PERSPECTIVES OF FOOD SUPPLY CHAIN TRACEABILITY

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ABSTRACT

Purpose of this paper
Several different perspectives exist on the importance of food supply chain traceability and why it is scientifically investigated. These include the assessment of food security and quality preservation, economic, logistic, supply chain management, and information technical. Because of this, the concept of food supply chain traceability is defined in many different ways, depending on the scientific area of the research perspective used for investigation. This makes the concept and the scientific value of food supply chain traceability sometimes hard to understand theoretically. Thus, it is of great importance to position the concept theoretically and in relation to other scientific research areas. The purpose of this paper is to examine how food supply chain traceability can be theoretically positioned in academic supply chain research.

Design/methodology/approach:
The paper is based on a literature review of definitions and perspectives of food supply traceability, and of the concepts and definitions used within the paradigm thinking found in relevant scientific articles and books.

Findings:
The results show that food supply chain traceability is pre-paradigm research and further suggests that it should be treated as a “physical representational space” in scientific theory. The results also verify that food supply chain traceability is a complex research field, which is studied by using several perspectives in different research areas, especially logistics. It is

important to clarify the perspective that has been applied when making suggestions concerning logistics development.

Research limitations/implications: The literature review only includes definitions and methods for positioning food supply chain traceability from a scientific theoretical perspective. The study excludes the concepts "track and trace", "internal traceability" and "external traceability", which are used in food supply chain management.

Practical implications:
The results of this paper are useful for practitioners as well as researchers since it addresses and aims to explain the concept of food supply chain traceability from a scientific perspective. This should influence future supply chain traceability setups.

What is original/value of paper:
The paper provides an extended understanding of food supply chain traceability in relation to scientific theory in a new unique way that can influence future research in and development of the area, particularly concerning societal perspectives.

Keywords: Food supply chain traceability, scientific theory, literature study

1. INTRODUCTION

1.1 Background

Different objectives of supply chain traceability for actors in the food industry have been introduced and investigated in recent literature (Furness and Osman, 2003; Golan et al., 2004; Lindh, 2009; Moe, 1998; Pouliot and Sumner, 2008). These can be categorised into objectives for: 1) risk management and food safety, 2) control and verification, 3) supply chain management and efficiency, 4) provenance and quality assurance of products, and 5) information and communication to customers (Coff et al., 2008).

These different objectives are used to improve traceability due to increased and changed demands on food supply chains, which range from the ability to transport a diversity of food products further distances at low costs (Stadig et al., 2002), to increased customer demands about cost, quality, safety, ethical and environmental sustainability during all stages of production, packaging and transportation. : If an objective of one actor contradicts that of others, this can result in further traceability demands and limitation on the whole food supply chain (Moe, 1998).

Related to the objectives of the actors to improve traceability are different perspectives of food supply chain traceability. These include perspectives of governmental control of food safety and quality, logistics, information technology, ethical, environmental and business.

An interesting area to investigate is the concept and definitions of food supply chain traceability from a scientific theoretical perspective, relating it to concepts such as paradigm, new paradigm business thinking, representational spaces and incommensurability used in scientific theory. This is because food industry companies and organisations have to face, understand and know how to use the term and concept of food supply chain when addressing traceability. The literature, however, reveals that there is no homogeneous understanding of traceability related to food in food supply chains, and that there is a gap in how the definitions of food supply traceability should be interpreted and practically used. One explanation for this is that existing definitions of food supply chain traceability are dependent on the organisational environment in which they are created (Dorp, 2002). Reviewing related literature on food supply chain traceability indicates that there still is a lack of research on different perspectives that consider the relationship among the actors to the categorisation of objectives for improvement of traceability.

The purpose of this paper is to investigate the concept and definitions of food supply chain traceability from a scientific theoretical perspective. This is achieved through a study of the literature on definitions and concepts used in scientific theory and food supply chain traceability, and of the perspectives used in food supply chain traceability. The following research questions were formulated so that the answers would achieve the purpose of the paper:
RQ1: How is food supply chain traceability positioned and interpreted from a science theoretical perspective?
RQ2: What different perspectives exist in food supply chain traceability?
RQ3: What are the relationships between the different perspectives found in food supply chain traceability and the objectives for improvement of traceability?

With the exception of the scientific theoretical perspective of food supply chain traceability already mentioned, the paper has an operational perspective on the application of an incommensurability analysis of definitions which further suggests how food supply chain traceability can be defined using scientific theory. These results can be useful for actors in the food industry as well as for other researchers in academia.

1.2 Aim

The paper has two aims: to examine the concept of traceability from a scientific theoretical perspective; and to identify and verify different perspectives of food supply chain traceability.

1.3 Limitations

The study examines the concept “traceability” in food supply chains from a theoretical perspective in science. It analyses existing definitions of food supply chain traceability in relation to the concepts of “paradigm” and “incommensurability”. It further examines perspectives for fulfilment and understanding of the concept “food supply chain traceability” and positions it in relation to the concepts “new paradigm business thinking” and

"representational spaces". Other perspectives for examining traceability in supply chains and of related terms to traceability are excluded.

2. RESEARCH METHOD

According to Yin, a research strategy can be defined as a logic sequence that links collected information to the initial research questions of the study (Yin, 2003). This means that the selection of research methodology depends on the research questions which are to be investigated (Yin, 2003; Saunders et al., 2007). This paper is theoretical and conceptual and is based on material collected from an explorative literature review of paradigm, paradigm business thinking, representational spaces, incommensurability and of different definitions of the paradigm concept.

This explorative review is complemented by a structured literature review on perspectives and definitions of food supply chain traceability depicting the current state-of-the art. The literature reviews were conducted by using the ELIN database platform (Electronic Library Information Navigator) at Lund University which integrates information from publishers, databases and electronically printed archives. Terms and combinations of the terms used for the literature search were "food supply chain traceability*", "traceability*", "perspectives*", "paradigm*", "new paradigm thinking*", "paradigm definitions*", and "representational spaces*". The validity in the research is twofold: first it stems from a comprehensive review of different definitions of food supply chain traceability and their analysis in terms of incommensurability; secondly it stems from an analysis of different perspectives of food supply chain traceability found in the literature.

