

MANAGEMENT OF PERCEIVED RISKS IN E-BUSINESS FOR EFFICIENT FOOD SUPPLY NETWORK MANAGEMENT: THE CASE OF TRUST

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*Melanie Fritz, Maurizio Canavari**

Abstract

Vertical coordination in food networks is characterized by dynamically changing supply and marketing relationships. E-business provides support and improvement options for vertical coordination processes and flexible supply chain management in food networks. However, adoption of e-business in food networks is low as available e-business offers as the communication of safeguards for trust and control as basis for the transaction decision is not realized appropriately. This paper analyzes decision preferences for trust generation as basis for the design of e-business environments for supply chain management in food networks. The analytic hierarchy process is applied to prioritize preferences for different transaction scenarios in food networks.

Keywords

Supply chain management, e-business, transaction decisions, trust, analytic hierarchy process (AHP).

1 Introduction

The food sector is a complex network of companies (e.g. MÉNARD, 2004) involved in the production of food on different stages of the food production value chain (CONNOR, SCHIEK, 1997). The production and consumption of food underlie seasonal variations and trends, which create supply and demand dynamics in food supply networks. Dynamically changing market situations affect the vertical coordination of supply and demand across network levels and create dynamically evolving networks of companies. As an example, recent growth rates in the market for organic food in Germany have caused supply problems and stock outs at retailers selling organic products. As a consequence, these retailers are increasingly moving to global sourcing strategies as domestic procurement of organic food is not possible.

Challenges from market dynamics ask for improvement and support options for vertical coordination across the food network. The need for improvements and support is particularly high for the vertical coordination between primary producers and the purchasers of their products (TAYLOR, FEARNE, 2006).

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E-business being the conduction of transaction processes using Internet-based information and communication systems (e.g. LEFEBVRE et al., 2003) provides support potentials for improving coordination across dynamically changing food networks. This paper understands e-business as electronic support of the supply and marketing processes and their transaction phases across a vertical value network.

For the use of e-business in food networks, an infrastructure of e-business providers tailored to food supply networks has emerged (FRITZ et al., 2004, KALAITZANDONAKES et al., 2003). However, in contrast to the pressure for coordination improvements and the potentials and availability of e-business offers for food networks, the adoption of e-business in food networks is lower than in other industries, in particular when it comes to small and medium sized enterprises (SMEs) prevailing in food networks (European Commission, 2005).

Explanations for the low adoption rate can be identified in the nature of transaction processes and transaction decisions. Business transactions are realized in an interaction and communication process between two partners, seller and buyer, and their decision upon the continuation of the transaction process and the finalization of the transaction (STÖLZLE, 1999). Transaction decisions are the result of an unstructured, fuzzy reasoning process (TURBAN, 1988) taking into account decision variables from (see TAN, THOEN, 2002)

- the *transaction situation* with potential gains and advantages for the company as well as risks or losses regarding the outcome,
- the *external transaction environment* creating trust and providing control mechanisms or hazards and risks.

In a decision situation such as a transaction, the relationship between risks, gain, trust and control as influencing factors is highly complex (see TAN, THOEN, 2002).

For the transfer of the current system status of food network coordination to a new system status with e-business adoption, transaction decision variables and influencing factors need to be taken into account. E.g., as it is difficult to scrutinize food quality, safeguards communicating trustworthiness and control opportunities are necessary decision variables to overcome perceived risks regarding product quality in food network transactions. E-business offers need to build on the provision of appropriate decision variables to influence the transaction decision as prerequisite for e-business adoption in food networks.

There is a gap at existing e-business environments for food networks in the communication of safeguards for trust and control as basis for the transaction decision. The essential question and prerequisite for the adoption of e-business for the dynamic coordination in food networks is how to communicate which information about trust and control to manage perceived risks to support the transaction decision.

This paper puts the focus on the analysis of decision preferences regarding trust and control in transactions in food networks as basis for the design of e-business environments for food supply networks. For the analysis of decision preferences regarding trust and control, the paper employs the Analytic Hierarchy Process (AHP; SAATY 1980 and 1990).

