Cost-Benefit-Analysis of Quality- and Traceability Systems in Supply Chains of Animal Products

Michael Roth [a] and Reiner Doluschitz [b]

a University of Hohenheim, Department of Farm Management 410c, 70599 Stuttgart, m-roth@uni-hohenheim.de

b University of Hohenheim, Department of Farm Management 410c, 70599 Stuttgart, doluschitz@uni-hohenheim.de

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Abstract

As a result of new EU regulations (regulation (EC) 178/2002) and the efforts of food retailers to avoid future food scandals, a quality- and traceability system (IT FoodTrace) along the supply chain of animal products will be established. Enterprises, authorities and other stakeholders will therefore face additional costs, which might result in their rejecting the new quality and traceability system. However, actors in the supply chain will receive benefits from the IT FoodTrace project, which are difficult to localize and even harder to quantify. Statements regarding the profitability and efficiency of the IT FoodTrace project can only be made with reservations. However, this is crucial to building acceptance of the program. Therefore the main objective of this research project is to carry out a cost-benefit-analysis that will focus on profitability and acceptability. This project is part of the BMBF-funded joint project IT Food Trace, in collaboration with IBM.

Key words: traceability, quality assurance, supply chain management, cost-benefit analysis, acceptability.

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1 Introduction

Recent food scandals (Horvath, 2004; 92) and the experience of consumers that food might be a threat to their health (Meuwissen et al., 2003; 41) have resulted in new law regulations (e.g. VO (EG) Nr. 178/2002) and efforts on the part of food retailers to minimize those kinds of threats. Therefore, an IT-based quality assurance and traceability system (IT FoodTrace) will be established through the cooperation of several German universities, authorities and business companies. Within this research project, an analysis of costs and benefits will be carried out.

So far, costs and benefits of quality assurance and traceability systems have not been carried out in a comprehensive manner (Unnevehr und Huirne, 2003; 2). The difficulties start with the reality that supply chains in agribusiness differ significantly from other sectors. There are multiple small companies, at the beginning of the chain, who are facing highly concentrated globally-acting companies at the other end of the chain. Another challenge is that they are dealing with a production system based in a natural setting (Schiefer, 2003; 55).

There are studies that deal with economic questions about specific aspects of Agro-Food-Chains. Lund, 2003: 79ff, Jensen, 2003: 66ff, Crutchfield et al., 1997) focused on the economics of HACCP, Disney et al. (2001) studied costs and benefits of animal identification systems. Banterle und Stranieri (2007) recently discovered that traceability itself cannot delete information asymmetry between producers and consumers in the Italian meat market. Meixner and Haas (2007) discovered that beside quality logos, which also provide traceability, the price tag is still an essential criterion indicating the quality of meat. Fries (2006) analysed costs and benefits of selected quality assurance systems in meat supply chains in her dissertation and recommended that the harmonisation of food security standards be suited to consumers' demands. Traceability in agro-food-chains is the topic of McKean (2001), who examined such systems as a kind of permission for market access, Theuvsen and Hollmann-Hespos (2005) analysed the drivers of investments in traceability systems and Hobbs (2003) dealt with the economic incentives of traceability. Gampl (2006) identified 32 chain-overlapping traceability systems in Germany in her dissertation. the allocation of costs from producers to consumers was successful in only a few cases. She also discovered that systems attempting to increase consumer trust did not give more detailed information concerning traceability (Gampl, 2006; 105). The aim of traceability systems from her point of view should rather be the strengthening of information systems to gain process efficiency (Gampl, 2006; 133).

2 Objectives and Methodology

2.1. Objectives

The main objective of this sub-project is a cost-benefit-analysis of the quality assurance and traceability system of IT FoodTrace, by means of a profitability and adoption analysis. Statements concerning the predicted profitability and acceptability of IT based quality- and traceability systems are essential for their success in the market. The development of such a system requires various inputs such as capital and know-how, however the success of the system is not certain. While it is not too complicated to assess all costs of a project, it is rather difficult to localize and to quantify all related benefits of the project. It is especially difficult to assess benefits that are of strategic meaning (Quaas, 2005). But, qualitative factors are essential for accurate results of a profitability analysis (Okujava and Remus, 2005).

Therefore, the following research questions are the primary interest of this research project:

- What are the benefits of a quality- and traceability system to the users (stakeholders) and how can these be measured?
- How can one assess all relevant costs of this project?
- Do the benefits outweigh the costs (analysis of profitability)?
- What is the willingness-to-pay of potential users (analysis of acceptability)?
- Which models of payment are suitable for the project?

