Supplier Integration Systems

Understanding Adoption Process and Structure

Master's thesis
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Master's thesis
Industrial Engineering & Management
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Preface

The inspiration for this master's thesis sparked at the course called Business Process Integration Lab. This course was a part of the master track Information Systems & Change Management of the master Industrial Engineering & Management at the University of Twente. The coursed about e-business encompassed all the ingredients that make the master interesting. A combination of business and technology, it covered economics, process management, tactical and strategic issues, and the complexities and opportunities of new technologies in business. When I had to arrange my master's assignment the contents of this course quickly popped up as an interesting topic.
The professor teaching the course, Jos van Hillegersberg, recognized my enthusiasm and provided me with some contacts. Capgemini was quick to respond to my application as my proposal fitted right in their research need. The result is this master's thesis.

As many of my fellow students could agree with, writing your master's thesis is a process of many ups and downs, but in the end a worthwhile learning experience. Without the help of others this would not have been possible. My supervisors at the University of Twente provided me with valuable feedback and guidance. They complemented each other as Fredo took up the role of a critical reviewer and Jos the role of a guide providing valuable directions. Also I would like to thank all the respondents for their cooperation and input for my case studies.

This thesis also marks the end of a great period as a student. Without the moral and financial support of my parents and the "moral" support of my friends, I don't think it would have been the same.

Last but not least Capgemini and especially my supervisor Paul deserve many credits for their support. They provided me with the means to do my work, valuable contacts, a positive working environment, a relevant assignment and valuable feedback. But most of all the sincere interest in me and my work was appreciated. While my studies are at an end, I am fortunate to be able to continue working at Capgemini as a consultant. I look forward to more learning experiences and to put theory into practice.

Management summary

Introduction
The challenge of coordinating all the actors of an increasingly complex supply chain, due to increasing globalization and growth, and the pressure to reduce costs, to improve efficiency, and to enhance customer satisfaction has stimulated manufacturing companies to implement a Supplier Integration System. These are inter-organizational systems that aim at the integration of suppliers. They are enablers of Supply Chain Management and are used in operational purchasing and planning of direct supplies in manufacturing firms.
Supply Chain Management thinking and the rise of e-business have significantly increased the diversity of Supplier Integration System structures. How companies arrive at these solutions can be described in an adoption process model. The impact of the adoption process on the structure is the topic of this study. This study extends an existing adoption model in order to better reflect the adoption of diverse structures.

Research method
To study the impact of the adoption process on the structure, eleven cases have been examined from the perspective of the purchasing manufacturing firm. The studied manufacturing firms are large global multinationals with at least 5000 employees and annual sales exceeding 2 billion Euros. Input for the cases comes from semi-structured interviews and referred and public documents about the company.

Supplier Integration System structure
The case studies indicated that Supplier Integration System structures can best be described in terms of three basic structures, complemented by the aspects of the structure; breadth (the % of partners integrated), volume (the % of automated information flow), diversity (the % of shared information and processes), technology (type of software, network and data standards) and context (relationship and supply type). The three observed basic structures have distinct governance structures, different advantages and are used in a complimentary way for both internal and external supply chain integration.

1. In the system-to-system structure, partner systems are directly interfaced. This structure is considered most difficult to implement, but it enabled a high degree of integration.
2. In the VAN structure an electronic integration hub is positioned between the involved parties. This hub can be provided by an external integration service provider. This structure enables a high degree of integration and large networks, but it makes the company dependent on a sometimes costly and not always competent service provider.
3. In the supplier portal structure an integrated website provides partners secured access to the data. It is the most accessible structure, but only provides partial integration, thus still requiring manual tasks.

Adoption process
The case studies could confirm most elements of the adoption process model used in this study. They showed long term projects with significant changes to the structure during the adoption and an unsettled and indecisive nature of the factors that may lead to adoption. The case companies are not in total control of their environment, but are not helpless victims either. Also the inter-firm level appeared to be an important part of the structure where the company could exert its influence.
Additionally the case studies showed diverse and dynamic structures and an evolving, intangible and iterative adoption process. Also it was noticed that an implemented Supplier Integration System structure impacts the organization and its environment and may lead to new innovations in the technologies used. These observations are used to extend the existing model.

Adoption process impacts on structure

While no conclusive answer can be given on the complete impact of the adoption process on the structure, the cases indicate some impacts, concerning specific aspects of the structure. The basic structure was mainly determined by the perceived nature of the technology and the perceived relative advantages. The cooperation, to achieve higher breadth, volume and diversity, was stimulated through persuasion tactics in a climate of trust, and coercion tactics using buyer's power. Also the skill and infrastructure of all the involved parties, the existence and use of an industry standard, the execution flexibility and the basic structure type were import conditions for achieving higher breadth, volume and diversity. Industry standards are actively promoted in industry associations. Experience with the system and widely diffused industry standards were reported to enhance flexibility. Concerning the technology path dependency and network effects are confirmed by the cases.

Recommendations

The extended adoption model can be used by practitioners to analyze their situation. Based on the model they can identify the conditions, which are not met, and develop deliberate actions (such as coercion and persuasion tactics) to meet them. Changes in the structure should be considered, based on the costs and benefits of these deliberate actions and alternative opportunistic behavior (seizing the right conditions at the right moment).

Contents

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1 Introduction

The internet-hype has settled down, but still the potential rewards of doing business electronically are considered huge. Improved inter-firm collaboration and integration with suppliers are among them. An example is the way STMicroelectronics (one of the world's largest semiconductor companies) faces its business challenges with system-to-system integration of contract manufacturers using RosettaNet standards. In a 2005 member's whitepaper of the European B2B forum for the Electronics Industry they share their experiences of a global solution [1]. They report that "the challenge of coordinating all the actors of an increasingly complex supply chain", due to increasing globalization and growth, and "the pressure for semiconductor companies to reduce costs, to improve efficiency, and to enhance customer satisfaction", have stimulated STMicroelectronics to implement their Supplier Integration System. The reported project outputs were "a strong improvement of real-time visibility of the manufacturing process, the automation of shipments and the improvement of data quality and productivity."

This example illustrates that e-business is a part of modern business. STMicroelectronics regards electronic communications and automated business processes with their partners essential to achieve large volumes and to compete with efficient business processes. Many other mass producing manufacturing companies are following the same line of thinking when they consider e-business in the supply chain in general and more specific in purchasing. Also software companies, such as e2open, are specializing in these kinds of systems. Figure 1 shows a screenshot of such a Supplier Integration System.

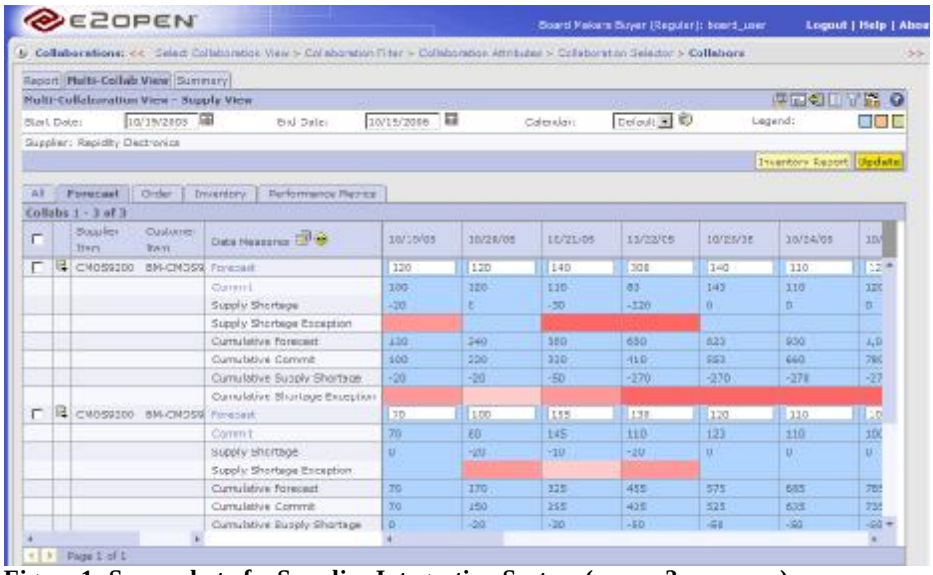

Figure 1: Screenshot of a Supplier Integration System (www.e2open.com)

This has drawn our attention resulting in the topic of this thesis: *Supplier Integration Systems*. These are inter-organizational systems that aim at the integration of suppliers. They are enablers of Supply Chain Management and are used in operational purchasing and planning of direct supplies in manufacturing firms.

The research project is part of the master's program of Industrial Engineering and Management at the University of Twente. The assignment is commissioned and facilitated by Capgemini Consulting Services. As a leading consulting firm, Capgemini needs to be on top

of the latest developments in the business world and therefore is constantly executing and facilitating practice oriented research. This master's thesis aims to contribute to Capgemini's research on collaboration and integration in the supply chain. The development of increasing integration in the upstream supply chain reflects a growing emphasis concerning the importance of suppliers. As part of the Consulting practice of Supply Chain Management the cluster Procurement is particularly interested in how its customers today are using technology to enable even tighter collaboration with their suppliers.
Although the idea of integration is not new, the execution of e-Business enabled integration in practice is not completely understood. It is recognized that Supplier Integration Systems are a class of systems that can have various structures. What structures are used in practice and why companies have these structures is not well understood. The process of arriving at a certain Supplier Integration System structure, called the adoption process, can explain why companies have their particular structures. New insights in this area would enable Capgemini to make better service offerings to potential customers.

Therefore this study aims at **understanding the adoption process and its impact on the structure of Supplier Integration Systems in manufacturing companies.**

To enable a fruitful study of this topic, we will first explore the research context in Chapter 2. This context forms the basis of the research design in Chapter 3. The research design covers the research contribution, - questions and - method. This is followed by a more elaborate outline of this thesis at the end of Chapter 3. In Chapter 4 the structure of Supplier Integration Systems is explored from a theoretical point of view. In Chapter 5 the theory on adoption processes is discussed. Chapter 6 covers the empirical part of the thesis. The adoption process and its impact on the structure in practice are studied with case study research. In Chapter 7 conclusions will be presented and the results and its implications will be discussed.

2 Research Context

The context of this study's topic is shaped by two closely related developments of the last twenty years. The first development is the elevation of the purchasing function and the second is about the rise of e-business. These two developments need to be understood first because they represent the business context and the IT context of Supplier Integration Systems (Sections 2.1 and 2.2.) The structures of Supplier Integration Systems are formed during the adoption processes within this business and IT context. This process and its resulting structure will be further explored in later chapters. An initial explanation of these important concepts is provided here in Section 2.3.

2.1 Purchasing becomes Supply Management

The elevation of the purchasing function from a purely transactional mindset towards the recognition of the strategic importance of purchasing and a collaborative approach to suppliers, explain the business context of Supplier Integration Systems. This section explains this development starting with purchasing and its definition. The section ends with supply management and the rise of the collaborative approach to suppliers. An approach that is supported by Supplier Integration Systems and at the same time is a necessary condition to make successful use of them.

2.1.1 Purchasing defined

No organization is completely self sufficient and therefore has to rely on external sources for its organizational needs. Purchasing is about the fulfillment of these needs. During the last decades the subject has received increasing attention both in literature and in practice. From this attention different terms, concepts and definitions have evolved. Monczka [2] for instance uses the term purchasing for the functional group in the organizational chart and for the functional activity of buying. In this thesis the definition of purchasing by van Weele [3] (p14) will be used because of its richer detail.

Purchasing is defined as: *"obtaining from external sources all goods, services, capabilities and knowledge which are necessary for running, maintaining and managing the company's primary and support activities at the most favorable conditions"*

This definition makes clear that purchasing is not only about purchasing materials or office appliances. Both direct and indirect goods and services are included in the definition. Furthermore it involves all activities in the purchasing process including administrative and managerial processes, and it relates to all departments involved in purchasing.

2.1.2 Supply Management and Supply Chain Management

According to some a firm has to focus on a few activities tot achieve competitive advantage in the long-term [4]. None core activities should then be outsourced to specialized suppliers. Nowadays even many large parts of primary activities such as production are outsourced to Contract Manufacturers, such as in the example of STMicroelectronics. This in part can explain the high and rising purchasing to sales ratio, which for industrial companies can be up to 70%. [3]. This development of increasing purchasing value and increased outsourcing of essential activities caused a higher awareness of the importance of purchasing to business.

The notion that purchasing, as any other business function, has to excel and contribute to competitive advantage was already stressed in the late 70s and early 80s. Kraljic [5] called for a total change of perspective: from purchasing as an operating routine to supply management

as a strategic function. Monczka [2](p8) follows this perspective as he defines supply management as "the process of identifying, evaluating, selecting, managing, and developing suppliers to realize supply chain performance that is better than that of competitors". It is cross-functional as it involves different business functions in make-or-buy decisions, engineering, quality assurance, operational purchasing and it involves the suppliers themselves. Because its objective is supply chain performance, it is closely related to Supply Chain Management (SCM).

SCM is defined as: "*the task of integrating organizational units along a supply chain and coordinating material, information and financial flows in order to fulfill ultimate customer demands with the aim of improving competitiveness of a supply chain as a whole"* [6](p11).

Supplier Integration Systems enable upstream SCM as they support the coordination of material, information and financial flows between manufacturing companies and their suppliers.

2.1.3 Collaborative buyer-seller relationships

The concepts of collaboration, integration and coordination are closely related. Integration and coordination are regarded as the two pillars of SCM and collaboration as an important building block [6]. Monczka [2] distinguishes the collaborative approach from the traditional approach to suppliers with the characteristics in Table 1. The traditional approach is the case where the marketplace is characterized by strong buyers' power and a purely transactional approach to the relationship.

	Traditional Approach	**Collaborative Approach**
Suppliers	Multiple sources played off against each other	One or a few preferred supplier for each major item
Cost Sharing	Buyer takes all cost savings when possible; Supplier hides cost savings	Win-win shared rewards
Joint Improvement Efforts	Little or none	Joint improvement driven by mutual interdependence
Dispute resolution	Buyer unilaterally resolves disputes	Existence of conflict-resolution mechanisms
Communication	Minimal or no two-way exchange of information	Open and complete exchange of information
Marketplace Adjustments	Buyer determines response to changing conditions	Buyer and Seller work together to adapt to changing conditions
Quality	Buyer inspects at receipt	Designed into the product

Table 1: Characteristics of buyer/seller relationships [2]

Collaboration between buyers and sellers today takes place in engineering, planning, marketing and logistics. Although the collaborative approach is increasingly applied, which is illustrated by the trend in business towards fewer suppliers and a higher degree of buyer-seller collaboration [7], this does not mean that it is always the best approach. It has both advantages and disadvantages. Advantages are a higher level of trust and long-term contracts, both leading to joint efforts resulting in a more efficient and agile value chain [2]. But disadvantages are that partnerships are expensive to develop and maintain, and that they cause the risk of supplier lock-in [3]. The choice of partners and the choice to which extend and how to collaborate with them are an important part of supply management.

2.2 E-business

The rise of e-business forms the IT context of Supplier Integration Systems, since Supplier Integration Systems are examples of e-business solutions.

E-business can be defined as: *"the conduct of automated business transactions by means of electronic communications networks end-to-end"* [8].

It means to automate and integrate business processes across all the members of an extended supply chain. Therefore it is about collaboration and coordination with business partners, including suppliers. The crucial difference with information systems in general is that e-business is about supporting intra-organizational and inter-organizational relationships. E-business therefore crosses organizational boundaries while most information systems support business processes and/or functions internally. The integration of separate information systems and business processes internally has long been an important development. Enterprise resource planning (ERP) systems, which are large, integrated business transaction processing and reporting systems, are a well known example. E-business aims to integrate business processes and information systems of different companies in a supply chain [8]. This fits in the tradition of inter-organizational systems (IOS).

IOS are defined as: "*planned and managed ventures to develop and use IT-based and/or human-based information exchange systems to support collaboration and strategic alliances between otherwise independent actors*" [9].

E-business solutions are also called e-business systems or networked systems.

2.2.1 Impact of e-business

The automation and integration of business processes across all the members of an extended supply chain has several advantages. Improved operational efficiency and reduction in operating costs are just some of the recognized benefits [8]. Another major recognized benefit is the reduction of the bullwhip effect [10]. In general e-business is thought to reduce transaction costs and at the same time achieve a higher level of coordination in markets, normally associated with hierarchies. It is therefore predicted to increase the degree of outsourcing. Also long-term relationships with fewer suppliers are stimulated due to higher investment costs in the relationship and progressive benefits from a longer learning curve [8].

But inter-organizational systems, which support information sharing and automate processes, are not new. Already in the early days of information technology, the 60s, the idea of information systems crossing organizational boundaries was pointed out [11]. Also the internet finds its origins in these days [12]. Inter-organizational systems therefore are not new. In the late 1980s Electronic Data Interchange (EDI) emerged to connect the new Manufacturing Resource Planning (MRP) and ERP systems to supplier's systems in order to deliver orders and schedules for direct items.

With the breakthrough of the internet in the 1990s, e-business came into use. Because the underlying technologies have developed significantly, the impact of e-business can be found in the increased possibilities, enabling more effective Supply Chain Management. Modern e-business technologies have some crucial advantages that make a difference when integration in the supply chain is pursued. Increased reach, range, speed and agility would summarize these crucial advantages [8]. Reach refers to number of actors and their locations that can be connected. Range is about the functionalities in terms of the processes the system supports and the information that is shared. Speed is about the timing (e.g. real-time or batch sharing of information) and level of integration with back end systems. Agility refers to the ease of

making changes to the system in terms of functionality or in terms of scale (e.g. adding a new partner). These advantages have triggered the adoption of new e-business solutions and migration to new technologies, enabling more effective Supply Chain Management. As a result the diversity of Supplier Integration System structures has increased significantly.

2.3 Adoption and Structure of Supplier Integration Systems

This study aims at understanding the adoption process and its impact on the structure of Supplier Integration Systems. In later chapters this will be addressed in more detail but in this section an initial explanation of the concepts structure and adoption process is provided.

2.3.1 Structure

The structure refers to the way the Supplier Integration System is composed of its individual components. These components are the business and technological aspects of the system. It is about how the information system looks like. This includes aspects such as: the system architecture, the information technologies, the information types, the business processes, the users of the system and its governance structure. The structure is initially a result of its adoption process including all the decisions made during this process. Later during its "product life cycle" decisions due to evaluations or changes in the system environment may lead to changes to its structure.

2.3.2 Adoption Process

Adoption is a demand side concept that entails the acceptance of an innovation (e.g. the Supplier Integration System). Innovation "*refers both to the output and the process of arriving at a technological feasible solution to a problem triggered by a technological opportunity or customer need*"(p68 [13]). This assumes that the person or organization is capable of adoption of the innovation. The adoption process starts when the organization becomes aware of the innovation and gains some understanding about it. The firm then forms an attitude towards the innovation. Based on this attitude formation a decision is made about the adoption. During the implementation the innovation is put into use. Finally in the confirmation phase the decision is evaluated. This adoption process is not a straightforward process. On the contrary it is a very diverse, complex and dynamic process involving numerous actors and iterations [13]. It is often a problem solving or opportunity driven long term endeavor and it is influenced by many different factors.

2.4 Conclusion

Supply Chain Management thinking and the rise of e-business have significantly increased the diversity of Supplier Integration System structures. New structures have been adopted, while at the same time older technologies, such as traditional EDI are not disregarded [8]. In this chapter it was pointed out that companies are increasingly outsourcing production, such as in the STMicroelectronics example. They are reducing their supplier base and are investing in increasingly long term relationships. Such developments stimulated companies to adopt varying e-business technologies to integrate their processes with their suppliers. The adoption processes of these inter-organizational systems are diverse, complex and dynamic. The outcomes are not always the same, as projects fail or are disregarded, and when they lead to an implementation the structure is very diverse.

3 Research Design

This section explains the set-up of this research project. In Chapter 2 it was concluded that Supply Chain Management thinking and the rise of e-business have significantly increased the diversity of Supplier Integration System structures. These structures are, at first, the result of their adoption process. The study aims at understanding the adoption process and its impact on the structure of Supplier Integration Systems. In Section 3.1 the research contribution to practitioners and particularly to theory will be explained. From this paragraph the central research question is derived. In order to answer the central research question some sub-questions need to be answered first. In Section 3.2 these research questions are explained. To answer these questions, knowledge, derived from literature and practice, is required. Section 3.3 will elaborate on the actions that have been performed to acquire this knowledge. This chapter will finish with a more elaborate outline of the rest of this thesis.

3.1 Research contribution

As the STMicroelectronics example illustrates, the business challenges and opportunities requiring integration and the possible benefits of Supplier Integration Systems, justify the efforts. Although there is much useful literature, theory falls short in some areas of Supplier Integration system structures and adoption processes. In this section these gaps in the literature are detected. These gaps concern both structure and adoption process.