The paper is organised as follows. The paper sets the ground with an analysis of the role of trust and control in transactions decisions in food networks (paragraph 2). It then explains the methodology applied (paragraph 3) and discusses decision preferences in trust antecedents for electronic transactions in food supply networks (paragraph 4). Paragraph 5 concludes.

2 Background

There is no doubt that transaction decisions for the coordination of a supply network are facilitated by information, control and safeguard, which are stipulated in formal or informal

contracts (O'REILLY et al., 2003). This is particularly true for food supply networks where it is difficult to scrutinize the product quality and information asymmetry exists between suppliers and buyers (e.g., HENNESSY, 1996). However, control and safeguard are not sufficient to enable decisions leading to transactions between companies. An essential complement and sometimes substitute for control and safeguard mechanisms in transactions is trust (FYNES et al., 2001).

In principle, trust is a generalized expectancy towards the behaviour of others and reduces the complexity of decision situations (LUHMANN, 2001). Trust is a highly subjective concept composed of cognitive and emotional dimensions (LEWIS, WEIGERT, 1985). It is important to note that its emergence in an individual depends on his or her perception of the reality. With regard to transaction decisions, trust is one party's belief that the other party will not exploit its vulnerabilities (BARNEY, HANSEN, 1995, MAYER et al., 1995). The economic relevance of trust as transaction facilitator becomes apparent as it is less costly than control and safeguards (DYER, 1997, ZAK, KNACK, 2001).

According to the basic model of transaction decisions by TAN and THOEN (2001, see Figure 1), transaction decisions are influenced by a complex system of influencing dimensions and mechanisms including trust and depend on the perceived level of transaction trust and the individual's transaction trust threshold. The perceived level of transaction trust is influenced by the trust in the transaction partner and the trust in transaction control mechanisms. Information cues signalling the trustworthiness of transaction partners in food supply networks include quality signs, reputation, transparency, or personal relationships (see FRITZ, 2006, for an overview). The position of the trust threshold varies and is influenced by the transaction situation with its potential gains, which are balanced against potential risks from the transaction. The individual's risk attitude is an important determinant for balancing gains against risks. It is essential to note that individuals would only engage in a transaction if the level of trust perceived in a particular transaction situation exceeds their trust threshold.

The availability of e-business solutions such as electronic offers potentials for the coordination of transactions across the stages of a supply network (GEOFFRION, KRISHNAN, 2001, SWAMINATHAN, TAYUR, 2003). Potentials for improved coordination are particularly interesting in food networks where market dynamics, global markets and fragmentation prevail (HAUSEN et al., 2006). However, adoption of e-business transaction support by businesses is low, in particular by small and medium sized enterprises (SMEs) in food networks (European Commission, 2005).

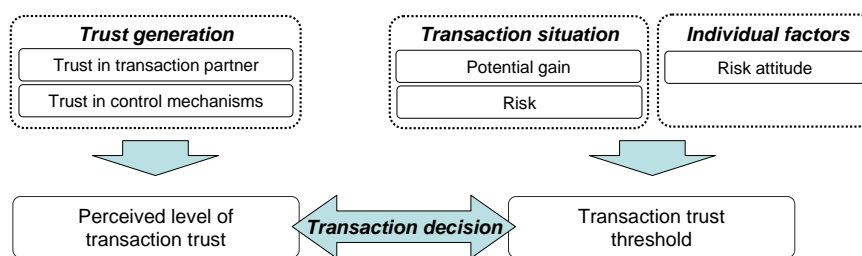


Figure 1: Transaction decision determinants
(based on Tan, Thoen, 2001)

The model of transaction decision determinants (Figure 1) assists at understanding the low adoption rate. The introduction of electronic transaction support changes the transaction setting being the basis for the transaction decision. Potential efficiency improvements in transaction processes and coordination potentials could affect the potential gains of a transaction situation. However, in e-business perceived risks could raise as electronic

transaction means might be perceived as anonymous, providing less availability of control and safeguards (see PATTON, JOSANG, 2004). Trust generation applied in the traditional way of doing business such as personal contacts could be missing. As a consequence, the perceived level of transaction trust and the transaction trust threshold as determinants for the transaction decision could be changed in electronic transaction settings.

