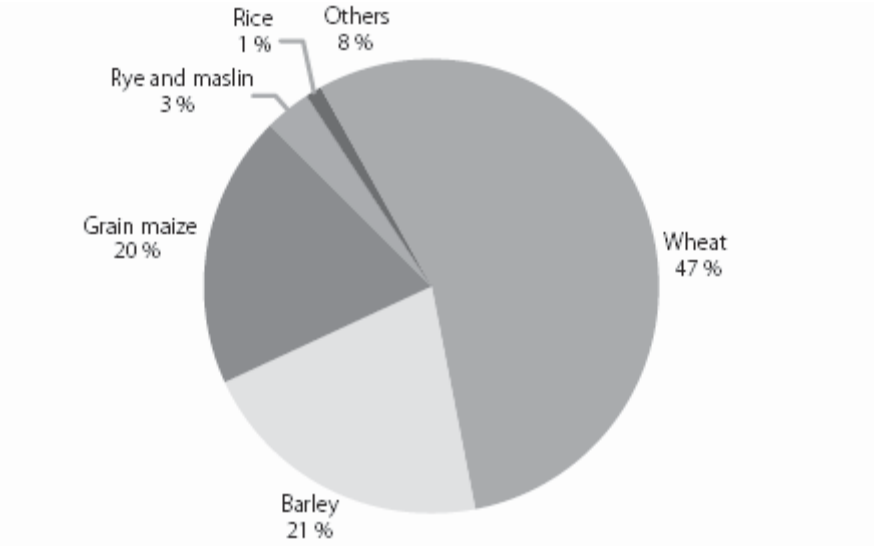

Figure 5-3: Main types of cereals based on the harvested production, 2009 (EUROSTAT 2010)

The case studies are focusing on the cereals industry, taking a supply chain view. According to the above given information, wheat is the main product. The following part presents a deeper insight in an important EU cereal supply chain. (EUROSTAT 2010)

5.3.1 The Supply Chain View

To guarantee high quality of the final product for the consumer food quality has to be ensured along the entire food supply chain, which includes all production stages from farm to retail (LUNING ET AL. 2002). A trend for quality management not only within an organisation but for quality requirements across the stages of the food supply chain is observable (SCHIEFER 2003). Thus, this work takes a supply chain view in the study. Wheat grain as food is used to make flour for bread, biscuits, cakes, pasta, alcoholic beverages, and some more. Wheat is also used as a forage crop for live stock, which is not of interest for this research. Based on literature research and on a case study in a German flour mill supply chain the main members of the cereal supply chain are identified. Focal point is the flour mill, milling wheat grain to flour as basis product for further food processing.

The suppliers of flour mills

In principal there are three possibilities for flour mills to acquire crop: crop retail, other flour mills, farmers or crop imports. Most of the crop is bought from crop retail or also from other flour mills. Acquisitions from farmers take about 20% of the milled crop. In average acquisition of crop imports are of less importance, wheat imports as well as rye imports. During the last years the import quota for Germany differed from 6% to 10%. Independent if the flour mill purchase the flour directly from the farmer or not, they are the producer of the raw product wheat.

The customers of flour mills

During the last years in Germany the average rate of exported flour mill products was about 8% to 9%. The export business is dominated by the large flour mills; almost 90% of the exported products are milled in flour mills with more than 100,000 tons capacity per year (VDM 2006). Nevertheless for small flour mills, which are not very well located to market, export business can be an important way for sales (DAUS-SPEICHER 1999).

About 3% of the milled crop will be processed in the own company to nutriments, bakery improvers and other products. Also about 3% stay at the flour mill as ending inventory (HOLLSTEIN 2001).

The main amount of milled crop is sold to the home market (85%; HOLLSTEIN 2001). The focal company is the flour mill, which produces mainly the typical bakery flour (type

550+630) and the typical household flour (type 405). Both together they represent 90% of the flour. The most important customers of flour mills are certainly bakeries with a turnover of flour of about 80%. It is important to distinguish between industrial bakeries and craft bakeries to consider the differences in product distribution. The business trend is that craft bakeries have one place of production and some local stores, where the products are directly sold to the end-consumer. Nevertheless, there are still a lot of craft bakeries, where production and sale is in the same location (ZENTRALVERBAND DES DEUTSCHEN BÄCKERHANDWERKS E.V. 2007). Industrial bakeries market their products via food retail, which is the following step in the supply chain, to the end-consumer (HOLLSTEIN 2001). The marketing channel with the second largest turnover of flour is sales of household flour to food retail, which takes about 8% of the flour. Food retail markets household flour via their local stores to the end-consumer.

The information above given by literature can be confirmed by the results of a case study in a German flour mill supply chain. The case study analysed the main distribution channels of flour mills by expert interviews with a representative of the second largest flour mill company in Germany, the German flour mill association, the association of the German craft bakeries, and the association of producers of bakery improvers. Summarising the results, the three main distribution channels in the cereal supply chain are:

(1) Agricultural holding – flour mill – craft bakery (46%*) – end-consumer
(2) Agricultural holding – flour mill – industrial bakery (24%*) – food retail – end-consumer
(3) Agricultural holding – flour mill – food retail (8%*) – end-consumer

* Proportion of flour

More detailed information about the case study is given in KRAPP (2008).

5.3.2 Most Contributing Countries

Primary production - agricultural holding

As already mentioned the production of cereals is concentrated in a few EU countries. In 2007 France, Germany, Poland, Spain, UK, and Italy produced more than 70% of all cereals in the EU. The agricultural holdings of France, Germany, UK, and Italy stand already for more than 50% of the cereal production.

Table 5-1: Most contributing countries growing cereals, 2009 (EUROSTAT 2010)

Country	Harvested production (rounded in %)	Country	Harvested production (rounded in %)
EU-27	100	Lithuania	1
Belgium	1	Luxembourg	0
Bulgaria	2	Hungary	5
Czech Republic	3	Malta	0
Denmark	3	Netherlands	1
Germany	17	Austria	2
Estonia	0	Poland	10
Ireland	1	Portugal	0
Greece	12	Romania	5
Spain	6	Slovenia	0
France	24	Slovakia	1
Italy	5	Finland	1
Cyprus	0	Sweden	2
Latvia	1	United Kingdom	7

Processor of food products

The EU's food, beverage and tobacco manufacturing sector (NACE subsection DA in EUROPEAN COMMISSION 2001) comprised about 309 thousand enterprises and 4.7 million persons employed in 2006. Within this sector the largest activity was the manufacture of bread, sugar, confectionary and other food products (NACE group 15.8) contributing about 37% of sectoral value added and 44% of sectoral employment. Around one half of the value added generated by the food, beverages and tobacco manufacturing sector in 2006 came from just three countries: Germany (18%), UK (17%) and France (15%). (EUROSTAT 2009a)

Table 5-2: Manufacture of food products, beverage and tobacco: most contributing countries, 2006 (EUROSTAT 2009a)

	Highest value added		Largest number of persons employed	
	Country	% of EU-27	Country	% of EU-27
1	Germany	18	Germany	18
2	United Kingdom	17	France	14
3	France	15	Italy	10
4	Spain	10	Poland	10
5	Italy	10	United Kingdom	10

Processor of food products – flour mills

Flour mills are processing grain. The processing of grain mill and starch products (NACE group 15.61) is one of the smaller food processing activities. In 2006 there have been about 8.0 thousand enterprises across the EU. These enterprises employed 121.2 thousand people and generated EUR 6.6 billion of added value, the equivalent of 2.6% of the employment and

3.4% of the value added within the food, beverages and tobacco manufacturing sector. Almost two thirds (67%) of the value added generated by grain mill and starch products manufacturing came from activities in the UK, France, Germany and Italy. (EUROSTAT 2009a)

Processor of food products – bakeries

Bakeries are processing mainly bread and pastry. Within the sector bread, sugar, confectionary and other food products, the largest activity was the manufacture of bread, fresh pastry goods, and cakes (NACE class 15.81). It generates about 40% of sectoral value added and accounted for 65% of people employed in 2006. In the upper level sector bread, sugar, confectionary and other food products almost two third of the value added in 2006 was generated by Germany, UK, France, and Italy. (EUROSTAT 2009a)

Table 5-3: Manufacture of bread, sugar, confectionary and other food products: most contributing countries, 2006 (EUROSTAT 2009a)

	Highest value added		Largest number of persons employed	
	Country	**% of EU-27**	**Country**	**% of EU-27**
1	Germany	19	Germany	21
2	United Kingdom	17	France	14
3	France	15	Italy	12
4	Italy	11	United Kingdom	9
5	Spain	7	Poland	8

Food retail

Food can be sold in non-specialized stores. Here the Eurostat classification system NACE distinguishes between retail sale in non-specialized stores with food, beverages or tobacco predominating (NACE class 52.11) and retail sale with non-food products predominating. Examples of non-specialized stores are supermarkets, hypermarkets, or convenience stores. The wealth generated within the sector of retail sale in non-specialized stores mainly came from retailers with food beverage, or tobacco predominating, more than four fifths value added in 2005. The predominant countries in terms of value added and persons employed are UK, Germany, and France, who contribute more than 50% of value added. (EUROSTAT 2009a)

Table 5-4: Food retail in non-specialized stores: most contributing countries, 2006 (EUROSTAT 2009a)

	Highest value added		Largest number of persons employed	
	Country	**% of EU-27**	**Country**	**% of EU-27**
1	United Kingdom	24	United Kingdom	21
2	Germany	17	Germany	15
3	France	16	France	11
4	Spain	10	Poland	8
5	Italy	8	Italy	8

Food can be also sold in specialized stores. Food retailing specialized are generally small retail outlets, for example, fruit and vegetable shops, bakers, and butchers. In the sector specialized in-store food retailing there is the sub-sector retail sale of bread, cakes, flour confectionery and sugar confectionery (NACE class 52.24), which generates with 67,000 enterprises a value added of about EUR 4.1 million and employs 264,000 persons. This counts for 16% of value added and 18% of persons employed of the upper-level specialized in-store food retailing. In this level Italy, Spain, and UK contribute more than 50% of the value added. (EUROSTAT 2009a)

Table 5-5: Food retail in specialized stores: most contributing countries, 2006 (EUROSTAT 2009a)

	Highest value added		Largest number of persons employed	
	Country	**% of EU-27**	**Country**	**% of EU-27**
1	Italy	18	Spain	18
2	Spain	18	Italy	15
3	United Kingdom	16	United Kingdom	13
4	France	13	Germany	13
5	Germany	13	Poland	8

5.3.3 Concluding Remarks

The case study focuses on the cereals industry in the EU. This chapter analyses the cereal supply chain in Germany and presented the most important distribution channels including the main stages of production. Each stage of production is analysed on the EU level according to its magnitude in the sector and between the EU countries. According to the information presented the following supply chain are to be considered:

(1) Agricultural holding – flour mill – bakery – retail – end-consumer, and

(2) Agricultural holding – flour mill –bakery – end-consumer.

The EU countries of interest are:

(1) Germany,

(2) France,

(3) Italy, and

(4) UK.

The four countries together generate more than 50% of EU's cereals production, and contribute about two third of value added in the sectors of manufacturing grain mill products, manufacturing bread, and food retail.

5.4 The Sequence of Arguments

5.4.1 Desk Research as a Discussion Basis

In chapter 4 the preliminary framework of a step-by-step approach presented a very basic argumentation line to come to the desired outcome. As mentioned the presented preliminary framework is based on general theory (chapter 2 and 3). The goal of chapter 5 is to go a step further and identify appropriate arguments for the given decision scenario which was already presented in detail in section 5.1. Section 5.2 presented the study procedure. To be well prepared for the expert discussions first a review of given knowledge related to the problem situation was done. The desk research focused on EU regulations, case studies, surveys and other already given information in that field to find information related to regulatory frameworks, enterprise's external and internal conditions, performance evaluation, and the enterprise compliance behaviour. The main findings are presented below.

The first step of the argumentation line focuses on the regulatory framework. Section 5.1 gave an introduction to the different regulatory frameworks. In the following the term regulation is used for all different regulatory frameworks and any legislative acts according to requirements on food quality and food safety. The regulation determines the focus of the step-by-step approach and affects each single step of the further procedure. The regulation defines its scope; i.e. its addressees, all enterprises which are affected by the regulation and are requested to act according to the requirements. And it also defines its requirements; i.e. what the enterprise is expected to do.

According to HENSON, HEASMAN (1998), a key issue in interpreting a regulation is the consideration if a specific firm falls under the remit of the regulation. Consequentially, a question of importance is: 'Which enterprises fall within the limits of the regulation?' Several regulations have been analysed to understand by which criteria a regulation determines which

kind of enterprise has to act according to the requirements. Underneath table 5-6 lists the analysed regulations, which are partly already mentioned in section 2.1, and presents criteria by which the regulations describe their scope.

Table 5-6: Criteria characterising affected enterprises

Source		Criteria
Regulation (EC) No. 178/2002	Laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety	Regional focus, Stage of production
Regulation (EC) No. 2160/2003	On the control of salmonella and other specific food-born zoonotic agents	Stage of production
Regulation (EC) No. 852/2004	On the hygiene of foodstuffs	Stage of production
Regulation (EC) No. 853/2004	Laying down specific hygiene rules for the hygiene of foodstuffs	Industry sector, Food stuff, Stage of production
Regulation (EC) No. 854/2004	Laying down specific rules for the organisation of official controls on products of animal origin intended for human consumption	Industry sector, Food stuff
Regulation (EC) No. 2073/2005	On microbiological criteria for foodstuff	Industry sector, Food stuff
Regulation (EC) No. 2074/2005	Laying down implementing measures for certain products under Regulation (EC) No. 853/2004, for the organisation of official controls under Regulation (EC) No. 852/2004 and amending Regulations (EC) No. 853/2004 and (EC) No. 854/2004	Industry sector, Stage of production
Regulation (EC) No. 2075/2005	Laying down specific rules on official controls for Trichinella in meat	Industry sector, Stage of production
Regulation (EC) No. 2076/2005	Laying down transitional arrangements for the implementation of Regulations (EC) No. 853/2004, (EC) No. 854/2004, (EC) 882/2004 and amending Regulations (EC) No. 853/2004 and (EC) No. 854/2004	Industry sector, Food stuff
Regulation (EC) No. 479/2007	Amending Regulation (EC) No. 2076/2005 laying down transitional arrangements for the implementation of Regulations (EC) No. 853/2004, (EC) No. 854/2004, (EC) No. 882/2004 and amending Regulations (EC) No. 853/2004 and (EC). No 854/2004	Regional focus
Regulation (EC) No. 1244/2007	Amending Regulation (EC) No. 2074/2005 as regards implementing measures for certain products of animal origin intended for human consumption and lying down specific rules on official controls for the inspection of meat	Industry sector, Food stuff

Next information is analysed related to those arguments indicated in the preliminary framework as external and internal enterprise conditions. As explained in section 4.2 the argumentation line has to explain the enterprise behaviour. Literature analysing the relation between regulations and enterprise behaviour has been studied to understand which criteria affect the enterprise compliance behaviour. These criteria may represent external as well as internal enterprise conditions and so might be useful for building up a sequence of arguments. Underneath table 5-7 lists the studied literature and presents the criteria identified.

Table 5-7: Criteria affecting compliance behaviour

Source		Criteria
HENSON 2006	The Role of Public and Private Standards in Regulating International Food Markets	Regional focus, Stage of production
HENSON, CASWELL 1999	Food safety regulation: an overview of contemporary issues	Firm size
HENSON, HEASMAN 1998	Food safety regulation and the firm: understanding the compliance process	Firm size
HENSON, HOOKER 2001	Private sector management of food safety: public regulation and the role of private controls	Firm size
LOADER, HOBBS 1999	Strategic responses to food safety legislation	Firm size
RUGMAN, VERBEKE 1998	Corporate Strategies and Environmental Regulations: An Organizing Framework	Regional focus
TAYLOR 2001	HACCP in small companies: benefit or burden?	Firm size
UNNEVEHR, JENSEN 1999	The economic implications of using HACCP as a food safety regulatory standard	Firm size
YAPP, FAIRMAN 2004	Factors affecting food safety compliance within small and medium sized enterprises: implications for regulatory and enforcement strategies	Firm size

In addition to the criteria listed above the criteria by which regulations define affected enterprises can be also seen as external enterprise conditions of those enterprises which are affected. Here the question is whether the criteria can serve as an argument in the sequence of arguments. This will be clarified in the expert discussions.

Following the steps in the preliminary framework, next there is the evaluation of the enterprise performance. An introduction to the general theory is already given in section 3.3. In the given decision scenario the impact of a new regulation on an enterprise and its potential change in the enterprise's business performance has to be analysed and evaluated.

Based on HENSON, HEASMAN (1998) after identifying the affected enterprises the next important question in understanding the compliance process of enterprises is: 'How are the enterprises affected?' The aim of this question is to reflect what the enterprise has to do to fulfil the requirements of the new regulation. Here the focus is on changes in different business areas, such as e.g. production processes, product properties and infrastructures, which would be the precondition for complying with the new regulation as the regulation's requirements may refer to it. That indicates the need of analysing the actions an enterprise has to take if it has to fulfil the regulation's requirements. To do so the process of performance measurement is a helping concept, as it quantifies the efficiency and effectiveness of past actions. In this case, past actions are those actions caused by the new regulation's requirements, actions taken in the named business areas. Figure 5-4 visualizes the direct relations of action taken in different business areas and the overall performance.

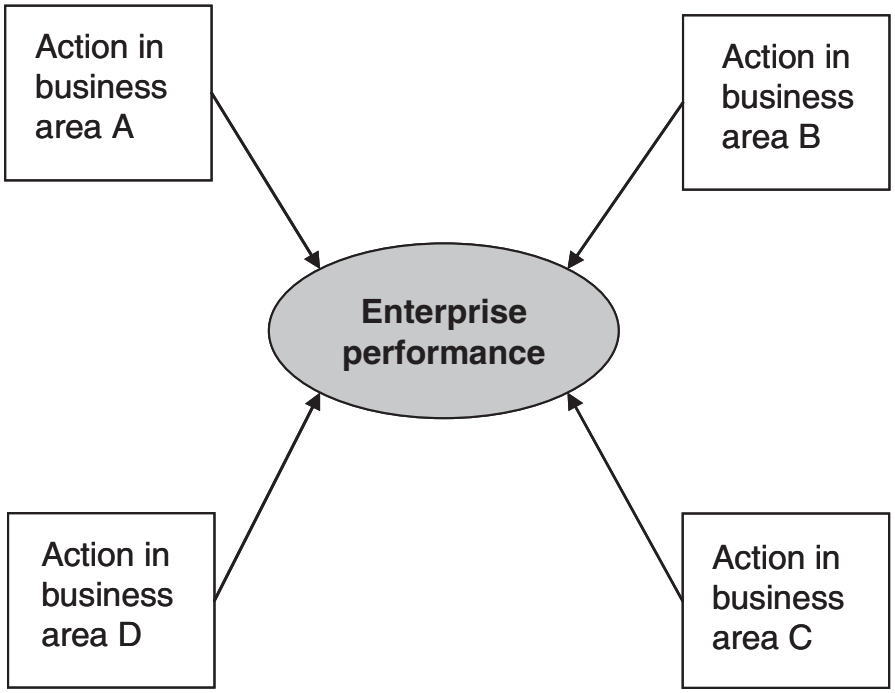

Figure 5-4: Effect of actions in business areas on enterprise performance

Based on the information given in section 3.3 a basic performance evaluation sheet could be elaborated. Its procedure could be as follows: First each single business area which is affected by the regulation's requirements, more precisely, all business areas where the enterprise has to take actions to fulfil the requirements have to be identified and listed. Second the impact of each affected business area on the enterprise business performance has to be evaluated. The impact on business performance is represented by changes in appropriate key performance indicators, e.g. production costs, lead time, and product safety. Performance indicators are

criteria, by which the performance of products, services and production processes can be evaluated. In other words, performance indicators are operationalised process characteristics, which compare efficiency and effectiveness of a system with a norm or target value (ARAMYAN ET AL. 2006). This procedure would enable to evaluate the tendency of the effects on the enterprise business performance; i.e. if the regulation has a positive effect on the enterprise or a negative effect compared to the status quo.

Figure 5-5 displays a very principal structure of the evaluation sheet. Here the effects of the actions an enterprise has to take in business area A, B, etc. on the key performance indicators 1, 2, etc. have to be evaluated.

Performance Evaluation Sheet				
By requirements affected business areas	Key Performance Indicators			
	1	2	3	4
A				
B				
C				
D				

Figure 5-5: Enterprise performance evaluation sheet – principal structure

Having knowledge about the cause-and-effect relations within the enterprise enable to visualize the overall effect on the enterprise business performance. Consequently this information leads to the next step of the preliminary framework, the patterns of behaviour. According to HENSON, HEASMAN (1998) there is a continuum of enterprise responses available, ranging from full compliance to non-compliance. In section 2.3 a differentiation of enterprise compliance behaviour is done by the two extremes of complying with a regulation and not complying with a regulation. An appropriate solution for the given decision scenario is discussed in the expert discussion. According to the hypothesis given in chapter 2 enterprises comply with a regulation if there is at least a non-negative effect on the business performance, in this step the enterprise compliance behaviour has to be judged assisted by the outcome of the previous step.

The desk research presented only very limited results which are general, not targeted to the decision scenario and on top not proven to serve as an argumentation line. As already

mentioned the attention was not to gather results but a baseline of information for effective expert discussions.

In the next part of the study expert discussions should confirm findings, identify gaps, filling these gaps, and finally define a sequence of arguments appropriate for the given decision scenario.

5.4.2 The Expertise of the Sequence of Arguments

To enhance the preliminary framework of a step-by-step approach and attune it to the given decision scenarios expert consultancy is essential. The aim is to end up with an appropriate sequence of arguments targeted on the given decision scenarios. In the next step of the study the research problem is discussed intensively with high level experts on the core fields of economics, food law, and food policy. An expert on food law and food regulations focused on specificities of food regulations and the linkage to enterprises. An expert on agricultural policy focused mainly on the practicability and the appropriateness according to the overall objective. The economic experts focused mainly on the norm affecting the enterprise behaviour and the cause-and-effect relations within enterprises.

The following figure (figure 5-6) gives an overview of the main results of the study and presents the sequence of arguments based on expertise.

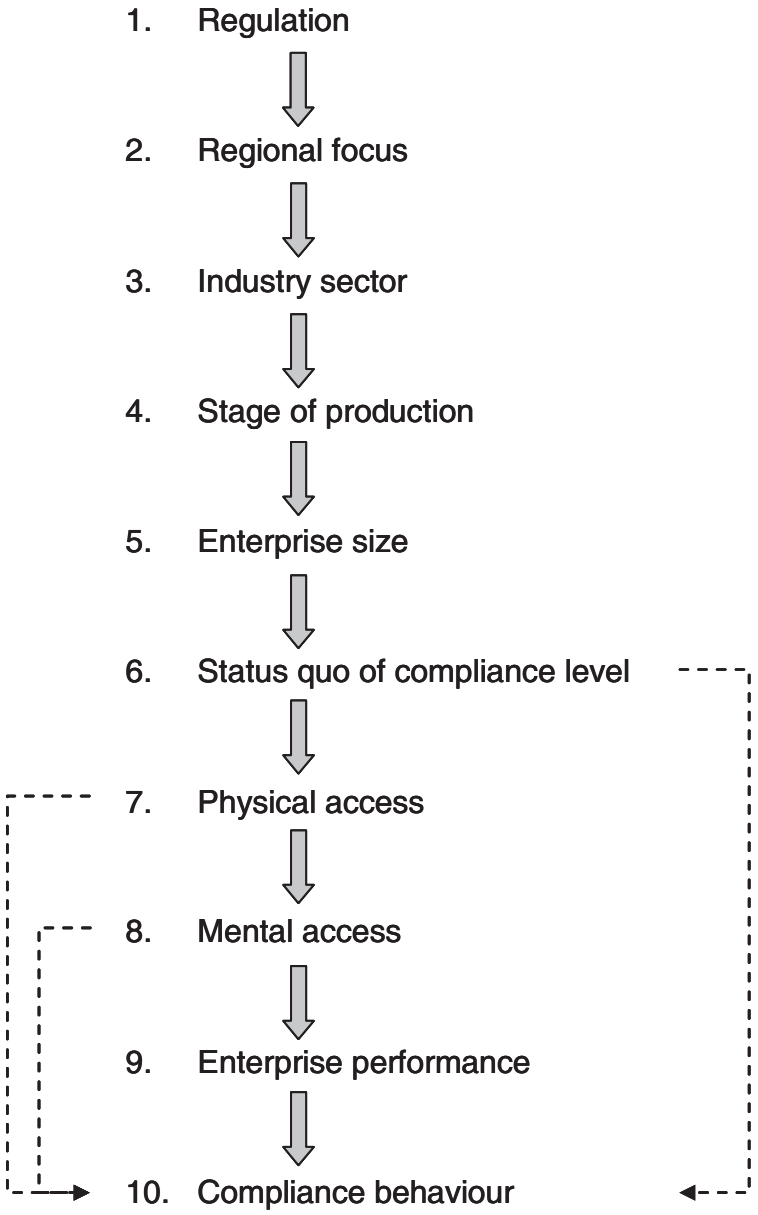

Figure 5-6: The sequence of arguments

Following each argument of the identified sequence of arguments will be explained in detail.

1. Argument: Regulation

The first point in the sequence of arguments is the regulation itself. It defines how an enterprise is affected and which enterprise is affected. It contains information necessary to take the small decisions coming up in the further steps of the approach.

The regulation contains the information according to:

- the scope, i.e. which enterprise falls within the limits of the regulation, and

- the requirements, i.e. what the enterprises have to do to comply with the regulation.

This information has to be figured out by analysing the new regulation. As the content of a regulation determines the further procedure of the sequence of arguments this step is of major importance. Regulations are often complex and hard to understand so it is necessary that the regulation is analysed by an expert who is proficient in understanding a regulation's conclusion for the corresponding enterprise classes.

2. Argument: Regional focus

The second argument represents the regional focus of the regulation and thus the region an affected enterprise is located in. A regulation can be aligned to different regions, e.g. EU member states, a regional authority of a state, or classes of states. In general one can think of various classifications of regions. Appropriate regions for this decision scenario are further discussed in section 5.5. Based on the regulation one has to specify on which region the regulation focuses on. Each region can be described by various characteristics effecting enterprises' business so that e.g. the conditions for an enterprise in Germany are likely to differ from the condition for an enterprise in Romania. Thus by opting for a specific regional focus, external conditions of an enterprise are considered in the argumentation line.

3. Argument: Industry sector

The third argument is the industry sector the regulation focuses on. The regulation may focus only on one industry sector or it doesn't make any exception. Possible industry sectors are for example the ones dealing with meat and meat products, fish and fish products, or fruit and vegetables. For the decision scenario appropriate industry sectors are discussed in section 5.5. As explained for the argument regional focus, also here, based on the regulation one has to specify on which industry sector the regulation is aligned to. Based on that the business environment of the affected enterprise is further characterised and thus elements influencing enterprise behaviour are considered.