3.1.1 Structure

Supplier Integration Systems are a sub-class of IOS that support vertical integration in the operational purchasing and planning process for manufacturing firms' direct supply. Implementation of Supplier Integration Systems, as an example of e-business, have endured the internet-hype and turbulent and rapid developments [8]. This has led to two problems.
The first problem is that these Supplier Integration Systems are ill-defined and have different names, which have different meanings to different people. Names used for instance are Web-ERP [12, 14], B2B electronic marketplace [15-17], Supplier Portal [18], Collaborative portals [19], e-Hub [15, 16, 20, 21], extranets [22] or Supply Hub [23].
The second problem is that these systems have very diverse structures, while many theories about these systems ignore these distinctions (e.g. [24-26]). While the first problem is just an inconvenient semantic problem, this generalization is an oversimplification of reality that cannot be ignored as different conditions and objectives require different Supplier Integration System structures.

Because of this a systematic description of the variety of structures is required. There are many classifications (see Chapter 4) but they all describe different aspects of this structure and the resulting classifications have a relative high level of abstraction. The diversity of networked systems is addressed in the inaugural lecture of van Hillegersberg [27], which resulted in a more complete list of characteristics that can be used to describe the diversity of structures. This line of thinking is therefore followed in this thesis, by developing a way to describe and distinguish Supplier Integration Systems structures in more detail.

3.1.2 Adoption process

The adoption of networked systems has been studied extensively before [24, 28-30], leading to factor and process models of adoption. The factor models typically categorize factors, which influence organizational actions leading to adopting or reject the system, in a technology–organization–environment (TOE) framework [24, 26]. This has resulted in a considerable list of factors that includes enablers and inhibitors of adoption and includes the

implicit and explicit motivations of companies to adopt or reject a system. For instance the lack of an adequate IT capability is an inhibitor in the organization category, while in the technology category the perceived efficiency gains of the new technology could be a strong explicit motivation for the company to adopt the system. In Figure 2 a simplified TOE framework is represented. This model will be discussed in more detail in Chapter 5.

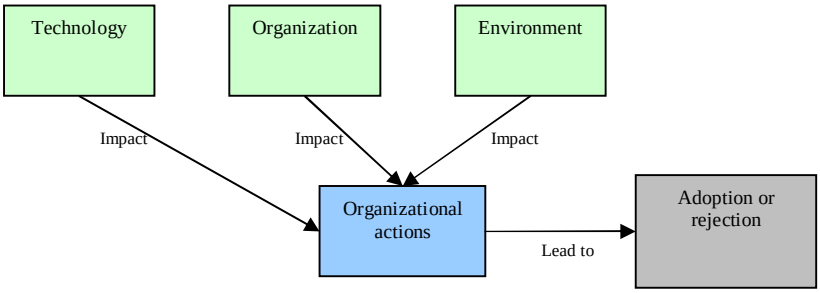

Figure 2: Simplified TOE framework

Process models extend this TOE framework with a more comprehensive view as they assume that organizational actions also impact these TOE factors, that there must be a distinction between environmental factors and industry factors, and that adoption processes are complex dynamic longitudinal processes [24]. In Figure 3 the process model is depicted in a simplified representation. This model will be discussed in more detail in Chapter 5.

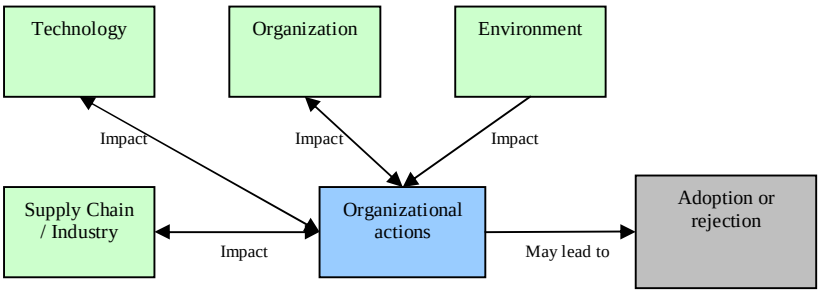

Figure 3: Simplified adoption process model [24]

But most studies still assume a dichotomous outcome. Either the organization adopts the system or it does not. This is a simplification of reality that was useful for studying the rise of e-business. It helped managers to see potential benefits and barriers and to decide whether or not to go along with the new technologies. But with the ongoing proliferation of Supplier Integration Systems the question shifts from the adoption decision to the decision what type and structure is most suited.

Some studies have studied the impact of the adoption process on some aspects of the structure. Already in studies of traditional EDI adoption, the use of these systems was taken into account [30, 31]. The use of EDI was measured in terms of volume (% of total messages send with EDI), breadth (% of total partners connected with EDI) and diversity (% of total document types supported by EDI). These measures provide a good picture of the range and reach of the networked system. Others have focused on the technological aspects [32]. Here this line of thinking is extended by investigating the structure in more detail as was argued for in Section 3.1.1. Then the relation between the adoption process and the structure becomes interesting again. The more comprehensive process model of adoption [24] is therefore enhanced to accommodate for the impact of the adoption process that is resulting in various structures.

To take into account the diversity of structures the adoption model needs to be enhanced with a more diverse outcome. In Figure 4 a simplified representation of the suggested adoption process model of Supplier Integration Systems is depicted. It builds on the adoption process model of Kurnia and Johnston, which in turn is an extension of the TOE-framework [24] (see Chapter 5). In green various factor categories, that impact organizational actions with regard to adoption, are shown. It can be seen that only the environment category can not (or at least almost not) be influenced by the organization. The other categories can be influenced. In grey the adoption of a specific Supplier Integration System structure is depicted. Taking into account the diversity of these structures is the most important contribution of this study. In Chapter 7 this model will be explained in more detail.

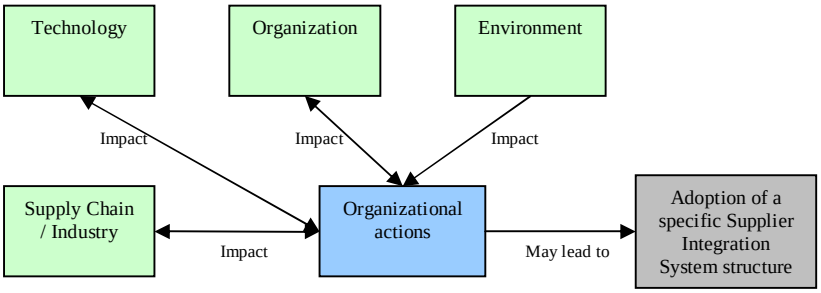

Figure 4: Simplified adoption process model including contribution

3.1.3 Conclusion: contribution

The contribution of this study mainly lies in a more detailed view of structure, the adoption process and the impact of the adoption process on the structure. This study will explore a systematic description of Supplier Integration System structures (see Chapter 4) and enhances the process model of adoption.
For practitioners a better understanding of the various structures and the adoption processes would be useful to improve decision making and management of such complex adoption processes. By systematically describing structures this study shows practitioners what options they have when they want to integrate with their suppliers. This study will improve existing adoption models and will show how to use them as a guideline to determine the right conditions to adopt a specific Supplier Integration System structure and what can be done to improve these conditions.

3.2 Research Questions

The objective of understanding the impact of adoption process on Supplier Integration System structures can be translated into the following central research question:

What is the impact of Supplier Integration System adoption processes on Supplier Integration System structures of manufacturing companies?

This main research question is divisible into three parts: 1. Structure, 2. Process, 3. Relation. For each part sub questions have to be answered in order to answer the central research question. The rest of this thesis will answer these questions.

1. **Structure: What are the various Supplier Integration System structures?**

    a. *How can Supplier Integration Systems be defined?*

    b. *How can Supplier Integration Systems be distinguished from other e-procurement types?*

    c. *What are suitable characteristics to distinguish different Supplier Integration System structures?*

    d. *What Supplier Integration System structures can be observed in practice?*

2. **Process: How can the Supplier Integration System adoption process (best) be studied?**

    a. *What are the different perspectives on adoption processes of inter-organizational systems?*

    b. *What are the contributions and shortcomings of these approaches?*

3. **Relation: What is the relation between the adoption process and Supplier Integration System structures?**

    a. *What theories explain the relation between the adoption process and Supplier Integration System structures?*

    b. *What adoption processes can be observed in practice?*

    c. *What explanations of the specific adoption process and its resulting Supplier Integration System structure can be observed in practice?*

3.3 Research Method

The central research question and its sub questions are answered with findings from a literature study and from an empirical study. The empirical study is based on case study research.

3.3.1 Literature study

The literature study is conducted using several online indexes for their advanced search functions and to apply the "snowball method". The snowball method involves using the browsing functions to quickly browse references and citations to find more relevant articles. The online indexes used for the literature study cover at least the top 25 IS journals [33]. Due to the semantic problem concerning Supplier Integration Systems (see Section 3.1.1), many different search terms had to be used resulting in a broad set of literature. The snowball method[1] was used to enhance the results and to find overlooked articles.

3.3.2 Case Studies

The empirical study is based on case study research because of two reasons. The first is of a practical nature. The efforts and costs to get a large data set required for quantitative research did not fit within the time and budget constraints of this research project. But more

[1] Searching relevant literature by following links to references and to articles citing the article.

importantly the second reason to do qualitative research is because of intrinsic reasons. The adoption process is a complex and dynamic process and the subject of Supplier Integration Systems is not without ambiguity. This means that qualitative research is better suited for this subject. In interviews the meaning of certain questions and answers can be interpreted better. Also the interviews contribute by allowing more richness and detail. The anecdotal data that can be provided by interviews is essential to understand the impact of the adoption process. This argument is supported by the call for a processual view of adoption (see Chapter 5 [24]).

Method

The case studies are based on face-to-face interviews with 1 or 2 subject matter experts of the case companies and additional information provided by the case company. The interviews can be characterized as semi-structured, unconstraint by time and are reviewed:

- The interviews are semi-structured. This means that the interview is guided by the researcher along the different topics, but that the respondents are allowed the liberty and time to answer questions with their own story and anecdotes. The researcher adepts its questions to the particular situation and he tries to anticipate and respond to the answers of the respondent.
- Interviews were finished when all the topics were sufficiently covered as perceived by both the researcher and the respondent. Time constraints did not cause insufficient coverage of specific topics. On average the interviews lasted about 90 minutes.
- All the interviews are integrally recorded. From these records comparably structured interview reports were made. The interviews were all held in Dutch. To reduce translation errors the interview reports are in English. These interview reports were reviewed by the respondents. The checked for errors, wrong interpretations and missing information. In some cases they consulted colleagues to improve the quality of these reports. The reviewed reports are used as inputs for this thesis.

Selection of cases

Cases were selected based on the following criteria. These criteria narrowed the selection down to a relative small subset from which an arbitrary choice was made. Time constrained the number of cases to 11. All of the case companies were customers of Capgemini in the past.

1. The company must be a *mass producing manufacturing company*. This study focuses on Supplier Integration Systems of manufacturing companies. Issues like contract manufacturing and ensuring on-time supplies for mass production, challenge businesses.
2. The company must be *large* (at least 5000 employees). Especially in large companies these types of systems are established. For instance traditional EDI was mainly adopted by larger companies because it was costly and required considerable organizational capabilities [8]. It is expected that also for newer systems larger companies have a leading role.
3. The company must be *internationally* operating. Supplier Integration Systems in large manufacturing companies are often applied in an international context. This is a complicating factor and should therefore be the same in all cases.
4. The company must be *active in the Netherlands*. For practical reasons the selected case companies have to be active in the Netherlands to allow easier access to potential respondents
5. The companies must be from *diverse industries*. In order to pick out industry and supply chain effects companies from a diverse set of industries are selected.

Table 2 lists the basic characteristics of the selected case companies.

Company	Annual Sales in millions €	# Employees	Strongest Geographic Presence (all are globally active)
Pharma1	5,917	13,900	Europe & East-Asia
Pharma2	2,611	13,700	Europe
Packaging1	7,000	40,000	Europe
Packaging2	11,000	51,000	Europe
Truck1	2,500	9,000	Europe & North America
Truck2	7,500	32,000	Europe
Electronic1	26,976	121,000	Global
Electronic2	72,448	398,000	Global
Electronic3	3,500	24,000	Europe & North America
Electronic4	6,365	37,000	Europe and East-Asia
FMCG	8,100	50,000	North America & Europe

Table 2: Case Companies

Respondents

The respondents are subject matter experts within their company concerning the subject of this study. They are located and approached in two ways. Because of established relations with Capgemini some respondents could be located and approached through Capgemini's contacts. In other cases the respondents were located and approached by phone after consulting the case company's website. Before interviews were planned the objective of the study and some example questions were communicated to find the appropriate respondent.

All respondents are active in logistics, supply chain management, purchasing and/or Information Technology. Most respondents were working in a centralized department or at the plant level. Table 3 lists the job titles of the respondents

Company	Respondent 1	Respondent 2
Pharma1	Senior manager Supply Chain Europe	Senior manager plant logistics
Pharma2	Application manager Supply Chain Management	-
Packaging1	Supply Chain support manager	-
Packaging2	Program Manager	-
Truck1	EDI Manager	EDI coordinator
Truck2	Manager Logistics	Manager Material Planning Truck Assembly
Electronic1	Program manager corporate supply management	-
Electronic2	SCM Program Manager; the Netherlands	-
Electronic3	Director Global Applications	-
Electronic4	Program Manager Purchasing Office	Project Manager Purchasing Office
FMCG	Business Process Manager IT services	-

Table 3: Respondents

3.4 Organization of the thesis

It was explained that there are three important aspects of the central research question: Structure, Adoption Process, and the relation between the two. These aspects are studied from a theoretical and empirical point of view. This thesis is therefore organized according to these aspects and views. Based on literature, Chapter 4 will cover the structure of Supplier Integration System from a theoretical point of view. In the same way the adoption process and its relation to the structure is covered in Chapter 5. These two theoretical chapters are input for the case studies. They are used as a guideline for the interviews. The empirical part of the study is covered in Chapter 6. The case analysis treats the structure, adoption process and the relation between two in practice. Chapter 7 will synthesize theory and practice into conclusions. This chapter will also provide some discussion of the study and its results. In Figure 5 this outline is summarized. Figure 5 schematically depicts the overview of the research design.

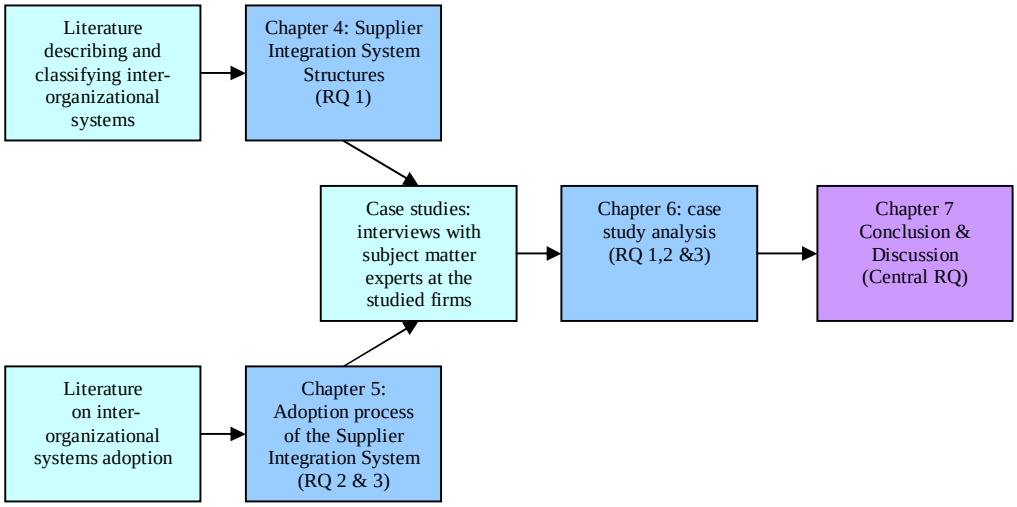

Figure 5: Overview of the research design

4 E-procurement and the Supplier Integration System

Without support of Information and Communication Technology (ICT) purchasing as it happens today cannot exist. As in the rest of the organization the purchasing function is supported by many types of applications and internet technology. This chapter presents an overview of the applications that support purchasing and positions the Supplier Integration System among these systems. This chapter answers the first sub-question, concerning the structure, from a theoretical point of view. In Chapter 6 this will be complemented by the observations in practice. The combination will then explain the various structures. Here the sub questions 1a, 1b, and 1c, are treated:

1. Structure: What are the various Supplier Integration System Structures?

a. How can Supplier Integration Systems be defined?

b. How can Supplier Integration Systems be distinguished from other e-procurement types?

c. What are suitable characteristics to distinguish different Supplier Integration System structures?

In the world of applications as much views and definitions exist as in management. In this chapter choices are made for certain views and definitions to delineate this research project. E-procurement is defined first in Section 4.1, followed by a classification of e-procurement types in Section 4.2 and finally an explanation of Supplier Integration Systems in terms of the e-procurement classifications in Section 4.3 These three sections combined answer the sub-questions 1a and 1b. In this way it will become clear what an Integration System is and how to distinguish it. In Section 4.4, answering question 1c, characteristics are identified to distinguish different Supplier Integration System structures. These characteristics are used in the case studies to guide the interview and to obtain a comparable description of the system structures.

4.1 E-procurement defined

E-procurement is a particular form of e-business aimed at supporting purchasing. In Chapter 2 both purchasing and e-business were explained as two related subjects in development. They are the basis for understanding e-procurement.

With purchasing and e-business in mind e-procurement can be defined in a narrow and a broad sense.

1. "In a narrow sense it entails information technology solutions for ordering, logistics and handling systems, as well as for payment systems." [3](p175).
2. In a broad sense it entails "the use of web-technology in the purchasing process" [3, 12]. Davila et al. [34] also distinguish these two definitions by labeling it in a narrow sense as "e-procurement software" and in a broad sense as "e-procurement technology".

The narrow definition is based on business functions related to purchasing, while the broad definition is explicitly based on a particular technology (web-technology) and the purchasing process. The narrow definition also includes systems used by the purchasing function that do not cross organizational boundaries or do not even interface with external systems. The broad definition explicitly mentions "the use of web-technology" and excludes older electronic

communication network technologies, such as Electronic Data Interchange (EDI) using a Value Added Networks (VAN) or dedicated communication channels. In practice though there are still many implementations using these older technologies. In this thesis we will use the broad definition of e-procurement, but without excluding older collaborative technologies. In this way e-procurement fits within the definition of e-business, since that definition speaks of electronic communication networks. But we want to exclude fax and phone from our definition. Therefore e-procurement is defined in this study as:

The use of inter-organizational computer networks in the purchasing process.

This definition includes computer networks that cross organizational boundaries, such as the internet and EDI, and excludes networks used only internally, such as intranets, no matter what computer network technology is used. In this way the definition is more robust with regards to the development of new network technologies and fits within the definition of e-business.

Although e-business can be explained in simple terms as "a technology that promotes inter-enterprise business relations"[8], e-procurement is not to be confused with Supplier Relationship Management (SRM). SRM has been confusingly defined by software vendors and in literature as some integrating suite of e-procurement software that could be viewed as a counterpart of customer relationship management (CRM), while SRM should be viewed as the management of the right relationship with the right supplier [35].

4.2 Distinguishing e-procurement types

Now that e-procurement is defined, this section will explain how to distinguish e-procurement types as it encompasses a class of information systems that includes Supplier Integration Systems. This makes clear what systems are related to Supplier Integration Systems and it helps to explain what they are and what they are not. The characteristics identified in literature are listed in Section 4.2.1. Some of these characteristics are later used to describe a classification of e-procurement types in Section 4.2.2, some are used to describe Supplier Integration Systems in Section 4.3, and some are used to distinguish different types of them in Section 4.4

4.2.1 Characteristics that describe e-procurement types

In literature many characteristics are used to distinguish among e-procurement types. These characteristics describe different aspects of the system. Some authors use the technological aspects, describing how it works, as a measure to classify different systems. Others describe what the system is used for in terms of the business processes that are supported, and others look at the inter-organizational aspect, describing the context of the system. Many authors use combinations of characteristics that describe different aspects. In a structured literature study of academic literature about e-business and e-procurement, these characteristics were identified. They are used explicitly in the identified sources to classify and distinguish e-procurement types. Here they are synthesized into one list in Table 4. In some cases characteristics found are very similar and therefore are grouped under one label. In the first column the characteristic is labeled, in the second column it is described and in the third the sources in literature that use the characteristics are listed.

