# The role of global data identification standards for supply chain visibility: the case of GS1

NATALLIA SEMIANIAKA
EKATERINA SILINA
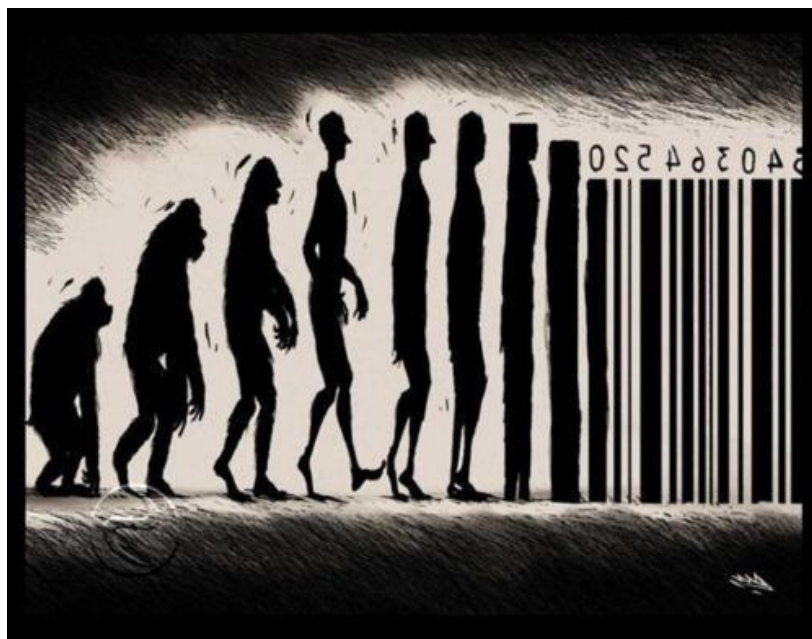
**KTH Industrial Engineering and Management**

# The role of global data identification standards for supply chain visibility: the case of GS1

Natallia Semianiaka
Ekaterina Silina

# *Abstract*

*Purpose.* Supply chain visibility is among the top concerns expressed by many supply chain leaders. While the traditional enablers of supply chain visibility are information sharing, IT implementation, and relationships between supply chain partners; the role of global supply chain standards as an integral part of each of these enablers is often underestimated. The purpose of this thesis is to investigate the adoption and applicability of global supply chain standards within the provisions of supply chain visibility among various supply chain designs.

*Methodology.* With the aim of theoretical replication, three case studies within the retail industry were conducted. Axfood and IKEA cases were analyzed as examples of opposite types of supply chain design and as companies with different degrees of implementation regarding their global data identification standards. The Clas Ohlson case was analyzed to illustrate a company with open paths in regards to its adoption of future global supply chain standards. In-depth, semi-structured interviews were performed directly with company representatives as well as with GS1, which is one of the assignors of this project. Finally, an analytical model for the potential adoption of global standards was developed.

*Findings.* The results of case analysis clearly illustrate that global data identification standards are one of the pillars of supply chain visibility. Different practices of global standard adoption in different supply chain designs are explained by a different need for supply chain visibility among various supply chains. Moreover, the higher the degree of adoption of global standards, the higher the possibility of gaining strategic benefits.

*Practical implication.* The model developed in this research aims to help logistics and supply chain managers estimate the need for supply chain visibility within their supply chains, and to also assess the potential adoption of global data identification standards within their supply chain practices.

*Originality/value.* This study contributes to theory in such areas of research as supply chain visibility, standardization in supply chain management, and supply chain design. The main contribution is made to the resource-based view (RBV) theory, which according to supply chain visibility can be seen as both a strategic resource and a tool for efficiency optimization. A new term in supply chain design which suggests many-to-many and exclusive supply chain classifications is proposed, as is a framework for assessing the need for supply chain visibility. An analytical model for the potential adoption of global standards is also developed.

*Keywords*: supply chain visibility, supply chain collaboration, information sharing, global data identification standard, supply chain design, resource-based view (RBV)

# ACKNOWLEDGEMENT

Natallia Semianiaka and Ekaterina Silina

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# ABBREVIATIONS

| | |
|---|---|
| *ASN* | advanced shipping note |
| *B2B* | business-to-business |
| *DC* | distribution center |
| *eCom* | electronic commerce |
| *EAN* | European Article Numbering system |
| *EDI* | Electronic Document Interchange |
| *EPC* | Electronic Product Code |
| *EPCIS* | Electronic Product Code Information Services |
| *FMCG* | Fast Moving Consumer Goods |
| *GEPIR* | Global Electronic Party Information Registry |
| *GDSN* | Global Data Synchronization Network |
| *GLN* | Global Location Number |
| *GTIN* | Global Trade Item Number |
| *IOS* | inter-organizational system |
| *IT* | information technology |
| *LTL* | less than truckload shipment |
| *PLC* | product life cycle |
| *RBV* | resource-based view |
| *RFID* | radio-frequency identification |
| *SCV* | supply chain visibility |
| *SKU* | stock keeping unit |
| *SSCC* | Serial Shipping Container Code |
| *TCE* | transaction cost economics |
| *TOE* | technology-organization-environment framework |
| *UCC* | Uniform Code Council |

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# 1 INTRODUCTION

*The introduction provides an overview of current trends in supply chains today, while familiarizing the reader with the key research areas of the thesis. The assignor of the thesis, the problem statement, the research questions, and the delimitations of the thesis are presented.*

## 1.1 Background

The increasing pace of globalization creates a growing challenge for managing supply chains. The current trend to outsource has resulted in the appearance of multi-tiered global supply chains that encompass multiple enterprises and channels. Consequently, supply chains are becoming more complex, costly, and vulnerable (Butner, 2010).

Coping with this uncertainty and complexity, companies are striving to stay competitive in a dynamic, global environment. A commonly accepted point of view is that only efficient cooperation and collaboration (Daugherty et al., 2006), along with supply chain visibility (Barratt and Oke, 2007) can help companies in this endeavor. This is why the role of collaboration and visibility has been recently highlighted by the business community. In fact, many industry white papers report supply chain visibility as a top concern (Aberdeen Group, 2012), while indeed, appealing for the need for improved cooperation and collaboration (IBM, 2012).

*Supply chain visibility* can be defined as the availability and transparency of information about products (quality, location, point of sale data, etc.) between the different supply chain actors. In order to achieve supply chain visibility and a high level of collaboration, companies must have a good level of information technology (IT) implemented, or better yet, build an inter-organizational information system (IOS).

Another facilitator of global trade is the Internet, which has brought about the replacement of proprietary IT-systems within companies, through the establishment of standardized e-business networks on an industry-wide scale. This has allowed business processes to be better integrated and synchronized. However, information quality is still a concern, even if that information is exchanged via the most sophisticated IT systems. Here, the role of standards comes forth.

Whereas previous studies (IBM, 2012) have stressed the need for open standards to improve collaboration and coordination in global supply chains, the ambition of this master's thesis is to broaden current understanding of the role of standards in achieving supply chain visibility, while focusing on the example of the retail industry and the GS1 global system of supply chain standards.

Companies in the retail sector usually follow common methods of operating supply chain processes that imply the adoption of a unified "language of business" (Georget, 2007). Such information is encoded according to freely available *open standards* within the whole supply chain. Taking into account the global extension of supply chains, open standards have now become *global* as well.

However, some major players in the Swedish economy, such as IKEA and H&M, are known for their exclusive supply chains. They implement their own supply chain practices and standards in communication with their supply chain partners. Do these companies try to protect or hide sensitive information with the help of *proprietary standards*? Is this how they remain competitive?

This raises a question as to why some companies are indecisive about the adoption of global standards, and about how it affects their supply chain visibility as well as the lessons learned from examples of different levels of global standards implemented. Thus, this research challenges the absolute need for supply chain visibility.

This thesis addresses the issue of global and proprietary standards' simultaneous existence, and investigates the applicability of global supply chain standards in different supply chain contexts. To denote these contexts, the term *"supply chain design"* is used in this thesis. It determines supply chains according to the place of product manufacturing and distribution, and suggests such extreme examples of supply chain design as *"many-to-many"* and *"exclusive"* supply chains. In other words, products in many-to-many supply chains can be sold in many stores; in exclusive supply chains, products can only be sold in exclusive stores.

This research does not aim to provide a universal solution. On the contrary, there is no right or wrong supply chain design or standard. What is essential is the alignment of the supply chain strategy with the corporate strategy in the process of supply chain standard choice (Chopra and Meindl, 2010).

In order to visualize and integrate all three concepts of supply chain visibility, supply chain design, and global standards, the *Theory development* chapter introduces the model which will help companies assess the applicability of global standards in the context of their supply chain design and their actual need for supply chain visibility.

## *1.2 The assignor – GS1 Sweden*

GS1 Sweden is a non-profit organization that develops *global supply chain standards* for product data identification and sharing. It is a member of GS1 International and owned by the customer goods retail industry in Sweden.

GS1, initially called EAN International (European Article Numbering system), was founded in 1977 and adopted the name "GS1" in 2005 due to its integration with the American Uniform Code Council (UCC) system.

The role of GS1 is to assign global unique numbers so that organizations can identify their items and share accurate data with their trading partners. There are four main standards in GS1 system (What is GS1? GS1, 2012-03-11):

- *BarCodes* (used on labels to automatically identify products)
- *eCom* (standards for electronic business messaging that allow automatic electronic data transmission)
- *GDSN* (Global Data Synchronisation Network which represents the repository of information about products and allows business partners to have updated item data in their systems)
- *EPCglobal* (Electronic Product Code which is encoded in radio-frequency identification (RFID) tags for item tracking).

GS1 System is the most widely used supply chain standards system in the world. It fosters cooperation and encourages information-sharing between trading partners worldwide. At present, GS1 has 108 membership organizations in 150 countries. Its service is royalty-free and is based on a subscription fee paid by each member of the GS1 community (What is GS1? GS1, 2012-03-11).

The GS1 system of standards is implemented in the following industrial sectors (What is Global Product Classification? GS1, 2012-03-11):
- food, beverages, tobacco
- home care, health care (including pet care, pet food, baby care, beauty/personal care and hygiene)
- clothing, footwear, personal accessories
- cross category
- general merchandise (furniture & furnishings, kitchen merchandise, musical instruments, toys & games, stationery, audio & visual, communications, computing, printed & reference materials, sports & well being, arts & crafts, outdoor & camping)
- hardlines
  - do it yourself products (lawn & garden supplies, building materials, hardware, tools & equipment hardware, safety & storage, electrical supplies, plumbing, heating, ventilation, air-conditioning)
  - automotive aftermarket
  - home appliances

The main areas of GS1 standards implementation are illustrated in Figure 1.
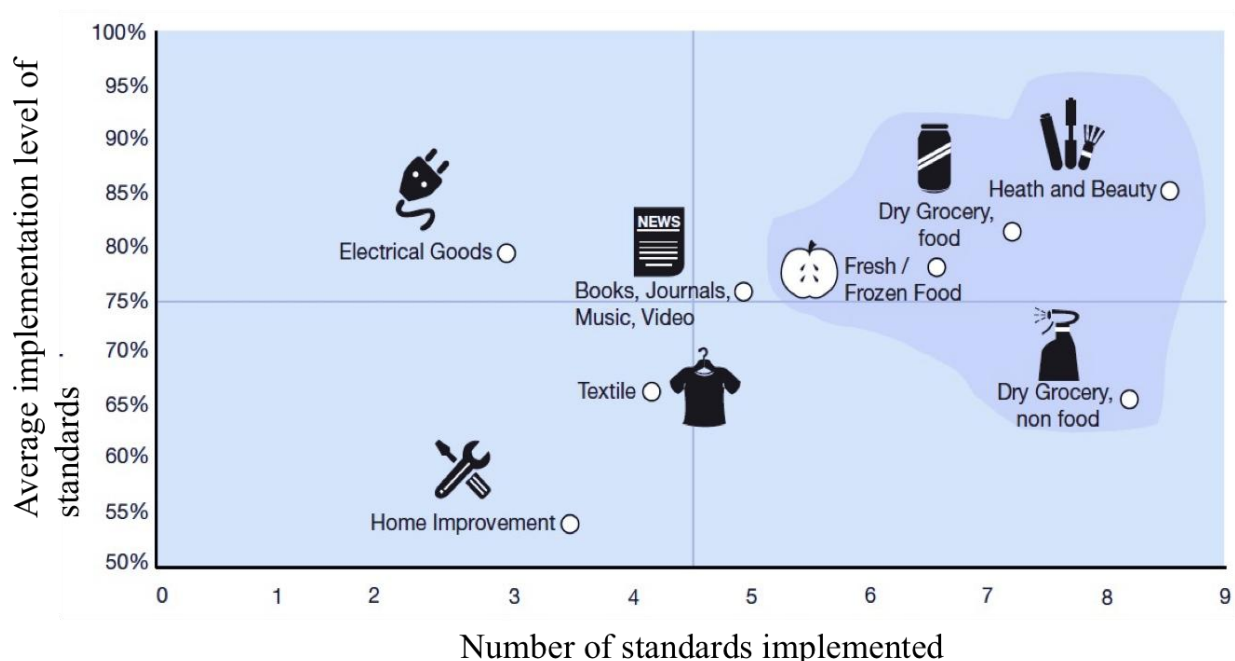


Figure 1. The main areas of GS1 standards implementation (IBM, 2012)

## 1.3 Problem formulation

The growing complexity of global supply chains forces companies to strive for supply chain visibility in order to improve the efficiency of their supply chains. The main enablers of supply chain visibility are usually considered to include IT system development, information sharing, and relationships between supply chain partners. However, the role of standards as the basis of accurate and consistent information sharing for providing supply chain visibility is often overlooked.

On one hand, the growing need for supply chain visibility has caused a trend towards supply chains that base their collaboration on global supply chain standards. Conversely, there are also

successful companies with exclusive supply chains that manage to stay competitive by using proprietary supply chain standards.

The connection between these simultaneous and contradictory trends remains underexplored. The existence of exclusive supply chains questions the imperative for supply chain visibility and suggests that the implementation of global supply chain standards is not an optimal solution for all supply chain designs.

Thus, a better understanding of the connection between the concepts of supply chain visibility, supply chain standards, and supply chain design is needed.

## 1.4 Objective and research questions

The objective of this master's thesis is *to investigate the potential of global data identification standards in providing supply chain visibility in different supply chain designs*.

RQ1: What is the role of global supply chain standards in providing supply chain visibility?

RQ2: How does the adoption of global supply chain standards depend on the supply chain design?

RQ3: How can companies within different supply chain designs benefit from using supply chain standards?

The intersection of the research areas and the research questions is illustrated in Figure 2.
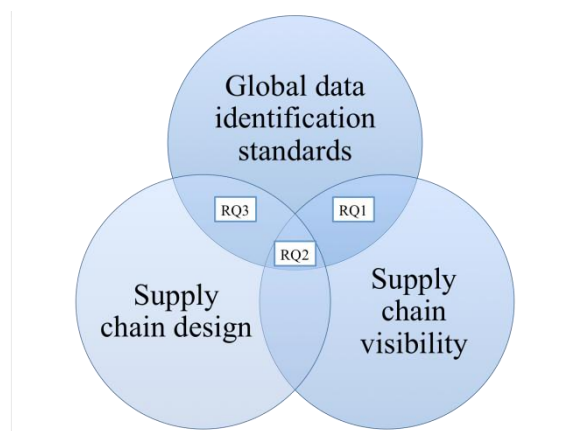


Figure 2. Linking research questions to areas of research

## 1.5 Target group

The primary target group of this thesis is comprised of companies that wish to gain a deeper understanding of the role standards play in achieving supply chain visibility. These businesses would also like to understand the potential benefits of adopting global data identification standards within their supply chains. Master students and researchers in logistics and supply chain management may also hold interest in the content of this report.

## 1.6 Delimitations

*Retailing industry.* It is important to take into consideration companies from a similar industry, of a similar size, and situated in the same position in the supply chain; since the question "Whose perspective do we take?" is very important here. This research is performed from the retailers' perspective, as these actors of the supply chain are situated closer to the final customer and possess more information regarding customer demand.

The focus of the research is on *dyadic relationships between the manufacturer and the retailer.* Many researches pinpoint the investigation of information sharing at the buyer-supplier level as too simplified (Kaipia and Hartiala, 2006b). However, in this research, the investigation of dyadic relationships is justified, because the main goal is to gain an understanding of standards' adoption potential. Moreover, there is evidence that companies typically fail to look beyond their first-tier suppliers (Caridi et al., 2010b).

This research is focused on the *GS1 system of standards*, since they are the only global standards used in the supply chains.

RFID is considered to be an advanced technology in the labeling process that provides the best possible product identification. However, no preference is given to any specific technology, since data coding is the same in all technologies implemented in GS1 standards.

This research focuses only on *business-to-business (B2B) benefits* within the supply chain, not on business-to-customers (B2C) benefits.

## 1.7 Outline of the thesis

This paper is organized as follows:

The *Introduction* provides an overview of current trends in supply chains today, while familiarizing the reader with the key research areas of the thesis. The assignor of the thesis, standardization organization GS1, is presented in the introduction. The problem statement summarizes the background of the research and pinpoints some contradictory trends regarding supply chain visibility and standards implementation within different supply chain designs that need to be investigated further. This is the basis on which the thesis objective and the research questions are formulated. The introduction ends with the thesis delimitations and the thesis outline.

The *Research methodology* chapter describes the process of conducting the research. The results of reviewing literature (with the number of articles found, the research databases used, the keywords and the search terms) are provided. The case study methodology is chosen, as it can provide in-depth understanding of global standards adoption within different contexts. The choice and the number of cases are justified in terms of theoretical replication. Finally, data collection, data analysis, reliability and validity are discussed.

The *Theoretical concepts and framework* chapter provides a theoretical context for subsequent chapters and consists of two subchapters – Literature review and Theory development & the analytical model. The literature review describes antecedent literature in the areas of supply chain visibility, supply chain design and supply chain standards' adoption. The review reveals a massive literature gap, especially in the area of supply chain design and data identification standards. This leads to the ambition of theory development and the creation of the analytical model, which incorporates two dimensions: the need for supply chain visibility and the type of

supply chain design. On the basis of this model an assumption regarding potential adoption of a global data identification standard can be made. The model is further used in the empirical chapter of this thesis.

The *Empirical case studies and analysis* chapter gathers empirical evidence for the developed analytical model and consists of a description and cross-case analysis of three case companies – AxFood, IKEA and Clas Ohlson. This chapter summarizes the respondent companies' supply chain practices. It also describes the current level of supply chain visibility, and the types and benefits of data identification standards implementation. This chapter compares findings from three case studies to chosen theoretical frameworks and verifies the usability of the previously developed analytical model.

The *Discussion and theoretical contribution* chapter reflects on what was known prior to case studies and how empirical findings have enlarged the understanding of the concepts of supply chain visibility, supply chain design, and adoption of global supply chain standards. In the end, the contribution of the research to supply chain management literature and fulfillment of the stated purpose are assessed.

The *Conclusion* discusses the limitations of the research as well as any managerial implications and possible areas open to future investigation.

# 2  RESEARCH METHODOLOGY

*This chapter describes and justifies the research approach and procedure applied in the thesis. The end explains how the reliability and validity of the research may be proven.*

## 2.1 Research design

The research was conducted in eight steps (Figure 3).



First, an introductory interview with GS1 representative was held in order to clarify the goals of the work and to choose which areas were to be further investigated.

A literature review around supply chain visibility, supply chain design, and standard adoption issues was carried out at the second step, and was continuously updated throughout thesis work.

Due to a lack of relevant theoretical framework involving supply chain design and standardization, a third step was performed to include the building of an analytical model that explains the relationship between the need for supply chain visibility and global standard adoption within various supply chain designs.

The fourth step included the choice of case companies through theoretical replication logic (Yin, 1994) in order to illustrate the extreme and mid positioning of the analytical model developed.

After the case companies were chosen, data were collected in order to discover the state of supply chain visibility within these companies' supply chains and to evaluate their practices of data identification standards implementation.

The transcript, analysis and interpretation of all the collected data (step six), culminated with the completion of a final report (step seven). The final report was discussed both with the case companies and GS1 representatives as well as at a final seminar at KTH.

Figure 3. Research process

## 2.2 Literature review and theory development

The literature search was conducted in several steps during the study as new concepts and ideas arose. An extensive search of articles was performed in such databases as Business Source Elite, Emerald insight, Engineering Village, IEEE Xplore, ScienceDirect, Scopus, SpringerLink, Wiley Online Library, and World of Knowledge, all of which are considered reliable sources of current studies. The main keywords for review and the different variations of search terms used are listed in the Table 1.

Table1. Keywords and searching terms

| Keyword | Search term |
|---|---|
| supply chain visibility | supply chain visibility / transparency<br>visibility/transparency of/in supply chain<br>traceability / trackability AND supply chain |
| information sharing | information/data sharing / exchange / interchange / transfer / flow / management / asymmetry / synchronization<br>AND visibility / supply chain visibility |
| supply chain collaboration | supply chain/network cooperation / coordination / integration / collaboration / collaborative supply chain AND visibility<br>supply chain visibility |
| supply chain design | supply chain/network design / configuration / architecture / structure<br>supply chain / network classification / taxonomy<br>vertical integration / coordination<br>open / closed/private/exclusive supply chain/network |
| supply chain standard | supply chain / network standard<br>data identification standard<br>communication standard<br>barcode<br>GS1 / EAN / UCC<br>open / shared / industry / global standard<br>proprietary / private standard<br>adoption of standard<br>role of standard<br>AND supply chain OR visibility |

Approximately 150 articles were found and read, 58 of which were considered the most relevant. Relevant articles were classified in several categories, and a summary table of articles was completed. It is also noteworthy here that the dominating methodology among the articles is the case study. The date range of the search is 20 years, and about 85% of the publications are academic journals.

Consequently, literature review was written, its length justified by the need to gain a theoretical saturation. The reviewed literature served as a basis and inspiration for further theory development.

Due to the lack of literature relevant to the objective of the thesis, the concepts of supply chain visibility and supply chain design were operationalized. A framework that assesses the need for supply chain visibility was created. The classification of supply chain designs was clarified. This enabled the creation of an analytical model for the potential for global standard adoption, which depends on the need for supply chain visibility and type of supply chain design.

Thus, the unit of analysis of this research is the adoption and applicability of data identification standards in different supply chain designs.

## 2.3 Choice of methodology

The research methodology should be chosen according to a research's objective (Collis and Hussey, 2009). The objective of this thesis is to understand the potential of global standards' adoption within different contexts. This requires finding and explaining links between three concepts: supply chain visibility, supply chain design, and global standard adoption. Therefore, the research can be positioned as an *explanatory* one, requiring the illustration of the theories proposed and the concepts introduced within examples from a practical point of view, i.e. industry case studies.

Case study methodology was chosen for a number of reasons:

- Case studies help researchers investigate the contemporary set of events over which they *"don't have any or little control"* (Yin, 1994, p. 8).
- A case study is also a popular methodology to obtain in-depth knowledge about phenomena (Collis and Hussey, 2009; Karlsson, 2009).
- A case study helps understand phenomena within a particular context and helps develop and illustrate a theory (Yin, 1994). In contrast to scientific statistical generalization, case studies are appropriate for *analytical generalization*, when the researcher's goal is to expand and generalize theories (ibid). It justifies the choice of case methodology for this research, since the developed analytical framework illustrates the theoretical views on the concepts discussed and can be used by other researchers and practitioners, i.e. generalized.
- Finally, case study was the main methodology used in the articles reviewed.

The analytical framework and its development are a synergetic combination of theoretical concepts, personal opinions, and observations of researchers and interviewees. In this way, case studies attempt to combine theory and evidence. Case studies allow the testing of proposed analytical models both in terms of accuracy (methodological rigor and diagnostic capability) and applicability within real contexts (i.e. usability).

An alternative method of research would have been a survey. However, a survey methodology was not possible to conduct due to a limited number of companies available. Additionally, a survey does not provide the possibility of open ended and clarifying questions, essential to gain an in-depth knowledge and understanding of standard adoption phenomenon.


## 2.4 Choice of cases

*Choice of industry*

The choice of cases was decided through discussions with representatives from the case assignor. After a preliminary literature review was conducted, several possible industries were highlighted, e.g. healthcare, retailing, automotive industry. GS1 representatives also proposed the wood industry as a new area of standard implementation, but ultimately the choice was made in favor of retailing. As products identification standards have emerged and developed in this area, the possibility of find contrasting and more established examples has outweighed the possibility to investigate unexplored areas.

Recently, the retail industry faces such specific challenges as high product diversity, strict traceability requirements, major volumes of goods, increasing inventory, and most critical to food retailing – short shelf-life of products and the need for temperature controls within the

supply chain (Wamba, 2008). All these challenges are seen as an interesting context for consideration within this area of analysis.

### *Choice of companies*

The research aims at *theoretical replication*, so the cases provide *"contrasting results but predictable reasons"* (Yin, 1994, p. 46). Since there were two extremes within the analytical model developed, multiple-case design was chosen. Throughout this report, one can follow the replication logic as to why each of the cases provides certain results based on the analytical framework introduced in chapter 3.2.