4. Argument: Stage of production

The fourth argument deals with the stage of production the regulation is aligned to. The regulation may focus only on one specific stage of production or at the entire production chain. It is of importance to have knowledge about the focal industry sector. According to the structure of the industry sector the main actors can consist of more tiers than just production, process, and retail and there can be more than one player on each step. For example, a supply

chain, which is typical for the focal industry sector, might consist of two main stages of processing. Furthermore some products can be marketed mainly via large retail shops like e.g. supermarkets and hypermarkets. Other products can be marketed mainly via small specialized shops like e.g. bakeries and butchers. Thus it is important to consider the specificities of the industry sector. According to the regulation one has to specify the stages of production which are affected. The stage of production an affected enterprise is in gives information on the enterprise's business and its environment, which influence the enterprise behaviour.

5. Argument: Enterprise size

The fifth argument focuses on the enterprise size of the possible affected enterprises. A size class can be defined by e.g. people employed or turnover. An appropriate way of defining enterprise size classes is discussed in section 5.5. Although regulations normally don't differentiate between enterprise sizes within the description of their scope, for the sequence of arguments a differentiation according to size classes is of use. Having knowledge of the enterprise size one can suggest internal enterprise characteristics, which affect enterprise behaviour. Based on the regulations scope one has to specify either specific size classes or all size classes which characterising the affected enterprises.

Summing up, so far the sequence of arguments helps to

- structure affected enterprises according to the arguments within classes and so filter out all enterprises which are not affected by the regulation, and
- characterise the affected enterprises based on the arguments and the information which are linked to the coordination within each argument.

6. Argument: Status quo of compliance level

The argument status quo of compliance level is totally new comparing with the preliminary framework presented in chapter 4. This argument considers the possibility that an enterprise already fulfils the requirements of the new regulation because of complying with a management system (e.g. quality management system) that includes the requirements of the new regulation. If so, this enterprise would comply with the regulation, too. In this case no further analyses are necessary and one could suggest directly the enterprise compliance behaviour. This reduction of the sequence of arguments is indicated in figure 5-4 by the broken arrow connecting the argument (6) status quo of compliance level with the argument (10) compliance behaviour. The idea of the procedure behind the argument is to look at a

comparable already known scenario, i.e. comparable enterprise classes facing comparable requirements, copying the already given information to the new decision scenario that should be analysed and so judging the enterprise compliance behaviour. If there is already sufficient information to judge the enterprise compliance behaviour this argument would lead directly to the outcome of the enterprise compliance behaviour for the specific analysed enterprise class. Thus for this enterprise class the arguments (7) physical access, (8) mental access, and (9) business performance are redundant.

Based on appropriate information one has to specify for each affected enterprise class, identified at the end of the previous argument, if the enterprise class already fulfils the requirements and thus would comply with the new regulation, too. Section 5.5 will discuss which information is necessary and which information is gathered so far helping to make this specification.

7. Argument: Physical access

The argument physical access is added to the baseline of arguments presented in the preliminary framework. It considers the statement that a precondition for every enterprise class to act according to the requirements is to get information about the new regulation. As indicated above, this argument corresponds to all enterprise classes for whom the compliance behaviour could not be yet identified based on the foregoing argument.

The argument physical access focuses on identifying if the particular enterprise has knowledge about the existence of the new regulation and if the enterprise has the infrastructure to get access to the regulation. One has to judge if each particular enterprise class fulfils these preconditions to be informed about the regulation. If the mentioned preconditions are given the next argument in the sequence of arguments follows. If this is not the case the argumentation line concludes that this particular enterprise class will not comply with the new regulation and thus the compliance behaviour is already suggested as non-compliance. This is indicated in figure 5-4 by the broken arrow connecting the argument (7) physical access with the argument (8) compliance behaviour.

8. Argument: Mental access

The next argument mental access is also added to the baseline of arguments presented in the preliminary framework. It is related to the statement that often enterprises don’t know what

they have to do to comply with the regulation because they don't understand the regulation and so they end up with non-compliance. The argument corresponds to all enterprise classes that are judged in the foregoing argument as having physical access to the regulation.

The argument mental access deals with the enterprise understanding of the regulation. Here one has to judge if the particular enterprise class understands the regulation in terms of what it has to do to fulfil the requirements. If the enterprises of the particular enterprise class understand the requirements the sequence of arguments goes on with the next main argument, (9) enterprise performance. For those enterprises which don't understand the regulation it is concluded that their compliance behaviour is non-compliance. Thus the argument (9) enterprise performance of the sequence of arguments is redundant. In figure 5-4 the broken arrow indicates that in these cases after argument (8) mental access directly argument (10) compliance behaviour follows.

9. Argument: Enterprise performance

The argument enterprise performance is based on the statement that effects on the enterprise performance control the willingness of enterprises to comply with regulations. This argument was already presented in the preliminary framework in section 4.2. The argument corresponds to all enterprise classes which are suggested to have mental access to the regulation so that they could potentially fulfil the regulation's requirements.

The cause-and-effect relations within an enterprise should be analysed to understand possible changes in the enterprise performance. To reach that goal the following procedure is prepared:

In the first step it has to be identified what the enterprise has to do to fulfil the regulation's requirements; i.e. where the enterprise has to take actions in terms of e.g. rearrangements or investments. Important business areas the regulation's requirements may refer to are e.g. the production processes, product characteristics, or the infrastructure environment. One has to specify in which areas the enterprise has to take actions and list them up for further analysis in the following step. As decision aid section 5.5 presents a list of possible affected business areas appropriate for the given decision scenario.

In the second step the effects of the actions within the business areas, identified in the previous step, on the enterprise business performance are evaluated. This procedure is

supported by a performance evaluation sheet already presented in figure 5-5. See also underneath figure 5.7. The identified business areas where actions have to be taken are listed in the left row 'By requirements affected business areas' of the performance evaluation sheet. In the example of figure 5-5 the affected business areas are indicated by the letters A to D. The number of identified business areas is not fixed and might vary with the decision scenario. Thereafter the effects of the actions in each business area on each key performance indicators have to be evaluated. The appropriate key performance indicators are indicated by the numbers 1 to 4, e.g. costs and sales. Which indicators are appropriate depends on the specific decision situation so that the number as well as the indicators themselves may vary. For the given decision situation key performance indicators are presented in section 5.5. The evaluation of the effects is based on an impact scorecard (table 5-8). The following scores define the possibilities of judging the effects on each key performance indicator (PI).

Table 5-8: Impact scorecard

Score	Performance indicator (PI)
Score +	The action has a positive estimated impact on the PI.
Score 0	The action has no estimated impact on the PI.
Score -	The action has a negative estimated impact on the PI.
Score --	The action has a ruinous estimated impact on the PI.
Score ?	The estimated impact can not be given.

According to the definition one has to mark the appropriate field in the performance evaluation sheet with "+", "0", "-", "--", or "?". Thereby the performance evaluation sheet presents the main cause-and-effect relations and so visualizes the changes in the enterprise business performance. Underneath figure 5-7 presents an example visualizing the evaluated cause-and-effect relations.

Performance Evaluation Sheet				
By requirements affected business areas	Key Performance Indicators			
	1	2	3	4
A	+	-	+	0
B	+	+	?	+
C	-	-	+	-
D	0	0	+	0

Figure 5-7: Performance evaluation sheet visualizing cause-and-effect relations

As shown in the example the performance evaluation sheet doesn't present an aggregated overall performance evaluation. As the weighting of the actions within the affected business areas as well as the key performance indicators may differ with the decision scenario no equation is intended. Considering this is rather left to the person who is doing this evaluation process enabling to consider certain specificities, if necessary. The aim of the performance evaluation sheet is to structure the evaluation process, reflect the decision situation and so to aid in judging if the effect on the total enterprise performance is positive, negative or neutral.

10. Argument: Compliance behaviour

The final argument in the sequence of arguments is the compliance behaviour. As indicated in figure 5-4 and already discussed this argument can be subsequent to the arguments (6) status quo of compliance behaviour, (7) physical access, and (8) mental access. Going through the entire sequence of arguments it is the last one and is subsequent to the argument (9) enterprise performance. In the latter case the argument refers to the statement that an enterprise is willing to comply with a regulation if the effect on the enterprise business performance is positive or at least not negative. With help of the foregoing procedure related to the argument enterprise performance one has to judge the willingness of compliance with the regulation as high or low. As the evaluation process of the effects on the enterprise business performance is a supporting element also other reasons may be taken into account for judging the willingness of compliance.

Summing up, so far the sequence of arguments helps to

- identify enterprise classes affected by the regulation,
- determine the status quo of the enterprises' compliance level,
- consider the enterprises' access to the regulation,
- understand the effects on the enterprise performance, and
- judge the enterprises compliance behaviour of each affected enterprise class.

Concluding step: enterprise behaviour magnitude

The first research objective is to generate a step-by-step approach for regulatory decision support in food policy (section 1.3). To reach the objective this concluding step is added to the sequence of arguments. The sequence of arguments leads to the information about the compliance behaviour of single enterprise classes. To realize the weight of the enterprise behaviour information concerning the magnitude of each enterprise class are added. Here it is

to think of information like e.g. the number of enterprises in a specific enterprise class, the average number of employees, or the average turnover of enterprises in a specific class. The exact information depends on the decision situation, i.e. the use of the information for the overall decision problem. The final step leads to the magnitude of the enterprise compliance behaviour by combining both information; i.e. adding to the information of the compliance behaviour a quantity dimension. Section 5.5 discusses which information are related to this step in the given decision scenario.

5.5 The Knowledge Base

In the section above the single arguments of the sequence of arguments are listed and explained. Going through the sequence of arguments it is asked for different small specifications, e.g. the regional focus of the regulation has to be defined, or the question if a specific enterprise class has access to the regulation has to be answered. To aid going through these processes and taking the small specifications the concept of the knowledge base is added.

The idea of the knowledge base is to store already given knowledge and so to link evidence to each argument of the sequence of arguments. This aids in taking the single specifications necessary to come to the final outcome. The stored knowledge can be based on various sources, e.g. case studies, surveys, statistics or experts. Different knowledge sources probably vary in reliability. Here the crucial point is if and which kind of knowledge for the specific decision situation is given. If there is no appropriate information published experts have to be consulted. The concept of the knowledge base is a modular one. That means that it is not to think of the stored knowledge as static and fixed information, but more as the sum of several information modules or items. These items can be updated, amended, or replaced by more appropriate information. For example, if presented knowledge is not sufficient to rely on one can go for an additional study and replace the given knowledge item.

In the following part of the study knowledge backing up each argument of the sequence of arguments is gathered and presented. It is to keep in mind that the study is based on a defined decision scenario. The knowledge presented is identified for the specific scenario. Following the sequence of arguments, this section picks up each argument and presents the results in terms of information gathered.

Knowledge linked to the 1st argument: Regulation

The first argument focuses on the scope and the requirements of the new regulation determining all further steps. There is no further knowledge necessary but the full version of the regulation. All information is given in the new regulation. Thus the regulation has to be analysed by a skilled person to figure out the necessary information. This knowledge source is linked to the first argument as it is a precondition to start. Still, as the regulation determines the further steps the knowledge is of importance for the following arguments, too.

Knowledge linked to the 2nd argument: Regional focus

The argument regional focus describes the region an affected enterprise is located in. Necessary knowledge is an appropriate list of clusters of regions. In addition with the information of the regulation one can select those clusters of regions which are within the scope of the regulation. The clustering process implicates the problem of the level of detail and the focus. For example one can choose clusters of a country level or clusters of geographical regions. What to go for depends on the decision situation as well as on the appropriateness. Keep in mind that the clusters in combination with the following arguments (industry sector, stage of production, and enterprise size) define the identified enterprise classes and thus the complexity of the overall step-by-step approach. This leads to consider the concept of decision aiding. Especially for improvements towards simplicity and transparency it is important to reduce complexity as far as possible. On the other hand, going through the single arguments 2 to 5 characterises the affected enterprise classes. Defining clusters it has to be considered that the sum of characteristics have to enable to analyse and judge the cause-and-effect relations and thus the compliance behaviour of the enterprises. For example, for this decision scenario it would not make sense to present clusters on a continental level. Following the knowledge identified for the given decision scenario is presented:

For the given decision scenario the argument regional focus is clustered by the EU-27 member states. According to the results of the study of the cereal supply chain in the EU (chapter 5.4) the study considers only enterprises in Germany, France, Italy and UK. Thus the clusters of the argument regional focus are:

- Germany,
- France,
- Italy, and
- UK.

Knowledge linked to the 3rd argument: Industry sector

The argument industry sector considers the industry sector respectively the product group the regulation is aligned to. By doing so the argument characterises the affected enterprise class by a further, a second feature. Gathering knowledge related to this argument the same considerations concerning the level of detail and aligned effects on the complexity of the overall procedure counts here like they have been discussed in the previous part about knowledge linked to the argument (2) regional focus.

Here it is referred to knowledge given at Eurostat. The EU database Eurostat presents a very detailed range of enterprise clusters. Economic activities in the EU are classified according to the European industry standard classification system 'Statistical Classification of Economic Activities in the European Community' (NACE). In this work it is referred to NACE Rev. 1 (EUROPEAN COMMISSION 2001). According to Eurostat (EUROSTAT 2008) agricultural products can be arranged within the clusters of: livestock, milk, cereals, fruit and vegetables, and fish. Further processed food products can be arranged within the clusters of: meat, fish, oil and fats, dairy products, grain mill products, and other food products (based on the 3-digid level of NACE). As explained in chapter 5.4 analysing the cereal industry this study takes a supply chain view including the main steps from the production of cereals to further processing, and finally to retail. As in NACE there is not one single superior cluster given which includes the main steps of the cereal supply chain, the identified cluster is not identical with NACE.

Deducted from NACE the identified clusters consider the differentiation between the superior industry sectors: meat, milk, fish, fruit and vegetables, and cereals including their raw products as well as their further processed products. According to the boundaries of the study the cluster of the argument industry sector is identified as:

- Cereals and cereals products

Knowledge linked to the 4th argument: Stage of production

Knowledge linked to the argument stage of production is described by a list of appropriate clusters of enterprises differentiated by their stage of production. To define proper clusters it is of high importance to have knowledge about the industry sector structure. The main supply

chains including the number of tiers from production to retail have to be known. The study presented in section 5.3 analysed the cereal industry in the EU. The results state that the predominant part of the cereals is market via the supply chains:

- agricultural holding – flour mill – bakery – retail – end-consumer, and
- agricultural holding – flour mill –bakery – end-consumer.

To present well defined clusters the classification system NACE is used.

Clusters identified are:

- Producer – Agricultural holdings growing cereals
- Processor 1 – Manufacture of grain mill products
- Processor 2 – Manufacture of bread and fresh pastry goods and cakes
- Retail 1 – Retail sale in non-specialized stores with food, beverages or tobacco predominating
- Retail 2 – Retail sale of bread, cakes, flour confectionery and sugar confectionery

Knowledge linked to the 5th argument: Enterprise size

The argument enterprise size characterises the affected enterprises by their size. Therefore the knowledge necessary is an appropriate way of clustering enterprises by size. There are different indicators of the enterprise size. It can be measured by e.g. the number of employees, the turnover or related to agricultural holdings the amount of arable land.

This part relies on knowledge of the European Commission. According to the Commission Recommendation 2003/361/EC small and medium-sized enterprises (SME) are defined by independent enterprises having less than 250 employees. All enterprises having 250 employees and more are large enterprises. Furthermore SMEs can be subdivided by micro enterprises with 1 to 9 employees, small enterprises with 10 to 49 employees, and medium-sized enterprises with 50 to 249 employees. (EUROSTAT 2009a) For agricultural holdings growing cereals Eurostat uses the amount of arable land as size indicator. According to this agricultural holdings can be classified within the following four size classes: holdings with less than 5 ha, holdings with 5 to less than 20 ha, holdings with 20 to less than 50 ha, and holdings with 50 or more than 50 ha. (EUROSTAT 2009b) Based on that the following classification system is added to support the argument enterprise size:

- Micro sized enterprises – Agricultural holdings with less than 5 ha or enterprises with 1 to 9 persons employed.

- Small sized enterprises – Agricultural holdings with 5 to less than 20 ha or enterprises with 10 to 49 persons employed.
- Medium sized enterprises – Agricultural holdings with 20 to less than 50 ha or enterprises with 50 to 249 persons employed.
- Large sized enterprises – Agricultural holdings with more than 50 ha or enterprises with more than 249 persons employed.

Knowledge linked to the 6th argument: Status quo of compliance level

Desired knowledge linked to the argument status quo of compliance behaviour is about comparable scenarios which can be projected on the given decision scenario and so deduce the enterprise compliance behaviour from. The argument builds on an external database, which stores information about several quality, environmental and occupational health systems in the agri-food industry in the EU. In chapter 2.1 an introduction to quality management in the agri-food industry is given. While the overall approach of this work focuses on analysing effects of EU regulations this database takes private requirements into account.

This external database enables to generate operational system descriptions, including their requirements, the country they are addressed to, the industry sector they are addressed to, the stage of production they are addressed to, and their degree of compliance in a specific country.

This external database is to be used within the knowledge base as follows:

(1) First the new regulation has to be entered into the database. The requirements of the new regulation are matched with the requirements of the already existing management systems stored in the database. As a result the database presents all given management systems with comparable requirements.

(2) The given management systems are addressed to a single or to several industry sectors and to one or more stages of production and played out in specific regions. In a second step this information is matched with the characteristics of the affected enterprise classes (see argument 2 to 5 of the sequence of arguments). The result is a list of given management systems addressed to the affected enterprise classes.

(3) Furthermore in the database information about the degree of compliance with management systems in the EU-27 member states should be stored, i.e. how many

enterprises of a particular enterprise class are complying with a particular management system. Based on that, in a third step the compliance information is combined with the information about the matching management systems. As a final result the external database presents for each affected enterprise class if there is already an existing management system with comparable requirements and in addition how many enterprises are complying with the particular management system.

To make the procedure of the argument Management System Comparison described in the sequence of arguments work, specific knowledge has to be gathered. One can differentiate between information about quality management systems itself, e.g. information about the requirements and about the addressees of the management systems, and information about the degree of enterprises complying with the management systems in the appropriate industry sector. Following it is specified which knowledge could be identified as already given and where information is still lagging.

As stated, at this step the knowledge base reverts to an already given database. This database was developed in a former research project of the University of Bonn, called 'QUALINT'. Within the project the realization of quality programmes is analysed to support firms in optimizing quality systems considering efforts and costs and to provide an appropriate data basis (www.qualint.de). Management systems are analyzed on each stage of agriculture and food industry. The research came up with a data basis of several quality, environmental and occupational health systems. It lists the common quality systems as well as detailed system description. The systems' requirements are analysed and arranged in categories of requirements. Furthermore the systems' focus is considered. The focus of quality systems can be towards enterprises at a specific stage of production (horizontal focus) or towards enterprises throughout the production chain (vertical focus). Vertically oriented systems set requirements at several or all stages of the production chain to ensure chain wide quality, e.g. the Q&S system. Horizontally oriented systems set no overlapping requirements for subsequent stages of the chain, e.g. the EurepGAP system is relevant for farmers only. Furthermore there are systems which focus on a country level and others which are internationally accepted and applied (FRITZ ET AL. 2008). For more information concerning the research project 'QUALINT' and the research outcome see www.qualint.de and KRIEGER (2008).

The given data basis, including the list of several quality systems and the detailed system description, enables to pick out any type of enterprise or agricultural holding and assign potential quality systems to it as well as the corresponding requirements. The converse argument is that if one or more requirements are given the corresponding quality systems can be identified and so the enterprise classes which are in the focus of the identified quality system. The knowledge stored in the given database enables to carry out the first two steps of the procedure explained above. (1) The requirements of the new regulation are matched with the requirements of the quality systems given in the database and so management systems with comparable requirements are identified. (2) The focus of the identified quality systems is matched with the enterprise classes identified after argument (5) enterprise size. So quality systems are presented which are aligned to the enterprise classes affected by the new regulation and which have comparable requirement.

For the third step of the procedure information about the enterprise compliance with the quality systems identified in step two is necessary. This knowledge is not given in the database of the presented project. Therefore a study was done to gather information about the degree of how many enterprises out of a specific class are complying with the most common quality systems in the countries of interest: Germany, France, Italy, and UK. The explanation of the study procedure as well as the outcome is restricted to the main points as it is of minor importance for the thesis and neither changes nor affects the principles of the knowledge base.

The research was limited to quality system and their degree of compliance. Based on desk research it could be figured out that within a huge list of quality management systems in the EU the most common systems are: BRC Global Standard, International Food Standard (IFS), Global Gap, ISO 9001, ISO 14001, ISO 22000, and QS-quality scheme. Furthermore information about the number of certificates of some standards could be identified but not in a reliable relation to the total number of enterprises for the given clusters. Thus a survey was done. A questionnaire (appendix C) was addressed to three international certification bodies, working in each country of the EU-27 members. The questionnaire asked for a judgement of the compliance level with the identified quality systems for the different enterprise classes. The questionnaire was send to responsible agencies in the countries Germany, France, Italy, and UK. None of them replied so that there is no information about the compliance behaviour stored in the knowledge base.

This situation doesn't hinder the procedure of the step-by-step approach as the knowledge source is not limited to e.g. statistics but flexible so that other knowledge sources as e.g. expert knowledge can be used, if available. Due to this reason, no further efforts were done to find already given knowledge to store in the knowledge base.

Knowledge linked to the 7th argument: Physical access

Knowledge which is of interest for the argument physical access should help understanding if the different possibly affected enterprise clusters have access to the new regulation in terms of knowing about the existence and having the possibility to go through the content. For the given decision situation there couldn't be any appropriate given knowledge figured out. That means that no knowledge is stored in the knowledge base. In this case one has to opt for consulting an expert who can present useful information aiding to make the specification related to this argument.

Knowledge linked to the 8th argument: Mental access

Here stored knowledge has to help in deciding if a specific enterprise class has mental access to the regulation; i.e. if the enterprises understand the requirements and know what to do to fulfil the requirements. Understanding the regulation depends a lot on the complexity of the regulation which can vary. Based on that and that there is no appropriate information given for the decision situation, no information is stored in the knowledge base. Also for this argument one has to consult an expert who can deliver useful information.

Knowledge linked to the 9th argument: Enterprise performance

The central point of the argument enterprise performance is the evaluation sheet (figure 5-5). Its composition and procedure is explained in the previous section about the sequence of arguments. What was missing so far is appropriate information about business areas possibly affected by a new regulation enabling to analyse the actions taken within an enterprise and appropriate information about key performance indicators enabling to evaluate the effects on enterprise business performance. Following knowledge can be identified:

Concerning a categorisation of business areas that might be affected by food quality and safety requirements there is already knowledge given. In the context of quality systems KRIEGER, SCHIEFER (2007b) present a first classification of core areas possibly affected by requirements. In general, requirements may refer to:

- the production process (e.g. specifications for the application of pesticides),
- product characteristics regarding product quality (e.g. cleanness), or product safety (e.g. pesticide residues),
- the administration, documentation and management of processes (e.g. specification of organization and controls), or
- the establishment of a certain infrastructure like construction and technical equipment.

The following table (5-9) lists and explains the identified main categories of business areas possibly affected by quality and safety requirements. These categories and the related sub-categories, explained underneath, are stored in the knowledge base. All categories together constitute the list of possibly affected business areas and thus the necessary knowledge to support the first step related to the argument enterprise performance; i.e. identifying the necessary actions to fulfil the regulation's requirements.

Table 5-9: Main categories of possibly affected business areas (based on KRIEGER 2008)

Main category	Explanation
Production process	Any activity or any set of activities to transform inputs into outputs can be described as process. To this classification all the requirements that can influence the process are counted.
Product characteristics	Among other claims, a product consists of the quality, safety and origin of the product. Product quality is considered as the appearance and freshness of a product. Food safety meets the needs of customers for security in the food industry. The origin of the products is for example in the regional marketing of food a decisive factor.
Management of the processes	The management is the framework that is needed to support maintenance of quality and safety requirements. This includes administrative tasks as well as other management tasks belonging to the organization process.
Infrastructure environment	The infrastructure provides the framework necessary to achieve compliance with the requirements and contains long-lived basic facilities. Here infrastructure is about technical equipment and work environment facilities.

In the study of KRIEGER (2008) the four main categories are further sub-classified to a more detailed level. It enables to specify the requirements' focus and to identify more precisely where enterprises have to take actions to fulfil the requirements.

The table underneath (5-10) presents and explains the identified sub-categories of the main category production process.

Table 5-10: Sub-categories of the main category production process (based on KRIEGER 2008)

Sub-category	Explanation
Cultivation measures	This category includes requirements for farmers concerning plant production. Examples are requirements concerning agricultural pesticides and fertilizer.
Occupational health and safety	Examples are the use of special material for occupational health and safety or the implementation of occupational health and safety plans.
HACCP	It includes the storage of products itself and the organisation of the storage, e.g. separated storage of accredited products and non-accredited products.
Product development	Requirements focusing for example on the purpose of use of a product, the product composition, or the shelf life of a product.
Production	Requirements of this category focusing especially on the process of manufacture and the flow of goods.
Traceability	Traceability is a component of the process and includes the maintenance of a traceability system, the trial of a recall, etc.
Veterinarian and veterinary medicines	Examples of this category are the medication of animals and the need of a veterinary.
Animal protection measures	Animal protection requirements include the measure for the handling and keeping of animals.
Transport	The category includes requirements on the transport vehicle, organisation of the transport and the driver.
Environment protection measures	This category includes demands on the environment, e.g. requirements related to environmental protection or waste management.

The next table (5-11) presents and explains the identified sub-categories of the main category product characteristics.

Table 5-11: Sub-categories of the main category product characteristics (based on KRIEGER 2008)

Sub-category	Explanation
Hygiene measures	Here examples of requirements covering pest control, cleaning and disinfection measures and hygienic precautionary measures like protective clothing. Hygiene measures have influence on both food safety and product quality.
Laboratory tests	This category includes requirements related to external and internal laboratory testing, so that if limits are exceeded early actions can be taken.
Packaging	The area of packaging is related to the product level. Packaging has a crucial impact on product quality, in particular the packing material and the microbiological cleanliness.

The third table (5-12) presents and explains the identified sub-categories of the main category management of the processes.

Table 5-12: Sub-categories of the main category management of the processes (based on KRIEGER 2008)

Sub-category	Explanation
Complaint management	The category focuses on the organization of customer complaints, i.e. the entry and the work on complaints.
Documentation	Documentation requirements can focus on various areas. Examples are the creation of a quality system reference book, work instructions, process instructions, or continually record keeping.
Self-monitoring	A periodic self-monitoring may contain a regular quality audit and the completion of a check list.
Identification	The range of identification and labelling contains requirements e.g. regarding the signpost in the factory or labelling of animals.
Management of the processes	Management of the system covers general administration costs such as document storage, filing and updating of information and in addition the definition of quality objectives and quality policy.
Staff training and qualification	Here requirements can focus on regular training courses or qualification certificates.

