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1 Management summary

The following report presents the Interoperability Impact Assessment Model (IIAM), part of the B3 work package. The aim is to develop a methodical framework to understand how interoperability creates value and, if possibly, quantify the benefits resulting from interoperability improvements. Together with the Business Interoperability Framework (BIF, DB3.1), the IIAM will be used to assess the Athena pilots in the Athena Impact Assessment deliverable (AIA, DB3.4).

A review of relevant research insights about interoperability and its role on supply chain efficiency is provided in chapter 2. On the basis of the resulting research challenges, we develop the core IIAM in chapter 3. This analytic framework builds upon transaction costs theory and causal analysis in order to identify the resulting benefits of interoperability and understand their origin. We develop thereby a concept to integrate IT-related costs into the general transaction costs theory and propose a pragmatic method to operationalize transaction costs at a firm level. The impact of interoperability on businesses is further broken down into a strategic and an operational impact. Based on the case studies, we state that interoperability acts as an improvement driver at a company’s boundaries (operational impacts). Nevertheless, the beneficial effects of interoperability at a company’s boundaries also impact the strategic positioning of the firm. We develop therefore a method to link the direct, classical, effects of interoperability with their contribution to the achievement of a competitive strategy and identify some potential interoperability impact patterns.

Finally, chapter 4 applies the framework to practical case studies performed in the chemical and healthcare industries in order to validate the concepts underlying the framework. While the first case study illustrates the relevance of separating the operational from the strategic impacts, as well as the lack of balance in the sharing of interoperability benefits, the second case study on business interoperability shows the critical role of governance structures in realizing interoperability concepts.
2 Introduction

Recently, interoperability is emerging as a new field of research. It comprises technological concepts – such as Semantic Web and service-oriented architecture – as well as methods and architectures – e.g. model-driven architecture – which facilitate end-to-end-integration in heterogeneous environments. It is often postulated that interoperability of information systems will generate numerous business opportunities and business solutions. This might mean new or improved products and services (e.g. through the combination of physical products and electronic services from different partners), new ways in which business partners can cooperate (e.g. collaborative product design or collaborative maintenance) and more effective management of value chains (e.g. through real-time monitoring of distributed supply chains). However, a comprehensive evaluation of the business impact of interoperability is still lacking.

The B3 work of Athena project focuses therefore on long-term interoperability research from a business perspective. The overall B3 objectives can be restated as:

To
- Develop a general model for determining the impact of interoperability on businesses,
- Apply this model to ATHENA for assessing the business impact on ATHENA results,

So That
Policy recommendations on interoperability can be derived for the European Commission.

To achieve this, the three main action plans for B3 consist of:
1. Development of the Business Interoperability Framework (BIF, DB3.1)
2. Development of the Interoperability Impact Analysis Model (IIAM, DB3.3)
3. Application to the frameworks to Athena results and assessment of the project’s impact (Athena Impact Assessment, AIA, DB3.4)

The current document details the IIAM and seeks to provide answers to the following questions:
- How does interoperability impact the firm and its value chain?
- How can the value of interoperability be identified and, if possible, quantified?
- How can non-quantitative strategic dimensions be integrated in a structured fashion?
- Is it possible to derive some general impact patterns?

The document will be organized as follows. Section 2 will first address the relevance of research on interoperability in the context of networked enterprises. In order to illustrate prior research achievements as well as upcoming challenges, an overview of research related to interoperability as well as INSEAD’s research on the impact of information technology on productivity and agility will be provided.

On the basis of these insights, B3 partners have developed a set of concepts to understand the impact of interoperability on the efficiency of business relationships. Section 3 will present the theoretical fundaments and the application logic of the Interoperability Impact Assessment Model. In order to better understand what interoperability means on a practical level, it is very important first to understand why interoperability is an issue for the value chain stakeholders at all. For this purpose, we will show in section 3.1 that interoperability problems occur because information is neither perfectly available nor fully processable for the human actors (bounded rationality). This so-called “information impactedness” (Williamson, 1975) is the source of transaction costs that will, in this context, be encompassed into our impact analysis.

Section 3.2 will present the dimensions of the Interoperability Impact Assessment Model. We specify thereby two levels of investigation: the direct operational impact and the strategic impact of interoperability improvement measures. While the operational impact is based on transaction costs theoretical insights, the strategic impact analysis relies on the “strategy maps” concept of Kaplan and Norton (2004). This differentiation of the impacts has been justified by the fact that most of the benefits from better interoperability are not located at the interface between two companies but are to be found in a better strategic position for one or both trading actors. These benefits might stem from an improved value for the customer, an increase of the competition on the procurement side or might result from a step towards operational excellence.

Since the Athena pilots allow us to draw only preliminary conclusions on how the value of better interoperability is distributed along the supply chain, we provide in section 3.3 an extensive literature overview on how the benefits of better information have been shared in other practical cases. We notice that external contingencies such as market power will determine the beneficiary of interoperability
improvements and provide insights into the conditions of success for the rollout of interoperability solutions.

To illustrate the relevance and benefits of the Interoperability Impact Assessment Model, section 4 will present two case studies providing an application of the IIAM. We point out that the case studies presented in this report are the results of Athena research performed in collaboration with private firms interested in solving interoperability issues. Selected Athena pilots will be assessed with help of the same methodical framework in the Athena Impact Assessment deliverable DB3.4.

![Diagram of IIAM deliverable, graphical overview](image_url)
3 Motivation and prior research

3.1 Motivation for interoperability impact research

Given the vision of the ATHENA consortium that “by 2010, enterprises will be able to seamlessly interoperate with others”, technical interoperability of software applications will generate numerous business opportunities and business solutions. This might mean new or improved products and services (e.g. through the combination of physical products and electronic services from different partners), new ways in which business partners can cooperate (e.g. collaborative product design or collaborative maintenance) and more effective management of value chains (e.g. through real-time monitoring of distributed value chains).

Whereas most of the existing frameworks and standards cover the technical aspects by suggesting standards for presenting, collecting, exchanging, processing and transporting data, a systematic analysis of business issues associated with interoperability of organizations is lacking. The current document fulfils a part of this void via the detailing of interoperability impact analysis. Prior to starting with the analysis, it is necessary to clarify two main keywords that will be often mentioned in the following: Business interoperability and Value of interoperability.

3.1.1 Business interoperability

Business interoperability is defined as the organizational and operational ability of an enterprise to cooperate with its business partners and to efficiently establish, conduct and develop business relationships with the objective to create value. We point out that this definition goes beyond the IEEE (1990) definition to the extent that ability of information systems to exchange messages also depend on the organizational ability and willingness to retrieve and transfer this information. We recall that IEEE defines interoperability as the “ability of two or more systems or components to exchange information and to use the information that has been exchanged”. The insights of transaction costs theory (see section 3.1) will help the reader understand why interoperability is not limited to electronic information exchanges although IT plays a great role in improving the way firms interact with each other. We refer to the Business Interoperability Framework (BIF) (HSG/Athena, 2006) from HSG for a detailed analysis of the layers impacting business interoperability. In the remainder of the report, the keyword “interoperability” will relate to the “business interoperability”.

3.1.2 Value of interoperability

Since interoperability describes the ability to electronically cooperate with external partners, it represents a state for which it is difficult per se to define what its value is. Nevertheless, the value of being more or less interoperable than you are now has a value than can be derived through an As-Is/To-be benchmark. The value of interoperability needs therefore to be assessed “dynamically”. We will furthermore assume that this change is accompanied by given investments that can be either (see BIF):

- **Cultural.** Bensaou and Venkatraman (1995) point out that the willingness to exchange information is triggered by a common understanding of the problems faced by the partners as well as trust. In order to improve the information flow, inter-organizational team-building activities are performed to learn from each other. Furthermore, some workers are placed on the sites of the partners to improve cultural understanding and solve problems directly without any delay.

- **Organizational.** Next to cultural investments, one might reengineer the process in order to improve its efficiency. As Hammer and Champy (1993) notice, the evolution of processes tends to be frozen while their environment (i.e. customer requirements, available technologies, etc.) is steadily evolving. In an extreme fashion, the authors recommend to downsize the old organization in order to avoid hierarchical intermediaries. The prior information workflows could be overtaken in this case by information systems, not only within a company but also at its borders.

- **Technical.** Logically, the last investment type concerns the building of an infrastructure to support the processes and may range from the setup costs for an exchange platform or to the establishment of a web-based coupling of information systems.

For this purpose, the Business Interoperability Framework aims at describing the change of business interoperability state subsequent to an interoperability investment (in other words, a change of profile in the BIF). Cultural investments will be covered by the “Management of external relationships” and the “Employee and Culture” layers of the BIF, while organizational investments will be encompassed in the “Collaborative business processes” layer of the BIF. Logically, technical
investments will be addressed in the BIF’s “Information systems” layer. On the basis of this interoperability change, the Interoperability Impact Assessment Model will assess the operational and strategic benefits of this investment for the supply chain stakeholders.

![Interoperability Framework and Impact Assessment Model](image)

**Figure 2: Interoperability impact assessment, dynamic view with BIF and IIAM**

In the next section, some preliminary research insights concerning the dynamics of interoperability will be presented.

### 3.2 Research insights on agility and interoperability

#### 3.2.1 Empirical interoperability assessments: a review

Although the literature on information technology and especially on the impact of inter-organizational systems has been steadily growing for the last 20 years, the specific research on interoperability is very focused on technological aspects. Surprisingly, very few publications have been addressing the impact of interoperability on businesses. According to the literature available, we can structure the interoperability research into four main analyses: NIST (1999)/Danziger et al. (2003), Nelson et al. (2002) and Gallaher et al. (2004).

To the knowledge of the authors, the first main analysis was performed by NIST (1999), who investigates the costs of lacking interoperability in the US automotive industry. In the report, the sequel costs of low interoperability are estimated at 1 billion dollars per year for the US industry, from the car manufacturer to the smaller third and fourth-tier suppliers. To obtain a detailed cost breakdown, NIST differentiates interoperability cost between avoidance, mitigation and delay costs which are defined as follows:

- **Avoidance costs** are the investment expenses in interoperability done to avoid future costs.
- **Mitigation costs** represent the avoidable costs through the interoperability investments in data standardization and repository. Mitigation costs encompass the opportunity costs such as additional coordination efforts between partners or additional construction/destruction expenses.
- **Delay costs** occur when the US carmakers and their suppliers are not able to put their products on time on the market and therefore forego sales and/or lose market share against non-US competitors.

On the basis of this analysis, Danziger et al. (2003) make an attempt to estimate the costs of lacking interoperability in the North American automotive industry. Using a conservative estimation, the authors come to the conclusion that an inventory visibility solution adopted by the main actors in the 1st, 2nd and 3rd tier chain would achieve savings of $295 million on inventory and freight costs and savings of $198 million on the supply chain coordination process and interoperability tool maintenance. On the basis of 16 million passenger cars manufactured in the US, this would amount for about $31 per car.
Gallaher et al. (2004) investigate the costs of lacking interoperability in the US capital facilities industry. In their macro-economic study, the authors encompass the total life-cycle of facilities, from the design phase to the facility management phase. The scattered structure of the facility industry consists of a nexus of thousands of architects, construction companies, facility managers and service providers. The difficulty stems from the fact that each actor uses specific software and semantics to communicate and cooperate with other partners. With means of an empirical study, the authors intended to filter out the costs resulting from the inadequacies between information exchanges needs and current practices. Gallaher et al. apply the same cost structure as NIST but customize the scope of delay costs to the construction industry. Delay costs occur here when the construction company and its suppliers have to pay compensations to the buyers or users of facilities in case of a late delivery.

The authors break the analysis down into three dimensions: partner type, cost type and life-cycle phase. Interestingly, the authors find out that the main “victims” of interoperability are not the stakeholders developing or constructing the facilities (which have already some rudimentary data exchange procedures). Surprisingly, 60% of the total interoperability costs, 9 billion dollars (for a total $15.8 billion / year) are carried by the owners and operators of houses and commercial buildings which do not have adequate information exchange workflows and standards with the designers and constructors. Nevertheless, the study does not mention to what extent interoperability solutions might contribute to reduce this significant burden.

Apart from the Athena and the Interop project, case studies dealing specifically with interoperability are very seldom. Nelson et al. (2002), for instance, investigate the impact of RosettaNet on its users and have the purpose to show the benefits of an improved interoperability in a given business relationship. Nelson et al. explore the relative advantage of using RosettaNet, i.e. “the extent to which a potential adopting organization views the innovation as offering financial and operational benefits over previous ways of performing the same tasks”. As the objective is to compute the return on investment of applying interoperable standards, this case study on RosettaNet also includes quantitative results. Their analysis shows a significant reduction of transaction costs for both manufacturer and distributor, as well as improvements in throughput and cycle time. Nevertheless, one of the main limitations of this representative interoperability case study is that a sole cost assessment is performed, therefore leaving the potential revenue impacts as well as strategic issues out of the investigation.

### 3.2.2 Impact of IT agility on value chain performance

This section considers how the agility of an organization’s IT capabilities affects its value chain agility. An organization’s ability to respond to changes in its environment (i.e., its dynamic capabilities) is largely resident in its processes. Organizational processes are heavily reliant on IT for their effectiveness. Thus, the responsiveness of an organization’s IT capabilities is critical for organizational responsiveness toward change. The nexus between IT and organizational responsiveness is often conceptualized under the moniker of IT agility, i.e., the manner in which a company’s IT agility enables or inhibits its ability to respond to changes, either proactively or reactively.
From a synthesis of prior research in operations management, strategy, organization theory and IT, Masini and Sengupta (2005) conceptualize IT agility as being of two types: range and time (Figure 3). Range represents an organization’s ability to broaden (or shrink) specific aspects of its capabilities. They include increasing / decreasing the repertoire of products and/or services offered to the market, or expanding / shrinking internal capabilities in manufacturing, services or processes. Adjustments in range can be accomplished by exercising options available internally (e.g., better integration in processes and/or strategic business units), and externally (e.g., alliances and partnerships). The time aspect of IT agility is best characterized as one of speed, i.e., the ability of an organization to initiate quick moves, either preemptively or in response to shifts in the marketplace, competitor actions, etc. Such moves can include a broad nexus of actions: changes in the organization’s strategic focus, external relationships, internal processes and IT infrastructure.

Accordingly, the authors define agility as an organization’s ability to respond to environmental changes by reconfiguring its internal processes across a wide range of functions or business units, and/or in a timely manner. Recursively, we characterize IT agility as an organization’s ability to modify its IT capabilities across a wide range of processes, in a timely manner. Thus, agility is a general property of an organization, whereas IT agility is a specific attribute of its IT capabilities, and often a necessary condition for attaining general agility.

The topic of IT agility has attracted much interest recently, with a widespread recognition that it matters to organizations. The quest for IT agility is reflected among researchers, business consultants, and IT companies. Developing a flexible and responsive IT infrastructure is considered a top priority, and one of the most important issues in IT management. Range-based agility in IT can enhance a firm’s ability to mass customize, and thereby create value. Time-agile companies can seize opportunities for creating sustained advantage through their ability to reconfigure processes and organizational resources faster than competitors.

The relationship between IT agility and firm performance is moderated by two factors, one internal and one external. The internal moderator is the ease with which a desired level of IT agility can be implemented. Ease can be conceptualized as the inverse of the effort or cost required to react to changes. Ease captures the relative effort (as well as the lack of pain or incremental cost) entailed in making changes with speed. For example, consider the effort entailed to connect a supplier with existing procurement systems. Organizations that can make such changes with relative ease are likely to exercise the option more often. The external moderator consists of market dynamism. Highly dynamic environments are usually characterized by greater unpredictability.

Masini and Sengupta’s research on large manufacturing companies shows that both range- and time-agility affect organizational performance positively. However, their interaction is negative, i.e.,
organizations find it difficult to extract value from both types of agility simultaneously. The moderating effect of ease on range-agility and performance is positive. That is, organizations that can make changes to range-agility with greater ease are likely to benefit from this capability. In contrast, the moderating effect of ease on time-agility and performance is negative. That is, organizations that can change their level of time-agility easily are liable to “overspeed” (e.g., introduce new products too quickly), and thus reduce value from this agility. The moderating effect of dynamism on time-agility and performance is positive. Thus, time-agility is much more valuable in highly dynamic environments. In contrast, this moderation effect between range-agility and performance is negative. That is, in highly unpredictable environments, it does not pay off to have high levels of range-agility. Thus, range-agility is valuable for firm performance, but less so in highly dynamic environments. Our research also finds boundaries on the extent to which a firm’s agility impacts its bottom line. Time agility exhibits a curvilinear relationship with performance, i.e., its value is reduced beyond a certain level.

The results of our research (and indeed, of most of extant research on the subject) are in the context of within-company agility, conducted with large companies. However, the value chain ecosystems of companies encompass partners of varying sizes. It is, therefore, important to establish the aggregate IT agility of the value chain.

### 3.2.3 Future research challenges

Extant research raises the following questions which will form part of our future research:

- Is it possible to identify interoperability investment patterns with respect to their actions and impacts?
- If yes, can we derive a priori the cost and revenue impact of interoperability?
- Can we derive an optimal fit between transaction characteristics and interoperability investments?

The first step towards obtaining such insights is to understand how interoperability impacts businesses and how it creates value. In this context, the core Interoperability Impact Assessment Model will be presented in the next section and intends to answer to the first two challenges mentioned. The two remaining challenges will be addressed in the Athena Impact Assessment deliverable with help of the application of the IIAM and BIF to the Athena pilots.
4 Interoperability impact assessment model (IIAM)

4.1 Transaction costs as a result of business interoperability issues

As mentioned in the introduction, business interoperability can be either interpreted in a technical way or in a more general way by considering social, political or economic factors. The capability of information systems to exchange data is an example for a technical interpretation of interoperability. An instance of an economic explanation of interoperability is the ability of a manufacturer to establish an electronic business relationship with his supplier. But why are the information systems or the manufacturer and the supplier supposed to be interoperable? The answer to this question is that the common goal of all participants is to efficiently interact with others. In the first example, the information systems are part of a production process, i.e. they represent a certain step in a production pipeline, which transforms input into output. Here, the aim is to achieve a cost-efficient transfer of the input throughout the production steps until the output is produced. In the second example, manufacturer and supplier need to be interoperable in order to establish a cost-efficient transfer of the products.

The underlying assumption of interoperability is therefore that the transfer of physical goods and non-physical goods, i.e. services, is not possible without an exchange of information. In addition, the exchange of information causes costs, called transaction costs. Depending on the ability of the participating partners to exchange the necessary information, the exchange of the good can be more or less smooth, i.e. more or less transaction costs arise. In other words, since interoperability describes the ability to gather and exchange information, a transaction-cost-efficient exchange of goods requires a high level of interoperability. In the following, we briefly look at the historical development of economics theory. While in the early days, information has not been recognized as an important factor, today there is a consensus amongst most researchers that information is one of the driving forces of economic growth. Furthermore, the development of transaction costs theory, whose foundations have been laid by the recognition of information as an important force in economics theory, is described. The last paragraph of this section analyzes the relationships between information, transaction costs and interoperability.

4.1.1 The role of information: an economic perspective

The assumption that a successful exchange of physical and non-physical goods, i.e. services, comes along with an exchange of information has not always been part of economics theory. The neoclassical theory, for instance, is based on the assumption that people have full information (Weintraub, 1985). Furthermore, firms merely fulfill the function of an integrating force which is a result of the increasing complexity of labor (Usher, 1920). Thus, there is no direct need for interoperability between firms, as the concept of information and firms are different. The facts that lead to this assumption of the neoclassic theory, as well the driving forces to revise some of its assumptions are described in the following.