The work presented in this paper focuses on trust generation as trigger for transaction decisions in electronic transaction environments. The recognition of trust as facilitator for e-business is mirrored by an emerging stream of research analysing rules for the generation of trust in e-commerce (e.g. MCKNIGHT et al., 2002, KOMIAK, BENBASAT, 2004, RATNASIGNHAM, 2005, PATTON, JOSANG, 2004). Trust generation in e-commerce is supported by the fact that the provision of information and interpersonal communication, which are inherent to ICT, is an important basis for the emergence of trust. However, there is a gap in current research in the integration of trust generation for e-business with the particular requirements towards transaction trust in food supply networks. The low adoption rate mirrors the gap between knowledge on trust generation for e-commerce and its application to electronic transaction support in food supply networks.

Starting point for the work presented in this paper is the first working hypothesis H1:

WH1: The generation of trust as trigger for transaction decisions is not yet appropriately supported by available electronic transaction support in food supply networks.

What are antecedents to trust generation in food supply network transactions? Which electronic information and communication mechanisms support the generation of trust for electronic transactions in food supply networks?

Food supply networks consist of different subnetworks related to the production and marketing of different food product groups such as fresh produce, meat and meat products, grain and cereal products or milk and dairy products. The product groups show different product characteristics; different requirements regarding the design of transaction processes are the consequence, which leads to different chain structures and governance forms in the subnetworks (e.g. HAUSEN, 2005, SEIDEL, 2005, FISCHER ET AL., 2006, GOLDSMITH, BENDER, 2004, O'REILLY ET AL., 2003; see Table 1). The differences in the governance forms in the food subnetworks lead to differences in the antecedents for the generation of trust. The second working hypothesis underlying the work presented in this paper is:

WH2: Different food subnetworks have specific demands regarding trust generation for electronic transaction environments.

What preferences for the generation of trust in electronic transaction environments exist in different food subnetworks?

Table 1: Characteristics of product-specific food subnetworks

	Fresh produce	Meat	Grain	Dairy
Product characteristics	Perishable, seasonal and uncontinuous production	Batch production	Changing qualities due to varying production conditions	Milk: continuous production
Governance	Short term contracts, mediated by specialised traders (produce type, production region); long term relationships	Repetition of short term contracts between same partners	Mostly long term relationships with mutual bindings, investments and cooperation; seldom contracts	Mostly cooperatives; also contracts; also spot market mediated by trader
Market characteristics	Buyer's market, small margins	Increasing prices	Decreasing prices	Decreasing prices, EU: milk quota

3 Methodology

3.1 Analytic hierarchy process

To identify decision makers' preferences regarding trust generation in electronic transaction environments in food networks, the paper employs the analytic hierarchy process (AHP) (Saaty 1990). The AHP is a method to support unstructured multi-criteria decision processes involving quantitative and qualitative decision criteria (see also MEIXNER, HAAS, 2002). Application areas of the AHP include decision support for system or process selection and usability evaluation (see WEI et al., 2005, PARTOVI, 2007, or RADCLIFFE, SCHNIEDERJANS, 2003)

The AHP builds on three core characteristics:

- Analysis and mapping of the decision space in a hierarchic decision model; the decision model splits the objective to reach into a hierarchic tree of subjective of objective, qualitative or quantitative criteria and sub-criteria affecting the achievement of the objective.
- Pairwise comparison of the decision criteria incorporated in the decision model with respect to their importance to the element in the next higher level to estimate priorities showing relative preferences.
- Integration of the pairwise comparison results to composed weights of the criteria to identify overall decision preferences for each criterion.