However, researchers, like all human beings, are influenced by their own "nature of science" (i.e. their social background and ability to create a perception of reality when making assumptions) (Arbnor and Bjerke, 1994). One characteristic of the research approach in Nordic logistics is that researchers take highly uncertain technical and strategic tasks into consideration (Vafidis, 2007). The research approach used in this paper is abductive since it can be described as a learning loop between existing theories and empirical literature studies where inductive research processes are used for the creation of understanding, and deductive research processes are used for the creation of well-defined hypotheses and research questions for finding the most suitable theory (Kovács and Spens, 2004).

The practical processes of abductive reasoning are further investigated by Gooding and Addis (Addis et al., 2008) emphasising that hypotheses in abductive reasoning are context dependent which is in line with the chosen research method of this study.

3. FRAME OF REFERENCE

3.1 Description of the paradigm concept

Thomas Kuhn's description of paradigm is a part of his concept structure of scientific revolutions described in his book, *The Structure of Scientific Revolutions (*1962). This revolution structure model can be broken down into six chronically different phases: "pre-science", "paradigm", "normal science", "anomalies", "crisis" and ending with the "revolutionary" phase. However, before an in-depth description of the model is given, it is necessary to state what Kuhn actually meant by revolution: that every prevailing paradigm sooner or later will be replaced by a new one through a "paradigm shift".

The shift is based on a deep discontinuity (or gap) between thought and concept which is masked by language before and after the revolution (Quinn, 2001). The word "revolution" in Kuhn's model thus refers to the concept that a theoretical structure in science is abandoned and replaced by another that is incompatible with the first.

The first phase, pre-science, in Kuhn's revolutionary science model highlights the consensus if any particular theory related to the research being carried out can be considered scientific in nature. Another characteristic of the first phase is that it includes several incompatible and incomplete theories to which a researcher eventually in a widespread consensus is attracted to. This concerns the choice of methods, terminology and type of experiment for the creation of increased insight in the research field being studied. The second phase, paradigm, is then characterised by the general theoretical assumptions, laws and techniques introduced by a specific scientific community and which the researcher decides to adopt. This phase is characterised by its regulation of the standards for valid work and methods of the science which it encompasses. The paradigm phase includes the metaphysical principles that guide the work within a given paradigm (Hacking, 1983). One implication of this is that a mature science only is regulated and supported by one paradigm (Kuhn, 1996). The terms of paradigm theory and the terms of successor replacement theory do not have the same implication. On the contrary, it is important to note that Kuhn also points out that a definition of a problem in the second phase can shift between different paradigms as well as the most appropriate methods for solving problems (Kuhn, 1996). This is explained by every paradigm also viewing the world as a combination of things.

Researchers within a specific paradigm then form the third phase, normal science, in Kuhn's model. This phase illustrates the fact that as long as there is a general consensus within the chosen discipline from the second paradigm phase, the procedure of normal science will continue. According to Kuhn, it is also the existence of a paradigm that supports a tradition within normal science that differentiates science from non-science (Hacking, 1983).

Because of this, normal scientists are uncritical of the paradigm in which they work since it provides them with well-defined problems and methods. A typical normal scientist will learn the methods, standards and techniques of a certain paradigm from a senior scientist or researcher who already is experienced in the paradigm and by conducting experiments. This

means that normal scientists are unaware of the condition of the paradigm in which they are working (Hacking, 1983). On the contrary, if normal scientists would begin to accuse the paradigm of incapability when solving a specific problem, this would mean that they were simultaneously criticising themselves in the same way as a carpenter criticises his tools (Kuhn, 1996), or quoting Kuhn:

> "But only his personal conjecture is tested. If it fails the test, only his own ability not the corpus of current science is impugned. In short, though tests occur frequently in normal science, these tests are of a peculiar sort, for in the final analysis it is the individual scientist rather than the theory which is tested" (Kuhn, 1996, p.5).

This does not mean, however, that a paradigm will not have unsolved questions and difficulties, but that these will depend on the capability of the scientist to solve them. Instead, according to Kuhn, unsolved questions and difficulties within a paradigm create the fourth phase, anomalies. Some of these anomalies will always exist since when the "anomalies that signal a new paradigm arise they may be invisible to the majority of normal science adherents. And when they are encountered they may be ignored, suppressed or discredited" (Swayne, 2008, p. 91). Under certain conditions confidence in the paradigm is undermined leading into the crisis (fifth) phase of the paradigm (Kuhn, 1996).

Examples of these conditions are: a) if the anomaly attacks the foundations of the paradigm and continuously resists all elimination efforts by the normal scientists within the paradigm, b) if the paradigm is important for an urgent society need, c) in times of resistance and the trials for removing it, and d) the number of difficult anomalies existing within the paradigm. The severe test of challenging an existing paradigm is that a new conceptual framework that includes the anomalies will be needed and has to be taken seriously by other scientists (Swayne, 2008, p. 91). Forming such a conceptual framework is difficult, according to Swayne (2008), since it questions the nature of scientific authority, and considers itself "self-evident and true" without need for justification from the first principles of the paradigm being questioned (Swayne, 2008).

Another difficulty, mentioned by Kuhn in challenging a prevailing paradigm, is that psychological and historical competence is needed to identify the crisis phase within science. A state of "enounced professional insecurity" will occur when the anomalies become serious problems, characterised by increasingly radical solution efforts from the normal scientists of the paradigm. These efforts result in the rules for solving problems within the paradigm becoming vaguer and deepen the state of crisis, ending in the appearance of a competitive and alternative paradigm. It is completely different and inconsistent with the previous one in the context that all the unsolved questions from the previous paradigm are perceived as legitimate or meaningful. In the stage of competition between two paradigms there is no logical binding argument for a researcher to abandon one paradigm for another. As the crisis in a paradigm deepens due to the existence of a competitive paradigm, the final revolutionary phase of Kuhn's structure model begins.