The reason why economic activities take place is that people have individual needs that have to be fulfilled. The problem is that the amount of goods which can satisfy these needs is limited. Consequently, economic systems and institutions were established with the aim of minimizing the scarcity of goods. Another issue is that only few goods exist that are appropriate for consumption without a preceding transformation. Therefore, an effective mechanism to reduce scarcity requires the allocation of resources and production factors in an optimal way. This makes exchange activities a fundamental element of any economy (Wigand et al., 1997). According to the classical economics theory which was developed in the middle of the nineteenth century, a product was distributed among the different social parties in accordance with the costs borne by those groups in producing it (Hollander, 1987). Thus, the price of a product is determined by the costs of its production. Furthermore, the price is the sole information needed for the distribution of the product. Overall, the explanation of distributions is congruent with the explanation of costs in the classical economics.

The fact that people are willing to pay more for a product than it has cost to produce it, in other words the fact that the individual value of the product differs from the actual costs of producing it, collides with the approach of the traditionalists. This is the point where neoclassical economics theory comes into play. Neoclassical economics theory extends the value theory of the classical economics theory by introducing “utility”. Utility is the perceived value of a good to the consumer. In the traditional economics theory the value of the product was determined by the product, i.e. by the costs to produce it. In the neoclassical theory the value of the product is determined by the person who wants to buy it. The
transfer of goods is coordinated via markets and the price of a product indicates whether the conflictive facts “satisfaction of needs” and “scarcity of goods”, later known as demand and supply, can be balanced. For instance, if the demand for a product is higher than the supply of it, prices rise which, in turn, prompts the manufacturer to produce more of the product. The opposite case, i.e. if the supply is higher than the demand of a product, leads to a reduction of the price. Neoclassical theory assumes that this balancing process eventually leads to an economic equilibrium. One of the underlying assumptions of this model is that people act independently on the basis of full information (Weintraub, 1985). Thus, the search of information is unnecessary and everyone has equal information (Wigand et al., 1997). Furthermore, firms are mainly characterized as entities which fulfill production functions (Williamson, 1985). The question why some goods are transferred via markets and others are transferred via a governance structure like a firm is not in the focus of this theory.

Among others, a group of economists known as the Austrian school of economics made some important suggestions how to modify the neoclassic theory. They suggested a different view of information and entrepreneurship in economic theory. One of the most famous representative of the Austrian school of economics, Friedrich August von Hayek, states (Hayek, 1945): “I fear that our theoretical habits of approaching the problem with the assumption of more or less perfect knowledge on the part of almost everyone has made us somewhat blind to the true function of the price mechanism and led us to apply rather misleading standards in judging its efficiency” (Hayek 1945, p. 527). He finally comes to the conclusion that there exists “the unavoidable imperfection of man's knowledge and the consequent need for a process by which knowledge is constantly communicated and acquired.” (Hayek 1945, p. 530). Thus, in Hayek's opinion, information was regarded as an essential factor of economic activities. In addition, the theory rests on the assumption that information is distributed asymmetrically which, in consequence, leads to entrepreneurship.

Wigand et al. explain the characteristics of entrepreneurship as follows: “In this entrepreneurial element, the unequal distribution of information is personified” (Wigand 1997, p. 26). The entrepreneur has an information edge over the other participants in the economic system. Therewith, he acts as “creative destructor” of existing structures in an economy since he builds on his information advantage to introduce innovations (Schumpeter, 1926). Furthermore, in the production process, the entrepreneur manages to coordinate the transformation of the input into output in such a manner that he profits from the difference between costs of manufacturing and the revenues. In other words, the entrepreneur takes on the risk of the hardly predictable market value of the product (Knight, 1921). Another function of an entrepreneur is the so-called arbitrage function. It means that the entrepreneur realizes economic advantages by using his information lead. For instance, the entrepreneur knows that he can buy a product in one location at a lower price than at another location. This knowledge makes him buy the product at the location where cheaper prices are offered and sell it at the location where he can claim a higher price than he originally paid. Thus, entrepreneurs use the asymmetric distribution of information and their information advantage to optimize their own profits.

To summarize, entrepreneurship arises because of information differences in the economic system and the ability to use information more profitably. Due to the different functions of the entrepreneurs, they are regarded as the main stimulus for dynamics in economy and long-run economy growth. The conclusions of the theory of the Austrian school of economics play a major role in the development of a new definition of the role of firms. Up to then, they were mainly regarded as entities which fulfill solely a production function (Williamson, 1985).

This marks the transition to a new theory of economics, namely the new institutional theory, in which the structure and activities of firms became a subject of scientific analysis. The new institutional theory builds on the concepts of the neoclassical theory but extends it in important aspects. Scarcity of goods is still considered as the main reason for competition, and the mechanics of the price theory are still considered as correct. However, it is not only used to explain the market behavior anymore but becomes an essential tool for the analysis of institutions which are now regarded as a critical factor in the reduction of the scarcity of goods.

### 4.1.2 Transaction costs as a result of lacking interoperability

In this context, transaction costs appear for the first time as a scientific concept. Douglass C. North describes transaction costs as “the connection between institutions and costs of production” (North 1992, p.3). The theory of transaction costs was developed by Ronald Coase in his pioneering article “The nature of the firm” in 1937 (Coase, 1937). In this paper, Coase gives an answer to the question why firms exist. Coase states: “Outside the firm price movements direct production, which is co-ordinated through a series of exchange transactions on the market. Within a firm, these market
transactions are eliminated and, in place of the complicated market structure with exchange transactions is substituted the entrepreneur-co-ordinator, who directs production” (Coase 1937, p. 388). Hence, he concludes that the “main reason why it is profitable to establish a firm would seem to be that there is a cost of using the price mechanism” (Coase 1937, p. 390). This notion is different from the neoclassical approach which acts on the assumption that the price mechanism can be used without additional charges (Wigand et al. 1997). Coase subsequently identifies two types of costs that come along with the employment of a price mechanism, i.e. the exchange of goods on the market. The first type is called organizing costs. They are defined as the costs “of discovering what the relative prices are” (Coase 1937, p. 390). The second type of costs is the “cost of negotiating and concluding a separate contract for each exchange transaction which takes place on a market” (Coase 1937, p. 390 f.). The main conclusions to be drawn from his pioneering article are (Williamson, 1975):

(1) Transactions and the costs associated with them are the central objective of the analysis.
(2) Uncertainty and implicitly bounded rationality are key features of the argument.

According to North, Coase made the connection between the theory of institutions, transaction costs and the neoclassical theory (North 1992). He also states that it is imperative that the “neoclassical result of efficient markets only obtains when it is costless to transact. When it is costly to transact, institutions matter.” (North 1992, p.3). In other words, the market and the firm represent two alternative ways of performing transactions at optimal costs. Finally, the alternative which leads to the highest cost reduction is preferred over the other. The new institutional economy thus does not mainly focus on production costs anymore, a situation which is typical for the neo-classical theory (Williamson 1985). The importance of transaction cost analysis is illustrated by the results of the empirical study performed by Wallis and North (Wallis and North 1986). Their study analyzes the share of transaction costs in the gross national product from 1870 to 1970. They differentiate between “transaction industries”, which comprises of wholesale and retail trade, finance, insurance, and retail trade, and “non-transaction” industries, i.e. manufacturing or agriculture. Furthermore, they sum up the wages of employees of the transaction industries and the wages of employees of the non-transaction industries which fulfill transaction task, i.e. the wages of managers, supervisors, clerical workers, and employees in purchasing and marketing departments.

The same approach is used for analyzing the size of the transaction sector within the government of the United States (Wallis & North, 1988). They found out that in 1970 54.71 per cent of the gross national product consisted of transaction services, whereas in 1870, only 25 per cent of the GNP could be traced back to transaction services (see Figure 4). This remarkable increase in the importance of transaction services is mainly caused by the conversion of the U.S. from an agricultural to an industrial economy. Based on these results, Wigand et al. conclude that “although division of labour and specialization have enabled, or still enable, progress in productivity trough improving efficiency in transformation processes, these gains can only be realized trough exchange activities. These exchange activities, however, expend economic resources themselves. The consequence is that transaction costs present a similar limiting factor for economic growth as do the costs for transformation processes”. (Wigand et al., 1997, p.20)

The empirical results support the assumptions of Coase concerning the theoretical underpinning for the transaction costs theory. Thirty years after the publication of Coase’s article, his ideas were picked up again by the scientific community to further extend them. Oliver E. Williamson, a former student of Coase, is one of the researchers that further refine the concepts invented by his mentor. His theory acts on the following assumptions (Williamson, 1975):

(1) Markets and firms are alternative instruments of completing a related set of transactions.
(2) Whether a set of transaction ought to be executed across markets or within firms depends on the relative efficiency of each mode.
(3) The costs of writing and executing complex contracts across a market vary with the characteristic of the human decision makers who are involved with the transaction on the one hand, and the objective properties of the market on the other.
(4) Although the human and environmental factors that impede exchanges between firms/ across markets manifest themselves somewhat differently within the firm, the same set of factors applies to both.
Figure 4: Evolution of transaction costs on gross national product according to Wallis and North (1986)

Statement three refers to the origins of transaction costs that Williamson has identified. They are depicted in Figure 5 and will be described in the following. The atmosphere represents all kinds of influences which have an impact on transaction costs. It comprises of social, legal and technological environments which are relevant for the coordination of an exchange (Wigand et al. 1997). Furthermore, Williamson differentiates between human factors and environmental factors. The combination of both creates transaction costs which (Williamson 1985) describes as “the economic equivalent of friction” (p. 19). By this means, he builds a bridge to Kenneth Arrow who defines transaction costs as the “costs of running the economic system” (Arrow 1969, p.48).

Figure 5: Transaction costs drivers (Williamson, 1975)
Bounded rationality means that although people try to act rationally, neuro-physical restrictions limit their ability to process all necessary information. The limited ability to process information would not cause any difficulties if the external conditions did not exhibit uncertainties. Since future developments can not faithfully be predicted, bounded rationality in combination with uncertainty of the external development makes a “frictionless” transfer of goods impossible. Another group of human and environmental factors that creates transaction costs are opportunism and small numbers. In this context opportunism means that economic agents are self-interested and pursue individual goals even if their behavior is detrimental for others.

The term small numbers describes the observation that opportunistic behavior would not have such a strong negative impact if there were many potential transfer partners. Putting it differently, if one transaction partner behaves opportunistically, the existence of a large number of other potential partners would enable the other participants in the transaction to change to another partner whose behavior is compliant with their common interest. A small number of potential partner increases the negative impact of opportunism. The problem of small numbers was later investigated by Williamson more closely which made him modify his original definition. In subsequent publications, he refers to the problem as “asset specificity” (Williamson, 1985).

Asset specificity still denotes the effect of small numbers but also takes into account the influence of transaction frequency. Asset specificity describes the fact that transactions may require certain investments in durable, transaction-specific assets in order to support them and that me be lost if the transaction ends. This situation may create lock-in effects, i.e. situations in which one partner is very strongly dependent on the other partner. Under these circumstances, the “weak” partner cannot move to another partner without substantial switching costs (see research insights in section 2.2). Williams identifies several types of asset specificity, namely, site specificity, physical asset specificity, human asset specificity and dedicated asset specificity. While the first three types are self-explanatory, an example of the fourth category could be the expansion of existing plants in order to improve the exchange of goods (Williamson, 1985). Williams also concludes that therefore the “benefits of specialized governance structures are greatest for transaction supported by considerable investment in transaction-specific assets” (Williamson, 1985, p. 60) since lock-in effects can be avoided.

Apart from this, Williamson further states that the “costs of specialized governance structure will be easier to recover for large transactions of a recurring kind. Hence the frequency of transactions is a relevant dimension.” (Williamson 1985, p. 60) This means that it is best to perform exchanges that don’t require specific investments on a market rather than internally. In contrast, specific transactions which have to be accomplished frequently are more likely to be integrated in a firm. Therefore, the transaction costs theory provides concepts and tools for analyzing vertical or horizontal integration. The dimensions of transaction costs, namely uncertainty, asset specificity and frequency, in combination with the human factors bounded rationality and opportunism lead to an asymmetric distribution of information, i.e. information impactedness.

The previous paragraphs delineated the changing relevance of information in different economics theories. In classical and neo-classical economics theory information played only a marginal role. In those days, economists assumed that everyone had full information and the market, respectively the price, provides all necessary information for free. Economists of the new institutional economics shifted their focus to the investigation of organizations. They argue that the reason why economic organizations appear is that certain exchanges of goods can be conducted more cost-efficiently via them than via the market. This finding implies that exchanging goods causes costs, namely transaction costs. Since trading partners do not have full information, they have to gather and exchange information, which in turn causes transaction costs. The amount of transaction costs depends on how proficient the individual trader is in gathering and exchanging information, i.e. how interoperable he is. Putting it differently, if actors would be perfectly interoperable, they would have full information and thus no transaction costs would arise. In consequence, the level of interoperability can be regarded as a variable that can be influenced by individual transaction partners. In the extreme case, transaction costs should become irrelevant when the level of interoperability goes towards infinity. Since interoperability does not come for free, the costs of increasing the level of interoperability have to be set in perspective to the savings in transaction costs. The analysis of this trade-off and the examination of the impact of improved interoperability on other economic factors, e.g. quality, is the objective of the IIAM.
4.2 Assess the impact of interoperability: a comprehensive approach

4.2.1 Requirements for interoperability value assessment

Since measuring interoperability value assumes a change in a relationship’s characteristics, we will consider the efforts to move from the As-Is situation to the To-Be situation as an investment. As we already know, interoperability investments do not exclusively relate to the setup of software applications and integration but also include the reorganization of the cross-organizational business processes, or measures to manage external partnerships and create a favorable environment for external collaborations. In order to cope with this variety, a framework assessing the value of interoperability should remain general in its concepts, build on an existing scientific background and be easily adopted by the future users: corporate decision-makers.

Interoperability investments do not only impact the operational efficiency of a single company but also affect the performance of its whole value chain. ETA CS, a manufacturer of watch parts (see Schemm et al., 2006) intends to improve its customer value through seamless information exchange. LAM, a first-tier automotive supplier (see section 5.1) could manage to improve the delivery quality of its suppliers by standardizing and automating the transfer of detailed production schedules. As (Wigang et al. 1997) point out, efforts spent on improving interoperability might also shift the boundaries of companies by making external sourcing more attractive. AVAG, a multi-brand car retailer develops a tool which turns specific customer requirements into the appropriate car configuration from their portfolio of brands. This service turns out to be appealing for new customers that were initially obliged to visit every brand retailer to obtain quotes (CAS, 2006). American Airlines (AA) provides with Sabre a good example of an extension of business through better interoperability (Cross, 1996). Sabre was initially designed as a proprietary booking system but became in fact the standard for the airline industries when AA decided to create a specific business unit licensing Sabre to competing airlines. The analysis scope for an interoperability improvement should therefore be extended to the network surrounding the company investigated (see Figure 6).

Since interoperability improvements are performed in a complex networked environment, the direct measurable impacts in terms of time, quality or costs are an important argument during the decision-making process. However, such myopic assessments might not show significant returns. Theory of constraints (Goldratt, 1990) tells us that the local improvements are not always able to improve the overall productivity of a transaction, since other bottlenecks might then occur. Hence, the use of causal diagrams to depict the impact of interoperability improvements turns out to be a useful extension to the quantitative assessment at a firm’s boundaries. By the means of causal analysis,
decision-makers are able to investigate the contribution of the interoperability change on the achievement of a competitive strategy. The strategic fit is indeed acknowledged as a main factor triggering investment decisions since it represents a better indicator than simple ROI computations on how the company will generate long-term benefits (Porter, 1985 or Hamel and Prahalad, 1990). To summarize, one needs to separate between the direct observable impacts (that should be quantified) and the expected strategic impacts.

We define therefore operational impacts as the impacts directly related to the transaction, i.e. costs, speed and quality of the transaction. Strategic impacts are the results of an improvement at a company’s boundaries (in other words operational impacts) and will impact a company’s value chain as well as its competitive positioning (see also Venkatraman and Henderson 1998 or Wigand et a. 1997 for first attempts to separate operational and strategic impacts of interorganizational systems).

4.2.2 Theoretical foundation and structure of IIAM

A first straightforward means to assess the value of business interoperability would consist in performing a simple return on investment computation balancing the initial investments with the future discounted savings on transaction costs. The presence of a positive return on investment would then be the criteria on which to justify the decision to perform an investment (Copeland, 2003). However, as Kaplan and Norton (1992) notice, the sole focus on financial figures to make a decision present two dangerous shortcomings: the expected financial flows are based on historical data and often assume a linear extrapolation of the past. Furthermore, the assumptions underlying the figures are not explicit and might therefore be unrealistic. As a result, ROI computations are generating quantitative measures but are not able to explain how the investment should help the company get there. Kaplan and Norton (1992) present the “balanced scorecard” concept in order to cope with these limitations and suggest a multidimensional approach for assessing a business. In a nutshell, the authors complement the financial dimension with additional perspectives covering customers, internal processes and innovation and break down strategic goals into a hierarchy of key performance indicators.

On the basis of their experience, Kaplan and Norton (2004) refine their “balanced scorecard” concept by introducing “strategy maps” which are intended to ensure the strategic alignment of business decisions. These maps are depicting the relationships between single decisions, their impact on a company’s stakeholders as well as their contribution to the achievement of a competitive strategy. Hence, an investment’s strategic fit turns out to be as relevant as its measurable returns. With respect to the specificities of interoperability networks, the IIAM will therefore endorse the multidimensional assessment of “strategy maps” to investigate the value created by interoperability investments on a firm level. Since interoperability relates to the ability to minimize the costs of transacting with business partners (see section 4.1.2), we will rely on transaction costs theoretical findings to quantify the operational impacts of interoperability. Based on observations from the Athena pilots and case studies, we further state that the impacts at a company’s boundaries (the operational impacts) will trigger the strategic impacts. Thus, the correlation between interoperability improvement and strategic impact is indirect (see Figure 7).
A detailed operationalization of transaction costs as well as their three drivers (speed, quality and transparency) will be provided in section 4.2.3. We include thereby a detailed questionnaire illustrating the correlations between operational key performance indicators. Given these indicators, we will derive the strategic impacts (in other words their contribution to the achievement of long-term profitability) in section 4.2.4. Here again, a questionnaire will enable us to understand and assess the links between interoperability actions and their consequences.

### 4.2.3 Operational dimensions

The operational layer of the IIAM depicts the impacts that can be directly quantified and provides therefore the basic figures initially fostering the investment decision. As analyzed in section 4.1, transaction costs are the consequence of lacking interoperability, therefore, a clear definition and scope setting of transaction costs is necessary in the context of interoperability value assessments.