Classification characteristic	Description	Source
Volume	% of document flow	[31]
Diversity	% of linked trading partners	[31]
Breadth	% of document types	[31]
Process / Phase	Purchasing processes or phases that are supported by different e-Procurement types	[12, 36-38]
Product type	Purchasing different types of items have different supporting systems: 1 Manufacturing (direct) vs. operating (indirect) inputs 2 Importance of purchased item	[12, 15, 17, 38]
Collaboration type	Horizontal collaboration (buying / selling groups) vs. Vertical supply chain collaboration (between buyer and suppliers)	[17, 37]
Network structure	The companies in the supply chain form a network of users of the e-procurement tool. This dimension distinguishes one-to-many, meaning one supplier vs. many buyers, many-to-one, meaning many suppliers vs. one buyer or many-to-many relationships.	[16, 39]
Power distribution /Ownership /Control	The power in the relationship and who controls and owns the IOS. The IOS can be buyer-centric, seller-centric or neutral	[16, 17, 36, 38-40]
Order type / Contract horizon	Spot vs. systematic orders / Short vs. Long term contracts	[15, 17]
Pricing mechanism	How the prices of goods or services are established. Fixed pricing, auctioning, bargaining, brokerage.	[15, 41]
Relationship type	This describes the type and the extend of the relationship. E.g. Arms' length vs. exclusive partnership	[38, 40]
Interdependency	Concerning the use of the IOS: The degree to which users require each other to achieve their goals. Pooled, sequential and reciprocal	[42]
Intermediation	Presence (and role) of a third intermediate party	[36, 39]
Integration / Timing and delay	Level of integration with back-end systems: measured in number of connected back-end systems, amount of shared information and in the timing and delay of information exchange (batch – real time)	[27, 38, 40]
Process & Data standard	The process & data standard used for the messages and joint processes. Open vs. closed or less open standards. These standards can be Proprietary -, Industry - or Universal standards. They can be based on older EDI standards or based on newer XML standards.	[27, 32]
Technology specificity / Execution and development agility	The type of software used for the system. This can be firm-specific, customized standard or completely standard software. This can also refer to hard coded vs. Web services.	[27, 38, 40, 41]

Table 4: Classification Characteristics of e-procurement

4.2.2 A classification of e-procurement types

A convenient way to start distinguishing e-procurement types is by using the purchasing processes these systems support as a primary characteristic and the product type as a secondary characteristic to classify them[12]. In this way a complete coverage of all e-procurement types is possible. The purchasing processes cover a wide range of activities. The definition of purchasing by van Weele [3] used in this thesis specifically covers the activities depicted in Figure 6. This process model is used by Harink to classify e-procurement types (see Figure 7). Many similar models are described in literature. For instance business action theory distinguishes six phases; the business prerequisite phase, the exposure and contact search phase, the contact establishment and proposal phase, the contractual phase, the fulfillment phase, and the completion phase [43]. But the van Weele model is appealing because of its simplicity and its applicability to industrial buying of direct goods. The activities in this specific model are distinguished as either Tactical or Operational. In the practice of manufacturing firms, for direct goods, usually a contract is created first as the final output of the tactical process and then this contract is called of many times in the operational process for individual orders. It follows inherently from this process model that the various activities are closely connected. The quality of the output of preceding activities highly impacts following activities. But in practice relatively seldom all steps of the purchasing

process are passed through. This depends on the purchasing situation as a new-task situation requires tactical purchasing activities while for re-buy situations a standard contract can be used many times and for modified re-buy situations only some tactical purchasing activities are required [44].

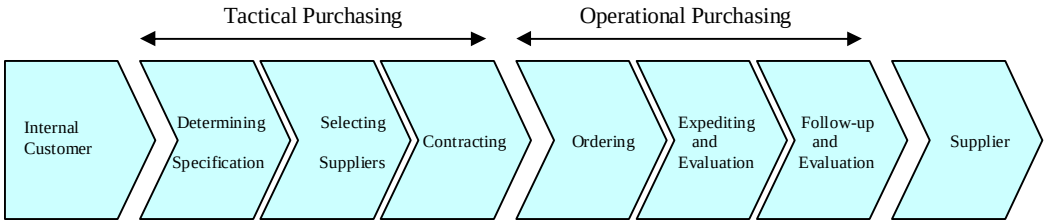

Figure 6: Purchasing process model ([3], p15)

Concerning e-procurement the management and execution of processes are distinguished in the purchasing process model. Each has their own class of e-procurement systems, which are e-informing and e-transacting. E-informing supports the management of the purchasing process and e-transacting supports the execution of the purchasing process. E-informing consists of purchasing intelligence and e-contract management. E-transacting consists of e-sourcing, Collaborative Product Commerce (CPC), e-tendering, e-reverse auctioning, e-ordering and finally Web-enabled ERP, which can be considered another name for Supplier Integration Systems. These e-procurement types are positioned in the purchasing process model, which is depicted in Figure 7. In this model the execution (in green) and management processes (in blue) are distinguished. The secondary characteristic, product type, is then used to distinguish between systems that support purchasing of direct items and those that support purchasing of indirect items.

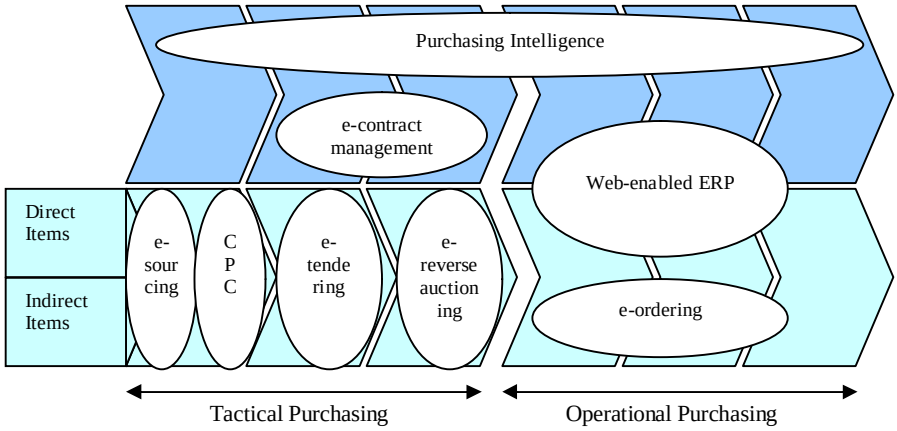

Figure 7: Positioning of e-procurement types (with adaptations [12])

- Purchasing intelligence consists of the uploading of data in order to process it into valuable purchasing information. With this information decision making is supported and the realization of targets is measured on the basis of performance indicators.
- E-contract management is about making information about contracts available to employees. It can also be used for operational management of contracts and follow up.
- E-sourcing concerns identifying new suppliers, products and services, by using web-technology. The term e-sourcing is confusing, because in practice it is used often to denote a concept that includes all tactical purchasing systems.

- CPC (Collaborative Product Commerce) relates to collaboration in new product design. Different organizations work together on a new product, which is to be produced by the supplier. The design process, involves a lot of communication and information sharing which is supported with web-technology.
- E-tendering is about tendering electronically. It involves developing and sending RFQs / RFPs and assessing the received information.
- E-reverse auctioning can be considered the opposite of an electronic auction. A buying organization makes a need for a product or service known to a number of capable suppliers, for which these suppliers can make an offer during an electronic auction. Competition is mainly based on the lowest price offered.
- E-ordering is about requesting, ordering and fulfillment of indirect goods. Mainly through electronic catalogues.
- Web-enabled ERP or Web-based ERP (Supplier Integration Systems) aims at the operational purchasing process of direct goods. It is about connecting internal ERPs to suppliers and enables Supply Chain Management.

It is important to note that these e-procurement types can be offered in packages, meaning that more then one type of e-procurement can be meant when a single name is used, such as SRM. Besides e-procurement types, Harink also mentions e-marketplaces. In his view these are electronic meeting places where business partners can exchange information (e-informing) and do business (e-transacting). The e-marketplace is in this view a platform to make e-procurement types available. Within this definition of e-marketplace different types can be distinguished [15, 17].

4.3 The Supplier Integration System explained

The objective of this section is to present an overview and a general description of Supplier Integration Systems and their characteristics. In Section 4.2 characteristics to distinguish among e-procurement types are listed and based on processes and product type a classification of e-procurement types is presented. Supplier Integration Systems are inter-organizational systems (IOS) that support vertical collaboration in the operational purchasing and planning process for manufacturing firms' direct supplies. In terms of Harink's classification they are called web-enabled ERP. This classification as a starting point helps to distinguish the Supplier Integration System from other e-procurement types (recall Figure 7). In Section 4.3.1 general features of Supplier Integration Systems will be explained and visualized. This section will use some characteristics from Table 4 to describe general characteristics. Since the description of web-enabled ERP in the last section was not very detailed, what Supplier Integration Systems do, will be elaborated in Section 4.3.2.

4.3.1 General Supplier Integration System characteristics

When recalling Table 4 the first characteristic to distinguish Supplier Integration Systems is the process characteristic. Using this aspect they were distinguished from other e-procurement types as web-enabled ERPs. In Section 4.3.2 this perspective will be elaborated. General characteristics discussed here are item type and collaboration type and network type. Also a representation will be discussed.

Item type: Based on the item type distinctively different systems can be observed based. Take for instance electronic catalogues. These online ordering systems, where users can order what maintenance, repair and offices suppliers from a pre-selected catalogue, are essentially different from Supplier Integration Systems, since they are aimed at ordering indirect items while Supplier Integration Systems are used for direct items. That makes them different, because in general direct items are ordered at larger volumes at higher frequencies, are often more specific and more important to the core business [3]. This means that generally for

direct items more centralized control is required, that it is important for logistics, operations and planning, that integration with ERP systems is more important and that impacts (including risks) are stronger.

Collaboration type and network type are also two useful characteristics. The Supplier Integration System crosses organizational boundaries in a collaborative buyer-seller relationship. This is called vertical collaboration and is distinctive from horizontal collaboration. Vertical collaboration is about collaboration between succeeding organizations in the supply chain, such as between buyers and sellers. There is a sequential interdependency [42]. Horizontal collaboration is about collaboration between organizations that are on the same level in the supply chain such as in buying groups or purchasing consortia [37]. The network type is a one-to-many relationship. It is about one buyer and a varying number of suppliers. This contrasts with marketplaces where there is a many-to-many network. For the Supplier Integration System it is assumed that the power in the relationship is located at the buyer, since they are the logical initiators of these kinds of systems. This is inherent to the network type as the suppliers of an organization usually do not have a relationship to each other.

Because of these general characteristics, Supplier Integration Systems are defined as *inter-organizational systems (IOS) that support vertical collaboration in the operational purchasing and planning process for manufacturing firms' direct supplies.* They are IOS that provide internal and external users customized access to integrated information, applications, business processes and people, in a collaborative buyer-seller relationship. They are enablers of Supply Chain Management (SCM) as the Supplier Integration Systems purpose of information integration and coordination corresponds to the objective of SCM [45].

The Supplier Integration System can be visualized with Figure 8. In this figure one can see that the buyer interfaces with the system and connects with information flows to the suppliers. To allow integration and automated processing by back-end systems the system transforms the data. For this transformation data standards are used. In this way the Supplier Integration System makes sure that it is compatible to interface with the suppliers. Process management is about the application of workflow system technologies to automate business processes. All Supplier Integration Systems have some degree of connectivity, usually some degree of transformation and in its most advanced form some degree of process management.

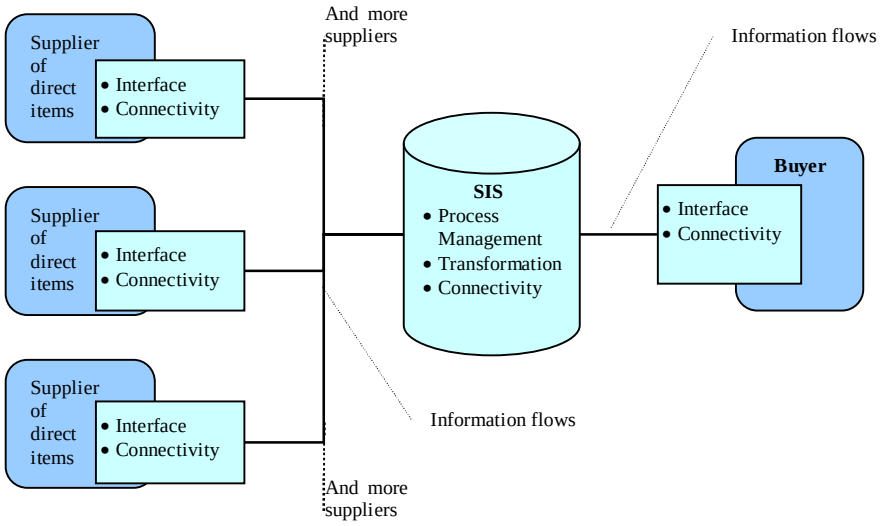

Figure 8: Supplier Integration System

4.3.2 What Supplier Integration Systems do: Processes

The Supplier Integration System supports operational purchasing processes of direct goods and therefore fits in the definition of Web-enabled ERP (see Figure 7). This name suggests that just like ERP, the integration of information systems across business functions is important. Therefore it involves much more then purely purchasing. This means for instance that the Supplier Integration System interfaces with the ERP and interacts with most business functions in the firm. The connection with ERP means that the system can be applied to two types of processes. These are collaborative transaction management and collaborative planning.

Transaction management is about the execution and management of operational purchasing. Ordering, expediting and follow-up are basic execution processes. This involves invoicing, fulfillment, verification and quality control. Also the management of returns falls in this category. These activities are repeated very often. Most frequently the purchasing situation is a re-buy situation, where the item is re-ordered based on an existing contract, plans and forecasts.

Collaborative planning and control are the supported management processes. This means that management information on operational purchasing is gathered, stored, processed and exchanged. The Supplier Integration System enables real time sharing of information on planning, production and schedules. Also the sharing of demand forecasts, inventory positions, point-of-sale (POS) data and lead times with partners is an important feature. This is called collaborative planning and forecasting. Some collaborative initiatives have been labeled. They all have the same philosophy and only differ in the information that is shared and in the case of Vendor-managed Inventory (VMI) the management principle that is used for replenishment. The basic philosophy prescribes the exchange of information between business partners in order to optimize the supply chain. It is argued that these collaborative planning initiatives are essential to achieve an efficient supply chain [46]. The earliest initiatives, which originated in the retail and grocery manufacturing industry, where called Efficient Consumer Response (ECR), Vendor-managed Inventory (VMI) and continuous replenishment (CR) [46]. ECR is about sharing information in a demand driven supply chain with the objectives of efficient replenishment. VMI is a technique aimed at the same objective, whereby the supplier has the sole responsibility for managing the customer's inventory policy and replenishment process. CR is a business practice where POS data is used to generate sales forecasts. One step further from these first initiatives, in terms of information sharing, is Collaborative Planning, Forecasting and Replenishment (CPFR).

4.4 Distinguishing Supplier Integration System structures

The objective of this section is to be able to distinguish Supplier Integration Systems in a meaningful way. This means that characteristics must be determined, based on which to distinguish the implementations. The general characteristics in Section 4.3 only make up a general description and are used to screen for suitable respondents and to communicate and agree on the subject of the interviews. The combinations of the characteristics identified in this section should allow refining of these general descriptions into more detailed sub-classifications. This section will therefore deliver a list of characteristics that can be measured during the interviews. However the selection of characteristics is constrained by practicalities of measuring them. To determine the characteristics the information and process perspective, the technology perspective, and the inter-organizational perspective are used. Using these perspectives should result in a comparable and comprehensive description of the structure.

4.4.1 What: Information and Process perspective

What the Supplier Integration System is used for defines from a high process level perspective what it is. But when looking at a more detailed level, the different types of Supplier Integration Systems can support collaborative transaction management and collaborative planning, in various ways. Therefore in this section sub-processes and information components are identified that are expected to be supported or used in some implementations and not in others. Besides process and information types two more characteristics that describe functional aspects are identified.

To determine what sub-processes are supported and what information types are used one has to look at the functionalities of the information system. To describe the functionalities of information systems in detail there are many modeling methodologies. For instance the Unified Modeling Language (UML) is a standard modeling methodology to create various models to describe different aspects of information systems in detail [8]. But this would require too much detail in order to produce additional value and does not provide a reference. The Supply-Chain Operations Reference (SCOR) framework is much more suitable for the purpose here. SCOR was developed by the Supply-Chain Council and provides a cross-industry, standardized process reference model [47]. The Supply-Chain Council (SCC) is an independent, not-for-profit, global corporation with membership open to all companies and organizations. SCOR was designed to help companies to improve their Supply Chain Management. It provides standardized descriptions of management practices, of processes and their relations, of metrics for performance measurement and of best practices. Here it is used to describe and distinguish the sub-processes of collaborative transaction management. In Table 5 the SCOR level 3 source processes are listed. They cover the same activities that fall in the category of the operational purchasing processes as identified by van Weele [3] (added in between brackets), but provide slightly more detail. The transferring process of the SCOR model is left out because it is not relevant here.

Schedule Product Deliveries (Ordering)	Scheduling and managing the execution of the individual deliveries of product against an existing contract or forecast. The requirements for product releases are determined based on the detailed sourcing plan or other types of product pull signals. This process includes (re)ordering and approval.
Receive Product (Expediting)	The process and associated activities of receiving product to contract requirements. This is a part of fulfillment or expediting. This process starts with a shipping notification and ends with the delivery notification of the receiving stocking location.
Verify Product (Evaluation)	The process and actions required determining product conformance to requirements and criteria. This is a part of fulfillment or expediting. Also called quality management.
Authorize Supplier Payment (Invoicing and Follow up)	The process of authorizing payments and paying suppliers for product or services. This process includes invoice collection, invoice matching and the issuance of checks.

Table 5: SCOR level 3 source processes (with adaptations) [47]

Although the SCOR model does provide planning processes it is not the most suitable in this situation. Collaborative planning processes typically follow a generic cyclical process [48]. In Table 6 the sub-processes are listed. In general these processes are repeated on a regular basis for varying overlapping time-intervals and are often refreshed. This means for instance that there are plans that cover a month or a year ahead that are refined on a weekly basis. During these weekly iterations the entire cycle of sub-processes is repeated. A notable exception is when the VMI concept is applied. Then there is no need to exchange and negotiate plans. The vendor is responsible for the customer's inventory and has the sole responsibility for planning. Local available information should be exchanged in agreed time intervals though, exceptions should be handled and the plans should be executed and evaluated.

Local Domain Planning	The process of developing a plan ("courses of action over specified time periods that represent a projected appropriation of supply resources to meet sourcing requirements" [47]) based on locally available information and the process of gathering relevant local information.
Plan Exchange	The process and associated activities of exchanging plans and relevant local information. This encompasses sending and receiving local information, the activities of ensuring correct communication and evaluating the received information.
Negotiation & Exception Handling	The process and associated activities of reaching an agreement on exceptions and committing on a joint plan, based on received plans and other relevant information.
Execution (of the source processes in Table 5)	The process of converting the agreed plan into the transaction management process and the activities to keep local information up to date.
Evaluation	Execution performance is measured and evaluated. This could lead to compensation schemes.

Table 6: Collaborative Planning processes [48]

Besides the supported business processes the information that is gathered, stored, processed, exchanged and re-used, is distinctive for different Supplier Integration System types too. Information is required to make decisions and to facilitate the various processes. The kind of information listed in Table 7 is based on information that is exchanged in the paper based operational purchasing process and literature on Supply Chain Management [10, 46].

Inventory position	The amount of inventory of a certain item on stock. The calculations for this type of information can vary though. Besides the items on stock, those that are in production or already part of finished goods minus the requirements for back orders can also be part of the calculation
Point-of-sale data	The amount of actual sales of the customer. This is added to historical POS data. This can be used to predict sales forecast of customers.
Forecast	The forecast of orders the customer will place in a certain time-interval according to contractual agreements. The customer calculates their requirements for a certain time-interval and makes a plan to order these requirements. This is the demand forecast for the supplier.
Capacity	The supplier's capacity to deliver certain amounts of items in certain time-intervals.
Lead time	The period of time between the order and the delivery at the customer. The calculation is
Order	Message from the customer to the supplier with aggregated order-lines for required items to be delivered in certain time-intervals according to contractual agreements
Order Confirmation	Message from suppliers that confirm orders and commit the supplier to deliver according to contractual agreements
Advanced Shipment Notification	Message from the suppliers that precede deliveries, informing the customer of the delivery schedule and all other relevant information that is required to receive the items properly
Good receipt confirmation	Message from the customer that the describes the conformance of the delivery to requirements
Invoice	Message from the supplier that aggregates the check of supplied items to be paid according to contractual agreements

Table 7: Information types

Besides the information and process types four other aspects are of interest here [27, 31, 38].

System Intelligence	The level of reasoning capabilities the system can offer to support users. This ranges from simple business rules that check messages to advance planning support and intelligent agents that can initiate and complete processes autonomously.
Integration timing and delay (also called Speed)	The average time required between release of information or any other signal by the senders back end system and the moment that the receivers back end systems receive the message. Real-time (0 – 0.1 h) Near real time (0.1 -1 h) Batched (1 – 24 h)
Volume	% of transactional document flow supported by the Supplier Integration System
Diversity (also called range)	% of transactional document types supported by the Supplier Integration System

Table 8: Functional aspects

4.4.2 How: Technology perspective

The second feature that distinguishes Supplier Integration System structures is determined by the underlying technology that is used. There has been a history of developments in the field that resulted in a considerable amount of technologies that enable supply chain integration. Even from a purely technological point of view there is no one best way. But it is sufficient to realize that in practice there are many different technologies available and used, because of, for instance, legacy systems in established companies. In Table 9 characteristics are listed based on the characteristics of networked systems identified in literature to distinguish e-procurement types or networked systems in general (also see Table 4) and based on the characteristics suggested by van Hillegersberg [27].