3.2 Procedure in research

For the analysis of the decision preferences regarding trust generation in e-business in food networks, a two phase research process was adopted (see Figure 2): In the modelling phase, AHP decision preference models mapping decision criteria preceding trust generation for e-business in food networks were developed. In the priority assessment phase, the decision preferences regarding trust generation were analysed.

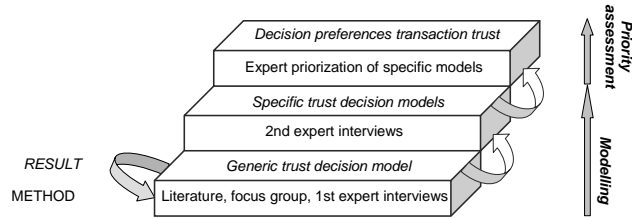


Figure 2: Research procedure

The modelling phase first developed a generic AHP decision preference model mapping criteria preceding trust generation for e-business in food networks; the generic model was then adapted to specific trust decision models incorporating particularities of different food subnetworks.

The modelling of the generic trust decision model was realized in an iterative process with feedback loops. It followed the grounded theory approach (GLASER, STRAUSS, 1967, STRAUSS, 1987) and adopted a methodological mix and triangulation with literature to integrate the results of empirical work with available expertise on trust in electronic transactions and trust in food networks.

Due to the multidimensional nature of trust in transactions, a focus group approach was chosen for the empirical analysis of trust generating factors for electronic transactions in food networks. A two hours focus group discussion was performed with experts from food network companies, ICT companies providing services for food networks, industry associations, and research (see Table 2). The focus group was moderated and stimulated through an introduction into the topic and the periodic consolidation of statements. The discussion was recorded and both quantitative (see RIVAROLI, 2005) and qualitative content analysis techniques were applied for the individualization of the role of trust and of concepts and constructs for trust generation in electronic transactions in food networks. For the collection of available expertise and triangulation of results, a literature review was realized to integrate the separate streams of knowledge on trust generation in food networks (FRITZ, 2006) and trust generation in electronic commerce (e.g. MCKNIGHT ET AL., 2002, KOMIAK, BENBASAT, 2004, RATNASIGNHAM, 2005, PATTON, JOSANG, 2004). Preliminary versions of the generic trust decision model were tested and refined in a 1st round of semi-structured expert interviews.

Based on the 2nd round of semi-structured expert interviews, the generic decision model was adapted to the particular transaction situations in the food subnetworks grain and cereal products, meat and meat products, fresh produce, and milk and dairy products.

Table 2: Overview of interviews

Research phase	Participants	Background of participants	Number of participants
Focus group		Food sector companies	11
		ICT providers	4
		Food sector associations	6
		Food economics research	14
		Computer science	2
1st round expert interviews		Food sector companies	1
		Food sector associations	3
2nd round expert interviews		Food sector companies	4
		Food sector associations	6
Priorization of the specific trust decision models		Food sector companies	1
		Food sector associations	3

The prioritization of the scenario-specific trust decision models for electronic transactions in food networks was performed in pairwise comparisons following the AHP supported by the software Expert Choice™. The pairwise comparison followed the scheme “How much more important do you consider the trust criterion A against the trust criterion B with regard to the attainment of the higher level trust criterion?”.

4 Transaction trust decision model with preference patterns

4.1 Transaction trust decision model

For the generic trust decision model for electronic transactions in food networks, the framework by TAN and THOEN (2002) providing a systematic structure of dimensions of transaction trust is taken as basis. Building on this basis, the factors for trust generation in food networks emerged from the empirical work and the literature study have been used for the construction of the hierarchic decision model for trust generation in e-business for food networks.

TAN and THOEN (2002) define the transaction partner and available control mechanisms as sources for the generation of trust in transactions and at the same time as objects, which need to be trusted (see Table 3). They distinguish objective and subjective criteria generating trust towards transaction partner or control mechanism. Objective criteria are commonly accepted indicators, which are widely known such as a uniform or a certified procedure. Subjective trust criteria are experience-based and regard previous, positive personal experiences, cognition-based understanding of a transaction partner’s objectives and capabilities or how a control mechanism works, and communality. Communality refers to opinions of trusted community members and includes reputation.