Williamson (1985) first proposes a division between ex-ante costs (costs prior to the execution of a transaction, i.e. partner search and contract negotiation) and ex-post costs (occurring during and after a transaction, i.e. policing and enforcement costs). With respect to the shortcomings of Williamson’s approach, Milgrom and Roberts (1992) propose to decompose transaction costs into motivation and coordination costs which encompass the cost of obtaining information, the cost of coordinating the production process as well as the cost of measurement. Olson et al. (1992) as well as Clemons et al. (1993) point out that coordination costs are highly linked to the use of information technology, therefore, infrastructure costs need to be specifically addressed in the transaction costs analysis. On the basis of these insights, we propose to break transaction costs into three quantifiable blocks: connectivity, coordination and monitoring costs, which are defined in Table 1.
Table 1: Transaction costs breakdown adopted by IIAM

<table>
<thead>
<tr>
<th>Transaction costs</th>
<th>Definition</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connectivity costs</td>
<td>nonrecurring expenses to setup or improve a business relationship</td>
<td>costs of negotiation costs of setting up organizational and technical</td>
</tr>
<tr>
<td></td>
<td></td>
<td>connectivity (labor costs, hardware procurement, software licence fees,</td>
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<tr>
<td></td>
<td></td>
<td>external consulting fees)</td>
</tr>
<tr>
<td>Coordination costs</td>
<td>costs of executing the transaction</td>
<td>costs of manual information processing (labor costs)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>costs of interacting (labor costs)</td>
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<tr>
<td></td>
<td></td>
<td>infrastructure and maintenance costs (e.g. maintenance fees, communication</td>
</tr>
<tr>
<td></td>
<td></td>
<td>costs)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>costs consequent to wrong decisions (opportunity costs)</td>
</tr>
<tr>
<td>Monitoring (Control) costs</td>
<td>costs to ensure the quality of the transaction</td>
<td>costs of monitoring and controlling the transaction (labor costs)</td>
</tr>
</tbody>
</table>

We notice that the transaction costs are driven by three performance indicators impacting the transaction efficiency: speed, quality and transparency. In the context of interoperability, quality refers to the output of the transaction as well as to the information transferred. This quality of information can be assessed through two criteria:

- **Reliability** (i.e. its ability to provide the receiving process with accurate information). Faulty information will trigger wrong decisions and as a result, provoke unnecessary interactions within agents in order to solve the resulting problems. These avoidable interactions are expensive, slow down the delivery process and prevent the management from addressing strategic issues.

- **Processability**. Unstructured information exchange often induces manual translation work on the receiver’s side. This labor-intensive step is not only one of the main coordination costs driver but also slows the overall transaction clockspeed down. The availability of the information is in fact the prerequisite for the execution of the downward processes. We refer to section 4.1 for an illustrative example.

In order to assess the impact of interoperability investments on transaction **speed**, one needs to break the speed effect down into:

- The time spent on processing the transaction.
- The overall impact on the transaction’s completion speed (cycle time). Although data quality issues represent a bottleneck for the downward process, improving the process quality may not automatically lead to a quicker service or product delivery time as many other factors (e.g. organizational fit or efficiency of downward processes) are influencing the transaction speed.

The last driver, **transparency**, depicts the increase of visibility related to the transaction and the ability of decision-makers to obtain the required information in a very short lap of time. This criterion stems from micro economic theories where markets are perfect when transparency (i.e. prices and quantities are known by every actor) is given (Varian, 1999). The lack of transparency (see also “information impactedness” in section 4.1) is generally issued from the difficulties to enter or update data on a common information platform. Here again, the slow information inbound is issued from data quality issues. As a result, low transparency will lead to intensive human interactions in order to retrieve information. Unfortunately, the delay required to gather information impacts negatively its accuracy and will therefore additional opportunity costs in case of a suboptimal decision (see Figure 8).
Figure 8: Exemplary relationship between operational interoperability impacts

Once the correlations between transaction costs and their drivers have been stated, one needs to concretize the concepts evoked above in order to retrieve the information related to interoperability investments. For this purpose, we create a questionnaire aligned with the life-cycle of the transaction and divide thereby the investigations into three operational blocks:

- **Connectivity phase**, including all drivers and activities occurring prior to the realization of the first transaction object as well as the expenses for further interoperability investments.
- **Coordination (execution) phase**, including all activities related to the execution of the transaction.
- **Monitoring phase**, including all activities related to the control of a transaction’s completion. In the context of repetitive transactions (e.g. mass production of cars), we consider that monitoring takes place not only after the end of a product life-cycle but also after each car produced.

1) Connectivity phase (Table 2)

The connectivity costs can be separated into four logical clusters. The first cluster encompasses the costs for partner finding and contractual negotiation, i.e. the time spent by both transacting sides on agreeing on contractual terms. In the case of repetitive transactions, the contracting process might be shortened by means of standard templates and electronic contracting. The second cluster encompasses the design and implementation costs for a specific IT solution. Development in software can be covered by a single company, by a software vendor which resells the software to other companies or by industrial associations which finance the development of tools or methods to be reused by their members. In this case, the development costs need to be divided by the number of potential partners taking advantage of this “common” investment. The third cluster concerns the inception costs for the interoperable solution (here also “infrastructure and process setup costs”). We differentiate thereby between the costs related to the system design, implementation and integration as well as the organizational design, rollout and change which are needed to make the solution work. These costs (except licenses) are mostly man-hour-driven and might include both the own workforce as well as external consultants. The last cluster embeds the dynamic view of interoperability by querying the efforts required to extend the interoperable solutions to additional functionalities, partners or to adapt it to new products or markets. While these costs do not occur immediately, their probability might be high when a company is operating in a dynamic environment. Hence their impact should also be assessed immediately.

The main driver of these costs is time. The time spent on finding a partner and agreeing on contractual terms might represent the first process bottleneck. The time lag between the contractual agreement and the start of the transaction is another key performance indicator (KPI) that needs to be integrated into the analysis. In the case of very specific connections required in order to run a transaction (see BMW/Magna Steyr case in the BIF), the development time of functioning interfaces might require some months before the first transaction can be conducted. In this context, process or message standards might play a role in reducing the connection efforts and thus the connectivity costs. Finally, we assess the time intensity of the development and inception phase prior to the transaction in
order to match these efforts with the total connectivity costs.

Table 2: Operational interoperability assessment: connectivity phase

<table>
<thead>
<tr>
<th>CONNECTIVITY PHASE</th>
<th>supplier</th>
<th>customer</th>
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<tbody>
<tr>
<td>Transaction costs/business relationship</td>
<td></td>
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<tr>
<td>costs for partner finding</td>
<td></td>
<td></td>
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<tr>
<td>costs for contractual negotiation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>setup costs: process / organizational design</td>
<td></td>
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<tr>
<td>setup costs: design of IT solution</td>
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<tr>
<td>setup costs: implementation of IT solution</td>
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<tr>
<td>setup costs: integration</td>
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<tr>
<td>setup costs: SWY licences</td>
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</tr>
<tr>
<td>setup costs: process rollout / organizational change</td>
<td></td>
<td></td>
</tr>
<tr>
<td>incremental costs for connecting further partners</td>
<td></td>
<td></td>
</tr>
<tr>
<td>incremental infrastructure costs for extending functionalities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>time required to find transaction partner (days)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>time required to establish organizational connectivity with partner and agree on exchange terms (days)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>time required to establish technical connectivity with partner (days)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>time required to run first transaction (days)</td>
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<td></td>
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</tbody>
</table>

2) Coordination phase (Table 5)

The coordination phase deals with the execution of the transaction. As a consequence, the transaction cost breakdown (coordination costs instead of connectivity costs) as well as the drivers will differ from the pre-transaction phase. Concerning the coordination costs, the most obvious cost drivers are the **data processing costs**, i.e., the time spent on capturing and manipulating data, and the **information retrieval costs** which are induced by human interactions to search for and obtain the information required. Recurring infrastructure costs might occur, e.g., **transaction-based fees** in the case of pay-per-use models or recurring license fees. These costs as well as **support and maintenance costs** are of fixed nature and need to be related to the total number of transaction per period for a fair assessment of interoperability investments. In a similar fashion than previously, we also include here a dynamic aspect by taking into account the **scalability costs** for the interoperable solution.

Opportunity costs are the consequence of decisions taken on the basis of unavailable or wrong information. Through the application of the IIAM to practical case studies, we have identified different potential sources of opportunity costs:

- **Inventory carrying costs**, which are the result of inaccurate demand forecasts used in production planning.
- **Overtime**. Overtime is often required when a company needs to deliver a product in a short lap of time while the core capacity potential is already full. In the absence of safety stocks, the only means to achieve this is to run overtime shifts.
• **Lost contribution.** By dedicating scarce capacity resources to unsold products, a manufacturer forgoes revenues while bearing production costs,

• **Penalty fees.** These occur when a company is not able to stick to its initial delivery deadlines. As a result, customers bear an additional costs (see for instance the airlines having bought some A380s) that is generally compensated by important penalty fees.

In these cases, accurate and available information is critical to minimize the opportunity costs of transacting. While human processes require more labor input to keep pace with growth, information systems can generally bear significant load increases.

The speed of the transaction execution phase is divided into the **processing** and **interacting time** (i.e. the true time spent by the workforce on each transaction), and the total lead-times at a company’s boundaries. For reasons of simplicity, we focus here on the **response or reaction time** and the **total cycle time**. It is interesting to notice that a company’s reactivity (short response and cycle times) will have a beneficial impact on a customer’s cost function. This aspect will be addressed in the strategic impact section in more detail.

The quality assessment segregates the **data quality** from the **quality of the transaction execution at the boundaries.** The quality latter is measurable by means of error rates, e.g. “percentage of wrong deliveries and invoices/year” and the “percentage of late deliveries per year”. The assessment of data quality requires us to define a scale translating quality into figures (see Table 3). In a first step, data quality can be judged with respect to its processability. We consider that the perfect state (5) takes place when the data exchanged is in a format that can be immediately and automatically used by the receiver, thus minimizing the processing costs. The manual work intensity is negatively correlated with the data quality. This assumption sounds logical as data processing is, in most practical cases, far from being a value-added activity.

**Table 3: Valuation of data quality with respect to processability**

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<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>5</td>
<td>data exchanged is or can be integrated without any transformation</td>
</tr>
<tr>
<td>4</td>
<td>data exchanged needs transformation prior to integration, no information loss, automation possible</td>
</tr>
<tr>
<td>3</td>
<td>data exchanged needs transformation prior to integration, information partly lost, automation possible</td>
</tr>
<tr>
<td>2</td>
<td>data exchanged cannot be processed automatically, needs manual work</td>
</tr>
<tr>
<td>1</td>
<td>no data available</td>
</tr>
</tbody>
</table>
The second data quality assessment is related to the **accuracy of the data transferred**. Here again, we quantify the ability of the data to give the right information with a scale from 5 (highest probability of information accuracy) to 1 (the information, if available, is completely outdated and is therefore useless). We reflect the fact that the sole existence of past data might not provide sufficient insights to derive future developments or to assess your current situation. Table 4 summarizes the valuation scale for the data accuracy assessment.

**Table 4: Valuation of data quality with respect to accuracy**

<table>
<thead>
<tr>
<th></th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>information reflects the current state of the situation and includes insights into future evolution</td>
</tr>
<tr>
<td>4</td>
<td>information reflects the current state of the situation</td>
</tr>
<tr>
<td>3</td>
<td>information reflects only the past state of the situation, thus allowing only extrapolations about now</td>
</tr>
<tr>
<td>2</td>
<td>information is outdated but can be used (does not include recent changes)</td>
</tr>
<tr>
<td>1</td>
<td>information is fully outdated and cannot be used as an input anymore</td>
</tr>
</tbody>
</table>

The last investigation aspect, which is strongly related to data quality and speed issues, concerns process transparency. We quantify the impact of interoperability on process transparency by assuming that the frequency of human interactions to retrieve day-to-day information prevents the workforce to perform analytical tasks. This organizational "interference" is the main cause of process opacity. The **ability of a company to create transparency** is quantified with help of Table 6.
### Table 5: Operational interoperability assessment: coordination phase

<table>
<thead>
<tr>
<th>COORDINATION PHASE</th>
<th>supplier before</th>
<th>supplier after</th>
<th>customer before</th>
<th>customer after</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transaction costs (coordination costs/transaction)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>data processing costs (workforce)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>human interaction costs (data retrieval)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>transaction-based fees (software)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>opportunity costs: inventory holding costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>opportunity costs: overtime</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>opportunity costs: express freight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>opportunity costs: penalty payments</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>opportunity costs: lost contribution</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>support and maintenance costs / transaction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>incremental infrastructure costs for one additional transaction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>man hours worked/transaction (processing)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>man hours worked/transaction (interacting)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>response time to request (hours)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cycle times (days)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>processibility of information*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>accuracy of information**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>transaction-error rate (% of total transactions)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transparency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>information availability***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Table 6: Valuation of data availability (transparency indicator)**

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Full transparency, information is available without any delay in the required form</td>
</tr>
<tr>
<td>4</td>
<td>Full transparency on the process, information is available immediately but requires specific queries</td>
</tr>
<tr>
<td>3</td>
<td>Partial transparency, information is available immediately but requires the consolidation of several sources which can be automatically queried</td>
</tr>
<tr>
<td>2</td>
<td>No immediate transparency, information is not available immediately but can be retrieved through intensive interactions with other partners</td>
</tr>
<tr>
<td>1</td>
<td>No transparency, information is not available</td>
</tr>
</tbody>
</table>
3) Monitoring phase (Table 7)

The post-transaction phase deals with the monitoring and controlling of the transaction execution. As we mostly apply here the same performance indicators as in the previous subsection, these will not be repeated. Nevertheless, we underline that the speed dimension is valued differently as the time lag required to detect deviations from contractual agreements and the lead-time needed to take corrective measures are per-se monitoring costs and are conceptually not taking place during the execution of the transaction.

Table 7: Operational interoperability impact: monitoring phase

<table>
<thead>
<tr>
<th>MONITORING PHASE</th>
<th>supplier</th>
<th></th>
<th>customer</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Transaction costs (monitoring costs/transaction)</td>
<td>before</td>
<td>after</td>
<td>before</td>
<td>after</td>
</tr>
<tr>
<td>man hours worked (processing)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>man hours worked (interacting)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>time required to discover discrepancies from plan (hours)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>time required to react to discrepancies (hours)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>processability of information*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>accuracy of information**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transparency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>information availability***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.2.4 Strategic dimensions

In order to determine whether interoperability impacts significantly revenues or costs of the company investigated, we will first analyze the three strategic vectors “customers”, “operational excellence” and “suppliers” (see Figure 9). The role of direct interoperability impacts in the creation and/or support of these vectors will be finally discussed at the end of this section.

![Interoperability impact map](image)

**Figure 9: Interoperability impact map**

1) Supply side

Interoperability reinforces the various effects of electronic transactions which have been identified by Malone et al. (1987), i.e. electronic communication effects, electronic brokerage effects and electronic integration effects. In the case of low specificity of goods and services, interoperability increases, according to Malone et al. (1987), the power of the buying side and leads to a shift towards market based coordination (“Move-to-the-Market”). This is underpinned by the increasing number of companies which are reevaluating their core competencies with the effect of reducing their own value-added contribution and realizing a higher degree of outsourcing to contract manufacturers. Brynjolsson et al. (1994) assume that the use of IT and especially inter-organizational information systems made outsourcing to focused suppliers more profitable due to the reduction of coordination and monitoring costs (see also Wigand et al., 1997). BMW and Magna Steyr provide a good example in how information technologies enables BMW to outsource the production of the BMW X5 to a supplier specialized on the production of 4WD automobiles (Maidl et al., 2005).

In the case of significant relationship-specific investments however, interoperability favors hierarchies over market-based coordination. In this case, enterprises realize significant efficiency gains, e.g. reduction of excess inventories across the entire supply chain, by creating strategic networks with a limited number of business partners. This trend towards hierarchical coordination has been described by “Move-to-the-Middle” by Clemons et al. (1993).

Concerning the supply side, three questions help us understanding how an investing company
might be able to reduce its current input costs or at least limit their long-term growth. First of all, the impact of interoperability on supplier competition is investigated. In line with economic theory, we assume thereby that an intensification of the competition has a beneficial impact for the customers (Varian, 1999) and increases buying power. This competition can only be enacted when the switching costs in supplier relationships are low. In addition, the overall efficiency of the transaction (mostly measured through the level of coordination costs and the service agreements) can be improved with means of interoperable technologies and processes. The final aspect investigated in the questionnaire concerns the overall industry setting and is closely related to the three prior questions.

2) Operational excellence

Operational excellence relates to the ability of a company to meet the strategic targets at a supply chain level (Anupindi and Chopra, 1999). The wide range of articles dealing with performance indicators in supply chains (see for instance Reichmann, 1993 or Zäpfel and Piekarz, 1996) agree on the fact that the efficiency of a value chain can be reduced to two indicators: asset utilization and productivity. As Lee (2004) observes, many companies that managed to achieve very short cycle times and to minimize their supply chain costs have failed to keep pace with their competitors. Among others, Lee identifies agility, i.e. the ability to adapt immediately to a changing environment as the main condition for maintaining a sustainable advantage from your supply chain. The outstanding performance of Zara’s value chain is materialized by intensive online information exchanges between the retail stores and the Zara’s replenishment (Lee, 2004). Zara’s reactivity enables the firm to update frequently its collections while ensuring that all outlets are sold without stockout rebates.

To assess the impact of interoperability on operational excellence, we have filtered out five questions. The first question is concerned with the impact of operational agility, which is understood there as the ability to quickly react to environmental changes. Question 2 relates to asset utilization and the removal of manufacturing bottlenecks through a better use of information in the production process. This effect is observable in case PLA Inc in section 5.1 where the improvement of forecast accuracy helps avoiding the production of the wrong stock keeping units, thus releasing capacity to produce the “right” items. The length of the lead-times is critical as it is positively correlated with the inventory levels and negatively correlated with the manufacturing agility. For this purpose, we also ask for the impact on both lead-times and inventories to understand how interoperability really affects the manufacturing process.

3) Customers

On the customer side, interoperability allows to realize more customer contacts, to intensify customer interaction and to better service the overall customer process. Interoperability thereby contributes to customer intimacy which is considered one strategic option besides product leadership and operational efficiency in order to attain market leadership (Treacy and Wiersema, 1993). Besides customer intimacy, interoperability supports companies extending their product and service portfolio by bundling core competencies from different partners and forming innovative networks of value creation and. The may result in emerging business models such as intermediaries (Klein, 1996).

We investigate the impact of interoperability on customers by setting four questions. First, does the interoperability service provide a unique value to the customer, i.e. a reason for which the customer will choose without any doubt the interoperable company. After the completion of the first transaction, additional revenues might also stem from lock-in effects (Cásař et al., 2004) as interoperability requires investments in connecting with business partners which may become sunk costs when quitting the business relationship in a latter phase. Sabre from American Airlines is an example of lock-in effects as its customers are now bound to the interoperable booking services. Interoperability investments might also contribute to improve the overall attractiveness of a company’s product mix, either through bundling effects or by demonstrating the technology lead of the firm. Finally, Porter (1985) mentions that the ability to improve the cost function of its customers might be one sufficient vector for positioning and is therefore asked here.

4) Financials

Interoperability improvements on “customers”, “operational excellence” and “suppliers” will finally impact the financial dimensions, i.e. revenues and / or costs. Concerning the financial dimension, it is worthwhile to differentiate between investments creating a distinct competitive edge from neutralization investments (Moore, 2005). Moore estimates for instance that only the minority of investments are apt to achieve competitive differentiation but also that an important fraction of these investments aimed at
copying the products and services of competitors. In this context, interoperability investments could be what Carr (2004) defines under commodity investments. Under these conditions, information technology can become an order qualifier (a prerequisite to remain on the market) instead of acting an order winner. Finally, we ask to what extent manufacturing and procurement costs are expected to be reduced. Questionnaire application shows that although interviewees mention both revenue growth and cost reductions through interoperability, one of them is always clearly dominating.