This revolutionary phase is characterised by a crisis period of a certain duration during which an anomaly or several anomalies in research reveal weaknesses or incompatibilities in the research paradigm. This period of crisis may go on repeatedly even though it is not always good for a science to shift often or easily within paradigms (Kuhn, 1996; Chalmers, 1999). However, scientific revolutions do occur and succeed. Kuhn compares scientific revolutions with gestalt physiological transitions, religious conversions and political revolutions, and suggests that different people's ideas will be approved (Kuhn, 1996; Chalmers, 1999, Swayne, 2008). This is a also one of the difficulties with paradigm shifts, since shifting between paradigms is not just intellectual but also involves changing hearts and minds at the same time.

Paradigm theories are not only general and global by nature, a characteristic highlighted by Feyerabend who describes them as non-instantial (Feyerabend, 1977), by Laudan who describes them as maxi and global (Laudan, 1977), and by Hung who classifies them as "generic" (Hung, 1997; 2001), but they are also criticised. One reason for the criticism of Kuhn's paradigm concept is that his theories have always been contentious and perplexing. Among the critics are Sharpere and Masterman (Hung, 2001), and especially Popper, who favours a more open approach than Kuhn (Swayne, 2008). Moreover, compared with Kuhn's theories of scientific paradigms, Popper claims that "a genuine commitment to the truth gives scientists the courage to challenge the truth of particular theories, including the ones associated with a scientific paradigm" (Popper, 2002). According to Popper, scientists should do this by putting their theories to test in experiments in a similar way as politicians put their policies to test during elections, meaning that scientists must challenge and change their minds concerning scientific principles when the evidence requires it. This means that a scientific hypothesis has to be stated in a manner so it can be falsified by an experiment. For testing any type of scientific theory, Popper introduced the concept of "falsifiability" (Popper, 2002). However, both Popper and Kuhn agree that certain scientific theories can be falsified while generic theories such as Einstein's, Newton's and Aristotle's cannot, according to Kuhn (Hung, 2001).

Additionally, Kuhn's and Popper's theories are commented on by the philosopher Fueller, who states that scientist are not mentally flexible and scientific revolutions arise because "argumentation in science does more to sway uncommitted spectators...than to change the minds of the scientific principles themselves" (Swayne, 2008). Popper's theory that scientists should put their theories to experimental test is commented on by Fueller as being something that marks the distance between normal science and actual scientific practice (Fueller, 2004). Kuhn's theories of paradigm and paradigm shifts are also commented on by Hacking who points out that Kuhn has two definitions of a paradigm: 1) paradigm-as-achievement and 2) paradigm-as-set-of-shared-values. These are evaluated by Hacking, according to scientific rationality, indicating that there is nothing in Kuhn's paradigm idea that speaks against scientific rationality. Hacking further comments that it is Kuhn's concepts about shifts in paradigms that threaten scientific rationality because the gestalt switches in the concepts do not include any necessary reasoning (Hacking, 1983).

In response to the later criticism of his scientific structure model, Kuhn explained that the paradigm term represented two different concepts – "exemplar" and "disciplinary matrix" – in which the core of paradigm theory lies in the former.

In responding to criticism, Kuhn also comments that normal science and revolutions are necessary functions, among similar ones, which are used for the description of functions within scientific components. Other similar functions mentioned by Kuhn are: a) periods of normal science during which the researchers have the opportunity to develop the esoteric details in their own theories, b) when the credence of their own paradigm generates energy to solve intricate questions in the paradigm instead of discussing methods and assumptions among researchers, and c) when science is a tool in the revolutionary function of leaving one paradigm for another (Kuhn, 1996).

3.2 Definitions of paradigm

Concepts are dependent on the structure of the theory in which they exist and can be made believable if the limitations in other alternatives in which a concept is perceived are highlighted. One such alternative is that concepts acquire a purpose by means of a definition (Chalmers, 1999). Additionally, a concept is created from an initial vague thought which is gradually clarified as the concept's theory develops.

The word "paradigm" comes from ancient Greek and thanks to the scientist Thomas Kuhn has become a vogue word that is not easily defined. Vafidis (2007) mentions that there are more than 50 definitions that are related to the original source. This is also supported by Hacking in the book, Representing and Intervening – Introductory Topics in the Philosophy of Natural Science, where he states that Kuhn uses the term "paradigm" in no more than 22 different ways in his book, The Structure of Scientific Revolutions (Hacking, 1983). This criticism of Kuhn's interpretation of the paradigm concept is also confirmed by Chalmers who states that Kuhn does not provide an exact definition of the concept (Chalmers, 1999).

However, one explanation for this is that Kuhn, when using the paradigm term, was rather unclear about what components a paradigm should consist of, and how the definition should be used when interpreting the scientific process of knowledge (Arbnor and Bjerke, 1994).

Another explanation is that Kuhn saw difficulties in the processes of creating a new paradigm, if it was created for the explanation of a phenomenon. Quoting Kuhn:

> "The man who embraces a new paradigm at an early stage must often do so in defiance of the evidence provided by problem solving" (Natoli and Hutcheon, 1993, p. 386).

Examining other definitions of paradigms will not only show that different definitions of the word exist, but also the difficulties of grasping the concept of paradigms. Burrel and Morgan (1979) define paradigms as:

> "…very basic meta-theoretical assumptions which underwrite the frame of reference, mode of theorising and modus operandi of social theorists who operate within them" (Burrell and Morgan, 1979, pp. 23-24).

While Vafidis (2007), whose definition is strongly linked to Thomas Kuhn's ideas, provides the following definition:

> "In the principle, paradigms mean fundamentally different approaches to research, making it possible to communicate research results to representatives of competing paradigms. Paradigms are characteristics of a mature discipline, in which one paradigm is seen as a superior approach to the discipline and becomes dominant" (Vafidis, 2007, p.25).

