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.

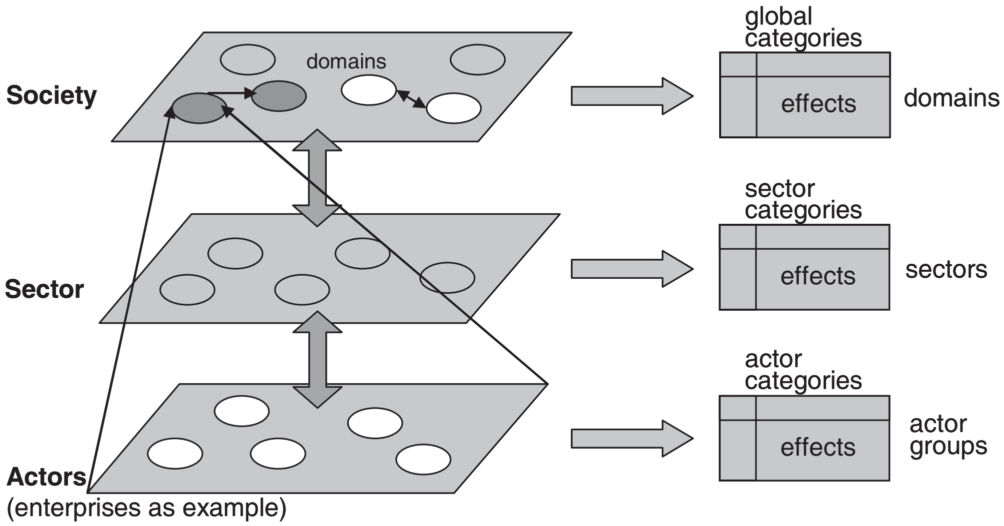

Figure 1-1: The multi-level approach (FRITZ, SCHIEFER 2008)

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.

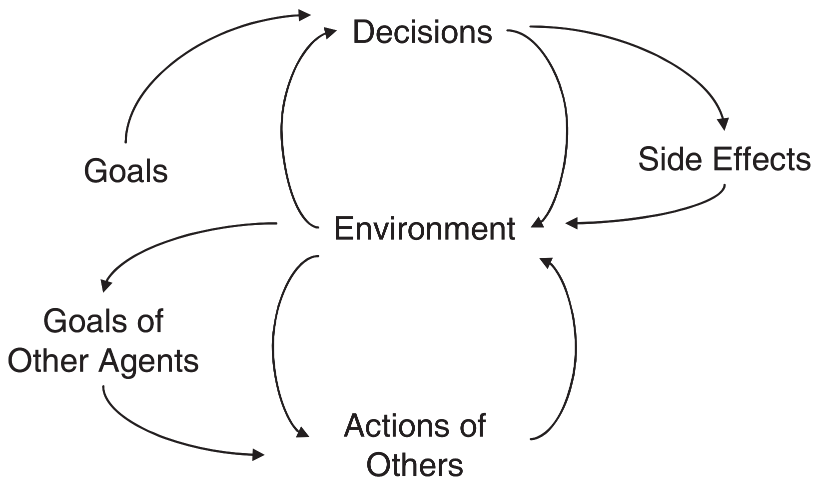

Figure 1-2: The feedback view (STERMAN 2000)

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.

