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AN APPROACH FOR ASSESSING THE BENEFITS OF IT INVESTMENTS IN GLOBAL SUPPLY CHAINS

Completed Research

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Abstract

This paper develops and demonstrates a novel approach for ex-ante assessment of business benefits from IT investments in global supply chains. Extant IT assessment approaches are typically based on the assumption that benefit realization from IT investments involves a single stakeholder and are produced by the technology as an isolated product. In contrast, research on global supply chains has shown that benefits generated from IT investments in this domain are typically generated by the coordinated use of many stakeholders and by technologies producing complimentary effects in systemic relationships. The assessment approach in this paper brings the contingent inter-organizational and technological dependencies of IT investments to the forefront of the assessment. It provides actors in industries relating to global supply chains the means to better apprehend the possible benefits from an IT investment and an understanding of the contingencies of these benefits. The approach was developed through an iterative design science research process in close collaboration with a major shipping line. The usefulness of the approach is demonstrated through the ex-ante assessment of the business impact of investing in digital container devices that enables monitoring of containers en route.

Keywords: IT assessment, IT evaluation, Maritime informatics, Global Supply Chains

1 Introduction

The maritime industry is facing challenges both imposed by external requirements and operational shortcomings in participating companies (Güven-Kocak, 2015). Increased customer demands regarding higher security and environmental standards combined with inefficient processes and a self-centred attitude of the many stakeholders involved in the supply chain force the whole industry to rethink their way of doing business (Güven-Kocak, 2015; Jensen et al., 2014; Jensen & Vatrapu, 2015a). It is widely acknowledged that increased collaboration and integration among the partners in a supply chain will open up opportunities for innovation and thus defend or strengthen their competitiveness (Chapman et al., 2003). Quick and resolute action is even more necessary due to new entrants that compete with the shipping industry in courting new and existing customers. Couriers like UPS have long been well aware of the new customer demands like visibility of their cargo throughout transit and are equally well prepared to provide the respective services (Hingorani et al., 2005).

Information technology (IT) is an indispensable mean for mere improvement of operational processes or, when integrated among the partners, even for product or process innovation that can lead to changes in business models and in turn to a significant competitive advantage (Gunasekaran & Ngai, 2004). Actors such as the UN, EU, World Trade Organization (WTO), and World Economic Forum (WEF), together with national customers, organizations, traders, logistic service providers and technology companies have all invested considerable resources in digital technologies to improve the conditions for international trade. Forum (2013) estimates that the adoption of state of the art digital technologies

in combination with redesigned information processes enabled by these technologies will lower the cost of international trade by 15%, leading to an increase in world GDP by 5%.

However, to introduce a technological innovation into a conservative and highly distributed setting like the maritime industry is difficult (Güven-Kocak, 2015; Jensen et al., 2014). On the operational side, there is the traditional reluctance of the maritime industry towards innovations related to other aspects than incremental efficiency improvements (Jensen et al., 2014). This leads to an environment where even minor novelties might require them to reengineer large portions of their processes and products (Bjørn-Andersen et al., 2007; Henningsson & Henriksen, 2011). On the economical side – which is tightly interwoven with a prior successful operational implementation – the investment needs to pay out. In a decentralized setting, however, the one investing might not necessarily be the one gaining most of the benefits (Hedman & Henningsson, 2012). In consequence, even the most promising technological investments may not see their possible benefits materialize.

For actors in the maritime industry, including traders, shippers, governmental agencies and multi-national interest organizations, the conditions of the industry raise important questions about how to assess the impact of technological investments on the global supply chain and, ultimately, the actions required to ensure that this possible impact actually materializes. Solid knowledge about this impact will in turn foster and ease the adoption of new IS especially in an industry that is as reluctant towards innovations as the maritime industry. It would help IT managers to make their cases about long overdue investments in the IS field. Therefore, considering a specific technological investment, an approach to ex-ante assess the benefits of the investment is required.

Unfortunately, traditional IT investment assessment approaches (see Section 2 for an overview) are not well suited to this sort of problem. Typically, these approaches are based on the explicit or implicit assumption that there is only one single actor involved in the materialization of benefits, and that the technological investment generates benefits as an isolated technology. In contrast, we know from research on the maritime industry and technological innovation in global supply chains (Baida et al., 2007; Forum, 2013; Güven-Kocak, 2015; Henningsson et al., 2011; Jensen et al., 2014) that a significant proportion of the benefits from innovative technologies are dependent on the coordinated action of a wide range of stakeholders and are produced systemically by the interaction of a set of technical components, that can be distributed across stakeholders.

Therefore, this paper develops a novel approach for the ex-ante assessment of business benefits generated by technology investments in global supply chains. In contrast to previous approaches that ignore the contingent dependencies of benefits on other stakeholder actions and complementary technologies, we bring the contingent aspects of technology investments to the forefront of our approach.