Therefore, three case companies from the retail industry were chosen in order to provide examples of supply chains with different supply chain designs and different needs of supply chain visibility. Two companies represent the extreme examples of the analytical model: Axfood as a many-to-many supply chain and IKEA as an exclusive supply chain. The third company, Clas Ohlson, is an example of a supply chain with intermediate characteristics capable of following either a many-to-many or exclusive path.

### *Choice of the number of cases*

Assuming that external conditions can bring little variation in the area of study, the number of cases can be reduced to three. Three cases follow the trends for theoretical replication. Although a small number of cases may limit the generalizability of the conclusions, and may increase the risk of misjudgment, it brings an opportunity to deepen observation and analysis (Karlsson, 2009).

In the following Table 2, key characteristics of the case companies are summarized in order to get overall vision of their economic positioning in the market.

Table 2. Case companies' characteristics

| Key characteristics | Axfood | IKEA | Clas Ohlson |
|---|---|---|---|
| Market | Food retailing | Furniture retailing | Hardware retailing |
| Net sales, mln SEK | 34 795 | 210 490 (24.7 bln EUR) | 5 828 |
| Operating profit, mln SEK | 1 250 | 97 149 (11 400 mln EUR) | 507 |
| Operating margin, % | 3.6 | N/A | 8.7 |
| Number of employees | 7 062 | 131 000 | 2 219 |
| Number of stores | 237 | 287 | 139 |
| Countries of presence | 1 (local) | 41 (global) | 4 (regional) |

## *2.5 Data collection*

As the use of a case study allows diverse sources of evidence, data were collected from multiple channels of information. Such a method of using multiple sources of data is called *data triangulation* and helps increase the reliability of data collected and the construct validity of the research conducted (Karlsson, 2009).

***Primary sources***

*Interviews* − In all, 8 in-depth interviews with 3 representatives from case companies and 4 representatives from the assignor were conducted, 3 of which were phone interviews. *Initial/pilot interviews* were held in the form of a detailed discussion with GS1 representatives responsible for communications within the case companies. These interviews helped to narrow questioning for the main interviews. The set of questions used in the *main interviews* with case company representatives were sent to each interviewee in advance to allow preparation. Questions were structured in a commonly used format, funnel model, where the interview starts with broad and open-ended questions ending with more detailed questions. All the main interviews were transcribed and thoroughly analyzed in order to formulate further questions, which were sent to interviewees by e-mail for further comment.

Even though the case companies were chosen to represent both extremes as well as the middle position within the proposed model (as the research aims at theoretical replication), the questions for the interview essentially similar in order to collect consistent information. Moreover, the outlines of interviews were sent to the respondents for confirmation in order to ensure internal validity and reliability of research.

Thus, information about each case company was collected from two "key informants" − a GS1 representative and a case company representative, which resulted in a sometimes different interpretation of the same issue as evidenced by an interviewees' bias. See the list of interview questions in Appendix 1.

*Field studies* − In order to test the GS1 system personally, there were several visits to case companies' stores, where item, carton and pallet level barcodes were pictured and checked on the www.gepir.org website for the reason of revealing any possible sensitive information.

*Content analysis of annual reports* − Case companies' annual reports published in the most recent year were one source of factual information about the companies. The information from the annual reports helped to better understand the principle organization and supply chain processes of the companies, as well as provide economic data and illustrate the overall current financial health of the companies.

***Secondary sources***

*Content analysis of industry reports* – The reports and whitepapers from such consulting leaders as Aberdeen Group, Capgemini, IBM, as well as GS1 official documents helped construct an overall vision of the supply chain visibility issue, the standardization issue in supply chains, and the retail industry.

*Informal conversations and discussions* – In order to gain greater insight, several informal conversations with colleagues and acquaintances, who had experience in the area of logistics and supply chain management, were arranged. This helped in understanding how barcoding and data identification systems work in the industry from the point of view of workshop employees.

## 2.6 Data analysis

*Interviews* – The interviews were recorded and then transcribed. Afterwards, the flow of the interviews was correlated to the themes of interest: supply chain visibility, supply chain design, and global data identification standards used.

*Descriptions* of the companies, their supply chain processes and supply chain designs, and outcomes of GS1 standards adoption and implementation were constructed. The need for supply chain visibility was assessed in accordance with framework developed in the theory development chapter.

*Within-case analysis* explains how the need for supply chain visibility is met by GS1 standards' implementation. Global standards applicability is assessed with contextual factors of TOE (technology-organization-environment) framework.

*Cross-case analysis* was performed in order to draw out differences as well as commonalities between case companies in terms of different types of visibility and supply chain design. Additionally, comparison was made in accordance to the positioning of companies within the analytical model.

*Monthly seminars* – During these seminars at the university, the report was discussed in a group of 15-20 people led by the professor. During each seminar, the peer-review group made comments about the current progress of work. The overall strategy of writing the paper and methodology of work were also discussed.

## 2.7 Reliability and validity

*Reliability* of the research refers to two main aspects, namely replicability and trustworthiness (Collis and Hussey, 2009).

Replicability of the research is ensured by operationalization of supply chain visibility and supply chain design concepts. The framework of assessment for the need of supply chain visibility serves as a data collection protocol and makes possible the later implementation of the analytical model.

Trustworthiness of the thesis is supported by data triangulation and reliable sources of information. Primary sources of information are interviews with both the assignor and case companies' representatives, which helped assure cross-check information and eliminate bias from both sides. Moreover, outlines of interviews were sent to respondents for confirmation. Finally, large number of academic articles from referenced journals and business cases were read, all of which were deemed reliable secondary sources of information.

*Validity* as the extent to which the research findings accurately reflect the phenomena can be divided into construct, internal and external validity (Yin, 1994).

*Construct validity* which is an appropriateness of operational measures for the phenomenon studied (Yin, 1994) in this thesis is increased through:

- using multiple sources of evidence during data collection stages (data triangulation), which helps eliminate subjective judgments

- theoretical triangulation: the concepts from supply chain management, strategic management, organizational economics, innovation management, and marketing, which were used to build the analytical model
- reading the draft case study report by key informants.

*Internal validity* deals with finding proper linkages between concepts (Yin, 1994). This was supported by the fact that outlines of interviews were sent to respondents for confirmation. An important step since interviews were held with knowledgeable persons actively involved in data identification standards adoption and implementation.

*External validity*, which means generalizability of the study's findings (Yin, 1994), is achieved by using theoretical replication logic in choosing case companies. In this thesis, theory becomes the main mechanism to generalize the results of the case studies and, as mentioned above, the principle of analytical generalization is used, i.e. the results of case studies are supposed to illustrate the model, and to fit into it, within the predefined principle.

# 3 THEORETICAL CONCEPTS AND FRAMEWORKS

## *3.1 Literature review*

*The purpose of this chapter is to summarize antecedent literature in the areas of supply chain visibility, supply chain design and data identification standards in order to gain insight into existing research practices and theories, classify them and identify areas of possible contribution.*

### 3.1.1 Supply chain visibility

The concept of supply chain visibility has gained increasing attention in recent literature since the lack of supply chain visibility was mentioned as the main concern by supply chain leaders, e.g. P&G, The Coca-Cola Company, Wal-Mart Stores (Aberdeen Group, 2012).

To begin with, there are two different developments in literature on supply chain visibility (from academia and practitioners), and the choice of topics covered in both cases is also different. Academic literature aims to give definition to the concept, find ways of measuring and quantifying visibility, link it to other supply chain concepts, and discuss benefits from supply chain visibility. Industry reports describe the importance and benefits of supply chain visibility and are more focused on solutions which help achieve it.

### Definition of supply chain visibility

The concept of supply chain visibility has received increasing attention since the 2000s as more companies realized its importance due to the growing complexity of global supply chains. Even though supply chain visibility is already a well-known concept, this area of research is quite young. A commonly accepted definition of supply chain visibility as well as a classification of supply chain visibility types in supply chain management literature do not yet exist.

There are several main traditional perceptions of supply chain visibility. Many authors address supply chain visibility in terms of *demand* (Kaipia and Hartiala, 2006b; Lee et al., 2004), i.e., information availability for upstream supply chain actors regarding customers' demand. Some papers (Aberdeen group, 2012; Capgemini, 2004) also add the *inventory visibility* perspective implying transparency of inventory level at downstream stages. In industry, supply chain visibility is often associated with the "where is my stuff?" practice of *shipment tracking* which was documented in Aberdeen Group's report (2006).

Additionally, in recent literature supply chain visibility is often substituted by the concepts of traceability and trackability. Not surprisingly, traceability and trackability themselves are often confused and are not well understood. Tracking can be defined as *"the ability to follow the path of an item as it moves downstream through the supply chain from beginning to end",* and tracing as *"the ability to identify the origin of an item or group of items, through records, upstream in the supply chain"* (Schwägele, 2005, p. 166). In further analysis, these terms are considered as benefits of supply chain visibility.

One of the reasons for this ambiguity in definitions and typology of supply chain visibility might be the fact that supply chain visibility is a multilateral concept that involves people, processes, technology and information flow at different stages of the supply chain (Zhang et al., 2008). Goh et al. (2009) performed an intensive literature review on supply chain visibility definition from

logistics, IT, information sharing, operation management, event management, demand and supply perspectives, as well as decision-making and knowledge management perspectives. Consequently, the most recent definition of supply chain visibility which is used in this master's thesis reads as follows:

*"Supply chain visibility is the capability of a supply chain player to have access to or to provide the required timely information/knowledge about the entities involved in the supply chain from/to relevant supply chain partners for better decision support"* (Goh et al., 2009, p.2549).

For further analysis, it is important to distinguish the term "supply chain visibility" from "visibility" in general. In supply chain management literature these titles are often confused and used interchangeably, while visibility is a broader and more abstract concept. Visibility stands for transparency in the supply chain and can exist both within the company and between companies, which means that information may be accessible to outside observers (Lamming et al., 2001). Supply chain visibility implies communication and the sharing of information between supply chain *partners* (Goh et al., 2009; Butner, 2010; Kaipia and Hartiala, 2006b).

Supply chain visibility is also often confused with "information visibility", whereas the latter generally refers to information availability, i.e. *"having the right data at the right time"* (Mangina and Vlachos, 2005, p. 417).

## Why is supply chain visibility needed?

### *Demand for supply chain visibility*

The growing demand for supply chain visibility has been highlighted in business reports in the last ten years (Aberdeen Group, 2012; IBM, 2007; Capgemini, 2004). The most recent survey executed by Aberdeen Group (2012) has revealed the following drivers to improve supply chain visibility (Figure 4):
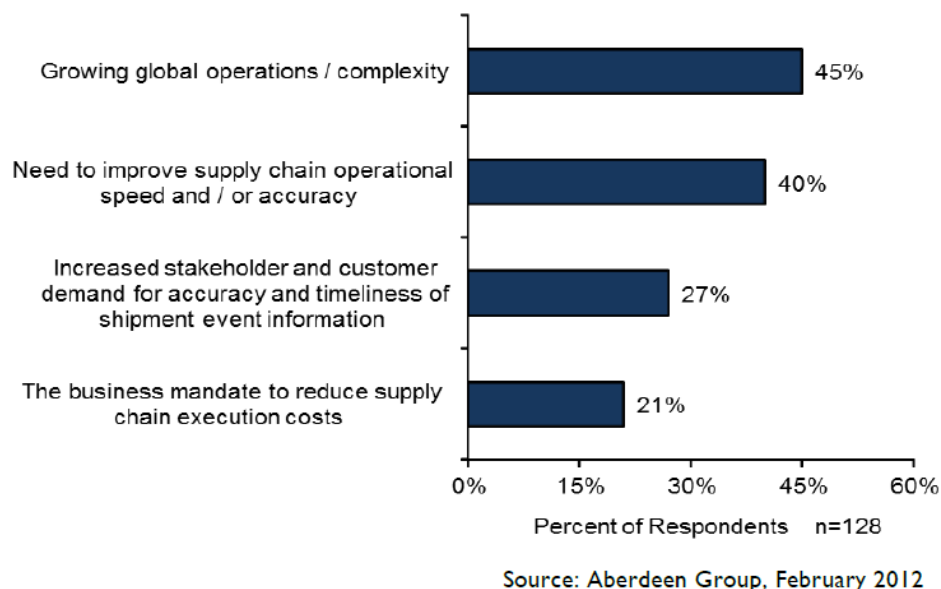


Figure 4. Top pressures to improve supply chain visibility (Aberdeen Group, 2012)

In other words, supply chain visibility is required in order to reduce supply chain costs, improve operational efficiency and agility, improve customer service, and monitor suppliers'

performance. Supply chain visibility is essential for companies that have many business partners to collaborate with (e.g., retailers and wholesalers) and companies where time is a critical business factor (e.g., fast-moving consumer goods companies) (IBM, 2012).

*Benefits of supply chain visibility*

Many benefits of supply chain visibility are derived from information sharing advantages such as reduced lead times, more accurate demand forecast and bullwhip effect reduction, capacity planning and inventory control (Kaipia and Hartiala, 2006b). This in turn helps reduce overall supply chain costs and better match supply and demand. It also helps to improve the responsiveness and efficiency of a supply chain (Chopra and Meindl, 2010).

The most documented benefit of supply chain visibility is the *supply chain performance improvement* which has been investigated by many researchers (Kim et al. 2011; Wei and Wang, 2010; Caridi et al., 2010b; Barratt and Oke, 2007; IBM, 2007; Kaipia and Hartiala, 2006b; Chan, 2003).

Furthermore, some researchers argue that supply chain visibility enables supply chain *responsiveness* and *agility* (IBM, 2007) as well as supply chain *reconfigurability* which means the ability to change supply chain partners (Wei and Wang, 2010). These correspond with tactical and strategic visibility concepts, respectively. *Tactical visibility* focuses on transactions and implies transparency regarding the flow of materials, the available capacity and resources within the supply chain; *strategic visibility* means evaluation and reshaping of the resource network due to the changes in business environment (Zhang et al., 2008).

It is important to mention the seminal work by Barratt and Oke (2007) that first connected supply chain visibility not only with supply chain performance improvement, but also with competitive advantage. Applying a resource-based view theory, the authors argue that not all information shared among supply chain partners can lead to supply chain visibility and sustainable competitive advantage. Only that information that corresponds to VRINN criterion (valuable, rare, imperfectly mobile, not imitable and not substitutable).

## How to achieve supply chain visibility?

There is a lack of empirical research showing ways to increase supply chain visibility (Kaipia and Hartiala, 2006a). Indeed, most papers on supply chain visibility are either too theoretical or too commercial in the aim. This may be related to the fact that supply chain visibility is a qualitative criterion of supply chain performance (such as trust and innovativeness) which is difficult to assess (Chan, 2003). However, some attempts to measure supply chain visibility have already been made by Caridi et al. (2010a,b) which indicates the development of the supply chain visibility concept.

*Enablers of supply chain visibility*

*IT*
The main enabler of supply chain visibility documented by business papers is IT implementation. Industry reports (Aberdeen group, 2012, 2006; IBM, 2007) mention such technological solutions as Enterprise Resource Planning (ERP), Vendor Managed Inventory (VMI), SAP, Electronic Data Interchange (EDI), XML, collaborative planning, forecasting and replenishment (CPFR), Radio Frequency Identification technology (RFID), etc., and also provide benchmarking studies from top performers. However, these examples have a more educational purpose and provide little to no guidance in how to achieve supply chain visibility (Figure 5).
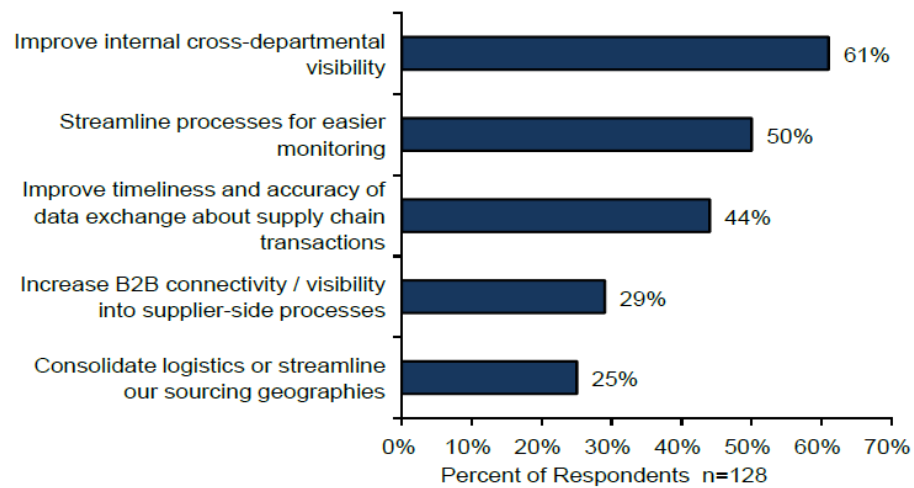
Figure 5. Strategic actions for improving visibility (Aberdeen Group, 2012)

Similarly, academic papers stress the importance of IT system implementation in order to achieve supply chain visibility (Kim et al. 2011; Cross, 2000). Modern IT systems make it possible to detach information flows from physical flows, which enables simultaneous information handling even before the physical shipment of goods. This improves efficiency of operations and facilitates supply chain agility and reconfigurability (Wei and Wang, 2010). Moreover, IT does not only improve the speed of information exchange but also the quality of information shared.

The role of IT in providing supply chain visibility was extensively discussed from transaction cost economics lens in terms of transaction costs reduction (Wang and Wei, 2007; Grover and Malhotra, 2003), but this issue will be addressed in the next subchapter.

The most recent trend in IT implementation is the use of interorganizational systems (IOS) (Kim et al., 2011) that imply the buyer's and the supplier's internal information systems' integration and compatibility and aim at providing supply chain visibility. Usage of IOS implies *virtual integration* between supply chain partners that facilitates common operations such as purchasing, shipping and receiving processes, and provides more opportunities for collaborative decision making and performance monitoring (Wang and Wei, 2007).

However, there are some studies that challenge the key role of IT in providing supply chain visibility. For example, Johansson and Melih (2008) argue that IT itself is not sufficient for supply chain visibility, but is only a tool for communication, while the real antecedents of supply chain visibility are information sharing and relationships.

*Information sharing*
Therefore, information sharing is seen as the second important enabler of supply chain visibility. Interestingly, before the seminal work of Barratt and Oke (2007) that emphasized that *"information sharing is an activity and visibility is a potential outcome of such activity"* (p. 1218), these concepts were used interchangeably.

It is important to note that not all shared information can provide supply chain visibility. Many authors claim that supply chain visibility can be achieved by sharing meaningful and useful information, but not by sharing all information with all supply chain members (Caridi et al.,

2010b); and only information that improves supply chain performance should be shared among supply chain partners (Kaipia and Hartiala, 2006b). This refers to the concept of *information quality*, according to which, information should be reliable, valid, accurate, timely, and of proper formatting (Moberg, 2002).

Adding to the "proper formatting" feature of information quality, Daugherty et al. (2006) claim that collaboration based on *standard procedures* can provide information visibility and supply chain competitive advantage. The role of *standardization* for information exchange and collaboration is also mentioned in an IBM report (2012) and in a Capgemini report (2004, p.14): *"actionable information assumes the metrics are standardized and well understood by all parts of the supply chain"*.

Finally, information sharing has a relationship aspect and implies that supply chain visibility requires closer communication between supply chain partners (Zhang et al., 2008). A lack of communication is the main obstacle in achieving supply chain visibility and may be caused by two major factors described in the following section.

### *Obstacles in achieving supply chain visibility*

Contrary to enablers of supply chain visibility, obstacles of supply chain visibility stem from difficulties in the information sharing process. There are two general factors that influence information sharing and feasibility of supply chain visibility: connectivity and willingness to share information. These dimensions are called information sharing capability and described in the connectivity-willingness matrix developed by Fawcett et al. (2007) (see the simplified matrix in Figure 6). The first factor has technological or organizational roots, while the second one refers to relationships between supply chain partners. In negative extremes, inability and unwillingness to share information create great obstacles to overcome in achieving supply chain visibility.
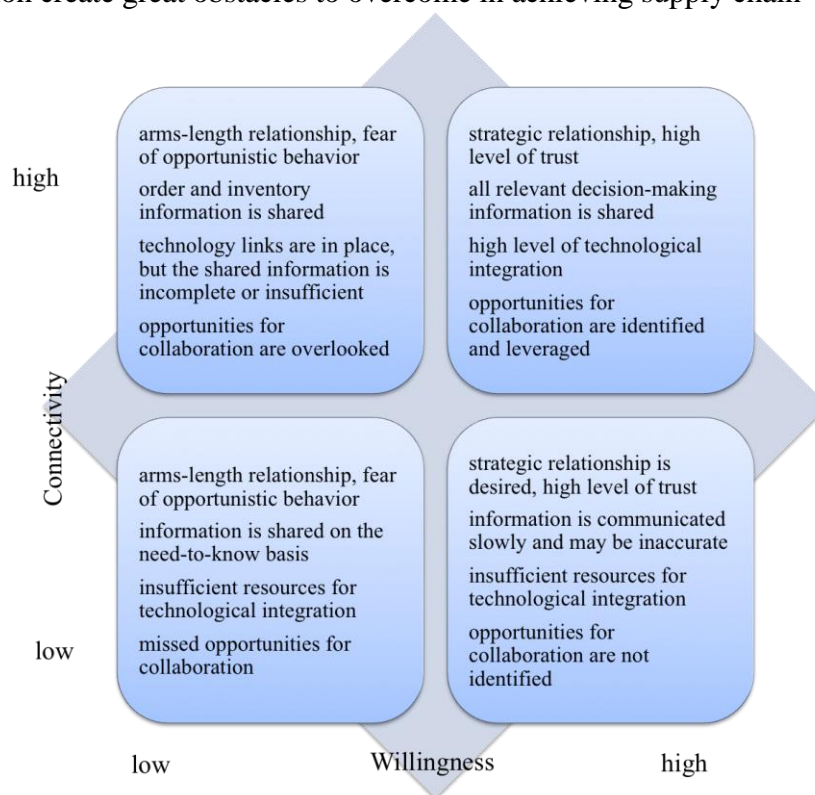


Figure 6. Connectivity-willingness matrix (Fawcett et al., 2007)

*Inability to share information*

Inability to communicate the necessary supply chain visibility information can be explained by a low level of IT adoption. This is often due to the high cost of investments (Fawcett et al., 2007; Aberdeen Group, 2006; Steinfield et al., 2011), the complexity of implementing advanced systems (Fawcett et al., 2007), or the absence of skilled people to manage the system (Capgemini, 2004).

Another factor that causes an inability to share information is IT systems' incompatibility which Fawcett et al. (2007) connects to the lack of common standards.

*Unwillingness to share information*

Although information sharing promises mutual benefits for supply chain partners, Eurich et al. (2010) reports that the low level of willingness to share information still exists within supply chains.

Willingness to share information may depend on different factors:

- awareness and availability of benefits from information sharing (Fawcett, 2007).

Different supply chain actors possess different information which might be useful or even critical for their supply chain partners. Consequently, different members of the supply chain have different priorities and reasons for sharing information (Simatupang and Sridharan, 2004). For example, the supplier is usually more interested in information sharing since information provided by the retailer can help save costs by optimizing the capacity and inventory levels. On the other hand, the retailer can benefit from sharing information with the supplier in the form of improved service level, and can, consequently, request reduced buying costs. Thus, incentive alignment (a degree to which supply chain members share costs, risks and benefits of collaboration) is important to foster information sharing between supply chain partners (Simatupang and Sridharan, 2004), otherwise unfair distribution of benefits can hinder willingness to share information (Wang, 2011).

- power balance

The more power a company has over its supply chain partners, the lower willingness to share information is, while "weak" companies are more prone to disclose their item-level information (Eurich et al., 2010). Power can be related to the possession of important information, critical resources or the size of the company.

- size and complexity of a supply chain

In large and multi-tiered supply chains, the level of willingness to share information is lower compared to small supply chains in which most – or even all – participants are observable and the level of trust is higher (Eurich et al., 2010).

- degree of goal alignment

Companies with aligned goals share information more voluntarily (Eurich et al., 2010).

- privacy risk (trust vs. opportunism)

Companies avoid sharing data with indirect business partners and prefer to share only transactional and delivery data with known suppliers (Eurich et al., 2010) in order to keep competitive advantage and avoid partner loss (Wang, 2011).

- industry-specific risks

Eurich et al. (2010) explains that companies from different industries might have different reasons for unwillingness to share information, e.g., a concern regarding price maintenance in

the consumer goods industry, and the risk of distribution channels' revelation and copying of strategic decisions by competitors in the pharmaceutical industry.

To sum up, information asymmetry and the fear of partner opportunism are the main reasons for an unwillingness to share information when supply chain members keep internal information proprietary and release information only on a need-to-know basis (Daugherty et al., 2006).

The risk of opportunistic behavior is one of the key concepts of transaction costs economics (TCE) which is important in order to gain an understanding of vertical integration described in the next chapter.