Process & Data Standard	The process & data standard used for the messages and joint processes. Open vs. closed or less open standards. These standards can be Proprietary -, Industry - or Universal standards. They can be based on older EDI standards or based on newer XML standards [32].
Governance structure	Management and control of the Supplier Integration System: this can Centralized vs. decentralized, and include the presence and role of a third party. Also the ownership of the system is an important part of this
Process Architecture	Business process management and workflow management is based on a Hub-and-spoke or federated architecture. Hub-and-spoke means that the system manages the processes at the central level. Federated means that the system connects local systems that do the process management itself.
Network type	The network technology used. Dedicated communication channels (ISDN) , Value-added-networks (VAN) or the Internet.
Technology specificity	The technology used for the system can be either proprietary (“home-made”) and very specific or broad based to varying degrees. The latter depends on the diffusion of the technology and degree of customization of a broad based technology. (this influences agility)

Table 9: Technological and structural aspects

4.4.3 Context: Inter-Organizational perspective

From an inter-organizational perspective the system is larger then the application itself and includes the actors and their relations and economic properties. These characteristics are based on the characteristics of networked systems identified in literature to distinguish e-procurement types or networked systems in general (also see Table 4). These characteristics are descriptive of the situation but are in some cases also expected to have a strong impact on many of the information, process and technological aspects of the Supplier Integration System structure [38].

Breadth (also called reach)	% of trading partners linked by the Supplier Integration System
Supplier type	Size, specific knowledge, available resources
Product types in scope	Degree of Complexity (maturity, technical complexity and engineering effort), Specificity (level of customization, amount of alternatives feasible), Single unit costs, Impact on cost price of end product, contribution to selling power of the end-product
Relationship type	Arms' length vs. exclusive partnership, level of trust,
Relationship asymmetry	level of required coercion
Order type / Contract horizon	Spot vs. systematic orders / Short vs. Long term contracts
Pricing mechanism	Fixed pricing, auctioning, bargaining, brokerage, discounting

Table 10: Inter-organizational characteristics

4.5 Conclusion

This chapter explained what the Supplier Integration System is, by listing general characteristics and contrasting them with other e-procurement types. This is used to define the subject and the scope of the study. In Table 11 characteristics, which can be considered general Supplier Integration System features are summarized. These features combined distinguish them from other e-procurement types. The other characteristics listed in Table 4 cannot be assumed as general characteristics. These remaining characteristics can vary for different Supplier Integration Systems.

Perspective	**Classification Characteristic**	**Supplier Integration System feature**
Information and process	Process types	Supporting the Operational purchasing process with collaborative transaction management and collaborative planning.
Inter-organizational	Product type	Direct items; defined as the items (products and materials) used in the production process (e.g. catalysts) or that end up in the final-product. These are Bill-of-Material items.
Inter-organizational	Collaboration / Network type	Vertical supply chain collaboration (1:M); one buyer collaborates with its many suppliers. Suppliers do not have a direct relationship with other suppliers concerning the system. There is a sequential interdependency.
Inter-organizational	Power distribution / Control	Buyer-centric: this study focuses on the buying organization. They are selected for their size and capabilities. They are all expected to be the most dominant actor, although in various degrees.

Table 11: General characteristics of the Supplier Integration System

In the communication with (potential) respondents the general characteristics are used as a reference for the interviews. The more detailed and distinctive characteristics are then used to determine, with the respondents, what the characteristics of their particular implementation are. The characteristics listed in Section 4.4 are used during the interviews as a checklist. In this way a description of the structure is obtained in a comparable way. In Chapter 5 factors affecting adoption process and its resulting structure are explained. It should be noted though, that many of the characteristics listed here are probably affecting each other too. As was for instance suggested in Section 2.2.1, breadth (reach) of the system is positively impacted by the newer e-business technologies.

5 The adoption process of Supplier Integration Systems

The diversity of Supplier Integration System structures was described in Chapter 4. The Supplier Integration System was explained as a class of inter-organizational systems. A checklist of characteristics was created to describe and distinguish different structures. Besides recognizing a Supplier Integration System this enabled a structured and comparable description of Supplier Integration Systems at the studied companies. The structure of a Supplier Integration System is the result of the adoption process model used in this study, as the model includes the motivations, enablers, inhibitors and the organizational actions leading to the adoption or rejection of a system. Therefore this section will explain the various theories of adoption that form the basis of this model and how these theories relate to the structure of Supplier Integration Systems. This chapter will answer the second sub-question about the adoption process and partially the third sub-question about the relation. The questions 2a, 2b and 3a are answered:

2: Adoption Process: How can the Supplier Integration System adoption process (best) be studied?

a. *What are the different perspectives on adoption processes of inter-organizational systems?*

b. *What are the contributions and shortcomings of these approaches?*

3: Relation: What is the relation between the adoption process and Supplier Integration System structures?

a. *What theories explain the relation between the adoption process and Supplier Integration System structures?*

In order to answer the main research question this study aims to enhance the adoption process model of Kurnia and Johnston [24] (also see Section 3.1.2). Therefore the processual approach to adoption is also followed in this study. In this chapter this processual view of adoption is explained. It is also explained how this model relates to and complements other theories of adoption. Especially with regards to the factor model of adoption as it is an extension of these models. To make these differences explicit, the taxonomy of adoption theories is discussed first as was done by Kurnia and Johnston [24].
Following this taxonomy the theories based on the most common perspectives, the factor approach, are discussed. These studies have resulted in models explaining what factors are necessary for adoption of Supplier Integration Systems. They include enabler, inhibitors and motivations to adoption in a technology–organization–environment (TOE) framework. The discussion of these models will cover both the merits of these models and the shortcomings.
The processual approach to IOS adoption is explained next and how this approach overcomes some of the shortcomings of the factor approach.
Finally the last shortcoming, which is not tackled by the process model, is discussed. Many studies, including the process model of Kurnia and Johnston, assume a dichotomous outcome (adoption or rejection), while in reality there are many different structures and therefore multiple outcomes possible. As was argued in Chapter 3 this is an oversimplification that cannot be ignored as different conditions and objectives require different Supplier Integration System structures. Some theories attempt to overcome this though, by studying the relationship between certain factors and some aspects of the structure of IOS. These theories explain what determines the structure of IOS to some extent and are therefore discussed next.

The results of this chapter are used in the case interviews to guide the story telling of the adoption process. Following the assumptions of the processual approach the respondents are asked about what happened and what was decided during their adoption process.

5.1 Perspectives on IOS adoption

As was discussed in Chapter 2, the initial innovation of IOS was followed by many smaller innovations, of which the Internet was a major one. Innovation "refers both to the output and the process of arriving at a technological feasible solution to a problem triggered by a technological opportunity or customer need"(p68 [13]). Adoption is a demand side concept that entails the acceptance of an innovation. This assumes that the person or organization is capable of adoption of the innovation. The adoption process starts when the organization becomes aware of the innovation and ends when the innovation is implemented or abandoned.

The concept of adoption has been studied extensively. This resulted in many different perspectives on the concept and theory of adoption. In this study the perspectives advocated by Kurnia and Johnston are used in what they call the processual view of IOS adoption, to complement the factor approach used in most studies [24]. They used the taxonomy of Markus and Robey [49] to describe the perspectives of other studies and their perspective. The taxonomy distinguishes three dimensions of causal structure of information technology adoption: causal agency, logical structure, and level of analysis.

Causal agency refers to beliefs about the nature of causality and has three perspectives:

1. *Technological imperative*: The technology and other external factors determines or strongly constraints individual or organizational behavior including adoption. Also called "situational control" perspective.
2. *Organizational imperative*: Rational choice consistent with preferences and goals determines individual or organizational behavior including technology adoption. Human actors have almost unconstraint control over the technology adoption. Also called "rational actor" perspective
3. *Emergent perspective*: individual or organizational behavior including technology adoption emerges unpredictably from the interaction of people, events and external factors

Logical structure is about the temporal aspect of the theory and the relationships between predicting variables and the outcomes. It has two perspectives:

1. *Variance theories*: These theories assume that certain variables measured at a certain time are necessary and sufficient to determine outcomes
2. *Process theories*: These theories assume that a set of sequential conditions is necessary over time to arrive at certain discrete outcomes. But even when all conditions are met outcomes may not occur, because of dynamic interactions between technology and actors.

Level of analysis refers to the entities about which the theory poses concepts and relations. With respect to technology adoption this dimension ranges from the highest macro-level of societies to the lowest micro-level of individuals.

5.2 The factor approach to IOS adoption

Many empirical studies of IOS adoption in organizations have used the factor approach. In terms of the Markus and Robey taxonomy; they assume the technological imperative, develop variance theories and study at the organizational level of analysis. The models studied, using the factor approach, are often based on the technology–organization–environment (TOE) framework [24, 26], developed by Tornatzky and Fleischer [50], explaining general technological innovation adoption by firms. The approach used in these studies, such as the EDI adoption studies by Iacovou et al.[28] and Chwelos et al. [51], assumes that factors in the technological, organizational or environmental context determine and sufficiently explain the

process of organizational adoption. This simple causal structure is empirically tested with surveys measuring the existence of these factors (the predicting variables) in relation to the dependent variable of IOS adoption. There have been enough statistically reliable studies to accept the reliability of the resulting factor model. The result is a factor model with a considerable list of factors in the three categories of the TOE framework. They include enablers and inhibitors of adoption and they include the implicit and explicit motivations of companies to adopt or reject the system.

Technology: The factors in the technology categories are about the perceived nature of the technology including existing technologies inside the firm, as well as the pool of available technologies in the market. In this case it pertains to the perceived characteristics of EDI and e-business technologies. The perceived costs, disadvantages and benefits of the new technology are measured. It is intuitively clear that when decision makers have to decide over the adoption of a new technology that they look at what the advantages and disadvantages of the new technology are.

Organization: The factors in the organization category are typically about the capabilities of the organization and other internal organizational characteristics such as firm size. It is intuitively clear that decision makers look at their own organization and assess whether or not they are capable of successfully implementing a new technology.

Environment The environment category contains the external factors, such as market pressure or government interference. Decision makers constantly try to adapt their organization to optimally fit in their environment, this includes perhaps adopting a new technology when the environment makes this necessary to survive as a healthy company.

In Figure 9 a TOE factor model that combines results of several empirical studies is depicted. It is an appealing model because it can be readily translated into a set of guidelines for practitioners. Take for instance the factor of top management commitment. This indicates that without top management commitment it is less likely that the organization will be able to adopt an IOS. Using the factors in this way as a checklist, companies can asses whether or not they are ready to adopt an IOS.

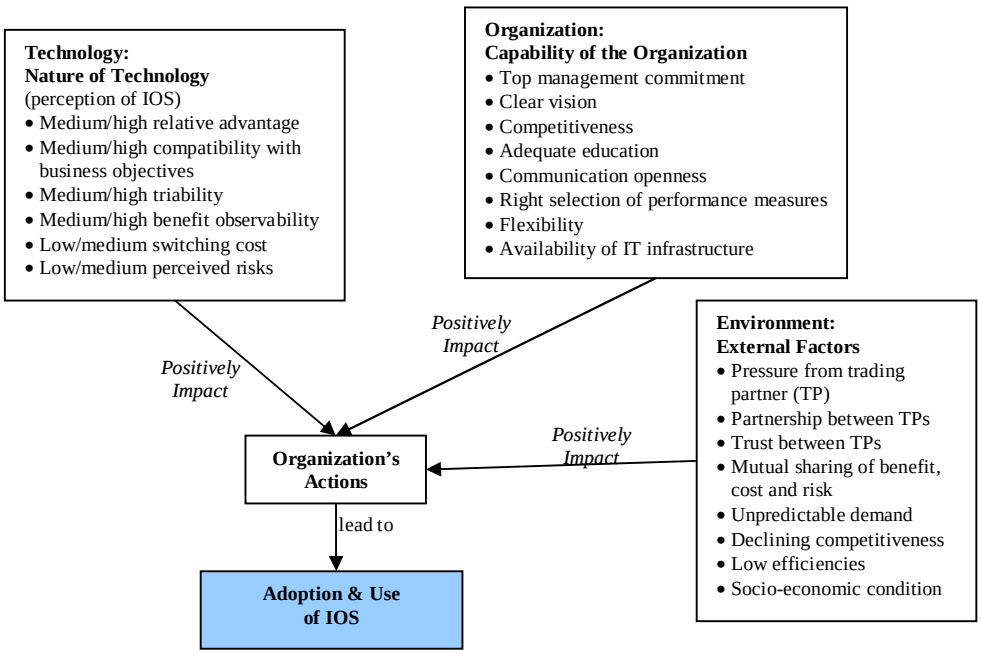

Figure 9: TOE Factor model of IOS adoption [24]

But the model has three shortcomings:

1. The list of factors is probably not complete. Although it lists a considerable number of factors, other studies have found other factors, such as firm size or firm scope, having important influences on IOS adoption [26]. Refinement and extensions therefore still remain necessary. This is also suggested by Kurnia and Johnston, as they do not provide a conclusive list of factors [24].

2. The underlying assumptions of the factor approach cause several shortcomings. Although the factor approach produces a set of necessary factors, these factors are not sufficient to account for the richness of adoption experiences [24]. The factor model neglects the dynamics of an IOS adoption process in an inter-organizational context.

3. The assumption of a dichotomous outcome is an invalid simplification of reality. Assuming that an organization either adopts e-business or does not, was useful for studying the rise of e-business. It helped managers to decide whether or not to go along with the new technologies. But with the ongoing proliferation of Supplier Integration Systems the question shifts from the adoption decision to the decision what structure is most suited. As was shown in Chapter 4 there are many different structures possible. As was argued in Chapter 3 this is an oversimplification that cannot be ignored as different conditions and objectives require different Supplier Integration System structures.

Because of these shortcomings the factor model is not suited to answer the main research question. The first shortcoming is not caused by fundamental flaws of the factor model but simply because of the large number of possible factors. The cases studies can only confirm factors, add richness and possibly can discover overlooked factors. The second shortcoming is about the underlying assumptions. The processual approach, explained in section 5.3, is used to reduce these fundamental shortcomings of the factor approach. But the process model of Kurnia and Johnston [24] does not mend the third shortcoming, as was already explained in section 3.1.2. Some theories that treat this shortcoming do exist though. Therefore these theories about the impact of certain factors on some aspects of the structure of Supplier Integration Systems are discussed in section 5.4. In the case studies specific attention is paid to these factors in relation to the structure of the Supplier Integration System.

5.3 The processual approach to IOS adoption

In this study the perspectives advocated by Kurnia and Johnston are used. They call their view the “processual view” of IOS adoption [24]. Contrary towards many studies using the factor approach their processual view advocates studying IOS on firm / inter-firm level using the emergent perspective and a process logical structure.

Firm / inter-firm level of analysis: Theories explaining the adoption of IOS should cover the focal company and its partners. This is important because the inter-organizational environment is inherently part of the IOS. The relationship with the trading partner illustrates this. The factor approach cluster factors covering the relationship with the trading partner in the environment category (e.g. trust). This implies that the organization has no influence on the nature of the relationship while in reality the relationship is off course affected by past interactions, attitudes and mutual agreements. The relationship is also affected by the behavior of the partner. Even the adoption process of IOS affects the relationship itself. In other words: organizational actions impact the relationship. Therefore the firm/inter-firm perspective is the appropriate level of analysis. This results in a distinction between environmental forces the organization cannot affect (external factors) and supply chain /

industry factors which become internal factors and are part of the organizational actions. In this way the complex interaction dynamics of the adoption process can be understood better.

Process logical structure: The study should have a longitudinal character taking into account the process of adoption as a long term project. During this process many conditions have to be met at given points in time. This is an important notion, because in reality it takes time and involves complex inter-organizational interactions to adopt IOS. The factor model is appropriate to identify the necessary conditions for adoption but not sufficient to explain this process. When looking at the adoption process over a longer period of time it becomes clear that the significance and nature of factors change over time.

Emergent perspective of causal agency: The emergent perspective is important because typically companies are not in total control of their environment, but are not helpless victims either. Organizational actions influence the environment, the supply chain, the perceived nature of the technology and its own organizational capabilities. And in turn these factors affect organizational actions.

Kurnia and Johnston's processual approach resulted in a more complex model, depicted in Figure 10, which is better able to explain the complex dynamics of the adoption process. The TOE framework is extended with the "supply chain / industry structure" category representing the inter-organizational domain and extra arrows to represent the emergent causal structure.

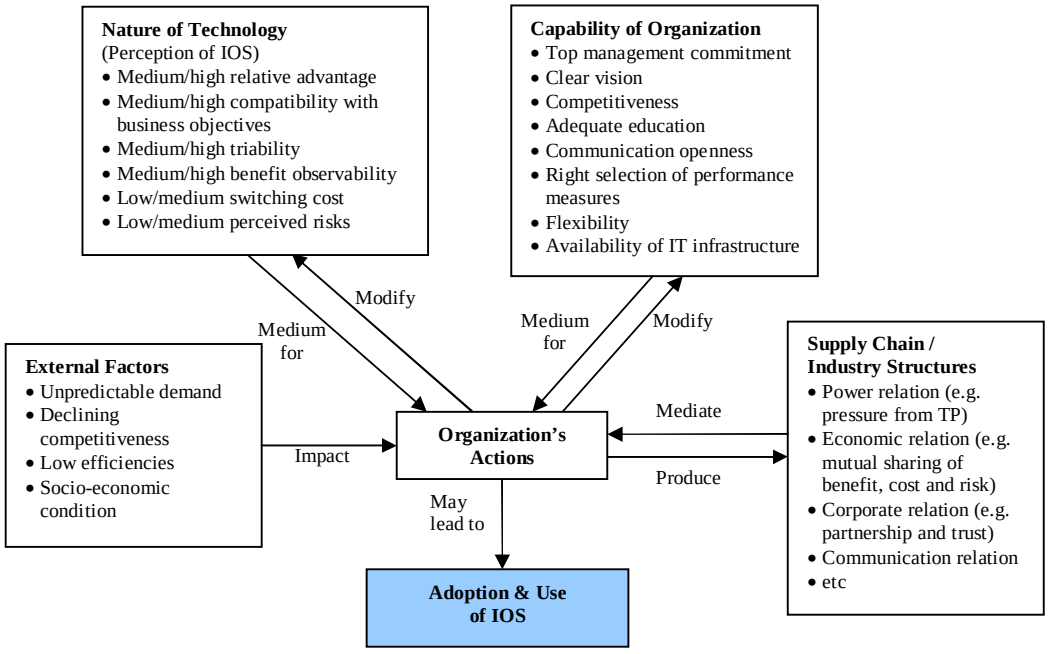

Figure 10: Second order model of IOS adoption (with some adaptations[2] [24])

5.4 Adoption and the structure of Supplier Integration Systems

This section focuses on the relation between factors, organizational actions and the outcome of adoption and use IOS, since this study aims to extend the second order model in Figure 10 with a more diverse outcome. As was seen in Chapter 4 many different types of IOS exist and also the structure of Supplier Integration Systems is pretty diverse. Building on the processual approach the Supplier Integration System structure is a result of the complex

[2] The blue output box was called "Adoption of ECR" in the original model. ECR was used as an example of IOS.

dynamics of the adoption process. These are the same interaction dynamics between factors and organizational actions described in section 5.3. The structure of the Supplier Integration System must be compatible with relevant organizational practices and policies (which are part of the organizational processes) [52] Like in any IT investment the strategic alignment of the technology and the organization and its environment is essential to realize value from these investments [53]. As organizations try to realize this fit, they try to influence the perceived nature of the technology, the organizational capabilities and the supply chain, like modeled in Figure 10 and at the same time tailor the structure of their new Supplier Integration System. Although this study is exploring relative new terrain when studying the adoption process in relation to its diverse outcome, a number of aspects of the outcome have been studied before. The following sections will treat some aspects studied in prior empirical research in relation to characteristics of a Supplier Integration System.

5.4.1 Processes and Information sharing

The adoption process leads to different outcomes concerning the processes that are integrated and the information that is shared. The extent to which processes are integrated and information is shared depends on many of the conditions in the second order model (Figure 10). Two critical factors in the adoption and use of IOS are power and trust [30]. Further empirical research showed that relational factors significantly impact the diversity of integrated processes and shared information [54]. It showed that the transaction channel climate and the partner persuasion method have significant impacts.

The transaction channel climate describes the atmosphere of a relationship between business partners. It can be expressed in terms of the cooperation level in a buyer-supplier relationship. A cooperative channel climate has more diverse integrated processes and shares more information. In the case of the Supplier Integration System this would suggest that in a cooperative climate more of the processes are integrated and that it is more likely that sensitive information is shared. Three determinants impact the channel climate. The level of trust that the partner's future actions will be beneficial (or at least not harmful) and the level of asset specificity, meaning that the partner has made relationship specific investments, positively impact the level of cooperation. Uncertainty about partner's future actions is negatively associated with the level of cooperation.

The partner persuasion method is about how the partner is treated by the initiator of the IOS when they try to connect their partners. Two strategies are distinguished. These are exercising power (the stick) and reciprocal investments (the carrot). While power (either explicitly exercised or not exercised) does force partners to adopt the IOS it would lead to low usage in terms of less diversity of processes. The reciprocal investments in the form of IOS related support, especially in a cooperative climate, often lead to a much more diverse amount of integrated processes. Therefore the more elaborate IOS are probably the result of more reciprocal investments and a generally cooperative atmosphere.