Vafidis' definition is completely in line with Hacking's opinion that, "We might like to compare the merits of an old paradigm with those of a successor" (Hacking, 1983, p.12). On the contrary, Vafidis' definition contradicts Hacking's opinion of paradigms. This is because there are no logical arguments that show why one paradigm is superior to another, which would force a scientist to shift paradigms because: 1) it would be impossible for a scientist to evaluate all the benefit factors of a scientific theory; 2) scientists of competing paradigms use different norms and metaphysical principles. This means that scientists of competing paradigms see the world differently and describe it using different languages.

Finally Arbnor and Bjerke (1997) see paradigms as:

> ". . . the bridge between the starting points of ultimate presumptions and of methodological approaches" (Abnor and Bjerke, 1997, p. 12)

This above definition is based on the scientific theorist Törnblom's (1974) evolutionary view model when defining the components (i.e. conception of reality, conception of science, scientific ideas, ethical/ aesthetical aspects) (Arbnor and Bjerke, 1997). However, the definition is mainly applicable in a practical deductive research perspective, but is difficult to apply to a hypothetical deductive one. Thus the definition supports Hacking's perceptions of science, since according to him, science "is not hypothetico-deductive" (Hacking, 1983).

Arbnor and Bjerke also suggest the consistence of an operative paradigm, defined as:
" …methodological approach to a specific area of study" … which should consist of "two important parts: methodological procedure and methodic" (Abnor and Bjerke, 1997 p.16).
Other definitions of paradigms which ought to be mentioned are "a paradigm acts like a cultural grid or filter" (Burke, 2008, p. 244), "...paradigm which is defined as standard case, archetypal pattern, or central reference configuration" (Quinn, 2001, p. 31) and
"... a mindset that determines, and restricts, the direction in which scientific thinking and investigation are allowed to progress" (Swayne, 2008, p. 90). What is common with these definitions is that they all describe the paradigm concept from a commensurable view (i.e. "a

grid", "a pattern", or a "mindset" are all words describing a paradigm as a "unity" within science). The many definitions of the term "paradigm" show, however, that the term is difficult to interpret in relation to incommensurability, a concept which was important for Kuhn since it concerns scientific methods and concepts (Hoyningen-Huene, 1990).

3.3 New paradigm business thinking

A concept which has caused a great deal of discussion and which is still in its early stages in business is "new paradigm business thinking" (Giacalone and Eylon, 2000). This is characterised by scientific theories and approaches that are formulated according to terms which previously were considered as unscientific and were rejected.

New paradigm thinking is characterised by a combination of ideas from different scientific disciplines: religion, biology, psychology, ecological studies, futurism, physics, and systems theory (Giacalone and Eylon, 2000). This brings different modes of knowing such as cognitive thought, emotional understanding, and intuitive recognition together with thoughts of understanding (i.e. sum of all parts vs. parts), which creates a more uniform and holistic view of reality using a collaborative, integrative, system view (Senge, 1990). Furthermore, new paradigm thinking includes a critical approach to previously accepted methodological and philosophical assumptions, and has a clear rejection of materialistic values. It tries to identify enough views of exploration for creation of understanding, building on the contributions, learning and methods from a variety of sources.

Giacalone and Eylon (2000) grouped the transforming assumptions of new paradigm thinking into three categories:

1. Individual transformation: Changes in individual assumptions among theorists who are striving to balance individual and community needs (which according to Kuhn can undermine an existing paradigm). These changes reflect shifts in how individuals interact and react to their environment when preparing for the future. The changes are also characterised by an acceptance of qualitative data, spiritual/ intuitive data and holistic approaches.

2. Social-ecological transformation: Changes in social and/ or ecological domain including societal expectations of change (opposite stability), need for learning (instead of blaming), seeking co-operation and win-win outcomes, an apparent timeline and efforts in changing others' views into a view of unity and inclusion. Social – ecological transformation is also characterised by the attempt from society to live in harmony with the environment due to a new perspective on resource usage.

3. Business transformation: Changes in how business function is valued in relation to social changes. These changes include economic balance, work life quality, social responsibility, and a change in gains from an individual to a group perspective.

The driving forces of new paradigm thinking in business are either profit or moral beliefs.

Based on these, Giacalone and Eylon mention four different types of new paradigm leaders; New Paradigm Darwinists, New Paradigm Pragmatists, New Paradigm Missionaries, and New Paradigm Humanitarians, see Figure 1.

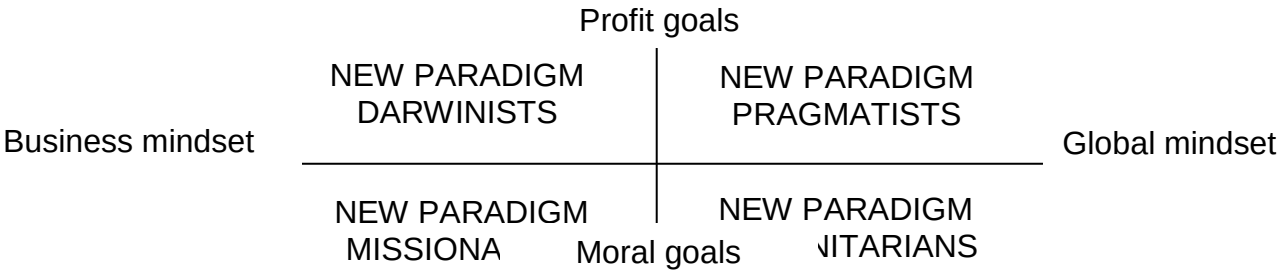

Figure 1 – Driving forces in new paradigm thinking (Giacalone and Eylon, 2000, p. 1223).