With regard to the generation of trust in transactions, it is important to differentiate that trust arising from positive experiences comes ex post and develops over time. In contrast, understanding, communality and social indicators can be used to generate trust ex ante before a personal experience has been made.

Table 3: Trust criteria for sources and objects of trust

(based on TAN, THOEN 2001)

Sources and objects of trust		Transaction partner	Control mechanisms
Trust criteria			
Objective trust criteria	Commonly accepted indicators	Uniforms	Control procedure certified by trusted organization
Subjective trust criteria	Experience-based	Previous, positive interactions (“normal” experience and transaction experience)	Previous positive interactions with control procedure
	Cognition-based understanding	Understanding of others’ goals, plans, capabilities	Understanding how control procedure works
	Community-based	Opinions and trust of trusted community members regarding party	Opinions and trust of trusted community members regarding control procedure

Figure 3 shows the generic decision model for trust generation in e-business in food networks. It splits the decision’s objective of “transaction trust” into the two sources and objects of trust “transaction partner” and “control mechanisms”. These are split into dimensions of trust criteria contributing to the generation of trust towards the sources and objects of trust.

In a stepwise process, trust criteria from the empirical work and the literature study were allocated to the appropriate trust dimension of the model hierarchy. With regard to commonly accepted indicators generating trust in a transaction partner in food networks, recommendations by associations such as industry associations or consumer associations, public institutions including federal agencies or ministries, or purchasing organisations play a role. Criteria for the experience-based generation of trust in a transaction partner in food supply networks are the usability of a transaction system, which is supported by the currency of data provided, the efficiency of the processes provided, the logical navigation, or multilingual support. The impression of a company representative, e.g. through videoconferencing, email exchange, or chat, former transaction experiences with the respective or even other suppliers, former personal experiences, or a product sample sent for inspection are other criteria contributing to the generation of trust in a transaction partner.

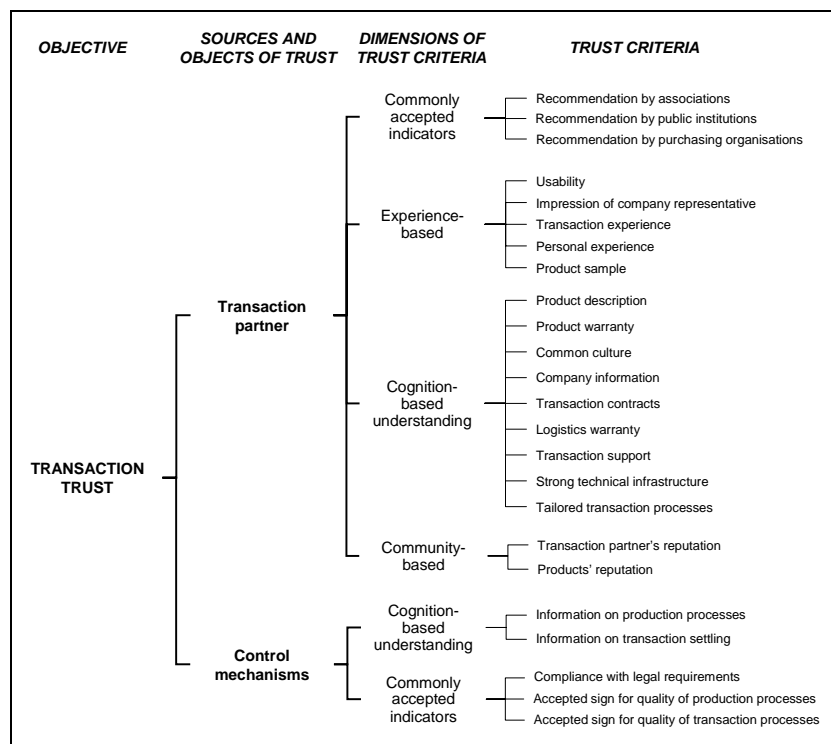


Figure 3: Generic trust decision model for electronic transactions in food networks