Table 8: Questionnaire – strategic impacts of interoperability for one transaction partner

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Strategic Impact</th>
<th>Question</th>
<th>y/n</th>
<th>Supplier</th>
<th>y/n</th>
<th>Customer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financials</td>
<td>Increase or maintain</td>
<td>Increase significantly the company’s revenues?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>revenues</td>
<td>maintain the revenues at the current level? (remain on the market)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reduce cost</td>
<td>reduce operating costs in a long term perspective?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational</td>
<td>Improve agility</td>
<td>enable the company to quickly adapt to environmental changes (new markets, demand variations) at low cost?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>excellence</td>
<td>Increase productivity</td>
<td>improve the use of production capacity of the current manufacturing assets?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improve asset utilization</td>
<td>reduce the total manufacturing lead times?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improve asset utilization</td>
<td>shorten the total product development time?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improve asset utilization</td>
<td>minimize inventories?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customer</td>
<td>Improve product</td>
<td>provide a unique value to customer?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>and service portfolio</td>
<td>improve the attractiveness of the company’s product mix?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improve product</td>
<td>creates customer lock-in?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>and service portfolio</td>
<td>increase number of customer contacts and interactions?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strengthen customer</td>
<td>minimize the life-cycle costs on the customer's side</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>relationships</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply</td>
<td>Increase buying power</td>
<td>intensify the competition between suppliers?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strengthen supplier</td>
<td>reduce the costs of transacting with suppliers?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>relationships</td>
<td>reduce/suppress supplier switching costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strengthen supplier</td>
<td>improve the relationship environment with transaction partner?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>relationships</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Increase outsourcing</td>
<td>allow the outsourcing of activities to focused and more efficient partners</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.2.5 Linking operational and strategic impacts

In order to demonstrate how the interoperability impact assessment works, it is necessary to illustrate the linkage between operational and strategic impacts. For this purpose, we will address each strategic dimension in the following.

Concerning the impact of interoperability on operational excellence (see Figure 10), we observe that data quality indirectly determines a company’s ability to adapt to changes. Looking at supply chain management as an example, better data of the actual demand reduces the response delays in the supply chain. This ability results finally in a better agility. The information retrieval efforts and delays (here gathered under time) act as a bottleneck in many business processes. From supply chain literature (e.g. Zäpfel and Piekarz, 1996), we know that extended lead-times:

1) Increase the level of finished goods inventory by freezing production plans before the demand is known. As a consequence, the probability of supply/demand mismatch is high, especially in a global and uncertain environment.

2) Increase the level of work-in-process inventory since the delay between production steps is extended in the same fashion.

At the same time adapt to changing demand will positively impact the production’s throughput (productivity) while simultaneously reducing inventories and improving utilization of production capacities (asset utilization).

The efforts spent on data retrieval and processing impact negatively the productivity of a firm since more people are needed to perform the transactions. The intuition behind this conclusion is backed by Brynjolfsson et al. (1994) or Hammer and Champy (1993) who also document the fact that information technology reduces the amount of personal required to perform and monitor transactions. Assuming that the company keeps the same output, this reduction of workforce (production input) will automatically increase its productivity.
Concerning the impact of interoperability customer side (see Figure 11), we notice that connectivity efforts play a major role in the ability to improve the quality of customer relationships and the attractiveness of a product portfolio. The inception and integration efforts determine the time required to run the first transaction of a new product (in other words the speed to market). Although these efforts could induce significant connectivity costs, a first-mover might benefit from lock-in effects on the short term. Furthermore, this innovative policy might provide a significant technological edge and offer competitive differentiation opportunities. Nevertheless, the CAS case (see AVAG, 2006) shows us that the ability to provide such innovative services at a competitive price is critical to turn benefits from interoperability. In this context, the connectivity and coordination costs (mostly maintenance costs) will strongly impact the ability to increase a portfolio’s attractiveness.

Next to this, data and service quality play a role in minimizing the transaction costs of the customer and thus maintain fruitful customer relationships. “Good” data impacts the customer in the same fashion than the focal company analyzed in the operational excellence dimension (see above). Service quality, i.e. the ability to meet or surpass pre-agreed service agreements, contributes to reduce the monitoring efforts as the focal company demonstrates thereby its ability to deliver. The customer can thus allow himself to limit his quality checks at the boundaries, just as Japanese carmakers and their first-tier suppliers do (Bensaou and Venkatraman, 1995).
Concerning the impact of interoperability on the suppliers’ dimension (see Figure 12), we differentiate between “move-to-the-middle” (strengthen supplier relationships) and “move-to-the-market” (increase supplier competition) opportunities. We consider that data accuracy and processability improve both reaction time and transaction costs at the boundaries and result therefore in a better cooperation environment with suppliers.

A reduction of efforts required to connect to new suppliers might shift the power balance in favor of the focal company. In fact, by reducing its connectivity costs, the focal company also minimizes its switching costs occurring to get out of a lock-in situation and signals in this context its ability (and/or willingness) to switch suppliers. The supplier competition is enforced in the case of satisfactory data quality as it gets less costly and time-intensive to compare the performance of several competing suppliers.
We note that the correlations depicted here are intended to be reused as a template to guide the empirical investigations on the strategic impacts and their link to the operational level. Given the various facets of interoperability, a “frozen” causality framework does not seem to be the right approach as every case study provides some specificities (see for instance the mammaNetz case study in section 5.2). Nevertheless, we are able to identify some impact patterns with help of the Athena pilots, this will be presented in our next B3 deliverable, the Athena Impact Assessment.
4.3 How do the benefits of interoperability get distributed? A review

4.3.1 Background

After examining the impact of interoperability, it is also important to understand the conditions that lead firms to invest in interoperability, the potential barriers to these investments and the possible correcting actions or incentives that firms and policy makers may use to favor the achievement of interoperability. This section aims at facilitating this analysis by proposing a conceptual scheme that helps understand when and under which conditions investments in interoperability are likely to be undertaken spontaneously by the various actors in a value chain.

While the benefits of interoperability as detailed present a compelling picture for firms to invest in interoperability solutions, the benefits from improving the degree of interoperability in a value chain may not be distributed evenly among the different actors. Even if increasing interoperability is a zero-sum or a positive-sum game, there might be instances in which implementing interoperability solutions may not be desirable for one or more partners in the value chain. Clearly, when these instances occur, external coordination mechanisms or other types of value-sharing solutions become necessary to align incentives among firms and promote the diffusion of interoperability solutions along the chain.

Several studies have investigated the issue of value distribution in a value chain, especially in relation to the advantages generated by better management of inventory and improved visibility of orders. This literature is too vast to be exhaustively covered, but Table 9 summarizes the result of some selected contributions to this literature. It distinguishes the various studies based on: i) the type of interoperability investments examined (from mere EDI adoption to implementation of Vendor Managed Inventory programs); the methodology used (empirical vs. modeling works) and the settings of the study (type of industry, number of actors analyzed etc...). Two general observations emerge from the analysis of this literature. First, no clear patterns can be identified for the distribution of the value generated by increasing interoperability. The largest majority of theoretical and modeling works suggest that the value distribution depends on several contingency factors, such as the type of interoperability solution examined, the distribution of customer orders, and the like. Second, it appears clear that there is a generalized lack of empirical studies that explicitly addresses the issue of value distribution, with the exception of a few industry surveys that generally emphasize the benefits of sharing information (Kurt Salmon Associates, 1993).
Table 9: Selected case studies on the value of interoperability and shared information

<table>
<thead>
<tr>
<th>Interoperability effect examined</th>
<th>Supplier</th>
<th>Buyer</th>
<th>TOTAL</th>
<th>Characteristics</th>
<th>Setting</th>
<th>Methodology</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information sharing between manufacturers and retailers</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>industry survey</td>
<td>Grocery</td>
<td>survey</td>
<td>Kurt Sammon Associates 1993, Troyer 1996</td>
</tr>
<tr>
<td>Retailer gives full visibility of demand to manufacturer</td>
<td>+</td>
<td>0</td>
<td>+</td>
<td>Demand iid over time and low variance, Demand autocorrelated</td>
<td>General</td>
<td>model</td>
<td>Gavirneni et al. 1999, Lee et al 2000</td>
</tr>
<tr>
<td>Manufacturer decreases lead time</td>
<td>0</td>
<td>+</td>
<td>-</td>
<td>Demand iid over time and low variance, Demand autocorrelated</td>
<td>General</td>
<td>model</td>
<td>Lee et al 2000</td>
</tr>
<tr>
<td>Retailer gives full visibility of demand to manufacturer</td>
<td>0⁺</td>
<td>0⁺</td>
<td>0⁺</td>
<td>one supplier-multiple buyers, demand iid</td>
<td>General</td>
<td>model</td>
<td>Cachon and Fisher 2000</td>
</tr>
<tr>
<td>Vendor Managed Inventory</td>
<td>0⁻(^{+})</td>
<td>0⁻(^{+})</td>
<td>0⁻(^{+})</td>
<td>one supplier-multiple buyers</td>
<td>General</td>
<td>model</td>
<td>Kulp 2002</td>
</tr>
<tr>
<td>EDI</td>
<td>?</td>
<td>0</td>
<td>0</td>
<td>one supplier-multiple buyers</td>
<td>Grocery</td>
<td>empirical</td>
<td>Clark and Hammond 1997</td>
</tr>
<tr>
<td>Vendor Managed Inventory + EDI</td>
<td>?</td>
<td>+</td>
<td>+</td>
<td>one supplier-multiple buyers</td>
<td>Grocery</td>
<td>empirical</td>
<td>Clark and Hammond 1997</td>
</tr>
<tr>
<td>Information sharing</td>
<td>0</td>
<td>?</td>
<td>0</td>
<td>one supplier-multiple buyers</td>
<td>General</td>
<td>empirical</td>
<td>Kulp et al 2004</td>
</tr>
<tr>
<td>Information sharing + Vendor Managed Inventory</td>
<td>+</td>
<td>?</td>
<td>+</td>
<td>one supplier-multiple buyers</td>
<td>General</td>
<td>empirical</td>
<td>Kulp et al 2004</td>
</tr>
<tr>
<td>Truth-telling collaboration mechanisms</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>one supplier-multiple buyers</td>
<td>General</td>
<td>model</td>
<td>Cachon and Lariviere 1999</td>
</tr>
<tr>
<td>Sharing of retailer POS demand data</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>one supplier-multiple buyers. Demand autocorrelated</td>
<td>General</td>
<td>simulation</td>
<td>Raghunathan 2001</td>
</tr>
<tr>
<td>Vendor Managed Inventory</td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>multiple supplier-one buyer</td>
<td>General</td>
<td>model</td>
<td>Mishra and Raghunathan 2004</td>
</tr>
<tr>
<td>Retailer gives full visibility of demand to manufacturer</td>
<td>0⁻(^{+}) (beneficial only if demand pattern has low variability)</td>
<td>0</td>
<td>-(^{+})</td>
<td>one supplier, one buyer</td>
<td>General</td>
<td>model</td>
<td>Steckel et al 2004</td>
</tr>
<tr>
<td>Retailer gives full visibility of demand to manufacturer</td>
<td>+</td>
<td>-</td>
<td>?</td>
<td>one supplier, one buyer</td>
<td>General</td>
<td>model</td>
<td>Li 2005</td>
</tr>
<tr>
<td>Retailer shares cost information with manufacturer</td>
<td>+</td>
<td>-</td>
<td>?</td>
<td>one supplier, one buyer</td>
<td>General</td>
<td>model</td>
<td>Li 2005</td>
</tr>
</tbody>
</table>
4.3.2 Scenarios of value distribution

Clearly, increasing interoperability generates value only if the benefits created are greater than the cost of achieving higher interoperability levels. We distinguish the following cases:

- If interoperability increases the productivity of the whole value network but not the profitability of any single echelon in a supply chain, then the whole value generated is appropriated by the consumers (or the government).
- The total value generated by increasing interoperability can have both the effects – increasing the value of one or more partners in the supply chain and increasing consumer value.
- The total value generated by increasing interoperability is appropriated only by the firms in the chain (unlikely to occur in a regime of perfect competition).

The value generation paradigm outlined above raises the natural question – When would firms invest in interoperability and who in Figure 13 appropriates the value created by interoperability?

Figure 13: Classical supply chain actors

As discussed in section 3.2.2, there could be conditions which may not be conducive to increasing the level of and investing in interoperability. The value of interoperability will essentially depend upon the buyer-supplier power relationships in the particular industry although, in theory, each of the four echelons can appropriate the value generated by interoperability. As a schematic consider in the following, the entity denoted by red as the one who appropriates the surplus arising out of interoperability. There may of course be a myriad mixture of one or more of these conditions.

Figure 14: Potential actors appropriating interoperability value

The value creation question then is – Is this appropriation of value by one or more echelons of the value chain, generate overall value for the value chain? For sake of simplicity we consider just a dyadic relationship between one buyer and one supplier (Figure 15). The actual value chain for a firm is much more complex, but we can get a sense of the issues involved by analyzing at the basic level of a dyadic relationship and then integrating upwards.

Figure 15: Dyadic relationship as object of investigation
We identify the following four different scenarios:

(A) Win-Win – The value generated is positive both for the supplier and the buyer (and of course for the value chain as a whole). Buyer and suppliers both have incentives to increase interoperability. No incentive mechanism is necessary (Figure 16).

(B) Supplier (or buyer) advantage but interoperability adds positive value to the whole chain – In this scenario, although the supplier (buyer) appropriates most of the rents while the buyer (supplier) suffers from a loss. In such a case, collaboration between the supply chain partners is still possible but the partner which benefits more needs to share in the costs of increasing interoperability levels (Figure 17).

(C) Supplier or buyer advantage but interoperability adds negative value to the whole chain. This is the scenario where collaboration is not likely to occur, unless power regime is strongly in favor of the supplier or the buyer.
(D) Interoperability adds negative value to both the echelons – buyer and supplier. Clearly, in this scenario, investment in increasing interoperability will clearly not occur. One needs however to demonstrate the negative impact of such investments in a structured manner. As Carr (2003) states, not all IT investments are necessarily beneficial for the firms since the benefits might not compensate the high introduction costs of an IT-solution.

Figure 18: Interoperability harms the value chain, one partner wins

Figure 19: Negative value to both echelons

4.3.3 A contingency picture

While it is difficult to argue a priori which actors in the chain will benefit the most from an increase in interoperability, some inferences can be made about when the value generated will benefit one or the other actor as a function of the industry structure (see Figure 20).
We argue that from a buyer’s point of view the value of interoperability increases with an increase of the buyer’s degree of dominance over the supplier. As a result, a long-lasting relationship between buyer and suppliers based on mutual trust is probably the most appropriate form of relationship to extract the benefits of interoperability. Conversely, in a situation in which the supplier’s dominance is the norm, the value of interoperability to the buyer is minimal. In such a context the buyer may prefer to enforce a type of relationship with its suppliers based on a competitive model.

Combining the arguments detailed in the previous paragraphs, we can summarize the following for interoperability investments. The governing variables for interoperability are market dynamism, industry structure and regulations. These variables will moderate and control the value creation in the supply chain under study and are encompassed in the Business Interoperability Framework. If the conditions are appropriate, investments in interoperability will be deployed in alignment with the strategic goals of the firm. The investments will focus on processes that are affected with the suppliers and customers. At the day-to-day working level, these may be largely operational processes (like distribution logistics, sourcing etc) and product development processes (like engineering collaboration). At the strategic level, the leadership practices, the strategic planning processes and the human resource policies will be affected. These changes may lead to enhanced value creation for the consumer in terms of better and faster products and lowered life cycle cost of the products.

Figure 20: Impact of power regime in the value chain
5  Case studies

5.1  Collaborative planning and forecasting: the PLA Inc. case

5.1.1  Scenario

PLA is a second-tier automotive supplier providing polyvinyl butyral sheets (PVB) to glass manufacturers (also called laminators, LAM). These plastic sheets are applied in the windshields in order to produce safety or colored glass. Since automotive manufacturers transfer their forecasts and orders via EDI, PLA is able to assess its global workload. Nevertheless, the demand for specific PVB product variants (size, formulation) as well as the detailed roll-out of PLA’s production is tied to the production schedule of its direct customers. Since OEMs change their demand data on a daily basis (sometimes even more frequently), laminators have to update their production schedule at the same pace. In order to keep in touch with the evolution of the demand, PLA’s supply chain managers have to retrieve their demand forecasts from their customers’ schedules to access to the latest information. By now, this data exchange is done manually and makes extensive use of email and fax between PLA and LAMs. Once the data has arrived, it needs to be analyzed and transformed in the internal target data format prior to be uploaded into the enterprise resource planning system. This upload then triggers a new computation of the supply chain plan if the demand variations go beyond a critical yield. Unlike automotive OEMs, PLA is a chemical company and its manufacturing technology does not enable either PLA or its competitors to manufacture just-in-time (especially because of the long setup times in batch production). In this context, batch sizes cover several days or weeks of production. Hence, PLA needs very accurate forecasts in order to avoid having the wrong products on inventory and optimize the utilization of production capacities.

Given the fact that PLA deals with at least 10 major automotive suppliers worldwide, the data retrieval process is very time-consuming and is therefore quite expensive. Internal assessments indicate that about 1 man-month/year is required per main automotive laminator to obtain, prepare, verify and upload the data of this strategically critical process. Since this process is only one aspect of the supply chain manager’s job, the data update is not always done immediately. This delay induces frequent interactions between PLA’s schedulers and supply chain managers as the schedulers are aware of this delay and want to ensure that their input data reflects the most recent situation.

![Diagram](image)

*Figure 21: Collaborative forecasting process: overview*

A standardized way for exchanging forecast data with LAMs would help achieving significant improvements on PLA’s side. The incoming data could be directly uploaded into PLA’s ERP system thus
speeding up the intake process while leaving more time for a critical review of the incoming data. The creation of a software module on LAM’s side transforming the detailed schedules into standardized forecasts is, nevertheless, a prerequisite to process the incoming data. Given the very high transaction frequency and the commoditization level of the chemical industry, the data sets are expected to remain stable in the long run and should contain the following information: the status (order, forecast and modification), the delivery date, the number of rolls, their specific width and length, as well as the product formulation. In the following, we will investigate the impact of this interoperability improvement at the strategic and operational level for both PLA and a typical main customer (laminator) called in the following LAM.

5.1.2 Operational assessment

Connectivity phase

The expected efforts for the conceptualization of the electronic workflow and forecast data exchange at PLA are evaluated at 20 K$ for as well as 50 K$ for the development of the supporting IT-solution. The rollout costs at each PVB supplier would amount for an equivalent amount given the fact that these are, like PLA, already experienced in mapping data sets from industry standards into their company-internal representation. The costs for integrating the exchange workflow in the ERP installation of PLA is not expected to exceed 10 K$ as the data mappings are not complex. From PLA’s standpoint, the costs for integrating one specific customer into this workflow would not exceed 10 K$ too. However, this assumption of 10 K$ incremental connectivity costs for PLA holds only if all laminators agree on a standard data structure and format that all from them will support in the future (see Figure 22). In the case where each OEM would impose a specific solution, PLA would be obliged to bear incremental costs of 90 K$ for each business relationship. In other words, PLA would need to develop a new application to interface with other laminators (see Figure 23). The contribution of Athena tools, i.e. ontologies and semantic reconciliation tools, in avoiding such situations is in this context evident.

Figure 22 Connectivity costs for 1:n relationship

As IT is considered as a supporting activity that would, in theory, not be required to run a transaction, the supply chain managers of PLA do not expect any reduction in the time required to setup business relationships and to run the first transactions.
Concerning the laminators, it is interesting to notice that the estimated setup costs are a bit higher than for PLA since the scheduling application needs to be extended and linked to the ERP system in order to ensure the quality of the information exchanged (ERP integration costs +/- 50 K$). In the worst case, the total sunk costs would amount for 120 K$ and could be amortized on the four main PVB suppliers worldwide. Assuming that the suppliers would stick to LAM’s implementation and not the other way round, the incremental costs for adding a new partner would be close to zero.