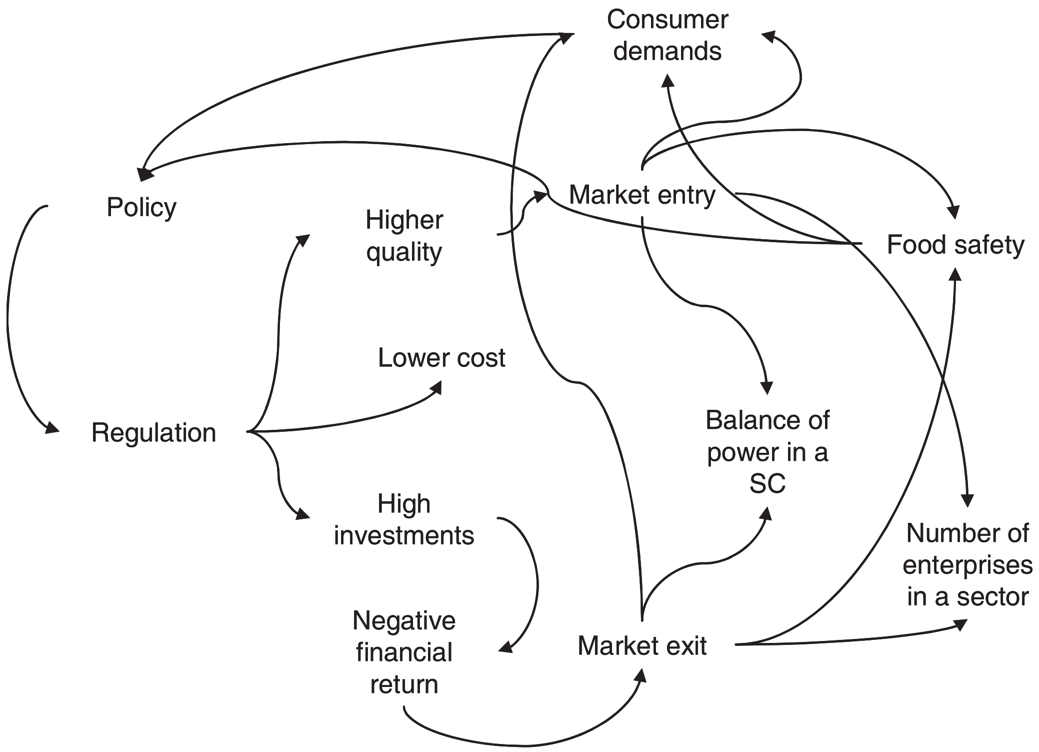

Figure 1-3: Example of system dynamics view

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.

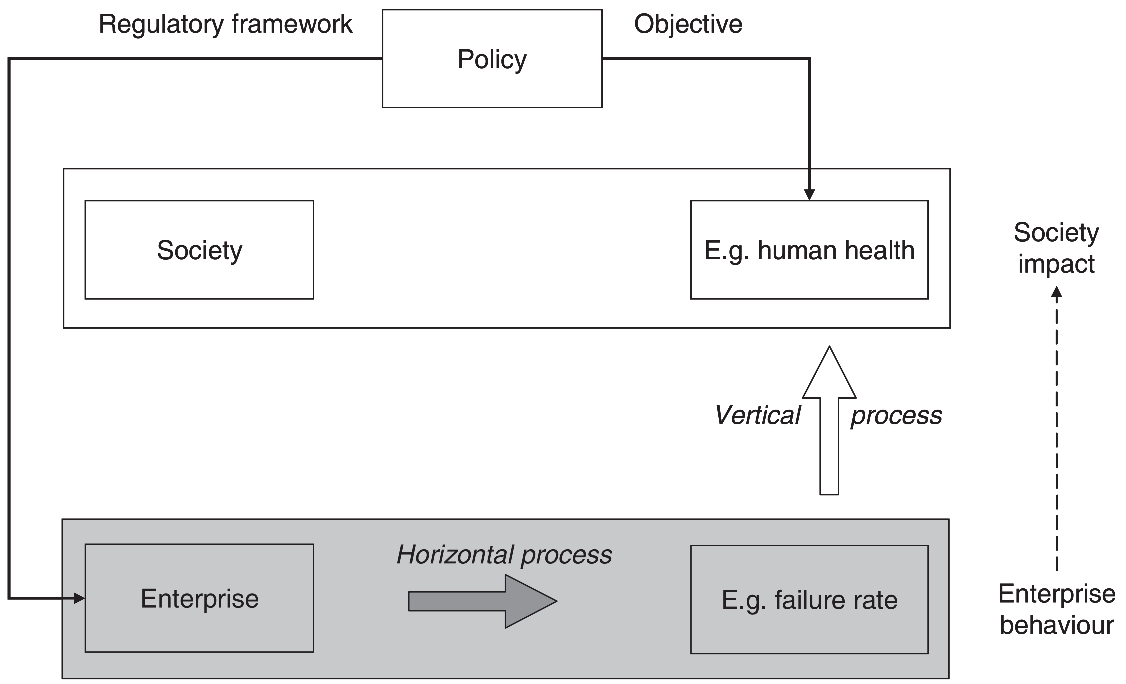

Figure 1-4: Differentiation of the horizontal and the vertical process

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.

