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## UNDERSTANDING TRACEABILITY AS AN ACTOR-NETWORK

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### **Abstract**

*Food poisoning, product recall, anti-counterfeiting, identity control... traceability is often presented as a system to resolve crisis in Supply Chain Management. Adopting a different approach, this paper analyses Traceability as innovation and then adopts the Actor-Network Theory as the original theoretical view.*

**Key Words:** Traceability, Actor-Network Theory, Strategic analysis, IS Research Methodology

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### Abstract

*Food poisoning, product recall, anti-counterfeiting, identity control... traceability is often presented as a system to resolve crisis in Supply Chain Management. Adopting a different approach, this paper analyses Traceability as innovation and then adopts the Actor-Network Theory as the original theoretical view.*

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### 1. Introduction

Much-publicized by the recent successive health crises (BSE, hysteria, dioxins, etc.), traceability has become a concept familiar to the consumers that we are. The term traceability is so widely used now that it is hard to believe that it is a recent term: it was only included in dictionaries from 1994. Even though traceability has existed for a long time in business, this technique is becoming greatly important in recent years with the vast developments made in the field of information and communications technology. Traceability systems are gradually developed within this context and becoming veritable company management tools (Fabbe-Costes and Lemaire, 2001 [6]).

The research work on traceability remains limited. It is spread out among many different fields (sociology, law, industrial economy, logistics, etc.) and there seems to be certain confusion regarding the concept. As soon as a problem arises, traceability is put forward, not only in the field of agribusiness but in many others as well: airport identity checks using biometric passports, electronic bracelets for prisoners used as a solution to prison over population, footballs equipped with radio frequency chips to reduce referee errors, etc.

The goal of this paper is to answer the following questions: What is traceability? What is a traceability system? And how is it a new management system for companies? The first section deals with defining the different aspects of traceability in order to better understand, in the second section, the different languages of traceability in an organisation.

### 2. DEFINITION OF THE DIFFERENT ASPECTS OF TRACEABILITY...

The concept of traceability requires academic consideration and so we must attempt to cover the horizon of definitions and the concept issues.

#### 2.1 The three objectives of traceability: people, goods and processes.

Firstly, a distinction must be made regarding the traceability of people and the traceability of objects. If the first form of traceability has always existed (civil status, social security number, passport etc.) the second is more recent and is linked to liberalization and the internationalisation of trade: traceability represents a government technique for both people and objects that has been applied to other techniques (isolation, quarantine...) "in order to maintain or improve health safety within the vast network of

economic production and distribution". It is therefore no great surprise when we hear traceability being applied to people in current affairs (the human form of avian influenza, biometric passports, electronic bracelets etc.).

The first forms of object traceability appeared in high risk areas or those related to state security: aeronautics, nuclear, weapons. This coincides with the work of Viruega (2005 [16]), which observes 3 defined periods in the evolution of traceability: its beginnings in the meteorology field in the 1960's (more precisely, in military manuals defining the best measurement practices), its development in the field of quality assurance and the media coverage provided during the BSE (mad cow disease) crisis. It was in fact the field of quality assurance that provided the initial definition of traceability with the ISO 8402 standard in 1994: "*The traceability of a product is the ability to discover the history, location or use of a product by using a recorded identification.*" It is true that if traceability is more than just a crisis management tool, as discussed later, we must admit that the different health crises gave media coverage to this concept while only focusing on its relevance in case of product removal or recall. This is a rather simplistic view given that traceability now represents an entire sector of activity holding annual trade fares in every country. The advent of traceability as an activity sector is closely linked to the recent progress in information and communication technologies.

A rapid linguistic analysis of the word itself reveals it to be simply contraction of the words *trace* and *ability/capability*. Thus traceability is literally "the ability to trace". Behind this idea of ability there is the idea that it is not enough to simply to trace products but that capabilities must be put in place to successfully implement traceability. Obviously traceability does not consist only of labelling a product. The information on this label must be processed and understood. Because, according to Hermitte (2003 [8]), "*In order to speak of traceability, three elements must be united: there must be traces and therefore a system that can be used to identify them; there must be a mechanism to collect these traces; finally, there must be a structure that can be used to process them and to analyse them in order to make conclusions. Without this type of organization, which requires a certain degree of will, traces exist but not traceability.*"

Once the idea that traceability requires an adapted organisation has been accepted, the two functions of traceability applied to objects must be distinguished; many logistics research projects prefer to dissociate *tracking* and *tracing* (Fabbe-Costes and Sirjean, 1997 [4], Fabbe-Costes 1998 [5], Fabbe-Costes and Lemaire 2001[6]). The *tracking* function consists of been able to locate a product on the distribution chain, while *tracing* may be used to obtain information regarding the manufacturing history of the product (materials, transformations, etc.) In order to dissociate these two forms of traceability they could be called logistic traceability and product traceability. We could say that the *tracking* function is a central logistics issue "which has always included a principle of traceability" (Fabbe-Costes et Lemaire, 2001[6]). On the other hand, consideration of the *tracing* function is more recent and is closely linked to the development of technology used to record product manufacturing information in real time.