New Paradigm Darwinists are driven by profit and efficiency for organisation expansion and sees new paradigm theories as operational changes to increase organisational profit and efficiency. New Paradigm Pragmatists are driven by profit and efficiency using a global focus on resources and recognising the interconnections between issues in social and ecological business. New paradigm theories are for understanding the interconnectedness and interdependence in the world. New Paradigm Missionaries, however, are driven by the effort to improve the quality of work life and to educate others about organisational environmental responsibility. New Paradigm Humanitarians are driven by a moral desire to improve the world from a larger perspective (building a better world vs. building better business). New Paradigm Humanitarians use new paradigm theories in relation to global uniformity despite differences and borders (cultural, national, economical, ethnic and religious) which separate people. (Giacalone and Eylon, 2000).

3.4 Representational spaces

Theories in science can either be scientific or general; a theoretical scientist's aim is to correct the representation of reality. This representation takes place in two steps: 1) the construction of a generic theory or a representational space, and 2) the modelling of reality aspects by construction of theories in the representational space. A representational space is formed if the properties and interrelationships between members are interpreted in terms of the properties and relationships between the members of a system (Hung, 2001).

In scientific theory, representational spaces are interpreted as structures that provide a set of related possibilities or instruments of the mind for the explanation of reality and activities. According to Hung (2001), there are two main categories of representational spaces: a) physical representational spaces, which are characterised by the structure of the physical object, and b) symbolic representational spaces, which consist of axiomatic representational spaces (including axiomatically defined structures) and generated representational spaces (with no need of axiomatic presentation).

Furthermore, changes between different representational spaces are either theoretic developments (depending on reduction and expansion of theories) or theoretic innovations, (depending on replacement or reorganisation of theories) (Hung, 2001). Representational spaces can hence be used for:

1. Explanation of anomalies, because a representational space is neither a uniform, nor a systematic set of possibilities.

2. Explanation of regularities, because a representational space allows exceptions in explaining the replacement of one representational space with another one, viewing the regularities from the former in terms of necessities for the latter. Because of this, representational spaces are laws of nature in a similar way as laws of nature are logical consequences of representational spaces.

3. Explanation of irregularities, because irregularities in data in one representational space are seen as projection images of events of an occurring new representational space.

The theory of representational spaces is also regulated by the following three laws: 1) law-like statements that are logic statements deduced from a given representational space, 2) potential laws that are law-like statements with an empirically sufficient base, and 3) laws that are potential laws based on a representation of a real representational space.

3.5 Incommensurability

"Incommensurability" means that terms or statements of one paradigm cannot be translated into terms and statements of another. Kuhn points out that incommensurability is partial or local in his last explanation of the term, and that only specific terms and statements can be transferred between paradigms. Quoting Kuhn:

> "My claim has been that key statements of an older science, including some that would ordinarily be considered merely descriptive, cannot be rendered in the language of a later science and vice versa. By the language of a science I here mean not only the parts of that language in actual use but also all extensions that can be incorporated in that language without altering components already in place" (Kuhn, 2000, p. 55).

The terms of a paradigm do not only, according to Kuhn, form a multidimensional lexical network (Kuhn, 2000, p. 55), but also depend on their position within the network (in addition

to their relationship to experience and the world). The translation of terms within the lexical framework must be homogenous with the network that formed the original terms, implying that any faithful translation of a term will maintain the structure of the multidimensional lexical network. Terms such as “mass” and “force” in Newtonian mechanics, for instance, cannot be translated into terms used in relativity since these terms are members of the lexical network of Newton’s Second Law of Motion which is not applicable to the Theory of Relativity (Hung, 2001). This thought is supported by Hacking who states that “We can pass from one world or language to another by a gestalt-switch, but not by any process of understanding” (Hacking, 1983, p. 66). Hacking also classifies the word “incommensurable” into the following three categories:

1. Topic incommensurability: a successor theory may simply have forgotten successes from an older theory at the same time as it attacks different problems, uses new concepts and applications.

2. Dissociation: shifts in theory may make an older theory unintelligible to a later audience or to anyone who is willing to spend time leaning it.

3. Meaning incommensurability: philosophical meaning of terms for description of theoretical unobservable units (i.e. how theoretical units and processes get their meaning). (Hacking, 1983, pp. 67-74).

Kuhn’s objective to incommensurability partly supports Wittgenstein’s theories of the usage of language and paradigm (Kuhn, 1979). For Wittgenstein the meaning of a word is defined by its use in language (Wittgenstein, 1921, p. 43), which is full of mysterious concepts that cannot be bound by logical statements depending on referential objects.

4. EMPIRICAL FINDINGS

4.1 Definitions of Food supply chain traceability

Efforts in analysing the term “traceability” have previously been performed, resulting in the conclusion that there is a lack of common understanding of the term (Dorp, 2002; Lindh, 2009). What these efforts share in common is that the traceability concept has been examined though the analyses of the terms “track” and “trace”, which in the literature also are considered to be the main functions in supply chain traceability (Schwägele, 2005). Table 1 lists some existing definitions of the term “traceability” used in food supply chains.

Table 1 – Definitions of food supply chain traceability.