In a first step, all relevant stakeholders, and then all aspects of their benefits, will be identified and measured. To succeed, different kinds of valuation methods can be used (Ahlheim and Frör 2003; Okujava and Remus, 2005). In order to verify the results, surveys of internal experts (i.e. project members) as well as external experts will be carried out. Based on this, a survey of the willingness-to-pay will also be conducted (analysis of acceptability) along the food supply chain.
In a further step, all costs related to the project will be analysed. Fixed and non-fixed costs, as well as costs for personnel and transactions, will be examined. The opportunity costs associated with not taking part in the IT FoodTrace project will also be considered.
In a final step, the valuated benefits will be placed into relationship with the results of the cost analysis (analysis of profitability and efficiency). In order to work with different scales of probability, it is necessary to find different scenarios, because real cash flows will only appear in an already running project (Ott, 1993).

2.2 Methodology: Risk based cost-benefit-estimations

To value benefits of non-commodity production requires either direct (e.g. contingent behaviour method) or indirect valuation methods (e.g. contingent valuation method). Both of these methods lack transparency and objectivity (Ahlheim and Frör 2003). Therefore, methods such as the NOWS-technique (risk based cost-benefit-estimations) are needed, which also consider the reliability of the estimations that will be made, along with the assessment of costs and the valuation of benefits (Ott, 1993).
The NOWS-technique is an extended cost-benefit-analysis and a participation-orientated evaluation process. It was developed by IBM in the 1980ies (Nagel 1988) and further advanced by Ott (1993), Streit (1997) and Weydandt (2000). The NOWS-technique is derivative of the benefit analysis and was originally developed as an participation- and benefit-orientated approach to assess technical inventions (Ott, 1993). Key elements include the differentiated cost- and benefit- estimations expressed in money terms. Categories of benefits as well as costs will be put into a matrix (see Fig. 1), and differentiated by value ability (direct, indirect difficult to ascertain) and entry probability (high, medium, low). After this is done with all relevant aspects of benefits and costs, the categories will be accumulated and set in relation with each other (Uribe 2003). This also allows for a visualisation of costs and benefits according to risk stages.

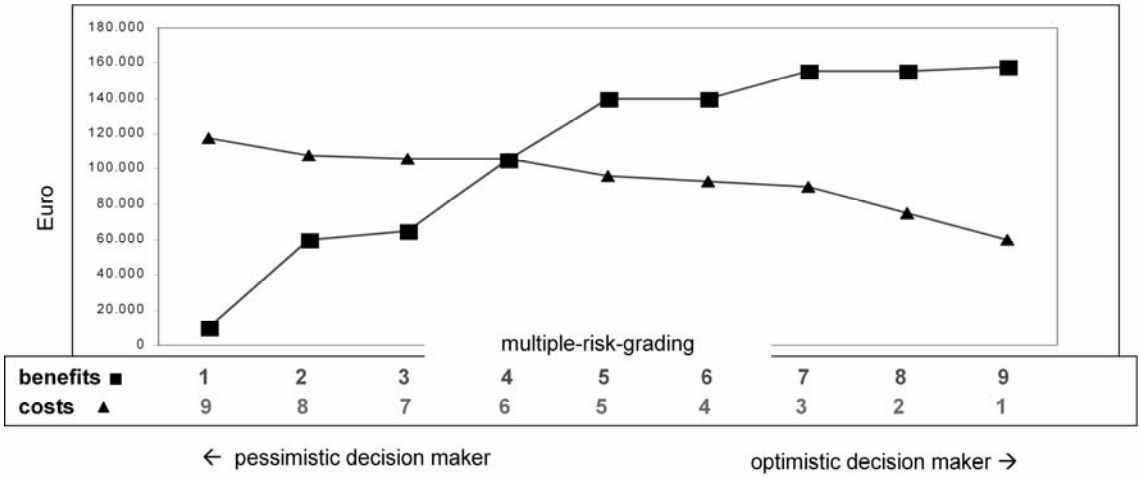

Fig 1: Example of the visualization of costs and benefits according to risk stages (Source: Uribe 2003; Michulitz and Flachskampf, 2006, modified)

The approach consists of the following steps:

1. Identification of all aspects of benefit
2. Valuation of the benefit aspects
3. Assessment of all costs
4. Accumulation of all cost- and benefit aspects
5. Evaluation of the individual willingness-to-pay of all Stakeholders
6. Measurement of the intensity of transactions

A key problem of any method dealing with the quantification of benefits is monetary valuation. In theory there are subjective approaches - mostly willingness-to-pay based methods - (see Ahlheim and Frör, 2003) and objective approaches (e.g. times saving times salary model or cost-of-illness-approach, see Ebner, 2004; 58, Fries, 2006; 35).
In order to gain objective and transparent results in the process of valuation, empirical methods like Delphi-Surveys (Ott, 1993) or Expert Valuations (Mann, 2003) will be used. Potential experts in the surveys will be internal experts (i.e. project members), as well as external experts from the supply chain of animal products.