The fourth table (5-13) presents and explains the identified sub-categories of the main category infrastructure environment.

Table 5-13: Sub-categories of the main category infrastructure environment (based on KRIEGER 2008)

Sub-category	Explanation
Constructional measures	This category considers requirements related to the working environment, the buildings and the construction of buildings for livestock.
Technical equipment	This category considers requirements related to the acquisition, the maintenance, calibration, etc. of technical equipment

Coming back to the introduction to performance measurement and performance indicators (chapter 3), ideally a performance measurement system is customised to a specific enterprise considering its business situation and its strategy. The objective of this research, i.e. to generate a step-by-step approach for regulatory decision support in food policy, doesn't allow such a detailed view on single enterprises but asks for an approach applicable for a whole range of different enterprises. It is obvious that different enterprises of different steps in a supply chain and different industry sectors have their own goals, performance criteria and indicators. Still, here the goal is to identify performance indicators which are probably of key

importance for the predominant enterprises and thus can be stored in the knowledge database to aid the processes of the argument enterprise performance.

Studying literature shows that a lot of efforts have been made in evaluating performance measurement systems including performance indicators focussing on different industries and on enterprise types acting on different levels of a supply chain. But there is very little information about performance indicators applicable for different enterprises along different supply chains in the agri-food industry. ARAMYAN ET AL. (2007) state that no integrated measurement system exists in agri-food supply chains that combines different aspects of performance (e.g. financial and non-financial, qualitative and quantitative) into one measurement system.

To gather knowledge about appropriate key performance indicators an extensive study on literature, case studies and surveys in that field was done. First a general literature review on performance indicators delivered a range of 21 different performance indicators. The sources list general performance indicators without any industry focus as well as performance indicators identified in the agri-food industry. Underneath table 5-14 present the list of general performance indicators.

Table 5-14: General performance indicators

Perspective	Objective	Performance indicator	Source
Financial	Revenue growth	Sales	KAPLAN, NORTON 1996A; NEELY 2002; NEELY ET AL. 2002; ARAMYAN ET AL. 2006; ARAMYAN ET AL. 2007
	Cost reduction	Costs	KAPLAN, NORTON 1996A; NEELY 2002; NEELY ET AL. 2002; VAN DER VORST 2000; ARAMYAN ET AL. 2007
	Asset utilization	Cash-to-cash cycle	NEELY 2002; NEELY ET AL. 2002
Customer	Increase customer value proposition	Customer satisfaction	KAPLAN, NORTON 1996A; NEELY 2002; NEELY ET AL. 2002; ARAMYAN ET AL. 2007
		Customer complaints	KAPLAN, NORTON 1996A; NEELY 2002; ARAMYAN ET AL. 2007
		Product lateness	KAPLAN, NORTON 1996A; NEELY 2002; NEELY ET AL. 2002; ARAMYAN ET AL. 2007
		Shipping errors	KAPLAN, NORTON 1996A; NEELY 2002; ARAMYAN ET AL. 2007
Internal business process	Increase process time	Lead time	KAPLAN, NORTON 1996A; NEELY 2002; NEELY ET AL. 2002; VAN DER VORST 2000; ARAMYAN ET AL. 2007
	Increase process quality	Process part-per-million defect rate	NEELY ET AL. 2002; ARAMYAN ET AL. 2007
		Waste	NEELY 2002; NEELY ET AL. 2002; ARAMYAN ET AL. 2007
		Water use	KAPLAN, NORTON 1996A; ARAMYAN ET AL. 2007
		Energy use	KAPLAN, NORTON 1996A; ARAMYAN ET AL. 2007
	Increase product quality	Appearance	KAPLAN, NORTON 1996A; ARAMYAN ET AL. 2007
		Taste	KAPLAN, NORTON 1996A; ARAMYAN ET AL. 2007
		Shelf life	KAPLAN, NORTON 1996A; VAN DER VORST 2000; ARAMYAN ET AL. 2007
		Product safety	KAPLAN, NORTON 1996A; ARAMYAN ET AL. 2007
		Salubrity	KAPLAN, NORTON 1996A
Learning and growth	Increase employee performance	Employee satisfaction	NEELY 2002; NEELY ET AL. 2002
		Employee productivity	NEELY 2002; NEELY ET AL. 2002
		Lost work days due to safety incidents	NEELY 2002
	Increase innovation process	Percentage of sales from new products	NEELY ET AL. 2002

Next, only those performance indicators are further considered which are mentioned in more than half of the sources, at least four out of seven, apart from the food specific indicators. This procedure ends up with a list of ten different performance indicators. In the next step these indicators are matched with the outcome of a study done by ARAMYAN ET AL. (2007). There a case study has been carried out in a Dutch-German tomato supply chain to identify performance indicators which are of key importance for the actors of the supply chain, from production to retail. The research outcome, the key performance indicators, is matched with the ten performance indicators identified in the literature analysis explained before. The following table 5-15 presents the performance indicators which have the highest consistency considering the analysed literature and case studies in that field. Furthermore the objective of each performance indicator is given as well as a definition of each indicator. These indicators are stores in the knowledge base to be available for the performance evaluation sheet.

Table 5-15: Identified key performance indicators

Perspective	Objective	Performance indicator	Measure definition*
Financial	Revenue growth	Sales	Value turnover
	Cost reduction	Costs	Combined costs of raw materials and labour in producing goods as well as combined costs of distribution, including transportation and handling costs
Customer	Increase customer value proposition	Customer satisfaction	The degree to which the customers are satisfied with the products or services
Internal business process	Decrease process time	Lead time	Total amount of time required to produce a particular item or service
	Increase product quality	Appearance	First sight of the product (colour, size, form, lack of damage)
	Increase product quality	Product safety	Product does not exceed an acceptable level of risk associated with pathogenic organisms or chemical and physical hazards such as microbiological, chemical contaminant in products, micro organisms

* KAPLAN, NORTON 1996A; VAN DER VORST 2000; NEELY 2002; NEELY ET AL. 2002; ARAMYAN ET AL. 2006; ARAMYAN ET AL. 2007

Furthermore, in the research project MoniQA there were experts on the topic of allergens within food, more precisely, an international group of laboratories providing a huge range of testing and support services to the food industry and to government. This contact should have been used to get reliable data to store in the knowledge base and thus to support the judgement on the effects on the enterprise performance within the decision scenario of a regulation on the exposure to allergens in food. Therefore in cooperation with an expert in food biotechnology a questionnaire had been elaborated, which focused on cost related information about rapid methods (appendix D). With help of the project partner an international survey should have provided solid information for the knowledge base, but the outcome was not sufficient to include in the further research as the laboratories were not willing to share information and give serious answers.

Knowledge linked to the 10th argument: Compliance behaviour

Concerning the last argument, compliance behaviour, it is necessary to know which possibilities of compliance behaviour an enterprise has. In section 5.4.1 it was already mentioned that there are several possibilities varying from the two extremes of non-compliance to totally compliance. With regard to the objective of decision aiding for the given decision scenario the argument compliance behaviour can be specified according to the two opposite possibilities:

(1) compliance with the regulation, and

(2) non-compliance with the regulation.

Knowledge linked to the concluding step: Enterprise behaviour magnitude

For the concluding step, enterprise behaviour magnitude, knowledge is necessary that enables to link to the information of the enterprise compliance behaviour a quantity dimension of each possible enterprise class. The quantity dimension can be pictured by information concerning e.g. the number of enterprises or the number of employees per enterprise for each enterprise class. For this reason statistics of Eurostat have been analysed. Of interest are statistics concerning the ‘structure of agricultural holdings’ and statistics concerning the ‘actors involved in the food chain’ with the enterprise unit as structural indicator. The information identified is the number of enterprises within each possible enterprise class, defined through the combinations of the procedure related to argument (2) regional focus, (3) industry sector, (4) stage of production, and (5) enterprise size, affected by a regulation of the given decision

scenario. In this section the statistics themselves are of less interest and thus put in the appendix (appendix E).

5.6 The Overall Step-by-Step Approach

In section 4.2 the preliminary step-by-step approach including the general concept of an argumentation line to follow through and necessary knowledge about mentioned clusters and tendencies connected to each argument was introduced as well as visualized by figure 4-2. Section 5.4 and 5.5 present the study results which improve the preliminary framework based on a given decision scenario. Underneath figure 5-8 visualizes the results of the study; i.e. the step-by-step approach for decision support fitting to the given scenario. The differentiation between the sequence of arguments, which here includes the final step enterprise behaviour magnitude, too, and the knowledge base is made clear. The sequence of arguments defines the steps to follow. It is based on expertise. The knowledge base stores given knowledge backing up each argument. It is based on statistics, check lists, survey, case studies, etc. Figure 5-8 points out the approach of a step-by-step procedure and the relation between the sequence of arguments and the knowledge base.

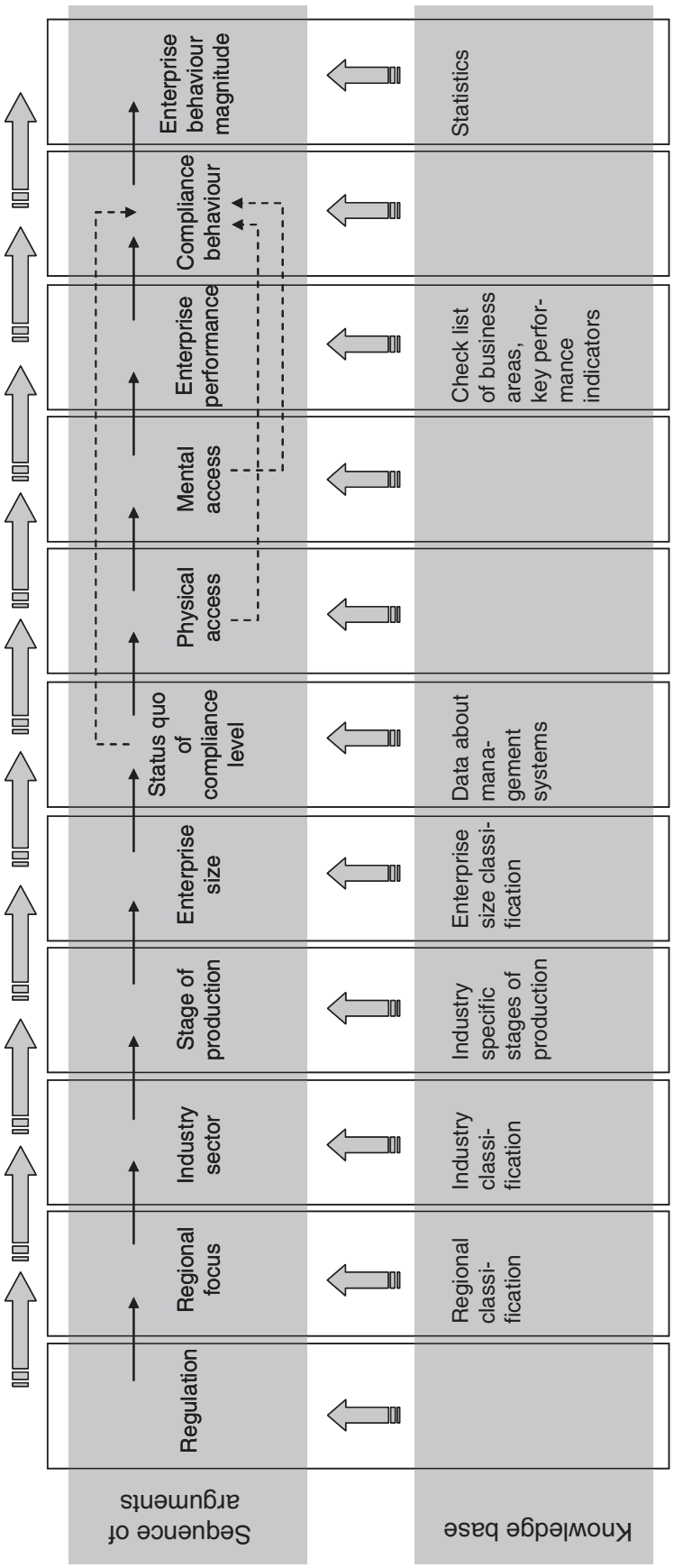

Figure 5-8: A step-by-step approach for decision support

5.7 Summary

The aim of the study presented in chapter 5 was to fulfil the first research objective, which is to generate a step-by-step approach for regulatory decision support in food policy. To reach that goal the preliminary framework of a step-by-step approach (figure 4-2) was further developed to a step-by-step approach for decision support adjusted to the given decision scenario (figure 5-7).

The generated step-by-step approach is based on two different knowledge areas. (1) The sequence of arguments, which is based on expertise and specifically adjusted to the decision scenario. (2) The knowledge base which stores data about the actual decision situation and relates it to the single arguments.

As the objective is to support decision making in the food regulation environment, of specific relevance is the reduction of complexity coming along with the need of improvements towards transparency and comprehension. The step-by-step approach is limited to the arguments enabling a judgement on the enterprise compliance behaviour. The procedure is defined by a sequence of 10 arguments followed by one additional step. The final judgement on the enterprise compliance behaviour is broken down to several smaller decisions / specifications following through the single steps. Of high importance is that this step-by-step procedure acts like a filter. The complexity of the overall decision problem is reduced going from each step to the next by eliminating enterprises which don't fulfil specific criteria connected to the arguments and so which are not of relevance for the outcome in a certain decision situation. Due to this the decision making process is not a black box, but the final outcome can be traced back to the single specifications. The necessary specifications are backed up by the data stored in the knowledge base. As it is a modular approach data can be replaced or improved easily.

The utilization of the knowledge within the step-by-step approach will be the focus of the field test following in chapter 6.

6 Field Tests: Implementing the Step-by-Step Approach for Decision Support

In chapter 5 the step-by-step approach for decision support including the sequence of arguments and the knowledge base was generated for the given decision scenario. In this chapter the step-by-step approach is implemented by field tests to test and improve it before translating into a computer-based system for decision support in chapter 7. The major contribution of this chapter is:

- the expansion of the knowledge areas (1) sequence of arguments and (2) knowledge base by (3) an analyst interacting with the sequence of arguments and the knowledge base,
- test runs of the step-by-step approach including the utilization of the identified knowledge within two field tests, and thus
- the identification of improvement potential before translating the step-by-step approach into a computer-based system.

Underneath figure 6-1 presents the structure of chapter 6.

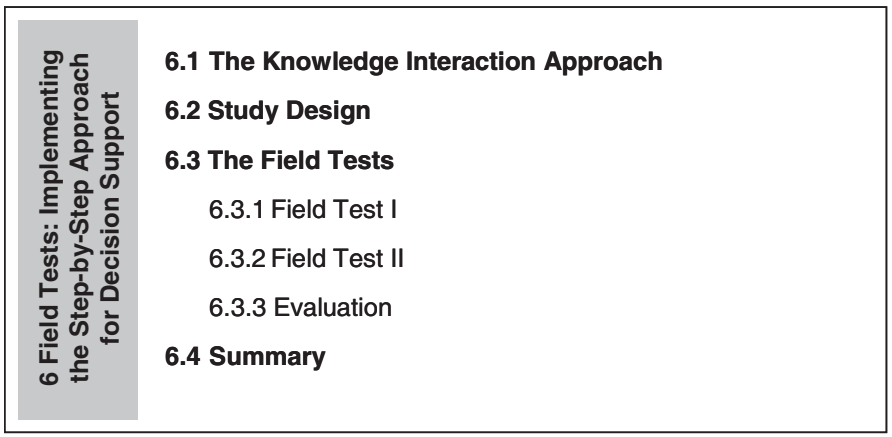

Figure 6-1: Overview of chapter 6

6.1 The Knowledge Interaction Approach

The step-by-step approach identified in chapter 5 contains two different areas of knowledge: (1) the sequence of arguments and (2) the knowledge base. Implementing the step-by-step approach a third knowledge area is added: (3) the analyst, which is the person who goes

through the step-by-step approach and takes the single decisions necessary to come to a final outcome.

The sequence of arguments is based on expertise. This means that it represents the knowledge of several experts specific for the given decision scenario. The knowledge base represents updated already given knowledge within the field of each argument. Here the knowledge sources can be various, e.g. statistics, case studies, surveys or experts, too. The two knowledge areas are related as follows: The sequence of arguments present an argumentation line which asks for small specifications to get from one argument to the other. To support this process there is the knowledge base. The knowledge base stores given information in relation to the arguments and makes them available to support the specifications necessary to come from one argument to the next. As already explained the idea of the knowledge base is a modular one, so that if the stored information is not sufficient or if there are better information given, knowledge can be replaced or added. Summing up, the relation of the knowledge base and the sequence of arguments is an indirect one, in figure 6-2 indicated by the broken arrow.

For transferring the knowledge an analyst is necessary. He is the third knowledge area. Section 4.1 introduced stakeholders of a decision aiding process. There the analyst is defined as the person who is performing the aid and enlightening the decision maker about the consequences. In this case it means that the analyst is the person who goes through the sequence of arguments and works the tasks and specifications related to each argument. As explained the analyst is aided by the knowledge base. Here it is important to keep in mind that the information stored in the knowledge base is not the only knowledge that influences the way through the sequence of arguments. The analyst is expert in his field, i.e. he is well experienced and informed about the current situation within the decision scenario, so that he can interpret and complete the given information within the overall context. Thus the analyst adds a third knowledge area to the step-by-step approach.

The relation between the analyst and the knowledge base is two-sided. The knowledge base stores information which helps the analyst to make the specifications related to each argument. In addition the analyst might add or update the stored information if necessary. The relation between the analyst and the sequence of arguments is two-sided, too. The sequence of arguments structures the thinking process of the analyst by presenting clear defined steps. The

analyst works the tasks and specifications related to the arguments and so he influences the way to follow through the sequence and come to the final outcome.

Underneath figure 6-2 visualizes the three different knowledge areas and their interactions.

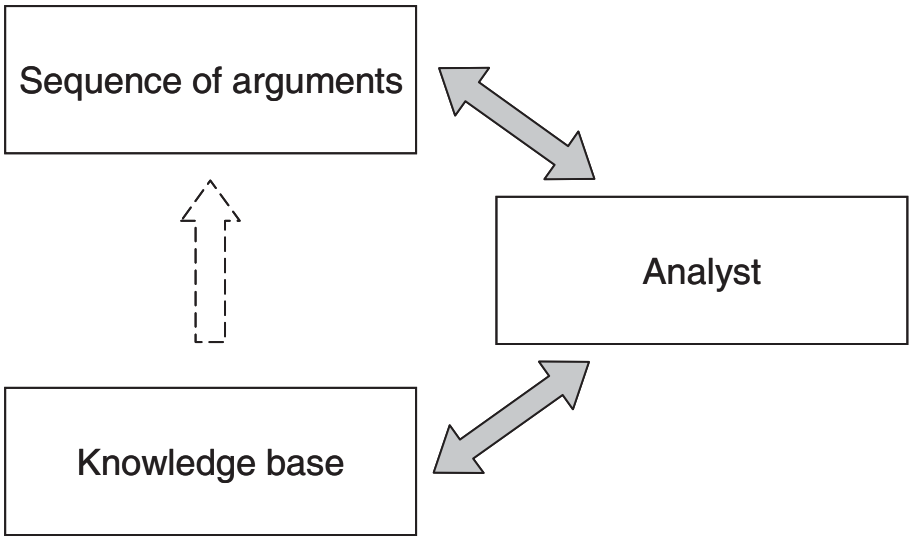

Figure 6-2: The knowledge interaction approach

6.2 Study Design

The following study conforms to the general study setting given by the underlying research project (MoniQA) introduced in section 5.1 and the outcome of the cereal industry study presented in section 5.3.

According to that the study is split up in two field tests:

(1) Field test I deals with the proposal for a regulation on the provision of food information to consumers (further information given in section 5.1).

(2) Field test II deals with the Directive 2009/128/EC establishing a framework for Community action to achieve the sustainable use of pesticides (further information given in section 5.1).

According to the related EU research project the scope of the study is the cereal industry focusing on the main players: agricultural holdings, flour mills, bakeries, and retail. The focal countries are Germany, France, Italy and UK.

For the implementation of the step-by-step approach it is of high importance to identify one or more appropriate analysts. In the given decision situation the analyst has to be familiar with the general problem, i.e. regulatory frameworks within the respective industry sector. More precisely the analyst should have knowledge about food regulations and business conditions within the enterprises' industry sector. Therefore, as analyst it is opt for the respective industry associations of farmers, millers, bakers, and food retailers in the countries Germany, France, Italy, and UK. In total 18 industry associations are addressed. Considering the scope of each regulation within field test I the industry association of flour mills, bakeries and food retail are addressed. Within field test II the associations of farmers are addressed.

For each field test the course of actions was as follows:

(1) A request letter was send to each listed industry association. The letter explained the problem situation and the further procedure of the study as well as it asked for the participation on the survey. The addressed person was the director of the industry association or an adequate person dealing with policy and business issues.

(2) In the second step, the questionnaire was send to all industry associations willing to participate and an appointment was arranged for a telephone interview. A questionnaire including a broad explanation and the corresponding regulation was sent in advance to give the interviewee the possibility to already engage in the survey and prepare the telephone interview.

(3) In the third step there was the telephone interview. The aim of the telephone interview was to go through the survey together with the interviewee. This procedure should enable to make sure that the interviewee understood the survey, that, if necessary, questions could be answered and further explanations could be given straight away, and so to ensure that the outcome would be usable. Furthermore a personally contact to the industry association should increase the rate of return. To those industry associations located not far away a face to face interview was offered, too.

The field tests present the very first implementation of the step-by-step approach evaluated in chapter 5. For this reason the parts of the step-by-step approach, which depends on interaction with the analyst are transformed into a questionnaire. The questionnaire follows the sequence

of arguments and includes the information stored in the knowledge base. The other parts of the step-by-step approach, which are based on the external database or external calculations and don't require the interaction with the analyst, are worked externally. At this point it is important to mention that the argument (6) status quo of compliance behaviour required another expert who is into the mentioned database including the information about the different management systems. Underneath table 6-1 gives an overview how the step-by-step approach is transformed in the field tests. Some arguments are integrated in a heading to give a better overview to the interviewee.

Table 6-1: Transformation of the step-by-step approach into the field tests

Procedure of the step-by-step approach	Transformation into the field tests
1. Argument: regulation	Regulation analysis Request to interviewee
2. Argument: regional focus 3. Argument: industry sector 4. Argument: stage of production 5. Argument: enterprise size	Enterprise classes identification Four questions to interviewee
6. Argument: status quo of compliance level	Management system comparison External evaluation
7. Argument: physical access 8. Argument: mental access	Regulation access Two questions to interviewee
9. Argument: business performance 10. Argument: compliance behaviour	Performance evaluation Three questions to interviewee
Concluding step: enterprise behaviour magnitude	External behaviour magnitude External calculation

Underneath the questionnaire's content is explained by following the procedure of the step-by-step approach. For the sake of completeness also those steps are listed which don't require interaction with the analyst. Here it is clearly said that they are not included into the questionnaire, but worked in another way. An exemplary questionnaire is added to the appendix (appendix F).

Regulation analysis

The corresponding regulation is handed to each interviewee to be analysed according to its requirements and scope as preparation for the following questions. This step is related to the argument (1) regulation of the step-by-step approach.

Enterprise classes identification

The first group of questions is related to the arguments (2) regional focus, (3) industry sector, (4) stage of production and (6) enterprise size. The interviewees should reply to the questions by marking predefined answers. The predefined answers are based on the information stored in the knowledge base and thus specific for the defined decision scenario. Each interviewee should answer the questions from the point of view of those enterprises he is representing. Furthermore he should just answer for those classes he has expertise. Each question builds on the answer of the previous question.

1. Question - The first question refers to the argument (2) regional focus. The interviewee is asked if the regulation affects enterprises located in his country, i.e. Germany, France, Italy, or UK. The interviewee should just mark that country he has expertise on.

2. Question - The next question refers to the argument (3) industry sector. The interviewee is asked if enterprises belonging to the industry sector cereals and cereals products are affected by the regulation.

3. Question - This question refers to the argument (4) stage of production. The interviewee is asked which stages of production are affected by the regulation: producer (agricultural holdings growing cereals), processor 1 (manufacture of grain mill products), processor 2 (manufacture of bread and fresh pastry goods and cakes), retail 1 (retail sale in non-specialized stores with food beverages and tobacco predominating), or retail 2 (retail sale of bread, cakes, flour confectionery).

4. Question - This question refers to the argument (5) enterprise size. It asks the interviewee which enterprise size classes are affected by the regulation: micro enterprises (farms with less than 5 ha or enterprises with 1 to 9 persons employed), small enterprises (farms with 5 ha up to 20 ha or enterprises with 10 to 49 persons employed), medium enterprises (farms with 20 ha up to 50 ha or enterprises with 50 to 249 persons employed), or large enterprises (farms with more than 50 ha or enterprises with more than 249 persons employed).

At the end of the part ‘enterprise classes identification’ several enterprise classes will probably be identified by the interviewee as affected by the regulation. The following part of the questionnaire is related to each affected enterprise class individually. That means that the interviewee has to repeat the following part for each enterprise class affected by the regulation.

Management system comparison

As explained in the step-by-step approach (chapter 5) here it is revert to an external data base. In the field tests the procedure is run externally and thus this step is not included into the questionnaire. The proposal of the regulation as well as the directive was handed to an expert matching them with the information of given management systems (e.g. quality management systems) stored in the database. The detailed procedure was already explained in section 5.5. The results are considered in the field tests and presented in section 6.3.

Regulation access

The next part of the questionnaire refers to the arguments (7) physical access and (8) mental access. The interviewee has to work the part for each affected enterprise class identified at the end of the part 'enterprise classes identification'. The answers are predefined and allow only a positive or a negative answer. For these two arguments there is no further information stored in the knowledge data base.

1. Question - The first question refers to the argument (7) physical access. The interviewee has to judge if the enterprises within a specific enterprise class know about the existence of the regulation and have physical access to the regulation. If the outcome is positive the next question should be answered. If the outcome is negative the questionnaire stops for the given enterprise class.

2. Question - The next question refers to the argument (8) mental access. The interviewee has to judge if the enterprises within a specific enterprise class understand the regulation's requirements and know what to do to fulfil them. If the outcome is positive the questionnaire goes on for the given enterprise class. If the outcome is negative the questionnaire stops for the given enterprise class.

Performance evaluation

This part of the questionnaire deals with the argument (9) business performance and (10) compliance behaviour. The part is built up of three questions attended by tasks which finally lead to the compliance behaviour of each enterprise class. The analyst has to work this part for all enterprise classes which have been judged positive in the question before. The possibilities to answer are predefined in form of checklists, a structured evaluation sheet and a given impact scorecard, and so revert to the information stored in the knowledge base.

1. Question - The first question refers to the argument (9) business performance. A checklist with business areas possibly affected by the regulation is presented to the

interviewee. The content of the checklist comes form the information stored in the knowledge base (section 5.5). The interviewee is asked to mark all business areas which are affected by the regulation, i.e. where the enterprise has to take actions.

2. Question - The second question still refers to the argument (9) business performance. The interviewee is asked to evaluate the effects of the enterprise actions within each marked business area on a given list of key performance indicators. This process is guided by a given evaluation sheet and an impact scorecard.