The approach was developed following an iterative design science research method (Carlsson et al., 2011; Gregor & Hevner, 2013; Peffers et al., 2007; Van Aken, Joan Ernst, 2005), in close collaboration with a world-leading shipping line. The approach is rooted in extant IT assessment methods that are extended to fit this class of problem. The usefulness of the approach is demonstrated through the ex-ante assessment of the business impact of investing in digital container devices that enable monitoring of containers en route.

2 IT Investment Evaluation

In the following, existing methods for IT investment evaluation are reviewed along with their shortcomings when it comes to the application for IT investments in the distributed supply chain context.

The evaluation of an IT investment can either happen ex-ante at the proposal stage or after the investment in order to measure its success. In this paper we want to develop an approach that allows to anticipate the impact of an IT investment and to provide a profound basis for the investment decision. The evaluation of an IT investment has to be seen in a different context than traditional financial investments. Technology usually does not generate value by itself but through the incorporation into the company organization and its processes (Nevo & Wade, 2010; Wade & Hulland, 2004). With the

emergence of connected and smart products some benefits might only arise if the regarded technology is used in combination with complementary technology. All these aspects hinder the unambiguous allocation of benefits and induced changes to the investment.

In the literature one can find several reviews of methods for IT evaluation at the proposal stage (Farbey et al., 1992; Irani & Love, 2002; Renkema & Berghout, 1997). Depending on the role of the evaluation, it can be used to broadly “define scope of strategy” or it can have a narrow focus and “exactly measure benefits and costs” (Farbey et al., 1992, p. 116). The corresponding techniques range from the ones traditionally used for financial evaluation, which have a focus on the economic value to approaches that specifically try to integrate qualitative and strategic decision criteria.

One group of evaluation methods comprises traditional financial techniques like ROI, payback period or cost benefit analysis. These are complicated to apply in the IT context and become very subjective when trying to capture both tangible and intangible benefits (Murphy & Simon, 2001).

A second group of methods allows for a broader analysis by accounting for strategic implications that are hard to quantify. This group includes methods like multiple criteria and value analysis (Canada & Sullivan, 1989; Money et al., 1988). Information economics, one well-known representative of the multiple criteria approaches, covers the economic value by an enhanced costs/benefits calculation. Besides, the approach accounts for strategic benefits arising from the business and the technology domain (Parker & Benson, 1988).

A third group relates to integrated approaches that comprise the entire IT implementation process. Methods like the IT balanced scorecard and the benefits management approach emphasize the realization of the initially anticipated positive effects resulting from the investment (van Grembergen & van Bruggen, 1997; Ward & Daniel, 2006). IT investments have an infamous reputation for not generating the value it has promised during appraisal not least due to the critical aspects mentioned above. Therefore, these approaches have developed techniques like the benefits dependency network that particularly emphasize the drivers of the benefits during the appraisal phase. Peppard et al. (2007) argue that only with a thorough understanding of the underlying driving forces, the investment has a chance to pay-off in the end.

However, these models are all based on three assumptions that do not hold when considering IT investments with effect over a distributed supply chain:

- The benefits are generated by the use of one single actor. One of the main issues with distributed supply chains, however, is the lack of coordinated use of technologies. The use usually takes place in isolated pockets (Baida et al., 2007; Björn-Andersen & Henningson, 2009; Jensen et al., 2014). A great deal of technologies’ potential in a supply chain is yielded through an integrated use by the supply chain actors, in particular the innovative technologies that are characterized by increasing economies of return (positive network effect) in the generation of benefits (Katz & Shapiro, 1994; Parker & van Alstyne, 2005).
- The technology is creating benefits in isolation from other technologies. It has been shown that technologies cannot be considered in isolation. Instead, the technologies are interrelated with each other in IT ecosystems, influencing one another in their evolution (Adomavicius et al., 2008).
- The one and the same actor is in charge of cost and value extraction. The lack of a joint ownership of the investment in a distributed supply chain inescapably results in an asynchronous distribution of costs and benefits across the stakeholders. While the supply chain as a whole may reap substantial benefits for a single unit the gained benefits may not make up for the investments (Henningson & Hedman, 2010).

In developing an approach to assess the impact of IT investments on global supply chains we need to relax these assumptions, and give particular attention to the contingencies of the IT investment on the organizational and technical context of the investment. To address this gap this paper develops an approach that will assess the potential of the investment not by putting a value tag on the respective ben-

efits but by *uncovering their drivers and showing what these benefits are conditioned on*. It will partially draw on existing approaches that take into account decision criteria other than mere economic value and will additionally tackle the mentioned issues that 1) *benefits might dependent on the collective use of the technology by several supply chain partners*, 2) *benefits might be dependent on the combined use with other technologies*, 3) *costs and benefits might be distributed asymmetrically across stakeholders*. Only with that knowledge a profound decision about investing or not investing in a technology can be made.

3 Methodology

For the design of the method we followed an iterative design science research (DSR) approach (Carlsson et al., 2011; Gregor & Hevner, 2013; Van Aken, Joan Ernst, 2005). Our DSR approach is structured around the six activities of the DSR reference process as proposed by Peffers et al. (2007): (1) problem identification and motivation, (2) definition of design objectives for a solution, (3) design and development, (4) demonstration, (5) evaluation, and (6) communication.