Figure 23 Connectivity costs for 1:1 relationship
Table 10: Operational interoperability impacts – PLA/LAM connectivity

<table>
<thead>
<tr>
<th>Transaction object:</th>
<th>PLA</th>
<th>LAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actor investigated:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interoperability actions:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Coordination phase

The standardized workflow which enables the electronic exchange of forecast data improves significantly the quality of the information in terms of processability and accuracy. As a consequence, the processing and interaction time between supply chain stakeholders (SC managers, PLA’s schedulers and LAM’s ones) are reduced by 25 minutes/transaction for PLA and by 10 minutes/transaction for LAM. This discrepancy is explained by the fact that PLA’s internal interactions encompass more people and would lead to savings of about $2,000 for this specific business relationship. The main beneficial impact for PLA is however that the information can now be easily updated into PLA’s ERP system without any delay. As a consequence, the campaign planning is performed with the best information possible, reducing thereby the probability of a demand/production mismatch. PLA estimates than 1-2% of the rolls produced for LAM have the wrong size and needs to be reworked. Assuming a rework cost of $1,000/roll, 5 rolls in average/transaction and a 2% misfit rate, the expected rework savings amount for $25,000/year (with 250 transaction/year), not including the reduction of inventory waiting for being reprocessed.
The overall expected coordination costs savings amount to about 27 K$ per year for PLA. Thus the discounted savings for one LAM-like business relationship sum up to 118 K$ over 6 years. Table 11 summarizes the value created by the interoperability solution with respect to the number of laminators connected and the way they setup their information exchange. According to the results, the value of interoperability strongly depends on the ability of PLA to strive for a 1:n or a n:m relationship in the future. The solution developed with LAM needs therefore to be standardized enough to allow relatively seamless integration with LAM’s competitors. We can also derive from the results that the payoff time is negatively correlated to the number of partners connected. This can be explained by network effects since in the current PLA-LAM scenario, the more partners are connected, the more value is created.

Table 11 Interoperability payoff for PLA with respect to setup and number of partners

<table>
<thead>
<tr>
<th>PLAs transaction costs</th>
<th>1 laminator</th>
<th>2 laminators</th>
<th>3 laminators</th>
<th>4 laminators</th>
<th>5 laminators</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1:n</td>
<td>-90 K$</td>
<td>-100 K$</td>
<td>-110 K$</td>
<td>-120 K$</td>
</tr>
<tr>
<td></td>
<td>n:m</td>
<td>-80 K$</td>
<td>-80 K$</td>
<td>-80 K$</td>
<td>-80 K$</td>
</tr>
<tr>
<td>coordination savings</td>
<td>all</td>
<td>118 K$</td>
<td>235 K$</td>
<td>353 K$</td>
<td>470 K$</td>
</tr>
<tr>
<td>value of interoperability</td>
<td>1:1</td>
<td>28 K$</td>
<td>55 K$</td>
<td>83 K$</td>
<td>110 K$</td>
</tr>
<tr>
<td></td>
<td>1:n</td>
<td>28 K$</td>
<td>135 K$</td>
<td>243 K$</td>
<td>350 K$</td>
</tr>
<tr>
<td></td>
<td>n:m</td>
<td>38 K$</td>
<td>155 K$</td>
<td>273 K$</td>
<td>390 K$</td>
</tr>
</tbody>
</table>

assumptions

- cost of capital = 10%/year
- all partners from the same size as LAM
- sum of discounted savings over 6 years

Although the resulting interoperability investment at a laminator (120 K$) can be amortized on the four main PVB suppliers worldwide that would benefit from this formalization, LAM has no specific incentive to do so given the current market powers and the expected savings on their side (< 1.5 K$/supplier/year). Even worse, LAM has no benefit in improving the n:m capability of his interface as the implementation costs on his side would remain at 120 K$. As a consequence, PVB suppliers would have to partly finance the investment to enable the realization of a value-creating interoperability solution. A collaborative approach in which the savings of PLA are shared with LAM is required to achieve the expected savings, as already expected in section 4.3.3.
5.1.3 Strategic assessment

Concerning PLA, we notice that both revenues and costs are impacted on the long-term by the quality improvement of the data exchanged. Firstly, the lower interaction intensity eases the task of the supply chain managers who can focus more on their primary coordination tasks and spend less time on troubleshooting. This should result in a better decision-making process on a day-to-day basis but this effect is very difficult to quantify. According to the estimations of PLA, less production/demand mismatches would not only avoid rework but also release some significant manufacturing capacity if all customers of PLA would stick to such a workflow. Nevertheless, this impact is limited if only one customer enables PLA to improve the accuracy of its planning data. We notice that the lower rework rates automatically reduce the amount of finished goods that need to be reprocessed, i.e. the inventory of finished goods is reduced. As the product structure is divergent (few input materials, many output variants), this effect has no impact on the inventories of raw materials. The lead-times for the 2% fraction of “mismatched” rolls are also reduced by a couple of days which are required to perform the rework activities. Thus the impact on lead-times concerns only a very small fraction of the total demand and is very limited.

The impact analysis on customers is very insightful about the dynamics underlying interoperability solutions. It turns out that a lock-in effect could be occurring only if the electronic workflow is performed in a 1:1 relationship although this situation is not very likely given the supply power of LAM. Once the
standard workflow is adopted by all suppliers of LAM, PLA does not have a transactional advantage over its competitors anymore.

### Table 13 Strategic interoperability assessment - PLA's perspective

Does the interoperability investment contribute to...

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Strategic Impact</th>
<th>Question</th>
<th>PLA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Financial</strong></td>
<td>Increase or maintain revenues</td>
<td>increase significantly the company's revenues?</td>
<td>y/n</td>
</tr>
<tr>
<td></td>
<td>Maintain the revenues at the current level?</td>
<td>By now, collaborative forecasting is not applied in the laminators industry (here LAM), it is therefore no order qualifier</td>
<td>n</td>
</tr>
<tr>
<td></td>
<td>Reduce costs</td>
<td>reduce operating costs in a long term perspective?</td>
<td>y/n</td>
</tr>
<tr>
<td><strong>Operational excellence</strong></td>
<td>Improve agility</td>
<td>enable the company to quickly adapt to environmental changes (new markets, demand variations) at low cost?</td>
<td>y/n</td>
</tr>
<tr>
<td></td>
<td>Increase productivity</td>
<td>improve the use of production capacity of the current manufacturing assets?</td>
<td>y/n</td>
</tr>
<tr>
<td></td>
<td>Improve asset utilization</td>
<td>reduce the total manufacturing lead times?</td>
<td>n</td>
</tr>
<tr>
<td></td>
<td>Shorten the total product development time?</td>
<td>This collaborative forecasting process is independent from the product development process</td>
<td>n</td>
</tr>
<tr>
<td></td>
<td>Minimize inventories?</td>
<td>The most expensive inventories kept are final products, which are reduced by better forecasts. The raw materials inventories are not impacted by this improvement as the three raw materials can be reused for all finished product variants</td>
<td>n</td>
</tr>
<tr>
<td><strong>Customer</strong></td>
<td>Improve product and service portfolio</td>
<td>provide a unique value to customer?</td>
<td>n</td>
</tr>
<tr>
<td></td>
<td>Improve customer relationships</td>
<td>create customer lock-in?</td>
<td>y/n</td>
</tr>
<tr>
<td></td>
<td>Increase number of customer contacts and transactions?</td>
<td>n</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Minimize the life cycle costs on the customer's side</td>
<td>PLA is obliged to deliver the products to a JIT process for which very high penalties are foreseen in case of delivery delays. LAM is able to force PLA to keep safety stocks, the inventory impact for PLA is not existent</td>
<td>n</td>
</tr>
<tr>
<td><strong>Supply</strong></td>
<td>Increase buying power</td>
<td>increase the competition between suppliers?</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>Strengthen supplier relationships</td>
<td>reduce the costs of transacting with suppliers?</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>Reduce/suppress supplier switching costs</td>
<td>PLA's suppliers are not impacted by this interoperability improvement</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>Improve the relationships with transaction partner?</td>
<td>n</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Allow the outsourcing of activities to focused and more efficient partners?</td>
<td>n</td>
<td></td>
</tr>
</tbody>
</table>

Concerning LAM, the strategic impact of the interoperable solution between PLA and LAM is low due to the industry structure. It turns out that LAM has no means here to improve its operational excellence as the company faces the same constraints with OEMs (safety stocks, JIT delivery) as PLA faces with LAM. As a consequence, the customer dimension of LAM is also not impacted by the collaborative forecasting solution.

The main strategic effects are expected on the suppliers’ side of LAM. A lock-in effect might result from the first connection with a specific PLA but a rollout to other suppliers will neutralize this effect and even ease the switching from one supplier to the other as no efficiency loss in the coordination phase would occur through the switch. Thus, although LAM has no financial incentive at an operational level to introduce the solution, it has a strategic interest in doing so as it would lead finally to a reduction of its procurement costs.
The reduction of the interactions between schedulers of LAM and the supply chain managers would contribute to improve the relationship’s environment but this effect is not significant from a strategic standpoint as price is the decisive order winner.

### Table 14 Strategic interoperability assessment - LAM’s perspective

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Strategic Impact</th>
<th>Question</th>
<th>y/n</th>
<th>LAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financials</td>
<td>Increase or maintain revenues</td>
<td>increase significantly the company's revenues?</td>
<td>n</td>
<td>Collaborative forecasting between PLA and LAM does not impact carmaker</td>
</tr>
<tr>
<td></td>
<td>Increase or maintain revenues</td>
<td>maintain the revenues at the current level? (remain on the market)</td>
<td>n</td>
<td>LAM is able to force PLA to keep safety stocks for which LAM does not pay, supply is ensured through safety stocks. By reducing the costs of his suppliers, LAM could be enacted to ask for a fraction of these savings</td>
</tr>
<tr>
<td></td>
<td>Reduce costs</td>
<td>reduce operating costs in a long-term perspective?</td>
<td>n</td>
<td>No impact as PLA keeps safety stocks at LAM’s sites to ensure JIT fulfillment at PLA’s cost</td>
</tr>
<tr>
<td>Operational excellence</td>
<td>Improve agility</td>
<td>enable the company to quickly adapt to environmental changes (new markets, demand variations) at low cost?</td>
<td>n</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Increase productivity</td>
<td>improve the use of production capacity of the current manufacturing assets?</td>
<td>n</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improve asset utilization</td>
<td>reduce the total manufacturing lead times?</td>
<td>n</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improve asset utilization</td>
<td>shorten the total product development time?</td>
<td>n</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improve asset utilization</td>
<td>minimize inventories?</td>
<td>n</td>
<td></td>
</tr>
<tr>
<td>Customer</td>
<td>Improve product and service portfolio</td>
<td>provide a unique value to customer?</td>
<td>n</td>
<td>Collaborative forecasting between PLA and LAM does not impact carmaker</td>
</tr>
<tr>
<td></td>
<td>Improve product and service portfolio</td>
<td>improve the attractiveness of the company’s product mix?</td>
<td>n</td>
<td>same as for PLA</td>
</tr>
<tr>
<td></td>
<td>Strengthen customer relationships</td>
<td>creates customer lock-in?</td>
<td>n</td>
<td>Collaborative forecasting between PLA and LAM does not impact carmaker</td>
</tr>
<tr>
<td></td>
<td>Strengthen customer relationships</td>
<td>increase number of customer contacts and interactions?</td>
<td>n</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strengthen customer relationships</td>
<td>minimize the life-cycle costs on the customer’s side</td>
<td>n</td>
<td>LAM faces in its relationship with automotive OEMs the same constraints as PLA with LAM</td>
</tr>
<tr>
<td>Supply</td>
<td>Increase buying power</td>
<td>intensify the competition between suppliers?</td>
<td>n</td>
<td>In a first step no, thanks to lock-in effect between PLA and LAM. Nevertheless, once collaborative forecasting is standardized and extended to competitors, then business relationship can be performed in the same efficient fashion with PLA and its competitors</td>
</tr>
<tr>
<td></td>
<td>Strengthen supplier relationships</td>
<td>reduce the costs of transacting with suppliers?</td>
<td>n</td>
<td>To a very small extent as the interactions with PLA are performed next to other scheduling activities</td>
</tr>
<tr>
<td></td>
<td>Strengthen supplier relationships</td>
<td>reduce supplier switching costs</td>
<td>n</td>
<td>Yes, if all suppliers stick to standard, all are able to pass savings to LAM</td>
</tr>
<tr>
<td></td>
<td>Strengthen supplier relationships</td>
<td>improve the relationship environment with transaction partner?</td>
<td>n</td>
<td>Less interactions lead to less frictions, but here again, low impact</td>
</tr>
<tr>
<td></td>
<td>Increase outsourcing</td>
<td>allow the outsourcing of activities to focused and more efficient partners?</td>
<td>n</td>
<td>The laminating process is a core competence that cannot be outsourced</td>
</tr>
</tbody>
</table>
5.1.4 Conclusions

This case study provides insights into the critical role of interoperability investments to improve the processing speed of repetitive transactions at the boundaries of organizations. We notice that the interoperability improvement impacts the relationship in several ways (see Figure 24): through the reduction of manual processing work, PLA’s planners have easy access to the most recent planning information and can react accordingly. The resulting increase in reactivity of the planning process has two consequences: first, it leads to less non-value-adding human interactions between supply chain managers and schedulers. Furthermore, it enables a later freezing of the production plans. The PLA which was subject to our investigation expected that about 2% of the total rolls produced have the wrong size given to this lack of reactivity. These mismatched rolls add up to the rework costs of PLA, delay the delivery of these rolls to the laminator and consume resources to fit the PVB rolls to customers’ requirements. Better interoperability therefore impacts positively both, productivity (less resources are required to manufacture the rolls) as well as the utilization of the available assets (marginal reduction of finished goods inventories). In this case, the interoperability solution contributes clearly to the achievement of a cost leadership strategy for PLA.

This case study is also insightful as it shows the relevance of separating strategic from operational impact analysis. We observe that LAM has no operational benefit of bearing the development costs and of adopting the interoperability solution as his power allows him to force his suppliers to carry significant safety stocks. Nevertheless, by adopting the standardized workflow, LAM is enacted to ask for rebates to all the suppliers aligning to this workflow. As a consequence, if LAM has no immediate benefits of interoperability, the company has a strategic interest in forcing the adoption of the solution.

A classical effect of interoperability solutions is also present in this case study. We notice that the payoff time for PLA’s interoperability investment depends strongly on the setup of the interoperability solution as well as on the number of actors (laminators and their suppliers) adopting the solution. We can deduce that significant network effects play when introducing interoperability solutions.

The definition of common process and message standards for the exchange of forecast information accepted by all laminators would contribute to the achievement of a n:m vision at low cost (see Figure 25). All partners would be able to connect to a virtual platform for the information exchange at no cost. In the current industry setup, this situation would benefit more to suppliers (sunk costs of
80K$, no incremental costs) than to the laminators whose connectivity costs would remain the same. It is thus questionable whether laminators have an interest in engaging in the definition of a common standards and bear additional development costs for this purpose. Considering the Athena vision of seamless interactions, one needs to recognize that interoperability technologies significantly contribute to the reduction of connectivity costs but not to their vanishing. Companies will still, in a near future, have to bear integration costs to communicate with internal applications. The question is how much of these efforts can be avoided by applying innovative interoperability concepts such as service-based integration, model-driven development or semantic reconciliation.

5.2 Healthcare management: improving cancer therapy through interoperable concepts

5.2.1 Introduction

In recent years, the ever increasing costs of the health care systems have developed into a serious financial burden for many countries all over the world. PricewaterhouseCoopers (2006) states in its report “Health Cast 2020” that the health expenditures of the 24 member countries of the Organisation for Economic Co-operations and Development (OECD) will more than triple by 2020. According to their forecast health care expenditures will eventually add up to 21 per cent of the gross domestic product (GDP) in the United States and, on average, 16 per cent of the GDP in other OECD countries (see Figure 26). In case of the OECD countries, the health care costs in real dollars will increase from 2 Trillion USD in 2002 to over 10 Trillion USD in 2020.

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**Figure 25 Connectivity costs in n:m relationship**

**Figure 26: Projected health spending in percent of GDP**
Even in as strong an economy as France the expected increase of the health care costs is alarming. The British newspaper “The Guardian” (Henley, 2004) cites financial experts even expecting the French health care system to collapse by 2020. Although the French health care system was ranked the best in 2000 by the World Health Organization, the French health ministry estimated already in 2004 that it was losing €23,000 a minute. By extrapolating these estimates, state officials expected that by the end of 2004 the health care system would turn a loss of 11.5 billion Euros.

The increasing number of drug prescriptions has been identified as one of the major causes of this negative development of the budget (Willsher, 2004). Today, France has the second highest pharmaceutical drug consumption rate among the OECD countries. According to OECD statistics, the French consumption of pharmaceuticals accounts for 21 per cent of France’s overall health spending, whereas this figure amounts to 12.4 per cent in the U.S. and 14 per cent in Germany. A big share of the high expenditures for drugs in France is explained by the over-proportionally frequent prescription of mood-altering drugs. Today, almost one in five of the adult French population take mood-altering medicines and almost one in 10 say that they had taken sleeping pills or tranquilizers in the previous week. Many factors contribute to this changing consumption behaviour.

However, experts state that the symptom thresholds above which a physician considers a medication to be necessary, e.g. in the case of insomnia or pain, have constantly decreased over the years. This development has been flanked by an ever decreasing scepticism of the patients against drugs and their adverse effects, and it is thus no wonder that both sides resorted to pharmaceuticals much earlier than it has happened in the years before.

The observations in the French health care system are just one example of an overall problem that many countries in the world will have to counter in near future: the exceeding of the health care budget caused by an over-proportional increase in spending. From an economist’s perspective, one of the main reasons for the rapidly developing imbalance between healthcare spending and earnings is that supply, demand and financing are not aligned. In a worst case scenario, this would mean that physicians only prescribe the most lucrative treatments and patients request as many treatments as possible, regardless if these are necessary or not.

The health insurances, on the other hand, try to save money by all means regardless of medical necessity or cost-benefit ratio. In other words, they focus on lowering the current costs and don’t take into account that short-sighted reduction of the current costs (e.g. in avoiding preventive actions) may result in higher expenses in the future. Consequently, the overall costs would keep on growing while the overall quality level would keep on decreasing. The given scenario is certainly an exaggeration of the current situation, but the symptoms one can currently observe indicate that many health care systems are heading in this direction. It is thus essential to take corrective actions at this stage with the tools of economic analysis, sustainable management and information technology.

In the current eHealth discussion, many approaches have been proposed to improve interoperability in the health care network. For instance, interoperability can be improved by maintaining an electronic file for each patient that stores a list of the conducted treatments, the medical findings and a list of the current medication. Ideally, this file should be available to every physician who can, by cross-checking with the entries in the file, prevent double examinations and hazardous combinations of pharmaceuticals. Another example is the electronic transfer of diagnostic findings between providers. Today, it is common practice in most countries to transfer diagnostic findings on paper basis. Standardized, secure electronic transfer would reduce transfer delays and significantly reduce failures in the medical treatment. However, while eHealth is mainly concerned with the technical implementation of these particular types of technology, the case study is mainly concerned with the interplay of economic units in the health care system and their need for interoperability.

The subject of the case study deals with the creation of an additional actor in the German health care network called “health management company”. The introduction of this new participant into the German network takes place in two stages. In a first stage, this novel participant improves the interoperability by supporting patients in the coordination of their therapy. In a second stage, which requires a solid legislative ground, the health care company will not only guide the patient through the therapy but also act as a cost centre that has better possibilities to achieve a cost-efficient recovery process while not compromising the quality of the treatment. The health management companies have a multitude of tools at their disposition that they can employ to streamline the workflow in the health care network.