## Do all companies need supply chain visibility?

Taking into account the benefits provided by supply chain visibility and difficulties in achieving it, few authors investigate different cases of supply chain visibility deployment.

Barratt and Oke (2007) defines the *level of visibility* as "*the extent to which the information shared is accurate, trusted, timely, useful, and in a readily usable format*" (p. 1218) and conclude that the level of supply chain visibility may differ across the linkages in a supply chain and depends on the perceived *level of importance* and interdependencies between partners. Aberdeen Group report (2012) adds to this idea and proposes to include visibility only into critical supply chain activities, which is due to the high cost of supply chain visibility maintenance.

Similarly, Kaipia and Hartiala (2006a) mentions that visibility need varies in accordance with the company's role and position in the supply chain. For example, the paper suggests that demand visibility is more important for suppliers than for retailers because the latter have a direct access to demand data.

In this context, Holweg et al (2005) questions the need for demand visibility because demand information can be extracted from the order history and, furthermore, many suppliers do not use extensive demand information gained from their partners. However, this proposition seems weak when taking the research of Kaipia and Hartiala (2006a) into account, which states that using different data sources regarding demand (e.g., order signals, sell-through data, point of sales (POS) data) better contributes to capacity utilization and inventory turnover. Moreover, using order history as demand information may be misleading since orders are often delayed and distorted (Lee et al., 2004).

Caridi et al. (2010a) discusses that the need for supply chain visibility depends on two dimensions of supply chain configuration, namely virtuality (the extent of outsourcing) and complexity (the number of tiers and suppliers). It implies that multitier supply chains with a high degree of outsourcing require more supply chain visibility to manage such complexity. In another paper Caridi et al. (2010b) concludes that the need for supply chain visibility is affected by the degree of supply chain vertical integration: the lower the level of vertical integration, the higher the need for visibility, and the higher the cost of visibility maintenance.

Lastly, Zhang et al. (2008) concludes that the need for supply chain visibility is industry-specific.

*Summary*

Supply chain visibility is an emerging concept in both business practice and academia, which is of great importance in global complex supply chains. Supply chain visibility is mostly associated with the customer sharing demand information with their supplier to help create a more accurate forecast. This, in turn, helps match supply and demand better and reduce overall supply chain costs, improve responsiveness and efficiency of a supply chain (Chopra and Meindl, 2010).

Supply chain visibility can be defined as the availability of accurate and relevant supply chain information to a relevant supply chain partner, which highlights the importance of what information to share, how much information to share and with whom. The quantity and quality of shared information can help either create supply chain visibility, increase supply chain performance and achieve competitive advantage, or be detrimental for both.

The main enablers of supply chain visibility are information sharing and IT implementation, while the main obstacles are insufficient IT adoption and an unwillingness of supply chain partners to communicate, as well as the lack of common communication language.

The need for and benefits from supply chain visibility differ among different supply chain partners depending on their position and role in the supply chain.

## 3.1.2 Understanding supply chain design

Striving to achieve supply chain visibility, it is important to understand in which environment information exchange takes place. This subchapter aims at finding antecedents of supply chain design typology and understanding of why companies choose one or another supply chain design.

The traditional definition of supply chain design implies making decisions regarding the facility role, facility allocation and capability (Chopra and Meindl, 2010), while in this thesis supply chain design means the type of supply chain depending on the place of product manufacturing and distribution. It suggests such extreme examples of supply chain design as many-to-many and exclusive supply chains. Taking into account the novelty of this classification, the literature review in this chapter aims at finding antecedents of supply chain design classification and at an investigation of different supply chains configurations.

As it was discussed in Caridi et al. (2010a,b), the need for supply chain visibility is affected by supply chain configuration. However, no other evidence that links supply chain visibility with supply chain configuration was found. Therefore, since information sharing is an antecedent of supply chain visibility (Barratt and Oke, 2007), it is reasonable to investigate different supply chain configurations in terms of information sharing instead of visibility.

Moreover, supply chain management literature suggests a strong connection between information sharing, supply chain visibility and collaboration concepts because they share similar enablers (IT), obstacles (inability or unwillingness to communicate), and benefits (performance improvement and potentially – competitive advantage). In order to achieve supply chain visibility, companies share information of a certain quality, and then, depending on their need and willingness, can act on this information, i.e. collaborate. Thus, it is also reasonable to investigate different supply chain configurations in terms of degree of collaboration instead of visibility.

The similarity of these three concepts is not surprising since all of them are parts of the information driver of supply chain performance (Chopra and Meindl, 2010) (Figure 7).
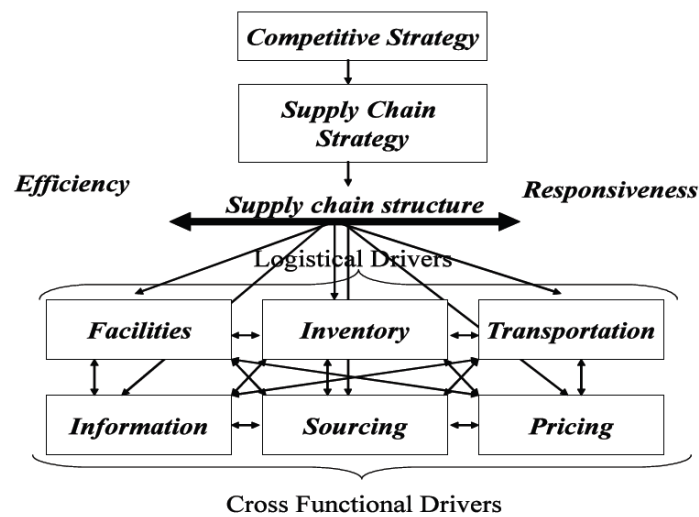


Figure 7. Supply chain performance drivers (Chopra and Meindl, 2010)

The important clarification is the distinction between the terms "supply chain network" and the "supply chain", which are often used interchangeably in modern supply chain management literature (Caridi et al., 2010b). The supply chain network describes a more complex structure and implies higher interdependence between supply chain actors which is relevant to the modern global environment. However, in this thesis the more traditional term "supply chain" is implemented. A typical view of a supply chain is illustrated in Figure 8.
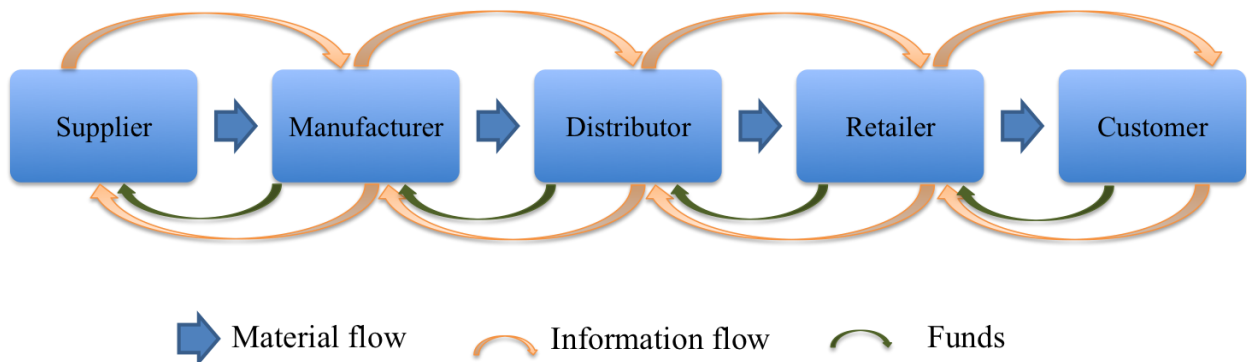


Figure 8. Typical supply chain (adopted from Chopra and Meindl, 2010)

## Typical information shared

Before assessing different supply chain configurations, it is important to mention which typical information is usually shared between the buyer and the supplier on which they can collaborate.

Caridi (2010b) mentions four types of information flows:

- transactions/events (e.g. order confirmation, order modification, advanced shipping notice, payment notice and sales reporting)

- status information (e.g. order status, stock level, sent orders, stocking capacity, residual shelf-life, work-in-progress, backlog, machine saturation and production residual capacity)
- master data: information about the product features (e.g. basic or extended technical features, commercial information, product life-cycle, ingredients, managerial product information and stock keeping unit features)
- operational plans (e.g. distribution plan, production plan, strategic sales forecast, operational sales forecast and promotions plan)

Similarly, according to Kaipia and Hartiala (2006b), collaboration takes place in three forms:

- transactional relationships (exchanging orders and invoices)
- information-sharing relationships (inventory levels or order status)
- joint planning and development of business plans (interactively)

Most current relationships in supply chains are based on transactional or information-sharing levels.

Comparing these two classifications, it is observable that transactional relationships include exchange of transactions/event information, information-sharing relationships include, in addition, exchange of status information and master data, and the most collaborative relationships include interactive sharing of operational plans, synchronization of operations and joined decision making between supply chain partners (Figure 9).
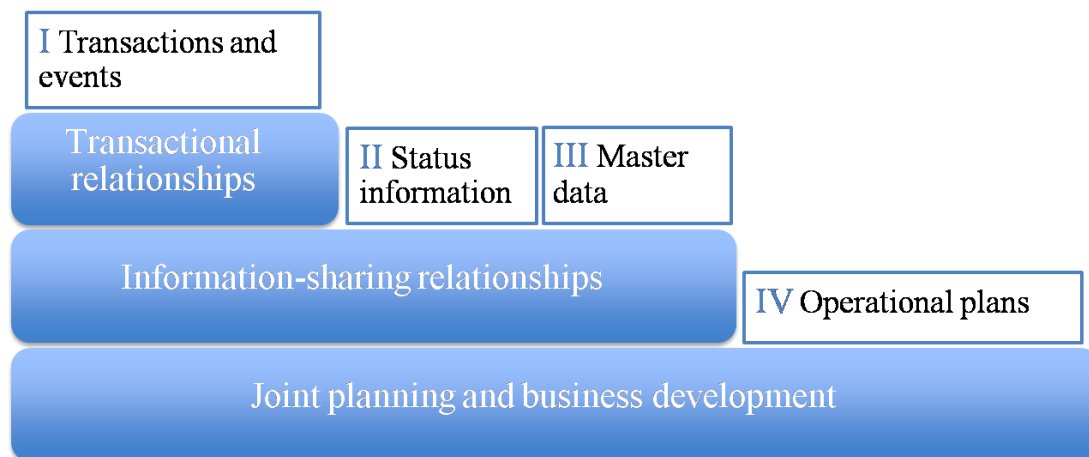


Figure 9. Forms of supply chain collaboration

## Factors that influence the choice of supply chain configuration

Supply chain configuration is characterized by the type of relationships between supply chain partners. That is why it is important to look into the theories that provide understanding of different governance structures within supply chains.

Transaction cost economics (TCE) and resource-based view (RBV) are the two prevailing economic theories for analyzing the choice of the governance structure in supply chains (Wang and Wei, 2007). Nevertheless, Grover and Malhotra (2003) mentions that TCE and RBV are underutilized in operations management (OM) literature in comparison with outsourcing-decision literature.

*Transaction cost economics (TCE)*

The TCE theory is developed by Williamson (1975, 1979) and provides an explanation to the market versus hierarchical governance structure between organizations. There are two key assumptions of TCE: bounded rationality and opportunism (Williamson, 1975 cited by Grover and Malhotra, 2003).

*Bounded rationality* refers to the fact that although decision-makers intend to make a rational decision, their ability to evaluate all possible decision alternatives is limited. This situation turns into a problem under conditions of complexity or uncertainty because additional negotiations to solve a problem raise the transaction costs (ibid).

*Opportunism* indicates the situation when a supply chain member seeks to take advantage of their supply chain partner. It might happen in a situation of bargaining with a small number of partners or in the case of relationship-specific investments when a supply chain member becomes "locked-in" and unable to switch the partner. The solution to this situation could be an extension of a supplier base in order to reduce the risk of opportunism; however, it may raise coordination costs (ibid).

Opportunism coupled with bounded rationality gives rise to the *transaction cost,* which includes (Clemons et al., 1993):

- coordination cost (cost of searching information, negotiating cost, monitoring and enforcement cost)
- operational risk (risk that the supply chain partner misinterprets or withholds information, or underperforms)
- opportunism risk (lack or loss of bargaining power resulting from the execution of a relationship which is influenced by the cost of relationship-specific investments, the number of potential suppliers for the product, the loss of resource control)

IT can reduce all these transaction costs since supply chain processes (e.g., procurement process) will be standardized and automated (ibid). Therefore, IT mitigates the consequences from opportunistic behavior at least by giving the company an opportunity to develop and manage a larger supplier base. Furthermore, investment in IT itself is not similar to investment in capital goods as it may not necessarily be relationship-specific (ibid).

However, Müller and Seuring (2007) does not completely agree with Clemons et al. (1993) and claims that reduction of transaction costs depends on the type of IT implemented, as highly specific investments in IT might lead to higher transaction costs.

The key characteristics of transactions in TCE are (Grover and Malhotra, 2003):
- degree of uncertainty regarding the transaction (which depends on the degree of information asymmetry between supply chain members)
- degree of asset specificity (refers to relationship-specific investment: if they are high, the switching cost will also by high)
- frequency of transactions.

According to TCE theory, the higher each of these characteristics, the more vertical integration is preferred in comparison with market governance structure (ibid). In other words, the choice of a supply chain governance structure is made with the aim to reduce the risk for opportunism and the level of transaction costs.

### Resource-based view (RBV)

The RBV theory in organizational economics literature explains how a company's resources and capabilities can affect performance and provide a competitive advantage (Barney, 1991). In order to stay competitive, the company should acquire and control resources that fulfill VRINN requirement (i.e. they are valuable, rare, imperfectly mobile, not imitable and not substitutable) and bundle them with capabilities.

In recent applications of RBV in operations management literature, the shift from resource availability to capability development is observable. *"Resources are tangible or intangible assets that are key inputs into the production and delivery of goods or services; and capabilities are organizational routines or mechanisms that enable a firm to acquire and deploy resources to facilitate the production and delivery of goods or service"* (Rungtusanatham, 2003, p. 1089).

There are four noteworthy studies that have adapted and applied RBV to supply chain research.

Rungtusanatham (2003) describes *VRINN resources* as supply chain linkages that guarantee availability of goods from the supply chain partner and *VRINN capability* as connectivity with supply chain partners which enable the firm acquire VRINN resources or VRINN knowledge (e.g., demand forecast, order status, POS data).

So supply chain linkage is viewed as both *resource* and *capability* that provide an operational performance benefit to a firm on a sustainable or temporary basis (Figure 10).
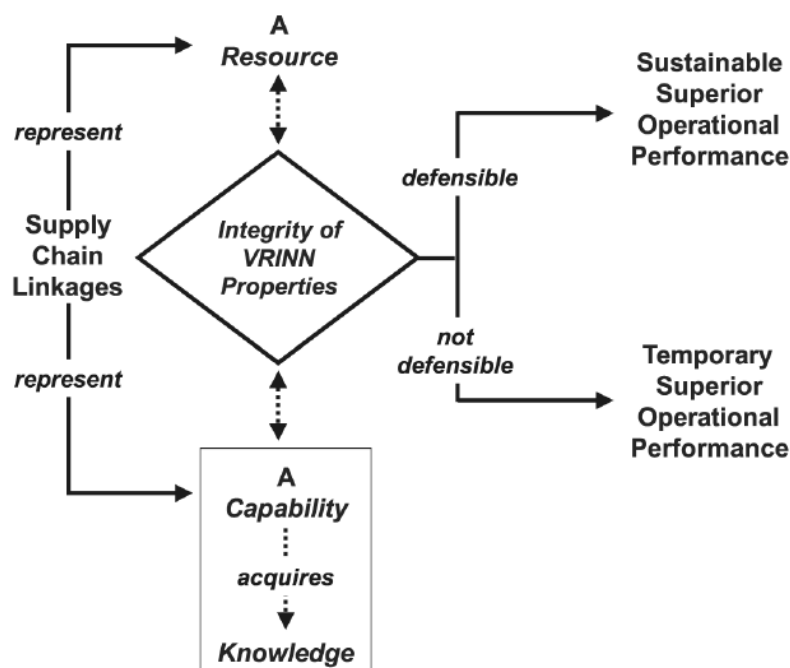


Figure 10. Supply chain linkages and operational performance:
through the RBV lens (Rungtusanatham, 2003)

IT-technologies facilitate transactions and make them cheaper, which is seen as a threat, and Rungtusanatham (2003, p. 1094) calls for the protection of VRINN resources and capabilities by motivating: *"if a firm is able to protect the integrity of the VRINN properties of its supply chain linkages, irrespective of whether they represent a resource or a knowledge-acquisition capability, the firm will enjoy sustainable superior operational performance benefits"*.

In their second seminal work, Barratt and Oke (2007) states that VRINN resources (technology or non-technology enabling factors) have a potential to provide distinctive supply chain visibility. In comparison with previous works, the authors claim that this visibility can lead not only to a supply chain performance improvement but also to a sustainable competitive advantage.

Wang and Wei (2007) adds on both Rungtusanatham (2003) and Barratt and Oke (2007) studies and considers information visibility and supply chain flexibility as unique capabilities that can lead to a competitive advantage. Supply chain flexibility is defined as willingness and capability of trading partners to change supply chain practices in order to improve their adaptability to new tasks and challenges. This definition is in line with the later concepts "reconfigurability" of these authors (Wei and Wang, 2010) and the connectivity-willingness matrix of Fawcett et al. (2007).

Information visibility and supply chain flexibility are seen as unique and inimitable capabilities because they require a high degree of virtual or physical integration and are useful only when they are taken together. Otherwise, the value of these capabilities disappears when one of the supply chain actors leaves the supply chain (Wang and Wei, 2007).

Finally, Ketokivi and Schroeder (2004) adds on capability-based aspect of RBV by arguing that *"it is the manufacturing practices, not resources per se, that are subject to inimitability and causal ambiguity and are context-specific, hence, they offer value for the organization"* (p. 173). So, this study proposes to extend the resource-based view to a routine-based view on supply chain competitiveness where routines as standard manufacturing practices and capabilities are seen as a source of a competitive advantage.

To sum up, TCE and RBV can provide an explanation of the choice of a supply chain configuration. Supply chains base their collaboration on TCE in order to control opportunistic behavior of supply chain partners and economize on transaction costs, while the RBV theory is usually chosen with the aim at effective collaboration and protection of valuable resources and capabilities (Wang and Wei, 2007). So, TCE is a theory of cost minimization, and RBV – that of value creation and protection, but both aim at maintaining the supply chain's competitive advantage.


## Types of supply chain configuration

Building on TCE and RBV considerations, the main distinction of different supply chains might be a degree of vertical integration. Furthermore, in attempt to find more typologies of supply chain design, the literature on innovation management and e-commerce is reviewed.

### *Vertical integration*

The classification of supply chains may be based on the *degree of vertical integration* according to the ownership of the assets. There are four main types of supply chain relationships: vertical integration, virtual integration, strategic alliances, and arms-length relationships (Hayes et al., 2005). The extreme examples of this scale are of interest to this thesis.

Vertical integration implies a high degree of mutual adaptation between supply chain functions within one owner-company. In arms-length relationships exchanged information should be standardized and highly codified in order to be understood by different supply chain actors. This creates the main benefits of not being vertically integrated – the ability to switch suppliers or partners.

From TCE perspective, the advantages of vertical integration are (Mahoney, 1992):

- transaction costs' reduction (output and/or input price advantages, while in arms-length relationships each intermediary has a power to charge a price above competitive level)
- coordination and control of opportunistic behavior
- audit and resource allocation (since a company has the legal right to audit its own divisions, but no right to audit supply chain partners)
- communication efficiency (due to development of a special coding system – standardized language of communication)

Guan and Rehme (2012) contributes to the vertical integration theory by distinguishing *"vertical integration"* in the supply chain and *"supply chain integration"* concepts and comparing driving forces for each one. Vertical integration, as was already mentioned, has ownership as the integrating mechanism, and TCE as the theoretical basis in terms of transaction costs reduction. The authors add such driving forces for vertical integration as the technical complexity of a product, product differentiation, higher margins, and an access to customer information in the case of downstream integration.

Supply chain integration, according to Guan and Rehme (2012), arises from the industrial dynamic and coordination theory and represents intensive collaboration between different supply chain actors, which suggests the name of such supply chains as "collaborative supply chains". The driving forces for supply chain integration are external pressures, environmental uncertainty, trying to reduce supply chain costs or increase service level and intensive competition between supply chains.

Guan and Rehme's (2012) study also provides an implication equivocal for this thesis: vertical integration can improve supply chain visibility which is decreasing along the length of the supply chain. However, according to the definition accepted in this thesis, supply chain visibility implies information sharing among different supply chain actors. Vertical integration can increase only internal visibility, and it is "supply chain integration" that may increase supply chain visibility.

So, the statement that vertical integration increases supply chain visibility is misleading since neither ability nor willingness to share information with external supply chain partners is clear. Moreover, it is not clear where information exchange is more efficient: in vertically integrated supply chains which share similar practices and procedures or in supply chains with arms-length relationships (collaborative supply chains) where information shared must be well codified and interpreted in an unambiguous way (Hayes et al., 2005). In the latter case, vertical integration is not needed to achieve supply chain coordination.

### *Open vs. closed supply chains*

Keeping in mind a willingness to share information, one of the first associations regarding communication and collaboration is openness and closeness of systems. The only evidence of this classification is found in Marsh's publication in the *Financial Times* (2011) which defines open and closed supply chains not in terms of $CO_2$ emissions and waste disposal (reverse and closed-loop supply chain classification) but in terms of open or closed communication within the supply chain. The author expresses the difference between open and closed supply chains and highlights the trend toward closed supply chains (Figure 11):

*"A **closed** supply chain is a highly integrated set of networks in which many of the technologies being applied are developed at least partially by the company orchestrating the system."*

*"In **open** supply chains – common in industries such as automotive, aerospace and many areas of consumer electronics – the emphasis is on standardized components that fit together in a modular fashion. In these systems, suppliers are generally encouraged to be the main innovators and sell the same components to a range of customers."*
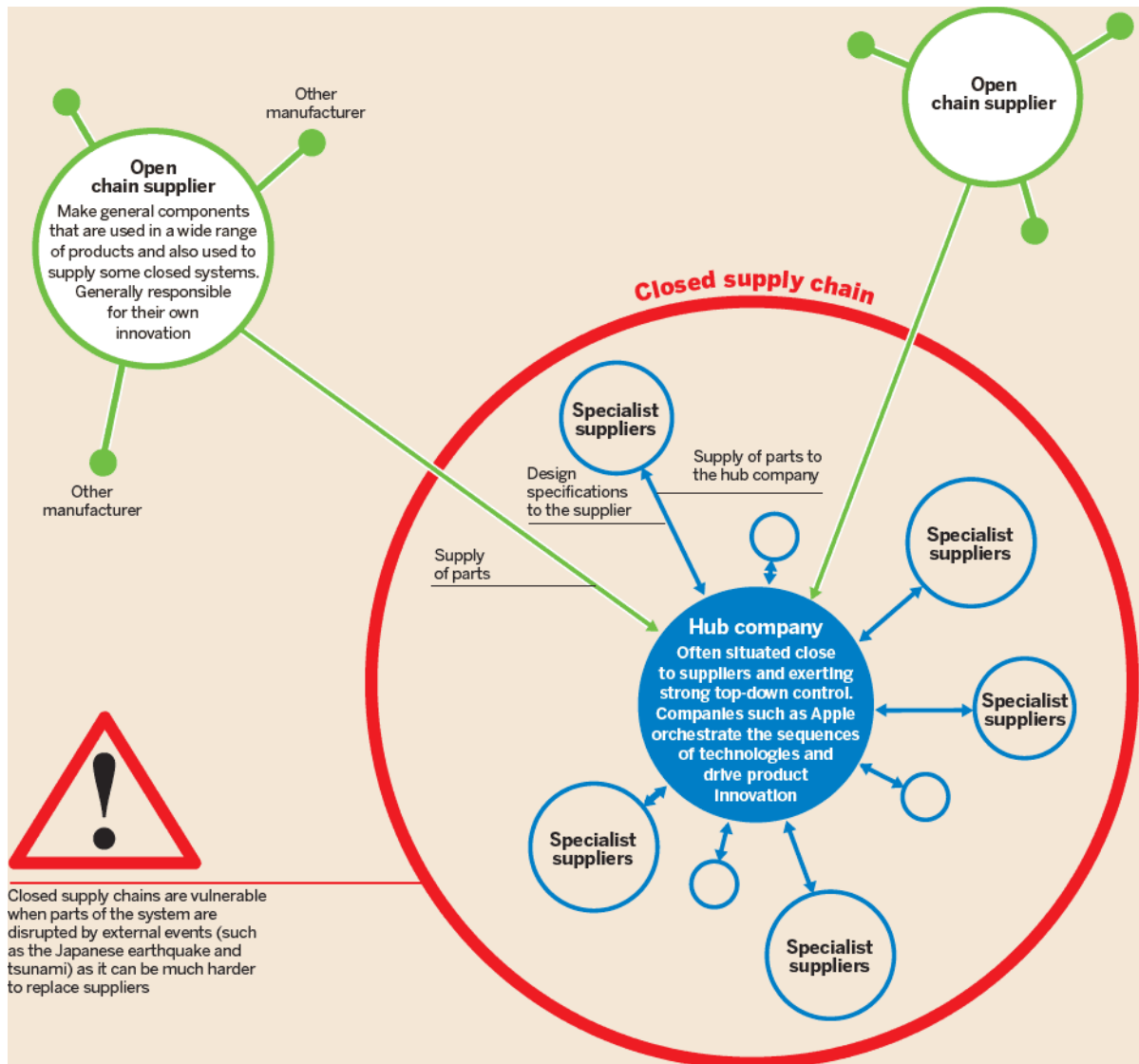


Figure 11. Open vs. closed supply chains (Marsh, 2011)

Even though the author defines different types of supply chains in the context of product development and innovation (not from the supply chain perspective on information sharing), there are some important aspects from Marsh's work that can be further used in our analysis.