3. Question - The last question refers to the argument (10) compliance behaviour. The interviewee is asked to judge the enterprise's willingness of compliance with the regulation as high or low. The enterprise performance evaluation of the step before aids the interviewee in making the judgement.

Enterprise behaviour magnitude

As explained in section 5.4 the step enterprise behaviour magnitude doesn't refer to an argument but it is the last step of the step-by-step approach. Here the information of the enterprise compliance behaviour identified after the previous step of the questionnaire is combined with enterprise statistics stored in the knowledge base. As this steps asks for no additional input of an analyst this part is not included in the questionnaire. Still the outcome will be presented reporting the results of the field tests.

6.3 The Field Tests

The second objective of the thesis is to transform the step-by-step approach into a computer-based interactive decision support system. Before this is done the step-by-step approach should be proved by the implementation through field tests enabling to identify possible improvements. Therefore the focus is not on the enterprise compliance behaviour itself, but on:

- the outcome of the step-by-step approach to be presented to the policy maker, and
- the interaction between the analyst, the sequence of arguments and the knowledge base.

Following the main results are listed and finally evaluated.

6.3.1 Field Test I

In the field test I the step-by-step approach for decision support is applied to the proposal for a regulation concerning the provision of food information to consumers with focus on allergen labelling, explained in section 5.1. Following the main outcome of the step-by-step approach is exemplary shown for the interview with the French industry association of bakers.

The interviewee had expertise on enterprises which belong to the stages of production: manufacture of bread and fresh pastry goods and cakes (processor 2) and on retail sale of bread, cakes, flour confectionery and sugar confectionery (retail 2). The interviewee was already firm with the regulation before participating in the survey. After answering the questions of the step 'enterprise classes identification' the outcome of the step-by-step approach so far shows that in France all manufacture of bread and fresh pastry goods and cakes and all retailers specialized in retail of bread, cakes, flour confectionery and sugar confectionery are affected by the regulation.

Next, in the questionnaire there is the part management system comparison. The external data base's procedure and results are presented in figure 6-3. The first step shows that one requirement (requirement 1) is covert by the International Food Standard and the standard British Retailer Consortium. This requirement is already in previous regulations given concerning allergen labelling. The other important requirement (requirement 2) is not covered by any given management system. As half of the requirements are not covered by any given management system, all enterprise classes should be further analysed in the following steps.

1. Step

Entering the new regulation and matching the requirements.

Requirement 1: Allergen labeling should apply to food sold pre-packed for direct sale, including catering.
Matching systems: - International Food Standard (IFS) - British Retailer Consortium (BRC)
Requirement 2: Allergen labeling should apply to food sold loose for direct sale, including catering.
Matching systems: - No management system given

Figure 6-3: Management system comparison – outcome field test I

In the next part, regulation access, according to the interviewee all affected enterprise classes have physical access as well as mental access to the regulation. The interviewee remarked that most of the enterprise classes are members of the industry association which informs the enterprises about new regulations.

In the part performance evaluation the interviewee evaluated the regulation's effects on the enterprise performance and judged the enterprise compliance. Figure 6-4 shows exemplary a filled in evaluation sheet including the business areas marked by the interviewee as affected by the regulation's requirements, the effects on the key performance indicators and finally the judgement of the willingness of compliance. Figure 6-4 represents the outcome for micro sized manufactures of bread and fresh pastry goods and cakes in France. For the small sized manufactures of bread and fresh pastry goods and cakes, micro and small sized retailer specialized on sale of bread, cakes, flour confectionery and sugar confectionery the interviewee evaluated the effects on the business performance and judged the willingness of compliance as high. The interviewee didn't work this part of the questionnaire for medium and large sized enterprises. Because of the small number of enterprises belonging to this enterprise classes the interviewee had no appropriate expertise to answer.

Performance evaluation sheet								
By requirements affected business areas	Key performance indicators						Willingness of compliance	
	Sales	Costs	Customer satisfaction	Lead time	Appearance	Product safety		
HACCP	+	0	0	0	0	+		
Traceability	0	0	0	0	0	+	X	HIGH
Hygiene measures	+	0	0	0	0	+		
Laboratory tests	0	0	0	0	0	+		LOW
Self-monitoring	0	0	0	0	0	+		

Figure 6-4: Performance evaluation – example outcome field test I

The last part of the step-by-step approach is the enterprise behaviour magnitude. As already mentioned the part was not given in the questionnaire, the calculation was done externally. The following table (6-2) presents the outcome of the calculation and thus the final outcome of the step-by-step approach for decision support applied to the field test I for France. There are no expert information concerning the effects on flour mills and retail sale in non-specialized stores with food predominating so that here no results can be presented, the appropriate fields are blank. For some enterprise classes the expert could not answer the questionnaire because he had not enough information about this enterprise classes. The

appropriate fields are marked with a question mark. Here an expert with more specific knowledge is necessary.

Table 6-2: Enterprise behaviour magnitude – outcome field test I

Cereal industry France, supply chain view of main actors		**Farms[1]**	**Flour mills[2]**	**Manufactures of bread etc.[3]**	**Retail sale non-specialized[4]**	**Retail sale specialized[5]**
Total number of enterprises		287610	593	49173	32693	4199
Micro enterprises	proportion of total	25%	71%	92%	85%	98%
	affected	NO		YES		YES
	compliance			YES		YES
Small enterprises	proportion of total	19%	23%	7%	11%	2%
	affected	NO		YES		YES
	compliance			YES		YES
Medium enterprises	proportion of total	19%	5%	1%	3%	0%
	affected	NO		YES		YES
	compliance			?		?
Large enterprises	proportion of total	37%	1%	0%	0%	0%
	affected	NO		YES		YES
	compliance			?		?

[1] Agricultural holdings growing cereals
[2] Manufacture of grain mill products
[3] Manufacture of bread and fresh pastry goods and cakes
[4] Retail sale in non-spezialized stores with food, beverages or tabacco predominating
[5] Retail sale of bread, cakes, flour confectionery and sugar confectionery

Concerning the other countries:

In Germany the willingness of compliance of flour mills independent of the size is judged as high. Concerning the other enterprise classes, bakeries and retail, there are no results as the industry associations didn't participate. In Italy the willingness of compliance of flour mills independent of the size is judged as high. Concerning the other enterprise classes, bakeries and retail, there are no results as the industry associations didn't participate. In the UK the willingness of compliance of flour mills independent of the size is judged as high. Concerning the other enterprise classes, bakeries and retail, there are no results as the industry associations didn't participate.

6.3.2 Field Test II

In the field test II the step-by-step approach for decision support is applied to the directive concerning the sustainable use of pesticides, explained in section 5.1. In this section the main outcome of the step-by-step approach is exemplary shown for the interview with the German association of farmers.

The interviewee had expertise on enterprises respectively farms which belong to the stages of production: agricultural holdings growing cereals (producer). The interviewee was already firm with the regulation before participating in the survey. After answering the questions of the step 'enterprise classes identification' the outcome of the step-by-step approach so far shows that in Germany all agricultural holdings growing cereals are affected by the regulation.

The management system comparison is the next part of the questionnaire. The external data base's procedure and results are presented in figure 6-5 and 6-6. In the first step the different requirements of the directive and the matching management systems are listed. After filtering the listed management systems by the characteristics of the enterprise classes it is shown that the system Global GAP covers already most of the requirements. Still there are some requirements which are not included. Furthermore, no information is given about the degree of compliance with Global GAP of the single enterprise classes. For these reasons the procedure goes on with the detailed analysis of each enterprise class.

1. Step

Entering the new regulation and matching the requirements.

Requirement 1: Frequently training of employees concerning assurance, health, use of machinery, pesticides, and other hazardous actions.
Matching systems: - Global GAP - McDonalds Agricultural Assurance Program
Requirement 2: Construction and equipment have to be build accordingly to the designated use and have to be used in a way that the risk of product contaminations is limited to a minimum.
Matching systems: - International Food Standard (IFS) - British Retailer Consortium (BRC) - Global GAP
Requirement 3: The handling of pesticides has to be done in a way that human health and the environment is not endangered.
Matching systems: - Global GAP
Requirement 4: Pesticides have to be stored in a way that human health and the environment is not endangered.
Matching systems: - Global GAP - QS-Farming Production Combinable Crops - QS-Farming Production Fresh Fruit - QS-Farming Potatoe Production
Requirement 5: The aerial spraying of pesticides is prohibited.
Matching systems: - No management systems given
Requirement 6: Protection of sensitive areas.
Matching systems: - No management systems given
Requirement 7: Integrated pest management: Professionals must in particular give priority to those plant protection methods which cause the least disruption to agricultural ecosystems and encourage natural pest control mechanisms.
Matching systems: - No management systems given

Figure 6-5: Management system comparison – outcome 1. step field test II

2. Step

Matching the information about the identified management systems with the enterprise classes affected.

Enterprise class characteristics:	
Enterprises in:	Germany, France, Italy, UK
Industry sector:	Cereals and cereal products
Stage of production	Producer
Enterprise size classes:	Micro, small, medium, large
Matching systems: - Global GAP	

Figure 6-6: Management system comparison – outcome 2. step field test II

Next in the questionnaire there is the part regulation access. According to the interviewee all affected enterprise classes have physical access as well as mental access to the regulation. Also this interviewee remarked that most of the enterprise classes are members of the industry association which informs the enterprises about new regulations.

The first step of the performance evaluation, marking the business areas affected by the directive, is not presented, because all affected business areas are listed in the second step, the performance evaluation scheme. Regarding the micro sized agricultural holdings the interviewee evaluated the effects on the key performance indicators and judged the willingness of compliance as high (figure 6-7). Furthermore, all the other size classes, i.e. small, medium and large enterprises, are affected by this directive, too. According to the expert the effects on these enterprise classes are not different so that the willingness of compliance is judged by the expert as high, too.

Performance evaluation sheet								
By requirements affected business areas	Key performance indicators						Willingness of compliance	
	Sales	Costs	Customer satisfaction	Lead time	Appearance	Product safety		
Cultivation measures	0	-	0	0	0	0		
Occupational health and safety	0	0	0	0	0	0	X	HIGH
Storage	0	0	0	0	0	0		
Environment protection measures	0	0	0	0	0	0		
Documentation	0	0	0	0	0	0		
Management of the system	0	0	0	0	0	0		LOW
Staff training and qualification	0	-	0	0	0	+		
Constructional measures	0	0	0	0	0	0		
Technical equipment	0	0	0	0	0	0		

Figure 6-7: Performance evaluation – example outcome field test II

The last part of the step-by-step approach is the enterprise behaviour magnitude. This part was not given in the questionnaire, the calculation was done externally. The following table (6-3) present the outcome of the calculation and thus the final outcome of the step-by-step approach for decision support applied to the field test II for Germany. According to the expert judgement all affected enterprise classes are willing to comply with the directive.

Table 6-3: Enterprise Behaviour Magnitude – outcome field test II

Cereal industry Germany, supply chain view of main actors		Farms[1]	Flour mills[2]	Manufactures of bread etc.[3]	Retail sale non-specialized[4]	Retail sale specialized[5]
Total number of enterprises		226770	615	15237	24790	4835
Micro enterprises	proportion of total	23%	70%	54%	79%	89%
	affected	YES	NO	NO	NO	NO
	compliance	YES				
Small enterprises	proportion of total	32%	21%	37%	18%	10%
	affected	YES	NO	NO	NO	NO
	compliance	YES				
Medium enterprises	proportion of total	22%	7%	7%	2%	1%
	affected	YES	NO	NO	NO	NO
	compliance	YES				
Large enterprises	proportion of total	23%	3%	2%	1%	0%
	affected	YES	NO	NO	NO	NO
	compliance	YES				

[1] Agricultural holdings growing cereals
[2] Manufacture of grain mill products
[3] Manufacture of bread and fresh pastry goods and cakes
[4] Retail sale in non-spezialized stores with food, beverages or tabacco predominating
[5] Retail sale of bread, cakes, flour confectionery and sugar confectionery

Concerning the other countries:

As the industry associations of farmers of the other countries didn't participate in the survey there are no results given.

6.3.3 Evaluation

Only five out of eighteen potential interview partners participated in the field tests. The objective was not to draw conclusions from the field tests' results to the overall enterprise compliance behaviour, but to test the step-by-step approach in practise and to identify possible improvement potential. The evaluation of the field tests is as follows.

Evaluating the outcome of the questionnaire:

Based on the field tests the step-by-step approach delivers following outcome to be presented to a policy maker:

(1) The step-by-step approach sums up who is affected by the regulation. Fulfilling the part enterprise classes identification an overview of an industry sector, including the main actors, is given, presenting which enterprise classes are affected by the regulation and which not. The enterprise classes are characterised by the country they are located in, their industry sector, their stage in the production chain, and their size.

(2) The step-by-step approach presents the estimated compliance behaviour of each affected enterprise class in terms of complying with the regulation or not complying with the regulation. Furthermore it can be traced back if the estimated behaviour of complying is caused by the already compliance with an e.g. quality management system with matching requirements or if it is caused by a positive effect on the enterprise performance. There is also the possibility to trace back the reason for the behaviour non-compliance, either caused by missing access to the regulation or by a negative effect on the enterprise performance.

(3) Finally the step-by-step approach visualizes the magnitude of the enterprise compliance behaviour. The information about the compliance behaviour is combined with the number of enterprises of each enterprise class and presented in a supply chain view of the industry sector. That enables to imagine the relevance of the compliance behaviour of each affected enterprise class within its business environment.

The outcome of the field tests show that the desired information, the enterprise compliance behaviour, can be estimated with help of the step-by-step approach. So far the final outcome differentiates only between compliance and non-compliance. More detailed information has to be traced back. Here an improvement potential can be identified. Reflecting the objective of giving support to a policy maker the step-by-step approach would gain if the outcome would deliver more diversified information. For translating the step-by-step approach into a decision support system following possible improvement should be kept in mind: a modification of the presentation of the final outcome to easy the identification of enterprises (1) already complying, because of e.g. quality management systems, (2) willing to comply because of a positive effect on the performance, (3) not able to comply because of missing access, and (4) not willing to comply because of a negative effect on the performance.

Evaluating the interaction between the interviewee, the sequence of arguments and the knowledge base:

The sequence of arguments was considered in the structure of the questionnaire. The interviewee had to answer each question before going to the next question and so the

evaluation was guided by the sequence of arguments. The information stored in the knowledge base was presented to the interviewee and used to answer the single questions. Still there is some need for improvement. The predefined answers allowed the interviewee always to answer only for all enterprises within an enterprise class. Although the interviewee knew that not all enterprises within an enterprise class would act the same it could not be considered in the questionnaire. This should be improved in the transformation of the step-by-step approach to the decision support system.

Evaluating the sequence of arguments:

The identified sequence of arguments is based on expertise (section 5.4). Both field tests showed that the sequence of arguments leads to the desired outcome, the enterprise compliance behaviour. The field tests approved the correctness of the arguments for the given decision scenario.

Evaluating the knowledge base:

The knowledge base supported the interviewee with given information related to the arguments to take the right path through the step-by-step approach. For some arguments the stored knowledge is based on statistics, e.g. in the last step statistics are used to come up with the enterprise behaviour magnitude, other knowledge is based on case studies, e.g. the identification of the key performance indicators. These differences in the data source require considering possible differences in data reliability. In the case that a specification in the step-by-step approach totally relies on the data stored in the knowledge base low data reliability might has a negative effect on the outcome of the step-by-step approach. This is true if the specification relies totally on the data stored in the knowledge base. Still, there is no compulsory causal relation between the data stored in the knowledge base and the specification, which means that the analyst can make a specification on an argument just partly based on the data in the knowledge base or not at all based on the data in the knowledge base. Therefore the data's reliability as well as the data's effect on the specification should be evaluated. That is a further improvement which will be considered in elaborating the decision support system.

Evaluating the analyst:

The step-by-step approach gives no guidance of how to choose an analyst. In the field tests industry associations were chosen as analysts under the assumption that they have expertise

on all different enterprises within their industry sector and that they are familiar with food regulations. All interviewees could work the questionnaire. But the field tests showed differences between the interviewees. One interviewee could not answer questions concerning medium and large sized enterprise within his industry sector. He argued that medium and large sized enterprises are so few that he had no expertise. Another interviewee mentioned that he could answer for all enterprises in his industry sector and in addition also for those in the other countries. A third example worthwhile to mention is that one interviewee could answer for both, processors (bakers) and retail (specialized in retailing bakery products), because this would go mostly together. Based on the field tests it can be concluded that chosen one or more appropriate analysts depends strongly on the decision scenario and the analyst's expertise.

6.4 Summary

To test the working procedure and identify improvement potential of the generated step-by-step approach chapter 6 presented its first implementation. The utilization of the knowledge areas (1) sequence of arguments and (2) knowledge base needed the third knowledge area (3) the analyst, which enables the interaction between the different knowledge areas. Within two field tests the step-by-step approach was applied to two different regulatory frameworks and with the help of several analysts the working procedure was demonstrated. It could be confirmed that the utilization of the step-by-step approach is feasible and end with the enterprise compliance behaviour of the enterprise classes affected by the regulation. Furthermore this first run of the step-by-step approach identified improvement potential for the further implementation into a decision support system.

After identifying the step-by-step approach for decision support in chapter 5 and testing it in chapter 6, the following chapter 7 translates the step-by-step approach into a computer-based decision support system.

7 Designing the Decision Support System

So far the step-by-step approach is elaborated (chapter 5) and tested by a first implementation (chapter 6). The second objective of the thesis is to transform the improved approach into a computer-based interactive decision support system. The major contribution of chapter 7 is:

- a presentation of decision support systems within the area of information systems, and
- the transformation of the improved step-by-step approach for decision support into a computer-based decision support system.

Underneath figure 7-1 presents the structure of chapter 7.

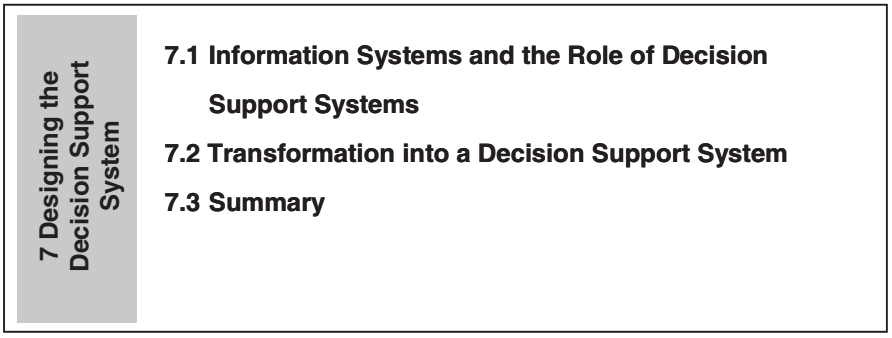

Figure 7-1: Overview of chapter 7

7.1 Information Systems and the Role of Decision Support Systems

Information systems in general aim at increasing the effectiveness, and the efficiency of the information itself, the information transmission, and the information processing (HEINRICH 1993). The increase of effectiveness refers to being up-to-date, the database, the accuracy and quality of the data aggregation as well as the flexibility and the provision of the information. The increase of efficiency refers to a faster and more cost-saving transmission of the information. According to KRCMAR (1997) information systems are systems containing human and automatic elements aiming at providing information and communication at optimal economic criteria. Information systems are considered as open, dynamic and complex systems. They are open, because there elements interact with their environment, they are dynamic, because based on the interaction the elements can change their characteristics, and

they are complex, because of the huge amount of elements within the system and their huge amount of interrelations (KRCMAR 1997).

In literature there are several approaches of systems classifying the different information management systems (compare the table of information system classifications in THIEL 1997). For example SCHEER (1994) arranges the information systems according to the hierarchy within an enterprise. The different information systems can be classified and visualized according to their operational area in a pyramid. At the lowest level there are functional systems, which deliver information concerning all business processes in all functional areas. At the upper level there are systems, which deliver information to support planning and controlling activities. At the third level there are information systems which serve as supporting medium-term planning and controlling activities including analysing and reporting systems. At the top of the pyramid there are information systems, which support strategic planning and decision making activities. This approach will not be further considered as the decision support system within this research is addressed to policy and not elaborated for the use within an enterprise. Instead SCHMIDT (1996) focuses on the functions of information systems.

SCHMIDT (1996) classified information systems according to their functions (1) information search, (2) information processing, and (3) information transfer. The following overview can be given (THIEL 2001):

(1) Systems for information search enable to store data and provide them if needed. Focus is on searching, storing and presenting data. Examples are database systems and management information systems.

(2) Systems for information processing enable to come up with a final outcome by the support of a given model or norm. Examples are expert systems or decision support systems.

(3) Systems for information transfer aim at transporting the information form the sender to the recipient. Examples are groupware systems and workflow systems.

Underneath figure 7-2 visualizes the classification of information systems and arranges decision support systems which are further described subsequent to the figure.

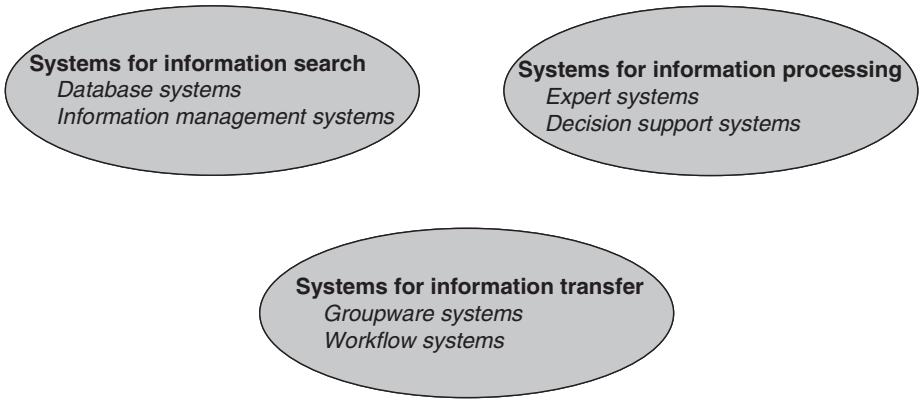

Figure 7-2: Classification of information systems including examples (based on SCHMIDT 1996)

Within this work an interactive computer-based system for decision support should be elaborated; i.e. a Decision Support System (DSS). DSS are computer programs which aim at supporting decision makers in complex, not well structured decision situations (HUMMELTENBERG, PRESSMAR, 1989). Solving the problem is highly influenced by the subjective judgements of the decision maker. Therefore it is not possible to integrate the decision situation into an enclosed mathematical model. A DSS is not targeting on automating the complete decision making process, but to deliver internal and external information for complex decisions. Data is administered in a database and offered via a user interface. Furthermore the final decision depends on the judgement of the decision maker or the user of the system and is not given by the system itself (MÜLDER, WEIS 1996).

SCHEER (1994) states following characteristics of a DSS:

- a high interaction,
- a flexible modelling approach,
- the possibility for the user to rework or further develop the model, for a higher acceptance and a better interpretation of the outcomes, and
- a fast delivery of information.

As a fundament of the decision supporting system there are database systems. Their function is to save, to administrate, and to provide information (THIEL 1997). VELDER (2000) states that database systems build a highly important groundwork for decision making.

7.2 Transformation into the Decision Support System

Section 7.2 presents the final step in working the thesis' objectives. It fulfils the second objective; i.e. transforming the step-by-step approach into a computer-based interactive system for decision support. The transformation into a DSS will not change any content of the

step-by-step approach. The content and thus the theoretical procedure of the DSS will equal the step-by-step approach presented in chapter 5 considering the improvement potential identified in the field tests of chapter 6. In addition to the improvements the value of this part of the research results from the characteristics of information systems in general and decision support systems in specific introduced in the section above, which can be summed up as an increase in the effectiveness and efficiency of information and thus a support of the decision maker in complex decision scenarios.

The technical process of transforming the step-by-step approach into a computer-based DSS was supported by an IT expert. The DSS is based on a combination of Microsoft Access and Microsoft Excel, which enhances the interaction of the three knowledge areas in practice: (1) the sequence of arguments, (2) the knowledge base and (3) the analyst (see section 6.1). Knowledge can be inserted, stored and presented.

The field tests of the research and herein also the questionnaire is arranged in sections integrating related arguments to present a well structured procedure. This is also done in elaborating the user interface of the DSS. Explaining the utilization of the step-by-step approach through the DSS the focus is on the user interface. The logic behind is already explained in detail in chapter 5 and is not to be repeated in this section. Furthermore the improvements of the step-by-step approach will be presented. Appendix G presents screenshots of all steps of the DSS. The results shown in the screenshots in this section and in the appendix are random examples to show how the DSS gets the final outcome across to the decision maker. The steps of the DSS are the following:

First (figure G-1 in the appendix) an introduction of the DSS including the aim and its composition of the three knowledge areas is given. The DSS is structured in the following parts:

- *Regulation analysis* – Including the argument (1) requirements.
- *Enterprise classes identification* – Including the arguments (2) regional focus, (3) industry sector, (4) stage of production, and (5) enterprise size.
- *Management system comparison* – Including the argument (6) status quo of compliance behaviour.
- *Regulation access* – Including the arguments (7) physical access and (8) mental access.

- *Performance evaluation* – Including the arguments (9) business performance and (10) compliance behaviour.
- *Enterprise behaviour magnitude*
- *Data evaluation*

The user has the possibility to directly run the DSS, to see already elaborated results of the DSS, or to adapt the information stored in the knowledge base via an administration button (see figure G-2 in the appendix).

Regulation analysis

Running the DSS first the user is asked to analyse the focal regulation (figure G-3 in the appendix).

Enterprise classes identification

This part of the DSS contains five steps. The first step is related to argument (2) regional focus and asks the user to mark that single country out of a given list where the regulation is applied to and the user has expertise on. The second step is related to the argument (3) industry sector and asks the user to mark that single industry sector out of a given list where the regulation is applied to and the user has expertise on. The third step is related to the argument (4) stage of production and asks the user to mark all stages of production out of a given list which are affected by the regulation. The fourth step refers to argument (5) enterprise size and asks the user to mark all size classes out of a given list which are affected by the regulation. As the single steps build on each other this procedure has to be done for all stages of production marked before. The fifth step presents an overview of the different enterprise classes affected by the regulation. Figure G-4 to G-8 in the appendix present screenshots of the DSS user interface of each step.

Management system comparison

This part refers to the argument (5) status quo of compliance level. The different enterprise classes identified in the previous step are listed. The user is asked to judge how many enterprises of each class are already fulfilling the requirements of the regulation by complying with an e.g. quality management system. The answer must be given on a presented scale ranging from 0% to 100% in steps of 10%. See figure G-9 in the appendix.

Regulation access

Following steps refer to each enterprise class listed in the step before and not judged as 100% compliance according to a given management system. To make the user aware of the respective enterprise class it is first characterised (figure G-10 in the appendix). The next step is related to argument (7) physical access and asks the user to judge how many enterprises of the respective enterprise class have physical access to the regulation. Thereafter, related to the argument (8) mental access the user is asked to judge how many enterprises of the respective enterprise class have mental access to the regulation. Both questions have to be answered on a given scale from 0% to 100% going in steps of 10%. Here steps build on each other, too, so that the indication in percentage refers to the answer of the previous step.