5.4.2 Standards

An important aspect of Supplier Integration Systems is what process and data standard is used. The more recent standards based on XML are considered more open standards and increasingly important. But older proprietary and less open standards, such as classic EDI, are still used. In order to better understand the process of standards diffusion, firms' migration from proprietary or less-open standards to open standards was studied empirically [32]. This study, by Zhu et al., showed that network effects and path dependency have significant impacts.

Network effects theory poses that benefits derived from a network technology is positively associated with the size of the network. When more peers adopt a certain standard (the network technology) the network size increases. Through network effects the benefits for each adopter will then increase because more partners are using the same standard allowing the adopter to share information and integrate processes with more partners. Expected benefits are off course significant drivers of adoption. But there is also a more direct network effect as peers and trading communities try to put pressure companies to adopt a certain standard because this also increases their own expected benefits. Peer adoption and trading community influence are therefore determinants for the strength of network effects.

Path dependency is the notion that a firm's ability and incentive to adopt a newer technology are largely a function of its level of related experience with prior technologies. Path dependency manifests itself both through the experiences of people and through past investments. Past investments in the organizational infrastructure may be lost when switching to a new technology. Classic EDI users often have made specific investments to create their inter-firm linkages. When adopting a new standard they would loose these investments and thereby incur additional switching costs besides the normal adoption costs. Switching costs are also consistent with lower incremental value of the new standard. At the same time, though, having a suitable infrastructure may reduce the costs of adoption when some of the hardware or software can be reused. Past experiences also have a twofold effect. They reduce adoption costs because the organization has learned from their past experience with similar technology and the organization is therefore better able to cope with managerial complexities. But these past experiences also tend to make the organization more cautious as they give the organization a better understanding of the adoption costs and potential benefits involved. New adopters may be unaware of the intangible costs and therefore underestimate the adoption costs or fear to fall behind technologically and therefore overestimate benefits.

5.5 Conclusion

This chapter explained how this study will treat the process of adoption in relation to its structure. The case studies are examined using the processual approach. This means that attention is paid, not only to the factors, but also to the historical development of the Supplier Integration System into the structure it is today. Respondents are asked to comment on choices made during the adoption process. What were the factors in these decisions, what were the actions to influence these factors and how did this dynamic process roll out. Were there any unexpected events or results? How is the final outcome perceived? And what are the future developments and courses of action? The factors listed in the second order model are used as a guideline for the interview. Specific attention is paid to the theories explaining some structural aspects of the Supplier Integration System, treated in this chapter.

6 Case Analysis

This chapter covers the empirical part of this study. Eleven case studies at large global manufacturing firms are performed. In Chapter 3 the study method and selection process was explained. In Chapter 4 and 5 the theory used as guidelines for the cases was described. In this chapter the results from these case studies are analyzed. Structure, adoption process and the relation between the two are treated here. This means that the remaining sub-questions (1d, 3b and 3c) are answered:

1. Structure: What are the various Supplier Integration System Structures?

d. What Supplier Integration System structures can be observed in practice?

3. Relation: What is the relation between the adoption process and Supplier Integration System structures?

b. What adoption processes can be observed in practice?

c. What explanations of the specific adoption process and its resulting Supplier Integration System structure can be observed in practice?

In the interviews the structure of the Supplier Integration Systems appeared to be the most suitable guideline throughout the interview. The impact of the adoption process (including its decisions) on specific aspects of the structure was discussed when these aspects were talked about. When a good description of the structure was established the focus shifted to an explanation of the decisions made. Also the perception its perceived benefits and costs, risks and occurring problems came up.

This chapter will follow the same organization as used in the interviews. The structure of the Supplier Integration Systems is leading. Section 6.1 will therefore describe the observed basic structures first. This in part answers sub-question 1d. Section 6.2 up to section 6.6 will go into the details of these answers. These sections also bring up the explanations from the adoption process for these aspects of the structure. Therefore these sections also answer question 3b and 3c. The adoption process is discussed in Section 6.7, providing more answers to sub-question 3b and 3c.

6.1 Basic structures

In academic and business literature terminology was used in a confusing manner (see Chapter 3 and 4). Also in the case interviews terminology appeared confusing. Terms required explanation and a systematic approach to cover the various aspects comprehensively. In Chapter 4 these various aspects of the structure were explained. In the interviews these tables were used as a checklist to systematically describe all the aspects of the system resulting in comprehensive descriptions of the Supplier Integration System structures. In these descriptions three fixed combinations of characteristics of the structure could be observed. These fixed combinations of characteristics are therefore called the basic structures. The three observed basic Supplier Integration System structures are: the system-to-system structure, the VAN structure and the supplier portal structure. These three basic structures have distinctive characteristics when compared to each other. Of course individual systems within these basic categories also have distinctive features.

The first three sections explain these basic structures. The basic structures are applied to different integration settings. The fourth section explains the basic integration focus. This

integration focus, describing the position of the system in the value chain, was not theorized in Chapter 4, but in the interviews it appeared to be an important aspect of the context. Finally the case observations of the basic structures are listed in the final section.

6.1.1 System-to-system structure

The system-to-system structure is the oldest Supplier Integration System structure. Traditional EDI systems are the main example. But also modern integration systems based on XML standards such as RosettaNet, fall in this category. They are also called virtual integrated supply chains [39].

The most important common feature is that there is a direct system-to-system link that integrates partner back end systems. Both the supplier and the buyer arrange their own integration software that provides the interface. There is agreement about a common data and process standard. The integration software transforms the data from back end systems into this common data standard according to the processes agreed. The connectivity is locally arranged using a network technology such as a dedicated phone line or the internet. The process architecture is federated. The Supplier Integration System can basically be viewed as a messaging system between otherwise separate systems.

Figure 11 shows a schematic representation of this structure. This figure shows 1 buyer and three suppliers to keep the representation simple. In reality the basic structure accommodates varying networks with one or more suppliers and one ore more buyers.

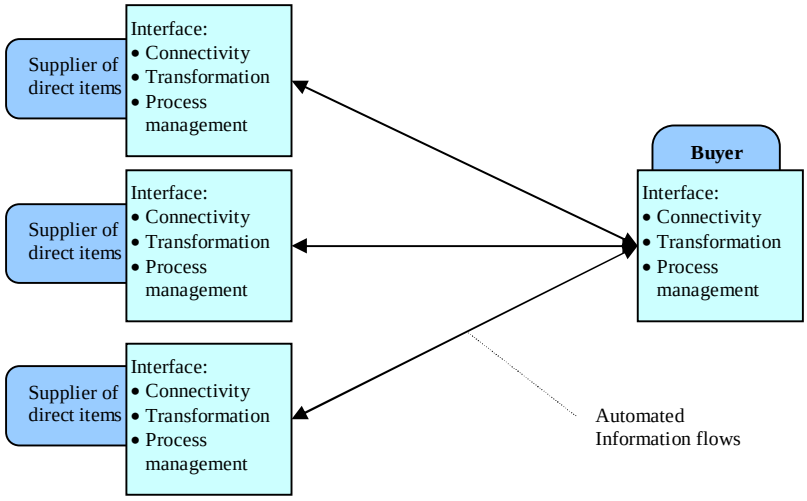

Figure 11: System-to-system structure

The system-to-system structure offers the possibility of a very high level of integration with the integrated partner. Common processes and information sharing can be completely automated. The main drawback is that with each partner a common data and process standard must be agreed. When there are no industry standards, or when there are many suppliers with many differences this proves to be very costly. Even when using open standards, practitioners face high implementation costs. In a number of cases, such as FMCG and Electronic4, this only proved worthwhile with important suppliers. Important suppliers are suppliers with high volumes, high order/delivery frequencies, and long term relationships. The organizational and IT capabilities of the partner and the willingness to cooperate also played an important role. Within this structure for each partner a separate business case is often required to support the decision to integrate them.

6.1.2 VAN structure

The name of this basic structure is based on the value-added network (VAN) service that appeared soon after the introduction of traditional EDI. These value-added networks are provided by integration service providers. These are intermediaries that act as a hub of information and thereby decrease the number of required connections in large networks with many buyers and many suppliers. Traditionally they provided traditional EDI services but today also modern technologies are used and a wide range of extra services can be provided.

The basic common feature of the VAN structure is a hub-and-spoke architecture using an intermediary entity. Two typical case examples are "e-invoicing" and the "e-hub logistics service provider". In the case of e-invoicing the invoicing process is supported by an external e-hub service provider. Suppliers' financial systems as well as the buyers' systems are integrated with this e-hub enabling the automated processing of invoices. According to a recent survey this is a key topic in many companies [55]. The logistics service provider example is an even more elaborate service supporting the entire planning and transaction management process.

The VAN structure encompasses what is by some viewed as a form of electronic marketplace in a business to business setting aimed at vertical collaboration [37]. The e-marketplace is in this view a platform or hub supporting integration in hierarchies. It should not be confused with b2b hubs for market-mediated interactions.

Figure 12 shows a schematic representation of the VAN structure. It shows one buyer, three suppliers and an integration service provider in between. In reality the structure encompasses varying network structures with one or more suppliers, one or more buyers and one integration service provider. Also in the case of e-invoicing the distinction between suppliers of direct and indirect items disappears.

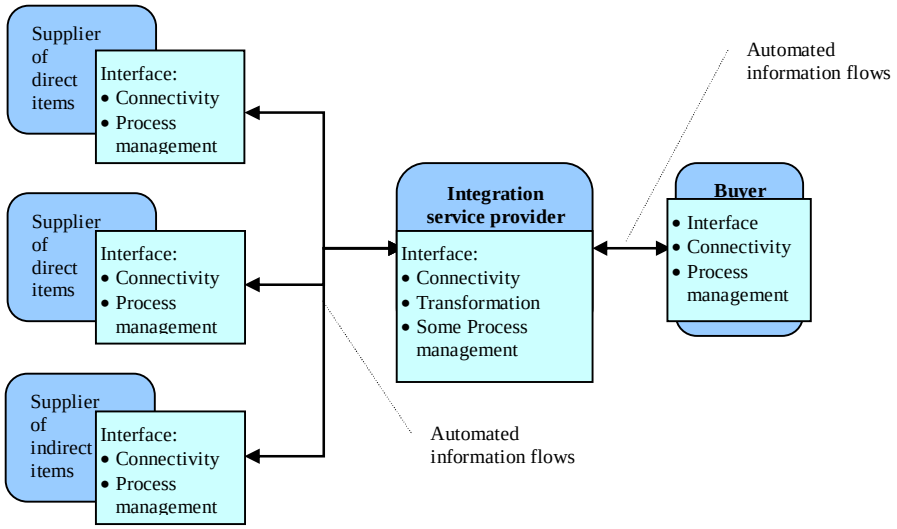

Figure 12: VAN structure

The VAN structure offers possibilities of high integration levels and outsourcing services, such as supplier development. An external integration service provider actively contributes to increase the network of integrated partners, as this specialized intermediary seeks new customers. Due to the network effects (see Section 5.4.2) it is inclined to do this. In this way, while only having to integrate with one partner (the integration service provider), a large network can be attained. Using the VAN structure can also help to show "one face" to partners. This was the idea behind the failed integration project of Electronics1 to use a VAN

structure with an internal (centralized) integration service provider. This centralized hub was to be the intermediary between the various divisions/departments and its suppliers. It proved to be very difficult for this intermediary to integrate with the many different actors on both sides. The diversity of these actors and their wishes were too great causing the project to fail. External integration service providers have more experience in integrating various actors and already have integrated networks. This is appreciated as the Electronics4 response illustrated: "managing another system is not our core business". The drawbacks are that one becomes dependent on these integration service providers and that they are costly and are in some cases not developed enough to suit the specific wishes. The VAN structure with external suppliers is not much adopted yet, by the case companies (only FMCG has a running system with a VAN structure with an external intermediary), but it is on the agenda of others too (e.g. Electronic4).

6.1.3 Supplier Portal structure

The supplier portal structure is the simplest of the basic structures and has been called a core supply chain business model before [45]. In this structure suppliers can log into secured websites that provide customized information and access to online applications. This portal website is integrated with the enterprise systems of the buying company. Because supplier back end systems are not integrated, employees of the supplier have to manually process and transform the information.

Figure 13 shows a schematic representation of the supplier portal structure. The structure can easily be extended to give access to more suppliers, requiring only an internet connection. At the same time suppliers can end up facing a portal for each of their customers.

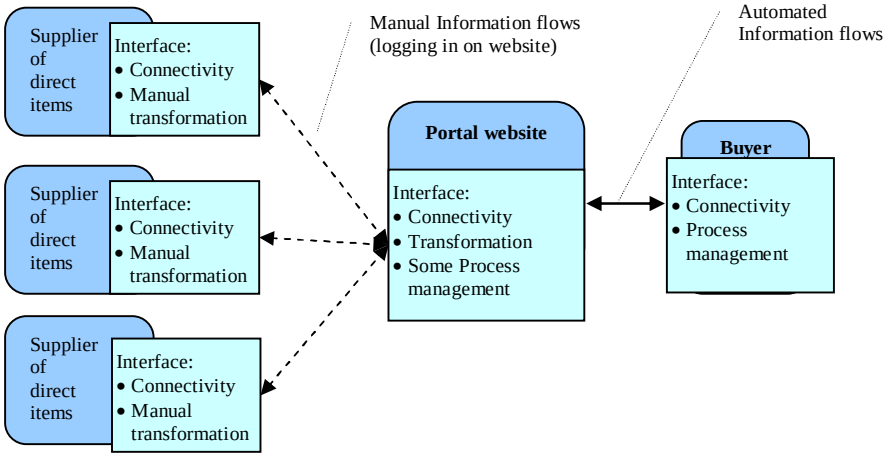

Figure 13: Supplier portal structure

The supplier portal structure is the easiest and most accessible solution, but at the same time does not provide end-to-end integration. The Supplier Portal structure does not require the coordination efforts to align data and process standards with partners such as in the other two structures. The partners do not need sophisticated organizational and IT capabilities to use the portal. The only need an internet connection and need to learn how to use the portal and its applications. This is relative cheap and easy to implement. But the drawback is that it does not provide end-to-end integration and thus still requires manual operations to be performed. Also the portal costs the supplier extra work because they need to adjust their normal operation routine to work with it and in some cases can end up facing various different portals with different processes for multiple customers.

6.1.4 Integration focus

It appeared in the case studies that the three basic structures described in the last three sections appear in different integration settings. This setting is an aspect of the context that describes the position of the system in the supply chain. This position is the focus of integration by the integration system. Two aspects describe the basic integration focus.

The first is the distinction between so called internal suppliers and external suppliers. Many of the studied corporations own themselves large parts of the supply chain. This means that supplier plants are owned by the same company as the buying plant, hence so called internal suppliers. For instance in the case of Truck2 the truck assembly plant procures its materials and components at various external suppliers, but the most important components such as the engines are obtained from internal suppliers. Truck2 manufactures the engines themselves. In the case of Packaging1 their own paper mills produce for their own corrugated and card-board plants. Here it gets even more complicated as the paper mills also sell to external customers and the corrugated- and card-board plants also buy from external paper mills.
In literature there is a very clear distinction between Enterprise Application Integration (EAI) and business to business (B2B) integration, but it appears that the same systems are used for both internal and external integration. Indeed in literature it is acknowledged that the same technologies can be applied for both types of integration [8]. It is also important to notice that integration of the internal supply chain gets precedence over integration of external suppliers. The reasons mentioned for this are that it is perceived to be easier to integrate internal suppliers, that internal suppliers are considered more important suppliers (resulting in more benefits from integration) and that it is considered a pre-condition before one can integrate with partners.

The second aspect describing the integration focus is the basic type of actor. It is either a plant (a producing actor) or a distribution unit (a sales unit). This results in an integration focus that is either plant-to-plant or plant-to-distribution. In the case of Truck1 the plant-to-plant integration focus is between producers of components and the assembly plant. The plant-to-distribution integration focus appears between plants and sales agents in the Pharma2 case, and appears between contract manufacturers and the OEM in the case of Electronic3.
The trend of increasingly using contract manufacturers (especially in the electronics industry) appears to shift the integration focus for the studied companies from plant-to-plant towards plant-to-distribution. The plant-to-distribution integration focus is easier because there are generally less suppliers, a smaller diversity of items and a reduced bullwhip effect (because one is closer to the end-customer).

6.1.5 Governance structures and process architecture

Each of the basic structures has a distinct governance structure and process architecture. Following Table 9 three aspects of the governance structures and process architecture were inquired.

The first aspect pertains to the *ownership* of the system. Most of the observed systems are owned by the focal firm. Only in the cases where a VAN structure with an external (third party) intermediary is used the Supplier Integration System is owned by one other then the focal company: the third party intermediary.

The *management* of the system is a more complex aspect of the governance structure. Usually it is centralized at the divisional or company level. But then also at the plant level operational management tasks related to the system occur. In some of the cases there is an IT outsourcing partner. The management of this partner with respect to the Supplier Integration System is usually centralized. In case of the VAN structure with an external intermediary many of the management tasks are taken care of by the third party. Examples are the development and

encouragement of suppliers to cooperate in the integration system and the management of the IT.

The *process architecture* is directly related to the basic structure. The system-to-system structure typically has a federated process architecture. While the VAN structure and the Portal structure typically have a hub-and-spoke architecture.

6.1.6 Case observations

The case observations of the basic structure, integration focus and the governance structure are listed in Table 12, Table 13 and Table 14. One can see that the three basic structures are used in a complimentary way.

Company	Description of the studied integration system (s)	Integration focus	
Pharma1	*1. System-to-system structure*: Integration with Contract Manufacturers is supported with interfaces. They have just recently become independent (since 2006). Integration with suppliers is planned (The business case is approved). Internally the supply chain is fully integrated with one enterprise system.	Plant-to-Plant	External
Pharma2	*1. VAN structure*: Integration between sales affiliates (local companies) and plants is supported with advanced planning and e-ordering. There is an internal hub since 2005 (idea started in 2001).	Plant-to-distribution	Internal
Packaging1	*1. System-to-system structure*: The system integration / VMI system on the e-business platform supports the integration of internal and external paper mills with internal and external corrugated and card board plants since 2001.	Plant-to-plant	Mostly Internal
Packaging2	*1. System-to-system structure*: System integration between internal paper mills and mostly internal and some external cardboard plants is supported based on VMI (since a few years)	Plant-to-plant	Mostly Internal
Truck1	*1. System-to-system structure*: The classic EDI system (started in 1987) supports integration between mostly external suppliers and the assembly plant *2. Supplier portal structure*: Additionally there is web-EDI (supplier portal) for smaller partners (with mostly the same functionalities) due life in 2008	Plant-to-plant	Mostly external
Truck2	*1. System-to-system structure*: The classic EDI system (started in the early 90s) supports integration between mostly external suppliers and the assembly plant. *2. Supplier portal structure*: Additionally there is web-EDI (supplier portal) for smaller partners (with mostly the same functionalities) since a few years	Plant-to-plant	Mostly external
Electronic1	*System-to-system, Supplier portal and VAN structure:* The current integration efforts on a divisional level with suppliers and Contract Manufacturers are discussed. This includes some EDI and supplier portals. E-faxes are also used a lot. The failed project to integrate all external suppliers and contract manufacturers with all plants through one firm wide e-business hub (VAN structure with internal intermediary) is also discussed.	Plant-to-plant / distribution	External
Electronic2	*1. System-to-system structure*: Integration of transactional process between plants and sales affiliates is supported. The Dutch situation is investigated.(running for more then 10 years)	Plant-to-distribution	Internal
Electronic3	*1. System-to-system structure*: Currently there are some older EDI connections, but mostly paper based communications *2. VAN structure:* A new integration system is in *development*. This should integrate suppliers and contract manufacturers with a logistics service provider and the focal company. (focus of the interview)	Plant-to-plant / distribution	External
Electronic4	*1. System-to-system structure*: There is a peer-to-peer integration system (RosettaNet based) with Contract manufacturers since the late 90s *2. VAN structure:* E-invoicing (in *development*) with all supplier types *3. Supplier portal structure*: There is a Supplier Portal with suppliers of direct items.(since +-2003)	Plant-to-plant / distribution	External

Table 12: Basic structure and integration focus (part 1)

Company	Description of the studied integration system (s)	Integration focus	
FMCG	*1. System-to-system structure*: EDI system: to support the VMI concept with two important suppliers since +- 2001 *2. VAN structure*: E-Invoicing: for suppliers of both indirect and directs. An external service provider offers integration services for the invoicing process.(since 2007 (development started in 2006) *3. Supplier portal structure*: Supplier Portal: website where about 100 of the larger suppliers can log in and download information and can commit to forecasts /orders (since +-2003)	Plant-to-plant / distribution	External

Table 13: Basic structure and integration focus (part 2)

	Governance structure		
Company	*Ownership by*	*Management*	*Process Architecture*
Pharma1	Focal company	There is an outsourcing partner responsible for IT management. At the plant level the systems are coordinated (including supplier relations)	Federated
Pharma2	Focal company	Centralized IT department since it concerns mostly enterprise integration	Hub-and-spoke
Packaging1	Focal company	Centralized e-business platform management	Federated
Packaging2	Focal company	Centralized IT department	Federated
Truck1	Focal company	Centralized at the plant level. Since production is for a large part concentrated at this plant	Federated (EDI) and Hub-and-spoke (portal)
Truck2	Focal company	Partially centralized and partially plant level. There is an IT and a purchasing service at the organizational level, but at the plant level logistical aspects and operations are managed.	Federated (EDI) and Hub-and-spoke (portal)
Electronic1	Focal company	Centralized project failed because the requirements where to different. Currently the divisions manage their own integration projects	Federated (EDI) and Hub-and-spoke (portal and failed hub)
Electronic2	Focal company	Centralized at the global level. The country level is responsible for operations	Federated
Electronic3	External service provider	The logistics service provider will be responsible for the system and will manage the relations together with the focal company	Hub-and-spoke
Electronic4	Portal and P2P: focal company e-invoice: external service provider	Portal and P2P: focal company e-invoice: external service provider	P2P is federated Portal and e-invoice use a hub-and-spoke architecture
FMCG	Portal and EDI: focal company e-invoice: external service provider	Portal and EDI: focal company e-invoice: external service provider	EDI is federated Portal and e-invoice use a hub-and-spoke architecture

Table 14: Governance structure

The case observations can be summarized by the following:

- The system-to-system structure is most difficult to implement but enables a high degree of integration.
- The VAN-structure can be combined with outsourcing services by an integration service provider but makes one dependent on a sometimes costly and not always competent service provider.
- The supplier portal structure is the most accessible structure but only provides partial integration, thus still requiring manual tasks.
- The three basic structures have distinct governance structures and are used in a complimentary way for both internal and external integration.