Trust generation in the dimension of cognition-based understanding can be supported by a product description in either text or multimedia format or a product warranty either signalled by high quality production processes or traceability. Common culture between transaction partners visible by joint attitudes or joint company structures, information about the supplying company accessible from the website, its creditworthiness, its contact persons, or multimedia information are other trust criteria for the dimension of cognition-based understanding. In addition, the transparency of contracts stipulating transaction rights and duties and the smoothness of its negotiation, a logistics warranty regarding the shipping procedure supported by e.g. delivery tracking and tracing, the availability of support during the transaction process, a strong internal or inter-company technical infrastructure, and the availability of tailored transaction processes play a role for the generation of trust in a transaction partner through cognition-based understanding. With regard to community-based criteria for the generation of trust in a transaction partner, the reputation of the transaction partner and the reputation of the product come into play.

As regards the generation of trust in the transaction control mechanisms, information on the control of production processes and the control of transaction processes are trust criteria for the dimension of cognition-based understanding. Commonly accepted indicators are the compliance with either national or international law, an accepted sign for the quality of production processes by a general, food sector specific or product group specific certificate, and an accepted sign for the quality of the transaction processes provided by either a seal or approval for the electronic transaction system or a data security certificate.

4.2 Patterns of decision preferences

Table 4 shows the results of the analysis of decision preferences for trust generation for the scenarios fresh produce, grain, milk, and meat resulting from the priority assessment with the

AHP, which were made based on the specific trust decision models. The assessment was done for the chain level primary production – manufacturing where the need for improvements and support of vertical coordination is particularly high (TAYLOR, FEARNE, 2006). The table shows the weighting of the trust criteria with their implementation referring to the respective last level in the hierarchy of the decision model. In addition, the table shows the ranking of the first fifteen trust criteria for each transaction scenario.

Table 4: Priorization results

AHP DECISION MODEL				RESULTS PRIORITY ASSESSMENT							
Objective	Sources and objects of trust	Dimensions of trust criteria	Trust criteria and Implementation	Fresh Produce		Grain		Milk - Dairy		Meat	
				AHP weighting	Ranking	AHP weighting	Ranking	AHP weighting	Ranking	AHP weighting	Ranking
Transaction Trust	Transaction partner	Experience-based	Recommendation by associations	0.001	11	0.006	6	0.099	2	0.028	8
			Recommendation by public institutions	0.003	10	0.004	7	0.042	7	0.012	8
			Recommendation by purchasing organisations	0.001	12	0.004	10	0.06	6	0.017	12
			Usability of electronic transaction system	0.005	10	0.004	7	0.024	9	0.121	12
			Impression of company representative	0.002	10	0.003	7	0.003	9	0.121	12
			Former transaction experience	0.006	7	0.007	9	0.024	9	0.024	10
			Former personal experience	0.006	7	0.019	10	0.018	10	0.086	3
			Product description	0.029	13	0.02	9	0.015	1	0.038	6
			Product warranty	0.007	11	0.004	5	0.139	1	0.058	5
			Visibility of common culture	0.012	11	0.032	5	0.023	10	0.029	7
			Company information	*	6	0.023	6	0.064	5	0.149	1
			Transaction contracts	0.002	11	0.001	6	*	*	0.003	*
			Logistics warranty	0.002	11	0.004	6	0.07	9	0.015	9
			Availability of transaction support	0.001	11	0.001	6	0.007	9	0.026	9
			Strong technical infrastructure	0.001	11	0.004	6	0.007	9	0.026	9
			Availability of tailored transaction support	0.001	11	0.004	6	0.007	9	0.026	9
			Transaction partner's reputation	0.001	11	0.004	6	0.007	9	0.026	9
			Community-based	0.001	11	0.004	6	0.007	9	0.026	9
			Cognition-based	0.001	11	0.004	6	0.007	9	0.026	9
			Control mechanisms	Commonly accepted indicators	Information on control of production processes	0.139	2	0.025	4	0.009	8
Information on control of transaction setting	0.068	6			0.285	1	0.026	8	0.018	11	
Compliance with legal requirements	0.208	1			0.004	8	0.005	9	0.001	11	
Accepted sign for quality of production processes	0.006	8			0.009	8	0.024	9	0.004	10	
Accepted sign for quality of transaction processes	0.028	4			0.118	3	0.026	8	0.002	10	
Food sector specific certificate	0.081	4			0.032	5	0.071	4	0.005	10	
Product group specific certificate	0.129	3			0.125	2	0.002	11	0.005	10	
Seal of approval of website	0.129	3			0.125	2	0.002	11	0.005	10	
Data security certificate	0.129	3			0.125	2	0.002	11	0.005	10	
Information on control of production processes	0.021	9			0.023	6	0.088	3	0.028	8	