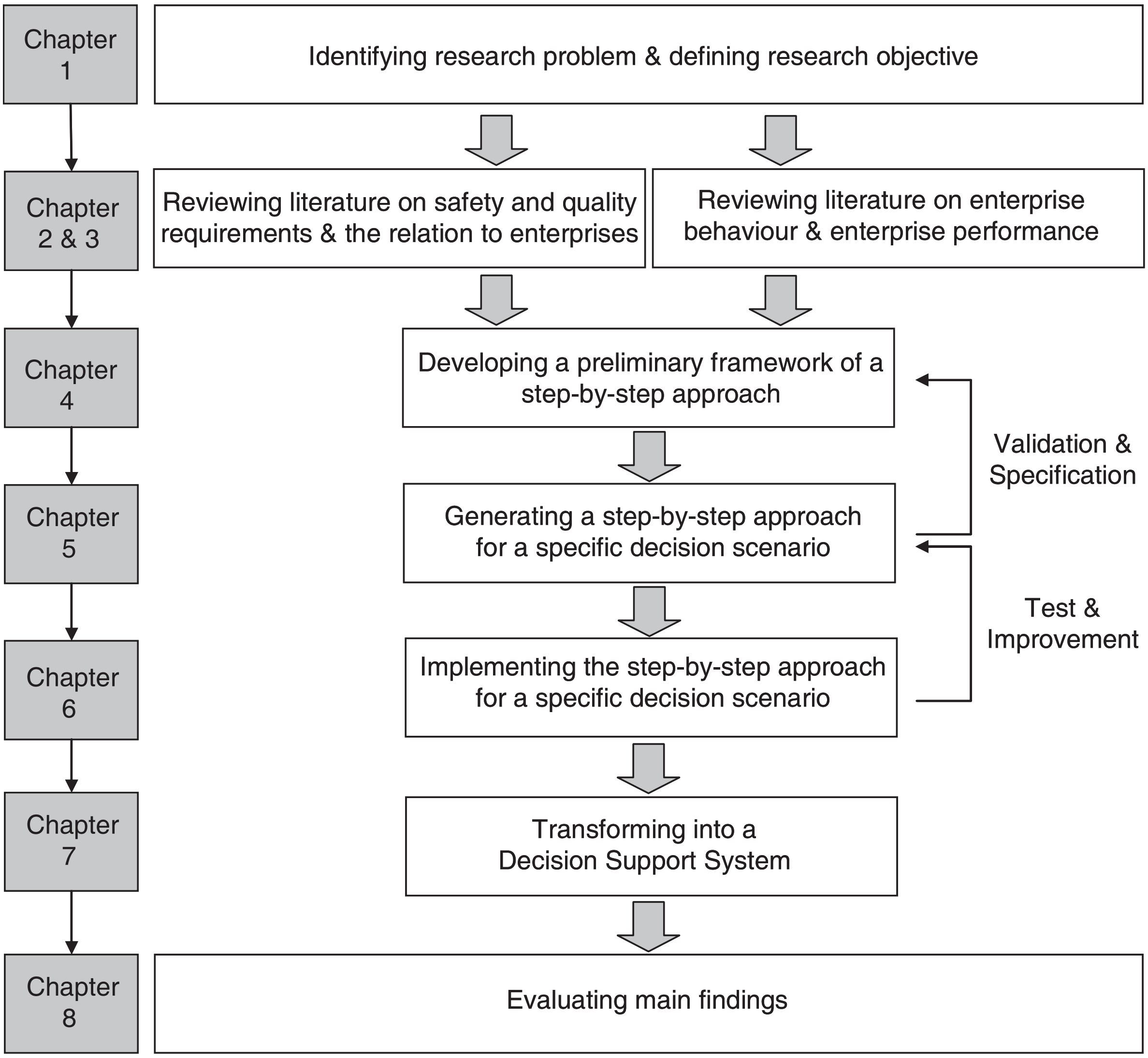

Figure 1-5: Outline of the thesis