3 Results

3.1. Stakeholder groups and their aspects of benefits

So far, first results of the identification and description of stakeholders, as well as their aspects of benefits are available. These aspects are a key element of cost-benefit analyses (Fries, 2006; 35).

The following stakeholder groups of the IT FoodTrace project could be identified:

- Authorities, farmers, agribusiness, processors, traders/restaurants, interest groups, consumers.

The identified benefits of these stakeholders are closely related to the business services in the system architecture of the IT solution, within the IT FoodTrace project:

- Supply chain management, information services, notification of authorities, marketing services.

These business services are each separated into different single services that belong together functionally. To name a few examples: tracing of products, quality assurance and an integrated animal health system.

3.2. Benefit aspects for livestock farmers

First empirical results of a livestock farmers survey are already available. 84 livestock farmers in the German federal state of Baden-Wuerttemberg were surveyed by means of a standardised, written questionnaire: the survey was assisted and contained primarily closed questions. It was conducted between December 2006 and January 2007. Sampling criterion was that the dairy farm had to have more than 40 dairy cows. A return rate of 100 percent was achieved because of the support by the LKV-staff.

The sample was not representative. The survey was carried out to evaluate benefit aspects for the farmers that come along with the intended IT solution. Farmers were also asked to name the time required and the methods used for specific tasks and duties.
An interesting find was that only 1% of the farmers asked do not have access to the internet. This might not be the case in small farms, but an internet access is needed for traceability solutions that are IT-based. To a large degree, livestock farmers administrate their stock book manually (see Fig. 2), which is not an ideal basis for a successful IT-solution.

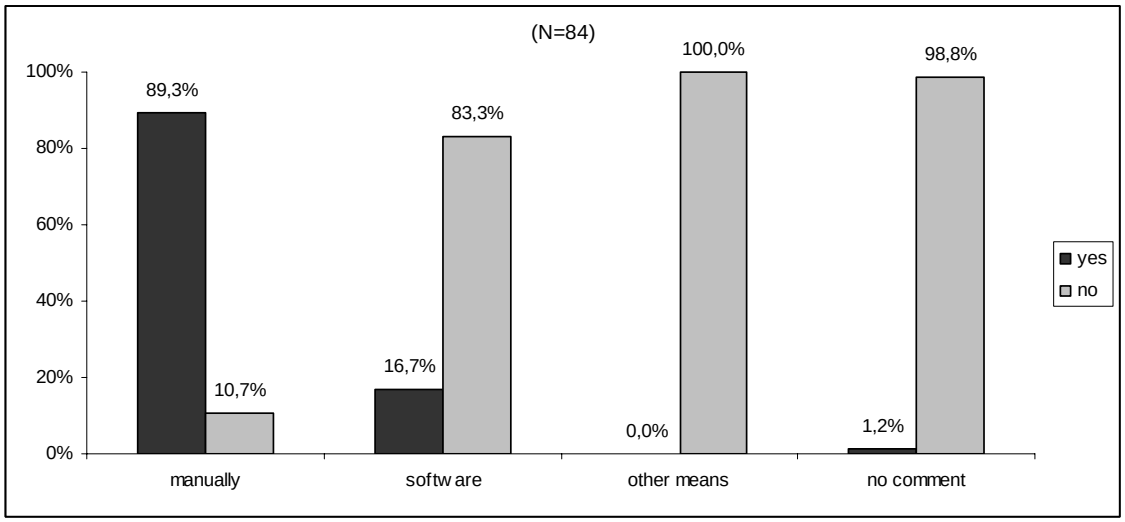

Fig 2: Administration of stock book by interviewed livestock farmers

While 95% of the veterinarians pass the application- and dispensing document (Anwendungs- und Abgabebeleg) to the livestock farmer by hand, nearly 85% of the interviewed livestock farmers use the Internet for the submission of animal data to the HI-T database (national animal identification data-base). This can be seen as an indicator of the acceptance of Internet use. Submissions to national statistics authorities are done by mail or fax by around 75% of the interviewees. The announcement of the sale of animals is primarily accomplished by phone. So, we can see the many ways stakeholders use to communicate on the farm level. In the following questions, livestock farmers were asked about their opinion of the planned integrated animal health system. As the results show (see Fig. 3), most of the interviewees (up to 80%) are interested in the use of animal health data that is collected by veterinarians. Also of importance is the use of data being collected during milking and the digital distribution of the application- and dispensing document (AuA-Beleg). A digital stock book appears to be useful to merely 60% of the farmers asked. Of minor importance is the digital preparation of transport documents.