The important aspect of an open supply chain is the emphasis on standardized components which makes these supply chains more time and cost efficient as well as more responsive in comparison with closed ones.

Closed supply chains are considered by the author as highly integrated with the presence of a hub company, which makes the supply chain organizational structure more centralized and coordinated. Marsh also highlights the important reason for being closed – it is the way to protect

the product from being copied by competitors as well as to ensure the concentration of innovative efforts. The main disadvantage of closed supply chains is seen in greater vulnerability to disruptions due to a limited supplier base and a close geographical situation.

The main implication from Marsh's work (2011) is that closed supply chains possess close collaboration with suppliers and a high degree of vertical integration in order to protect competitive advantage, which corresponds to the RBV theory.

### eCommerce

An important classification of supply chain configuration can be extracted from the literature on business-to-business (B2B) eCommerce. Cross (2000) mentions that implementation of IT solutions has facilitated the departure from traditional one-to-one (one supplier has a business relations with one buyer) and one-to-many supply chains to many-to-many supply chains (many suppliers interact with many sellers). This classification seems promising in retail industry because it explains the logic of product flow: in many-to-many supply chains, the product is produced by many different suppliers and sold in many different stores.

Mansell (2003) argues that the many-to-many electronic marketplace facilitates coordination between firms because it reduces the cost of searching for information and the costs from incomplete or asymmetric information. This statement means that transaction costs reduction is not a prerogative of only vertically integrated supply chains.

Another benefit of many-to-many supply chain configuration is observable from Williams et al. (2002) *re-linking concept of electronic supply chains*: the authors stress that the relative focus on partnerships and strategic alliances has changed from establishing and maintaining long-term partnership relationships to productivity and ability to re-link quickly.

Yet, Laukkanen et al. (2007, p.506) provides evidence that some companies *"have expressed an increasing interest in private exchanges – one-to-many solutions allowing a company to exchange customized information with its selected supply chain partners over a secured connection"*. Even though this study concerns inter-organizational IT system adoption, it still shows the preference and motivation of companies regarding a secure information exchange.

Another classification from B2B commerce is extracted from Dai and Kauffman's (2006) work which distinguishes the extranet (closed networks) and the e-market (open networks). A comparison of these networks is illustrated in Table 3.

Table 3. A comparison of extranets and e-markets in e-procurement (Dai and Kauffman, 2006)

| Dimensions for comparison | Extranets | E-Markets |
|---|---|---|
| Network features | Private networks–only open to pre-selected business partners | Open networks–accessible to a large set of potential business partners |
| Market-making | Limited market-making functions and restricted set of trading partners | More market-making functions and easier access to a larger pool of potential partners |
| Information sharing | Both transactional and strategic information can be shared | Mostly transactional information is shared; strategic information is not |
| Implementation costs | Higher costs to have additional participants in the network | Lower costs to add additional participants to the network |

The important finding of this paper is the conditions under which an e-market is preferred over an extranet (Dai and Kauffman, 2006, p. 110): *"a buyer will adopt an e-market approach when the competitive advantage that a supplier gains over its rivals by joining the e-procurement network is modest"* which can be translated into avoidance of the supplier's opportunism.

The second important finding is that the *"buyer will need to have a bigger trading network with an e-market than with an extranet in order to achieve the highest benefits"* (p. 110) which means that the increasing number of business partners due to choosing an e-market supply chain configuration is not only a benefit, but also a necessity in order to cover the expenses of maintaining this network.

Oh and Kim's (2011) and Milliou and Petrarkis (2004) add on Dai and Kauffman's research and investigate public and private e-marketplaces depending on the openness or closeness for participants:

- public e-marketplace is open to all participants and exhibits a high level of information sharing and collaboration
- private e-marketplace is open only for a limited number of trusted participants and consequently, the level of information sharing and collaboration is higher.

Milliou and Petrarkis (2004, p. 101) explains the reasons why companies join a public or a private e-marketplace: *"the individual firm's incentives to create its own private e-marketplace are stronger, the closer is the supplier-buyer collaboration within the private e-marketplace, the higher is the degree of spillovers within the public e-marketplace, and the larger is the buyer's profit share in its exclusive relation with its supplier inside the private e-marketplace"*.

The main finding of Oh and Kim's (2011) work is that both e-marketplace types improve operational performance, but only the many-to-many e-marketplace contributes to financial performance. The paper also investigates different types of e-marketplaces and suggests that many classifications of the e-marketplace share similar characteristics. For example, the abovementioned classification of e-marketplaces can be combined with the classification according to the number of participants (many-to-many, many-to-one, one-to-many). The authors claim that the many-to-many e-marketplace is more public and horizontally integrated, while the many-to-one e-marketplace tends to be more private and vertically integrated.

From these examples, a new typology for supply chain design appears: supply chain design for companies in retailing industry will be most probably described by the "many-to-one" or "many-to-many" scheme since retailing implies the income of products from different suppliers.

Additionally, in retailing industry many different brands pass through many different retailers, which is the reason for a common standard for communication and coding information (it will be discussed in the next subchapter).

*Summary*

There is a lack of literature related to different types of supply chain design in terms of supply chain visibility, information sharing and collaboration. Therefore, findings from organizational economics, innovation management, and e-commerce areas suggest the following typologies of the supply chain: arms-length vs. vertically integrated supply chains, open vs. closed supply chains, and open (public) vs. private networks.

Intuitively understandable types of the supply chains share common characteristics: open, collaborative and public supply chains are more prone for collaboration with a big amount of partners and sharing transactions information; and closed, vertically integrated, private supply chains can be characterized by collaboration with pre-selected trusted partners and sharing both transactions and more strategic information.

Based on TCE and RBV considerations, the underlying reasons for the first type of supply chain configuration are security considerations (protection of information from competitors and opportunism avoidance), transaction cost reduction, access to downstream information about demand, environmental uncertainty, and the need to increase service level. The main reason why companies might choose open supply chain configuration is the ability to switch partners, which means reconfigurability and flexibility in global uncertain environment enabled by common standard-based information exchange (Hayes et al., 2005).

While the found supply chain typologies provide an important insight into governance of supply chain relationships, these typologies do not provide the characteristics of supply chain design intended in this thesis, namely many-to-many and exclusive supply chains. Further consideration of supply chain characteristics as well as the introduction of the term "exclusive supply chain" within retail industry context will be performed in chapter 3.2. "Theory development".

## 3.1.3 Global data identification standards

In order to collaborate more efficiently, supply chain actors need to use a unified format of information exchange. In this subchapter open and proprietary standards are defined as well as frameworks for standard adoption are described. At the end, the GS1 system of standards is presented.

## Standards in the supply chain

*"Standardization is the voluntary process of developing technical specifications based on consensus among all interested parties"* (European standards, European Comission, 2012-05-25). So, standard is a voluntary agreement that structures any activity or any industry.

Standards in supply chain management are viewed as a resource and a coordination mechanism which can help improve operational compatibility and connectivity, efficiency and effectiveness of inter-organizational supply chains due to clear and unambiguous communication between partners (Fabbe-Costes et al., 2006).

According to Brunsson and Jacobsson (2000) cited by Fabbe-Costes (2006, p.95), *"standards facilitate market transactions by making it easier to exchange information"*. Consequently, in order to optimize supply chain processes, information should be standardized, updated and regularly available (Brüggemann and Hübner, 2008). One of the solutions to achieve this lies in the creation of electronic catalogs, where structured and standardized information can be easily changed, updated and communicated on a bigger scale (ibid).

Fabbe-Costes et al. (2006) reports about a lack of studies on supply chain standards as compared to standards in technology development, and mentions the following standards used in logistics:

- load carriers (e.g., EURO-pallet, ISO containers)
- communication standards (e.g., EDI, RosettaNet, XML)

- labeling standards (e.g., GS1, Globally Harmonized System of Classification and Labeling of Chemicals – GHS)
- product identification standards (GS1)
- evaluation tools (standard performance measures)
- quality systems (ISO-9000).

The focus of this thesis is on the GS1 System whose standards fall into several categories such as communication, labeling and product identification standards. Since the labeling standard is more closely associated with the carrier of information, the focus of this research is on the identification and communication aspects of the GS1 system of standards.

In business reports GS1 standards are used under different names, such as product/article numbering standards, codification standards, product data identification standards, international traceability standards, global standards for data capture and item identification, product and location identification standards. This can be explained by the diversity of the GS1 standards portfolio. In this thesis the term "global data identification standards" is used.

There is a lack of academic papers on global data identification standards in supply chain management literature. Only a few articles related to coding and identification issues of the GS1 system of standards are found (Power and Simon, 2004; Burbano, 2011). For this reason, the theory from IT and IOS standards classification and adoption (Zhu et al., 2005; Chong and Ooi, 2011; Steinfield, 2011) as well as theory related to RFID adoption (Schmitt et al., 2008; Thiesse et al., 2011) are used in this chapter.

The important classification of standards that is of great interest for this thesis is open and proprietary standards.


## Open vs. proprietary standards

The history of bar code development reveals the difference between open and closed environment in terms of open or proprietary data identification standards (Georget, 2007). The author claims that the development of proprietary standards is caused by the need to serve the firm's internal productivity and quality targets, while involvement of other actors in the process of standards development and adoption ("many-to-many" in the internet jargon) creates an open environment for the company (Georget, 2007, p. 28).

A classification of standards according to the levels of openness is mentioned in Zhu et al. (2005, p.3) that cites David and Greenstein (1990):

*"If a standard is developed and then available only to a closed set of firms that require a private communication platform and translation software, it is considered to be a **proprietary standard**.*

*In contrast, if a standard is developed by an open community that uses public communication platforms and software, it is considered an **open standard**."*

According to Steinfield et al. (2011), proprietary standard solutions have failed to solve the information transparency problem in global supply chains. The paper also highlights the need for both industry-wide data and process standards and shared IT-architecture.

Brüggemann and Hübner (2008) defines open standards from the economic point of view as freely available standards in contrast to standards that require license fees. So this classification

does not contradict but does not correspond either to Zhu et al.'s (2005) classification. Even though GS1 standards adoption implies payment of a membership fee, these standards are still considered open ones – and even global standards – since they have worldwide adoption.

Fabbe-Costes et al. (2006) reports about a drawback to open and proprietary standards. The proprietary standard can imply a power imbalance towards the actor that has developed and maintained a standard; and the open standard can cause revelation of important information since all partners use the same system.

## Adoption of global data identification standards

Only two studies that describe the adoption of global identification standards are found in this literature review. Power and Simon (2004) conducted a survey of companies-EAN members (former GS1) in Australia. The following types of EAN system implementers were investigated:

- *reactive* – companies that implemented standards at item level, and usually upon request from trading partners.
- *tactical* – companies that implemented EAN standards with the aim to improve efficiency
- *strategic* – companies that implemented EAN standards with the aim to achieve integrated supply chain management.

The main finding of the study is that the degree of benefits from EAN system implementation depends on the extent of standards implementation, the company size and the industry sector.

The research revealed that companies from the "tactical" and the "strategic" groups gain significant business benefit from the use of the EAN system; besides they are more knowledgeable of the techniques and implications of use. By contrast, the "reactive" group can be characterized as indifferent or even negative about the EAN system and its contribution to real or potential business outcomes.

The study suggests that the smaller the company, the more likely it is it will take the reactive strategy positioning, whereas the larger companies get more benefits from data identification standards adoption. For example, "strategic" implementers are more likely to be larger organizations in the retail or wholesale distribution sectors.

In the later work Power (2005) explains that the extent of standards implementation is significantly determined by:
- the level of understanding of the range of options
- potential benefits
- the range of applications available for implementation.

Similarly to the previous chapter, literature from IT and RFID adoption can be implemented in order to find an appropriate framework for data identification standards adoption. While the focus of this research is not on standard development, but on potential for standard adoption, Thiesse et al. (2011) proposes the following theoretical lenses for standard adoption:

- *diffusion of innovation (DOI) theory*

Standard adoption is determined by five attributes of innovation: the relative advantage, compatibility, complexity, triability, and observability (Rogers, 2003 cited by Thiesse et al., 2011).

- *TCE*

This theory was discussed in chapter 3.2.2.

- *collective action theory*

Rosen (1994) explains that standards do not emerge in a vacuum; instead, they are rather the yield of individual or collective actions of companies. Their actions can be either coordinated or not, but over time standards will be established. Therefore, in some cases, the dominant members of an organizational field might prefer their partners to adopt their proprietary formats for interconnection rather than industry-wide standards.

Moreover, due to the network context, decisions of the organizations regarding standard adoption are interdependent (Fabbe-Costes et al., 2006). As an advantage, it means that the common standard adopted becomes a coordinated mechanism in the network, but there is a risk of a "lock-in" situation, i.e. the more enterprise uses the standards, the more difficult it becomes to change them.

- *technology-organization-environment (TOE) framework*

The TOE framework seems the most suitable for this research as it includes contextual factors. This is important because the adoption of global standards is investigated in this thesis within different contexts (supply chain designs).

### *TOE framework*

Thiesse et al. (2011) and Burbano et al. (2011) describe the use of the TOE framework and highlight the contextual factors influencing standard adoption that are mentioned in Table 4. These factors can serve as both drivers and barriers for standards implementation in practice.

Table 4. TOE framework

| Contextual factor | Contributing research |
|---|---|
| **Technological context** | |
| *degree of technological complexity* – difficulties associated with understanding, implementation, and use of standards | Schmitt et al. (2008), Egyedi and Spirco (2011)<br><br>Chong and Ooi (2008) adds on such supply chain factors as product characteristics, i.e. product complexity, product frequency and volume as the ones that can influence adoption of standards |
| *perceived benefits of adoption* – perceived advantages from standard adoption for all stakeholders | Schmitt et al. (2008); Power and Simon (2004)<br><br>According to Zhu et al. (2005), using open standards makes it easier for the firm to search for and connect to potential business partners that also support open standards. This can open new markets for a firm as well as new opportunities for business development<br><br>Egyedi and Spirco (2011) mentions that standards adoption will be higher and even can catalyze infrastructure transitions if:<br>- their content well-reflects relevant stakeholder interests<br>- standard specifications are simple and performance-oriented |

| Contextual factor | Contributing research |
|---|---|
| *perceived compatibility –* compatibility with existing values, strategic orientation, practices, infrastructure | Schmitt et al. (2008) |
| *perceived cost of adoption* | Thiesse et al. (2011); Schmitt et al. (2008) |
| **Organizational context** | |
| *size of an organization* | Schmitt et al. (2008); Abbott (2004)<br><br>The smaller the company, the more likely it will take the reactive strategy positioning, whereas larger companies get more benefits from data identification standards adoption (Power and Simon, 2004).<br><br>Thiesse et al. (2011) confirms that larger organizations usually have more funds and other resources to implement a standard |
| *top management support* | Thiesse et al. (2011), Schmitt et al. (2008), Chong and Ooi (2008), Egyedi and Spirco (2011), Zhu et al. (2005)<br><br>It is important to mention that most authors underline the need of trust for the standard from top management and other stakeholders as well as the overall willingness and the ability to adopt new standards |
| *employee resistance to change* | |
| **Environmental context** | |
| *forces within the supply chain (partner's power)* | Thiesse et al. (2011); Chong and Ooi (2008)<br><br>The standards' adoption process can also be facilitated by the power of one of the actors – the "focal company" or a big retailer (Power and Simon, 2004), whose aim is to increase the management of goods and information flows between trading partners.<br><br>Schmitt et al. (2008) highlights such factors that slow down the adoption of RFID as the "wait and see" approach, skepticism, a long standardization process, a lack of inspiration from the dominant supply chain partner (here the role of the supply chain captain is evident) and a lack of agreement for a single standard |
| *external pressure* | Schmitt et al. (2008); Zhu et al. (2005)<br><br>Chong and Ooi (2008) highlights such external pressures as the type of industry, competitors, accessibility to the resources supplied by others |

# GS1 system of standards

In this section GS1 system of standards is discussed in order to educate the reader about these standards and show examples of barcodes handling.

Barcode was invented as a way to automatically record items at the checkout, but it became the solution for broader issue for business as a whole (Georget, 2007). The bar code itself is a simple carrier of information, but the data encoded in it represents a language for business partners. This language is used to monitor everyday business processes, such as orders, delivery, and invoicing.

Nowadays most of the wholesalers and retailers require the identifier assigned for each type of the product. Consequently, in the global trade environment the identifier must be globally unique in order not to be misinterpreted. This implies a need for global standards.

GS1 standards are much more than the barcodes, they also include standards for electronic business messaging (eCom), data synchronization (GDSN) and RFID-based identification (EPCglobal) (GS1 system of standards, GS1, 2012-07-20).

GS1 develops and manages a system for identification, capture and communication of information regarding goods, logistics units, services, suppliers, and locations.

GS1 System consists of two main elements: GS1 Automatic Identification Standards and GS1 Communication Standards (Figure 12) (ibid).
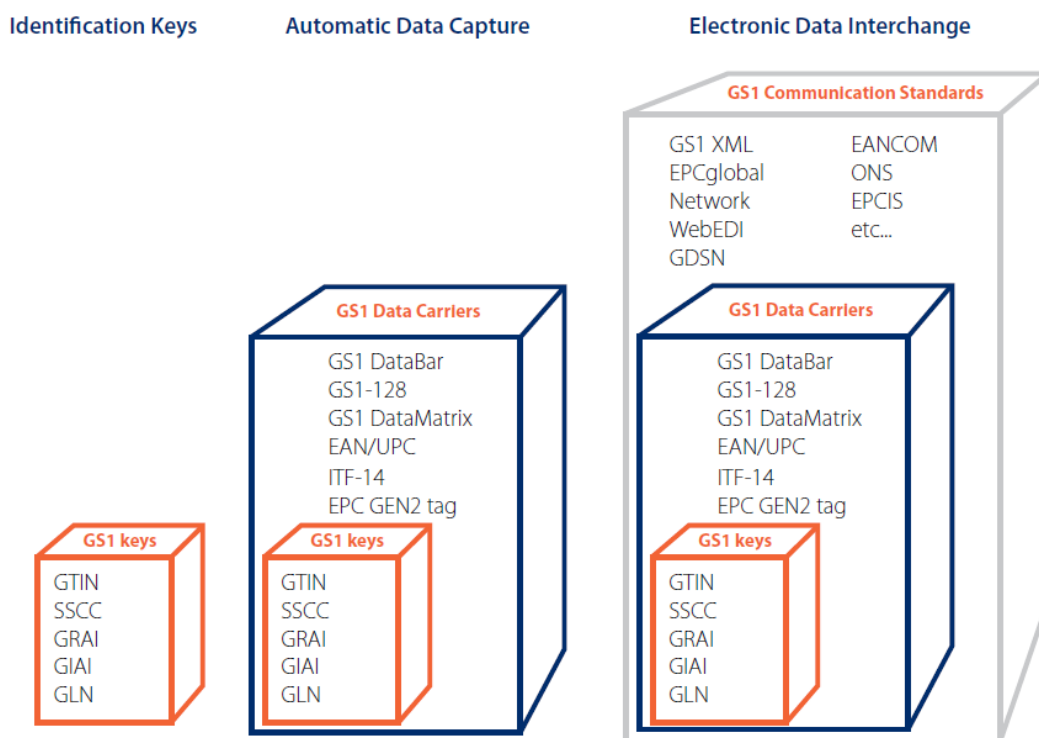


Figure 12. GS1 System of standards (GS1)

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### GS1 identification standards

GS1 Automatic Identification Standards consist of identification keys and data carriers (ibid). It is important to understand the difference between them. Identification key is a code, and data carrier is a physical symbology which is attached to the item's, carton's, pallet's or truck's label.

### GS1 key identifiers

The most widely used identification keys are GTIN, GLN and SSCC (Figure 13).

*GTIN* (Global Trade Item Number) is used to uniquely identify trade items. It is assigned for every modification of a product (for example milk in one liter package and two liters package has different GTIN). Any GTIN code can be checked in database at any point of supply chain process in order to get item's price, record its sale, confirm its delivery or identify its order.

*GLN* (Global Location Number) provides a standardized way to identify locations and legal entities and automatically process this address information of senders and recipients. Location can be a physical place, such as warehouse or office, or even specific shelf within a store. Legal entity can be a company or its division.

*SSCC* (Serial Shipping Container Code) is assigned for logistics units (cartons, pallets, trucks). It enables logistics units' to be tracked individually and provides such benefits as order and delivery tracking, and automated good-receiving. SSCC consists of 18 digits (comparing to 14 in GTIN and GLN), which allows for more items to be coded such as the pallet number for a quantity of products, a use-by date and manufacturing batch number.

GTIN – Global Trade Item Number

0123456789123 4

GS1 – Company Prefix    Item Reference    Check Digit

GLN – Global Location Number

0123456789123 4

GS1 – Company Prefix    Location Reference    Check Digit

SSCC – Serial Shipping Container Code

0 123456789234567 8

Extension    GS1 – Company Prefix    Serial Reference    Check Digit
Digit

Figure 13. GS1 Identification keys (GS1 System of standards, GS1)

So, product identification number consists of two parts: company prefix and product identifier. GS1 is responsible to assign the company prefixes, while the product identifier is decided by the company itself.

Above mentioned key identifiers can be checked in internet-based service GEPIR (Global Electronic Party Information Registry, www.gepir.gs1.org). By entering GTIN, GLN or SSCC

code into GEPIR, anyone can find the information about the barcode's owner (company-member of GS1) and its contact information.

*GS1 data carriers*

Key identifiers are encoded into physical solutions – barcodes or RFID tags. Bar code is a graphical representation of a product's identification number that is unique for every product. It is a dominant solution for item identification because RFID tags are still too expensive.

Levels barcode's implementation is illustrated in Figure 14.



**item**
*consumer unit*

**carton**
*orderable unit*

**pallet**
*logistics unit*
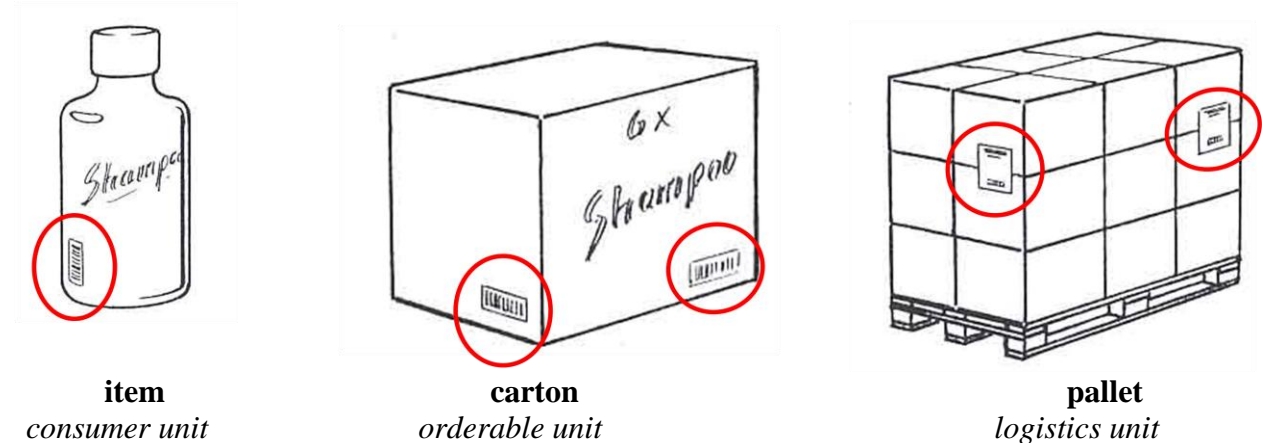
Figure 14. Levels of barcode's implementation

The symbology for a data carrier is decided according to the amount and type of information that needs to be kept and level of label implementation (item/carton/pallet). It is also varies in the number of digits in the capacity. The most widely used data carriers are shown in the Table 5 (ibid).

The most typical barcodes used in retailing are EAN-13 on the item level, EAN-13 and ITF-14 on the carton level, and GS1-128 on the pallet level.

Barcodes on the item level are used to:
- automate checkouts
- optimize shelf-planning
- choose the right temperature zone
- mark the shelves.

Barcodes on the carton level are used to:
- optimize store distribution
- optimize the use of roll cages and trucks
- choose the correct storage zone according temperature and humidity.