For example, health management organizations can negotiate lower prices with the providers that are applicable to large groups of patients. In return, the patients are sent to the providers with which a contract has been signed. By means of this symbiosis, the overall effectiveness is improved and the
cost reduced. In other words, a business relationship is established between health management companies and providers during which information about the patient is exchanged. As a result, both parties have a strong interest in establishing a high level of interoperability in order to decrease their transaction costs. Therefore, the steps to improve interoperability that are taken in the first stage are later on further extended.

In fact, the interoperability improvements in the first stage can be enhanced in the second stage such that the new role of the health management company is supported and strengthened. A further beneficial effect of the health management company acting as cost centre and contracting providers is that the overall structure of the health care system is modified and a new kind of competition in health care is established. Nowadays, many health care systems suffer from the problem that underperforming health care providers simply remain in the system. The reason for this systematic flaw is that health care providers don’t directly compete with each other, i.e. there are no competitors that could replace them. In other words, market rules don’t apply in health care which is one of the major reasons why supply and demand are not balanced.

Competition in health care, if at all, only takes place at the level of health insurances. But health insurances are not the entities which directly create value for the patient. Thus, it must be one of the goals to establish competition on value for the patient at the stage of health care providers. This will eventually remove mediocre health care providers, support innovations, and decrease costs. Hence, the case study complements the technical contributions of eHealth by examining interoperability in health care at the business economic level where members of the health care network are economic units, respectively, business companies establishing business relationships with each other to stay competitive. Thus these actors exchange information within their “healing network” and are therefore in need of high interoperability.

The establishment of such business relationships between economic units in the health care network builds on a concept called managed care which is described in more detail in section 5.2.2. It describes managed care by means of its central organizational entity, namely the managed care organizations. Furthermore, the shortcomings of the U.S. system are delineated and compared to the planned health management companies in Germany which were briefly delineated above. Section 5.2.3 explains the case study, called mammaNetz, and is structured as follows. First, the state-of-the-art of the breast cancer therapy is described. Thereafter, the two steps in which mammaNetz shall be realized and the accompanying improvements to the health care system are detailed. In step one, the case manager is introduced while step two is concerned with the introduction of a virtual interoperable health management company. Currently, mammaNetz is still in phase one and preparations are under way for the second step. However, this is still a future vision of the project as a necessary legal basis for the establishment of this company has not been created until now. The recent political discussion in Germany about how to overhaul the health care system is just one more proof of how important the development of alternative ways in health care is. In section 5.2.4, the interoperability evolution at the different stages of mammaNetz are described and explained by applying the Business Interoperability Framework (BIF). Finally, we analyze the impacts of interoperability at both operational and strategic levels for the “patient recovery value chain” in section 5.2.5.

5.2.2 Managed care in the U.S.: principles and problems

Managed care is a general term that denotes systems and techniques to control the use of health care services and to improve their quality (Austrin, 2000). Examples of such techniques are health care management, development of efficient payment mechanisms, methods for the enhancement of collaborations, establishing of review mechanisms and a lot more. Improvements are often achieved by changing managerial and organizational structures of the participants in health care, e.g. by arranging doctors, hospitals, and other providers into groups. This way, the quality and cost-effectiveness of health care delivery is expected to improve (Shouldice, 1991).

From a global management perspective, managed care is about optimizing the workflow in the health care network. The first major group of participants in the care network consists of the providers of medical treatments, for instance the physicians or hospitals. The health plans represent the second group of participants, i.e. entities that take on the risk of paying for medical treatments, e.g. health insurances or the uninsured patient himself. An instance of a health plan that is specific to the United States is the self-insured employer who offers not only a salary but also health services to his employees. The remaining members of the health care network are the suppliers (e.g. for pharmaceuticals, devices, or equipment), and finally the consumers, respectively the patients. Optimization of the workflow means reduction of costs and the enhancement of quality. Thus, managed
care aims at improving interoperability in a complex network. To be more precise, managed care is a prime example for a management principle that can achieve clear systemic improvements through the implementation of interoperability enhancement measures. To gain a better understanding of the term and due to the fact that managed care was pioneered in the U.S., the following section is concerned with the United States’ approach of managed care. We will first investigate what went wrong with the initial managed care concept by describing the limitations of the U.S. approach of managed care and presenting potential solutions.

1) Managed Care in the U.S.

The central organizational entity of managed care in the U.S. is the managed care organization. Managed care organizations are not health insurances in the traditional sense. They are prepaid health care systems, offering services to which the member is entitled (Kongstvedt, 2000). By contrast, health insurances guarantee an amount of money. Managed care organizations negotiate prices with providers and thus can charge lower fees than health insurances which reimburse patients for fee-for-service payments. Fee-for-service means that a specific payment is made for a specific service conducted (Austrin, 2000). Thereby the costs increase if more services are conducted, if the costs of the services itself increase, or if less expensive services are substituted by more expensive services. By contrast prepaid systems are characterized by the fact that the expenditures do not correlate with the number of services provided.

The primary aim of managed care organizations is the reduction of the costs of health care delivery. They achieve this by means of strict price negotiations and a dense control and approval system. There are two different payment modalities that managed care organizations typically negotiate with the providers. Either they pay the providers fixed fees for their services according to a scale of charges that both parties agreed on, or they transfer a fixed monthly rate for each patient, also known as capitation, regardless how often the patient was treated. In addition to this, most of the treatments have to be approved by the managed care organization which put emphasis on preventive care, i.e. regular check-ups, e.g. physical exams, screenings, or detection tests. One important type of a managed care organization in the U.S. is the so-called health maintenance organization (HMO) which will be described in more detail in the following.

Health maintenance organizations act as gatekeepers between the health plans, providers and patients. This means that on the one hand health maintenance organizations negotiate prices with providers and contract them, and on the other hand health maintenance organizations pass on the negotiated price advantage to health insurances, employers or single persons. There are 4 basic variants of health maintenance organizations which differ in the way how they integrate into the healthcare network (Lereau, 2001).

The first variant is the so-called staff model. It is characteristic for this variant that the physicians are employees of the health maintenance organization and work in medical centres owned by it. The second variant is the so-called group model. Here, the health maintenance organization signs contracts with a group of physicians who work in their own surgeries. The third variant is the so-called independent practice association mode. An independent practice association is an association of physicians, hospitals and other health care providers. The health maintenance organization contracts with the independent practice unit which in turn contracts with the physicians. And finally, the last variant is the so-called network model. In the network model the health maintenance organization contracts with a combination of groups, independent practice associations or individual physicians. Of course, there are mixed models as a staff model HMO might also contract with physician groups. Further differences between the 4 basic models can often be observed in the way that payments are transferred to the providers, as well as in the patient groups which are treated (see Table 15).

<table>
<thead>
<tr>
<th>Table 15: Payment mode and group of treated patients of different HMOs</th>
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<tbody>
<tr>
<td>Open panel</td>
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<td>Directly paid</td>
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The staff model and the group model are closed panel health maintenance organizations, i.e. physicians are not allowed to treat other patients than the members of the health maintenance organization. In contrast, independent practice association and network models are allowed to treat HMO and non-HMO patients. The staff model is the only variant in which the health maintenance organization pays the physicians directly, i.e. physicians get a salary. All the other HMO models pay a rate according to a negotiated scale of charges. How the money is further passed on to the single physicians is in the responsibility of the organization having a contract with the HMO and its physicians (Austrin, 2000).

As the health maintenance organization negotiates conditions and arrangements with health care providers, there are also restrictions that the patients have to be aware of. Firstly, patients are bound to consult participating or approved providers of the health maintenance organization for all health services. The costs of services performed by providers who did not sign a contract with the health maintenance organization are not or only partially covered. Secondly, health maintenance organizations offer the patient only services to which the patient is entitled. Special services require explicit approval by the health maintenance organization.

Apart from these most important restrictions, health maintenance organizations often employ primary care physicians which the patient needs to consult first for any of his medical problems. In case special services are needed that can not be provided by the primary care physician, an explicit referral to a specialist is needed. In particular due to the restrictions of the patients' freedom of choice, health maintenance organizations are obliged to validate the professional competence as well as the professional behaviour of subscribed physicians. In fact, several lawsuits have been filed in the U.S. which were not only concerned with medical malpractice but also with improper professional behavior.

The health maintenance organization is the most restrictive form of managed care organization. Another type of managed care organization in the U.S. that restricts the patients' freedom of choice less is the preferred provider organization (PPO) (Austrin, 2000). In contrast to HMOs that do not at all reimburse the costs of providers that are not contracted, PPOs at least partially reimburse the patient. In practice, they don’t reimburse the full amount but choose lower reimbursement rates, charge higher deductibles or co-payments, or a combination of this. To summarize, managed care organizations are third party administrators which provide health care to the clients at reduced rates which they negotiated with the providers (Gold, 1998, Shouldice, 1991).

2) Managed Care issues in the U.S. and their origin

While so far we have mainly talked about the principal properties and the operational details of managed care, this paragraph will have a closer look at problems and failures of the managed care approach in the U.S. The reasons are described in the following paragraph. Figure 27 depicts the expenses on health per capita and the compounded annual growth rate (CAGR) of the costs in the U.S. and other developed nations. It shows that the United States of America have the highest per capita health care spending of all examined countries. The compounded annual growth rate is similar to the CAGR of the other compared nations.
Figure 27: Expenses on health per capita and the compounded annual growth rate (CAGR) of the costs in the United States

One may argue that the increased quality of health care justifies higher costs. However, this supposed augmentation of health care quality parallel to the higher expenditures can not be observed in general. In reality, health care quality is subject to great variations which can not be traced back to health care expenditures. Figure 28 depicts the relationship between health care expenses and the life expectancy of women in twenty-nine OECD countries in 1996.

Figure 28: Relationship between health expenses and life expectancy of women in 29 OECD countries

It shows that the life expectancy of women from the U.S. is at an average although the U.S. have managed care and although the U.S. have spent most of all on health care. Figure 29 supports this conclusion.
It illustrates the difference between how much care was delivered and how much care should have been delivered in the U.S. sorted by different categories. The biggest gap can be found at the item “Counseling or education”. Only 18.3 per cent of the recommended appropriate counselling or education activities have been realized. The findings result from a study concerned with health care quality in the United States (McGlynn et al., 2003). In the study the leading causes of illnesses, death, and utilization of health care and the standard procedures to treat them were identified. Thereafter, indicators were developed to assess potential overuse and under average utilization of the identified key processes. A random sample of adults living in 12 metropolitan areas in the United States was interviewed about the experiences with health care delivery. Then, copies of their medical records of the most recent two-year period were made if the interviewed person agreed to it. All this information was used to evaluate the performance on the defined indicators of quality of care. Based on these figures, one has to conclude that the managed care approach in the United States neither reduced the costs nor improved the quality. We need now to investigate the reasons why managed care previously missed its goals.

Porter and Teisberg (2006) state in their book “Redefining Health Care” that, although competition exists in the U.S. health care system, the wrong kind of competition takes place, the so-called zero-sum competition. With this term, they denote the fact that competition in health care is not focused on delivering value for the patient. Here, value means the health outcome per dollar expended according to the authors. For instance, value can be the recovery time or the emotional well-being during the process of care. According to their analysis, there exist several dimensions on which the members of the health care system compete on (e.g. competition to shift costs, competition to reduce costs by restricting services, competition to increase bargaining power, etc.). However, none of these competitions leads to an improved value for the patient. In fact, the opposite effect takes place. Every member of the network pursues individual goals which lead to many local optima, but not to a global optimum of the value. Therefore, Porter and Teisberg (2006) claim that competition should take place in such a way that a higher value for patient is created. The authors go even one step further. They don’t only think that the members of the health care network are competing on wrong issues, they also believe that competition occurs at the wrong level of detail (Porter and Teisberg, 2006, p.44):

“Competition is both too broad and too narrow. Competition is too broad because much competition takes place at the level of health plans, networks, hospital groups, physician groups, and clinics. It should occur in addressing particular medical conditions. Competition is too narrow because it now takes place at the level of discrete interventions or services. It should take place for addressing medical conditions over the full cycle of care, including monitoring and prevention, diagnosis, treatment, and ongoing management of the condition.”

In contrast to the current state, value-based competition on results will actuate the traditional market rules which will lead to efficiency, quality improvements and incentives for innovations. Porter
and Teisberg provide an example of the opportunities that value-based competition can offer to the health care system. According to them, in cosmetic surgery there is nowadays a very strong competition that is even comparable to industrial markets. Physicians have to compete against each other and convince the potential customers of their skills. Furthermore, the providers of cosmetic surgeries are experts for the full cycle of care of one particular medical condition. Figure 30 illustrates the price differential of traditional versus innovative cosmetic surgery in 2002 (Parker-Pope, 2002).

![Figure 30: Price difference of traditional versus innovative cosmetic surgery](image)

> Figure 30: Price difference of traditional versus innovative cosmetic surgery

The results indicate that if market rules apply and a value-based competition on a certain medical condition over the full cycle of care takes place improved quality via innovations leads to costs reduction. To summarize, one of the main shortcomings in the current managed care is that competition is not focused on value for the patient, or putting it differently, competition is not focused on medical results.

3) The German Managed Care approach

The case study presents one possible way of implementing managed care in Germany that explicitly tackles the problems from which the American system suffers. The main actor in the case study is the health management company which plays the role of a cost centre. It contracts with providers in order to manage one specific medical condition. The health insurances provide the health management company a fixed budget for each patient who suffers from this condition. The company now has full control over this budget and tries to achieve the optimal and, at the same time, most cost-efficient therapy for the patient. The first difference to the United States’ approach is that the health management company manages only those services necessary to treat one dedicated medical condition and does not manage all the other health services a patient may also need. A first benefit from this specialization is the improved ability of the patient to benchmark the services and the performance of different health management organizations. He can more easily compare the set of treatments that they offer and thus decide which one of them suits its needs best. It becomes feasible to keep statistics of the success rates of different health management organizations which can be made available to the public. In turn, the health management companies have to compete for the patient who bases his decision on the expected value.

Eventually, the patients suffering from a specific medical condition will only turn to the best performing health management company (i.e. the network of “healing actors” providing a high rate of healing or at least a significant improvement of their well-being).

The fact that the health management organizations, in turn, pass on the demand for good health care quality to their subscribed providers, is a logical consequence of competition. Only if they also adhere to high quality standards, the health management company can offer high quality services to the patient. As a consequence, before they are selected to be partners, providers have to undergo a selection process in which the quality of their services is verified with respect to the health management companies’ requirements. Only if this evaluation had a positive outcome, a contract is signed. But even after the contract is signed the providers will permanently be subject to a monitoring process. This way,
the health management companies continuously verify whether the therapies performed lead to the desired positive results for the patient. In other words, by having health management companies focusing on specific medical conditions, value-based competition is established in the health care system, which is not the case in the U.S. health care system.

Another difference to the health system of the United States is that providers don’t have to deal with budget issues, such as capitation. In the scenario suggested in the case study, the responsibility to adhere to a budget is shifted from the provider to the health management company. Thus, there are no incentives for the providers to refuse the patient an optimal treatment in order to make a higher profit. One may argue that, although providers don’t have to deal with capitation, they are nonetheless forced to offer lower prices in order to get a contract with a health management company, and therefore there is still an incentive to minimize their efforts. However, since providers and health management companies compete on results, under-treatment would be harmful for their competitiveness. In addition, since a contract with a health management company also immediately means a significant increase in the number of patients, it is actually economically reasonable for a provider to offer high-quality services at low costs, even if this means a reduction in its operational profit in the first place.

Another difference to the U.S. version of managed care is that the health management company handles the full cycle of care. In other words an entity is established which monitors each patient’s recovery process from the start until the end. To serve this purpose, a health management company employs case managers who assist the patients throughout their entire therapy. This is a novelty as the state-of-the-art in the German health care system is rather functionally organized. Many different providers are involved in the treatment of the patient who act more or less independently and mainly focus on their own part in the health care network. There is no pilot entity which coordinates their activities. The establishment of a case manager who has an overview of the full cycle of care thus corresponds to a migration process from a functional structure to a business unit structure, in which all participating parties are arranged around the patient.

In a nutshell, the case study is about the initiation of value-based competition in the German health care system. Therefore, a health management company was founded that coordinates the therapy of a specific medical condition: breast cancer. In consequence, business relationships between the providers which are involved in the therapy of breast cancer and the company are established. Thus, the partners have a natural interest in establishing a good interoperability, which in turn leads to lower administration and transaction costs. The positive effects of the interoperability improvements that could be observed in the pilot project called mammaNetz are described in the next chapter.

5.2.3 mammaNetz: a case study on managed health care in Germany

mammaNetz has been developed and is managed by betaInstitut and the University of Augsburg\(^1\), betaInstitut is a research and development institute in Augsburg, Germany whose main field of activity is health management. mammaNetz is a pilot project which suggests procedures to establish managed care in Germany in the treatment of breast cancer. The investigation of the case study began in September 2003. The realization of mammaNetz is planned to take place in two subsequent steps. In the first step, a case manager is introduced who supports each patient during her therapy and who coordinates the sequence of medical treatments. The individual support leads to a patient-tailored therapy and thus results in more value for the patient. Furthermore the establishment of a case manager who has survey of the full cycle of care keeps the therapy on the right track. For example unnecessary treatments are avoided or the case manager intervenes if there is a deviation from the patient-defined therapy path. During the first phase of mammaNetz, an IT tool has been developed which supports the case manager in his tasks. At the current point in time, the project is still in its first phase.

In a second step, a health management company will be established which takes over even more responsibilities in the management of the breast cancer therapy. In contrast to the case manager, health management companies can also establish business relationships with health care providers. At this stage, interoperability is thus much more important than in the first phase. Therefore, the implemented processes and IT technologies which improved the interoperability at the first step are enhanced in the second step. Figure 31 and Figure 32 depict how the two subsequent stages of mammaNetz simplify the information exchange in the health care system, and structurally redesign it into a patient-centric system.

\(^1\) From which two of the authors stem from and have been involved in the mammaNetz development.
A woman suffering from breast cancer has to consult several providers, e.g. a gynaecologist or a hospital where the tumour is removed. Due to the current organization of the German health care system, all these providers are fairly independent from each other and only concerned with the part they play themselves in the healing process. Interactions are limited to the transfer of diagnostic findings. From a management science point of view, the prevailing structure in health care is a functional structure which leads to losses at the interfaces due to low interoperability. For instance, the patient often has to organize the schedule of the therapy by herself. However, since she is inexperienced and under considerable strain the schedule is most often not optimal. This leads to a longer healing process during which the quality of life is restricted. However, not only the value for the patient is reduced, the longer healing process also results in higher costs.

In phase one, a case manager is introduced. The case manager is as an assistant of the patient and has complete overview of the full cycle of care. Thus, he can play the role of a process manager who coordinates and monitors the therapy. The experience of the case manager and his individual support of the patient lead to more value for the patient and, due to improved interoperability, fewer losses at the interfaces occur.

Figure 31: Network evolution for each mammaNetz development step
Due to prevailing legal barriers the case manager is at the first stage only able to improve the information exchange between patient and physician. The improvement of the interoperability between the providers is the objective of the second stage. In stage two, a health management company is founded which is the employer of the case manager and establishes a business relationship with the providers. In addition to providing the guidance function that the case manager already offered, the health management company tries to assure a cost-efficient process. Since many different providers contribute to the recovery process the health management company and the providers are interested in improved interoperability in order to reduce their mutual administrative and transaction costs.