6.2 Breadth and volume

Following Table 8 and Table 10, breadth and volume are, besides diversity (see section 6.3), important indicators of Supplier Integration System usage [56]. They describe the "size" of the system. Generally it is considered that a higher breadth and volume is more beneficial for the owner of the system. In this section first the evolving nature is described, then some explanations are discussed and finally the case observations are presented.

6.2.1 Evolving size

In the observed cases during the adoption process the size of the system gradually increased up to the current levels. Especially from higher volumes most gains are expected. Therefore the more important suppliers are often approached first. Important suppliers are suppliers with high order/delivery volumes and frequencies, and long term relationships. Contract manufacturers are often among these most important suppliers. A standard implementation strategy is therefore to integrate the most important suppliers within a system-to-system structure first. When with these suppliers the integration is successful, then the breadth of the system is gradually increased to include the less important suppliers. At a certain point it is not worthwhile anymore (or possible) to integrate more suppliers within the system-to-system structure. Within this structure for each partner a separate business case is often required to support the decision to integrate them. Then the more accessible and easier Supplier portal structure comes in the picture to reach these smaller and less sophisticated suppliers

6.2.2 Achieving higher breadth and volume

It is striking that only the truck companies achieve a high breadth and volume. Compared to these two, the other companies all have a relative low breadth and volume. A logical explanation of this is that the truck companies have a much longer history of using the same Supplier Integration System. It takes time to integrate your partners in your system and achieving a high breadth and volume is something that requires large efforts and long term commitments. Newer technologies, based on open standards or the internet, are not the reason as the truck companies mainly rely on the mature classical EDI technologies. They do use web-EDI (Supplier Portal structure) in a complimentary way to reach smaller and less sophisticated suppliers. Most truck suppliers are integrated with classical EDI (system-to-system structure).

In achieving higher breadth and volume the cooperation of partners is considered essential in every case. Two tactics (or a combination of the two) have been used in the cases to get this cooperation: coercion and persuasion. This boils down to using the carrot and the stick to increase the cooperation of partners. The coercion tactic is about making use of the buyer power and the persuasion tactic means relying on reciprocal investments [54]. For instance in the Truck1 and Truck2 case the willingness and capability to use EDI is a strong supplier selection criterion. The truck companies use their buyer's power because if suppliers do not cooperate then they loose their sales. But at the same time it is reported that both companies also relied on the persuasion tactic. They both were (and still are) actively involved in industry networks that promoted integration in the industry through for instance the establishment of industry data standards. Another example of the persuasion tactic is found in the FMCG case. In this case the portal usage is stimulated with reciprocal investments such as portal related training and support of the supplier by FMCG.

The VAN structure with an external integration service provider was not adopted much among the case companies (only FMCG). But some are thinking about it or have such a structure in development, because (among other reasons) it is expected to enable a higher breadth and volume.

6.2.3 Case observations

In Table 15 the current breadth and volume at the studied companies is listed.

Company	Volume (% document flow)	Breadth (% trading partners)
Pharma1	Currently 20 %, when Suppliers are also connected this is to be 50%	3 (10%) of the most important Contract Manufacturers and the 10 % most important suppliers
Pharma2	Estimated 50 % (mainly larger affiliates are integrated)	35% of local affiliates
Packaging1	Most connected plants are larger therefore volume is probably higher then 20 %	12% of the plant locations in the network are connected
Packaging2	Estimated 60 %	Internally 100% of the 7 paper mills and 60 % of the 400 corrugated plants. 25% of the external corrugated plants are integrated
Truck1	95 %	90% largest suppliers (rest manual or with web-EDI)
Truck2	95%	80% largest suppliers (10 % with web-EDI, rest manual)
Electronic1	The failed project was aimed at the highest possible volume %. The divisions currently have 5 % EDI and 30 % Supplier Portal volume	The failed project aimed at all suppliers of direct items. The divisions currently have EDI connections with less then 5% of the partners and with 25% supplier portal relations
Electronic2	100% of the internal transactional document streams are supported. Only in exceptions manual intervention is required.	The 40 internal suppliers are all connected. A few external suppliers are also connected (<%5)
Electronic3	The suppliers who are to be integrated account for the most part of the document volume.	20-100 most important suppliers are to be integrated. They are Contract Manufacturers and therefore the supplier base will be reduced (currently 1000)
Electronic4	Peer-to-peer covers 90% of the volume produced by the contract manufacturers Portal 15%	P2P: Top 10 Contract Manufacturers Portal: 15 % of BOM suppliers E-invoice: aims to integrate 70-80 % of all suppliers
FMCG	EDI <5% Portal <10% e-invoicing < 10%	EDI 2 large suppliers with high consumption Portal: +-100 of the larger BOM suppliers and contract manufacturers (total +- 5000 of which 2500 active) e-invoicing: used by +- 250 suppliers of indirect and direct items

Table 15: Breadth and Volume

The case observations can be summarized by the following:

- The truck manufacturing companies reach the highest breadth and volume using mature technology because of their longer engagement in Supplier Integration Systems, the collaborative culture in the industry, strong and long-term relationships, the wide diffusion of industry standards, the homogeneity in the industry and strong competitive pressure to produce efficiently.
- Internal integration reaches a higher breadth and volume then external integration, because it is considered easier and because it is considered a pre-condition of external integration
- Supplier Integration Systems breadth and volume levels evolve gradually based on a separate business case for each partner and usually starting with the most important partners first
- Partner cooperation is considered essential to achieve high breadth and volume and is achieved through persuasion and coercion tactics

6.3 Process and Information diversity

Diversity is, besides breadth and volume (see section 6.2), an important indicator of Supplier Integration System usage [56]. It explains what the system is used for. Higher diversity means that the systems functionality scope is wider. In general a higher diversity indicates a higher level of integration. First the diversity in general is discussed here. Then the processes and information types are discussed in more detail in the next subsections.

6.3.1 Diversity

In many cases it appears that the diversity is different for different partners. With some partners only a view documents are shared and a view processes are supported while with others the diversity is much higher. When looking only at these highly integrated partners the diversity is generally high. This means that, concerning planning and operational purchasing, there are few manual tasks left (only exception handling is often manual). But this does not mean that the maximum possible amount of information is shared. The percentages in Table 16 are relative to the total amount of document types shared. Especially concerning planning, exception handling and confirmations, more information could be shared to increase visibility.

Company	Diversity (% document types concerning planning and operational purchasing)
Pharma1	All document types in use (excluding exceptions) are supported, but not for all partners.
Pharma2	80 % of the document types exchanged is supported (for most partners)
Packaging1	All document types (excluding exceptions) concerning planning and operations are supported for all integrated plants
Packaging2	Most document types are supported, but not with external partners
Truck1	All document types (excluding exceptions) in use are supported, but not for all partners
Truck2	All document types (excluding exceptions) in use are supported, but not for all partners
Electronic1	Most document types are shared with e-faxes, e-mail or manually. The portal only covers some concerning ordering, forecasts and confirmations
Electronic2	Mainly transactional documents. Only some of the planning documents with a few partners
Electronic3	All documents types in scope are to be supported.
Electronic4	P2P is most diverse covering all document types in use (excluding exceptions). Portal is less divers, and e-invoicing is least diverse.
FMCG	The three systems are limited in diversity. They cover different types.

Table 16: Diversity

6.3.2 Processes

The supported processes at the case companies are listed in Table 17. This table shows what processes are supported for those partners that make full use of the system. In most cases plan exchange, scheduling & ordering, receiving & expediting and invoicing are supported in some way. But when looking at these processes in more detail they appear different and are supported in various ways and degrees. They are not as standard as they seem. Even the most standard process of scheduling & ordering is different in the various cases. In some cases the VMI concept is applied or running forecasts are used as schedules, making the action of sending orders redundant. In some cases explicit order confirmations are required while in others it is agreed in the contracts that every order (within certain boundaries) is delivered, making confirmations implicit. Many of the choices to adopt a certain process are prompted by keeping it as simple as possible. In this way it is easier to automate the processes with the Supplier integration system.

In most of the observed cases during the adoption process the diversity of the system gradually increased up to the current levels. New functionalities to support processes and information types were added. In many of these cases the functionalities were added according their place in the total process from plan to execution and payment. The processes are sequential and that order is kept when processes are introduced. Therefore a general order

of development was that first some plan exchange and ordering was introduced. In later stages of development receiving & expediting and invoicing was introduced in the system. But this general order of development was affected by the problem owner in the focal company. This problem owner, in becoming the integration champion, advocates support for the processes they want integrated first. For instance in the Electronic4 case the e-invoicing system focusing on invoicing only is strongly advocated by the purchasing department, because suppliers complained about payment problems.
Invoicing was in many cases regarded as a special process with its own difficulties and problems. Not only were specific e-invoicing systems setup, but in other cases invoicing was not supported because this was too difficult. This was because the process is not standardized enough across companies and because the regulations for invoicing across different countries also differ considerably. Also it was reported that it requires more trust in the supplier then the other processes, "because it is about the money".

It is striking that large parts of the planning process and the operational purchasing process are not or hardly supported. Local domain planning is not supported by any of the Supplier Integration systems. It is performed in the back end systems, based on information that is locally available. Negotiation & exception handling is hardly supported. Negotiation about plans is mostly not done. Usually the plans are implicitly accepted when they are within the contractual agreements. Exceptional orders are possible within most systems but most exceptions have to be handled manually. Evaluation of plans and compensation schemes are not supported beyond some monitoring functionalities. This is done manually. In the operational purchasing process the verification is not supported at all. In case of wrong or bad products the management of returns and its consequences is performed manually.

	Planning Processes				**Operational Processes**			
Company	*Local Domain Planning*	*Plan Exchange*	*Negotiation & Exception*	*Evaluation*	*Scheduling & Ordering*	*Receiving & expediting*	*Verification*	*Invoicing & follow up*
Pharma1		*Forecasts*			*V*	*V*		*partially*
Pharma2		*Mostly VMI*	*Partners can correct for exceptions*		*V*	*V*		
Packaging1		*Mostly VMI*		*Some monitoring*	*V*	*V*		*V*
Packaging2		*Mostly VMI*			*V*	*V*		*Internal only*
Truck1		*Forecast and JIT*			*V*	*V*		*V*
Truck2		*Forecast and JIT*			*V*	*V*		*V*
Electronic1		*Mostly VMI*	*important suppliers only*		*V*	*V*		
Electronic2		*some*			*V*	*V*		*V*
Electronic3		*VMI planned*			*Planned*	*Planned*		*planned*
Electronic4		*System-to-system*			*Portal and system-to-system*	*Portal and system-to-system*		*All three systems*
FMCG		*EDI and Portal*			*Portal*			*e-invoice*

Table 17: Processes supported

6.3.3 Information types

The processes described in the last section require the exchange of information. The shared information types are listed in Table 18.

Information is only shared on a need to know basis. The information types of capacity, inventory position, POS data, capacities and lead times are only needed when the VMI principle is applied. In the cases where no order confirmation is send the order is implicitly confirmed according to the contractual agreements. Good receipts do not include the results of the verification process. They only confirm receiving the goods. Usually barcode scanning supports this.

Trust was reported as an important factor affecting the level of information sharing. For instance in the Pharma1 case the VMI principle requiring more detailed information then requirement forecasts was not an option because this would reveal to much about the production process. The suppliers are not trusted enough not to misuse this information.

	Information shared									
Company	*Inventory position*	*Point-of-sale data / sales forecasts*	*Forecast*	*Capacity*	*Lead time*	*Order*	*Order Confirmation*	*Advanced Shipment Notification*	*Good receipts*	*Invoice*
Pharma1			*V*			*V*	*1/2*	*V*	*1/2*	*V*
Pharma2	*V*	*V*	*V*			*V*	*V*			
Packaging1	*V*			*V*	*V*	*V*		*V*	*V*	*V*
Packaging2	*V*	*V*				*V*		*V*	*V*	*1/2*
Truck1			*V*			*V*		*V*	*V*	*V*
Truck2			*V*			*V*		*V*	*V*	*V*
Electronic1	*V*		*V*			*V*	*V*	*V*		
Electronic2			*some*			*V*		*V*	*V*	*V*
Electronic3	*V*	*V*				*V*		*V*	*V*	*V*
Electronic4			*Peer-to-peer*			*Portal &P2P*	*Portal &P2P*	*Portal &P2P*	*Portal &P2P*	*All 3*
FMCG	*EDI*	*EDI*	*Portal*			*Portal*	*Portal*			*e-invoice*

Table 18: Information shared

The case observations can be summarized by the following:

- The diversity of information types and supported processes is increased gradually over time.
- The diversity of information types and supported processes varies among partners because of the different capabilities of the partner and the different requirements due to for instance the application of VMI with only a few partners.
- Invoicing is considered a more difficult process to integrate because in practice it varies more among different companies, faces different regulations in different countries and requires more trust in the partner
- Trust was reported as an important factor affecting the level of information sharing

6.4 System Intelligence and Integration level

System intelligence describes what kind of decision support the system provides. The integration level with back end systems describes what manual task and delays occur between the moment of a relevant change in the back end data and the delivery of the message to the partner.

System intelligence is not widely incorporated in the Supplier Integration Systems. Most of the Supplier Integration Systems can best be seen as a messaging service. They deliver messages and transform them according to the agreed message standard. Logistics intelligence (e.g. decision support) is not supported. This is supported by back end systems. The Supplier Integration Systems do support the tracking and tracing of messages (e.g. message delivery receipts). The systems do monitor their own performance as a "mail carrier". Also in some cases business rules trigger alerts when certain required data is not available or exceeds exceptional values. Higher levels of system intelligence are not expected. Back end systems are regarded to be more suitable for decision support.
The VAN structure with an external integration service provider is expected to provide more opportunities to increase system intelligence in combination with outsourcing services of the third party. But this is not yet put into practice.

Also concerning the *integration level* the case companies do not completely rely on the technology. It also often desired that there are manual checks of the messages by logistics professionals. This is illustrated by the Pharma1 respondent: "garbage in is garbage out and therefore messages need to be checked before they are sent". Especially with respect to the forecasts this is considered very important.

6.4.1 Case observations

In Table 19 the system intelligence and the back end integration level are summarized.

Company	System Intelligence	Integration level
Pharma1	Only in back end modules. Message delivery receipts and error notifications.	Batch delayed by manual checks before release of any message
Pharma2	There is an advanced planning module integrated. Also: Track and trace capabilities, message delivery receipts and error notifications.	Near real time, batched & delays by manual checks before release concerning planning
Packaging1	Message delivery receipts and simple Business rules only: resulting in error notifications.	Near real time and batch delayed by manual checks before release concerning planning
Packaging2	Minor system intelligent functions in first tier back end. Message delivery receipts and error notifications.	Idem as Packaging1
Truck1	Messaging only. There are delivery receipts and error notifications when delivery fails	Near real time and batch delayed by manual checks for some messages.
Truck2	Idem as Truck1	Idem as Truck1
Electronic1	Only in back end modules. The system only has message delivery receipts and error notifications.	Batch delayed by manual checks before release
Electronic2	The system only has message delivery receipts and error notifications.	Near real time, batched & delays by manual checks before release
Electronic3	The advanced planning capabilities of the logistic service provider are integrated with the sourcing system. This will allow for logistics optimization routines	Near real time, batched & delays by manual checks before release
Electronic4	The peer-to-peer (P2P) system has message delivery receipts and error notifications (exceptional values). The portal uses very strict business rules with most changes requiring special authorization. e-invoicing is purely transactional	Near real time, batched & delays by manual checks before release
FMCG	The system only has message delivery receipts and error notifications.	Batch delayed by manual checks before release

Table 19: System intelligence & integration level

The case observations can be summarized by the following:

- System intelligence is only applied to support in the form of exception notifications such as failed deliveries of messages or exceptional or missing data, because most of the required system intelligence is provided by back end systems
- Manual checks causing sharing delays and resulting in batch deliveries of messages are required to ensure information quality

6.5 Technology

The technological aspects of the structure discussed are the network type, the technology specificity and the process & data standards.

The *network type* used was either a dedicated phone line or the internet. The dedicated phone line is only used for the classical EDI systems in a system-to-system structure. The internet is used in most cases. It is the newer technology and provides more possibilities. The portal structure is only possible because of the internet.

The *technology specificity* says something about the agility of the system. More customized systems are generally more difficult to integrate with new partners and cannot benefit as easily from innovations in the software industry. Off-the-shelve software can benefit from software updates and is generally easier to integrate with new partners. But customization is often required because in some cases the off-the-shelve software does not fit the specific business needs. In all the cases there was a trade-off between agility and level of customization. To some degree customization always was required. The general IT policy and the availability of software at the initial phases of adoption are reported as the two most important factors in the decision. The general IT policy is important because it led to shortcuts in the decision making process. For instance in the Pharma1 case there is a very strong "SAP-unless" policy combined with an outsourced IT function. In others there is still a strong internal IT function combined with a strong legacy of home-made software. These two different legacies influenced the decision making strongly toward either (in the Pharma1 case) off-the-shelve software and in others such as Truck2 towards home made software.
The availability of suitable software is also important because software providers at the time of introduction did not always fit the requirements urging to build home made software or switching to smaller providers. This was the reason FMCG chose a small supplier in spite of their "SAP-unless" policy.
In the VAN structure with an external service provider the software is provided by the service provider.

The *process & data standards* are crucial in the use of any IOS. There are many different standards in use. The case companies prefer to use industry standards since this makes it easier to integrate with partners. But not all industries these standards are fully developed or accepted. Another complicating matter is that companies either operate in different industries or that their suppliers are from different industries. This is very dependent on the industry structure. In the automotive industry the use of standards is widely accepted. There is a strong organization (Odette), with representatives from the entire industry, which promotes integration through the development of these standards. Also in the automotive industry the supplier-buyer relationships are strong and long term. There is a collaborative culture. In the electronics industry the RosettaNet organization provides the de facto standards. In the packaging industry it is Papinet. Also SAP is now beginning to provide its own data standards.
The traditional EDI systems rely on standards based on EDIFACT. This is the older and more mature technology. In many of the newer systems the standards are based on XML. XML is considered cheaper, more transparent, easier to test, more flexible. It was mentioned in the

Electronics3 case: “XML is still developing and EDI is standing still”. Successful traditional EDI users (such as the Truck companies) will keep on using the traditional EDI standards. It is expected that this will gradually be complemented with XML standards. But it is not expected to be replaced by it.
The Pharma2 case is a special case. In this industry there were at the time of the initial adoption phases no real industry standards. Therefore they chose to create a special proprietary data standard based on ASCII. The internal IT department had to produce the home made software and was capable to create this proprietary standard. This was easier to implement (low key) then XML based standards. Because of the many different partners and their varying capabilities this was important (not everybody could support XML). ASCII could always be produced and processed (including by low tech partners). But ASCII messages sometimes are more prone to errors when people change the messages.

6.5.1 Case observations

The technological aspects of the structure are described in Table 20.