Barcodes on the pallet level are used to:
- optimize order quantities
- find a suitable storage location
- choose a correct temperature zone.

Table 5. Description of main GS1 data carriers

| Data carrier | Encoded information | Level of implementation | Description |
|---|---|---|---|
| EAN-13 | GTIN | item, carton | *EAN-13* is used to identify the FMCG at the cashiers (point of sale – POS) and in logistics processes. EAN-13 contains 13 digits and can be reduced in size to EAN-8 in order to fit onto a smaller package |
| ITF-14 | GTIN | carton | *ITF-14* barcode (GS1's interpretation of interleaved two of five barcode) contains 14 digits and is mainly used on a carton level and cannot be used at the POS |
| GS1 Databar | GTIN, serial numbers, lot numbers of expiry dates | item | *GS1-DataBar* is a smaller 14 numeric barcode, which is used at the POS on a smaller items |
| GS1 Datamatrix | GTIN, batch and serial numbers, expiration date | item | *GS1 DataMatrix* is a two-dimensional barcode, which can include up to 3116 digits of capacity. It can be placed on small space and on the metal surface. It requires the camera-based scanner for data capturing, and that is not intended to be used at the POS |
| GS1-128 | all GS1 identification keys (GTIN, GLN, SSCC, etc.) best-before date, etc. | pallet | *GS1-128* is implemented at pallet level for logistics processes and consequently includes more information (up to 48 alphanumeric digits). GS1-128 cannot be used to identify items at the POS |
| RFID/EPC | EPC (Electronic Product Code) which contains all GS1 identification keys | item, carton, pallet | *RFID tag* is a microchip that stores much larger amount of data comparing to barcode and provides significant time-saving advantage since it does not require manual scanning |

An example of GS1 standards implementation at the process of automated goods receipt is illustrated in the Figure 15. It illustrates how material and information flows are managed simultaneously with help of SSCC. Automated goods receipt may happen between different supplier-customer dyad, e.g. manufacturer-wholesaler, wholesaler-retailer's DC, DC-store.
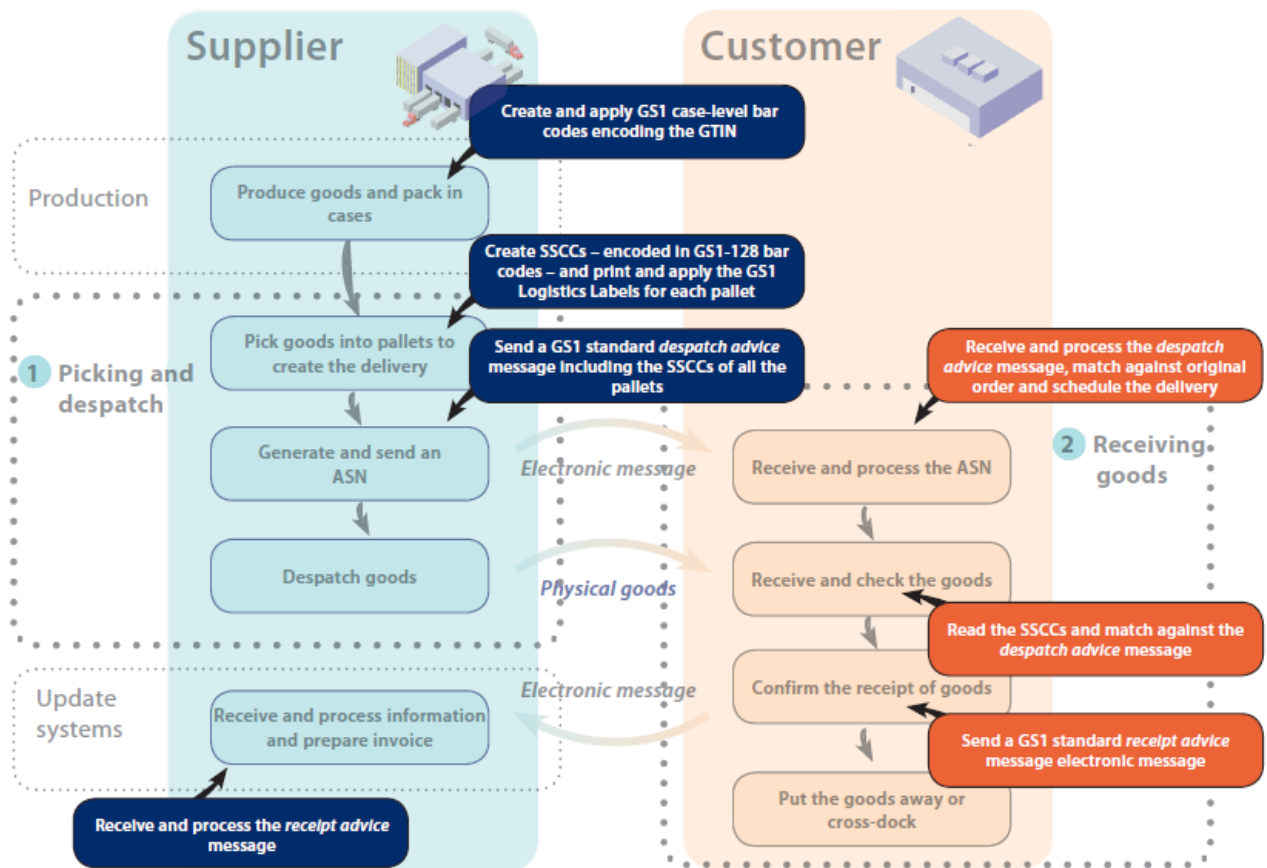
Figure 15. The process of automated goods receipt (GS1)

### GS1 communication standards

GS1 Communication Standards enable sharing between supply chain partners of master data, transactional data and event data (ibid).

Master data is a static information about products, location, contracts (prices). It is stored in *GDSN* (Global Data Synchronization Network) and available through barcode scanning. All GS1 members have an access to GDSN which enables secure and continuous synchronization of accurate data. When a supplier and a customer use the same network with up-to-date data, it is simpler, quicker and cheaper for them to do business.

*GS1 eCom* communication standards include GS1 EANCOM and GS1 XML and enables smooth exchange of transactional information between companies. One of the examples is linking POS data with ordering process (orders are send electronically to the DC via EANCOM messages), which improves customer responsiveness and efficient replenishment, lower inventory level and higher product availability.

The simplified process of electronic transaction data exchange between retailer and suppliers is illustrated in Figure 16.
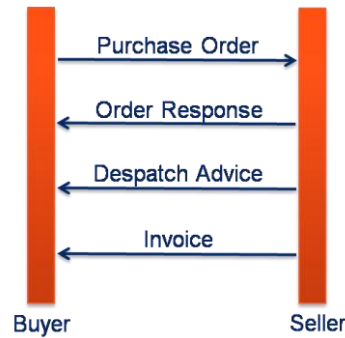
Figure 16. Simplified electronic transaction data exchange

*EPCIS* (Electronic Product Code Information Services) is a communication standard intended for EPCglobal solution and is analog to GDSN for barcodes. EPCIS is created for sharing event data when supply chain partners can monitor events and know the current or past status of things, including the time, location, disposition and business step of each event that occurs during the life of an item.

### Benefits from GS1 System adoption

As it was mentioned in TOE framework of standard adoption, one of the factors that influence the decision regarding standard adoption is perceived benefit from adoption.

Documented benefits of GS1 System of standards adoption are the following (IBM, 2012):
- lower inventory level at raw material place
- higher order accuracy
- higher invoice accuracy
- shorter lead time
- higher supplier service level
- lower distribution cost
- lower inventory level in retail distribution center
- out-of-stocks reduction
- higher traceability of products

*Summary*
There is a lack of literature on global data identification standards as well as generally supply chain standards in supply chain management literature. GS1 standards can be classified as open data identification and communication standards. Collective action theory and TOE (technology-organization-environment) framework can be implemented for analysis of GS1 standards adoption. Perceived benefits of adoption seem the most important factor of adoption.

### 3.1.4 Literature gap

The concept of supply chain visibility has been attracting more attention in the last decade, but the theory on this topic is not yet well developed. Many authors mention drivers, the benefits and obstacles of achieving supply chain visibility, but there is hardly any literature that provides the typology of different types of visibility. However, the existing variety of perspectives on supply chain visibility may be a sign of the existence of different types of supply chain visibility.

Additionally, studies on supply chain visibility are mainly theoretical and do not address the problem of implementing supply chain visibility in practice. Nevertheless, such supply chain visibility enablers as IT implementation, information sharing and relationship building are widely discussed.

All four – IT, information sharing, collaboration, and standards – are parts of information drivers of supply chain performance (Chopra and Meindl, 2010). Moreover, the role of global supply chain standards in providing supply chain collaboration is highlighted in the IBM report (2012). These two factors lead to the conclusion that the role of global standards in providing supply chain visibility is overlooked.

This may be related to the fact that the topic of supply chain standards is still not well established in supply chain management literature. Many researchers highlight or imply that information should be standardized, but no specific studies on the standardization issue of supply chain management have been made. Academic journals are mostly dedicated to the IOS and communication standards, while in the course books, standards are given little attention.

There are two hints that imply the important role of standards in providing supply chain visibility. First, the "proper formatting" aspect of information quality clearly denotes the fact that information should be standardized. Second, even though standards are not mentioned among enablers of supply chain visibility, the lack of standardized metrics for information exchange is reported as one of the obstacles in achieving supply chain visibility (Capgemini, 2004; Daugherty et al, 2006; Steinfield et al., 2011).

Also, even though there are no articles that challenge the need for supply chain visibility, some evidence was found that visibility need varies according to a company's role and position within the supply chain (Caridi et al., 2010a,b). Thus, it is interesting to investigate whether the need for supply chain visibility differs in different contexts. Pier Georget in his book (2007) discusses the history of implementation of barcodes in open and closed environments, suggesting the classification of many-to-many and exclusive supply chains, as well as suggesting a need for different supply chain visibility. The terms "many-to-many" and "exclusive" supply chains were discussed with and accepted by industry practitioners. Moreover, the characteristics of a many-to-many supply chains can be found in e-commerce literature.

The intensive literature review reveals a lack of understanding of the link between supply chain visibility, global supply chain standards and supply chain design concepts. The ambition of this research is to fill the aforementioned gap and investigate the role of global data identification standards for supply chain visibility and applicability within different supply chain designs.

Clear opportunity exists to contribute to theory in each of the three topics investigated in this thesis: to operationalize the need for supply chain visibility, identify characteristics of different supply chain designs, and finally translate future findings into a model that links all three topics together and investigates the applicability of global data identification standards in different supply chain designs.

## *3.2 Theory development and analytical framework*

TOE framework is a universal framework that can help assess the potential of standard adoption. However, it does not address the choice of which supply chain standard to adopt − open or proprietary. That is the very reason why this chapter aims to develop an appropriate model that can fit the objective of this thesis.

According to literature reviews 3.1.1 and 3.1.2, the need for supply chain visibility and the type of supply chain design are both important characteristics that influence the adoption and applicability of global data identification standards. In order to investigate these connections, it is important to operationalize the concepts of supply chain visibility and supply chain design.

### 3.2.1 Need for supply chain visibility

The antecedent and closest concept to the "need for supply chain visibility" is a note by Barratt and Oke (2007) that the level of supply chain visibility may differ across linkages depending on the perceived level of importance and interdependencies between partners. Thus implying there is a different need for visibility in different supply chain stages.

Analysis of literature reviewed suggests the following typology of supply chain visibility depending on a supply chain stage: demand visibility, order visibility, inventory visibility, shipment visibility, supply visibility.

Building on the literature studied and the interviews conducted, a framework that assesses the need for supply chain visibility is proposed in this chapter (Table 6). The table summarizes the factors which influence the need for each type of visibility and proposes the main benefits which can be gained from achieving those types of visibility.

Table 6. Assessment of the need for supply chain visibility

| Type of supply chain visibility | Supply chain factors influencing need for visibility | Main benefits | Contributing research |
|---|---|---|---|
| Demand visibility | demand predictability − degree of collaboration − | accurate demand forecasting; matching demand with supply | Lee et al. (2004); Capgemini (2004); Zhang et al. (2008); Caridi (2010a) |
| Order visibility | order frequency + order evenness − | synchronized planning; matching demand with supply | Capgemini (2004) |
| Inventory visibility | inventory turnover rate + level of inventory + | trackability; inventory optimization | Capgemini (2004); Aberdeen Group (2006); Zhang et al. (2008) |
| Shipment visibility | duration of lead time + number of less than truckload (LTL) shipments + | trackability; delivery reliability | Aberdeen Group (2006); IBM (2007); Capgemini (2004) |
| Supply visibility | governmental regulations (legislations, ecology certification, safety issues) + | traceability | Folinas et al. (2006) |

Note:
+ denotes positive relationship between the factor and the need for supply chain visibility,
− denotes negative relationship between the factor and the need for supply chain visibility

There are also *general factors* that influence the need for supply chain visibility:
- company size +
- product uniqueness +
- cost of goods +
- duration of product life cycle −


# Demand visibility

Demand visibility means the availability of demand information for relevant supply chain partners.

Demand information sharing helps match demand and supply within a chain and reduce the bullwhip effect − demand distortion while moving upstream of the supply chain (Lee et al., 2004). Demand visibility is more important for suppliers who need to know how many goods must be produced in a given period and to plan their production capacity.

Demand predictability is an important factor influencing need for supply chain visibility: the less predictable the demand, the less visibility there is for suppliers to plan production. It can be smoothed over with the help of contracts, defining the quantity of goods sourced. Demand predictability also varies according to the demand and supply uncertainty spectrum (Chopra and Meindl, 2010) as shown in Figure 17. For example, food products have more predictable demand and supply as compared to high-tech devices.
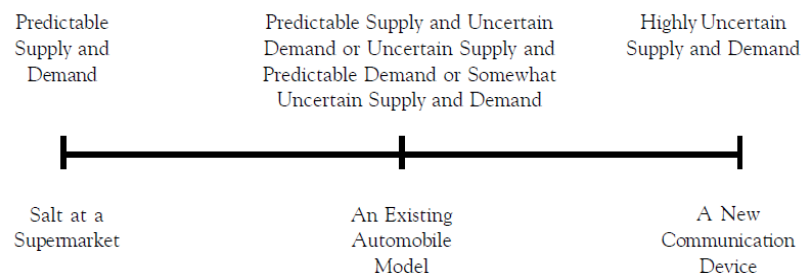


Figure 17. Demand and supply uncertainty spectrum (Chopra and Meindl, 2010)

⇨ the higher the demand predictability, the lower the need for demand visibility

The availability of demand information also depends on how companies collaborate. In highly collaborative supply chains, demand information is voluntarily shared and consequently there is no need for demand visibility. However, when only transactional information is shared on a need-to-know basis, the need for demand visibility is high.

⇨ the higher the degree of collaboration, the lower the need for demand visibility

# Order visibility

Within order visibility, inventory visibility, and shipment visibility, the logic of assessing the value of factors is twofold: both efficiency of operations and security (product availability vs. product loss) must be considered. Concerning order and inventory visibility, an efficiency perspective is deemed more importance. For shipment visibility, the product availability perspective is more appropriate.

Order visibility has two meanings:
(1) ability to track purchase orders and delivery schedules (which is more important for the customer); and
(2) supplier's awareness of future orders from its retailer (which is not always equal to demand visibility).
While the first definition depends on connectivity, the second definition is influenced by two dependent variables, i.e. order frequency and order evenness.

Order frequency implies how often orders are placed. For example, if a company orders on an every week basis or only spot orders once a year. From the efficiency perspective, more orders require more resources for tracking and, consequently, there is a higher need for visibility. From the perspective of product availability, infrequent orders need to be given higher visibility because lost order may only be replenishable over a long period. However, if an efficiency perspective is taken into account:

⇨ the higher the order frequency, the higher the need for order visibility

The evenness of orders is also important. When companies make orders often, they know the procedure pattern better and can foster their own relationships, which leads to better visibility, i.e. the need for visibility decreases.

⇨ the higher the order evenness, the lower the need for order visibility

# Inventory visibility

Inventory visibility means the transparency of stock levels among supply chain partners, which implies that an item's quantity and status are known. Internal inventory visibility is important for each supply chain actor. However, in this research the main focus is on the availability of inventory status information for supply chain partners. Together with demand visibility this helps reduce the bullwhip effect.

The need for inventory visibility depends on two factors – the level of inventory and the inventory turnover rate.

When the level of inventory is low, it is easy to track goods even manually; however, the risk of running out of stock is higher. Thus, building on the efficiency perspective, however, companies with high levels of inventory tend to share inventory information with an aim towards reducing the cost of holding inventory. Moreover, a high level of inventory implies a higher need for transparency of items' status in order to share inventory information more efficiently.

⇨ the higher the level of inventory, the higher the need for inventory visibility

The greater the inventory turnover rate or the faster stock keeping units (SKUs) flow through a warehouse or distribution center (DC), the more important it is for managers to know exactly

where goods are stored and devote proper resources towards managing those goods. On the other hand, higher turnover implies that goods are replenished quickly, so the risk of running out of stock can be covered by the next order. We assume that the first tendency is more important and that is why the need for inventory visibility increases when the number of products increases.

⇨ the higher the inventory turnover rate, the higher the need for inventory visibility

In this research, the retailers' supply chain is explored. The inventory turnover rate in DCs and the inventory level in stores are also assessed.

## Shipment visibility

Shipment visibility means the visibility of goods (right products, right quantities, right time) in transit. It leads to an increase in delivery reliability. This depends on how long (and how safely) it takes goods to arrive from a first tier supplier to the DC, i.e. lead time. The longer the lead time, the more crucial it is for a company to know that the goods were not lost on their way to the warehouse. A short lead time decreases the need for supply chain visibility, since product loss can be compensated through a subsequent order.

⇨ the longer the lead time, the higher the need for shipment visibility

Less than truckload (LTL) shipments are organized in responsive supply chains and incur higher transportation cost per unit. Consequently, better visibility of shipment setup can save costs.

⇨ the larger number of LTL shipments, the higher the need for shipment visibility

## Supply visibility

Supply visibility means the awareness of downstream supply chain partners as to where those products come from. This is critical for most of the retailers, since in a global marketplace customers need to know where products were produced and stored. This is especially true in such areas as healthcare, the food industry, toys, and so forth. Most governmental organizations force companies to trace the origin of products to ensure the safety of people and their health.

⇨ the greater the legal demand, the greater the need for supply visibility

Finally, it is likely that not all types of supply chain visibility are equally important for a specific company. For example, a company may have already developed collaborative relationships with suppliers enabling demand visibility within its supply chain. However, a company's low level of automation can hinder inventory visibility. Therefore, another suggestion is that the need for supply chain visibility should be assessed for the typical product within a supply chain. In some cases, a cumulative effect is more appropriate. For example, order frequency may be low for typical products, but the overall number of products in the store may imply a significant amount of everyday transactions and thus a greater need for inventory visibility.

## General factors

The greater a *company's size*, the more global it may be and the more standardized procedures it may need, so the need for supply chain visibility increases with the size of the company.

⇨ the larger the company, the higher the need for supply chain visibility

The *type of product* may also influence the need for supply chain visibility. The more expensive or unique a product, the greater a company's need to know where it is at every moment.

> ⇨ the greater the uniqueness or cost of a product, the greater the need for supply chain visibility

Some products have a short *shelf-life* (e.g., FMCG), so the need to track (e.g., best-before date) increases.

> ⇨ the shorter the PLC, the higher the need for supply chain visibility

## 3.2.2 Supply chain design

The focus of this research was on the retail industry. To investigate the applicability of a global standard implemented within this industry, it is important to first define the characteristics of retailing supply chains where the adoption process takes place.

Georget's (2007, p.28) notion about the open and closed environments for barcode implementation is related to the type of stores that either sells multiple brands or alternatively only their own-branded products (OBPs). The underlying assumption of this thesis is that supply chains that produce and sell OBPs have a lower degree of openness.

The purpose of the literature review in chapter 3.1.2 is to find the classification, or at least evidence, of such supply chains in academic or business literature and find a suggestion in defining such supply chains, their characteristics, and the underlying reasons for following their strategy.

The literature review revealed four somewhat related classifications of supply chains:

- arms-length relationships vs. vertically integrated supply chains
- open vs. closed supply chains
- open vs. proprietary networks
- many-to-many vs. many-to-one, one-to-many, one-to-one supply chains

The open vs. closed classification seems appropriate because it illustrates the degree of openness/closeness of processes within the supply chain. Here it should be noted that the term "closed" should not be confused with the "closed-loop supply chain".

The last classification, adopted from e-commerce literature, seems the most appropriate for retailing, since it describes the supply chain from the product position: according to the place where the product is manufactured and where it is sold. It means that this classification is applicable to every company within the supply chain, regardless of its position in the chain.

However, multiple variants of one extreme (many-to-one, one-to-many, one-to-one) can also create confusion depending on how to title supply chains that sell OBPs. This led to the development of a new term, "exclusive supply chain", which highlights the exclusiveness of relationships between supply chain partners within the supply chain as well as the exclusion of occasional supply chain partners.

Thus, the extreme examples of a new supply chain design are "many-to-many supply chain" and "exclusive supply chain," as discussed with and accepted by industry practitioners.

In "many-to-many" supply chains the product is produced by many suppliers and can be sold by different retailers. In other words, the retailer in "many-to-many" supply chains distributes multiple-branded products.

In "exclusive" supply chains the product can be produced by many suppliers, but sold in dedicated stores. So the retailer in an "exclusive" supply chain distributes OBPs.

The second and the third research questions of this thesis are investigated within different supply chain designs. Therefore, assumptions regarding characteristics of different supply chain designs are mentioned in Table 7.

Table 7. Characteristics of supply chain design

| # | Characteristics | Many-to-many supply chain | Exclusive supply chain | Contributing research |
|---|---|---|---|---|
| 1. | Type of supply chain standards | open | proprietary | Hayes et al. (2005) |
| 2. | Degree of vertical integration | lower | higher | Oh and Kim (2011) |
| 3. | Information sharing | mostly transactional | transactional and strategic | Dai and Kauffman (2006); Oh and Kim (2011) |
| 4. | Degree of collaboration | lower | higher | Dai and Kauffman (2006); Oh and Kim (2011) |
| 5. | Number of supply chain partners | potentially many | relatively limited | Marsh (2011); Dai and Kauffman (2006); Oh and Kim (2011) |
| 6. | Level of supply chain visibility | relatively high | relatively low | |
| 7. | Supply chain flexibility | more flexible | less flexible | |
| 8. | Supply chain maturity | less mature | more mature | |
| 9. | Length of relationship with partners | may differ | mostly long-term | |

Illustrated above are the two extreme examples of supply chain design, though there may be intermediate variants.

Note that many-to-many supply chains can have numerous brands, but also benefit from selling OBPs. The reasons why retailers include OBP in their assortment are:

- building customer loyalty
- flexibility in pricing
- higher margins (or a lower selling price)

- control over product attributes and quality
- elimination of the manufacturer's promotional costs

## 3.2.3 Analytical model

The analytical model for assessing the potential for a global standards adoption has been developed to fulfill the objective of this thesis (Figure 18). This model integrates the three concepts investigated in this thesis: supply chain visibility, supply chain design, and supply chain standards' adoption.
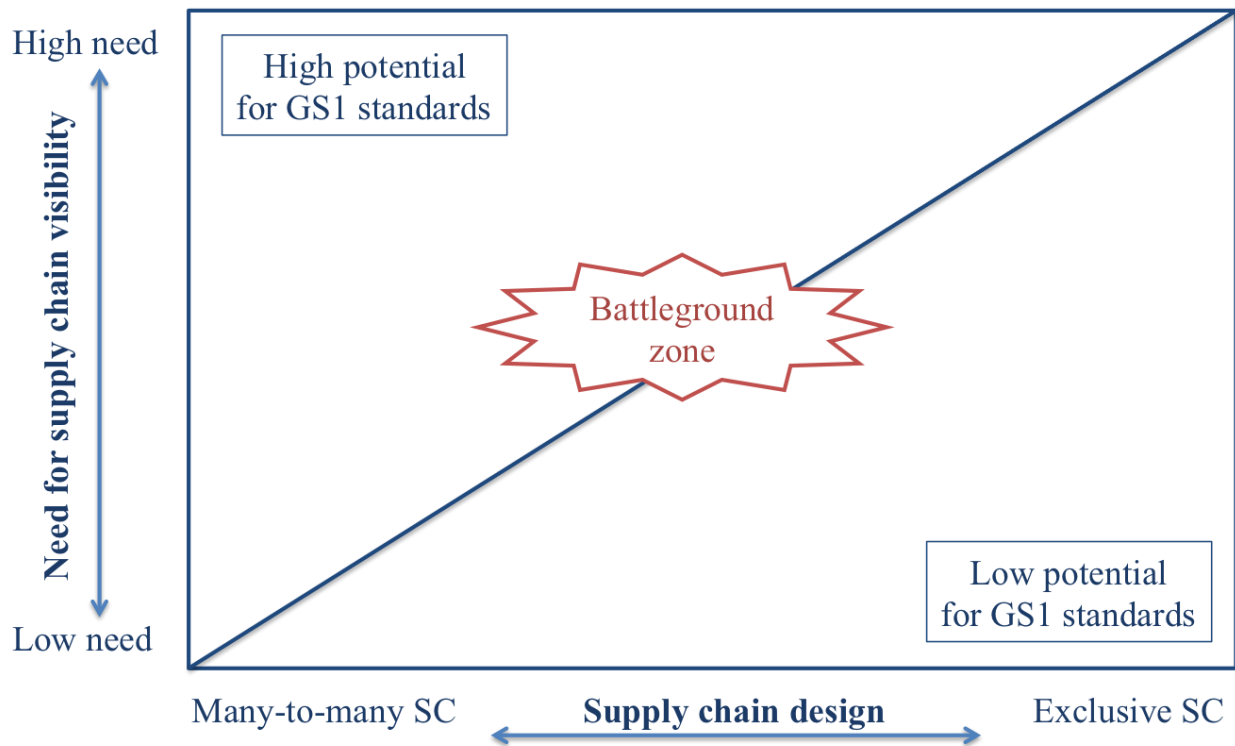


Figure 18. Analytical model – potential for global standards adoption

According to this model, many-to-many supply chains with a high need for supply chain visibility possess a higher potential for global standards adoption than do exclusive supply chains with a low or average level of need for supply chain visibility.