Performance evaluation

This part refers to the argument (9) enterprise performance and (10) compliance behaviour. In the first step the list of business areas and their explanation is presented. The user is asked to mark all business areas which are affected by the regulation's requirements (figure G-11 in the appendix). In the next step (figure G-12 in the appendix) the user should evaluate the effects of actions taken in the business areas on the key performance indicators and finally judge how many enterprises of the respective enterprise class are willing to comply with the regulation. Again the answer has to be given on a scale from 0% to 100% going in steps of 10%.

Enterprise behaviour magnitude

This part of the DSS presents the outcome to the user; i.e. the key information supporting the policy decision maker. The results are presented in a table (example given in figure G-13 in the appendix) and in addition visualized in a diagram, exemplary shown underneath in figure 7-3.

At this point the DSS presents the following information to the user:

- A supply chain view on an industry sector of the respective country, which is at least partly affected by the regulation, is given. Here it is stated which enterprise classes are affected by the regulation and which are not affected. The number of enterprises within each enterprise class is given and thus enables to visualize the proportion of each enterprise class within the industry sector.

- For each affected enterprise class the status quo of the compliance level is presented. That means that the user is informed about how many enterprises of each enterprise class are already fulfilling the regulation's requirements because of the compliance with given management systems (e.g. quality management systems).
- For each affected enterprise class it is stated how many enterprises are willing to comply with the regulation if it would be passed by policy.
- For each affected enterprise class it is stated how many enterprises have no access to the regulation and thus can't comply with the regulation.
- For each affected enterprise class it is stated how many enterprises are not willing to comply with the regulation if it would be passed by policy.

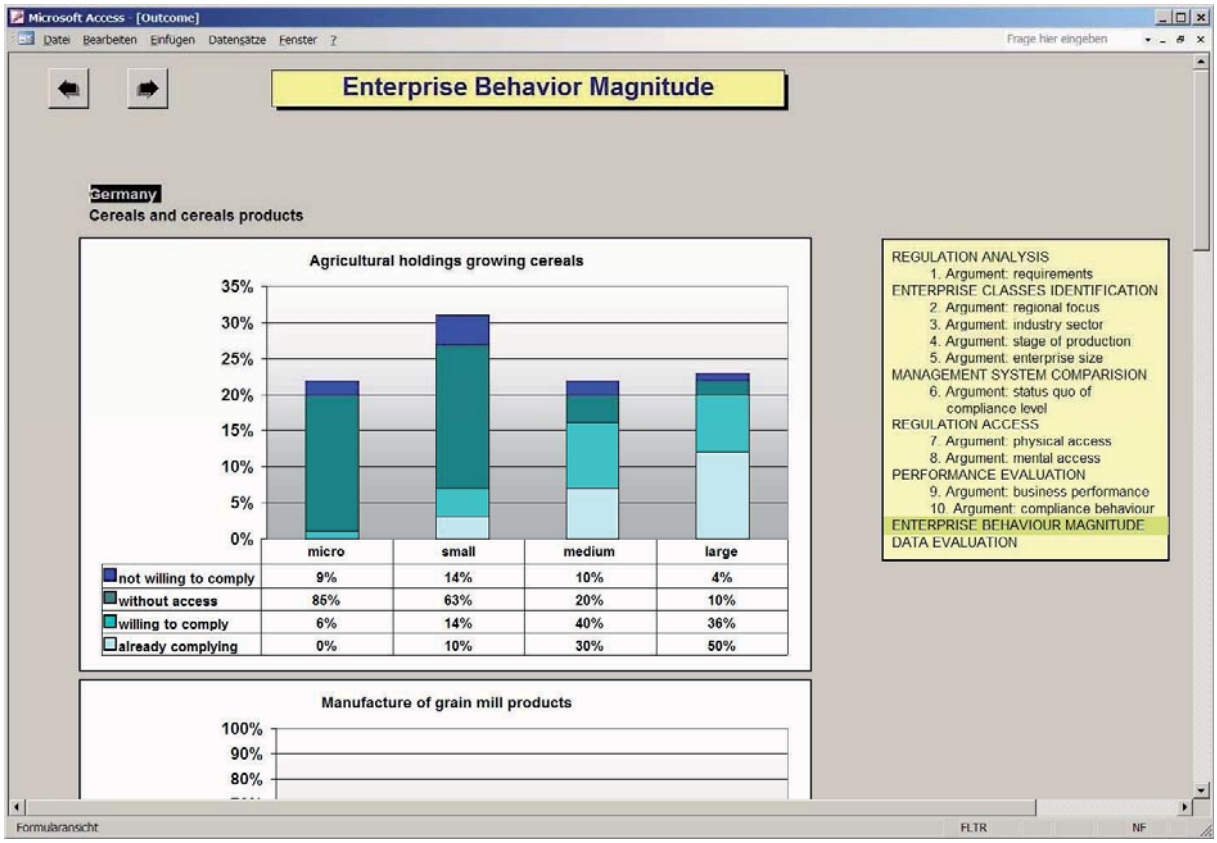

Figure 7-3: DSS enterprise behaviour magnitude

Data evaluation

This part is added to the steps of the step-by-step approach and not discussed so far. Based on the results of the field tests the need for the possibility to evaluate the knowledge backing up the sequence of arguments was identified.

A list with the different knowledge items backing up the steps of the DSS is presented to the user (table 7-1).

Table 7-1: Data to evaluate

Step in DSS	Data in knowledgebase
Enterprise classes identification	Classification of regions Classification of industry sectors Classification of stages of production Classification of enterprise size classes
Management system comparison	Information concerning management systems description Information concerning the degree of compliance
Regulation access	Information concerning physical access Information concerning mental access
Performance evaluation	List of business areas List of key performance indicators
Enterprise behaviour magnitude	Information concerning enterprise statistics

As explained in section 6.3.3 the presented knowledge is based on different sources (e.g. case studies, surveys, or experts), which suggests differences in reliability. Therefore in this step the user of the DSS is asked to judge the reliability of the data stored in the knowledgebase in a qualitative way: low, medium or high reliability. Furthermore there is the possibility to differentiate the data in terms of there potential effect on the specification done in each step (see figure G-17 in the appendix). It might be possible that although the reliability of specific data is judged as low the corresponding specification within the procedure is still sufficient because the data's effect on the specification is low. This case occurs if the analyst makes the specification without or with minor help of the stored data. Combining the data's reliability and the data's effect on the specification enables to present a matrix visualizing if there are data items which need further improvements before taking the outcome of the DSS as a base for policy making (see exemplary figure 7-4). The matrix makes clear if the outcome of the DSS is based on data which can be judged as critical and thus needs further improvements, in the matrix arranged in the red area. Or if the data is judged as non-critical, which doesn't need further improvements, in the matrix arranged in the green area. Or if the data is judged in a way that the decision maker has to balance if he goes for further investigations or if it is still sufficient for the specific decision situation, in the matrix arranged in the orange area. The evaluation process, both, for the reliability and for the importance, depends strongly on the specific decision scenario the decision maker is in.

Figure 7-4: DSS data evaluation matrix

7.3 Summary

Chapter 7 presented the final step of the research. After elaborating the step-by-step approach in chapter 5, testing the utilization and identifying improvement potential throughout two field tests in chapter 6, the improved step-by-step approach is transformed into a decision support system in chapter 7. Thus the second research objective is fulfilled, too.

The introduction to information systems and in this relation decision support systems confirmed that the elaboration of a DSS was right in dealing with the problem situation explained in detail in chapter 1. The DSS administers information in a database and via a user interface the given knowledge is presented in a structured way to the user. The DSS guides the user in the utilization of the step-by-step approach.

The transformation of the step-by-step approach into the DSS considered the identified improvement potentials so that the DSS outcome can present significant information to the policy maker: for each affected enterprise class the status quo of the compliance level, the potential increase in compliance after passing the new regulation, the amount of enterprises

not complying because of missing access, and the amount of enterprises not willing to comply because of negative effects. Thus a multifaceted picture of the probable enterprise compliance is given to the policy maker. Furthermore, as the data stored in the knowledge base might affect the outcome of the DSS heavily its reliability as well as its effect on the corresponding specification in the DSS procedure is evaluated.

With the transformation of the step-by-step approach for decision support into a decision support system for policy makers this research is completed. Finally chapter 8 will present conclusions and an outlook.

8 Summary and Outlook

To formulate and decide on regulations information on the possible effects are of high importance. Several approaches, mostly ex-post, for policy decision support are given like cost-benefit analysis or impact assessment evaluating effects on the society level which are of general interest, e.g. public welfare. Instead this research approach supposes a differentiation of levels of analysis and thus highlights the development path starting with the effects of regulations on individual actors like enterprises and ending up with consequences on the society level. After identifying the overall problem situation the thesis limits the research on the arguments that describe the development path from the regulation to the activities of the single enterprises within a scenario defined by the regulation. The objectives of the research were:

(1) to generate a step-by-step approach for regulatory decision support, and
(2) to transform this approach into a computer-based interactive system for decision support.

The evaluated system should support policy makers in deciding pro or contra a regulation proposal and thus it should increase the effectiveness of regulatory food policy. This chapter concludes the thesis by summing up the research in section 8.1 and giving an outlook in section 8.2.

8.1 Summary

The study started in chapter 2 with a literature review on food safety and quality requirements and their relation to enterprises. The concept of quality management was introduced and related terms clarified. The society, the enterprises and the consumers are identified as driving forces for quality management, which are reflected in public and private food safety and quality control initiatives. Both aim at increasing food safety and quality, at which private initiative tend to go a step further in terms of requirements. The research focuses on public regulations. Although they are compulsory the enterprise compliance behaviour depends on the effects on the overall business performance. A positive effect is the precondition for compliance.

As the enterprise behaviour and according to the previous findings in this connection the enterprise performance is of major interest for this research, in chapter 3 literature is reviewed in these fields. The key subject in strategic management is the investigation of firm behaviour and its interrelation with competitive performance. Here the structure-conduct-performance paradigm was identified, which presents a baseline of a norm leading to the enterprise performance. Its main argumentation line is that the performance of enterprises is determined by their behaviour, which in turn is determined by the industry market structure. In addition, the concept of performance measurement and performance measurement systems visualizing the cause-and-effect relations within an enterprise is introduced. Here the Balanced Scorecard provides a basic structure for a multi-dimensional way of measuring enterprise performance.

Based on the information gathered so far chapter 4 presented a preliminary framework of a step-by-step approach for decision support. It serves as the working hypothesis for the following study by presenting a baseline of a norm that states if an enterprise in a specific situation, defined by external and internal conditions, facing a food safety regulation with given requirements will behave in a causal way. The framework of a step-by-step approach considers the principals of decision aiding by breaking down complexity and concentrating only on a few critical steps.

Chapter 5 aimed at validating and specifying the preliminary framework to fulfil the first research objective; i.e. to generate a step-by-step approach for regulatory decision support in food policy. To do so a specific decision scenario was taken as a basis, which involved the implementation of a proposal for a regulation on the use of pesticides and of a directive on the provision of product information concerning allergens to consumers. The decision scenario was defined by a connected EU research project.

The main finding is the step-by-step approach for decision support basing on the two knowledge areas: (1) the sequence of arguments relying on expertise and specific for the given decision scenario, and (2) the knowledge base storing data about the actual decision situation, which relies on several sources coming from desk research.

The aim of the step-by-step approach is to support decision making in the field of food policy. Of specific relevance is the reduction of complexity coming along with the need of

improvements towards transparency and comprehension. This is achieved by the following features:

- The decision problem of judging the enterprise compliance behaviour is broken down to several smaller specifications related to each argument. The procedure is to go through the step-by-step approach giving the single specifications one after another.
- This process is backed up by data stored in the knowledge base. Still, there is no causality that each specification has to rely totally on the presented data. Other information might be taken into account, too. As the knowledge base has a modular approach data can be replaced or improved easily.
- The step-by-step procedure acts like a filter. The complexity of the overall decision problem is reduced going from each step to the next by eliminating enterprises which don't fulfil specific criteria connected to the arguments and so which are not of relevance for the further procedure.
- The enterprise decision is not a black box. The performance evaluation sheet visualized cause-and-effect relations and enables so to trace back reasons for choosing non-compliance.

The next step in the research was to test the generated step-by-step approach and identify improvement potential before transforming it into a computer-based system. In chapter 6 the step-by-step approach was implemented within two field tests considering the given decision scenario. The utilization of the step-by-step approach required analysts giving the specification related to the arguments. They represent the third knowledge area beside the sequence of arguments and the knowledge base.

The field tests confirmed that the utilization of the step-by-step approach is feasible and leads to the desired outcome; i.e. information about the enterprise compliance behaviour. Still, the following improvement potential was identified:

- The final information presented to the decision maker shouldn't be limited to compliance or non-compliance but give more diversified information, which is already gathered in the step-by-step approach.
- The specifications done by the analyst are limited to given alternatives. So far these alternatives referred to all enterprises within the respective enterprise class. In the improved version it should be considered that although enterprises are in the same class they might behave different.

- Differences in the source of data stored in the knowledge base suggest differences in reliability. Furthermore the expert specifications don't have to rely on the given data which suggests differences in the data's effect on the specification. Both should be evaluated to support the decision if the final outcome can be relied on or if further improvements in the stored data are necessary.

Finally in chapter 7, with the aid of an IT expert the improved step-by-step approach is transformed into a DSS to fulfil the second objective of the thesis: transforming the step-by-step approach into a computer-based interactive system for decision support. The additional gain of the DSS is that the user interface supports the utilization of the step-by-step approach. Not only in terms of guiding the user through the single steps, but also in maintenance of the gathered knowledge. The DSS provides the following information to the policy maker:

- For all affected enterprise classes the probable compliance behaviour is given in percentage of the total enterprise class differentiated by:
    - Already complying because of a matching management system.
    - Willing to comply because of a positive effect on the enterprise performance.
    - Not able to comply because of missing access to the regulation.
    - Not willing to comply because of a negative effect on the enterprise performance.
- The results are presented in a supply chain view visualizing which tiers from producer to consumer will fulfil the requirements and which will not. Taking information about the product flow into account (distribution and through-put time), these tiers could be identified which are of major importance to fulfil the overall policy objective of an increase in the food safety status.
- The results and the possibility to trace back the cause-and-effect relations enable recommendations for further policy actions. Improving communication in terms of calling the enterprises' attention to the new regulation and explaining the mission would probably lead to a higher degree of compliance. It could be assumed that the degree of compliance would increase in the same proportion in which enterprises with access to the regulation are willing to comply.
- The second possibility is to influence the behaviour of the enterprises not willing to comply. The performance evaluation sheet gives an insight to the main effects on the performance. Countervailing actions, e.g. compensatory payments, could change the willingness of compliance.

The evaluation of the data's reliability and the data's effect on the corresponding specification and its presentation in a matrix points to the stored data and might put it into question. If the data's reliability is judged low and the data's effect on the corresponding specification is judged high there is reasonable doubt on the DSS outcome. The option might be further investigations related to the specific data.

8.2 Outlook

The thesis worked on the given problem situation within a specified area. The present work includes limitations, which could be a starting point for further research to build on and further develop the outcome of this work.

Concerning the applicability of the DSS the presented one is limited to the decision scenario explained at the beginning of chapter 5. That means a restricted use for the policy maker as it is not ready to use for analysing the enterprise compliance behaviour in other scenarios, e.g. a regulation targeted on the pork sector. To make the DSS applicable for another decision scenario one might not have to start at the very beginning and elaborate a totally new DSS. It might be sufficient just to replace single arguments in the sequence of arguments. This is a starting point for further research. One could think of elaborating a standard of a sequence of arguments and in addition a range of several arguments on top. This would enable to build up an appropriate sequence of arguments for different decision scenarios (e.g. different sectors) by combining already given components. If this research would be done in advance the applicability of the DSS for the policy maker would highly increase.

The user navigation of the DSS considers the concept of decision aiding, explained in chapter 4. In the first step, it is implemented theoretically in the stepwise procedure of the step-by-step approach for decision support. In the second step, it is implemented technically in the functionality of the DSS's user interface. In both steps the navigation of the user could be increased by further research. On the one hand the knowledge base could include more data aiding the analyst in taking the necessary specifications related to the arguments. Here an example would be the survey (appendix D), which was done to get cost related information backing up the argument enterprise performance. On the other hand the functionality of the DSS could be increased. The scope of the policy maker is the EU level, but so far the DSS presents the compliance behaviour of enterprises taking a supply chain view on the country

level. Though the policy maker gets all information concerning the enterprise compliance behaviour, but they are not presented at a glance. Further work could end up with a more comprehensible conclusion of the enterprise behaviour on the EU level.

Chapter 1 arranged this research within the multi-level approach of the overall problem situation and indicates the problem of system dynamics. Here is a further need for future research. In addition to the regulations' effects on single enterprises, the effects on enterprise groups like e.g. industry sectors or supply chains could be investigated. Section 1.2.1 as well as section 2.3.2 indicated that groups of enterprises might have different interests than individual enterprises, e.g. transaction costs or traceability. Furthermore, after looking at enterprises in a static scenario research could consider dynamics within the enterprise environment in a certain time period. Enterprise behaviour might change because of the behaviour of other enterprises or external effects. These interactions could take place within an enterprise class as well as between enterprise classes, e.g. along a supply chain.

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Appendices

Appendix A

Proposal for a Regulation of the European Parliament and of the Council on the provision of food information to consumers

This draft regulation consolidates and updates two areas of labelling legislation: (1) Directive 2000/13/EC on 20 March 2000, which lays down common labelling requirements applicable to all foods to be delivered to the final consumer, and to food supplied to mass caterers. (2) Directive 90/496/EEC of 24 September 1990, which introduces mandatory labelling of key nutritional elements. The draft regulation on the provision of food information to consumers aims at protecting consumer's health and interests by establishing a basis for final consumers to make health conscious food choices. One key objective is the simplification of food information to consumers.

The draft regulation applies to all stages of the supply chain, where the operations of food businesses affect the provision of food information to consumers. It applies to all foods intended for the final consumer, including foods delivered by mass caterers and food intended for supply to mass caterers. It applies to all members of the EU.

According to the study setting of this research the following elements of the proposal are of specific interest:

Article 22 - Labelling of certain substances causing allergies or intolerances
Any ingredient causing allergies or intolerances listed in appendix II of the proposal or any substance originating from an ingredient listed in that appendix shall be indicated on the label. Of specific relevance for the study are cereals containing gluten and products thereof.

For more detailed information see:
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0040:FIN:EN:PDF.

Appendix B

Directive 2009/128/EC of the European Parliament and the Council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides

The regulation's subject of matter is to constitute a framework to achieve a sustainable use of pesticides by minimizing risks and impacts of pesticide use on human health and the environment. Moreover, this objective shall be achieved by encouraging the use of integrated pest management and of alternative approaches or techniques, as for example chemical alternatives to pesticides. This directive applies to all pesticides that are defined as plant protection products. Furthermore, this directive applies to everyone using pesticides in the course of their professional activities, in farming and other sectors.

The elements of the Directive can be summarized as follows:

National Action Plans - National Action Plans shall contain objectives, measures and timetables to reduce risks of pesticide use on human health and the environment. They should also foster the use of alternative ecological approaches or techniques.

Training - Systems of training for professional users, distributors and advisors shall be set up. It shall be sanctioned by the obtaining of a certificate, which attest sufficient knowledge regarding the legislation in force, the dangers and risks associated with pesticides, procedures for preparing equipment, emergency action in case of accident, etc.

Inspection of pesticide application equipment – Pesticide application equipment used by professionals must be inspected every five years by bodies designated by Member States. The purpose of these inspections is to check that equipment functions reliably and that it is used properly for its intended purpose.

Aerial spraying of pesticides - The aerial spraying of pesticides is prohibited. Derogations are nevertheless possible where there is no viable alternative, or where aerial spraying has advantages in terms of reduced impacts on human health and the environment as compared with land-based application.

Protection of the aquatic environment and drinking water - Specific measures shall be adopted, which give priority to the use of the least toxic products, the most effective techniques, equipment limiting drift of products, and the establishment of buffer zones along surface waters.

Protection of sensitive areas - In certain sensitive areas, the use of pesticides is prohibited or strictly limited.

Integrated pest management - Integrated pest management prioritises the least dangerous solutions for health and the environment. Professionals must in particular give priority to those which cause the least disruption to agricultural ecosystems and encourage natural pest control mechanisms.

For more detailed information see:
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:309:0071:0086:EN:PDF

Appendix C

Survey concerning the degree of compliance with quality systems in the EU food industry

Please name your country: _____

If you are interested in the results, please write down your name and your email address.

Name: _____

Email address: _____

Please give a judgement of how many producers, processors and retailers comply with the following quality systems (BRC, IFS, Global Gap, ISO 9001, ISO 14001, ISO 22000) in each industry sector in your country by marking the appropriate field with 'X'. If you want to give any remarks, please do so underneath each table. The pages are printed on both sides.

BRC Global Standard						
Industry sector	Degree of enterprises complying with the quality system in respect of total number of enterprises					
	Primary production		Processing		Retail market	
Meat and meat products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Fish and fish products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Fruit & vegetables		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Dairy and dairy products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Grain and grain mill products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %

IFS - International Food Standard						
Industry sector	Degree of enterprises complying with the quality system in respect of total number of enterprises					
	Primary production		Processing		Retail market	
Meat and meat products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Fish and fish products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Fruit & vegetables		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Dairy and dairy products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Grain and grain mill products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %

Global Gab						
Industry sector	Degree of enterprises complying with the quality system in respect of total number of enterprises					
	Primary production		Processing		Retail market	
Meat and meat products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Fish and fish products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Fruit & vegetables		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Dairy and dairy products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Grain and grain mill products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %

ISO 9001						
Industry sector	Degree of enterprises complying with the quality system in respect of total number of enterprises					
	Primary production		Processing		Retail market	
Meat and meat products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Fish and fish products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Fruit & vegetables		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Dairy and dairy products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Grain and grain mill products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %

ISO 14001						
Industry sector	Degree of enterprises complying with the quality system in respect of total number of enterprises					
	Primary production		Processing		Retail market	
Meat and meat products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Fish and fish products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Fruit & vegetables		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Dairy and dairy products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Grain and grain mill products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %

ISO 22000						
Industry sector	Degree of enterprises complying with the quality system in respect of total number of enterprises					
	Primary production		Processing		Retail market	
Meat and meat products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Fish and fish products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Fruit & vegetables		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Dairy and dairy products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Grain and grain mill products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %

QS - Quality scheme						
Industry sector	Degree of enterprises complying with the quality system in respect of total number of enterprises					
	Primary production		Processing		Retail market	
Meat and meat products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Fish and fish products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Fruit & vegetables		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Dairy and dairy products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %
Grain and grain mill products		76-100 %		76-100 %		76-100 %
		51-75 %		51-75 %		51-75 %
		26-50 %		26-50 %		26-50 %
		0-25 %		0-25 %		0-25 %

Appendix D

Questionnaire on costs and benefits of new rapid methods
Food allergens working group

It is the overall objective of the questionnaire to assist in the selection of new and/or not yet validated rapid methods for further development and validation.

The questionnaire focuses on the characterization of the new rapid method.

- Part 1: technical characterization
- Part 2: costs and benefits

Important remark: Please answer all questions, even if you are unsure. In that case you should make a 'judgement'. Mark judgements with a '?' (question mark).

In case you have any questions regarding the questionnaire and how to fill it in please contact:

	Tel	E-mail
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Henrik Krapp	+49-228-733500	henrik.krapp@uni-bonn.de

Part 1: Technical characterization of the new rapid method

1	Name of new rapid method / test.				
2	Please characterize the focus of alteration of the new rapid method by crossing with X.	Test kit		Equipment / procedure	
3	How would you judge the method's 'fitness for purpose'? Please specify the basis of your judgement.				
4	Please specify what the new method can analyse.				
5	Who can potentially perform the new method (please cross with X)?	Internal lab of food processor / retailer	Legal / official / accredited laboratory	On-line analysis	Other
6	What is the turnaround time for a single analysis for each type of food? Please specify in minutes, hours or days as appropriate.		Time in minutes, hours or days		
		Meat / meat products			
		Dairy / dairy products			
		Grain / cereal products			
		Fruits / fruit products			
		Vegetables / veg. products			
		Other:			
		Other:			
7	Sample size of each product required for analysis. Please specify the product and the unit of weight.				
8	At what processing stage of a food product could the new method be used (please specify)?	Raw material	Processed material	End product	

Part 2: Costs and benefits of the new rapid method

<table>
<tr><td colspan="2"></td><td colspan="3"></td><td>Please put any remarks you might have.</td></tr>
<tr><td>9</td><td>Price of the test kit (in Euro)</td><td colspan="3"></td><td></td></tr>
<tr><td rowspan="2">10</td><td rowspan="2">Is it possible to use the new equipment for parallel analyses of several contaminants, analytes etc.? If so, how many different contaminants can be analysed?</td><td>Yes (please specify!)</td><td colspan="2">No</td><td rowspan="2"></td></tr>
<tr><td></td><td colspan="2"></td></tr>
<tr><td rowspan="2">11</td><td rowspan="2">Competence level of responsible personnel required.</td><td>Technical assistant</td><td>University degree</td><td>PhD</td><td rowspan="2"></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td rowspan="2">12</td><td rowspan="2">Do you consider the new method has a chance to become official and legal?</td><td colspan="2">Yes</td><td>No</td><td rowspan="2"></td></tr>
<tr><td colspan="2"></td><td></td></tr>
<tr><td rowspan="3">13</td><td rowspan="3">Please rank the criteria ‘turnaround time’, ‘costs’ and ‘fitness for purpose’ according to their importance. Put ‘1’ for the most important criterion, ‘2’ for the following and ‘3’ for the last important criterion.</td><td colspan="2">Turnaround time</td><td></td><td rowspan="3"></td></tr>
<tr><td colspan="2">Costs</td><td></td></tr>
<tr><td colspan="2">Fitness for purpose</td><td></td></tr>
</table>

Appendix E

Appendix E presents the enterprise statistics stored in the knowledge base related to the final step of the step-by-step approach 'enterprise behaviour magnitude' (compare section 5.5). Table E-1 to E-4 display the main actors of the cereal industry in Germany, France, Italy and UK. Here the number of enterprises of each possibly affected enterprise class is given as well as the proportions of the different size classes (mirco, small, medium, large) within each stage of production are presented.

The presented data is based on statistics given by Eurostat. All data refer to the year 2007. The statistics given in Eurostat are limited concerning their level of detail so that the desired information couldn't be directly extracted from Eurostat. The following assumptions have been made to come up with the figures given in table E-1 to E-4.