Therefore, the case manager who is now backed by a health management company not only improves information exchange between the patient and the providers but also enhances the information exchange between the participating physicians (see Figure 31). The goal is a consistent workflow without losses at the interfaces. Furthermore, the implementation of a health management company modifies the functional structure of the health care system. Since the case manager focuses on the patient and coordinates the providers and processes around the patient a business unit structure is initiated (see Figure 32).

In the following, the concepts briefly introduced above will be further detailed. For a better understanding, the implementation of mammaNetz is described in chronological order. In the next subsection, the current state-of-the-art (i.e. the breast cancer therapy without a case manager) is explained and its costs are identified. Subsequently, the establishment of the case manager and his positive contribution to the coordination of the therapy are detailed. The second stage of mammaNetz is the subject of the last subsection.

1) State-of-the-Art of the Breast Cancer Therapy in Germany

In order to illustrate the state-of-the-art in breast cancer therapy, the so-called patient path is used which is a modelling tool that illustrates consecutive steps of a therapy for a certain medical condition. It is not a fixed specification which every patient has to follow it rather is a graphical visualization of the basic steps that are advisable. The actual implementation of the patient path depends on the individual patient, i.e. which sequence of steps an individual patient actually takes. The patient path models two important aspects, namely the workflow of the individual steps to treat the patient, and the costs of each of these steps. The classical patient path for treating a patient who suffers from breast cancer is summarized in Figure 33.
Figure 33: Stages and costs of the traditional breast cancer therapy

The patient path consists of three parts. The first part, termed outpatient, covers the first two weeks after the occurrence of the first symptoms. In the first part the patient mainly undergoes diagnostic checks. A typical step taken at this stage is, for instance, a mammogram. The second part, termed inpatient, covers the hospital stay, and in consequence the surgeries that might be necessary. The last part, outpatient, comprises of the chemotherapy and the irradiation. It is typically followed by a longer period of rehabilitation. Below the medical path, the costs are depicted that arise over the full cycle of care. Medical costs are the costs of physicians, the hospital stay and rehabilitation. Typically, they amount to approximately 7,500 Euros. The remaining costs are for example costs caused by pharmaceuticals, e.g. the medicine for the chemotherapy or adjuvants. Altogether the costs of a breast cancer therapy add up to approximately 20,000 Euros.

2) Stage 1: Case manager

The patient path with a case manager differs from the classical patient path in as much as the case manager assists the patient in all the stages of the therapy. The case manager acts as a piloting agent who optimally guides the patient through the individual stages of the patient path (see Figure 34).

Figure 34: Breast cancer therapy with case manager

The process starts after the diagnosis of breast cancer. At this point the physician informs the
patient about the possibility to participate in mammaNetz. If she agrees she gets in contact with the case manager for the first time. Thereafter, she has to visit a doctor and perform a mammogram as well as a punch biopsy. After these more detailed diagnostic checks, she receives information about the remainder of the therapy from the case manager. After the first therapy schedule has been set, she has an appointment with her physician who informs her about the detailed diagnostic findings. Afterwards, she consults the case manager again in order to plan the starting date of chemotherapy. They agree on a starting date and the case manager arranges an appointment with an oncologist. Meanwhile the patient enters the inpatient phase, i.e. she is taken to hospital. During the hospital stay, she gets in touch with the case manager for some additional information about rehabilitation. After the hospital stay the case manager contacts the patient to talk about the further proceeding of the therapy. The frequency of contacts with the case manager during the different medical steps depends on the individual patient. Some patients merely want to get full information about the therapy. For other patients, in contrast, the case manager is like a psychologist to whom they can talk about their problems. The case manager is trained to fit in all of these roles, being it only a source of information or as much as a mental backer. Figure 35 gathers the primary tasks of the case manager at the different stages of the medical path.

Figure 35 gathers the primary tasks of the case manager at the different stages of the medical path.

- Intake
- Assessment
- Development of a help plan

- Withdrawal of CM

- Reminding
- Reassessment
- New help plan
- Intervention and monitoring
- Final report for health insurance

The process starts with an intake of the personal data of the patient. Thereafter, the patient receives all the relevant information about the therapy and an assessment of the strains and the resources of the patient is conducted. A strain is, for example, the fact that the woman is a single mother. A resource in that case could be a grandmother who can take care of the child during tough phases of the therapy. Other frequent strains are physical restrictions or psychological conditions which occur as a result of the cancer. The case manager uses a classification code called ICF to assess such physical restrictions (WHO, 2001). ICF stands for International Classification of Functioning, Disability, and Health and was developed by the World Health Organization. It completes the ICD-10 code which is the International Classification of Diseases and Related Health Problems (WHO, 2005). While ICD-10 is a standardized code for medical conditions, the ICF characterizes how people deal with their medical condition. The WHO describes the ICF as follows:

"ICF is a classification of health and health related domains that describe body functions and structures, activities and participation. The domains are classified from body, individual and societal perspectives. Since an individual's functioning and disability occurs in a context, ICF also includes a list of environmental factors. ICF is useful to understand and measure health outcomes."

The ICF defines normal physical functions and provides categories of the extents to which they are limited. Visual perception, for instance, is defined as the sensual function of one or both eyes to perceive light, shape, size, and colour of the sensory stimulus from different distances. The restrictions of the visual perception can be classified as "light", "moderate", "extensive" or "fully pronounced". The detailed identification of the strains and resources helps the case manager to develop the help plan. A help plan is a schedule and a to-do-list for the patient. For instance, if the patient agrees on starting the chemotherapy as soon as possible, this will be recorded in the help plan. It will also contain a note which
reminds the case manager to phone the oncologist. Everything described so far happens at several appointments during the outpatient stage. When the woman enters the inpatient phase and is in hospital the case manager backs out and only gets in touch with her on request. However, if the patient needs someone to talk to or needs some encouragement, the case manager is available and visits the patient in hospital. Two weeks after the patient has left the hospital the case manager contacts the patient again in any case. A reassessment is conducted as the patient may have changed her mind on some points or the circumstances may have changed. For instance due to a reassessed ICF classification it may turn out to be reasonable to start physiotherapy. So the updated help plan includes a note about this fact. The next step is called intervention and means that the case manager monitors whether the schedule and the to-do-list are met. If he discovers a deviation from the health plan the case manager intervenes. This may, for instance, be necessary if the patient doesn’t attend physiotherapy although she wanted to and the ICF code indicates the necessity of physiotherapy. The case manager intervenes by calling the patient and trying to convince her to follow the therapy plan previously agreed. Thus, the case manager permanently monitors the achievement of the objectives. Finally, as the therapy comes to an end, the patient contracts out of mammaNetz. The case manager is compelled to write a final report for the health insurance. During all of these tasks the case manager is supported by an IT tool called CM Assistant. The CM Assistant’s main features are the illustration of the medical path of the patient in combination with the primary tasks of the case manager. Furthermore, the CM Assistant has a reminding function and offers the functionality to keep detailed record of the incurred costs.

The screenshot illustrates some of the primary features that were mentioned above. The arrow with the different icons on it in the bottom of the screen corresponds to the mentioned illustration function. Each symbol has a semantic meaning, e.g. the second symbol stands for the intake and the green triangle stands for the hospital stay. Medical treatments as well as priority tasks of the case manager are arranged in chronological order. In addition to the primary tasks the case manager also has to fulfill secondary tasks like administrative work, meetings, case discussions, dissemination of information about mammaNetz, etc. A task is classified as a primary task if it contributes to the improvement of interoperability. Secondary tasks, on the other hand, don’t have an immediate influence on the interoperability.

A multi-disciplinary team participates in the pilot project. The team consists of nurses experienced in oncology, employees trained in social pedagogy, gynaecologists, psychologists, priests, and administrative employees. A multi-faceted network of providers was built and consists of 250 institutions located in the area around Augsburg, Germany. Augsburg’s central clinic as well as other hospitals in the nearby region are participating to this program. Further elements of the network are formed by
Here, the CM Assistant not only acts as internal IT tool of mammaNetz which assists the case manager will be described in the following paragraph depends on an extension of the IT tool “CM Assistant”. Furthermore, the patient is entitled to use a transportation service which is paid by the health insurance which usually has special arrangements with certain transportation companies. By allocating the patient exclusively to these companies an optimal utilization can be achieved which reduces the costs as well. In the two previously given examples, the influence of mammaNetz is at a medium level. The arguments are conclusive, but either the saving can not be achieved in practice, or the quantification of the cost reduction is difficult. The biggest cost reduction is achieved by having to pay less sickness benefits. At the beginning of the therapy the patient is on sick leave during which she gets her usual salary. If the sick leave lasts longer than six weeks the patient gets the sickness benefits instead of the usual salary. The sickness benefit is paid by the insurance company and amounts to around 50 Euros a day. The cost reduction can be achieved in the following way. The chemotherapy usually starts five weeks after the hospital stay. Actually it could start one week after the surgical operation but the appointment is often delayed due to the patient’s lack of knowledge or personal reasons. If the patient is stable enough she can be informed through the case manager about the possibility to start chemo therapy already one week after the surgical operation. She might then accept to begin the chemotherapy earlier. The recovery process can consequently be shortened by an average of four weeks and accounts for a saving of 1000 Euros in sickness benefits. Up to this point, the case manager has mainly improved the interoperability between the patient and the providers. In other words, due to the assistance of the case manager the patient passes through the therapy more fluently. Providers indeed profit by the introduction of a case manager as well but the achieved advantages come in the form of a reduction of work rather than in the form of interoperability improvements. To achieve these interoperability improvements the providers have to be included in the recovery process more strongly. This is the objective of the second stage.

3) Stage 2: Health management network

Providers are integrated into the recovery process on two levels. The first level is the strategic level, because mammaNetz places contracts with different providers. The providers are not chosen at random but have to fulfill strict quality requirements. Thus, mammaNetz has to develop a selection process which is applied to every potential partner. Furthermore, mammaNetz negotiates with the providers about the prices of their services as well as number of patients sent from mammaNetz to the providers. After an agreement is reached, the subscribed providers are integrated at the operational level, i.e. efforts are made to reduce connectivity and coordination costs between mammaNetz and the new partners. In addition to the negotiation costs, the connectivity costs also consist of the inception costs for the Case Management Software.

There are several possibilities to achieve such savings. Every interoperability improvement which will be described in the following paragraph depends on an extension of the IT tool “CM Assistant”.
but becomes an external instrument which improves the interoperability between mammaNetz and its partners. Therefore, the CM Assistant is also established at the providers’ side in order to achieve enhancements in administration and transaction as described below.

The first activity which can be simplified by improved interoperability is the intake. The intake is the first task of the case manager and can be fully automated as it will be shown in the following. The patient who matches the profile, i.e. who is diagnosed with breast cancer, is informed by the provider, e.g. the gynaecologist, the hospital, or the health insurance, about the possibility to become a member of mammaNetz. Then, if the patient agrees to take part in mammaNetz the provider electronically transfers the patient’s master data, i.e. the name, date of birth, gender, and the name of health insurance to mammaNetz. A file is generated for the new member within the CM Assistant and a case manager is allocated to the new patient. After the development of the help plan the case manager has to schedule the different appointments of the patient with the various providers. Thereby the CM Assistant supports the case manager insofar as the case manager does not have to phone the different providers but can electronically access their capacity planning as described in the following. The case manager registers a caution for a specific date and time which has to be confirmed by the provider. After a positive response the case manager can continue and appoints a date and a time with the subsequent provider. Having the confirmation of the subsequent provider, the case manager informs the preceding provider about time and date of the appointment with the subsequent provider in order to assure an accurately timed transfer of the necessary documents, e.g. diagnostic findings. Therewith, the case manager identifies the providers that can offer appointments to the patient at the earliest possible dates. Therefore, he adjusts the appointments of consecutive providers more efficiently due to shorter delays and transfer of necessary documents. Furthermore, the case manager is able to transfer the ICF code of the patient which was created during the assessment phase to the providers. For instance, a detailed description of the physical strains based on an already existing standard could lead to a better adapted physiotherapy and therefore to better healing results. Moreover, the adherence to appointments can be verified automatically as follows: Every provider has to validate electronically whether the patient has kept the appointment or not. If the patient has missed an appointment the case manager is informed about it by CM Assistant and can intervene. Finally, another interoperability improvement is feasible by transferring the final report to the health insurance in electronic form. The implementation of the above described network leads to several problems which will be looked at more closely in the following.

On the operational level, the implementation of an IT network of the described scale has strong requirements concerning security and privacy. It is thus essential that the IT system complies with the state-of-the-art in security technology. In addition to the technical and formal requirements at the operational level, the government has to initiate the necessary bills in order to meet the requirements also on the legal side. Other approaches for managed care in Germany already exist, but they fall short in realizing the ambitious aims of the second development step of mammaNetz.

mammaNetz was developed to be part of the framework of “Integrierte Versorgung” which is a managed care approach in Germany. “Integrierte Versorgung” tries to initiate managed care in Germany by enabling health insurances to negotiate prices with different providers and to conclude an agreement with them in order to achieve a cost-efficient and quality-improved health care (Mühlbacher, 2002). Thus, a direct payment mechanism between health insurance and provider is initiated. This is contrary to the traditional payment mechanism in Germany which is as follows. An umbrella organization, namely the “Kassenärztliche Vereinigung” (KV), represents the physicians who provide outpatient treatment in a certain regional district. It is one of the primary tasks of the KV to negotiate prices of services with the health insurances in the name of the physicians. The KV places collective agreements with the health insurances which prescribe the total budget that can be spent in a district within a certain period. The individual physicians are paid by the KV. The billing mechanism is based on a code called “Einheitlicher Bewertungsmaßstab” (EBM) (Kassenärztliche Bundesvereinigung, 2004) which defines the billable, ambulant treatments and the monetary evaluation system of the services. The EBM was developed by a committee which consists of representatives of the KV and the health insurances in equal shares. For all their inpatient services, the hospitals apply another billing mechanism called “Diagnosis Related Groups” (DRG) (Thiele, 2003). The DRG is an economic-medical classification system due to the fact that medical indicators provide the basis for an economic grouping. Actually the DRG divides the patients into groups which are differentiated according to the monetary expenditures associated with the treatments of the patient’s disease. The DRG was developed by Prof. Fetter from Yale University in 1967 and nowadays is a billing scheme used in many countries. The DRG of the Australian federal state Victoria forms the basis for the German version of the DRG which was developed in 2001 by a committee of representatives of public and private health insurances, as well as delegates of the German hospital association.
In contrast to this current state of the health care system, managed care offers the possibility that health insurances and providers directly negotiate prices. However, in all the managed care approaches other than mammaNetz, it is always one of the participating providers, i.e. either the hospital or a physician that also has to take over the administrative tasks in the patient’s therapy (Deutsche Krankenhausgesellschaft, Riedel et al., both 2004). In contrast, in the framework of mammaNetz, an independent third party takes over these administrative and coordination tasks are. Another problem inherent to “Integrierte Versorgung” is the patient’s freedom to freely choose a physician, which is actually guaranteed by German law, is restricted. Health insurances in the first place require patients to consult subscribed providers although these can still decide to go to any other provider but they have then to accept financial disadvantages. Supporters of “Integrierte Versorgung” (IV) argue that the freedom of choice is not truly restricted since the patient is informed about the restrictions implied with the participation in IV and consciously agree to it. Moreover, patients participating in “Integrierte Versorgung” are allowed to consult out-of-network providers if a legitimate reason exists. In the context of mammaNetz, the establishment of a cost centre may lead to an even stronger limitation of the patients’ freedom of choice. On the other hand the quality assessment of the potential partners that is conducted by mammaNetz is a useful tool for the patient. Since she normally is no medical expert, the patient has no sound way of assessing the service quality of health care providers. Her only possibility is to rely on her intuition or the reputation of the chosen provider which is usually spread by word-of-mouth. Since a health management company has to compete with others based on results, it has to establish a well-defined quality assessment scheme. The patient can thus rely on being advised to go to medical providers that meet high quality standards according to objective criteria. Furthermore “Integrierte Versorgung” grants the health insurances more rights to collect and transfer more of the patient’s data in order to meet the new requirements. However, since health management companies like mammaNetz are a novelty in the Germany, these extended rights do not yet apply to them.

Overall, legislation concerned with “Integrierte Versorgung” provides many approaches for managed care in Germany but it does not support the introduction of a further member in the German health care system as it is only considering existing parties (Deutsche Krankenhausgesellschaft, Riedel et al., both 2004). Thus, mammaNetz does not yet have the necessary rights to evaluate providers with respect to quality, to negotiate prices, to contract providers, to collect and transfer data of patients, and to assign patients to the subscribed providers. Furthermore, the relationship between the health management company and the health insurance requires a legislative foundation as well. Thus, new bills have to be passed before mammaNetz can fulfill the function of a cost centre, as well as the function of a gatekeeper between health insurance and provider. However, this is an improvement of the German managed care approach which is currently derogatory for providers as they have to take over administrative and coordination tasks themselves. At the moment, this inhibits the diffusion of managed care in Germany. In contrast, by introducing health management companies in the German health care system, these disadvantages could be overcome.

5.2.4 Assessing the interoperability state of mammaNetz (BIF)

In this section the different interoperability levels of the different stages of mammaNetz are explained by applying the business interoperability framework (BIF) which was developed in the B3 work package by the University of St. Gallen (University of St. Gallen, 2006). The BIF specifies relevant categories to describe the interoperability of a company. The main categories are “Management of external relationships”, “Business Processes”, “Employee and Culture”, and “Information systems”. Each of the main categories is further divided into sub categories. The framework builds on the assumption that an enterprise can influence its business interoperability, e.g. by choices in the organisational design or information system design. Furthermore, the BIF focuses on a single enterprise and its interoperability with its external partners. In the following, the health management company is the single company which is examined at the different stages of the implementation of mammaNetz. As a reminder, these stages are the traditional therapy before mammaNetz, the introduction of a case manager, and finally the establishment of a health management company. Since the traditional therapy does not include mammaNetz the interoperability analysis at this stage focuses on the different members of the health care network and their interoperability between each other. The BIF specifies five levels of interoperability described in Figure 37.
In order to cover the life-cycle aspect of IT-supported relationships, the Business Interoperability Framework assesses the status applying the RADAR logic from the EFQM model (EFQM, 2006):

- The organization plans and develops **interoperability approaches** (abbreviated with “A”) and methods to realize its business targets.
- The organization **deploys** (abbreviated with “D”) the approach to ensure the realisation of these targets.
- The organization **assesses** and **reviews** (abbreviated with “A” and “R”) the approaches and their application through monitoring and analysis of the achieved results. The organization identifies, prioritizes and plans improvements and implements them.

![Figure 37: BIF’s interoperability levels](image)

The first key category is concerned with the management of the external relationships. Here, the main question which should be answered is “How do we manage and control external relationships?” as it is assumed that interoperable organizations manage and monitor their external relationships. The subcategory “cooperation (management) process” is defined as the process of initiation, realization, control and monitoring of the cooperation. It furthermore addresses to what extent the cooperation is embedded in the company’s strategy and how the partner selection process is handled. “Cooperation targets” denote the plans and the objectives of the partners in a business relationship and whether they are defined and reconciled with the partners. “Risk and conflict management” comprises of for instance provisions made in view of unreliable partners or the establishment of an intermediary who intervenes if conflicts occur. The roles and responsibilities of the business partner and the agreement about the purpose and content of the cooperation and the deployed resources should be stipulated in the “cooperation contract”. The evaluation leads to the results depicted in Figure 38 and explained in the following.