Supply chains that have average needs for supply chain visibility and intermediate supply chain design are in the battleground zone of this model. Meaning, they can adopt either global or proprietary supply chain standards.

It is important to mention that the model is analytical and does not aim at providing strict rules regarding standard adoption. However, the model proposes a structured approach to the evaluation of possible alternatives.

Operationalization of the model's axes have been conducted in sections 3.2.1 and 3.2.2 in order to achieve the model's usability and diagnostic support.

*Usability* means that the main variables (the need for supply chain visibility and the type of supply chain design) should be easy to assess in real companies.

*Diagnostic support* implies that the axes should be useful to define the position of any supply chain in the matrix.

Even though the analytical model is not prescriptive, it is possible to define the position of the company in the matrix at least approximately. The type of supply chain design can be assessed by the percentage of OBPs. Further, the need for supply chain visibility can be assessed according to the framework developed in the chapter 3.2.1. This framework does not aim at a strict measurement of the need for supply chain visibility. Rather, a rule of thumb may be implemented. Each of the five main types of supply chain visibility stands for just 20% of the whole supply chain visibility scale. Simply stated, it is enough that at least one factor is critical in order to consider the relevant type of visibility as critical for the supply chain.

In conclusion within this chapter an analytical model for the potential for global standards' adoption has been developed. The axes of the model – the need for supply chain visibility and supply chain design – has been illustrated and operationalized.

# 4  EMPIRICAL FINDINGS AND ANALYSIS

*This chapter provides a description and analysis of three case companies – Axfood, IKEA, and Clas Ohlson.  It summarizes their supply chain practices and describes their current level of supply chain visibility, with, types and benefits of data identification standards implementation.*

## 4.1 Axfood

### 4.1.1 Company background

Axfood is a Swedish food retail group, which was formed in the year 2000 after the merger between Hemköp and D&D Dagligvaror. It eventually resulted in the establishment of four companies: Willys, Hemköp, Axfood Närlivs and Dagab. PrisXtra was founded in 2008.

At the moment, Axfood Group includes 237 own retail stores in Sweden and approximately 820 agreements with proprietors. The total product portfolio includes approximately 8000 products. The vision of the company: *"Through profitable growth and innovative thinking, Axfood aspires to be the best food retail company in the Nordic region"* (Axfood annual report, 2011).

The Swedish food retail market is steadily developing and growing in the urban metropolitan areas, where there is a higher concentration of customer purchasing power. Beginning in the mid-1990s, Axfood is one of the three retailers that have dominated the Swedish market: ICA (46%), Coop (20%), Axfood (20%).

### 4.1.2 Supply chain

Axfood's supply chain includes transportation, distribution and retailing stages of a typical supply chain process (see Figure 19), which implies a medium level of vertical integration.
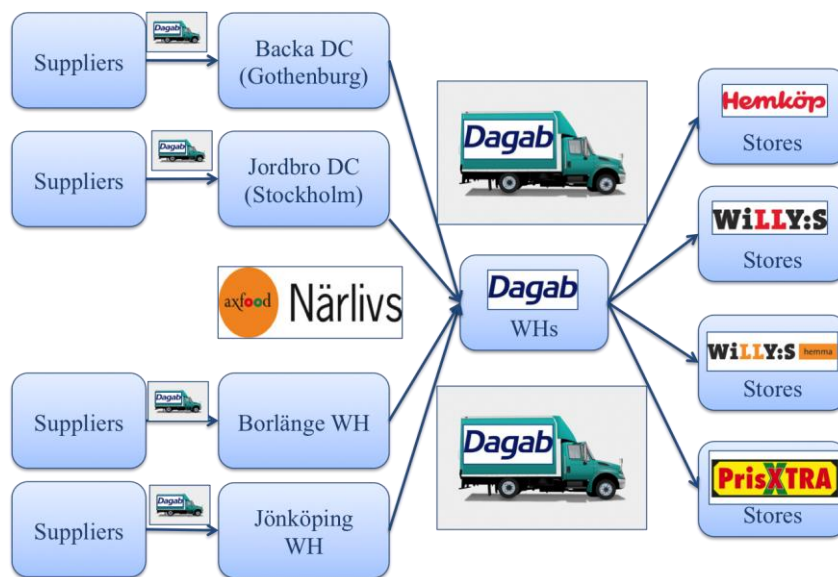


Figure 19. Axfood's simplified supply chain

## Facilities

The Axfood Group includes three retailing companies one wholesaler, and transportation company. Each of its labels aims at a different target customer:

- Willys – retailer that aims at the discount retail segment by offering "Sweden's cheapest bag of groceries" (170 wholly owned stores)
- Hemköp – is a "personal food store" offering a wide range of products for modern families and inspiring their food ideas in day-to-day life (183 stores, 62 of which are wholly owned)
- PriXtra – retailer that targets to customers with premium food taste, who also pay attention to customers who are also price-concious (5 stores)
- Axfood Närlivs – a wholesaling part of Axfood, whose customers are the above mentioned brands as well as the service stations/minimarkets that are not owned by the Group
- Dagab – operates as a logistics partner for nearly all stores of the Group.

### *Stores*

Axfood intends to raise the level of automation in the stores and in logistics. Consequently, the Group wants to increase the number of self-scanning devices and self-checkout lanes in stores, and the number of products included in the Auto-ordering system, in order to further develop re-stocking at the stores. The customers themselves can scan their own merchandise at a cash registers. After that, POS data is automatically entered into the system. When the ordering level is reached, Auto-ordering system sends the request to the wholesaler. Though, not all the products are included in the system yet. One more initiative showed a good result in the central DC in Jordbro – the voice directed picking was successfully used for tinned and dried products and might be expanded for other DCs.

### *Warehouses and distribution centers*

There are two main distribution centers in Axfood's supply chain (see Figure 17) – Backa in Gothenburg and Jordbro in Stockholm, and two complementary cold storage warehouses in Borlänge and Jönköping. The inventory turnover rate in the warehouses is 26,3 times in a year (Axfood annual report, 2011). From there, approximately 70% of deliveries are channeled by Dagab to their own warehouses and then distributed to the stores.

## Shipment

Dagab is Axfood's own shipment company. It controls 70% of transportation flow through a central purchasing and ordering system, whereas 30% of Axfood's shipments are operated by other freight companies.

The shipment system of Dagab has shown a high level of delivery reliability in 2011 – 97,1%, which was sustained from 2005 with minor changes. In 2012 this level has reached 97,5% of reliability, which is the highest in the history of Dagab.

Dagab's own transport fleet includes 146 vehicles, which are equipped with the necessary machinery to reduce environmental impact. Additionally, the routes are made in a way to reduce $CO_2$ emissions and vehicles are usually fully loaded to reach the full truck capacity in order to avoid "air-delivery". The inventory turnover rate in Dagab warehouses is 29,2 times in a year (Axfood annual report, 2011). Dagab has the target to have a stronger connection with the Group and more effectively integrate into it.

## Own-branded products

Axfood trades the fast-moving consumer goods (FMCG) under the following private brands: Garant, ECO, Såklart, Aware, Eldorado, Func, Fixa (for more detailed information, see Appendix B).

By the end of 2011, Axfood has reached the level of 24,2% of private label share in all product portfolio. Even though the target was to reach 25%, the company is satisfied with this result, since it is the highest private label share in the Swedish food retail market. The result is mainly based on a further establishment of a Group-wide label called Garant, which is sold in the vast majority all stores of Axfood Group.

The majority of own-branded products (88%) come from the EU, including Sweden; 11% of them are delivered from Asia, and less than 1% come from South and North America.

*Analysis*
According to the Theory Development chapter, Axfood's supply chain can be characterized as a many-to-many supply chain, since most of the products (75%) are multi-branded goods that are produced by different suppliers and can be sold in any other food retail stores (ICA, Coop, etc.).

## 4.1.3 Data identification standards

## Adoption

Axfood adopted the GS1 system of standards in 2005, prior to which the company used its own data identification system. The company's decision to change its entire IT-system in 2002 was the enabler leading to this change in data identification standards.

The acceptance of an industry-wide standard was necessary for Axfood Group in order to simplify communications with supply chain partners. However, to reach this simplicity in communications, common data identification standards were first needed (Hanna Andersson and Ann-Sofie Stamyr, Axfood). Thus, after the change of the IT-system in 2002 a standard selection process began and was held in cooperation with major Swedish food retail players-competitors of Axfood (ICA, Coop, etc.) (Peter Jönsson, GS1 Sweden). The GS1 system was the dominate alternative since many manufacturers had already accepted it. Moreover, it also had its own global appeal.

A preliminary step in standards adoption was also initiated in 2002 when Axfood Group, in cooperation with its suppliers, began creating a Master Data nomenclature. This nomenclature currently updates through the Validoo system - the Swedish certified Global Data Synchronization Network.

On the local level, not all Axfood suppliers used the GS1 system at the beginning of the change process. From 2005 onwards, 12 suppliers a year were encouraged to implement the GS1 standards in their operations (Hanna Andersson and Ann-Sofie Stamyr, Axfood).

## Outcomes of implementation

Axfood has adopted the entire GS1 system of data identification standards (on the item, carton, and pallet levels) as well as communication standards.

The main outcomes resulting from GS1 system implementation are:

- establishment of *Merchant flow (Handelsflödet)*

Merchant flow (Handelsflödet) refers to the automation of transactions between the supplier and the retailer. This results in greater accuracy of data entry in confirming and validating product movements. It helps simplify invoices and communications between the various supply chain partners. The *cost of one invoice has now decreased* from 130 SEK to 8 SEK. All operations performed in warehouses, DC's, and stores are integrated into a centralized IT-network. All invoices and messages are handled automatically, while the system detects emergency situations and alarms the personnel.

- optimization of warehouse and store management

Suppliers constantly update master data via the Validoo database, helping optimize warehouse space because package weights and sizes of products are known prior to product arrival.

- better matching between demand and supply secures reliable delivery of products

For example, in the case of damage during transportation only 8 pallets may arrive from a wholesaler instead of 10. Now it is possible to relocate them, i.e. all stores receive a percentage of the product (Hanna Andersson and Ann-Sofie Stamyr, Axfood). Previously, the system was unable to detect this situation and so the store placing the original order received the entire order.

- traceability

Traceability is critical in the case of product recalls. The GS1 system helps Axfood in such emergency situations because it is urgent to know where the products came from. If for example, glass is found inside baby food, it is much easier now to trace where the series of products came from, in which DC/warehouse they were stored, and in which stores they were sold (Hanna Andersson and Ann-Sofie Stamyr, Axfood).

Axfood has not yet implemented additional options provided by GS1 system such as collaborative forecasting and planning, but intends to do so in the future (Hanna Andersson and Ann-Sofie Stamyr, Axfood). Presently, demand forecasting is performed based upon information provided by the Nielsen company, which collects and analyses POS data from major retailers. Also, Axfood's suppliers forecast future demand based on their prior order history through Axfood.

In summary, the adoption of the GS1 system of standards has provided Axfood with major benefits in invoicing, warehouse operations, and traceability.

## 4.1.4 Need for supply chain visibility

The need for supply chain visibility may be assessed through a typical product sold in an Axfood store, for example a *carton of milk* (Table 8).

Table 8. Assessment of the need for supply chain visibility in Axfood's supply chain

| Type of supply chain visibility | Factors influencing need for visibility | Factor assessment | Analysis |
|---|---|---|---|
| Demand visibility | demand predictability | high | demand is stable; fluctuations are mainly seasonal, but can also be connected to health issues, which cannot be predicted (like e-coli issue with vegetables and fruits) |
| | degree of collaboration | high | IT-systems are connected and all the necessary information can be easily reached in real time |
| Order visibility | order frequency | high | order frequency is several times per week, which is defined by the type of goods sold – FMCG |
| | order evenness | high | orders are even except for some special product in special occasions (Christmas, Easter) |
| Inventory visibility | inventory turnover rate in DCs | high | 26,3 in DC and 29,2 in Dagab; relatively high in retailing comparing to other industries |
| | level of inventory in stores | low | low level of inventory is enabled by auto-ordering system and also caused by short product lifecycle (PLC) |
| Shipment visibility | duration of lead time | short | several days |
| | number of LTL shipments | low | Dagab minimizes the air-shipment because of environmental issue – to minimize $CO_2$ emissions |
| Supply visibility | governmental regulations | high | very strict legal demand for the traceability of products, since it is connected to the health issue |

| | | | |
|---|---|---|---|
| General factors | company size | big | 34 795 mln SEK of net sales; 7062 employees |
| | product uniqueness | low | consumer goods |
| | cost of goods | low | food retailing is selling FMCG, which in most are cheap |
| | duration of product lifecycle | short | perishable goods – food mostly has short PLC |

\* Colored cells highlight factors which add weight for the need for supply chain visibility

From Table 8, Axfood's main need for supply chain visibility is determined by its high order frequency (*order visibility*), high inventory turnover rates in DC's (*inventory visibility*), and its need to trace products (*supply visibility*) due to governmental regulations connected to food safety and health issues.

Hanna Andersson and Ann-Sofie Stamyr highlighted that it is not necessary for Axfood to know where goods are at every moment of time. This is because lead time is so short that nearly every day delivery ensures the timely availability of products to stores. In this manner, *inventory* and *shipment visibility* are influenced by the low cost of goods, which in turn decreases the need for such types of visibility.

General factors, except for large company size, do not add to the need for greater supply chain visibility since product uniqueness, cost of goods, and duration of PLC are low.

## 4.1.5 Within-case analysis

A global GS1 standards implementation within many-to-many supply chains is considered to be a more convenient way to operate a supply chain. As products are produced in one place and distributed through many stores, the use of industry-wide standard simplifies the work of the retailer, who in such cases receives the goods tagged with proper barcode allowing them to be scanned and interpreted by the retailer's system.

According to TOE framework, the adoption of the GS1 system of standards by Axfood can be explained by:

- a low degree of technological complexity of barcode implementation, since most suppliers today are familiar with barcodes
- a high perceived compatibility with existing practices, since GS1 was implemented soon after the development of a new IT-system
- a high awareness of perceived benefits of adoption, explained by Axfood's many-to-many supply chain design
- the large size of the company, which implies a greater need for supply chain visibility
- a top management supporting the GS1 system of standards
- a food retailing industry with external government pressures in terms of traceability requirements
- and collaboration with competitors aiming to develop industry-wide standard

The omnipresent deployment of the GS1 system of standards within the Axfood supply chain processes has helped the company achieve supply chain visibility in its most critical areas - order visibility, inventory visibility, and supply visibility. While collaborative forecasting and planning have yet to be implemented at Axfood, matching supply and demand is achieved via automated transaction information sharing (Handelsflödet) and operational efficiency.

## *4.2 IKEA*



### 4.2.1 Company background

IKEA group is a privately owned home product company, which was founded in 1943 by Ingvar Kamprad. The first furnishing store was opened in 1958 in Älmhult, Sweden. Now the company has reached a global level of expansion and is known everywhere around the world for its low-priced design products and shopping experience for the whole family.

IKEA operates in 41countries. In 2011, IKEA group had 287 stores total in 26 countries; the remaining countries are home to distribution centers and customer distribution centers (IKEA annual report, 2011).

The vision of the company is *"a better everyday life for the many people",* which is inseparable from IKEA's business idea: *"to offer a wide range of well designed, functional home furnishing products at prices so low that as many people as possible will be able to afford them"* (IKEA annual report, 2011).

The Swedish furniture market is stable and showed a 5% growth in export in year 2011.

### 4.2.2 Supply chain

IKEA's supply chain encompasses the functions of raw material supply, distribution, transportation and retailing (Figure 20) which implies rather high level of vertical integration.
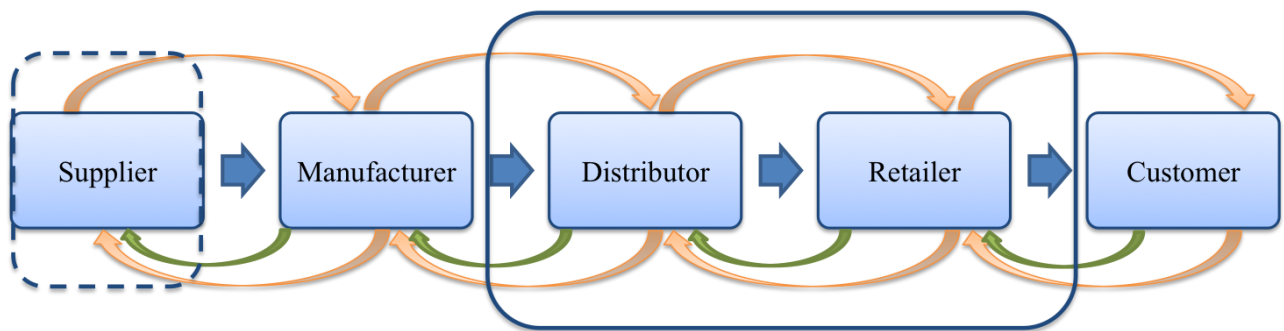


Figure 20. IKEA's simplified supply chain

### Facilities

IKEA as the major player in the furniture and wood market owns a *raw material suppliers* Swedwood and Swedspan.

IKEA *stores* are located in the following regions: Western Europe (72%), Eastern Europe (5%), Asia (5%), Northern America (17%) and Australia (1%). There are 17 stores in Sweden. IKEA stores combine stores and warehouses (high-flow and low-flow), where customers can pick up

the goods they have chosen in the showroom. The high-flow warehouse area is more automated and is only used by the IKEA workers, while the low-flow area implies manual handling and is made in a way that customers find it easy to navigate.

*Distribution centers*

One of IKEA's parts – Distribution Services Operations (DS Operations) – manages the system of *DCs* in the supply chain. The DCs are divided in different areas according to geographical location. In order to optimize operations, management system determines two types of DCs: high-flow and low-flow. Goods with a short storage period go through high flow DCs, while the rest goes through low flow DCs.

There are three distribution centers in Sweden, which are connected by a system of railways, which helps IKEA Sweden have a high exchange rate between the DCs. This enables the company to arrange the products in the right DCs, deliver goods into the right store and to the right customer at the right time.

All IKEA's DCs are connected with one IT-system: IDW (IKEA Data Warehouse). Information from all the stores is reported into MHS (Möbel Hus System) and then transformed into IDW, except for the franchise stores, which use their own systems. Status information is mainly shared through Cognos – a tool that has a system of predefined reports. The system ensures that reports and measurements are made in a standard way. Data handling processes in IKEA are standardized according to proprietary standards.

# Shipment

IKEA's transportation system includes five geographical areas: three in Europe, one in Asia and one in North America. Each area organizes the transport system in its own way, but they are tightly connected to the Distribution Services area; that is why they are often working together for a better result. The freight is made by the following means of transport: 59% is a truck shipment, 20% – rail freight, 20% – sea transportation, in emergency situations 1% of the freight is made by plane.

# Suppliers

In 2011, IKEA had 1018 suppliers from 53 countries (IKEA annual report, 2011). In order to communicate with suppliers, IKEA follows its own standards – IWAY (IKEA code of conduct). This document includes all the information and special requirements for the suppliers and the conditions of employees' work on the factories. While at the field audits, IKEA examines the operations of suppliers in regards with standards mentioned in IWAY, and help them encourage their own sense of responsibility.

# Own-branded products

The IKEA product range consists of approximately 9500 products, all of which are OBPs. Most of the product designs are developed in-house, while most manufacturing is outsourced.

In addition to the furniture, IKEA sells such complementary products as toys for children and food for IKEA restaurant, which now has a turnover of 1.2 billion EUR in 2011 and stands for approximately 5% of total sales.

According to the theory developed, IKEA stands for an exclusive supply chain due to 100% of OBPs and exclusive store chain.


## 4.2.3 Data identification standards

## Adoption

During the 1980's, IKEA was searching for ways to optimize its operations. At that time it decided to implement Interleaved 2 of 5 (ITF) barcoding (Jan Ståhl, IKEA). However, the company at that time had fewer suppliers, and it was easier to have them implement new technology. Moreover, some suppliers had already used EAN-13 barcode in the 1980's, so the process of barcoding was already familiar to them. No new investment was needed by suppliers since they merely received a pdf-file containing a barcode, which they printed and stuck to the products.

In the beginning of this century, IKEA experienced increasing regulatory demand from authorities of various countries. After conducting a pre-study on this issue, IKEA realized that it could not fulfill this legal demand as its own internal traceability was very slow (Jan Ståhl). After arriving at a warehouse, pallets were given numbers which were valid only for that particular warehouse. The movement of the pallets between warehouses required the re-registering of pallets in each and every warehouse. This was time and labor consuming resulting in long, waiting queues while unloading trucks.

To solve this problem, several alternatives were proposed (including the development of a proprietary standard for traceability). In 2006, it was decided not to *"reinvent the wheel"* (Jan Ståhl, IKEA) but rather to implement one of the GS1 standards – SSCC – recorded in the GS1-128 barcode on the pallet level. This was first piloted in IKEA's warehouses in Älmhult and Torsvik, in collaboration with three of its largest suppliers.

Implementation of the GS1 standard SSCC was accompanied with some risks. One of IKEA's core competences is building supplier relationships in order to ensure low sourcing price, while providing large purchasing volume discounts. Low prices of goods is the very way IKEA competes in the marketplace. However, the use of open standards can cause a leak of information by suppliers and result in a loss of its competitive advantage: SSCC contains serial references allocated by the supplier – the creator of the logistics unit. This reveals information regarding the supplier's contacts and this is why it can be harmful for the business itself, according to Jan Ståhl. To deal with this issue, IKEA has had to implement a specific solution, which results in IKEA being the pallet owner, while checking the SSCC on the GEPIR webpage.

The Adoption of the GS1 system involved significant investment in internal labeling, scanning, crane and software systems (Karolin Harsanji, GS1 Sweden).

## Outcomes of implementation

Currently, IKEA's data identification system works through the combination of two standards: proprietary data identification standards (which are implemented on the item and carton level) and SSCC (which is implemented on the pallet level).

After SSCC deployment, the time necessary to unload a truck was reduced by 44%, so trucks now experience shorter delays unloading. As a result, turnover in the warehouse dock area

increased by 55%. Additionally, the SSCC implementation helped IKEA to optimize not only the warehouse management system, but also the within-store management system as pallets are also kept or placed in stores.

Another outcome of such a successful SSCC implementation is that IKEA has started to consider the GS1 global standards as a solution for item labeling.

## 4.2.4 Need for supply chain visibility

The need for supply chain visibility may be assessed for a typical product sold in an IKEA store – a bookshelf for example (Table 9).

Table 9. Assessment of the need for supply chain visibility in IKEA's supply chain

| Type of supply chain visibility | Factors influencing need for visibility | Factor assessment | Analysis |
|---|---|---|---|
| Demand visibility | demand predictability | medium | furniture products are situated in the middle of demand spectrum |
| | degree of collaboration | medium | not only transactional but also operational plans are shared |
| Order visibility | order frequency | low | several times a year |
| | order evenness | even | less even comparing to food retailing, but can be higher according to the contracts |
| Inventory visibility | inventory turnover rate in DCs | N/A | N/A |
| | level of inventory in stores | high | defined by the stores layout |
| Shipment visibility | duration of lead time | long | relatively long comparing to food retailing |
| | number of LTL shipments | N/A | N/A |
| Supply visibility | governmental regulations | high | high demand for the traceability of products from the local authorities of different countries (which forced IKEA to use SSCC) |

| | company size | big | 24.7 bln EUR of Net sales |
|---|---|---|---|
| General factors | product uniqueness | low | |
| | cost of goods | low | the cheapest segment of furniture market |
| | duration of product lifecycle | long | can be stored for years except for the food |

\* Colored cells highlight factors which add weight for the need of visibility

From Table 9, IKEA's most critical needs for supply chain visibility are: the need for *inventory visibility* (due to a high inventory level in stores) and the need for *shipment visibility* (due to a long lead times). However, IKEA's inventory level in stores is directly connected with its DC's , which in this particular case means the need for supply chain visibility converts into internal visibility. This in turn can force IKEA to use a more advanced IT-system in order to optimize inventory levels and replenishment processes.