Concerning the agricultural holdings the number of enterprises is taken from the data set 'number of agricultural holdings growing crops or rearing animals, by crop and category of livestock' (http://epp.eurostat.ec.europa.eu/portal/page/portal/food/data/database). As in this data set there is no differentiation between the different size classes the proportion is taken from the data sets 'agricultural holdings with agricultural area < 5 ha', 'agricultural holdings with agricultural area 5 - < 20 ha', 'agricultural holdings with agricultural area 20 - < 50 ha', 'agricultural holdings with agricultural area > = 50 ha' (http://epp.eurostat.ec.europa.eu/portal/page/portal/agriculture/data/main_tables). The proportion of the different size classes was translated into the number of agricultural holdings identified in the previous mentioned data set.

Concerning the manufacture of grain mill products the number of enterprises are taken from the data set 'number of enterprises, persons employed and turnover in the manufacturing of foodstuffs' (http://epp.eurostat.ec.europa.eu/portal/page/portal/food/data/database) choosing the enterprise class 'NACE 15.61 Manufacture of grain mill products'. As in this data set there is no differentiation between the different size classes the proportion was take from the data set 'SMEs - Annual enterprise statistics broken down by size classes - industry and construction' (http://epp.eurostat.ec.europa.eu/portal/page/portal/european_business/special_sbs_topics/small_medium_sized_enterprises_SMEs) choosing the enterprise class 'NACE

15.6 Manufacture of grain mill products, starches and starch products'. The proportion of the different size classes was translated into the number of manufactures of grain mill products.

Concerning the manufacture of grain mill products the number of enterprises are taken from the data set 'number of enterprises, persons employed and turnover in the manufacturing of foodstuffs' (http://epp.eurostat.ec.europa.eu/portal/page/portal/food/data/database) choosing the enterprise class 'NACE 15.81 Manufacture of bread and fresh pastry goods and cakes'. As in this data set there is no differentiation between the different size classes the proportion was take from the data set 'SMEs - Annual enterprise statistics broken down by size classes - industry and construction' (http://epp.eurostat.ec.europa.eu/portal/page/portal/european_business/special_sbs_topics/small_medium_sized_enterprises_SMEs) choosing the enterprise class 'NACE 15.8 Manufacture of other products'. The proportion of the different size classes was translated into the number of manufactures of grain mill products.

Concerning the retail sale in non-specialized stores with food beverages or tobacco predominating the number of enterprises are taken from the data set 'structure of food retailers: number of enterprises, employment and turnover' (http://epp.eurostat.ec.europa.eu/portal/page/portal/food/data/database) choosing the enterprise class 'NACE 52.11 Retail sale in non-specialized stores with food beverages or tobacco predominating'. As in this data set there is no differentiation between the different size classes the proportion was take from the data set 'SMEs - Annual enterprise statistics broken down by size classes - trade ' (http://epp.eurostat.ec.europa.eu/portal/page/portal/european_business/special_sbs_topics/small_medium_sized_enterprises_SMEs) choosing the enterprise class 'NACE 52.1 Retail sale in non-specialized stores'. The proportion of the different size classes was translated into the number of retail sale in non-specialized stores with food beverages or tobacco predominating.

Concerning the retail sale of bread, cakes, flour confectionery and sugar confectionery the number of enterprises are taken from the data set 'structure of food retailers: number of enterprises, employment and turnover' (http://epp.eurostat.ec.europa.eu/portal/page/portal/food/data/database) choosing the enterprise class 'NACE 52.24 Retail sale of bread, cakes, flour confectionery and sugar confectionery'. As in this data set there is no differentiation between the different size classes the proportion was take from the data set 'SMEs - Annual enterprise statistics broken down by size classes - trade ' (http://epp.eurostat.ec.europa.eu/portal/page/portal/european_business/special_sbs_topics/small_medium_sized_enterprises_S

MEs) choosing the enterprise class 'NACE 52.2 Retail sale of food, beverages, tobacco in specialized stores'. The proportion of the different size classes was translated into the number of retail sale in non-specialized stores with food beverages or tobacco predominating.

For sure this procedure affects the data reliability. Still, it is not considered negatively for this research as first the number itself of enterprises behaving is a specific way is not of major importance in the field tests and second the final DSS includes a reliability evaluation sheet which takes account of variability in data reliability.

Table E-1: Enterprise statistics Germany

			Number of enterprises by size class							
		Number of	micro		small		medium		large	
Stage of production	Country	enterprises	absolut	%	absolut	%	absolut	%	absolut	%
Agricultural holdings growing cereals	Germany	226770	52001	23%	72983	32%	50149	22%	51636	23%
Manufacture of grain mill products	Germany	615	431	70%	128	21%	41	7%	15	3%
Manufacture of bread and fresh pastry goods and cakes	Germany	15237	8269	54%	5581	37%	1118	7%	268	2%
Retail sale in non-specialized stores with food beverages or tobacco predominating	Germany	24790	19547	79%	4556	18%	521	2%	166	1%
Retail sale of bread, cakes, flour confectionery and sugar confectionery	Germany	4835	4299	89%	497	10%	33	1%	6	0%

Table E-2: Enterprise statistics France

			Number of enterprises by class							
		Number of	micro		small		medium		large	
Stage of production	Country	enterprises	absolut	%	absolut	%	absolut	%	absolut	%
Agricultural holdings growing cereals	France	287610	71140	25%	54888	19%	54113	19%	107469	37%
Manufacture of grain mill products	France	593	420	71%	137	23%	27	5%	8	1%
Manufacture of bread and fresh pastry goods and cakes	France	49173	45185	92%	3600	7%	316	1%	72	0%
Retail sale in non-specialized stores with food beverages or tobacco predominating	France	32692	27937	85%	3549	11%	1045	3%	160	0%
Retail sale of bread, cakes, flour confectionery and sugar confectionery	France	4199	4107	98%	87	2%	4	0%	1	0%

Table E-3: Enterprise statistics Italy

Stage of production	Country	Number of enterprises	Number of enterprises by class: micro absolut	micro %	small absolut	small %	medium absolut	medium %	large absolut	large %
Agricultural holdings growing cereals	Italy	621990	455797	73%	120480	19%	30895	5%	14818	2%
Manufacture of grain mill products	Italy	1466	1227	84%	220	15%	17	1%	3	0%
Manufacture of bread and fresh pastry goods and cakes	Italy	39676	36964	93%	2493	6%	190	0%	29	0%
Retail sale in non-specialized stores with food beverages or tobacco predominating	Italy	55710	51603	93%	3525	6%	456	1%	126	0%
Retail sale of bread, cakes, flour confectionery and sugar confectionery	Italy	8444	8389	99%	53	1%	1	0%	0	0%

Table E-4: Enterprise statistics UK

Stage of production	Country	Number of enterprises	Number of enterprises by class: micro absolut	micro %	small absolut	small %	medium absolut	medium %	large absolut	large %
Agricultural holdings growing cereals	UK	57690	22951	40%	11556	20%	8949	16%	14234	25%
Manufacture of grain mill products	UK	124	46	37%	31	25%	35	28%	12	10%
Manufacture of bread and fresh pastry goods and cakes	UK	1635	874	53%	521	32%	166	10%	74	5%
Retail sale in non-specialized stores with food beverages or tobacco predominating	UK	29444	26987	92%	2167	7%	199	1%	92	0%
Retail sale of bread, cakes, flour confectionery and sugar confectionery	UK	3501	3215	92%	268	8%	14	0%	4	0%

Appendix F

Underneath the questionnaire is reproduced. The questionnaire was build and also sent out in Microsoft Excel. The steps related to one single enterprise class could be replicated in the questionnaire depending on how many enterprises are affected by the regulation. Furthermore the affected business areas marked in the table have been listed automatically in the performance evaluation sheet.

The step-by-step approach for decision support

INTRODUCTION

This questionnaire is done in the context of the research of the economic assessment group of the MoniQA project (Monitoring and Quality Assurance in the Food Supply Chain), a European Commission funded initiative within the 6th framework programme (http://www.moniqa.org/). The questionnaire is part of a study elaborating a Decision Support System that aids in analysing the effects of regulations on enterprises and judging their compliance behaviour. The questionnaire goes step by step following a sequence of arguments which is based on expertise and specific for the given decision scenario. The questionnaire is structured as follows:

REGULATION ANALYSIS

1. Argument: regulation

ENTERPRISE CLASSES IDENTIFICATION

2. Argument: regional focus
3. Argument: industry sector
4. Argument: stage of production
5. Argument: enterprise size

REGULATION ACCESS

6. Argument: physical access
7. Argument: mental access

PERFORMANCE EVALUATION

8. Argument: business performance
9. Argument: compliance behaviour

REGULATION ANALYSIS

1. Argument

The focal regulation determines the following steps of the procedure and so the final outcome. Please analyse the regulation carefully according to:

- its scope, and
- its requirements.

ENTERPRISE CLASSES IDENTIFICATION

The objective is to define and identify enterprise classes which are affected by the new regulation. The results are the basis for analysing the enterprise behaviour.
Please answer the following questions by marking the appropriate field with 'X'. Several answers can be possible.

2. Argument

To which region does the new regulation apply to?

Regulation applies to	EU countries
	Germany
	France
	Italy
	United Kingdom

3. Argument

To which industry sector does the new regulation apply to?

Regulation applies to	Industry sector
	Cereals and cereals products

4. Argument

To which stage of production does the new regulation apply to?

Regulation applies to	Stage of production	Explanation
	Producer	Agricultural holdings growing cereals
	Processor 1	Manufacture of grain mill products
	Processor 2	Manufacture of bread and fresh pastry goods and cakes
	Retail	Retail sale in non-specialized stores with food beverages or tobacco predominating
	Retail	Retail sale of bread, cakes, flour confectionery

5. Argument

To which enterprise size classes does the new regulation apply to?

Regulation applies to	Enterprise size classes	Explanation
	Micro enterprises	Farms with less than 5 ha or enterprises with 1 to 9 persons employed
	Small enterprises	Farms with 5 ha up to 20 ha or enterprises with 10 to 49 persons employed
	Medium enterprises	Farms with 20 ha up to 50 ha or enterprises with 50 to 249 persons employed
	Large enterprises	Farms with more than 50 ha or enterprises with more than 249 persons employed

Based on the previous steps the following enterprise class is identified as affected by the regulation and will be further analysed concerning its compliance behaviour:

Country:_____

Industry sector:_____

Stage of production:_____

Enterprise size:_____

REGULATION ACCESS

The objective is to identify if an enterprise is aware of the new regulation and understands the regulation's requirements. Both are preconditions to be able to comply with the new regulation. Please answer the following questions by marking the appropriate field with 'X'.

6. Argument

Is the enterprise aware of the existence of the new regulation and does it have access to the new regulation?

	Yes
	No

If you marked 'Yes' please go on with the next step. If you marked 'No' the procedure for this particular enterprise class is completed.

7. Argument

Does the enterprise understand the new regulation's requirements and does it know what it has to do to fulfil the requirements?

	Yes
	No

If you marked 'Yes' please go on with the next step. If you marked 'No' the procedure for this particular enterprise class is completed.

PERFORMANCE EVALUATION

The objective is to support judging the enterprise's willingness of compliance by evaluating the new regulation's effects on the enterprise business performance. The following step is a pre-stage to identify where the enterprise has to take actions to fulfil the regulation's requirements. In the next step the effects of actions taken in the affected business areas on the given key performance indicators have to be evaluated based on the presented impact scorecard. Finally the willingness of compliance has to be judged. Please answer the following question by marking the appropriate field with 'X'. Several answers can be possible.

8. Argument

Which business areas are affected by the regulation's requirements, i.e. where does the enterprise has to take actions to fulfil the requirements?

Requirements affect	Business area	Explanation
Production process		Any activity or any set of activities to transform inputs into outputs can be described as process. To this classification all the requirements that can influence the process are counted.
	Cultivation measures	This category includes requirements for farmers concerning plant production. Examples are requirements concerning agricultural pesticides and fertilizer.
	Occupational health and safety	Examples are the use of special material for occupational health and safety or the implementation of occupational health and safety plans.
	HACCP	It includes the storage of products itself and the organisation of the storage, e.g. separated storage of accredited products and non-accredited products.
	Product development	Requirements focusing for example on the purpose of use of a product, the product composition, or the shelf life of a product.
	Production	Requirements of this category focusing especially on the process of manufacture and the flow of goods.
	Traceability	Traceability is a component of the process and includes the maintenance of a traceability system, the trial of a recall, etc.
	Veterinarian and veterinary medicines	Examples of this category are the medication of animals and the need of a veterinary.
	Animal protection measures	Animal protection requirements include the measure for the handling and keeping of animals.

	Transport	The category includes requirements on the transport vehicle, organisation of the transport and the driver.
	Environment protection measures	This category includes demands on the environment, e.g. requirements related to environmental protection or waste management.
Product characteristics		Among other claims, a product consists of the quality, safety and origin of the product. Product quality is considered as the appearance and freshness of a product. Food safety meets the needs of customers for security in the food industry. The origin of the products is for example in the regional marketing of food a decisive factor.
	Hygiene measures	Here examples of requirements covering pest control, cleaning and disinfection measures and hygienic precautionary measures like protective clothing. Hygiene measures have influence on both food safety and product quality.
	Laboratory tests	This category includes requirements related to external and internal laboratory testing, so that if limits are exceeded early actions can be taken.
	Packaging	The area of packaging is related to the product level. Packaging has a crucial impact on product quality, in particular the packing material and the microbiological cleanliness.
Management of the processes		The management is the framework that is needed to support maintenance of quality and safety requirements. This includes administrative tasks as well as other management tasks belonging to the organization process.
	Complaint management	The category focuses on the organization of customer complaints, i.e. the entry and the work on complaints.
	Documentation	Documentation requirements can focus on various areas. Examples are the creation of a quality system reference book, work instructions, process instructions, or continually record keeping.
	Self-monitoring	A periodic self-monitoring may contain a regular quality audit and the completion of a check list.
	Identification	The range of identification and labelling contains requirements e.g. regarding the signpost in the factory or labelling of animals.
	Management of the processes	Management of the system covers general administration costs such as document storage, filing and updating of information and in addition the definition of quality objectives and quality policy.
	Staff training and qualification	Here requirements can focus on regular training courses or qualification certificates.
Infrastructure environment		The infrastructure provides the framework necessary to achieve compliance with the

		requirements and contains long-lived basic facilities. Here infrastructure is about technical equipment and work environment facilities.
	Constructional measures	This category considers requirements related to the working environment, the buildings and the construction of buildings for livestock.
	Technical equipment	This category considers requirements related to the acquisition, the maintenance, calibration, etc. of technical equipment

Please evaluate the effects of each affected business area on each key performance indicator by marking the appropriate field with '+', '0', '-', '--', or '?' in the performance evaluation sheet according to the impact scorecard legend underneath. Thereafter please judge the willingness of compliance by marking high or low willingness of compliance.

Score	**Performance indicator (PI)**
Score +	The action has a positive estimated impact on the PI.
Score 0	The action has no estimated impact on the PI.
Score -	The action has a negative estimated impact on the PI.
Score --	The action has a ruinous estimated impact on the PI.
Score ?	The estimated impact can not be given.

Performance evaluation sheet							
By requirements affected business areas	Key Performance Indicators						Willingness of compliance
	Sales	Costs	Customer satisfaction	Lead time	Appearance	Product safety	
							high
							low