Number	Author/ organisation	Definition
1	European Union (1998), REGULATION (EC) No. 178/2002 Article 3 §15.	"'Traceability' means the ability to trace and follow a food, feed, food-producing animal or substance intended to be, or expected to be incorporated into a food or feed, through all stages of production, processing and distribution".
2	Liu and Ólafsdóttir, (2002).	"Traceability concerns only the ability to trace things, which means that the necessary information must be available when required" (Liu and Ólafsdóttir, 2002, p.11).
3	International Standards Organisation (ISO) (1994) ISO Quality Standards 8402:1994.	"The ability to trace the history, application or location of an entity by means of recorded information" (Folinas, 2006, p. 623).
4	International Standards Organisation (ISO) (2007) ISO Farm to Fork Traceability-ISO 22000.	"The ability to trace the history, application or location of that which is under consideration", and "When considering a product, traceability can relate to the origin of materials and parts, the processing history, and the distribution and location of the product after delivery" (Srinivasan, 2007).
5	International Standards Organisation (ISO) (2000), ISO 9001:2000, clause 3.5.4.	"The ability to trace the history, application or location of that which is under consideration" (Thompson, Sylvia, and Morrissey, 2005. p.1).
6	United Nations, Joint FAO/WHO Food Standards Programme (2007). Codex Alimentarius - Food Import and Export Inspection and Certification Systems.	"The ability to follow the movement of a food through specified stage(s) of production, processing and distribution" (World Health Organisation and Food and Agriculture Organisation of the United Nations, 2007. p.79).
7	Moe (1998).	"Traceability is the ability to track a product batch and its history through the whole, or part, of a production chain from harvest through transport, storage, processing, distribution and sales (hereafter called chain traceability) or internally in one of the steps in the chain for example the production step (hereafter called internal traceability)" (Moe, 1998. p. 211).
8	Wilson and Clarke (1998).	"Food traceability can be defined as that information necessary to describe the production history of a food crop, and any subsequent transformations or processes that the crop might be subject to on its journey from the grower to the consumer's plate" (Wilson and Clarke, 1998. p. 128).
9	Lindh (2009).	"The ability to identify history, origin, location or attributes, of an item or group of items through records held".

An examination of the above definitions of traceability in food supply chains in terms of incommensurability reveals that almost all definitions are commensurable since they include the word “ability” (except number 8), six include the word “history” (numbers 3, 4, 5, 7, 8 and 9), and definitions 1-5 use the word “trace”. This indicates that there is a uniform lexical framework for the paradigm in which food supply chain traceability exists. However, examining the definitions using topic incommensurability highlights that traceability is a multidisciplinary concept related to other disciplines such as supply chain management, production (due to the terms “production”, “product”, “distribution”, “process” in definitions 1, 4, 7, 8 and 6) and information technology (due to the terms “information” in definitions 2, 3 and 8 and “record” in 9).

Food supply chain traceability can hence be defined as “the ability to trace the history of application, information or location of a product or group of products through all stages of production, processes and distribution”. This definition also supports the conclusion that food supply chain traceability includes different objectives and perspectives, ranging from supply chain management, business, logistics to communication.

4.2 Perspectives of food supply chain traceability

Food supply chain traceability is now a matter of concern for suppliers, producers, customers and authorities. Recent outbreaks of diseases such as the bovine spongiform encephalitis (BSE) and food-and-mouth disease (Regattieri et al., 2006; Folinas et al., 2006), and discussions concerning gene-manipulated food (GMO) (Opara, 2003), the utilisation of living resources, food scandals and the increase in demands for product recalls (Senneset et al., 2007) have forced the commercial and industrial markets to build up food infrastructures for production, processing and delivering of food in which the information is traceable and controllable at each link (Furness and Osman, 2003). This resource of information has according to Coff et al. (2008) five objectives: 1) risk management and food safety, 2) control and verification, 3) supply chain management and efficiency, provenance and quality assurance of products, and 5) information and communication to customers (Coff et al., 2008). Related to these five objectives of food supply chain traceability are the different perspectives that each company or organisation has to take to achieve traceability. Different perspectives on traceability in supply chains have been studied by Van Dorp (2002) by using a business scope on tracking and tracing and proposing the following four perspectives:

- The enterprise perspective: views tracking and tracing of products due to manufacturing.

- The multi-site perspective: views tracking and tracing issues for companies with several plants or manufacturers.

- The supply chain perspective: views tracking and tracing issues due to a holistic and integrative supply chain approach, which includes planning and control of materials, and efficient information flow through the complete supply chain.

- The external environment perspective: views issues for tracking and tracing of products due to existing regulations for traceability that authorities, organisations, and companies have to follow.

However, analysing different perspectives on food supply chain traceability in relation to the objectives and concerning fulfilment of food supply chain traceability reveals that the perspectives are to be extended into the following eight categories.

- Safety and risk management
- Quality
- Information technology
- Governmental
- Business
- Logistics
- Environmental
- Ethical

Table 2 shows the objectives and the different aspects in each perspective of food supply traceability found in the literature reviews.

Table 2 – Objectives, perspectives and aspects of food supply chain traceability.

OBJECTIVE according to Coff et al. (2008)	**PERSPECTIVE**		**LITERATURE**
	Perspective	**Aspect**	
Risk manage-ment and food safety	Safety	Health risks measurement and control	Trade secrets: remaining and mislabeling of seafood (Jacquet and Pauly, 2007), Traceability in agriculture and food supply chain: a review of basic concepts, technological implications and future prospects (Opara, 2002). Traceability system in a Danish domestic fresh fish chain (Frederiksen et al., 2002). Perspectives on traceability and BSE testing in U.S beef industry (Bailey et al., 2005). Traceability from a European perspective (Schwägele, 2005). One ingredient in a safe and efficient food supply (Golan et al., 2004). Traceability of foods and foodborne hazards (Aarnisalo et al., 2007). Traceability as a key instrument towards supply chain and quality management in the Belgian poultry meat chain (Viaene and Verbeke, 1998). Fuzzy traceability: a process simulation derived extension of the traceability concept in continuous food processing (Skoglund and Dejmel, 2007).
	Quality	Control	Value added on food traceability: a supply management approach (Wang and Li, 2006). One ingredient in a safe and efficient food supply (Golan et al., 2004). Traceability as a key instrument towards supply chain and quality management in the Belgian poultry meat chain (Viaene and Verbeke, 1998). Risk management and quality assurance through the Food supply chain – case studies in the Swedish food industry (Olsson and Skjöldebrand, 2008).
Control and verification	Information technical	Data capture	Traceability data management for food chains (Folinas et al., 2006). Developing traceability systems across the supply chain (Furness and Osman, 2003). Traceability system in a Danish domestic fresh fish Chain (Frederiksen et al., 2002). Traceability from a European perspective (Schwägele, 2005).
		Labelling	A RFID-enabled traceability system for the supply chain of live fish (Hsu et al., 2008). Trade secrets: remaining and mislabeling of seafood (Jacquet and Pauly, 2007). Challenges regarding implementation of electronic chain traceability (Senneset et al., 2007). Developing traceability systems across the supply chain (Furness and Osman, 2003). Traceability system in a Danish domestic fresh fish Chain (Frederiksen et al., 2002). Traceability of foods and foodborne hazards (Aarnisalo et al., 2007). Radio frequency identification and food retailing in the UK (Jones et al., 2005). RFID-enabled traceability in food supply chain (Kelepouris et al., 2007).