The *tracing* function allowed for the development of a third form of traceability called activity traceability whereby not only products are traced but also their manufacturing processes. The information collected in this manner, or activity traces, can be extremely useful to the different services of a company, Fabbe-Costes (1998 [5]) even considered them as useful for strategic decision processes.

Therefore when speaking about traceability, a distinction must be made between the traceability of people, the traceability of objects (or goods) and activity traceability.

## **2.2 Three issues of traceability: security, counterfeiting and customer relationship.**

Having defined traceability, we must set out the issues. The main issues linked to traceability are thus the general obligations (for example, as defined by the European Union), the growth of counterfeiting and the black markets and consumer information demand.

For example, the regulation EC n°178/2002, which came into effect on the 1st of January 2005, obliges the traceability of all foodstuffs on the production chain and on sale for companies from the agri-food industry. Thus in order to guarantee the consumer "traceability from fork to fork" following the different health crises *"The traceability of all food, feed, food producing animals and any other substance intended to be, or expected to be, incorporated into food or feed shall be established at all stages of production, processing and distribution"* (article 18). To comply with the general traceability obligation, companies must guarantee five-year records of all flow, must be able to reconstruct the information using a structured system and to ensure immediate traceability of the precedent and subsequent stages (complete traceability is reconstructed by the authorities). The EC n°178/2002 regulation thus established traceability as one of the main concerns of agri-food sector companies, who must have results but not necessarily any specified means. The industry is free to implement any "traceability systems" which can be used to fulfil the requirements of the regulation EC n°178/2002, all the more since there is no standard regarding traceability. French companies are particularly concerned due to the fact that France is the second largest producer and exporter of agricultural and agri-food products in the world after the United States and the largest producer of processed food. Traceneurs [15] evaluated the development of the European agri-food traceability market from 0.6 billion euros to 2 billion euros between 1997 and 2005. Beyond the regulation requirements, traceability is essentially an issue for companies in the agro-food industry given that losses can be significant in case of a recall, especially if it is widely publicised and affects the image of the company brand.

The second most important issue in favour of the consideration of the traceability problematic in companies is counterfeiting and the black market. It is estimated that about 10% of products worldwide are counterfeit. It is over simplistic to think that counterfeiting is limited to luxurious products and medicines (for example, between 2003 and 2004, confiscations of counterfeit food and drinks on the European borders increased by 200% (Pôle Traçabilité [13]). At the same time, products from the black market represent a real problem for companies regarding control and security of their product distribution network. Consequently, the implementation of authentication and security technologies is becoming an issue that must be dealt with by companies when considering the traceability of their products.

Finally, the third issue is related to customer demand. Hobbs (2004, [9]) considers that traceability systems are an answer to the asymmetry in information between consumers and producers. Since the BSE crisis, consumers begun to demand information about the products they consume (origin, label certificate, strict identification and classification,

ingredients used, etc). This is a marketing aspect of traceability that may be used to unite customer confidence, fidelity and satisfaction (Fabbe-Costes and Lemaire, 2001, [6]).

Obviously, given these different issues, traceability is now central to business strategy, whether it is simply a question of complying to legislation, of avoiding losses (recalls, counterfeiting), of controlling product sales routes (black market) or simply making it a marketing advantage. Traceability is thus becoming a genuine strategy for organisations.

### **3. ... IN ORDER TO BETTER TRANSLATE THE DIFFERENT LANGUAGES OF TRACEABILITY**

The notion of a traceability “system” is still not clear and requires certain clarifications. This means understanding the installation of traceability systems in organisations by work on a management strategy and translation theory.

#### **3.1 The three levels of traceability systems: capture, treatment, channels**

When studying different works about traceability, the close links with technology are striking. Thus for Pedrot (2003, [12]) traceability is "the illusion of turning back time using technology", for Hermitte (2003, [8]) it is " the construction of a mechanism to control technical objects by technical systems" and it is also " the possibility offered by modern techniques to provide information to the public and to closely follow industrial products whether they are distributed by a small or large company". Likewise, for Fabbe-Costes and Sirjean (1997 [4]) “the evolution of information and communication technologies has been a powerful stimulator to develop both tracking and tracing”. Although it is possible to carry out traceability manually, we must admit that information and communication technology has offered extraordinary possibilities in the development of traceability practices in organisations to such a degree that today we speak of "traceability systems".