Appendix G

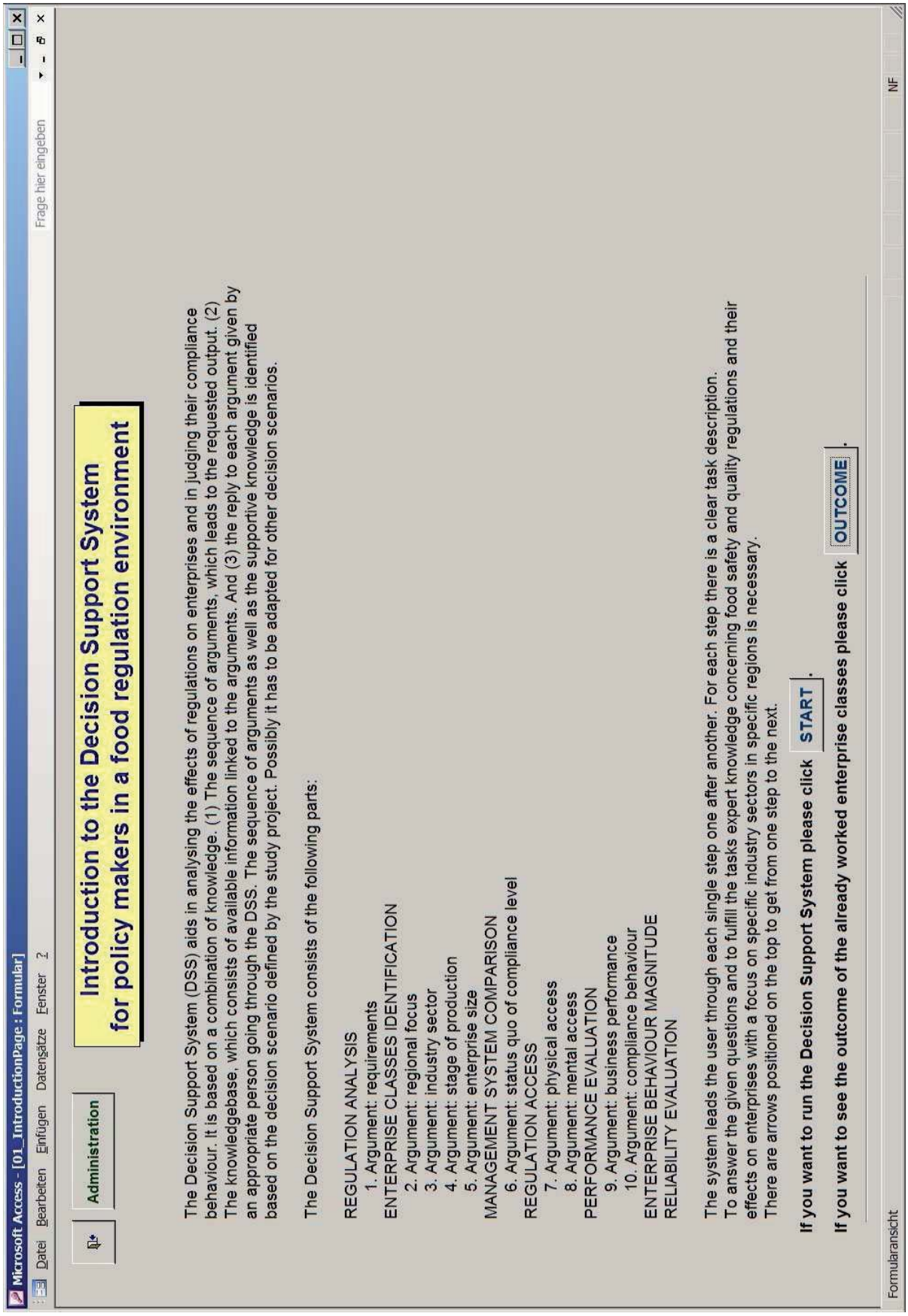


Figure G-1: DSS introduction

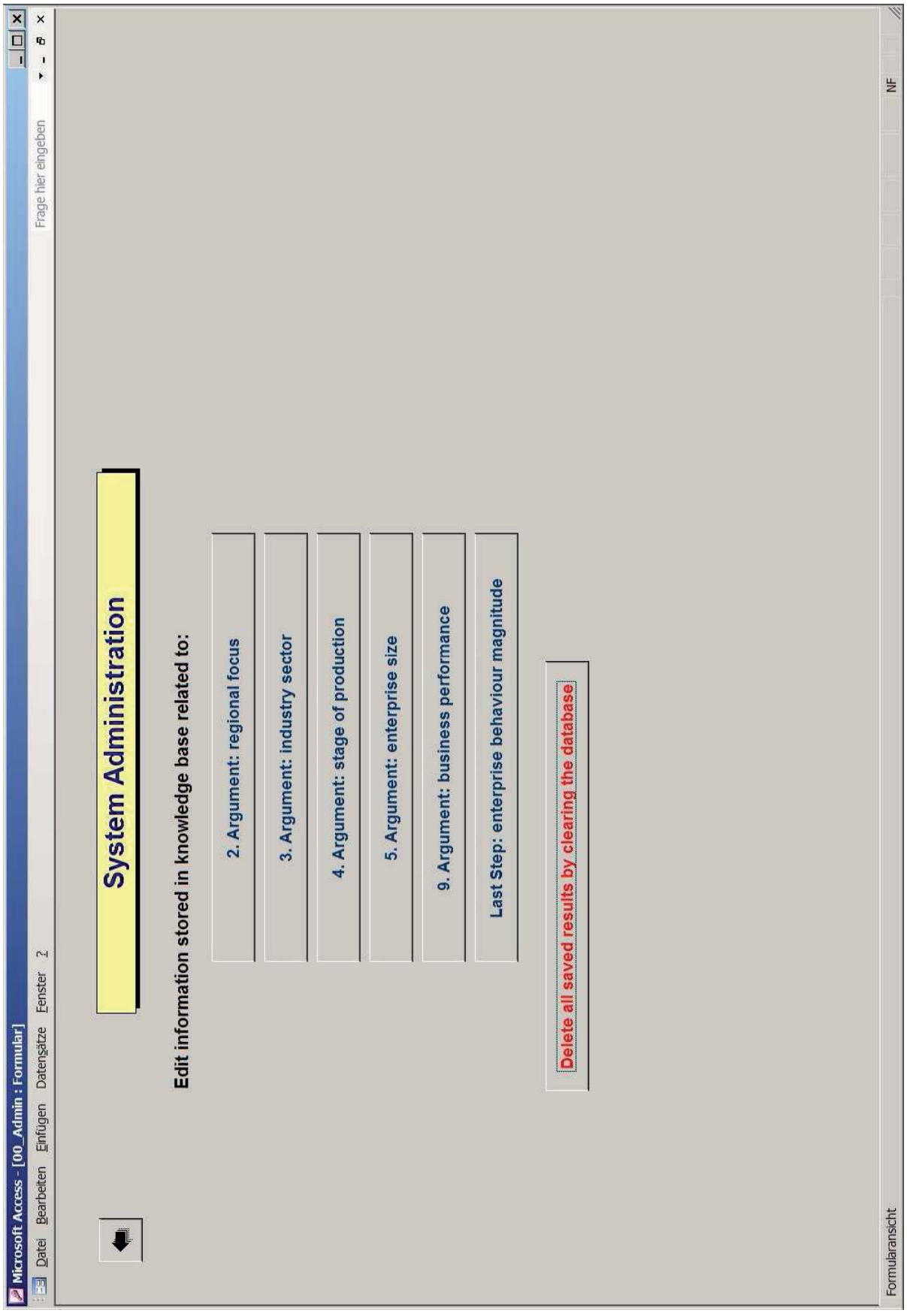


Figure G-2: DSS system administration

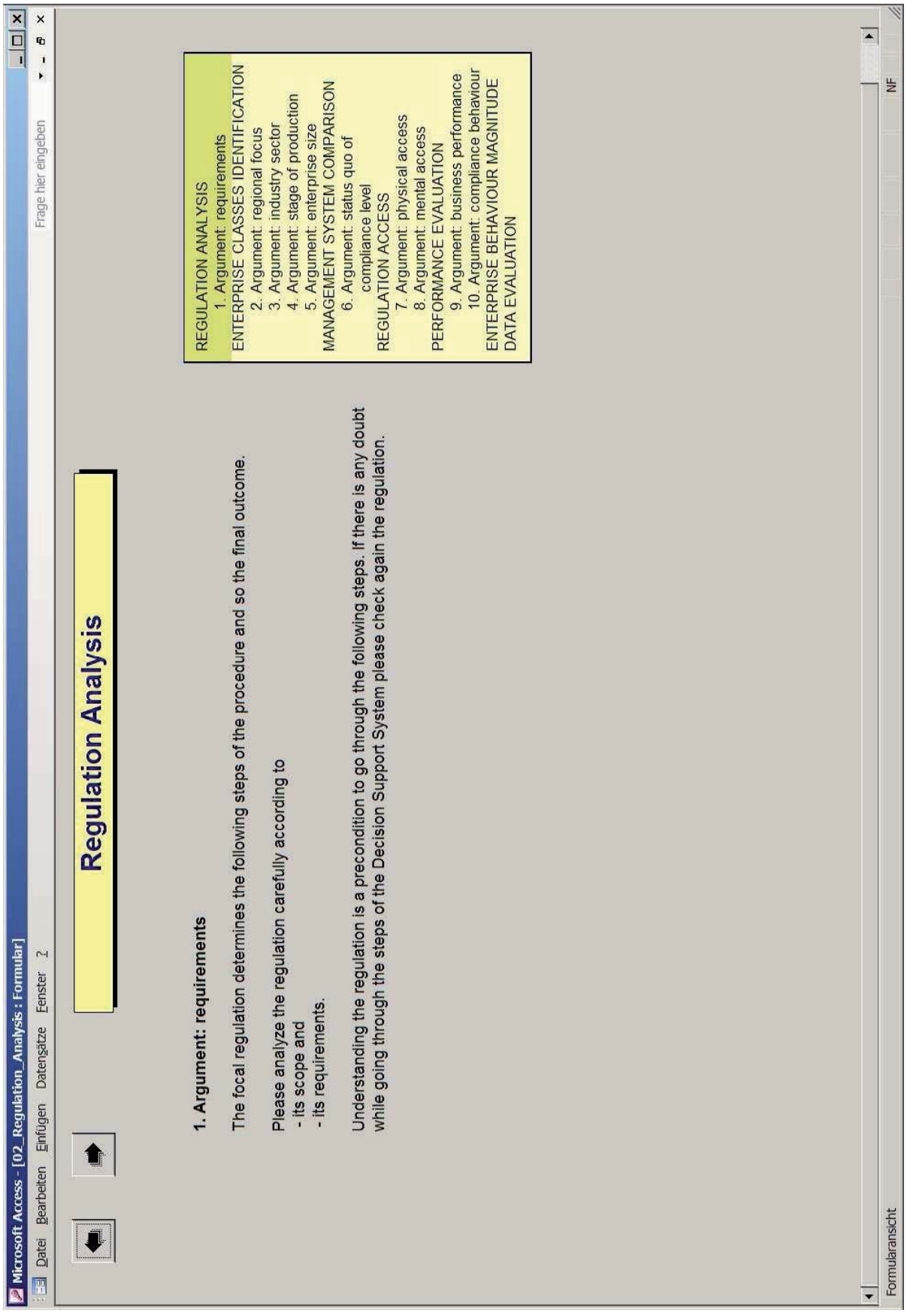


Figure G-3: DSS regulation analysis

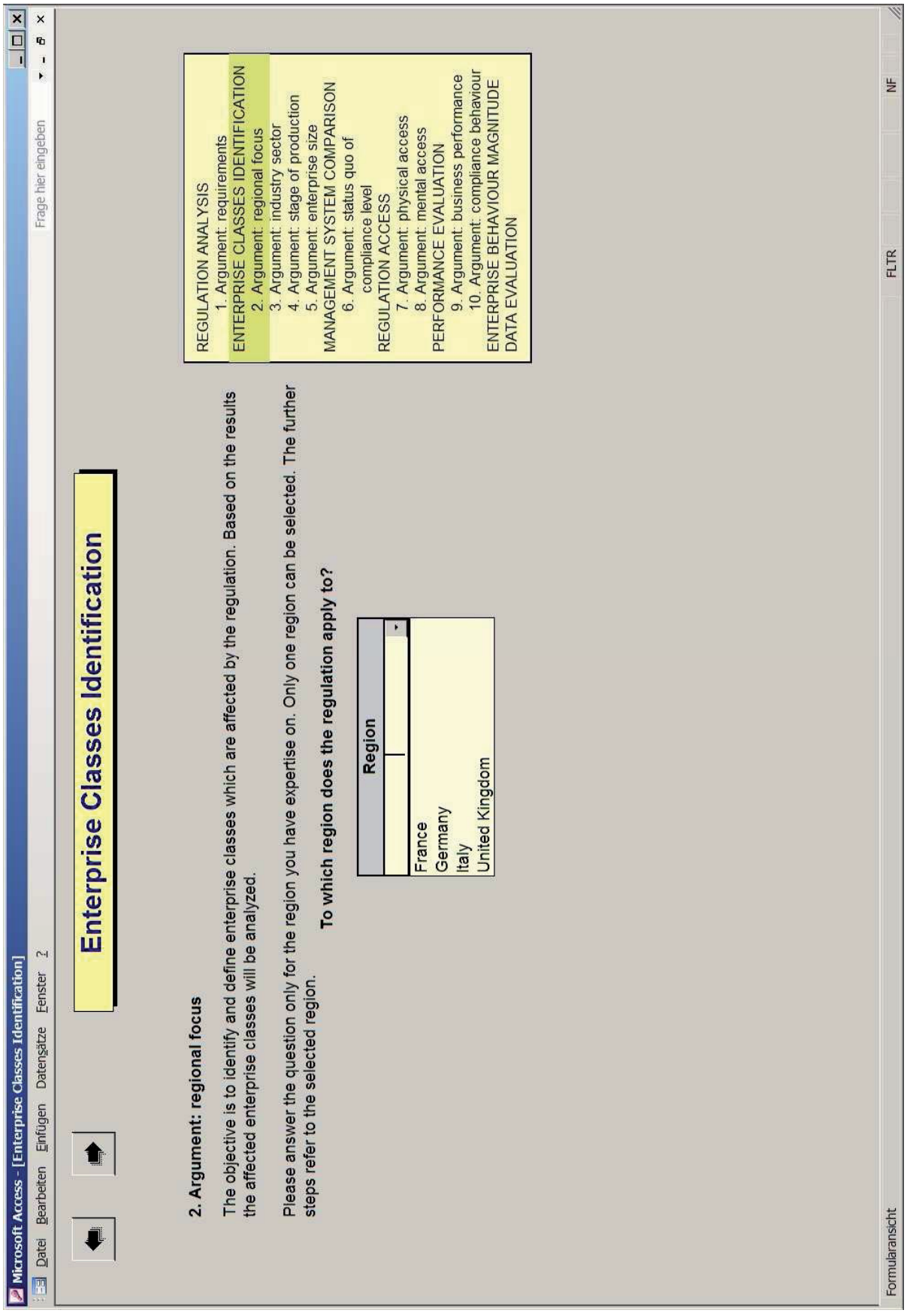


Figure G-4: DSS enterprise classes identification 1. step

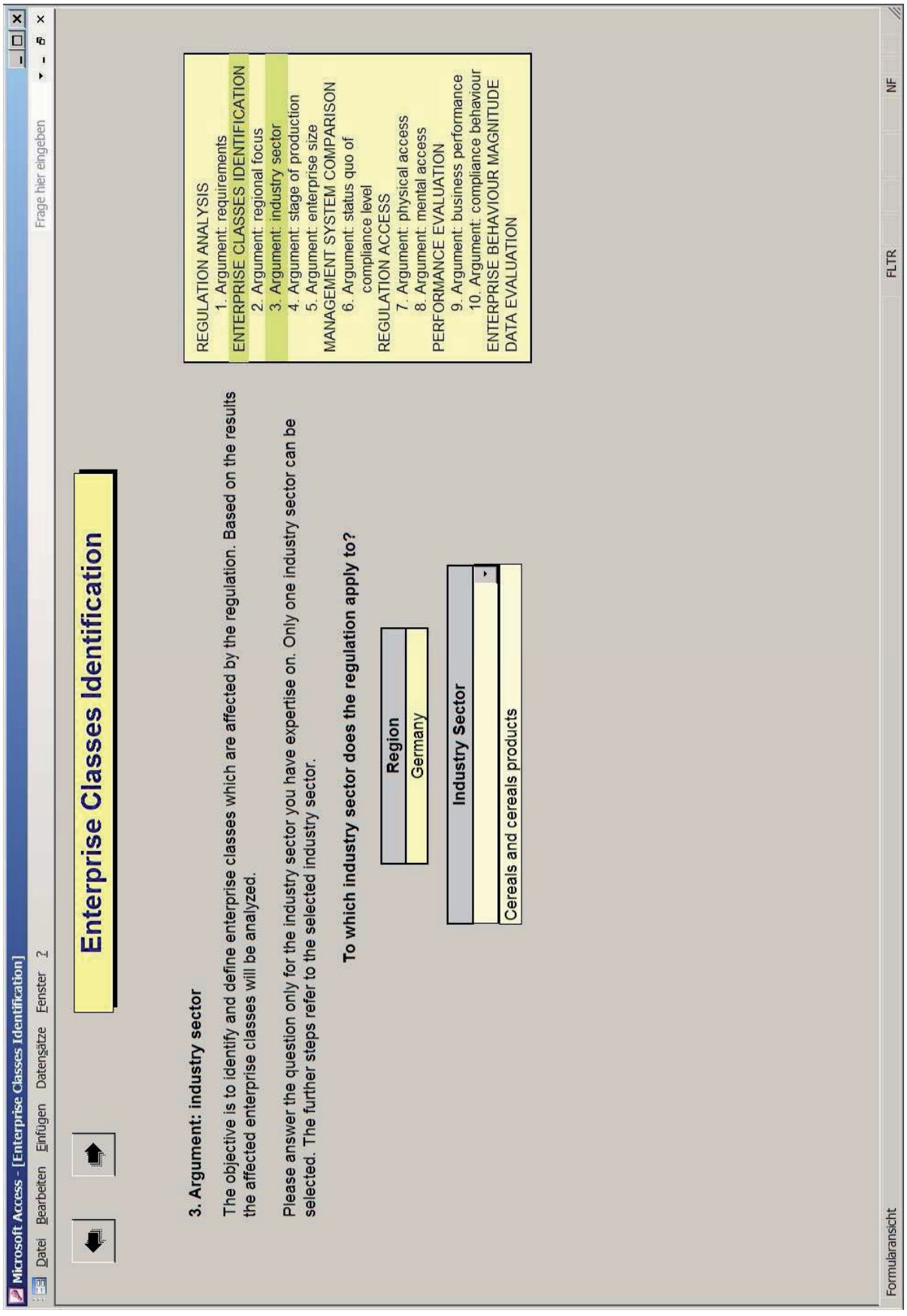


Figure G-5: DSS enterprise classes identification 2. step

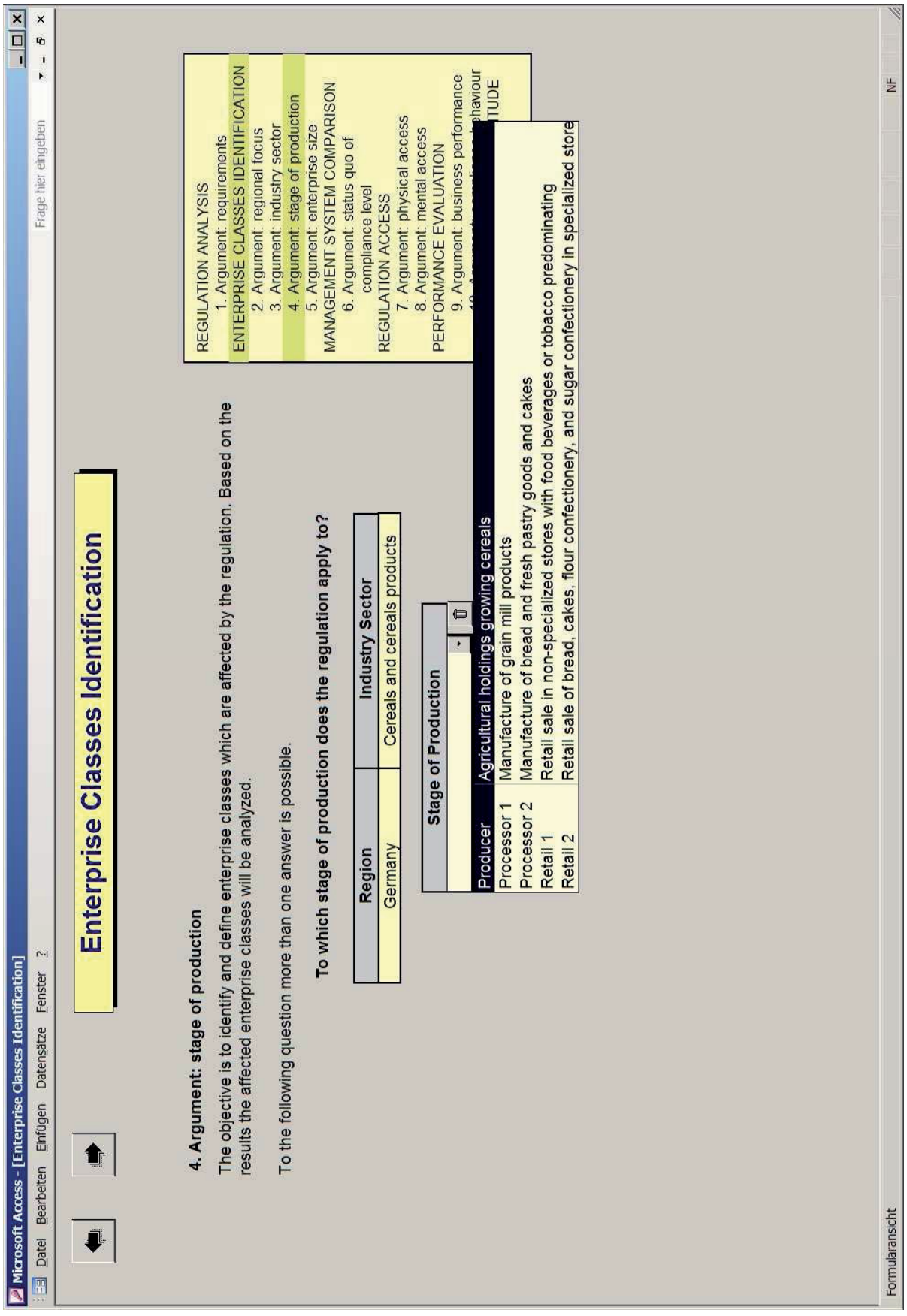


Figure G-6: DSS enterprise classes identification 3. step

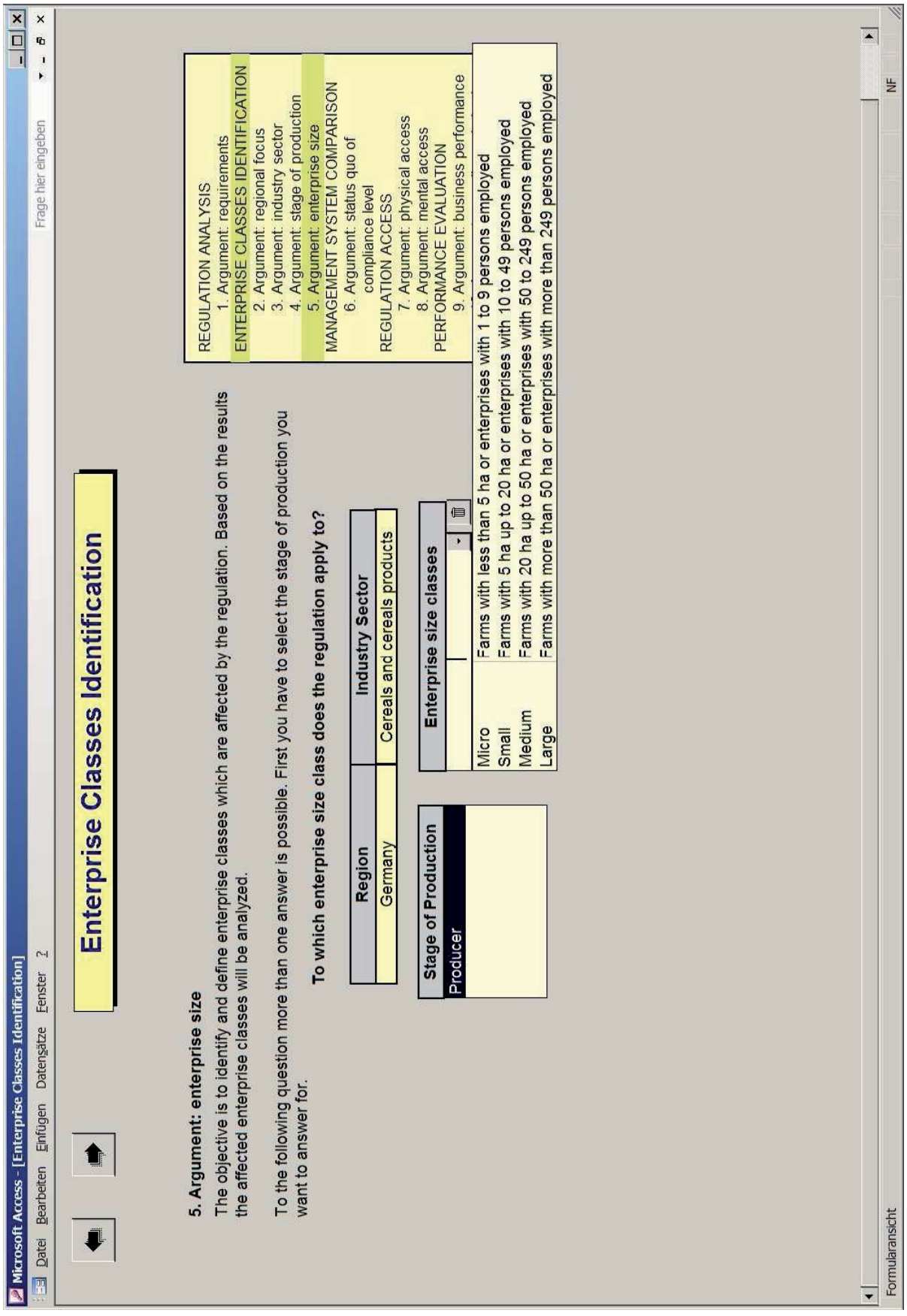


Figure G-7: DSS enterprise classes identification 4. step

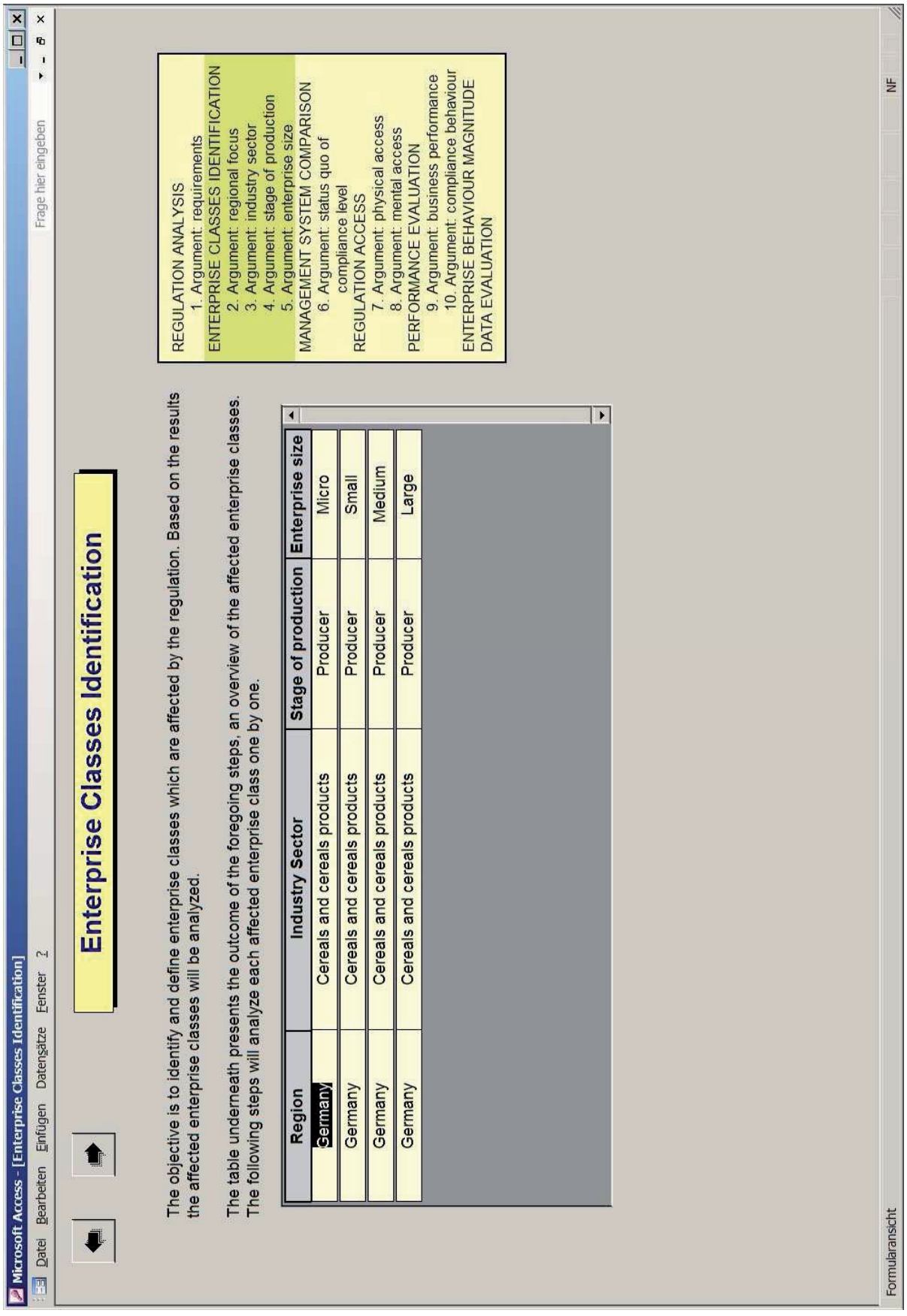


Figure G-8: DSS enterprise classes identification overview

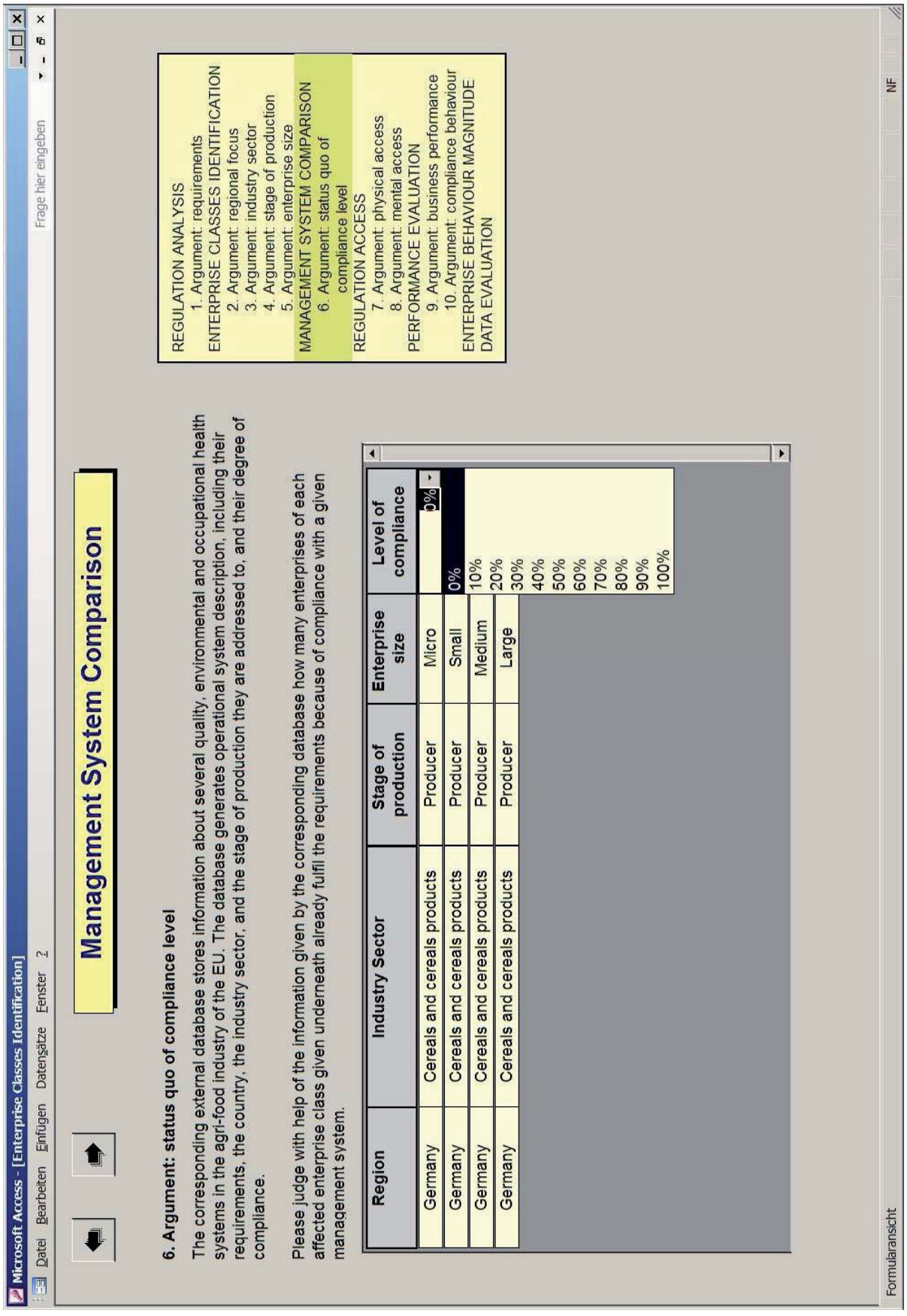


Figure G-9: DSS management system comparison

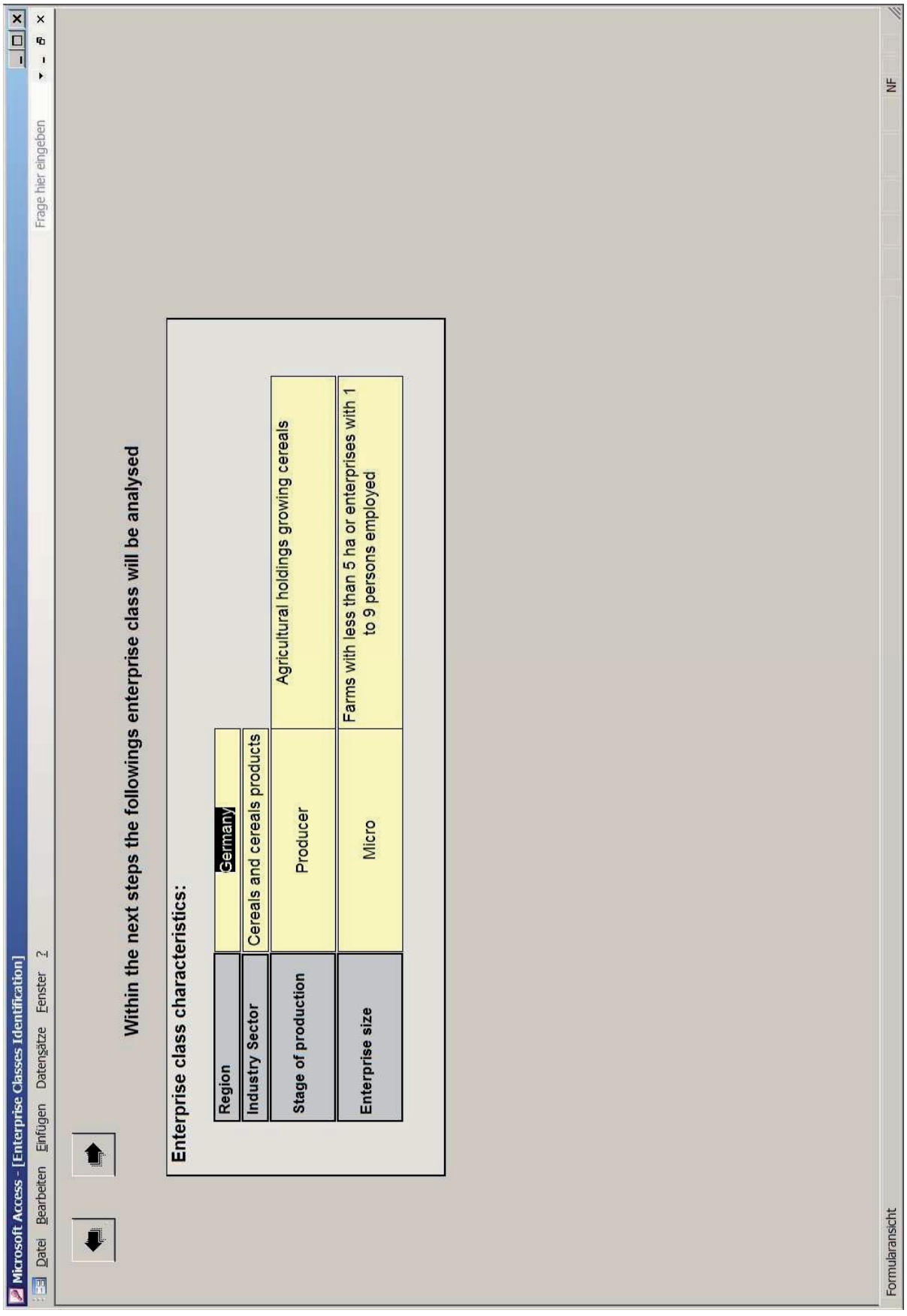


Figure G-10: DSS enterprise class characteristics

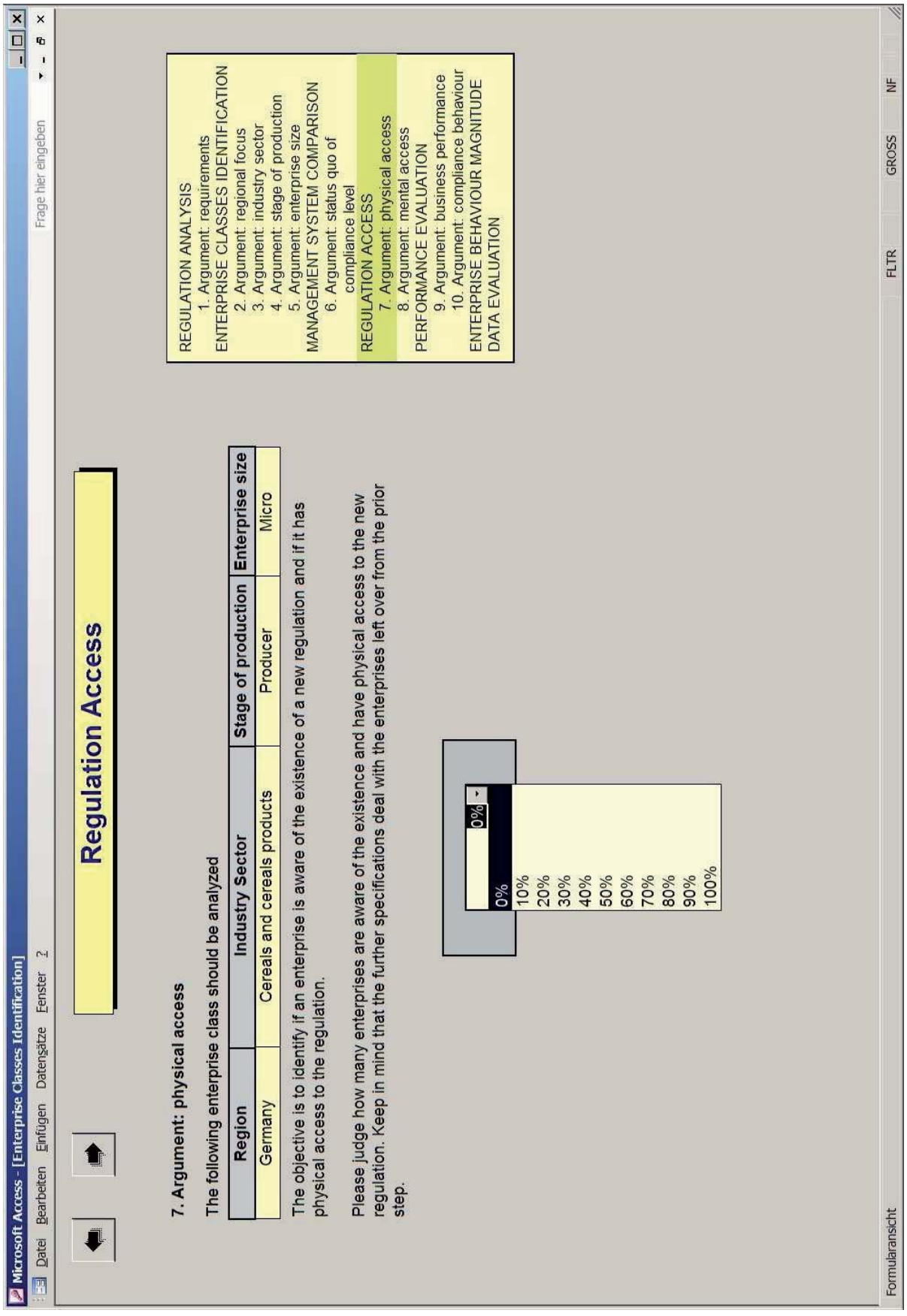


Figure G-11: DSS regulation access 1. step

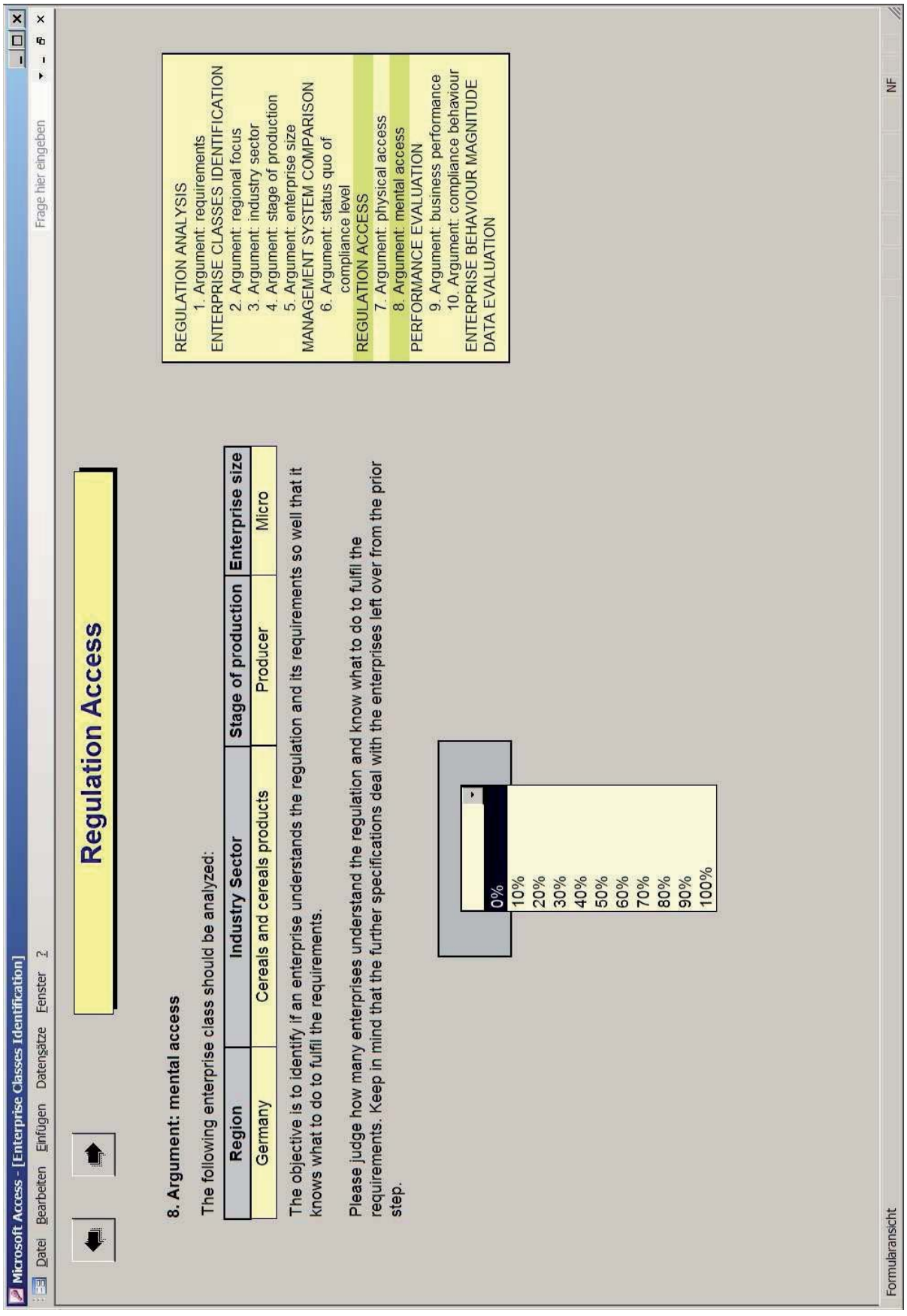


Figure G-12: DSS regulation access 2. step

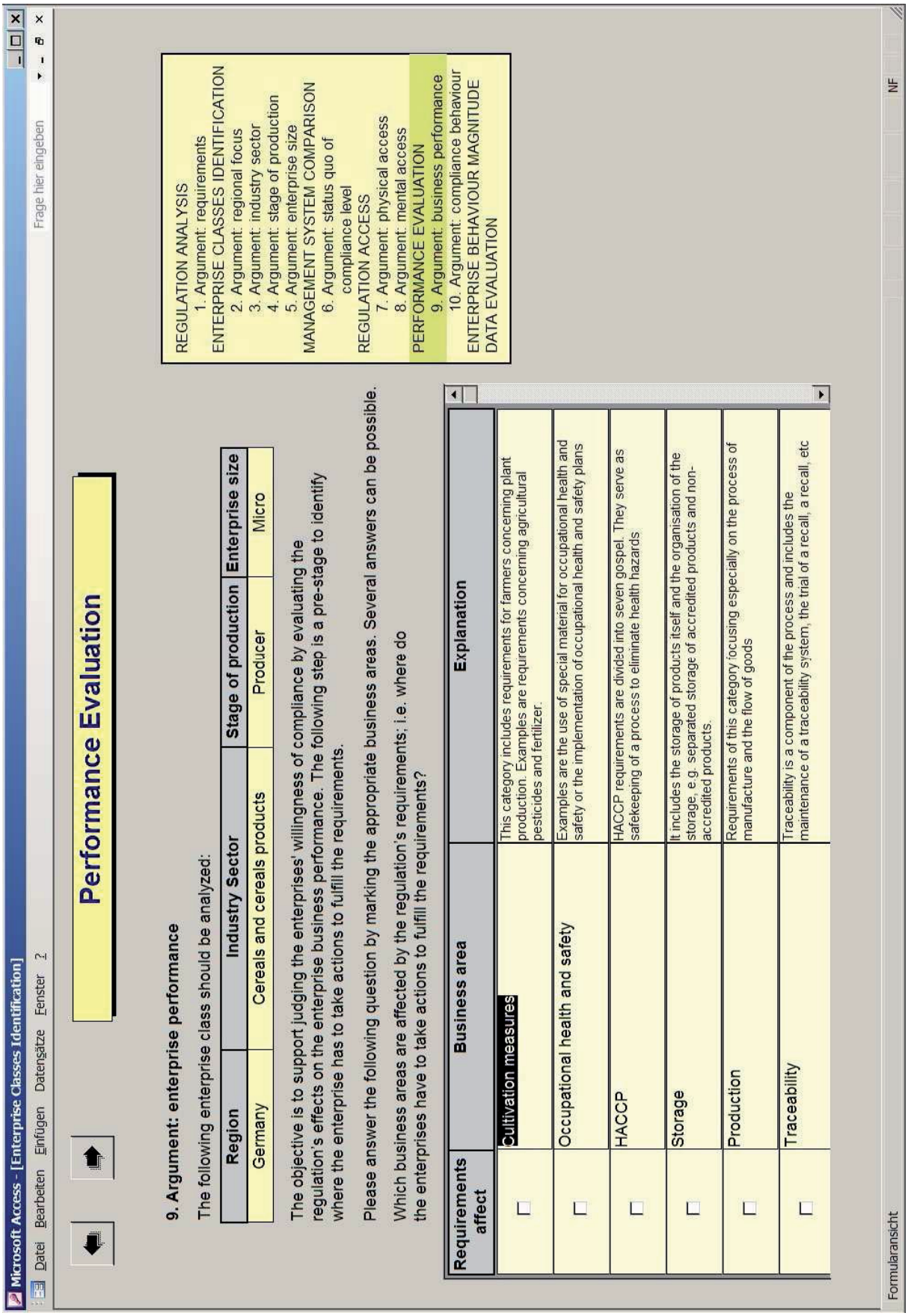


Figure G-13: DSS performance evaluation 1. step

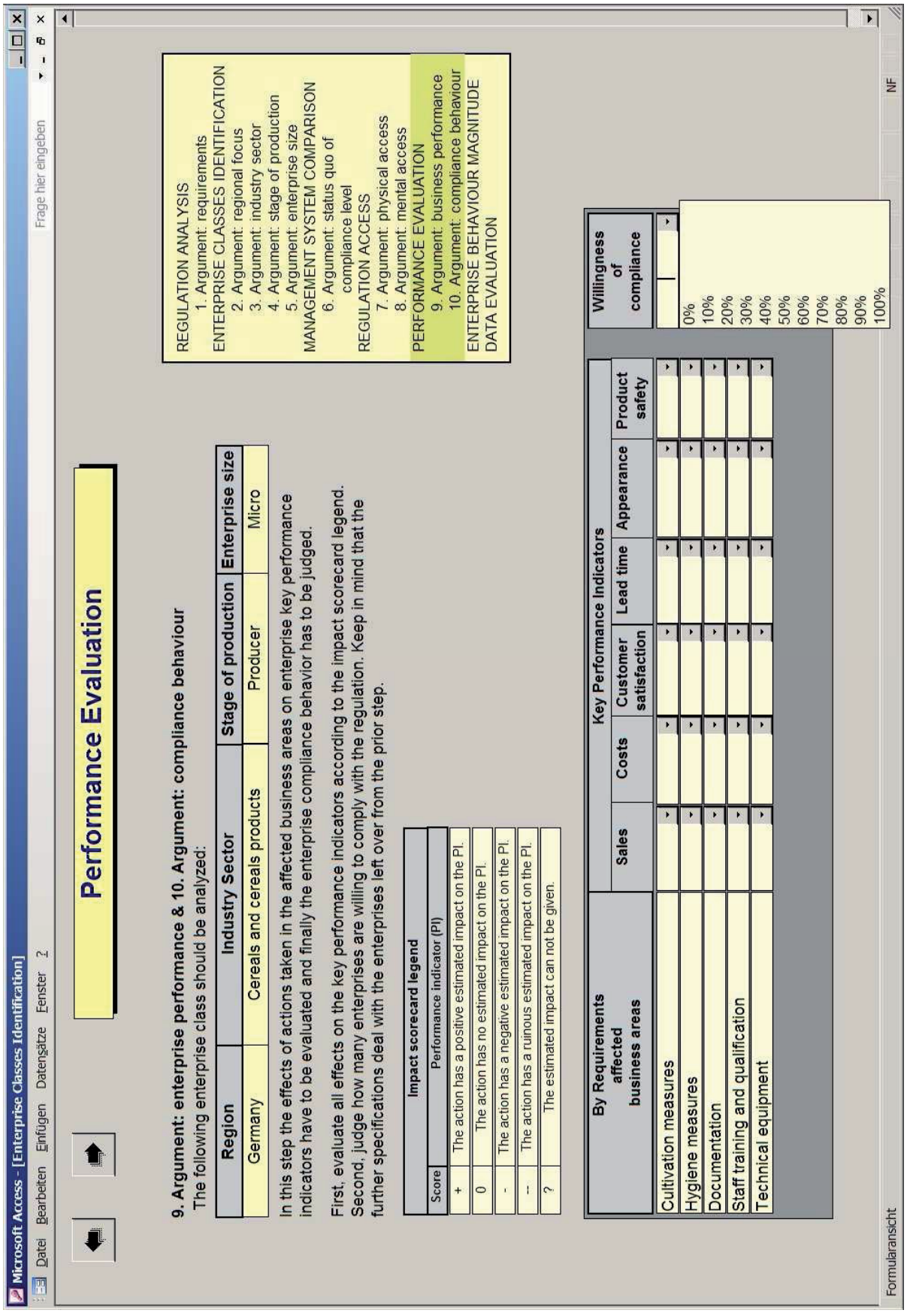