	Technology		
Company	*Network type*	*Technology specificity*	*Process & Data Standard*
Pharma1	Internet	Customized Off-the-shelve software. The organization has a SAP backbone	SAP Idoc (xml) because the entire company is SAP compliant and
Pharma2	Internet	Home made software with off the shelve middleware	Proprietary ASCII based data standard (automatically processed e-mail)
Packaging1	Internet	Off-the-shelve software with custom made components.	Industry standard: Papinet, UIM (XML based)
Packaging2	Internet	Home made and off-the-shelve middleware. Back end systems are very diverse, but mostly SAP	Industry standard: Papinet (XML based)
Truck1	Dedicated phone line	Off-the-shelve software is used. The back en ERP is home made.	EDIFACT from the Odette industry standard
Truck2	Dedicated phone line	Home made software is used	EDIFACT from the Odette industry standard
Electronic1	Internet and Dedicated phone lines	Off-the-shelve software. Very diverse across the company.	Proprietary and some industry standards There is a lack of industry standards, partially due to the diversity of suppliers and the divisions.
Electronic2	Dedicated phone lines	Home made and SAP backbone	Proprietary EDIFACT standard
Electronic3	Internet	The service provider arranges the software. This will be customized.	An XML based RosettaNet industry standard will be used
Electronic4	Internet	There is a SAP backbone. The peer-to-peer integration system is SAP based, the Portal is a customized SAP portal	RosettaNet industry data is used, SAP Idoc standard is used for the Portal, e-invoice will use the third party XML based standard
FMCG	Internet and dedicated phone line	The service provider’s own software is used for e-invoicing. Off-the-shelve software from a small provider is used for the Portal, although there is a SAP unless policy this smaller provider was chosen because at the time SAP’s ICH was not advanced enough. There is a SAP backbone and SAP middleware is used.	SAP based proprietary standard are used for the Portal, EDI standard is also proprietary, E-invoicing uses an XML based standard of the service provider

Table 20: Technology

The case observations can be summarized by the following:

- Using standardized and homogeneous software in backend and integration systems would ease integration, but customizations often remain necessary to align with the business.

- The legacy of systems strongly constraints feasible solutions.
- Companies stimulate the diffusion of industry standards because with widely accepted industry standards it becomes easier to integrate with your partners.
- While developments in XML based standards are considered promising, practitioners experience the same difficulties as in using traditional EDI standards

6.6 Supply and Relationship Context

The context is an important aspect of the Supplier Integration System structure. It also appears related to other aspects of the structure. The supply context and the relationship context are discussed here. They are listed in Table 21 and Table 22.

6.6.1 Supply Context

The supply context is related to the integration focus. In a plant-to-distribution focus the product types are mainly finished products, while in a plant-to-plant focus the product types are mainly components and other BOM items. Increasingly production is outsourced. Therefore there are many Contract manufacturers and more finished products are in scope. This generally reduces the number of partners. This allows economies of scale but it makes integration also more important to reduce the transaction costs. The outsourcing trend seems to stimulate Supplier Integration Systems as these systems replace the former hierarchy.

"The product types" in scope do seem to affect the adoption process indirectly. They play a role through their characteristics and through their supply market. The supplied product type affects the relationship (see section 6.6.2). Also the volume and the frequency of supplies, which are important criteria in the adoption process (also see section 6.2), depend on the supplied product type and the supply market for these goods. This is what makes suppliers important enough to invest in integration. The supplied product type also determines the commitment of this supplier to the industry of the buyer. In section 6.5 it was shown that a strong industry culture (such as in the automotive industry) is important to stimulate industry cooperation and the establishment of the important industry standards.

The integration of important suppliers is preferred. They are more often integrated and are integrated earlier in the adoption process. Besides delivering more supplies more often, these important suppliers are generally larger and more sophisticated in their IT capabilities. Therefore both benefits are higher and costs are relatively lower.

6.6.2 Relationship context

In most cases the relationship with the partners integrated in the Supplier Integration System are characterized by the respondents as long term and stable. This makes sense because the time to integrate a partner and the costs to do this are generally high. The time to accomplish integration varies between a few weeks in the best circumstances to a year in the worst cases. This depends greatly on the learning curve of the own organization, the diffusion of industry standards and the capabilities of the partner. In most cases the time to accomplish integration is at least a few months, after the contractual agreements have been made.

According to the respondents their relationship with their partners depends on the history together, the cultural match, the amount of relationship specific investments, the level of interdependency, the power distribution between them and the relative importance towards each other.

The commitment and trust in the relationship are important to get the cooperation of suppliers. This is also the reason that there is generally no flexible pricing mechanism

incorporated in the system. Prices are fixed, although rebates are possible when orders are for instance aggregated (larger). But this kind of arrangements are agreed and settled in contracts. Also the contract horizon is generally at least 1 year and often much longer. As was seen in section 6.2, the persuasion tactic in a climate of trust and good relationships is used to achieve cooperation of the partner.

Besides interdependency and trust in the relationship, buyer's power is also considered important in the relationship. The coercion tactic relies on this buying power.

6.6.3 Case observations

The supply context and the relationship context are listed in Table 21 and Table 22.

	Supply context	
Company	*Product types in scope*	*Supplier types*
Pharma1	All direct items are in scope. Order volumes and frequency is the key decision variable	Currently only larger contract manufacturers. Later also important suppliers of direct items. Partners are large companies. Their capabilities are sufficient
Pharma2	Finished products	Contract manufacturer and internal plant integrate with Partners (which are local affiliates)
Packaging1	Direct items: the range of items is not very large (10 to 20). They are highly standardized.	The paper mills rely on large economies of scale. Most are internal but some also external.
Packaging2	Highly standardized direct items	Paper mills rely on large economies of scale and require stability
Truck1	All truck components	Industry specific of all sizes. Also internal suppliers for most important components
Truck2	All truck components	Industry specific of all sizes. Also internal suppliers for most important components (e.g. engines)
Electronic1	Components and materials	Very Diverse: integration only succeeds with some. There are Contract manufacturers, material suppliers and component suppliers
Electronic2	Finished products and components	Aggregation of plants through internal suppliers.
Electronic3	Mainly components and finished products	Mainly contract manufacturers with high tech skills.
Electronic4	Portal and e-invoicing: BOM items include Chemicals, Metals, plastics and components. E-invoicing also includes MRO suppliers	Contract manufacturers, direct suppliers and indirect. Some are very specialized others are more generic
FMCG	finished products, components and ingredients	Contract manufacturers, direct suppliers and indirect. Some are very specialized others are more generic

Table 21: Supply context

	Relationship context	
Company	*Relationship type*	*Relationship asymmetry concerning integration partners*
Pharma1	Former colleagues/ long term / stable	The buyer can dictate terms. This buyers power is perceived essential to succeed
Pharma2	The affiliates are relative autonomic, but most are fully owned	Production / central management is the key power.
Packaging1	Very stable and long term, Integration is highly valued	External partners adept to the system. Internally the power is centralized
Packaging2	Very stable and long term, Integration is highly valued	The paper mills are decisive
Truck1	Stable and long term, also in development there is collaboration	Buyer power is relative strong, collaboration in the industry is strong
Truck2	Stable and long term, also in development there is collaboration	Buyer power is relative strong, collaboration in the industry is strong
Electronic1	As diverse as the supplier types. Ranging from arm's length to stable and long term.	Diverse: with some the buyer power is strong while with some the supplier power is strong. (depends market, product and supply characteristics)
Electronic2	Most are internal: therefore power politics are important. Plants do have an incentive to integrate but in higher levels of the organization it is not much supported	The affiliates are relative independent but have little power outside their part of the organization
Electronic3	Long term relationships, Personal contacts. (people know each other), joint product development, mutual investments, relationship specific investments are relative high, VMI (VMI is to be applied with all suppliers in the new situation.)	The interdependency is very high. This enforces a collaborative attitude.
Electronic4	Depending on the market characteristics, with some suppliers and especially sub-contractors there is a very good and long term relationship (Relationship specific investments are high >> switching would be costly). With others there is a more arm's length relationship	Interdependency with Contract Manufacturers is very high (power is divided). For other suppliers the buyer power is relative strong
FMCG	The relationship varies greatly. Some are arm's length and short term and other are much more stable and strategic. The integrated suppliers in general: are in more stable long term relations and are of more strategic importance. Especially contract manufacturers are among them. EDI system partners are the fast runners (high consumption)	Interdependency with Contract Manufacturers is very high (power is divided). For other suppliers the buyer power is relative strong

Table 22: Relationship context

The case observations can be summarized by the following:

- Important suppliers in terms of order volume and frequency are integrated first, because with them the greatest benefits can be achieved.
- Larger partners are usually integrated more successfully because they are generally more sophisticated
- Outsourcing manufacturing reduces the number of suppliers resulting in a smaller but more important supplier base.
- Supplier Integration systems are perceived to be critical to efficiently operate with contract manufacturers and to counter the disintegration caused by outsourcing manufacturing.
- Long term relationships, characterized by trust, and buyers power are considered important to achieve cooperation of suppliers

6.7 Adoption process

In Section 2.3.2 the generic phases in the adoption process were described. These are sequentially: awareness, attitude formation, decision making, implementation and confirmation. There and in Chapter 5 it was explained that the adoption process of IOS cannot be seen as a simple straightforward process. In the case interviews it became clear that the Supplier Integration System adoption process indeed can be characterized as a complex, organic, iterative process. They are not finished at once as they grow and evolve over time. This means that the starting point and the ending point of an adoption phase are not clearly recognizable. Organizations are shifting forward and backward between the various adoption phases. They also can be in a different phase at the same time for the various parts of the system's structure. This is best illustrated by the fact that in most cases the systems are not adopted in one big introduction but are gradually developed by starting with only a few partners and few processes and then later by adding more partners and processes. By going through the adoption process iteratively the organization goes through a learning curve. Another example is the technology used as for instance data standards are in constant development.

Some characteristics of each phase could be observed as respondents talked about the history of their system. In the following sub sections these are discussed.

6.7.1 Awareness and attitude formation

The cases made clear that awareness and attitude formation are tacit intangible processes. Through interactions with the environment the organization learns about new innovations and forms an attitude towards them. This happens both informally and formally. A formal way is illustrated by FMCG were a specialized department was created to study the possibilities of e-business. Partners, consultants, software vendors, new employees, academics and the media are reported to influence this process. It is clear that this is not straightforward and occurs dynamically. It is also only at best partially a rational process.

This is most frankly illustrated in the Packaging1 case. They started with integration systems during the highs of the internet-hype because of partner pressure. But it later became clear that at the time both the partners and the internal organization were not capable to integrate successfully. A long learning curve and some crucial changes were required before the system could become a success. This was one of the reasons that they started to use their Supplier Integration System for internal integration.

In the Electronic3 case the awareness and attitude formation was highly influenced by a newly hired senior manager who became the champion of a new Supplier Integration System. Coming from the military this person brought in much experience in logistics and started to advocate his view on logistics. He quickly found key supporters but also found large resistance to change.

Another example is the Truck1 case. New developments in logistics and EDI triggered the truck company to seek out EDI. Large government grants helped to push decision making in favor of the then new innovation of traditional EDI systems. Without these grants that stimulated industry wide collaboration, implementation would have been much more difficult.

6.7.2 Decision: costs, risks and benefits

The decision making phase comprises of both high level "go or no-go" decisions and decisions about detailed aspects of the structure. These decisions are based on the attitude that was formed before. The decision maker's attitude (or perception) towards a Supplier Integration System is (or should be) formed by the best possible estimation of the costs, risks and benefits of the system and its various aspects. In Table 23 and Table 24 the perceived and/or estimated costs, risks and benefits are listed for the various case companies. As was shown in section 6.7.1 the attitude formation was also influenced by other factors. It also

became clear during the interviews that both costs and benefits are difficult to quantify and specify. Decision making was therefore not always completely rationalized.

Perceived benefits of the Supplier Integration System	*Pharma1*	*Pharma2*	*Packaging1*	*Packagin2*	*Truck1*	*Truck2*	*Electronic1*	*Electronic2*	*Electronic3*	*Electronic4*	*FMCG*
More information can be handled				*V*			*V*				
Better quality information (more detail and better aggregated)	*V*			*V*						*V*	
Increased reliability of information	*V*			*V*						*V*	*V*
Faster communication	*V*	*V*		*V*	*V*	*V*	*V*			*V*	*V*
Reduction of lead times	*V*	*V*						*V*	*V*		
Reduction of errors	*V*	*V*	*V*		*V*	*V*	*V*			*V*	*V*
Standardization and alignment as a by product	*V*										
Reduced stock level	*V*	*V*	*V*	*V*	*V*	*V*	*V*	*V*	*V*		
Increased efficiency for partners >> leading to better prices	*V*										
Faster reactions on contingencies	*V*						*V*				
Increased visibility		*V*	*V*				*V*	*V*	*V*	*V*	*V*
Planning and forecasting abilities increase (advanced planning)		*V*		*V*							
Increased administrative and transactional efficiency		*V*	*V*	*V*	*V*	*V*	*V*			*V*	*V*
Cycle time reduction	*V*	*V*						*V*	*V*		
Increased deliver reliability			*V*					*V*	*V*		
Stock flexibility			*V*								
Product flexibility increased				*V*							
JIT concept becomes possible				*V*	*V*	*V*					
lower overhead costs									*V*		
Reduction of managerial complexity (smaller supplier base)									*V*		
Cost reduction finance department											*V*
Payments are faster										*V*	*V*

Table 23: Benefits

Perceived costs and risks of the Supplier Integration System	*Pharma1*	*Pharma2*	*Packaging1*	*Packagin2*	*Truck1*	*Truck2*	*Electronic1*	*Electronic2*	*Electronic3*	*Electronic4*	*FMCG*
Tuning master data is costly	*V*										
Many costly detailed agreements with each partner are required	*V*			*V*			*V*				
Operating Costs are unclear (hidden costs)	*V*	*V*	*V*				*V*	*V*		*V*	
Implementation Costs are unclear (hidden costs)	*V*	*V*	*V*		*V*	*V*	*V*	*V*		*V*	
High operating costs									*V*	*V*	
High implementation costs			*V*	*V*	*V*	*V*	*V*	*V*	*V*	*V*	*V*
Building and Maintaining interfaces is considered very costly				*V*							
Upgrades are costly				*V*							
Switching to another system is very costly and destroys capital					*V*	*V*					
System-, Network-, Message Sending / receiving-, errors				*V*							
When the system fails the plants runs out of stock very fast (JIT)					*V*	*V*					
Becoming dependent on service provider									*V*		
Partners make extra costs										*V*	*V*
Vendor lock in because of relationship specific investment										*V*	

Table 24: Costs and risks

6.7.3 Implementation

The implementation of a Supplier Integration System was in the case companies a prudent process. Usually a pilot phase started with only a few partners and processes. Partners and process diversity was later added gradually. A learning curve could be observed as the time to integrate each additional partner shortened. Formal evaluations are not reported. They

constantly occur informally though, as new attitudes towards aspects of the structure are constantly formed. Companies gain understanding about Supplier Integration Systems while they are engaged with them.

Prudence in the adoption process does not appear superfluous as most successful cases had a prudent approach while the large failed project at Electronics1 is an example of wanting to do too much at once.
The implementation of a Supplier Integration System has many similarities with large enterprise system implementations. Many processes, tasks and responsibilities must be changed to optimally benefit from the new system. Like in enterprise system implementations the organization undergoes a transformation. Resistance to change must be overcome. For instance in some cases the organizational culture is an impeding factor. In the Electronic2 case; the dominant culture is oriented towards technical product innovations and not orientated towards SCM. This is illustrated by the respondent: "New gadgets and technological innovations are cool, SCM is not".
Also the cooperation of partners is important during adoption. It seems that most success is achieved in the cases with stable and long term relationships characterized by a climate of trust. "The partner must be convinced that the change is beneficial" according to the respondent of FMCG.

6.7.4 Case summary on adoption

The case observations can be summarized by the following:

- Organizations are prudent in the adoption of Supplier Integration Systems
- Decision making is not completely rationalized as costs, risks and benefits are difficult to specify and quantify.
- The adoption of Supplier Integration Systems is an intangible and iterative process

6.8 Case conclusions

This chapter has treated the structure of Supplier Integration Systems and the relation with its adoption process from a practice oriented point of view, thus answering sub-questions 1d, 3b and 3c. The structure (answering 1d) has been treated extensively in this chapter. At same place in this chapter the explanation the respondents could give (answering 3c) for an aspect of their structure has been treated. The adoption process (answering 3b) has been treated in Section 6.7.

Although all case companies have adopted some sort of Supplier Integration System, the structures they adopted differ considerably. Three basic structures are observed and they are used in complementary ways. A Supplier Integration System can also be part of a larger supply chain platform offering more functions and features, also aimed at servicing the downstream supply chain.
The maturity of the case companies concerning Supplier Integration Systems varies greatly. It has become clear that among the studied cases the truck companies are most mature. But compared to what is theoretically possible the gap is even larger. The truck companies rely on traditional EDI which is the most mature technology. The case companies are not as mature as could have been. After all the internet hyped 10 years ago and classical EDI is more then two decades old. Many of the case companies do not have systems with a large breadth, volume or diversity, while the respondents say that they do pursue them. System intelligence, system flexibility and the integration level also could be much higher. But these levels seem to be more according to their current preferences.
Integration is clearly more difficult then the concept at first seems to indicate. Implementation costs are high and benefits are difficult to quantify. Concerning the technology and the legacy of integration and backend systems the path dependency is high. According to the respondents

this is caused by high switching costs and a strongly felt constraint of back-end and legacy systems.
Heterogeneity of partners and internal divisions is considered a large problem. The case companies operating in a single cohesive industry, having many dedicated partners and having a collaborative culture seem to integrate easier. Also in the cases a high level of integration internally is considered to be a prerequisite before one can integrate externally. But at the same time integration systems can help to integrate internally and help to enforce standardization. It appeared that the same systems are used for internal supplier as well as external supplier integration. The difference between EAI and B2B is small according to the respondents.
Most of the case observations are about the structure and the explanation the respondents could give for their situation. The adoption process itself was difficult to describe. But they could be characterized as a complex, organic, iterative process. They are not finished at once as they grow and evolve over time. This means that the starting point and the ending point of an adoption phase are not clearly recognizable. Organizations are shifting forward and backward between the various adoption phases. They also can be in a different phase at the same time for the various parts of the system's structure.

In the next chapter the findings presented in this chapter combined with findings from the literature study are discussed more comprehensively. Here in Table 25 and Table 26 the case conclusions from this chapter are listed. It must be noted that these are only the conclusions of this particular set of cases based on the answers provided by the respondents. They can not be instantly generalized to other cases.

Basic structures	The system-to-system structure is most difficult to implement but enables a high degree of integration
	The VAN structure can be combined with outsourcing services by an integration service provider but makes one dependent on a sometimes costly and not always competent service provider.
	The supplier portal structure is the most accessible structure but only provides partial integration, thus still requiring manual tasks.
	The three basic structures have distinct governance structures and are used in a complimentary way for both internal and external integration.
Breadth & volume	The truck manufacturing companies reach the highest breadth and volume using mature technology because of their longer engagement in Supplier Integration Systems, the collaborative culture in the industry, strong and long-term relationships, the wide diffusion of industry standards, the homogeneity in the industry and strong competitive pressure to produce efficiently.
	Internal integration reaches a higher breadth and volume then external integration, because it is considered easier and because it is considered a pre-condition of external integration
	Supplier Integration Systems breadth and volume levels evolve gradually based on a separate business case for each partner and usually starting with the most important partners first
	Partner cooperation is considered essential to achieve high breadth and volume and is achieved through persuasion and coercion tactics
Diversity	The diversity of information types and supported processes is increased gradually over time.
	The diversity of information types and supported processes varies among partners because of the different capabilities of the partner and the different requirements due to for instance the application of VMI with only a few partners.
	Invoicing is considered a more difficult process to integrate because in practice it varies more among different companies, faces different regulations in different countries and requires more trust in the partner
	Trust was reported as an important factor affecting the level of information sharing
System Intelligence & Integration Delays	System intelligence is only applied to support in the form of exception notifications such as failed deliveries of messages or exceptional or missing data, because most of the required system intelligence is provided by back end systems
	Manual checks causing sharing delays and resulting in batch deliveries of messages are required to ensure information quality

Table 25: Summarized case observations (part 1)

Technology	Using standardized and homogeneous software in backend and integration systems would ease integration, but customizations often remain necessary to align with the business.
	The legacy of systems strongly constraints feasible solutions.
	Companies stimulate the diffusion of industry standards because with widely accepted industry standards it becomes easier to integrate with your partners.
	While developments in XML based standards are considered promising, practitioners experience the same difficulties as in using traditional EDI standards
Relationship Context	Important suppliers in terms of order volume and frequency are integrated first, because with them the greatest benefits can be achieved.
	Larger partners are usually integrated more successfully because they are generally more sophisticated
	Outsourcing manufacturing reduces the number of suppliers resulting in a smaller but more important supplier base.
	Supplier Integration systems are perceived to be critical to efficiently operate with contract manufacturers and to counter the disintegration caused by outsourcing manufacturing.
	Long term relationships, characterized by trust, and buyers power are considered important to achieve cooperation of suppliers
Adoption Process	Organizations are prudent in the adoption of Supplier Integration Systems
	Decision making is not completely rationalized as costs, risks and benefits are difficult to specify and quantify.
	The adoption of Supplier Integration Systems is an intangible and iterative process

Table 26: Summarized case conclusions (part 2)

7 Conclusion and Recommendations

In the last three chapters the sub-questions posed in chapter 3 have been answered. In this chapter these answers are used to answer this study's main research question.

What is the impact of Supplier Integration System adoption processes on Supplier Integration System structures of manufacturing companies?

By answering this question our understanding of Supplier Integration System structures and where they come from, can be improved. This chapter will give some answers to this question in two ways. First in section 7.1 the conclusions of this study will boil down to a refinement of the adoption process model, as was suggested in Section 3.1.2. This refined model should give more insights in the adoption process and its impact on the structure. Naturally this is constraint by the limitations of the study. Then this chapter finishes with the recommendations for practitioners and future research projects.