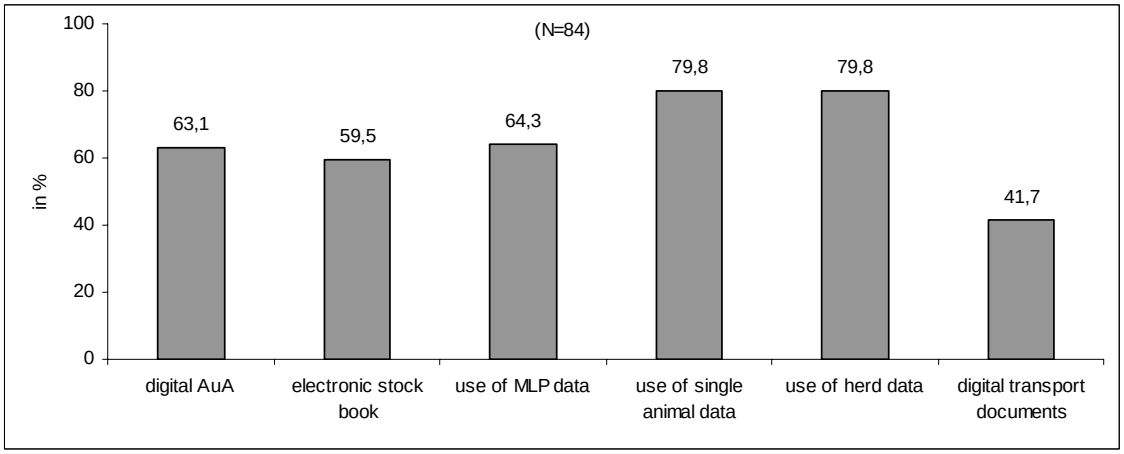

Fig 3: Usefulness of components of the integrated animal health system

By the EFITA 2007 Conference, further results concerning benefits to stakeholders will be available.

4 Conclusions

So far, common valuation methods such as contingent valuation (CVM) are often used to assess non-market production, for example, conservation of the countryside (Ahlheim and Frör 2003). On the other hand, approaches such as return on investment (ROI) or total cost of ownership (TCO) are more common in IT related projects (Okujava and Remus, 2005). Both approaches have severe shortcomings in terms of objectivity and/or transparency concerning the process of the valuation of benefits. Therefore, results will be estimations with a high degree of uncertainty (Antle, 1999; 620). The described technique uses different scales of entry probabilities to produce an accurate plot of results. Therefore, it is possible for decision makers to work with nine different (pessimistic to optimistic) scenarios. The inclusion of empirical methods such as Delphi-Surveys or Expert-Valuations deepens the quality of the valuation process (Mann, 2003). This enables stakeholders to make profound decisions, such as whether to adopt the quality- and traceability system or not.

References

Ahlheim, M. und O. Frör (2003): Valuing the non-market production of agriculture. In: Agrarwirtschaft 52 (8), 356-369

Antle, J.M. (1999): Benefits and costs of food safety regulation. In: Food Policy 24 (1999), 605 - 623.

Banterle, A. and S. Stranieri (2007): Information, labelling and vertical co-ordination: an analysis of the italian meat supply chain. In: Pre-Prints of the 1st International European Forum on International Center for FoodChain and Network Research, February 2007, Innsbruck-Igls, Austria.

Crutchfield, S.R., J.C. Buzby, T. Roberts, M. Ollinger and C.-T. Jordan Lin (1997): An Economic Assessment of Food Safety Regulations: The New Approach to Meat and Poultry Inspection. Food Safety Branch, Food and Consumer Economics Division, Economic Research Service, United States Department of Agriculture, Agricultural Economic Report No. 755.

Disney, W.T, J.W. Green, K.W. Forsythe, J.F. Wiemers and S. Weber (2001): Benefit-cost-analysis of animal identification for disease prenvention and control. In: Scientific and Technical Review, Vol. 20 (2), August 2001, 385 - 405.

Ebner, M. (2004): Ein Beitrag zur monetären Bewertung von digitaler Netzinformation in Versorgungsunternehmen. Dissertation an der Universität der Bundeswehr München.

Fries, E-A (2006): Benchmarking ausgewählter Qualitätssicherungssysteme der Fleischkette - eine vergleichende Kosten-Nutzen-Analyse. Dissertation an der Justus-Liebig-Universität Gießen.