As expected, the traditional therapy operates at a very low interoperability level due to an ad-hoc cooperation process. The cooperation between patient and providers is marginally organized. In fact, an ad hoc cooperation process exists since no consistent modus operandi is defined but the patient progresses stage-by-stage through the therapy, i.e. by referral. Furthermore, the provider selection is not
Based on a quality assessment since the patient does not have the capability to evaluate the providers’ quality. At the first stage mammaNetz still has no defined provider selection process as it depends on a critical mass of providers to be able to operate. However, the steps of the cooperation process are well-defined and controlled by the case manager. As soon as mammaNetz acts as cost centre a selection process of the partners is established. The introduction of a well-working relationship is part of the company’s strategy, so that a defined cooperation process is a prerequisite for this “business”.

Cooperation targets in the traditional therapy are non-existent as no cooperation exists. In fact, every party pursues individual targets, e.g., insurance companies try to minimize costs and physicians try to maximize profits. Stage one of mammaNetz does not lead to a business cooperation in the traditional sense. However, every member of the health care network plays a part in achieving cost savings by tightening the patient path. Thus, due to the closer cooperation described above a global optimum instead of many local optima is reached. At this stage the case manager communicates the target but the providers are not obliged to make a contribution and may pursue other hidden aims. By contrast, stage two establishes a business relationship which leads to a mutual dependency and thus to a distinct cooperation target, namely competitiveness and customer retention.

Due to the loose partnerships and the reduced communication of the different parties during the traditional therapy little conflicts arise so that risk and conflict management is no critical issue. In contrast, the closer partnership at stage one of mammaNetz creates an increased conflict potential. Since providers are less dependent on mammaNetz than vice versa the case manager has to act as an intermediary and resolve occurrences of risk and conflict ad hoc. Thus, a conflict and risk management exists but is not well-defined. At stage two, the mutual dependency due to the established business relationship shifts risks on both sides so that physicians as well as the health management companies are interested in risk and conflict management. This leads to pre-defined risk and conflict management mechanisms which are updated irregularly.

Since during the traditional therapy no business cooperation exists, a cooperation contract is not necessary. Here, contractual agreements are based on laws, e.g., the charging between providers and insurance companies. At stage one, members of mammaNetz sign standard contracts. The contract regulates no economic issues as they are not part of the cooperation. At stage two, the cooperation contracts are based on standard parts, e.g., general terms and conditions, and are complemented by cooperation-specific parts, e.g., the negotiated prices of treatments or the negotiated number of patients sent to the provider. This leads to an establishment of cross-enterprise (collaborative) performance standards and measures, e.g., the functional performance, the cost/revenue contribution, or the budgeting.

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Business semantics (documents)

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Figure 39: Category: Collaborative business processes

The category “business processes” provides answers to the question “How do we cooperate with business partners?” A cross-organisational process is the business process between two or more independent partners within a cooperation. It describes the interactions between the partners, e.g., the activities, responsibilities, input/output, or the messages. A “public process” is a special cross-organisational process that abstracts from the internal processes and can be defined independently of
internal business processes. It should be clear and well documented, practical and should reflect industry standards. “Process visibility” means that business partners gain a certain visibility of the corresponding business processes, e.g. status information, availability, or inventories. This allows them to better plan and align their internal processes. “Business semantics” is divided into business documents and master data. Business semantics define the contents and the structure of business documents as well as the meaning of their elements. The semantics for main business documents should be based on a common agreement and adhere to industry standards. Business semantics also describe the semantics of identification, description and classification of relevant master data, e.g. of the product or of the partner. The semantics for master data should likewise be based on common agreement and follow industry standards. The evaluation results of the different categories (see Figure 39) are described in the following.

In terms of business processes the traditional therapy is lacking cross-organizational processes as every party is only interested in the next step and not the whole process. Interactions between two parties are based on established patterns, i.e. the parties “know” which documents they have to exchange at which point in time. In parts, these patterns are regulated by law. At stage one and two processes are defined between the case manager and the other parties. The case manager controls the process as integrator between the patient and the providers.

One of the main problems of the traditional therapy is that the involved parties have restricted process visibility, e.g. examinations are made twice or diagnostic findings are not reported on time between the providers. Since the case manager has full overview of the process the patient has full overview of the process from stage one on as well. At stage two, the visibility requirements for collaboration-critical information are specified and measures are taken to ensure data accessibility. By this means, the process visibility for providers is enhanced as well because the case manager informs the provider when and to whom important documents have to be transferred.

In the traditional therapy, the semantics of business documents are not well-defined between the medical partners, and information is mainly shared on paper. Every party uses its own semantics for documents, e.g. the description of diagnostic findings. In contrast, the exchanges of business documents between the medical parties, e.g. physicians or hospitals, and the “Kassenärztliche Vereinigung” (KV) which is the entity that performs the billing exhibit a high level of interoperability. The accounting system builds on standardized codes, e.g. the above mentioned EBM or DRG. However, since the patient does not profit from the well-defined business documents exchanged between physicians and the KV, the interoperability level of the traditional therapy is regarded as low. At stage one, only little or no documents are exchanged between the case manager and the providers so that hardly any changes regarding business documents occur with respect to the traditional system. At stage two, by contrast, changes in business document processing are necessary. The case manager is now able to transfer the ICF code which was identified during the assessment phase. Since the ICF code is a worldwide standard developed by the World Health Organization an adherence to generally accepted message standards which reflect common practice is achieved. The message standard ICF is used in the communication with every partner of the health management company. Since the ICF was not developed by mammaNetz itself updates or changes are initiated externally, i.e. they are initiated by a dominant partner, namely the WHO. Therefore, the interoperability level of the category “business semantics (business documents)” at the life-cycle category “review and assess” is regarded as minimum. In addition, mammaNetz is not involved in the exchange of diagnostic findings between providers such the above mentioned flaw, paper-based transfer, is not included in the evaluation of the interoperability level of stage two.

Master data that are necessary for administrating health care are, for instance, the name, date of birth, address, and the health insurance of the patient. In the traditional therapy, every provider uses his own semantics for the master data. At stage one, mammaNetz internally defines semantics for its own handling of the master data within the IT tool CM Assistant, but these semantics are not meant to be the standard for all participants. Due to the fact that the business partners of mammaNetz work with the CM Assistant at stage two as well, a multilateral agreement on a master data format exists.
The third category “employee and culture” deals with the question “How do we behave towards our external business partners?”. The introduction of specific roles, e.g. a partner manager within the organisation or the establishment of well-defined information and communication paths are examples for “Partnership management”. “Trust” comprises of responsibility, sympathy, reliability and confidence between partners. Thus, trust should establish a climate of confidence and develop a dependable relationship. “Social capital” refers to the social integration among employees that are involved in the cooperation. Informal mechanisms on the inter-personal level based on shared information or common ground, e.g. mutual knowledge, mutual benefits, or mutual assumptions should build a social structure of the cooperation. The evaluation of the different categories is accomplished as follows (see Figure 40).

During the traditional therapy, a contact person exists neither for the patient nor for the other partners. At stage one, the case manager is the main contact point for the patient and the other parties in the process. Due to the fact that case managers are a novelty, regular reviews are conducted about their efficiency and effectiveness. The case manager fulfils the role of a contact person at the operational level only. Since mammaNetz places contracts with the different providers at stage two a contact person at the strategic level is necessary as well. At stage two, communications occur much more regularly than at stage one. This leads to a regular interchange of feedback between partners about the quality of their respective managers and the communication process. Thus, a review about the effectiveness and the efficiency of the partner managers is conducted as well. However, this review is not due to the novelty of the partner managers but due to the necessity of a well-defined communication path.

As each party follows its own goals the trust level of the traditional therapy is very low. The different parties are not willing to share information due to fear of negative impact, for instance on their reputation. At stage one, the case manager tries to establish a trustful relationship as he depends on the contribution of the providers as well as the patient. In contrast, the establishment of a business relationship with mutual dependency makes trust a relevant factor at stage two. Providers and the health management company have a vital interest in a trustful relationship. For the patient trust becomes more relevant as well since at this stage the collection and transfer of confidential data of the patient plays a major role.

Social capital is of no relevance for the patient or the providers during the traditional therapy. At stage one, the case manager invests in social capital, for instance by visiting the patient in hospital. However, for the other parties social capital is still of no relevance. At stage two, social capital becomes important not only on the patient’s side but also on the providers’ side since it may contribute to a better atmosphere in their mutual cooperation.

Figure 40: Category: Employee and culture
Figure 41: Category: Information systems view

The last category “information systems” tackles the question “How do we connect with business partners?”. “Interaction type” is the type of electronic interaction with the partners which may be human-to-human, human-to-machine, or machine-to-machine. “Cooperation architecture” describes the connectivity relationships with the external partners. A high connectivity is achieved by replacing individual connections (1:1) with many-to-many connections (m:n). Furthermore, “security and privacy” means that electronic transactions have to respect the business partner's privacy and security concerns. It is also important that electronic transactions have to comply with the legislation on eBusiness. The evaluation of different sub categories of “Informations systems” is depicted in Figure 41 and explained below.

The interaction type during the traditional therapy is mainly human-to-human. Documents about the patient are given from one party to the next on paper. Further interactions take place via phone or eMail. The interaction type between medical parties and the billing entity is well-defined, e.g. recent approaches are concerned with online billing. However, as the patient does not profit from this particular well-defined communication, the interoperability level of the traditional therapy is regarded as low. The integration of a case manager at stage one results in no improvements due to the interaction type. The interactions between case manager and patient as well as case manager and providers are still human-to-human, i.e. communication happens on a face-to-face level, via phone or eMail. Stage two introduces a human-to-machine interaction by extending the functionality of the CM Assistant and making it the standard software tool also on the partners' side. Almost all activities between case manager and providers, e.g. arrangement of appointments, confirmation that the patient has kept the appointment and so on, are conducted via the CM Assistant. Therefore, the interoperability level is regarded as “moderate” (level 3) at the life-cycle category “approach".

Please note that for the assessment of the life-cycle category “approach” on stage two within the interoperability category “interaction type”, two marks are given. The second mark which is evaluated as “qualified” (level 4) refers to the transfer of the ICF code. The simple file exchange of machine-readable documents is regarded as preliminary stage of machine-to-machine exchange, and therefore given a higher value than human-to-machine exchange which is rated as “moderate” (level 3) only.

The traditional therapy does not include a cooperation architecture as no real cooperation exists. Again, the relationship between medical parties and billing entity is an exception but it is not included in this evaluation since it does not add value for the patient. The introduction of a case manager at stage one leads to no changes in this area due to the fact that mammaNetz has not the necessary influence and permissions to build this cooperation architecture. The extension of the CM Assistant and its introduction at the partners’ side at stage two leads to the establishment of this cooperative workspace, i.e. a common set of standards, protocols and interfaces on a proprietary bilateral basis is used. 1:n-connections are prevailing and standards are defined by a single partner, namely mammaNetz.

Privacy and security both within the traditional therapy, as well as in the context of stage one are protected by law. At stage two, mammaNetz not only has to obey to laws protecting privacy of the patients, but also has to assure that partner-specific data have to be protected. Thus, a higher interoperability level is observed due to increased awareness of privacy and security at stage two.
Overall, stage one must be regarded as field study which builds a basis of trust and comprehension in order to enable the migration to stage two of mammaNetz in the future. Providers and patients are prepared for and included in the further development of mammaNetz to become a health management company. The enhancement of the interoperability at stage one leads to improved quality and reduced costs. The described progression of the interoperability at stage two is in accordance with the new role of mammaNetz as health management company. It is expected that the introduction of further health management companies in the health care system following the example of mammaNetz will lead to value-based competition and result in further quality improvements and cost savings.

5.2.5 Strategic interoperability impact assessment of mammaNetz’s development phases

Figure 42 summarizes how the elements, i.e. the variables, of the IIAM are instantiated if it is applied to assess the interoperability improvements in the framework of the health care case study. Realization step one and realization step two of the case study are jointly examined, and as such elements of both phases jointly appear in the diagram. The IIAM enables us to identify the following positive effects to the health care system that are due to improved interoperability.

![Figure 42: Interoperability impact assessment (mammaNetz)](image)

During the therapy, the case manager acts as the primary contact person of the patient and provides him with all kinds of relevant information about the therapy. To illustrate this, the patient is informed by the case manager about the possibility to start therapy already one week after the surgical operation. She then might be willing to start chemotherapy much earlier which leads to a shorter recovery process, as well as an improved patient service since she can return to a “normal” way of life earlier. The case manager can be regarded as the process intelligence since he monitors and coordinates the therapy. Taken as a whole, the process becomes more flexible since it is much easier for the case manager to change the therapy plan at any time according to the individual requirements of each patient. In other words, the process agility is enhanced. In addition, certain procedural standards are established, since the case manager works in accordance with a pre-defined but flexible activity plan. Eventually, an optimized therapy schedule leads to a shorter recovery time and thus to a reduction of coordination costs. The alignment of the appointments of the different providers by the case manager is another example of process standardization which reduces connectivity costs. In this case, the overall communication overhead (coordination and monitoring costs) between service providers is reduced since treatments take place in an optimal and supervised order.
## Table 16 Strategic assessment - Global case management unit

### Case manager

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Question</th>
<th>Answer</th>
<th>If yes, please explain</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Financials</strong></td>
<td>Increase significantly the company's sales?</td>
<td>n</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maintain the sales at the current level? (remain on the market)</td>
<td>n</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reduce operating costs in a long-term perspective?</td>
<td>y</td>
<td>Better information of the patient leads to shorter recovery time and thus to an decrease of the costs.[IT integration reduces coordination and monitoring costs]</td>
</tr>
<tr>
<td><strong>Operational\ excellence</strong></td>
<td>Enable the company to quickly adapt to environmental changes (new markets, demand variations) at low cost?</td>
<td>y</td>
<td>Introduction of a case manager meets the individual needs of the patient</td>
</tr>
<tr>
<td></td>
<td>Increase the total production capacity of the current manufacturing assets?</td>
<td>y</td>
<td>[IT integration reduces information exchange between case manager and provider so that case managers can concentrate on the work with the patients]</td>
</tr>
<tr>
<td></td>
<td>Reduce the total manufacturing lead time?</td>
<td>y</td>
<td>Recovery time is reduced</td>
</tr>
<tr>
<td></td>
<td>Shorten the total product development time?</td>
<td>n</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Minimise system inventories?</td>
<td>n</td>
<td></td>
</tr>
<tr>
<td><strong>Customer</strong></td>
<td>Provide a unique value to customer?</td>
<td>y</td>
<td>Shorter recovery time result in a quicker return to &quot;normal life&quot; and thus more quality of life for the patient</td>
</tr>
<tr>
<td></td>
<td>Create a valuable lock-in effect?</td>
<td>y</td>
<td>Valueable lock-in effect is created by contracting providers</td>
</tr>
<tr>
<td></td>
<td>Improve the attractiveness of the company's product mix?</td>
<td>n</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Minimise the life-cycle costs on the customer's side?</td>
<td>n</td>
<td></td>
</tr>
<tr>
<td><strong>Supply</strong></td>
<td>Internally the competition between suppliers?</td>
<td>y</td>
<td>Providers become more comparable</td>
</tr>
<tr>
<td></td>
<td>Reduce the costs of transacting with suppliers?</td>
<td>y</td>
<td>[IT integration reduces information exchange between case manager and provider]</td>
</tr>
<tr>
<td></td>
<td>Reduce/suppress supplier switching costs</td>
<td>y</td>
<td>Providers are contracted</td>
</tr>
<tr>
<td></td>
<td>Improve the relationship environment with transaction partner?</td>
<td>y</td>
<td>Relationship is established</td>
</tr>
<tr>
<td></td>
<td>Allow the outsourcing of activities to focused and more efficient partners?</td>
<td>n</td>
<td></td>
</tr>
</tbody>
</table>
Another positive effect of process standardization is that the overall process becomes more transparent to all participants, i.e. the case manager, the providers and the patient. The case manager, for instance, has electronic access to the capacity planning data of the providers. The providers, on the other hand, are informed by the case manager about the date of the subsequent appointment such that they send necessary documents on time to the next provider in the workflow. The biggest benefits are the benefits for the patient herself, since she gets all necessary information about the therapy from a single source and therefore does not miss an important step in the therapy due to lack of knowledge. Improved transparency facilitates the monitoring task of the case manager, i.e. the electronic verification whether the patient has met all appointments. In consequence, monitoring costs are reduced. The IT integration, i.e. the development of an electronic document exchange platform enables an automated exchange of data, such as the ICF code or the files related to the electronic intake. Overall, the “manual” work is greatly reduced and thus coordination costs drop as well.

The better integration of the IT infrastructure, the standardization of the process, as well as the improved transparency facilitate the establishment of common benchmarking criteria and support a competition between individual health care providers. This becomes clearer by looking at the following effects. Process standardization and a common IT exchange platform lower the connectivity costs which make the integration of new partners much easier. Thus, competition is facilitated. In addition to this, reduced monitoring costs through improved process transparency facilitate the monitoring of the involved partners. Thus, the adherence to commonly accepted benchmarking criteria is also easier.

5.2.6 Conclusions

In a nutshell, the direct impacts of improved interoperability lead to strategic improvements on the side of the IIAM elements customer, operational excellence and supply. As described above the customer, i.e. the patient, benefits from an improved service quality. Operational excellence is augmented by shortening the cycle time, i.e. shortening the recovery, and improving agility of the overall workflow. In terms of the suppliers, improvements are achieved by making providers comparable and by making it easier to include new suppliers into the process. The overall goal is a sustainable recovery of the cancer patient and thus a significant reduction of the long-term costs.

We notice that the technical interoperability solution (phase 2) is strongly depending on the organization underlying the transactions. In the initial, fully decentralized, breast cancer process, the technological solution applied in phase 2 would be doomed to fail as the governance for piloting the whole process would be missing. As a consequence, the investigation of the organizational setup of a transaction is very insightful in assessing the viability of interoperability platforms.
6 Conclusion and outlook

While interoperability issues are becoming apparent as more and more firms are acting in a networked environment, very few integrated methods have been developed to assess the impact of measures intending to solve these issues. On the basis of literature findings, we have developed in this deliverable the “Interoperability Impact Assessment Model”. This model represents a structured but flexible way to analyze the value resulting from interoperability improvements at a strategic and an operational level. The relevance of this methodology has been verified with help of three practical case studies. Interestingly, we notice that:

- Interoperability investments should not only take the improvements at the companies’ interfaces into account but should also the impact on the total value chain. A higher level of interoperability is, in this context, a driver for competitiveness and not only a means to reduce the information processing costs at a company’s border.
- The value of improved interoperability is in fact not equivalently distributed along the value chain. This aspect needs to be recognized in order to avoid difficulties during the implementation of interoperable solutions.
- The value created by interoperability is heavily determined by the connectivity possibilities. 1:1 relationships are generally much more expensive to establish than 1:n and n:m relationships. As a consequence, the Athena tools contribute to reduce connectivity costs.
- While interoperability technologies can improve the transaction environment (see all case studies), some greater productivity leaps can only be achieved when the organizational structure of the transaction fits to the technological possibilities (see health care case).

With help of this methodology, the Athena pilots will be investigated in their ability to contribute helping the contracting firms to reach sustainable competitiveness through Athena tools (see Athena Impact Assessment, DB3.4). Furthermore, the insights gained from the IIAM application to various cases will also enable us to draw valuable managerial insights concerning:

- The optimal way to “seamlessly” integrate SMEs into greater business networks,
- The critical role of business interoperability on agility and the competitiveness of European companies, and
- The optimal pattern of interoperability investments on the basis of transaction characteristics.
7 References


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