In the agro-food industry, Lecomte and al. (2004 [11]) observed three levels of tools making up a traceability system: first level tools, consisting of information media (bar codes, RFID labels, etc.), second level tools used to capture the information (readers, terminals, etc.) and third level tools, the software packages used to store and search information (MES, ERP, etc.). These three levels of tools cannot be considered without the analysis of Hermitte (2003 [8]) regarding the need for an organization adapted to traceability and including three elements: a media allowing the identification of traces, a collection mechanism and the processing structure. The first two levels of traceability tools are used to carry out the coupling between associated physical flow and information flow. The third level tools (software applications) provide companies with a better knowledge and control of their products and processes. A complete traceability system is considered to be a system that may both track products and their processes. Many companies are now using "middleware" between the second level and third level tools and that may be used to successfully link capture technology and information storage and processing technology (between the hardware and software). Consequently, this requires companies to consider the place of technology dedicated to traceability within their information system: given that traceability management is integral in the implementation of an information system, traceability tools must not be considered apart from information systems.

Moreover, the main characteristic of traceability is its inter-organizational dimension, and for this reason we may add a fourth level of traceability consisting of technology used to share traceability information between organizations, such as EDI (Electronic Data Interchange). It is precisely this inter-organizational dimension that represents the greatest difficulty when implementing a traceability system given that it creates, among others, interoperability and standardization problems. As observed by Fabbe-Costes and Lemaire (2001, [6]), "even if the local or company level of operations does not create any real problem (relative homogeneity of language, of culture and choice of technologies; unification of responsibility), the global supply chain represents a real challenge". This leads a certain number of companies in the aggro-food industry to consider their traceability management in terms of a network or a branch of industry, sometimes even preferring to trust specialist traceability data companies with their data (TraceOne for example) or adapting a "*coopetition*" behaviour (Hamel and al. 1989 [7]) including cooperation and competition via membership of organizations such as GSI (ex GENCOD) which attempt to promote the adoption of standards.

While it is generally accepted that dedicated traceability technologies may be used to identify and find products, one of the biggest issues of traceability is counterfeiting and the black markets. The technologies and techniques used to authenticate and secure products complete the localization and identification objectives, for example by providing evidence that a particular olive oil does in actual fact come from the region mentioned on the bottle. The traceability system of an organization will thus be a reflection of their understanding of traceability and their objectives when implementing dedicated technology. This means considering organizations as Daft & Weick (1984 [3]) according to whom they receive information from their environment and act as "filters" by interpreting this information depending on their beliefs, values, common sense, etc. Depending on their interpretation of traceability, organisations will implement different traceability systems.

Following this analysis, we would therefore like to offer a definition of a traceability system as "a set of information and communication technologies used to clarify an implicit link between a product and its relative information for identification, localization, authentication and security".

### **3.2 Proposition for a Traceability analysis framework: Strategic analysis and Actor-Network Theory**

A priori, traceability represents a constraint when approached as a regulation requirement or a customer demand and seems for companies to be often synonymous with additional costs (work costs, investment in new technology, etc.). However traceability can quickly become an advantage for companies if they accept to view it as an opportunity, then the traceability system implemented will become a genuine strategic management tool.

M.J. Avenier (1985 [1]) defines strategic management as a "particular form of strategic management under which the adaptation to events in the company environment is offensive, or represents a systematic intention to benefit and to establish a long term advantage over their competition". We consider strategic management as defined by Avenier, as an interesting analysis framework for understanding the implementation of traceability systems. Effectively, in the strategic management frame of mind, the objective is to transform the environmental constraints into advantages. As we have

already seen, European regulations, counterfeiting and the pressure from consumers have placed traceability as one of the central concerns, if not the centre-most concern, of companies. Consequently, these were forced to adapt by implementing traceability systems. However, if some companies have attempted only to respond to a constraint others were able benefit from this constraint by turning it into a strategic advantage. Traceability is therefore not only a constraint but can also represent a source of competitiveness for companies that know how to implement effective traceability systems. Traceability systems then become real strategic management tools.

Today, companies exist in a complex, constantly changing environment, in which strategic management based only on planning is no longer possible. Therefore, it is essential for companies, as suggested by Avenier, to “benefit from the unexpected” by transforming constraints into advantages with an offensive approach.