It is interesting to note that for the scenarios fresh produce and grain, the highest ranked criterion regards the control mechanisms. For fresh produce and grain, almost all of the five highest ranked criteria are concentrated regard control mechanisms overlooking the transaction. For the scenarios milk and meat, however, the highest ranked criterion is located in the dimension “experience-based” and regards the transaction partner. For both milk and

meat, the majority of the criteria on ranks 1-5 are in the area of the experience-based trust generation towards the transaction partner. Interestingly, for the meat scenario, only one criterion on ranks 1-5 is located in the area of trust generation through control mechanisms. One reason for this priority assessment could be related with the repeated crises in the meat sector, which might have reduced the trust in control mechanisms and their ability to generate trust in a transaction.

Figure 4 shows emerging patterns in trust decision priorities in the analysed scenarios of food networks, which have emerged from the expert assessments. With regard to the design of electronic transaction environments for the different scenarios, the patterns of needs towards trust generation need to be taken into account.

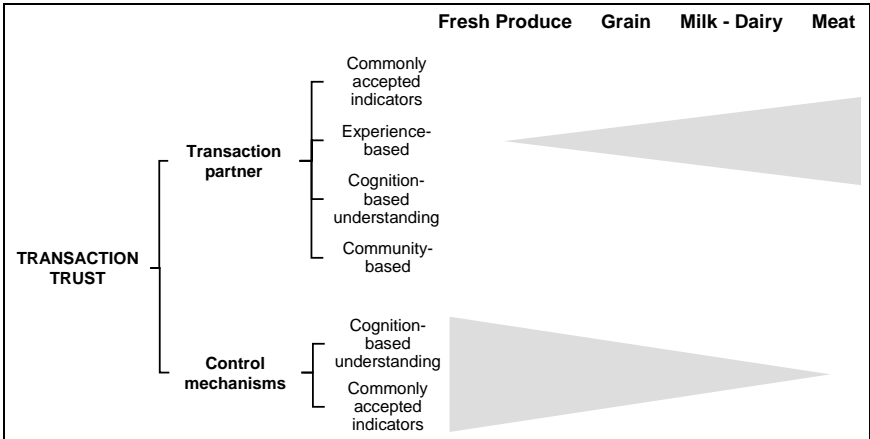


Figure 4: Patterns in trust decision priorities

5 Conclusions

For the adoption of e-business in food networks, the essential question is how to communicate which information content to support the transaction decision and to manage perceived risks by creating trust and confidence. This paper has analyzed decision preferences regarding trust and control in transactions in food networks as basis for the design of e-business environments for food supply networks. Based on a decision model mapping criteria for the emergence of trust in food network transactions, decision preferences for transactions in fresh produce, grain, milk-dairy, and meat chains were identified for the chain levels primary production to manufacturing.

Further research is required to include the analysis of decision preferences at more chain levels of the food network and to analyze intercultural differences as food networks are a highly global business and the emergence of trust in an individual is related to the cultural background.

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