Control and verification	Information technical	Connectivity/ integration	Food product traceability and supply network integration (Engelseth, 2009), A RFID-enabled traceability system for the supply chain of live fish (Hsu et al., 2008). Seafood traceability in the United States: current trends, system design and potential applications (Thompson et al., 2005). Traceability data management for food chains (Folinas et al., 2006). Traceability in agriculture and food supply chain: a review of basic concepts, technological implications and future prospects (Opara, 2002). Developing traceability systems across the supply chain (Furness and Osman, 2003). Traceability of food products: general framework and experimental evidence (Regattieri et al., 2007). Traceability system in a Danish domestic fresh fish chain (Frederiksen et al., 2002). Improving information exchange in the chicken processing sector using standardised data lists (Donelly et al., 2009). Tracking and tracing: principles and practice (Stefansson and Tilanus, 1998). A general framework for food traceability (Bechini et al., 2005). The consequences of voluntary traceability system for supply chain relationships. An application of transaction cost economics (Banterle and Stranieri, 2008).
	Govern-mental	Legislative and regulative	Seafood traceability in the United States: current trends, system design and potential applications (Thompson et al., 2005). Trade secrets: remaining and mislabeling of seafood (Jacquet and Pauly, 2007). Challenges regarding implementation of electronic chain traceability (Senneset et al., 2007). Developing traceability systems across the supply chain (Furness and Osman, 2003). Traceability of food products: general framework and experimental evidence (Regattieri et al., 2007). Tracking and tracing a structure for development and contemporary practices (Dorp, 2002). Traceability from a European perspective (Schwägele, 2005). Traceability of foods and foodborne hazards (Aarnisalo et al., 2007).
Supply chain management and efficiency	Business	Economic	Trade secrets: remaining and mislabeling of seafood (Jacquet and Pauly, 2007). Perspectives on traceability and BSE testing in U.S beef industry (Bailey et al., 2005). A transaction cost analysis of quality, traceability and animal welfare issues in UK beef retailing (Hobbs, 1996). The consequences of voluntary traceability system for supply chain relationships. An application of transaction cost economics (Banterle and Stranieri, 2008).
		Enterprise	Tracking and tracing a structure for development and contemporary practices (Dorp, 2002). Buyer-supplier relationship's influence on traceability implementation in the vegetable industry (Alfaro and Rábade, 2006).
		Multisite	Tracking and tracing a structure for development and contemporary practices (Dorp, 2002). Buyer-supplier relationship's influence on traceability implementation in the vegetable industry (Alfaro and Rábade, 2006).

Supply chain manage-ment and efficiency	Business	Legislative and regulative	Seafood traceability in the United States: current trends, system design and potential applications (Thompson et al., 2005). Challenges regarding implementation of electronic chain traceability (Senneset et al., 2007). Developing traceability systems across the supply chain (Furness and Osman, 2003). Traceability of food products: general framework and experimental evidence (Regattieri et al., 2007). Tracking and tracing a structure for development and contemporary practices (Dorp, 2002). Traceability from a European perspective (Schwägele, 2005). Traceability of foods and foodborne hazards (Aarnisalo et al., 2007).
	Logistics	Efficiency	Tracking and tracing a structure for development and contemporary practices (Dorp, 2002). Value added on food traceability: a supply management approach (Wang and Li, 2006). Perspectives on traceability in food manufacture (Moe, 1998). One ingredient in a safe and efficient food supply (Golan et al., 2004), Traceability in the fish supply chain – evaluating two supply chain mapping techniques (Ringsberg and Lumsden, 2009). Tracking and tracing: principles and practice (Stefansson and Tilanus, 1998). Buyer-supplier relationship's influence on traceability implementation in the vegetable industry (Alfaro and Rábade, 2006). RFID-enabled traceability in food supply chain (Kelepouris et al., 2007). Fuzzy traceability: a process simulation derived extension of the traceability concept in continuous food processing (Skoglund and Dejmel, 2007). Risk management and quality assurance through the food supply chain – case studies in the Swedish food industry (Olsson and Skjöldebrand, 2008).
		Benefits	Value added on food traceability: a supply management approach (Wang and Li, 2006). Perspectives on traceability in food manufacture (Moe, 1998).Traceability of foods and foodborne hazards (Aarnisalo et al., 2007).
Supply chain manageme nt and efficiency	Information technical	Connectivity/ integration	Food product traceability and supply network integration (Engelseth, 2009).). Traceability data management for food chains (Folinas et al., 2006). Seafood traceability in the United States: current trends, system design and potential applications (Thompson et al., 2005). A RFID-enabled traceability system for the supply chain of live fish (Hsu et al., 2008). Challenges regarding implementation of electronic chain traceability (Senneset et al., 2007). Developing traceability systems across the supply chain (Furness and Osman, 2003). Traceability of food products: General framework and experimental evidence (Regattieri et al., 2007). Value added on food traceability: a supply management approach (Wang and Li, 2006). Traceability from a European perspective (Schwägele, 2005). Improving Information exchange in the chicken processing sector using standardised Data Lists (Donelly et al., 2009).). Value Added on Food Traceability: a supply management approach (Wang and Li, 2006). Traceability in the fish supply chain – evaluating two supply chain mapping techniques (Ringsberg and Lumsden, 2009). A general framework for food traceability (Bechini et al., 2005). RFID-enabled traceability in food supply chain (Kelepouris et al., 2007).
Provenance and quality assurance of products	Environ-mental	Resource loss	Trade secrets: remaining and mislabeling of seafood (Jacquet and Pauly, 2007).
		Legal and regulative	Tracking and tracing a structure for development and contemporary practices (Dorp, 2002). Ethical rooms for maneuvre and their prospects vis-á-vis the current ethical food policies in Europe (Korthals, 2008).