Jan Ståhl highlighted a great and increasing need for product traceability due to legal demands from governments of different countries. Thus, *supply visibility* provides an added weight to the need for supply chain visibility.

Of all the general factors, the company's size is a most important issue since IKEA needs to manage relationships among multiple tiers in 41 different countries.


## 4.2.5 Within-case analysis

Implementation of global data identification standard in IKEA was a result of two main reasons:

- the need to comply with traceability requirements
- the need to optimize warehouse operations at the process of unloading the trucks.

By implementing the SSCC on the pallet level, IKEA has found ways to fulfill the needs for both inventory and supply visibility. In terms of *inventory visibility*, SSCC has eliminated the need to re-register pallet barcodes at every warehouse, and consequently, has connected the warehouse management systems and stores. From the *supply visibility* perspective, SSCC has enabled the company to trace goods to better comply with legal requirements.

However, the method of SSCC implementation differs from the one made by many-to-many supply chains. The serial reference in the code does not include information regarding the supplier and refers only to IKEA itself, which is a step aside from the usual standard implementation. This illustrates an exclusive method of global standard adoption.

According to TOE framework, the adoption of SSCC by IKEA can be characterized by the following facts:

- a low degree of technical complexity of GS1 system, since most of supply chain actors know the barcode handling processes
- the perceived benefits of adoption were assessed in research conducted by IKEA prior to SSCC adoption
- the perceived cost of adoption was assessed in research conducted by IKEA prior to SSCC adoption
- top management supporting and encouraging the change process
- initial employee resistance to change - warehouse workers found it difficult, at least at first, to work with the new standards
- and external pressure, regarding the traceability of goods required by governmental authorities, which forced IKEA to begin the change process in the first place

## 4.3 Clas Ohlson

**clas
ohlson**

## 4.3.1 Company background

The history of Clas Ohlson started with a small 25-square-metre shop in Insjön which opened in 1918. Now the store has been relocated and expanded to 3,200 square meters and known as "Mega-Clas" – the world's largest Clas Ohlson store. In 1985 the company started business in Norway, in 2002 expanded to Finland, since 2008 Clas Ohlson has been opening stores in the UK and operates in Shanghai (China) with representatives from the purchasing and the customer social responsibility (CSR) department.

Clas Ohlson has the total amount of 139 stores in the Nordic region and employs 2219 fulltime workers (Clas Ohlson annual report 2010/11).

Vision of the company: *"We want to develop a strong European retail chain characterized by high profitability and healthy growth in shareholder value"* (ibid).

The Nordic hardware market in the Clas Ohlson products segment is thought to become mature with such cross-border players as Clas Ohlson, Swedish Biltema and Jula, and Finnish K-rauta. These companies have greater possibilities to stay in the market due to large economies of scale, major purchasing volumes and more efficient logistics.

## 4.3.2 Supply chain

Clas Ohlson's supply chain includes distribution and retailing stages of typical supply chain process (see Figure 21), which implies a low level of vertical integration.
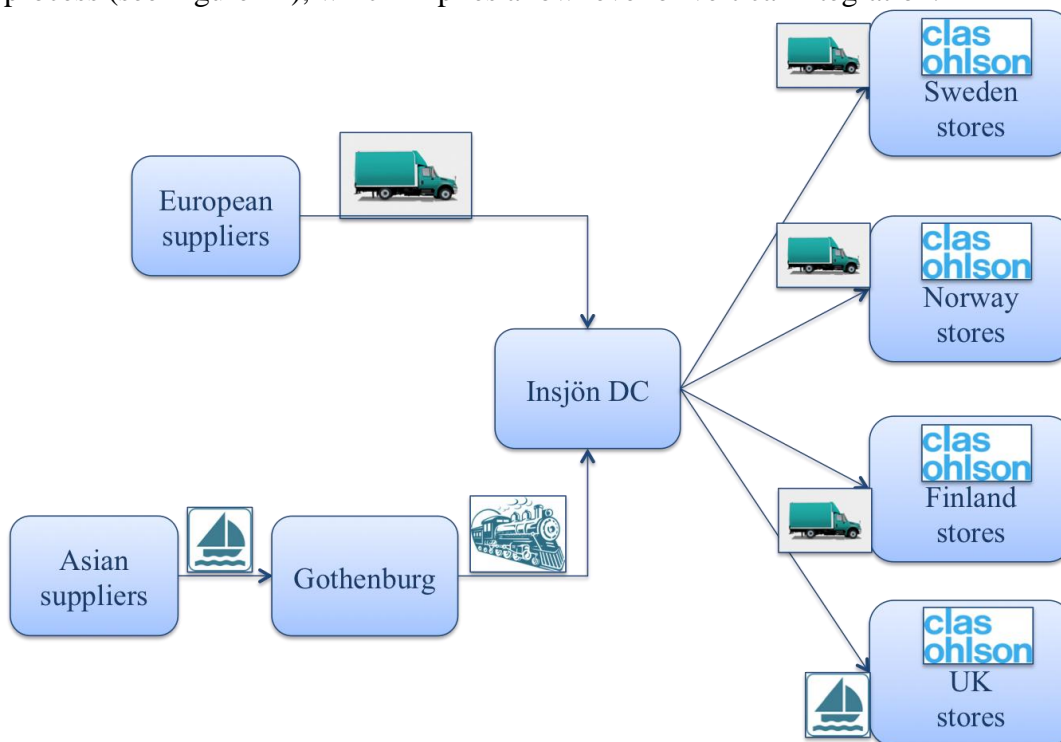


Figure 21. Clas Ohlson's simplified supply chain

## Facilities

Clas Ohlson has a total of 139 stores in the Nordic region: 61 in Sweden, 50 in Norway, 17 in Finland, 11 in UK and the office in Shanghai. The Shanghai office has been created in order to control, assess and monitor the activities with suppliers and manufacturers in Asia. 38 employees conduct training at the supplier's plants as well as CSR audits at the factories (426 audits in year 2011) (Clas Ohlson annual report, 2010/2011).

There is a trend among the hardware retailers in opening stores: most of the companies now try to move stores out of the city centers and try to open as big stores as possible. Clas Ohlson has an opposite strategy to choose the central location in city centers, in big shopping centers in order to be closer to customers.

### Distribution center (DC)
When the goods arrive to the DC in Insjön, they are unpacked from the pallets, measured and counted. They can be either kept in the DC or delivered by trucks to the stores directly. In 2011 the total replenishment of DC was 6 times a year.

In its DC Clas Ohlson uses the IT system developed by Logica, which is called Raindance. Besides it has its own IT development department and own system for warehouse management and purchasing. Big project that took place in 2004-2009 has resulted in complete automation of warehouse management system and warehouse control system.

Ordering system is completely automated: every store has its back-office system that registers every SKU's maximum inventory level and order level. When order level is reached, the replenishment is ready for delivery on the next day.

Clas Ohlson's IT system is not integrated with suppliers' one, and there is no automatic order system, i.e. all orders are made manually. European suppliers send the notifications by mail or fax; from Asia – Clas Ohlson receives the notification from the Shanghai office and from the transport and logistics service provider. These notifications are transformed into an Excel file which is not connected to Raindance. Integration with suppliers is the area of further improvement of DC IT system (Håkan Solarfs, Clas Ohlson).

## Suppliers

Clas Ohlson purchases all of their products from 600 suppliers in 30 countries around the world. The suppliers are located in the following regions: 64% are in Asia, 11% – Sweden, 22% – rest of Europe, 3% – other.

For each product Clas Ohlson has from 1 to 4 suppliers, but the general policy is to source products from a single supplier. From Asian suppliers goods are delivered by boat to Gothenburg and then by train to the central DC in Insjön, from European suppliers orders are delivered directly to DC by trucks. Asian orders are shipped in 40 days after the order is made, while European suppliers can deliver in 1-2 days, that is why European suppliers are sometimes used for the emergency deliveries (Håkan Solarfs, Clas Ohlson).

## Own-branded products

There are approximately 15000 products in Clas Ohlson's portfolio, which are usually divided into five categories: hardware, home, multimedia, electrical and leisure.

Currently, the share of OBPs is approximately 23% of all sales (Håkan Solarfs, Clas Ohlson). The company's objective in is to increase their share of OBPs to at least 25% in the coming years. More detailed information about Clas Ohlson's OBPs is available in Appendix B.

*Analysis*

Clas Ohlson's supply chain design can be classified as many-to-many supply chain according to the theory developed, as it consists of only 25% of OBPs.

## 4.3.3 Data identification standards

## Adoption

Clas Ohlson started to implement barcodes as product identification technology 15 years ago using Interleaved 2 of 5 (ITF) barcodes. 10 years ago, the company started to use GS1's EAN-13 code on the item and box levels. Nearly all of its suppliers used GS1 standards, so there was no need for specific investments by these suppliers to merely stick labels, with EAN-13 code, onto items. Currently 99.9% of products is marked with EAN-13 barcode.

RFID technology was assessed as a possible alternative, but it was deemed still too expensive for Clas Ohlson to use in their supply chain process (Håkan Solarfs, Clas Ohlson).

## Outcomes of implementation

Deployment of EAN-13 on the item and carton levels provides Clas Ohlson with basic benefits of standardization in supply chains, such as the automation of POS and improvements in basic warehouse management.

A sophisticated IT-system involving over 30 maintenance team members, allows Clas Ohlson the possibility to compensate for its lack of data identification standards on the pallet level in terms of efficiency of warehouse and store operations.

However, the creation of a Master data, as in the Axfood case, could help manage space and storage operations. Currently goods arrive in cartons, which are not standardized and their measures are not known in advance. This slows down the truck unloading process. Because space management in DCs cannot be planned in advance, there is big room for improvement.

Clas Ohlson intends "*to become more involved with their suppliers*" (Håkan Solarfs, Clas Ohlson). Similar to IKEA's case, Clas Ohlson is considering the GS1 system as a possible solutions that may help address this issue. A connection to Validoo can help the company build a Master data, and consequently improve merchant flow within the enterprise and with their suppliers. As one alternative, Clas Ohlson can also consider a solution derived from the transportation contractors responsible for the train and sea freight. Their systems can be merged in order to gain more visibility and connectivity within the supply chain.

## 4.3.4 Need for supply chain visibility

The need for supply chain visibility may be assessed for a typical product sold in a Clas Ohlson store, for example a *drilling machine* (Table 10).

Table 10. Assessment of the need for supply chain visibility for Clas Ohlson's supply chain

| Type of supply chain visibility | Factors influencing need for visibility | Factor assessment | Analysis |
|---|---|---|---|
| Demand visibility | demand predictability | medium | hardware products are situated in the middle of demand spectrum; for spot suppliers demand predictability is 0 |
| | degree of collaboration | low | transaction information is shared on need-to-know basis due to lack of IT integration |
| Order visibility | order frequency | low | 6 times a year |
| | order evenness | even | less even, comparing to food retailing less even comparing to food retailing, but can be higher according to the contracts |
| Inventory visibility | inventory turnover rate in the DC | low | 6 times a year |
| | level of inventory in stores | low | low level of inventory is enabled by auto-ordering system |
| Shipment visibility | duration of lead time | long | relatively long comparing to food retailing |
| | number of LTL shipments | N/A | N/A |
| Supply visibility | governmental regulations | high | very high demand for the traceability of such products like chemical substances, paints, children toys |

| | | | |
|---|---|---|---|
| General factors | company size | medium | 5828 mln SEK of Net sales |
| | product uniqueness | low | |
| | cost of goods | low | the most of the products cost less than 300 SEK |
| | duration of PLC | long | products can be stored for years |

\* Colored cells highlight factors which add weight for the need of visibility

The critical types of supply chain visibility are order, inventory, and supply.

There is a strong need for *demand visibility* for Clas Ohlson due to the absence of connectivity with suppliers caused by a low degree of collaboration with them.

Product transportation by contractors and long lead-time increases the need for *shipment visibility*.

For items such as chemical substances or toys, Clas Ohlson must increase traceability (*supply visibility*) due to mandated regulations, specifications, and health certificates.

## 4.3.5 Within-case analysis

Clas Ohlson is an example of a many-to-many supply chain, which has fulfilled the need for internal visibility with the help of a complex IT-system – not standards. However, there is still need for supply chain visibility. The EAN-13 barcode allows it to only track and trace items and cartons from DC's to stores, but not pallets from suppliers to stores.

Contextual factors from the TOE framework can form the basis on which Clas Ohlson's decision on GS1 system implementation may be conducted:

- the degree of technological complexity

Clas Ohlson has already implemented one of the GS1 standards - EAN-13 on the item level. Thus, the expansion of the GS1 standards on the carton or pallet levels could be the next step of their adoption and should not be any more difficult from a technological point of view, requiring only modest hardware investment.

- perceived compatibility

A complex IT-system developed by Clas Ohlson may be changed in accordance to new standards. For Clas Ohlson this shouldn't be a problem since there are currently 30 IT specialists working as a maintenance team on the communication system.

- perceived benefits of adoption

The awareness of Clas Ohlson regarding the possible benefits of the GS1 system in supply chain management is interpreted as being rather low. Therefore, one of the aims of the thesis is met. That is, to educate the companies regarding the perceived benefits of global standards implementation.

- perceived cost of adoption

A financial analysis of standards adoption requires a deeper involvement in the company and the disclosing of more internal data, so that the project's financial assessment can be evaluated as to whether it is worth implementing the GS1 system or not.

- size of an organization

As Clas Ohlson is operating on a regional level, the scale of the company can be compared to Axfood. Thus the adoption of standards will involve a smaller investment compared to IKEA. However, on the relative scale of Clas Ohlson, it is a serious investment and should therefore be a well analyzed and evaluated decision.

- top management support

Support of top management is thought to be the main driving force towards major changes in the supply chain processes, and top management should be fully aware of all the perceived benefits of standards implementation. This was not the case with Clas Ohlson.

- forces within the supply chain (partner's power)

A possible connectivity within supplier base is evidenced by the fact that most of them are already members of GS1. Thus, the possibility to merge IT-systems and create Merchant flow in unison is very strong.

- external pressure

Although Clas Ohlson has yet to experience external regulatory pressure from authorities to date, it may be an issue considered by Clas Ohlson in the near future.

## *4.4 Cross-case analysis*

### 4.4.1 Supply chain design

A comparison of case companies' simplified supply chains is illustrated in Figure 22. The degree of vertical integration increases from Clas Ohlson via Axfood to IKEA: all case companies manage the distribution and retailing stages of supply chain processes. Axfood and IKEA have their own transportation systems, while finally only IKEA owns some supplier facilities (raw materials Swedwood and Swedspan).
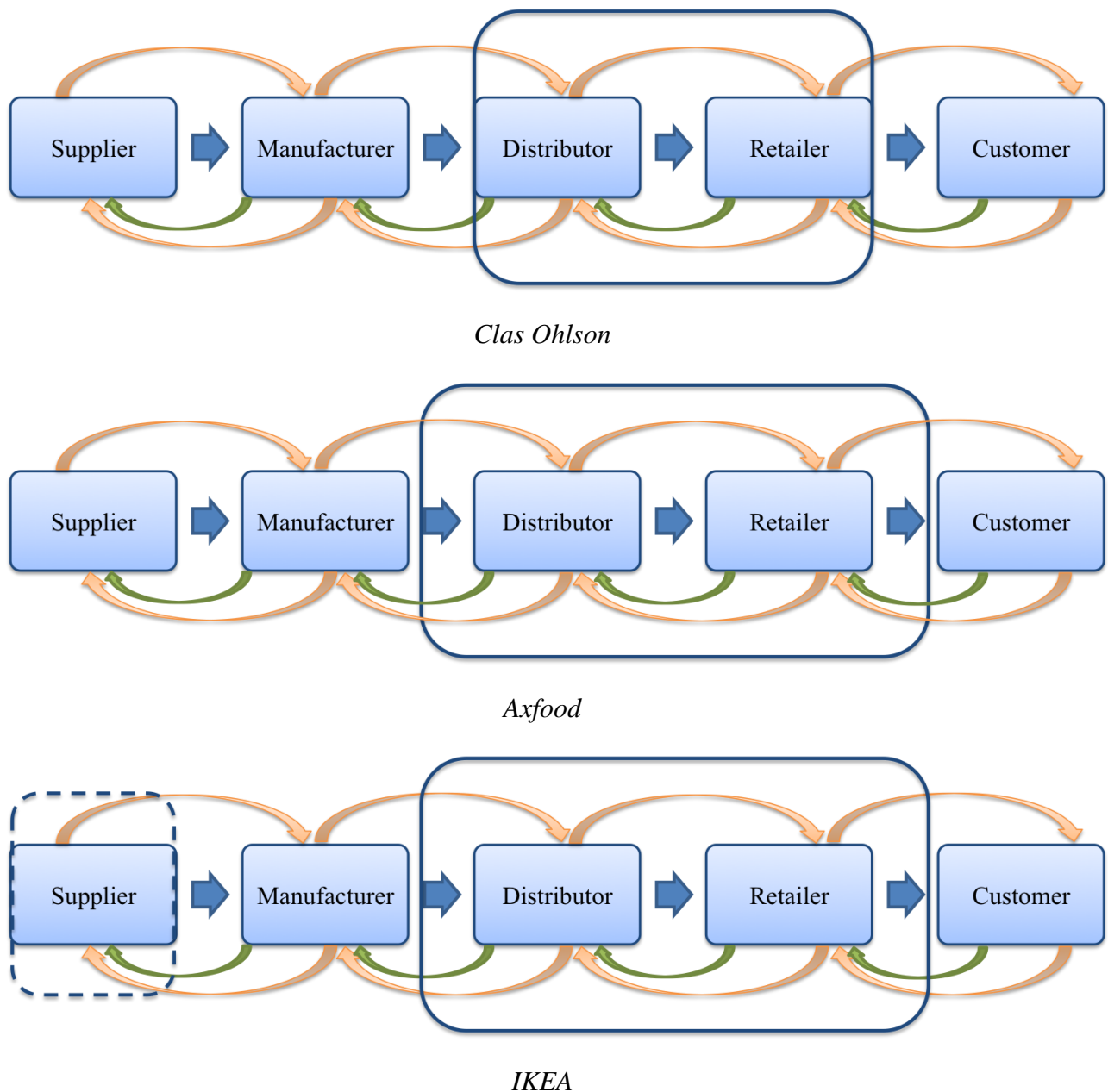


*Clas Ohlson*



*Axfood*



*IKEA*

Figure 22. Comparison of case companies' supply chains

The percentage of own-branded products in case companies' products range is assumed to be the main factor in determining supply chain design. Axfood and Clas Ohlson with respective 24,2% and 23% of OBP's have many-to-many supply chains, while IKEA with 100% of OBP's is an exclusive supply chain.

## 4.4.2 Data identification standards

The importance of standards in providing supply chain visibility is illustrated by the cases of Axfood, IKEA, and Clas Ohlson.

Axfood has implemented the whole GS1 system of standards on item, carton and pallet levels. This has provided them the opportunity to decrease the manual handling of products and events. The adoption of the GS1 system of standards has provided Axfood with main benefits in invoicing, warehouse operations and traceability. It has yielded in the big economies of scale and automation of processes, and consequently has increased supply chain visibility. The partial integration of IT-systems of suppliers and Axfood has also increased the possibility for collaboration.

IKEA has adopted only one GS1 standard, SSCC on the pallet level, which has reduced the time to unload trucks by 44% and increased turnover in the warehouse dock area by 55%.

The use of only EAN-13 on the item and box levels provides Clas Ohlson with only basic benefits that can be gained from implementing the GS1 system.

Therefore, the case studies have illustrated that the amount of benefit from GS1 system implementation depends on the number of standards adopted, which is in accordance with the IBM report of 2012.

Axfood has gained the maximum amount of benefits, since it has implemented the entire GS1 system. IKEA has improved its warehouse and traceability management by implementing GS1 standards on the pallet level. Finally, Clas Ohlson has only basic benefits from implementing GS1 on the item and box level.

## 4.4.3 Need for supply chain visibility

*Demand visibility* – For both retailers and suppliers, it is important to possess up-to-date demand information in order to plan capacity (suppliers) and orders (retailers). The need for demand information in Axfood and Clas Ohlson is provided by the Nielsen company, who collects and analyzes POS data. All three case companies' suppliers make forecasts of future demand based on order history from their retailers. However, due to the complete implementation of the GS1 system of standards, Axfood is already quite close to joint forecasting and planning with its suppliers, while in Clas Ohlson's case, demand visibility is problematic owing to the lack of connectivity with its suppliers.

*Order visibility* is a more critical area in Axfood's supply chain compared with IKEA and Clas Ohlson due to higher order frequency. This can be explained by the specificity of Axfood's products, namely FMCGs. Order visibility, in terms of ability to track order status, may be a problem for Clas Ohlson, although owing to the low frequency of orders this factor is not deemed critical.

*Inventory visibility* is a main issue in Axfood's and IKEA's supply chains due to high inventory turnover. The examples of IKEA and Axfood show the importance of standards in inventory management systems. As discussed earlier, Axfood uses standards on all three levels (item, carton, pallet) allowing it to achieve high automation of warehouse operations and high replenishment ratios. Warehouse management was improved at IKEA after the implementation

of SSCC, i.e. pallet handling and truck unloading was dramatically simplified. The manual measurements of boxes and similar actions can be seen as inefficient work by Clas Ohlson's DC management. However, it can still be justified by the relatively small number of transactions compared to Axfood and IKEA, and the low replenishment cycle of Clas Ohlson's DC. Nevertheless, if Clas Ohlson's growth rate remains the same, a need for more standardized procedures with suppliers and within DC's will appear.

*Shipment visibility* is dependent on the duration of lead time as well as whether a company uses services of contractor organizations or not. A long lead time makes shipment visibility a critical area for IKEA's and Clas Ohlson's supply chains. IKEA and Axfood maintain control over the transportation process, while Clas Ohlson outsources this stage of the supply chain process. Such outsourcing increases the need for shipment visibility, while closer collaboration with contractors can improve this type of supply chain visibility.

*Supply visibility* is one of the most critical areas for all three case companies, since for each company, their products may affect the health and safety of customers. The traceability of goods for IKEA is ensured by the implementation of SSCC. In Axfood it is by the whole GS1 system of data identification and data communication standards. In Class Ohlson, however, the issue of traceability has not yet been addressed.

In all, it is important to set clear that supply visibility is considered to be the most important for all three case companies. Supply visibilty is connected to their positioning in the supply chain as retailers, and supply visibility is important due to increasing legal demands from food and health security authorities.

A summary of the need for supply chain visibility in all three case companies is illustrated in Table 11.

Table 11. Need for supply chain visibility for Axfood, IKEA and Clas Ohlson

| Type of supply chain visibility | Need for supply chain visibility | | |
| --- | --- | --- | --- |
| | **Axfood** | **IKEA** | **Clas Ohlson** |
| Demand visibility | | | + |
| Order visibility | + | | |
| Inventory visibility | + | | |
| Shipment visibility | | + | + |
| Supply visibility | + | + | + |

## 4.4.4 Analytical model

Within-case and cross-case analyses allows us to estimate the approximate need for supply chain visibility and supply chain design of the case companies, and to place them within the model introduced in the theory development chapter (see Figure 23).
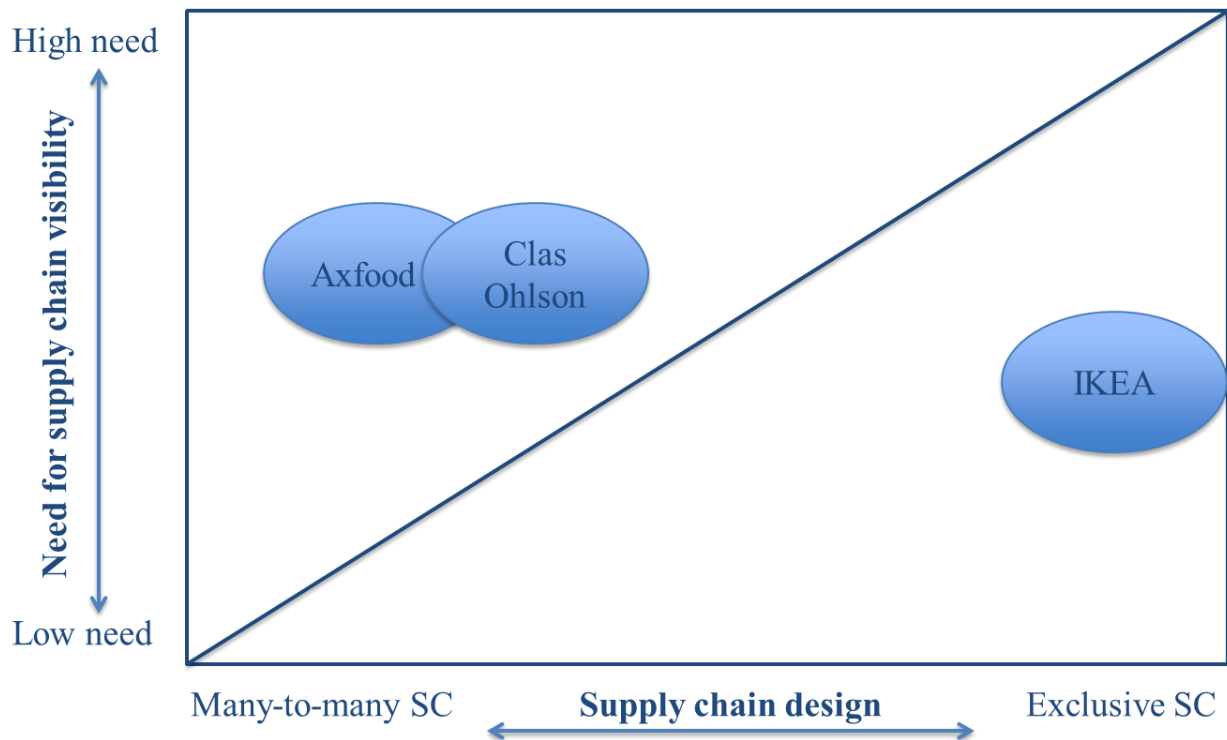


Figure 23. Potential for global standard adoption for Axfood, IKEA and Clas Ohlson

In accordance with theoretical replication, the results of Axfood and IKEA case studies have provided evidence that:

- many-to-many supply chains have a higher need for supply chain visibility and greater potential for global standards adoption
- exclusive supply chains have lower need for supply chain visibility and lower potential for global standards adoption.