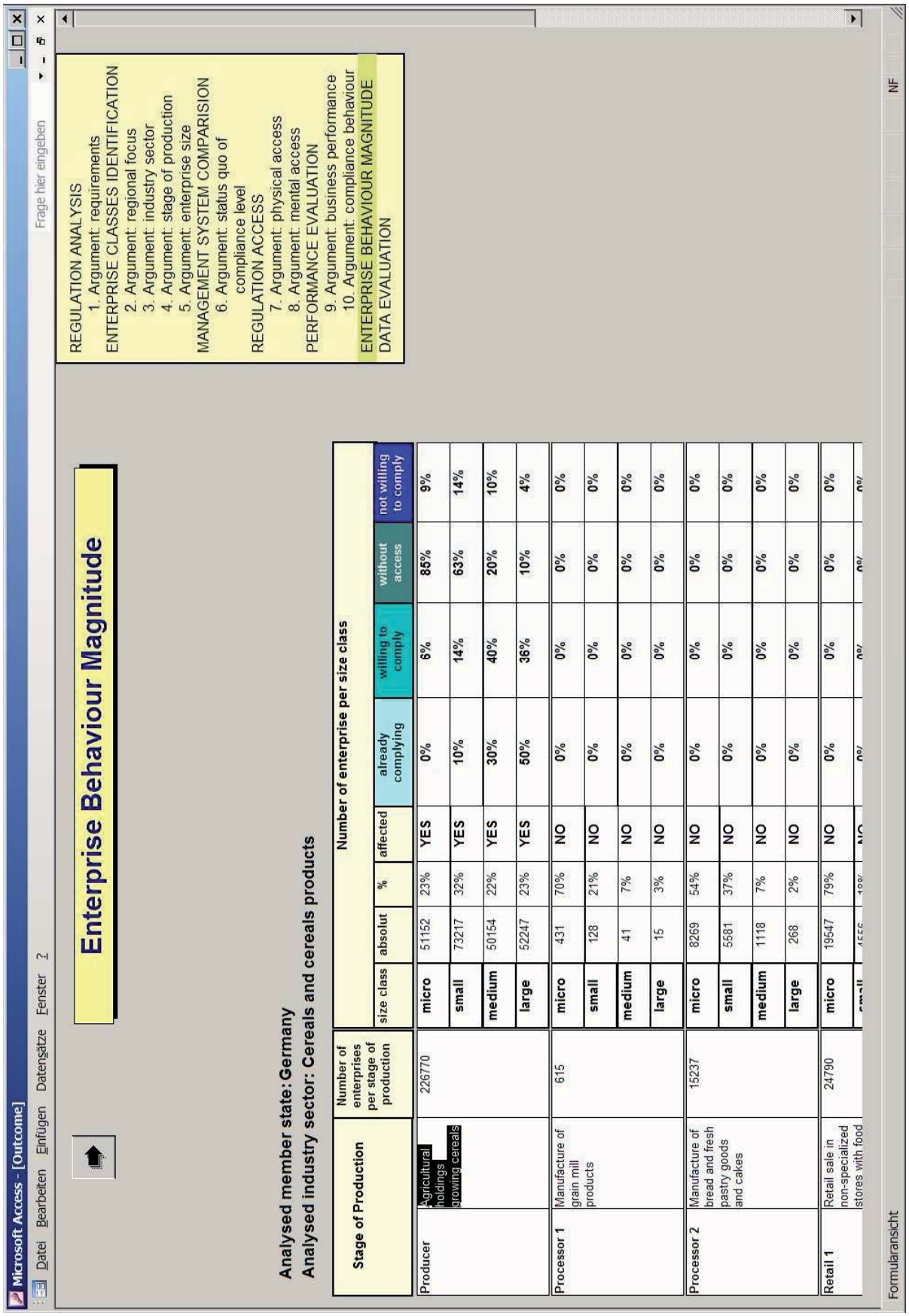


Figure G-15: DSS performance evaluation 2. step



Stage of Production		Number of enterprises per stage of production	Number of enterprise per size class							
			size class	absolut	%	affected	already complying	willing to comply	without access	not willing to comply
Producer	Agricultural holdings growing cereals	226770	micro	51152	23%	YES	0%	6%	85%	9%
			small	73217	32%	YES	10%	14%	63%	14%
			medium	50154	22%	YES	30%	40%	20%	10%
			large	52247	23%	YES	50%	36%	10%	4%
Processor 1	Manufacture of grain mill products	615	micro	431	70%	NO	0%	0%	0%	0%
			small	128	21%	NO	0%	0%	0%	0%
			medium	41	7%	NO	0%	0%	0%	0%
			large	15	3%	NO	0%	0%	0%	0%
Processor 2	Manufacture of bread and fresh pastry goods and cakes	15237	micro	8269	54%	NO	0%	0%	0%	0%
			small	5581	37%	NO	0%	0%	0%	0%
			medium	1118	7%	NO	0%	0%	0%	0%
			large	268	2%	NO	0%	0%	0%	0%
Retail 1	Retail sale in non-specialized stores with food	24790	micro	19547	79%	NO	0%	0%	0%	0%

Figure G-16: DSS enterprise behaviour magnitude 1. view

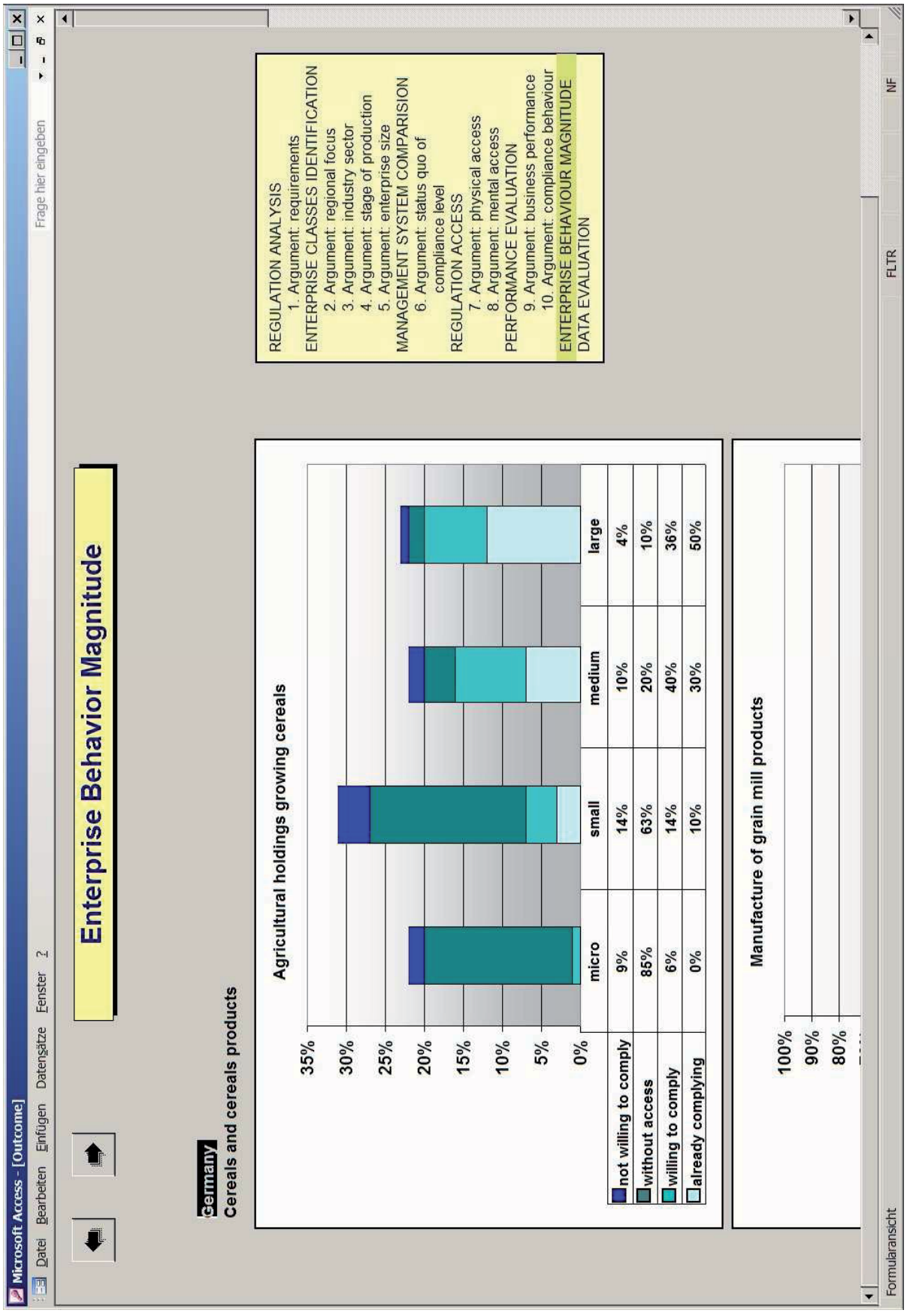


Figure G-17: DSS enterprise behaviour magnitude 2. view

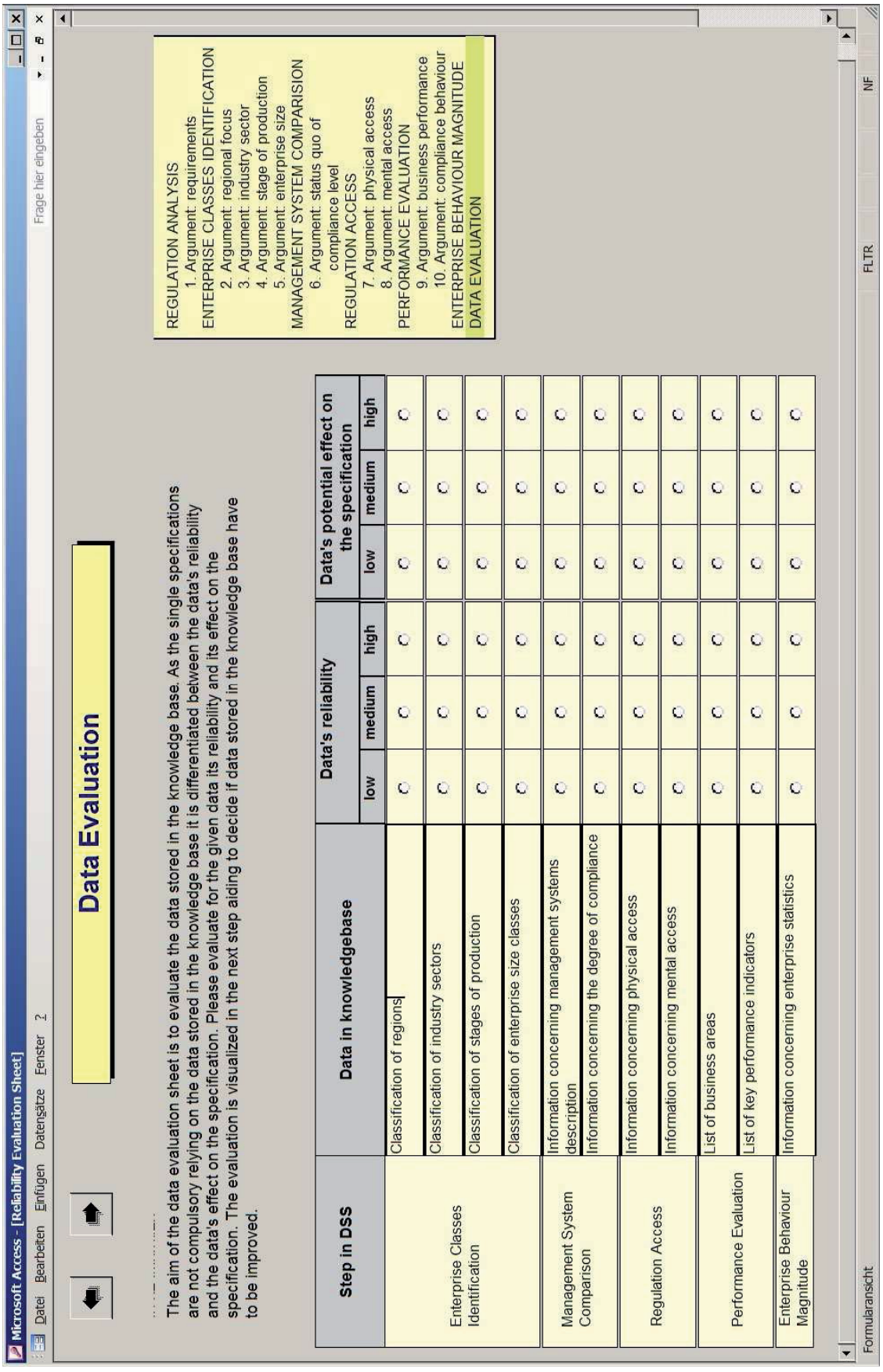


Figure G-17: DSS data evaluation 1. step

Figure G-18: DSS data evaluation 2. step