However, it seems that work on strategic management does not permit them alone to analyse the complexity of traceability system implementation in and between organisations. Effectively, traceability is a transversal concept for organizations. The implementation of traceability systems affects all services of the company, from management to production, quality control, information systems management, etc. It is therefore difficult to understand and coordinate the installation of traceability: for the quality controller it will be synonymous with the ISO standard, for the computer technician ERP, MES or even middleware, for the operation of RFID readers and tags, while for the marketing director it represents the opportunity for a sales argument and communication, for the jurist it means an evaluation of responsibility and conformity regarding regulations etc. all the more given that this concerns the intra-organizational aspect of traceability. We can only imagine what this may represent in an entire network or supply chain for aggro-food companies. The implementation of traceability systems can only become the introduction of innovative tools if all the actors in the organization coordinate and understand each other, something that is not at all easy given the diversity of language used to understand traceability in the different services of a company.

Actor-network theory (ANT) is an innovative *translation* model, where any actor (be it person, object or organization) is equally important (Callon 1986 [2], Latour 1991 [10]). Translation can be defined as the means by which one entity creates a role for other: Other agents must be persuaded. “*Chains of translation*” entails metamorphosis and loss of sovereignty, each social group may react to this in different ways: modification, defection, betrayal, addition, appropriation, abandon. It is a process of continuous transformation: the form of innovation is essential for long-term existence. The key to innovation is the creation of a sufficiently powerful consortium of agents to complete it: when innovation does interest a new group they transform it to varying degrees (Tatnall and Gilding, 1999 [14])

With ANT methodology we can analyse discussion about humans and technology without considering one as context for the other: investigation of negotiations, associations between actors, investigation of each contributions of a common register. ANT analysis provides us with the information to understand the success or failure of traceability in both manufacturing processes as well as relationships along the supply chain. The principal result is that traceability is seen as a “legal construction of social relations” to restore control over goods and merchandise by the control of information.

ANT depends on five key ideas:

- *The network* is a “meta-organisation” assembling people and objects into relations with one another.
- *Translation* is the operation establishing a link between heterogeneous activities: we can easily change from one spatial-temporal framework to another without losing the link. The reconstitution of the network requires the analysis of controversy.
- *Controversy* always precedes the emergence of innovation; agreements regarding facts are thus constructed and concretised.
- *The intermediate definition*. The event is a result of the network and the network only exists by the event around which it is formed.
- *The principles of symmetry*. Equal importance is given to people and to objects, while the creation process of the network depends as much on failure as well as success.

Based on these five concepts, Latour (1991 [10]) suggest a ten-stage method for translation of a network and possible modification.

*The analysis of context*. This is an analysis of agents present (human and non-human), their advantages, their issues and their level of convergence.

*The problem analysis by the translator*. That which divides and unites must be identified. This collective problem analysis can only be done by a translator accepted by the network agents.

*The obligatory crossing point*. This is the unavoidable point (physical or institutional) by which construction of the network must pass.

*The spokesperson*. They represent both human and non-human entities and make expression and concerted action possible.

*Form investment*. This is the work done by translators to reduce complexity

*The intermediaries*. Form investments produce intermediaries who in turn concretise the network: information, technical objects, money, expertise, etc.