In fact, lower positioning of IKEA on the model confirms that the higher the degree of vertical integration, the lower the need for supply chain visibility as it turns into internal visibility. The successful SSCC implementation in IKEA's supply chain provides evidence that the implementation of global supply chain standards in exclusive supply chains is still possible, although with some deviations from the usual implementation procedure.

The role of Clas Ohlson's case study in this research demonstrates that while having a significant need for supply chain visibility, a company can try to satisfy it in different ways. Clas Ohlson copes with this need by using a sophisticated IT-system which ensures warehouse efficiency and internal visibility. This strategy is similar to one of exclusive supply chains. However, it should be noted that the possible implementation of global data identification standards could increase the visibility of supply chain partners, which can have both positive and negative consequences for a company.

# 5  DISCUSSION AND THEORETICAL CONTRIBUTION

*This chapter reflects on what was known prior to case studies and how empirical findings have enlarged the understanding of the concepts of supply chain visibility, supply chain design, and adoption of global supply chain standards. Implications for decision makers that face the choice of adoption of global data identification standards are discussed. In the end, theoretical contribution and purpose fulfillment are both highlighted.*

## 5.1 Discussion

This thesis finds links between three concepts: supply chain visibility, supply chain design and global data identification standards (see Figure 2, p. 4).

### 5.1.1 Supply chain visibility

Supply chain visibility is a multilateral concept which has yet to be fully investigated in supply chain management literature. Both academic papers and business reports confuse supply chain visibility with information visibility, transparency, and even traceability.

Supply chain visibility is seen as a panacea in managing global multi-tiered supply chains because the concept implies such benefits as increased responsiveness, agility of supply chains, performance improvement, and even the supply chain itself being a competitive advantage as a whole (Barratt and Oke, 2007).

Intensive literature review has revealed that contemporary researches are more concentrated on enablers, obstacles, and benefits of supply chain visibility, while there is a clear lack of understanding of the real need for supply chain visibility and its various types. Most studies perceive supply chain visibility as demand visibility and relate its benefits more to a reduction in the bullwhip effect. Alternatively, viewing supply chain visibility as visibility within the transportation process brings only confusion between supply chain visibility versus traceability and trackability, which are in fact the very benefits of supply chain visibility.

Different supply chain actors have different motives for what they wish to achieve through supply chain visibility. Suppliers need to know demand information in order to plan capacity in advance, while retailers should know their suppliers' capacities as well as detailed information regarding products' deminsions and characteristics to best plan space management in their warehouses and stores.

Typically, a company's management is not aware of the concept of supply chain visibility, nor is proper attention paid to it. The incentive for companies to start thinking about visibility is mostly external, e.g. legal demands or inefficiency in relationships with other supply chain partners. In fact, it is important to scrutinize supply chain visibility as a complex relationship of different visibility types, especially within complex chains. Furthermore, it is enough to have only one dominating need for visibility (e.g., supply visibility for healthcare or food companies) that may force a company to seek greater supply chain visibility.

With the aim of providing better guidance, the authors have operationalized the need for supply chain visibility in a framework implemented through three case studies.

*Supply chain visibility and standards*

It is surprising that among the enablers of supply chain visibility, current studies often fail to mention standards, while concentrating instead on IT implementation, information sharing, and relationship building. However, it should be noted that standardization is an important aspect involving the quality of information shared, since the information shared must be well understood by all supply chain partners.

As being a part of the information driver of supply chain performance (Chopra and Meindl, 2010), standards within supply chains should be treated with the same attention as IT implementation. The possibility to achieve supply chain visibility with the help of standards was demonstrated through the case companies. So, similar to an IT enabler, a global supply chain standard is one of the pillars of supply chain visibility.

*Supply chain visibility and supply chain design*

While considering standardization aspects of supply chain visibility, the authors have come to the conclusion that there is a third component in this link, namely the environments in which information sharing takes place and supply chain visibility is to be achieved. Thus, supply chain configuration (in this thesis – supply chain design) significantly influences the need for supply chain visibility and the role and type of standards in achieving it.

So, before accepting the need for supply chain visibility as an imperative, it is worth looking more precisely on the actual need for supply chain visibility within a particular context – the supply chain design. The strategic implementation of visibility takes place mostly in many-to-many supply chains, when companies possess the ability to reconfigure (i.e. have partners with such benefits) and have turned it into their own competitive advantage.

## 5.1.2 Supply chain design

The relationship between supply chain partners varies with the degree of information shared between them, i.e. the more information that is shared, the more possible it is to act on this information, and thus the closer the collaboration is in the supply chain. Most companies communicate information on a need-to-know basis, which simplifies transactions while also preventing partner opportunism.

In order to simplify all transactions within an entire supply chain, some companies vertically integrate as a way to reduce the number of transactions and ultimately their costs. The more supply chain activities a company embraces, the more possible it is to standardize supply chain practices and transactions. Developing an individualized procedure for handling the supply chain processes may even be treated as a resource by a company to help stay competitive, i.e. standardized supply chain practices can be turned into a competitive advantage. This is most likely to occur in the case of exclusive supply chains.

Alternatively, implementation of global supply chain standards can help many-to-many supply chains achieve the same level of information integration among its supply chain actors as with exclusive supply chains, but without integrating in an organizational way.

### 5.1.3 Global data identification standards

The implementation of global or proprietary standards within supply chain practices depends on how companies perceive them and how much is known of the possible benefits of their implementation. Moreover, the applicability of global supply chain standards is tightly related to the type of supply chain design.

Many-to-many supply chains mostly use global standards in the whole supply chain processes since they experience a constant flow of multi-branded products. Consequently, they try to extract as many benefits as possible. They are considered to be strategic implementers of standards (Power, 2004), while exclusive supply chains can implement only a portion of the global standard in a tactical manner in order to solve efficiency problems.

Implementation of global data identification standards ensures matching demand and supply via automation of transactions between supplier and retailer. Additionally, the cost of transactions decreases with the increase of speed and responsiveness of operations. This has the effect of moving the efficiency-responsiveness frontier upwards without any trade-offs (Chopra and Meindl, 2010). However, for companies which do not implement standards as a tool in optimizing supply chain performance the use of standards turns into merely a cost.

It should be noted that the use of global standards is not the one and only solution since the deployment of proprietary data identification standards reduces the risk of revealing sensitive information about suppliers. Information potentially encoded within barcodes. Such a solution is more appropriate for exclusive supply chains. The fact that a company's willingness to implement global supply chain standards is not the only determining factor in the adoption decision clearly stresses the importance of security issues, which all exclusive supply chains should take into account.

Therefore, the issue that exclusive supply chains do not always have a high need for supply chain visibility can be explained by the fact that they achieve internal visibility with the help of proprietary standards or sophisticated IT-systems, which can fulfill all the necessary external demands related to the traceability of products.

However, the use of proprietary standards limits the possibility to reconfigure and limits the choice of supply chain partners; while in the case of global standards, a collective action theory works. The more companies that implement a global standard the more advanced it becomes. The more companies adopt a global standard, the more possible supply chain partners there are, which in turn is even more beneficial for many-to-many supply chains.

In summary, the results of case studies suggest the following:

1. Global data identification standards implementation is an important enabler of supply chain visibility.

2. Implementation of global data identification standards should differ in different supply chain designs.

3. Benefits from global data identification standards implementation are different within different supply chain designs. While exclusive supply chains can experience no benefits or only operational improvement benefits, many-to-many supply chains may gain strategic benefits, namely the ability to reconfigure and increase the pool of potential business partners.

## 5.2 Theoretical contribution

The theoretical contribution of this thesis is the operationalization of the need for supply chain visibility, the development of a model for global standard adoption, and identifying global standards as an important enabler of supply chain visibility as well as a part of the information driver of a supply chain.

This research also makes an important contribution to the RBV theory. A traditional implementation of RBV can be observed in exclusive supply chains. These supply chains tend to implement proprietary supply chain standards in order to protect sensible information, e.g. supplier base. Also, the capability of exclusive supply chains to develop this base and maintain supplier relationships is a core competence that leads to their competitive advantage.

Additionally, the RBV approach is applicable within many-to-many supply chains. Supply chain visibility is seen as an important capability of a supply chain that can also lead to a competitive advantage via operational improvements and the ability to reconfigure.

Therefore, in line with Wang and Wei (2007), this study contributes to the RBV theory. The authors extend the theory by highlighting the role of standards in value creation from the perspective of RBV. In many-to-many supply chains implementation of open standards provides supply chain visibility with is considered as a unique supply chain capability that leads to both efficiency and a competitive advantage (Ketokivi and Schroeder, 2004). In exclusive supply chains, exclusive supply linkages are seen as VRINN resources that should be protected though implementation of proprietary standards in order to keep a competitive advantage.

## 5.3 Fulfilment of purpose

It is important to align whether this work has answered the questions raised in the beginning, and whether the objective of this thesis is reached.

*RQ1: What is the role of global data identification standards in providing supply chain visibility?*

As there was no exact information in the theory that standards are important in providing supply chain visibility, the use of three case companies and their experience of implementing the standards in supply chain processes, helped to establish this link. The Axfood case was the most developed example, whereby GS1 standards were implemented on all three levels, showed that adoption of standards helped the company to trace and recall the goods, and added visibility to ordering and the invoicing processes. In the case of IKEA, legal demands for traceability (supply visibility) was also met with the help of GS1 standards on the pallet level with the use of SSCC, which was further used in combination with proprietary standards on the item and carton levels.

In this way, data identification standards play an important role in creating visibility for companies.

*RQ2: How does the adoption of global data identification standards depend on supply chain design?*

As in the first question, the adoption of global data identification standards were analyzed based on the case companies. According to preliminary research, the companies with exclusive supply chains, with 100% of OBP's, tend to use proprietary standards, while in many-to-many supply

chains global data identification standards are more applicable. However, the case of IKEA shows that there exists the potential for global data identification standards in these supply chains, since sometimes the proprietary solutions do not provide sufficient levels of visibility. To increase the level of supply chain visibility, exclusive supply chains need to develop more proper standards or more sophisticated IT-systems, which require major investments. As in the IKEA case, companies tend to use established solutions – GS1. Nevertheless, the risk that there will be a leak of some critical information regarding suppliers and locations still exists.

*RQ3: How can companies within different supply chain design benefit from using global identification standards?*

The benefits which a company enjoys from implementing a global data identification standard, depends on the levels at which these standards were implemented. The most basic benefits such as the automation of a POS processes and basic warehouse management are reached when the standards are used on the item and carton levels. This is similar to the Clas Ohlson case in combination with a proper IT-system, where the use of item and carton labeling can help create an automated ordering system to better manage stock levels. More advanced benefits can be reached when using the pallet identification standard as in IKEA case, where the ability to trace goods and manage space in the DCs and warehouses was improved. The deployment of data identification standards at all three levels integrated into a proper IT-system allows the company to increase the efficiency of transactions, decrease the time of decision-making in emergency situations, and conduct space shelf-management with the help of master data and merchant flow.

The developed model integrates three concepts being discussed throughout this research – supply chain visibility, supply chain design, and adoption of standards – and shows the potential of global data identification standards adoption in supply chains among various supply chain designs.

*This chapter discusses the limitations of the research as well as managerial implications and possible areas open to future investigation.*

The developed model integrates three concepts being discussed throughout this research – supply chain visibility, supply chain design, and adoption of standards – and shows the potential of global data identification standards adoption in supply chains among various supply chain designs.

## 6.1 Managerial implications

There are two main managerial implications of this thesis.

First, the thesis has educational goals. Logistics professionals can use the analytical model developed here to assess the current state of supply chain visibility within given companies and within the supply chain as a whole. It can also be used in considering the potential adoption of global standards within a company, as well as the possible benefits of adoption itself. If an industry differs from retailing significantly, other characteristics from the horizontal axis may be found instead of a supply chain design.

Second, this research also helps inform decision-makers regarding the different value of standards in different supply chains, and warns companies regarding thoughtless implementation of standards according to a "one-size-fits-all" principle in pursuit of visibility. The adoption of standards is part of supply chain strategy, and so it should be aligned with the overall corporate strategy.

## 6.2 Limitations

One limitation of this research may well be the small number of interviews carried out. However, the questions asked during the interviews were very precise in order to understand the underlying reasons and attitudes towards the studied phenomena from the perspective of each and every case company. Additionally, the smaller number of interviews were countered with a thoroughly discussed and information-rich analysis of the data.

Another limitation of the research is a lack of financial and operational data shared by the companies. However, this factor cannot be addressed since this is a company's code of confidentiality. Nevertheless, this research is only the first step in a new direction of the role of standardization in supply chain management, and the main purpose of case studies – gaining understanding of how the three theoretical concepts were linked – was successfully fulfilled.

## 6.3 Further research

As this thesis aims at theory extension while simultaneously dealing with new concepts of supply chain design, the area of further research is broad and can be developed in different directions.

This research is based on three case studies and represents the first step in an investigation into linkages between concepts. The next step would be to test the analytical model and conclusions by means of a survey using a larger sample size, which would improve the external validity and generalizability of the research.

Yet another area of future research could be to further study companies that are currently in the "battleground zone" of the model developed. What do they see as benefits and obstacles in choosing one or another standard solution? Further research could improve the model and define relationships inside the "battleground zone."

One of the delimitations of the study is a focus on the retailing industry. The applicability of the study in other industries would be interesting, as well as an industry-specific need for supply chain visibility. Even though the design of this research is fit for the retailing industry and their position within the supply chain, the information on how other supply chain actors assess the need for supply chain visibility, and which benefits they enjoy, is also of great interest. Furthermore, it would be also interesting to further investigate the objectives, enablers, obstacle, and benefits of each type of supply chain visibility introduced in the theory development chapter.

As was mentioned earlier, different supply chain actors in the supply chain possess different information. In our case, retailers own the POS data, i.e. demand information which can be valuably used by other supply chain actors in order to plan and optimize their processes. Here, an important issue of information asymmetry arises. Thus, an area of further investigation and study would be how companies perceive information as a tool to optimize the overall supply chain processes, and as a tool used to develop and support a competitive advantage.

Information asymmetry is followed also by the important concept of power balance within the supply chain – there is always a supply chain actor, which owns more information than others, and can somehow influence the processes of standard choice, adoption, and implementation of companies. So, the issue of focal companies (mentioned in Caridi et al. (2010a,b); Kim et al. (2011); Power and Simon (2004)) is also of significant interest for further research as it not investigated in this thesis.

We have assumed that supply chain visibility creates the availability of information in the supply chain, which companies act upon. Does supply chain visibility always provide a base for collaboration? It was mentioned in the empirical portions that Axfood, as the most developed in terms of supply chain visibility and implementation of global data identification standards, has not yet introduced the most complex stage of partner relationships – collaborative planning. Therefore, the bond between supply chain visibility and collaboration also deserves further investigation.

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## Interviews

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Mia Lenman, Business Manager for Transport and Logistics. GS1 Sweden. 30-03-2012.

Karolin Harsanji, Business Manager for Automatic Identification and Data Capture. GS1 Sweden. 30-03-2012.

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Håkan Solarfs, Supply Chain Development Manager. Clas Ohlson. 11-05-2012; 10-07-2012.

Jan Ståhl, Business Developer at Supply Chain Development. IKEA. 18-05-2012.

# APPENDIX A: INTERVIEW QUESTIONS

The following question were used at the first round of interviews to get the general knowledge about companies, their attitude towards supply chain visibility and supply chain design as well as their relative positioning on the developed analytical model.

**Axfood**

*General questions*
1. When did you start to implement GS1 standards?
2. Who was the initiator in adopting GS1 standards? What was the reason for it (lack of information or its poor quality or anything else)? Was it a desperate need or a forward-looking step?
3. What was the scope of implementation?
4. Were there other retailers in Sweden that were implementing GS1 standards at that time?
5. How would you define visibility? SC visibility (SCV)? Have you achieved SCV since GS1 standards implementation?
6. Which standards from the GS1 portfolio did you use at the beginning of their implementation and now?
7. What inter-organisational information system (IOS) do you use to implement GS1 standards?
8. Which standards and IOS did you use before? (Any proprietary standards?)
9. Have you ever had confusion with implementation of data identification standards before GS1 standards implementation? Did they diminish after?
10. How did the process of GS1 implementation go? (employee resistance, top management support, IT related investments, technological challenges)
11. When is the investment going to pay off? Could you please provide us with some financial numbers of the project dynamics?

*Case-specific questions*

1. What does your SC look like in general? (global representation, number of tires, size of partner companies)
2. Did GS1 standards implementation enlarge AxFood's portfolio of suppliers (due to access to data pool), on the contrary, did they diminish (due to suppliers' resistance/inability to adopt GS1 standards)?
   a. Did AxFood's implementation of GS1 standards force your existing partners to adopt GS1 standard too? Do all your suppliers use GS1 standards? When/ How do you cooperate with companies that have not adopted GS1 standard yet, if at all?
3. We suppose that AxFood, being a retailer, is a "SC capitan" in its SC. Is it right? What is your power over your suppliers? Are there other intermediary "SC captains" in your SC?
4. Which benefits, in your opinion, did you get with GS1 system implementation?
   a. Does it mean that, since implementing GS1, you can "see" the whole SC?
   b. What events do you track? Is food traceability important for you?
   c. What information do you share with suppliers?
   d. What information do you get from your suppliers?
   e. Do you make synchronization of decision making processes?
5. What problems (if any) do you have with GS1 standard implementation?
   a. Do you think you receive some unnecessary (excessive) information?
6. How do you perceive whether your need for SC visibility is high or low?
7. How do you perceive your level of integration with your partners?

**IKEA**

1. Please describe your supply chain (roles and number of different external and internal actors in your supply chain, for example: suppliers, manufacturers, distributors, DC/warehouses, retailers).

2. What IT system does IKEA use? To what extent is information handling in all supply chain processes (planning, ordering, storage, shipment, sourcing) automated? Please provide an example of information that is exchanged within IKEA (for example between DC and store).

3. How is your IT system connected to the partner's IT systems? Please provide an example of how you interact electronically with a typical supplier. What kind of information do you send each other and with what frequency?

4. How much power do you have over your suppliers? How dependent are the suppliers on IKEA? How large fractions of your suppliers' sales does IKEA account for?

5. Do you have short-term or long-term relationships with your suppliers? What is the percentage of dedicated suppliers?

6. Supply chain visibility can be defined as the availability and transparency of information regarding products (quality, location, point of sales data, etc.) between different supply chain actors (external visibility) and within a company (internal visibility). As IKEA embraces several steps of the supply chain, please describe its level of internal and external visibility today and any possible future needs.

7. Which material flows do you track? Are product trackability (where product are at each moment of time and at each stage of the process) and traceability (where the products come from – pedigree) important for you?

8. Please describe how your data identification technology works: barcode system handling, degree of RFID adoption, etc.

9. Which data identification standards do you use? If they are proprietary, when and how have you developed them? How many people are involved in standards maintenance?

10. In 2007 IKEA reported the successful results of a traceability project in cooperation with GS1 (namely SSCC and GS1-128 barcode implementation) and was going to extend that initiative to its 400-900 suppliers worldwide:

    a. What result have you currently achieved in this field?

    b. What forced you to use GS1 standards?

    c. Who is responsible for putting the SSCC label on the container/pallet?

    d. Which perception of GS1-128 barcode implementation have you got? Please, provide some examples.

11. Which of GS1 standards do you use now? How do your own and GS1 standards fit together? Has the situation with double standards made it more difficult to handle data identification processes (require changes in IT, communication with suppliers, etc.)?

12. How do you help your suppliers to adapt to the standards you use. Do you require that invoices and shipment data is sent from suppliers in a particular way? Do your suppliers require that information be transmitted in a certain format?

13. What are your plans for the future – are you going to adopt more GS1 standards? What obstacles in GS1 standards adoption do you see?

**Clas Ohlson – interview #1**

1. What does your supply chain design look like (roles and number of different actors in the supply chain)?

2. What is the percentage of own branded products (OBP) in the Clas Ohlson portfolio?

3. What inter-organisational information system (IOS) do you use? Is information handling in all supply chain processes (planning, ordering, storage, shipment, sourcing) automated?

4. Supply chain visibility is defined as "the capability of a supply chain player to have access to or to provide the required timely information about the entities involved in the supply chain from/to relevant supply chain partners for better decision support". According to this definition, do you think you have enough visibility in your supply chain processes?

5. What events do you track? Are product trackability and traceability important to you?

6. Which product identification technology do you use in your supply chain processes (barcodes, RFID or else)?

7. Do you use any data coding standards in this technology? Have you developed these standards by yourself or have you adopted open (industry) standards? When?

8. Do you know about GS1 standards? Have you ever considered using this system?

9. Are you satisfied with the implementation of your data identification standards?

10. How many people are involved in standards maintenance?

11. How do you help your suppliers adapt to the standards you use. How much power do you have over your suppliers?

12. Do you prefer long-term relationships with your suppliers (intermediary parties/manufacturers)? What is the percentage of dedicated suppliers?

**Clas Ohlson – interview #2**

1. What number of trade items does Clas Ohlson have? From the first interview we have learned that Clas Ohlson is growing their percentage of own branded products (OBPs) in the product portfolio. Why is this the case? Why it is important for Clas Ohlson to increase the number of OBP?

2. What do you perceive as a main competitive advantage of Clas Ohlson's supply chain – for example, good store management, high responsiveness, cost efficiency, good supplier relationship management, brand value, high marker presence?

3. What is your perception of Clas Ohlson's willingness and possibility to collaborate with its suppliers? Please describe the collaboration process with your typical supplier. What do the ordering and invoice processes look like (degree of automation, intensity of communication, etc.)? Are there processes in place to communicate problems with your partner as soon as they are identified?

4. In the previous interview you mentioned that there is a lack of integration between Clas Ohlson's DC and its suppliers. Please, describe your plans to improve the level of collaboration (supplier capability development, relationship-specific investments)? Are your suppliers mostly dedicated to you or do they have some other customers?

5. Supply chain visibility can be defined as availability and transparency of information related to products (quality, location, point of sales data, etc.) between different supply chain actors. Do you share all information that your suppliers demand from you? Could you make an example of typical information shared?

6. Do you perceive Clas Ohlson's need for supply chain visibility as high or low and what are possible future needs? In which supply chain process do you need supply chain visibility the most (collaborative forecasting and planning, ordering process, inventory management, transportation process, supplier capability management)?

7. What barcodes do you use on the carton and pallet levels? Please describe how your data identification process works: barcode handling at different steps of supply chain process on item/carton/pallet level.

8. Do your suppliers often make new package and design of the product, and consequently you need to make additional space management in your DC?

# APPENDIX B: LIST OF OWN-BRANDED-PRODUCTS

**Axfood's own-branded products**

| Brand | Segment | No. of products |
|---|---|---|
|  | Food and non-food products | 608 |
|  | Products that meet organic criteria from KRAV and/or EU organic certification | 128 |
|  | Body care, laundry and household cleaning products | 22 |
|  | Fairtrade certified products | 12 |
|  | Discount food and non-food products | 831 |
|  | Non-food products: batteries and light bulbs (Func), and kitchen and household cleaning supplies (Fixa) | 282 |

**Clas Ohlson's own-branded products**

| Brand name | Segment |
|---|---|
|  | Outdoor equipment |
|  | Kitchen utensils |
|  | Aquatic sports equipment |
|  | Lightning |
|  | Hand tools |
|  | Fishing gear |
|  | Telephony, video and audio |
|  | Power tools, batteries and electrical components |
|  | Domestic appliances |
|  | Watches |
|  | Artists' materials |