Gampl, B. (2006): Rückverfolgbarkeit von Lebensmitteln. Eine empirische Analyse kettenübergreifender Informationssysteme. Cuvillier Verlag Göttingen.

Hobbs, J.E. (2003): Traceability in Meat Supply Chains. In: Current Agriculture, Food & Resource Issues, Number 4/2003, 36 - 49.

Horwath, L. (2004): Supply Chain Management in der Fleischerzeugung: Konzeption, Implementierung und Perspektiven. Dissertation. Technische Universität München, Weihenstephan.

Jensen, H.H. (2003): Food-system risk analysis and HACCP. In: Velthuis, A.G.J. et al. (eds.): New Approaches to food-safety economics. Kluwer Academic Publishers, Dordrecht, 63 - 77.

Loew, T. K. Fichter, U. Müller, W.F. Schulz, M. Strobel (2003): Ansätze der Umweltkostenrechnung im Vergleich. Texte 78/03, Umweltbundesamt Berlin.

Lund, M. (2003): The economics of HACCP: farm-to-table analysis. In: Velthuis, A.G.J. et al. (eds.): New Approaches to food-safety economics. Kluwer Academic Publishers, Dordrecht, 79 - 87.

Mann, S. (2003): Expert Valuation as an alternative to contingent valuation. Agrarwirtschaft 52 (2003), Heft 8.

McKean, J.D. (2001): The importance of traceability for public health and consumer protection. In: Scientific and Technical Review, Vol. 20 (2), August 2001, 363 - 371.

Meixner, O. und Haas, R. (2007): Importance and relevance of quality labels in the Austrian meat supply chain. In: Pre-Prints of the 1st International European Forum on International Center for FoodChain and Network Research, February 2007, Innsbruck-Igls, Austria.

Meuwissen, M.P.M., A.G. J. Velthuis, H. Hogeveen and R.B.M. Huirne (2003): Technical and economic considerations about traceability and certification in livestock production chains. In: Velthuis, A.G.J. et al. (eds.): New Approaches to food-safety economics. Kluwer Academic Publishers, Dordrecht, 41 - 54.

Michulitz, C. und Flachskampf, P. (2006): Leitfaden Zur Umsetzung von erweiterten Geschäftsmodellen im Werkzeug- und Formbau. Internet: http://www.ifu-kybernetik.de/downloads/leitfaden_umsetzung_modelle_gemowzb.pdf, Abrufdatum 26.02.2007.

Okujava, S., U. Remus (2005): Methoden zur Untersuchung der Wirtschaftlichkeit von Unternehmensportalen. competence-site. (2005) - http://www.competence-site.de/

Ott, H.J. (1993): Wirtschaftlichkeitsanalyse von EDV-Investitionen mit dem WARS-Modell am Beispiel der Einführung von CASE. Wirtschaftsinformatik, 35 (6), 522-533.

Quaas, R. (2005): Messung der qualitativ-strategischen Nutzeneffekte von IT-Investitionen. www.isento.de/documents/wirtschaftlichkeitsanalyse.pdf

Schiefer, G. (2003): Traceability and certification in food quality production - a critical view. In: Velthuis, A.G.J. et al. (eds.): New Approaches to food-safety economics. Kluwer Academic Publishers, Dordrecht, 55 - 60.

Theuvsen, L. und T. Hollmann-Hespos (2005): The Economics of Traceability: A Model of Investment in Tracking and Tracing Systems in Agriculture and the Food Industry. Paper presented at the EFITA/WCCA Joint Congress on IT in Agriculture, July 2005, Villa Real, Portugal.

Unnevehr, L.J. and R.B.M. Huirne (2003): New approaches to food-safety economics: overview and new research directions. In: Velthuis, A.G.J. et al. (eds.): New Approaches to food-safety economics. Kluwer Academic Publishers, Dordrecht, 1 - 8.

Uribe, J (2003): NOWS-Technique: Participation-orientated Evaluation of further Education Strategies and Measures. 8th Symposium on Automated Systems Based on Human Skill and Knowledge, Gothenburg, Sweden. http://www.ifu-kybernetik.de/weiterlesen/archiv/oldsite/downloads/NOWS_Technique_Gothenburg_eng.pdf, Abrufdatum 26.02.2007

Weydandt, D. (2000): Beteiligungsorientierte wirtschaftliche Bewertung von technischen Investitionen für prozessorientierte Fertigungsinseln. Dissertation an der RWTH Aachen, D 82, Unternehmenskybernetik in der Praxis, Band 2, Shaker Verlag, 2000.