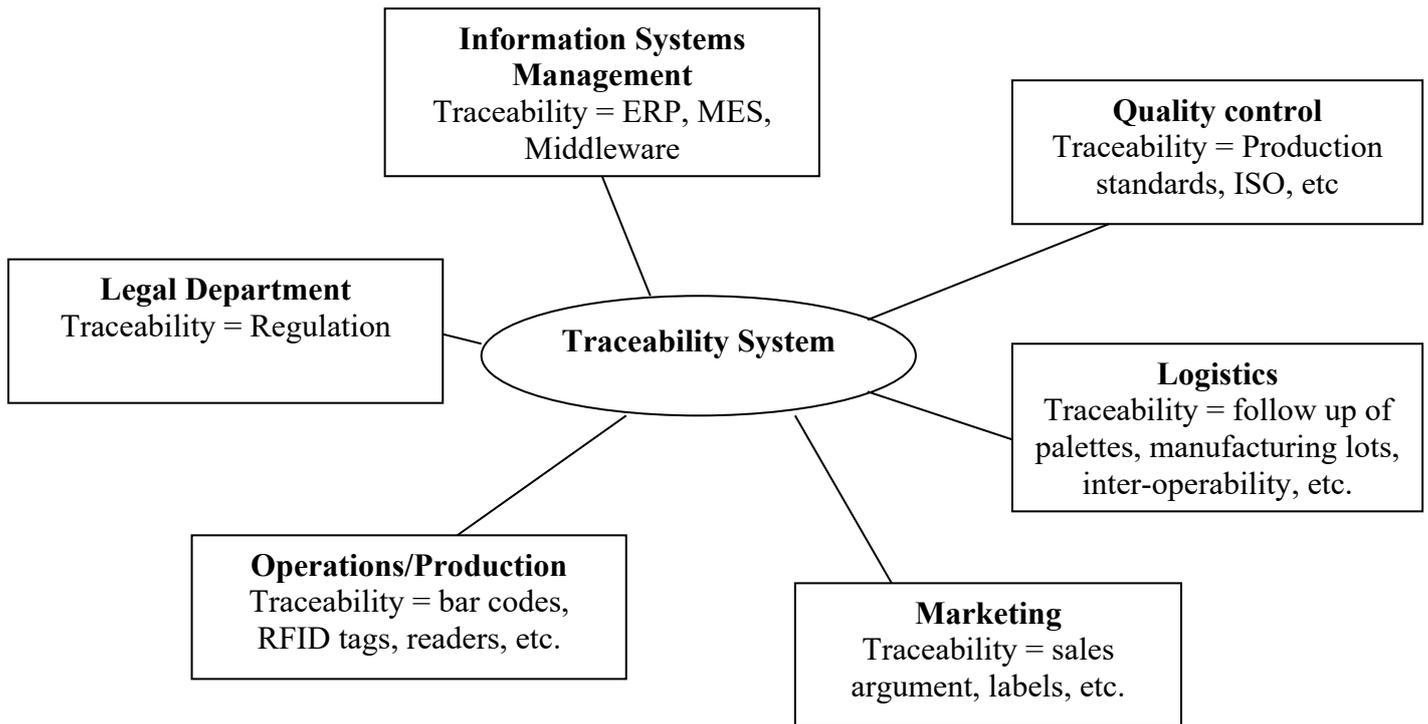
*Enrolment and mobilisation*. Members of the network are assigned a precise task facilitating their involvement in the action.

*Extension and irreversibility*. The entities making up a network around a node are multiplied. To avoid the risk of dispersion, two conditions are necessary, vigilance and transparency:

*Vigilance*. The attention given to detail, permanent monitoring.

*Transparency*. Transparency must be ever present in order to establish confidence between agents.

The theory of translation can be used to demonstrate the diversity of actors concerned by traceability (Walsham, 1997 [17]). Too often, traceability is claimed to be the responsibility of one person in companies: sometimes it the quality controller who takes on this responsibility, sometimes the logistician, sometimes the information systems management. Yet traceability is transversal project in companies requiring the decompartmentalization between the different company services, as well as a translation effort so that each actor concerned may understand the advantages for the other regarding traceability. For this reason, the creation of a dedicated traceability management position in organisations may seem necessary. The person responsible for traceability thus plays a role of translator between the different services of the company concerned by traceability.



For example, the Saint-Charles International Market is the main European fruit and vegetables distributing centre (210 firms on a private site, 2 500 employees, 1,6 billion €, 1 500 000 traded tonnes, 1 500 trucks a day...) with very different stake holders: warehouses, unions, Chamber of Commerce and Industry, phytosanitary services and fraud repression, forwarding agents, truckers, brokers, public weight... Traceability System started in 2005. <http://www.saintcharlesinternational.com/public/ang/index.asp>

Another example is the Traceability Centre, a "skills centre" in France operating a cluster for networking. It provides economic players with traceability consultancy and training, it demonstrates tracing technologies in a dedicated centre, and it continuously monitors technologies and professions linked to the world of traceability. [www.poletracabilite.com](http://www.poletracabilite.com)

#### 4. Conclusion

The objective of a traceability system is to establish monitoring of goods, activities or people by control of the information related to them. It consists of localization (*tracking* function) or history reconstitution (*tracing* function) with very different possible objectives: security, customer relations, ecology, anti-counterfeiting, etc.

Technological revolutions in data capture (intelligent labels, biometry, etc) may be used to organise a **decoupling** between flow management (logistics, traffic, etc) and the information flow (standardisation of data, data processing outsourcing, EDI, SCM, GS-1, etc.).

**Organisational** changes are a measure of these revolutions: innovation within networks, expertises of new key actors, collaborative work, new language, cooperation over a network, etc.

ANT offers some advantages for the analysis of traceability, as well as a situation where interactions of social, technological and political elements are considered particularly important. Traceability is a process of network formation by which all actors attempt to persuade others to become allies.

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