7.1 Conclusions

This section deals with the structure and the adoption process of Supplier Integration Systems and the relation between the two. The conclusions on the structure are first explained in Section 7.1.1. Then in Section 7.1.2 the conclusions on the adoption process are presented. This includes refinements to the second order factor model of adoption. The conclusions on the impact of this adoption process are discussed in Section 7.1.3. Finally the limitations of these conclusions are discussed in Section 7.1.4.

7.1.1 Structure

This study demonstrates that Supplier Integration Systems do not have a uniform structure as this sample of eleven cases contains various structures. Three basic structures could be observed and these basic structures could be complemented with a range of characteristics to distinguish individual systems. Systems are used to integrate internal supplier as well as external suppliers

The structures of the studied companies can be considered dynamic. While the basic aspects of the structure remain the same during its entire life cycle, many aspects change. The cases suggest that Supplier Integration Systems usually start small and usually end up with more volume, diversity and breadth. Some case systems are also expected to evolve more in this respect. Also in the cases the technologies in use are updated during the systems life cycle. The evolving nature of the Supplier Integration System structures observed in this study should be confirmed by more studies before this can be generalized though.

It is noticeable that the Supplier Integration System structures in the studied cases are less advanced and less comprehensive then could be expected when looking at theoretical possibilities and the reputation of the companies. The cases used in the study are selected because these companies are the usual suspects to have sophisticated integration systems. They are very large multinationals with much resources and a strong presence in their markets. They are leading companies and could benefit much from high integration levels. But in terms of breadth, volume and diversity most case companies are not mature. Especially invoicing has a very low support rate. And many of the systems focus on the internal suppliers because this is thought to be easier as internal partner cooperation can be enforced by top management. Also system intelligence is limited to monitoring of messages and some notifications of errors and exceptional values. System intelligence in terms of for instance decision support or smart agents supporting planning negotiations and exception handling

seams a far fetch. The integration level is usually not real time as information is often sent in batch messages and delayed due to manual checks. The systems are rigid as changing partners and changing processes, usually takes months and in the best cases weeks. Dynamic pricing mechanisms or flexible sourcing mechanisms were considered not possible.

It can be concluded that there is a variety of Supplier Integration System structures, which are used by companies in a complimentary way. Also it can be concluded that these structures can have an evolving nature and that there are still companies having less advanced structures then could be expected.

7.1.2 Adoption process

The current system structure and its evolution are determined by the adoption process. In this study the adoption model of Kurnia and Johnston [24] was used (also see Chapter 5). The results justify an extension of their model, but they also indicate that most elements can be confirmed.

The process logical aspect of adoption is the most evident element that could be confirmed. The case studies showed that it takes time to arrive at their specific structure. All the cases were projects taking years. They were undergoing significant changes to their structure during their adoption. During this process the organizational actions are influenced by many kinds of factors and at the same time the organization is changing itself and its environment. Also over a longer period of time it becomes clear that the significance and nature of factors change over time. They can only be seen as conditions that may lead to adoption.

The emergent aspect of the adoption process is also confirmed. The case companies are not in total control of their environment, but are not helpless victims either. Deliberate actions and strategies to influence the environment and partners, to improve the organizational capabilities and to adapt the nature of the technology are successfully applied in practice. Prime examples are the active involvement in industry associations to develop industry standards and the tactics to achieve partner cooperation. But also opportunistic as well as helpless behavior occurs. Companies seize opportunistically the right moment to implement their structure. Take for instance the case example where SAP developed a new integration module resulting in the implementation of this integration model at some of the case companies and the Truck company seizing government grants to help finance their integration system. But companies also blindly follow hypes and partner pressure, as the respondent of the Packaging1 company dared to admit.

The firm/inter-firm aspect of the Supplier Integration System adoption process and structure also was confirmed. The inter-firm level appeared to be an important part of the structure. In this plane the system is situated and success factors such as partner cooperation are influenced by the firm with persuasion and coercion tactics. Therefore the choice to distinguish the categories “Environment”, which cannot be influenced by the organization, and “Supply Chain / Industry Structures”, which can be influenced by the organization, is supported. This does not mean that the intra-firm level of analysis is not important. In some of the studied companies the internal supply chain is the primary integration focus.

The results of this study also justify an extension of the model. In Figure 15 the second order adoption model by Kurnia and Johnston [24] is adapted to fit the results of this study (compare Figure 10). Four changes in the model are proposed.

1. The case studies show that the assumption of a dichotomous outcome of the adoption process is an invalid simplification of reality. As was explained in section 7.1.1 the case studies show varying and dynamic structures. Companies do not arrive at their ultimate

structure at once. It takes time to arrive at a certain structure and during further iterations of the adoption process the structure keeps changing. In Figure 15 this is represented by the box tagged “a Supplier Integration System structure”.

2. This study showed that an implemented Supplier Integration System structure can impact the organization and its environment and may lead to new innovations in the technologies used. A possible explanation, confirmed by the respondents, is that organizations and partners go through a learning curve as they gain experience with using Supplier Integration Systems. As they and their partners gain experience they can and will improve for instance the industry standards they are using. Also other influences on the relationship are noticed in some of the cases. Because of the mutual relationship specific investments involved in the Supplier Integration System the relationship was strengthened and partner trust was increased. In Figure 15 this is represented by the extra arrow pointing back from the box tagged “a Supplier Integration System structure”.

3. The results show an evolving and iterative adoption process. It is almost impossible to pin point the end of the adoption process, because during the systems life cycle changes to the structure remain occurring. Therefore the adoption process can be considered a cyclic and iterative process. In Figure 14 the adoption process is schematically depicted. While the original model [13], already discussed in Section 2.3.2., also is explained having an iterative nature, the representation is linear. To emphasize the cyclic and iterative nature of adoption, the figure is a circle. This figure can be illustrated by the example of the Truck cases. Their current data standards are not the same as they started with. They had implemented their EDI-system, but at a later point in time they became aware of new developments concerning the industry standard. They formed a positive attitude and decided to implement it with key suppliers. It turned out to be a positive change and more partners were beginning to use it.

Figure 14: Adoption Process (with adaptations [13])

The circle in Figure 14 is used in Figure 15. The organization’s actions are represented by the circle in the middle. The circle is the smaller version of Figure 14 with the five phases of the adoption process. It is meant to represent the dynamics and iterative nature of the adoption process. Companies are at different levels of analysis involved in different phases of the adoption process. In every phase the factors impact organization’s actions and the organization’s actions impact these factors. These actions may lead to the adoption of a specific Supplier Integration System structure. But from the adoption and use of this system the organization and its partners learn through the formal and informal evaluation of the system and the actions performed. These organizational learning actions impact the factors. Therefore there is an arrow added that points from the “Supplier Integration System structure” back to the circle.

4. The factors are adapted to the specific situation of Supplier Integration System adoption. These conditions affecting the organization's actions are listed in the boxes in Figure 15. They are grouped according to technology, organization, environment and industry structure like in the original model. These categories represent a wide number of factors, which are only summarized by the lists here. While the precise factors are not exactly the same as in the original model they confirm the original argument that factors must be seen as conditions that may lead to adoption. Therefore this model does not presume to present a complete list, nor does it mean to suggest that all the factors are always important. Also each factor can manifest itself in different ways and many factors are related and/or impact each other.

External factors are the only factors, like in the original model, the organization has no real direct influence in. But these factors do impact the organization's actions. Government regulations are important because they set constraints. The government may also provide support in the form of grants or knowledge like in the Truck1 case. A competitive and global marketplace and low efficiencies forces companies to change like in the Electronic4 case. The current outsourcing trend and the integration efforts are both directions of this change. Outsourcing, as illustrated in the Electronic3 case, is also an example of a socio-economic trend that both forces and eases integration.

The perceived **nature of the technology** is a set of conditions the organization can affect to a certain extend but also strongly impacts the organization's actions. The integration benefits are the perceived benefits of integration (see Table 23 in Chapter 6) and are the prime reason to adopt a Supplier Integration System. The compatibility with the business objectives factor reflects the strategic relevance of integration. Execution flexibility (the effort required to integrate another partner) is an important aspect because it is required to achieve high breadth and volume and because it decreases the partner switching costs. This in turn depends on the basic structure, organizational capabilities (especially integration experience) and the diffusion and use of industry standards. Developing flexibility is the degree and costs to which new functionality can be added. This is important to achieve diversity (see Section 6.3). Like benefits the costs and the perceived risks are important in any business case. The costs to implement the new system and to operate the system are important but difficult to specify (see Section 6.7.2).
The conditions in this category can be affected by dedicated teams exploring e-business opportunities, external expertise, research and development.

The **capability of the organization** is a set of conditions the organization can affect strongly but also impacts the organization's actions. Top management commitment, clear strategic vision, communication openness and organizational flexibility are critical for the organizational transformation. This could be compared with any major enterprise system implementation. The required skills of the staff and partner staff are enhanced by adequate training and education capabilities. Performance measures are required for the evaluation the system. To adopt a Supplier Integration System it is a pre-condition to have adequate IT infrastructure internally. This is also the reason that integration of the internal supply chain is considered a pre-condition before external integration. Integration experience represents the learning curve of the organization. As companies gain experience their capabilities increase.
The conditions in this category can be affected through the development of vision and support by top management, hiring external expertise and change management.

The **Supply Chain / Industry Structures** represents a set of conditions which are external to the organization but still can be affected. This category strongly affects the adoption process as was shown in Section 6.6. The relationship in terms of power and trust is important to achieve cooperation and enhance the breadth, volume and diversity of the system (see Section 6.2 and 6.3). Also when partners can benefit they are more likely to cooperate. The

capabilities of the partner organization determine the costs to integrate. The diffusion and use of industry standards (see Section 6.5) is a very important factor because through network effects the value of using this standard would increase when more partner use the standard. It also increases execution flexibility.
The conditions in this category can be affected by active involvement in industry association and relationship specific investments. The implementation of a Supplier Integration System itself was also affecting this category through its relationship specific investments, organizational learning by partners and possible vendor lock in.

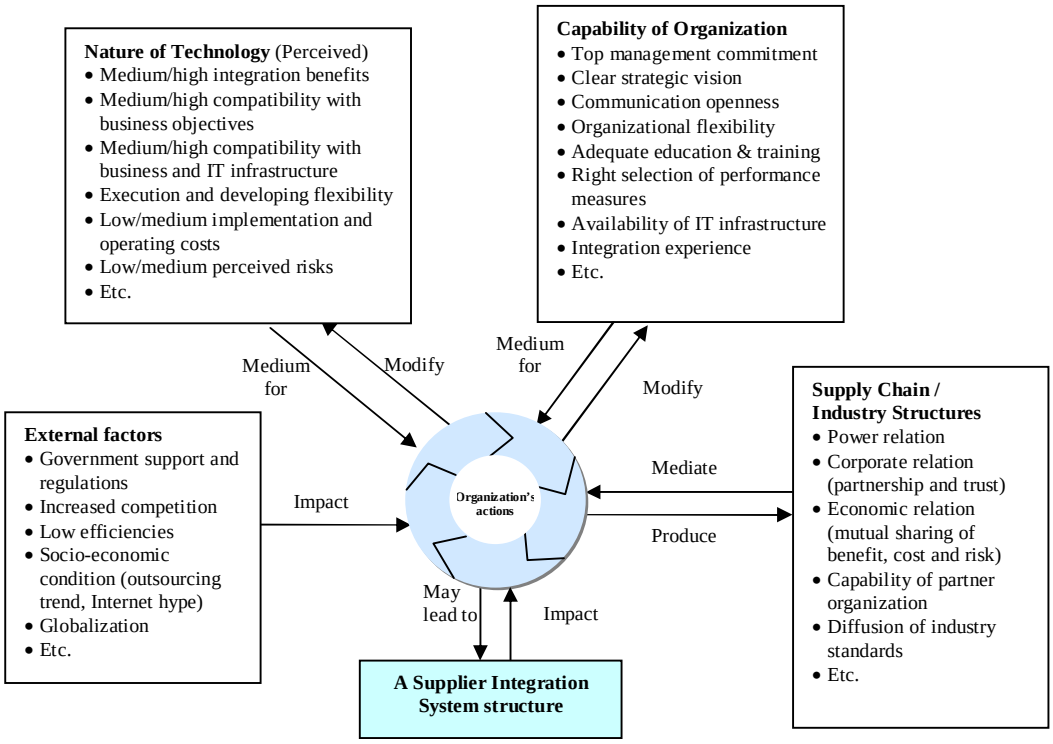

Figure 15: Extended adoption process model

7.1.3 Adoption process impacts on structure

It is not possible to tell exactly what *the* impact of *the* adoption process is on *the* structure. A conclusion from this study is that there is not one single path to arrive at a certain Supplier Integration System structure. The case companies arrived at similar basic structures in different ways. Some companies took more deliberate actions to exert their influence, while others behaved more opportunistically. But also the question what the optimal structure is in a given situation, taking into account the possibilities to positively affect this situation and the costs to achieve this structure, could not be answered conclusively. In general the respondents consider higher breadth, volume, diversity, and flexibility positive. Although benefits are difficult to quantify and costs are difficult to specify, higher breadth, volume and diversity are thought to increase the benefits from integration at decreasing marginal costs. Flexibility is considered important because the structure must be adaptable to changing circumstances (e.g. a changing market).

The impacts of the adoption process comprise of the deliberate actions of the organizations and comprise of the opportunistic reactions to the conditions (the factors in Figure 15). While no conclusive answer can be given on the complete impact of the adoption process on the

structure, the cases indicate some impacts, concerning specific aspects of the structure. The following explanations could be synthesized from the case studies:

The **basic structure** of the studied systems is mainly determined by the perceived nature of the technology. The portal-structure is easy to implement and is a very flexible technology when compared to the other structures. But the relative advantage of the other two basic structures is the higher degree of integration resulting in higher operating efficiencies.

The **breadth and volume** of the studied systems is mainly determined by the cooperation of the partner and the costs to connect a partner. Cooperation can be stimulated through persuasion and coercion tactics. This is mediated by the nature of the relationship. The relationship can be characterized by the power distribution and level of trust. Coercion tactics work best when there is much buyer's power. And persuasion tactics work best when the relationship is based on high levels of trust. The costs depend largely on the skill and infrastructure of all the involved parties, the existence and use of an industry standard, the execution flexibility, the basic structure type and the level of cooperation. Industry standards can actively be promoted in industry associations. Furthermore the cases show that achieving high breadth and volume takes time.

The **diversity** of the studied systems is mainly determined by the expected costs and benefits of adding a process and/or information type and the nature of the relationship. Costs and benefits are contingent on the specific situation. Costs depend largely on the skill and infrastructure of all the involved parties, the existence and use of an industry standard and the level of cooperation. Industry standards can actively be promoted in industry associations. Cooperation can be achieved through persuasion and coercion tactics. In the cases trust was an important factor positively affecting diversity (see Section 6.3)

The **flexibility** of the studied systems is mainly determined by the diffusion and use of industry standards, the organizational capabilities of all the involved parties and the basic structure type. Experience with the system in terms of a positive learning curve was reported to enhance flexibility.

The **integration partner selection** in the studied cases is mainly determined by the costs and benefits of integration with the specific partner. Benefits are dependent on the order volume, frequency and to some extend value of the items (because stock reduction of valuable items reduces inventory costs more). Costs consist of the implementation costs and the operating costs. The costs depend largely on the skill and infrastructure of all the parties, the existence and use of an industry standard, the execution flexibility, the basic structure type and the level of cooperation. Internal supply chain partners are generally preferred because this is considered easier and a pre-condition.

The **technology** of the studied systems is mainly determined by the perceived benefits, the legacy (compatibility) and the future expectations of the technology. The standards used depended largely on the diffusion in the industry as the perceived value of the standard increases with its acceptance among trading partners. The studied companies prefer an industry standard and actively promote this in industry associations. Path dependency and network effects are confirmed by the cases.

7.1.4 Limitations

Some limitations of this explorative research project are the equivocal results and the lack of conclusions that can be generalized for every large company. This is in part caused by the nature of IOS adoption as a complex process and in part by the explorative and qualitative nature of the research approach. The small number of cases does not qualify for a statistically significant conclusion. The reader should therefore not blindly jump to conclusions and

remain prudent. That being said the reader can use this model as its use is illustrated in this thesis. Here some general comments on the applicability are provided.

The refined model is based on a more generic model of inter-organizational systems. But the study focused on large manufacturers and their suppliers and on the integration of operational processes. The integration focus might not matter much to the applicability of the model in other supply chain situations. More downstream or upstream the supply chain the conditions likely have a similar nature. But integration systems that concern the integration of tactical processes are likely to face different conditions.

Furthermore the research method also caused some limitations that should be heeded.
The selection of the cases and respondents limits this research to some degree. The studied companies are all very large multinationals. Small and medium sized companies could have a different adoption process as it is likely that they are less able to influence their environment. Most of the case companies have a European background and all the respondents are Dutch. This could have caused some bias to the European/Dutch perspective. This is countered by the fact that all the companies are global. Finally the respondents are professionals with responsibilities overlapping the subject. This made them subject matter experts but could also have biased their perception too positively.

Finally it should be noted that the case studies could not be optimally examined. In only four of the eleven cases more then one respondent was interviewed. This could have caused a bias to the soul respondent's perceptions, although this bias could not be found in the data. The respondents were subject matter experts within their organization. Therefore it can be relative safely assumed that their statements about the current status and facts correspond with reality. But answers with causal statements are probably more biased by the perception of the respondent. Also due to the semi-structured nature of the interviews the bias of the researcher could have influenced the respondent's answers. Especially concerning factors and results this could have caused a bias in the answers.

7.2 Recommendations

The contribution of the study ultimately converges in the recommendations to others. The thesis targets an audience of practitioners and academics. In this section the practitioners are helped with some recommendations about how to apply the model and the lessons learned from the case studies. Then the recommendations to academics are discussed in terms of future research.

7.2.1 Practitioners

The refined model of adoption should help practitioners to better understand their own Supplier Integration System adoption process. This section explains how practitioners can use the results of this study. First the considerations with respect to what one would want to achieve are discussed. This is followed by a reflection on the organization's actions to achieve the desired structure.

The question for companies, which fit in the case study profile, should not only be whether or not to adopt a Supplier Integration System but rather it should also question what structure would be optimal. The Supplier Integration System structure one would want depends on the situation, taking into account the possibilities to positively affect this situation and the costs to achieve this structure. In general higher breadth, volume, diversity, and flexibility are considered positive, although benefits are difficult to quantify and costs are difficult to specify. The most successful cases in this study, which are the truck companies, achieved a breadth and volume of over 80 % combined with high diversity and relative high flexibility in

their industry. Ultimately this would probably be a good objective for any company that fits in the case study profile, as the truck companies can be considered best practices.

To achieve this best practice one can use the refined adoption model presented in this study. But one should approach the adoption as a complex and long term project and take small steps forward. The following steps should be followed through:

1. Use the adoption model as a checklist to analyze the situation.
2. Identify the conditions, which are not met, and develop deliberate actions to meet them.
3. Weigh the costs and benefits of these deliberate actions and alternative opportunistic behavior (seizing the right conditions at the right moment).
4. Based on this analysis, choose changes in the structure(s), taking into account that different structures are also successfully used in a complementary way.
5. Repeat the previous four steps

When following these steps some recommendations, which would hold in most cases, could be provided:

1. Choose the Portal-structure when you prefer low implementation costs and lower risks over lower operating costs or when the capabilities of most partners are at a low level.
2. Choose the System-to-system structure when you prefer high integration benefits over higher implementation costs or when there is a widely diffused industry standard.
3. Choose the VAN-structure when you want to benefit from integration services, high integration benefits and higher execution flexibility against extra operating costs.
4. Choose important suppliers (in terms of order volume, frequency and value) to integrate first.

7.2.2 Future research

Based on the results from this study future research can contribute by studying tactics and their effectiveness, by studying the structure in relation to firm performance, by studying the impact of the Supplier Integration System on the Supply Chain structure and by studying how to achieve flexibility. Future research can also contribute by improving the adoption model.

In this study several tactics were encountered to positively affect the situation. The coercion and persuasion tactics to achieve partner cooperation, the use of innovation teams to study new developments, the active participation in standards associations are prime candidates to be studied for their effectiveness.

It became clear that it is difficult to quantify and specify both costs and benefits of a Supplier Integration System structure (see section 6.7.2). What would be the best structure depends on many factors. It would therefore be interesting to sort out the impact of a structure as a whole. Some crucial aspects such as breadth, integration level and flexibility could then be specifically studied to find their impact on firm performance.

When the Supplier Integration System is placed in the inter-firm environment it is likely to have an impact on the Supply Chain structure. The relationship with partners could be improved and there could be a shift in power or trust. Also the economic relation could be affected as switching costs could increase. Therefore the impact of the Supplier Integration System on the Supply Chain structure would be an interesting subject to study.

It became strikingly clear that it still takes a lot of time to integrate with partners or to change functionality, while flexibility is important. How to improve this flexibility is a technical and organizational problem.

Future research can improve the adoption process model by studying the adoption phases separately. Some conditions could be more important in earlier adoption phases then others while other factors are more important in the implementation phase.

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