Information and communication to the customer	Environ-mental	Costumer trust	Trade secrets: remaining and mislabeling of seafood (Jacquet and Pauly, 2007).
	Ethical	Costumer trust	Food product traceability and supply network integration (Engelseth, 2009).). Ethical traceability and informed food choice (Coff et al., 2008). A transaction cost analysis of quality, traceability and animal welfare issues in UK beef retailing (Hobbs, 1996). Ethical rooms for maneuvre and their prospects vis-á-vis the current ethical food policies in Europe (Korthals, 2008). Risk management and quality assurance through the food supply chain – case studies in the Swedish food industry (Olsson and Skjöldebrand, 2008). Ethical challenges for livestock production: meeting consumer concerns about meta safety and animal welfare (Verbeke and Viaene, 2000).

Analysing food supply chain traceability from different perspectives shows that most of the articles published have an information technical perspective and that most of them also cover several different perspectives. The analysis further shows that the perspectives least yet explored are the environmental and the ethical ones in the objectives for “Provenance and quality assurance of products” and “Information and communication to the customer”.

One additional finding of the literature review on perspectives of food supply chain traceability is that the concept needs to be analysed from a theoretical perspective. This is because food supply chain traceability is multidisciplinary between several scientific paradigms, which sometimes make the concept difficult to understand and use.

Analysing food supply chain traceability from a scientific theoretical perspective also shows the ability to classify traceability as new paradigm according to new paradigm thinking in business. Some similarities are: a) traceability, as in new paradigm thinking characterised by a combination of different ideas from different scientific disciplines, b) traceability based on a uniform and holistic view of reality using a collaborative, integrative, system view, c) the incentives behind food supply chain traceability are either profit, moral but also a combination of values, and d) the traceability concept has similarities with several of the categories of new paradigm business thinking (traceability researchers strives to balance community needs, seeking co-operation and win-win solutions, live in harmony with the environment, economical balance). However, it should be noted that it is important to identify if the primary motivation is profit or moral values when determining if new paradigm concepts should be considered for food supply chain traceability. An additional, but more general, similarity between new paradigm thinking and traceability is that traceability as thought in new paradigm business thinking is a relatively young and immature concept which is difficult to define. Kuhn’s paradigm theories are because of this much better to understand as schematic theories for structuring subjects in science ranging from atoms, laws of mass and force, and even including supply chain management.

However, the motivation for using new paradigm thinking varies also significantly among business leaders, in terms of consistency of application as well as loyalty to new paradigm values and thinking. For example, New Paradigm Darwinists and Pragmatists are more

focused on profit and efficiency which make them less loyal to issues which are not profitable. This shows an inconsistency within new paradigm thinking which should not be accepted by Kuhn due to his definition of a normal scientist. New paradigm thinking in business does not meet Kuhn's criterion that there is no need to repeatedly clarify and justify basic principles and assumptions of one paradigm since these are simply taken for granted by anyone who supports the paradigm (Kuhn, 1970 p.19). This is because new paradigm thinking in business formulates scientific theories and approaches in terms which previously have been considered as unscientific and or rejected.

Finally, since the terms used in definitions of food supply chain traceability are commensurable, viewing the lack in incommensurability between food supply traceability and other existing and related paradigms, food supply chain traceability should not be treated as a new paradigm in business. This since incommensurability between paradigms is an essential concept when treating a science as a paradigm. One suggestion is instead that it should be treated as a physical representational space; a) food supply chain traceability be seen as a set of related possibilities for an explanation of reality and activities, and, b) is formed when the properties and the interrelationships between members are interpreted in terms of the properties and relationships between members of a bigger food supply chain system. Treating food supply chain traceability as a representational space in scientific theory would also help scientists to explain and resist anomalies from other sciences which attack the theoretical foundations.

5. CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

This paper explores different perspectives of food supply chain traceability. It examines the concept from a scientific theoretical perspective by analysing different definitions of food supply chain traceability in relation to incommensurability. This concept is especially essential in scientific theory when definitions are analysed, since every paradigm consists of its own lexical multidimensional lexical network (Kuhn, 2000 p. 55). Based on the analysis of food supply chain traceability due to incommensurability, a new definition was formed defining food supply chain traceability as:

> The ability to trace the history of application, information or location of a product or group of products through all stages of production, processes and distribution.

Secondly, the paper further positions food supply chain traceability theoretically by showing that the concept should be interpreted as a "representational space", rather than a new paradigm within "new paradigm thinking in business" within science. This is because food supply chain traceability is a multidisciplinary discipline between several paradigms with relations and terms from several other scientific disciplines and or paradigms. However, one

additional finding related to the scientific analysis is that food supply chain traceability sometimes, as the paradigm concept, is difficult to understand, define, explain and use.

Finally, the paper identifies eight different perspectives of food supply chain traceability (except from the theoretical science perspective above) related to the different objectives found for improvement of traceability by Coff (Coff et al., 2008): safety, quality, information technical, governmental, business, logistics, environmental and ethical. This analysis also includes the conclusion that the perspectives in food supply chain traceability least explored are the environmental and ethical in the objectives "Provenance and quality assurance of products" and "Information and communication to the customer", leaving these objectives as a suggestions for further research.

The results of this paper are useful for practitioners' as well as supply chain researchers since they explain and position the concept of food supply chain traceability from a scientific perspective in a new unique way, and identify different perspectives in relation to the objectives found. The paper provides an extended understanding of the concept and of different perspectives which should influence the development of future supply chain traceability setups especially from societal perspectives.

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