The main elements of the design approach are presented in Table 3-1. The design process was, however, not linear across these activities.

The definition of objectives and design steps were conducted in an iterative, three phase process in close collaboration with the intended users of the assessment approach. We took a starting point by reviewing extant literature and identified a set of tools and techniques that could be useful components for our approach. During the first phase – the pilot – the relevant elements to consider in the approach were further discussed with experts from the shipping company during workshops. These especially helped to incorporate components that emphasize critical aspects from a practical perspective like the initial stakeholder analysis. In a second phase, the first draft of the approach was validated by testing it with an initial set of informants to make ‘proof of concept’ before applying it to a real case, a specific technology that is supposed to be introduced into a global supply chain in the third phase.

Pries-Heje et al. (2008) point out the difficulty to prove the soundness of a process. The product of an evaluation method is ultimately an investment decision and its quality depends on whether it generates economic value or not. However, such an objective quality measure is impossible to get at this point. Instead, we decided to seek the opinions of the IT managers that have to make these investment decisions on how much this new approach improves their basis for decision-making. These iterations have been conducted both during the development of the method and afterwards, including aspects of action research in the evaluation method.

Activity	Methodological guidelines	Activity description
1. Problem identification	<p>“Define the specific research problem and justify the value of a solution. Since the problem definition will be used to develop an artifact that can effectively provide a solution, it may be useful to atomize the problem conceptually so that the solution can capture its complexity.”</p> <p>Van Aken, Joan Ernst (2005) argues that the mission of a design science research is “to develop knowledge that can be used by professionals in the field in question to design solutions to their field problems.” (p.22)</p>	<p>The professionals targeted in this paper are IT managers of companies operating in distributed supply chains that have to decide on a technology investment. The need to address this problem was raised by an IT manager from the field of international trade and further motivated through an extant literature search where the lack of an appropriate evaluation method could be asserted. The problem was atomized as ability to assess the impact of an IT investment on the entire supply chain by understanding the underlying drivers of the potential benefits.</p>

2. Definition of objectives	<p>“Infer the objectives of a solution from the problem definition and knowledge of what is possible and feasible. ... The objectives should be inferred rationally from the problem specification.”</p>	<p>The overall goal of this research is to provide guidelines for a purposeful analysis of the impact of IT investment in supply chain that ultimately results in a profound basis for the investment decision. A purposeful analysis is achieved by recognizing and considering the peculiarities of IT in combination with a distributed supply chain. The design objectives are derived from the absence of methods that neither technically nor with regards to the content take into account these characteristics.</p>
3. Design and development	<p>“This activity includes determining the artifact’s desired functionality and its architecture and then creating the actual artifact. Resources required moving from objectives to design and development include knowledge of theory that can be brought to bear in a solution.”</p> <p>“A method is a set of steps (an algorithm or guideline) used to perform a task.” (March & Smith, 1995)</p> <p>(Lind & Goldkuhl, 2002) suggest the grounding of methods in three different ways: “internal, theoretical and empirical grounding” (p. 6)</p>	<p>We developed a method according to March and Smith (1995) using the guidelines of (Lind & Goldkuhl, 2002) for justification of methods. An internally consistent and coherent method is achieved by a detailed, verbally description of its goals and its procedural steps leading to them in addition to graphical representation of the tools supporting the execution of the method. The method builds on justificatory knowledge about the impact and the value creation of IT on supply chains (Craighead & Shaw, 2003; Lee & Whang, 2001; Rai et al., 2006). Partly prescriptive knowledge from existing methods for IT evaluation is used. The empirical grounding is described in activity 5.</p>
4. Demonstration	<p>“Demonstrate the use of the artifact to solve one or more instances of the problem. This could involve its use in experimentation, simulation, case study, proof, or other appropriate activity.”</p> <p>“Validity means that the artifact works and does what it is meant to do ... The utility criteria assesses whether the achievement of goals has value outside the development environment.” (Gregor & Hevner, 2013, p. 351)</p>	<p>We used a natural setting for demonstration. The validity and utility of the method was shown with the help of a case from a global supply chain for international trade. The investment constitutes the equipment of containers with a container security device that collects various kinds of data. Qualitative feedback was</p>
5. Evaluation	<p>“Observe and measure how well the artifact supports a solution to the problem. ... Conceptually, such evaluation could include any appropriate empirical evidence or logical proof.”</p> <p>For evaluation of a method or process Pries-Heje et al. (2008) suggest the idea of process-based quality, “that a good process will lead to a good product.” For that, “opinions of the method/process users can be sought.” (p. 8)</p>	<p>The testing was conducting according to Pries-Heje et al. (2008) by seeking the opinions of the users. The design artefact was evaluated through a number of iterations both during the development and after the case study by consulting users and experts on how they perceive the quality of the outcome of the method, i.e. the basis for decision-making.</p>
6. Communication	<p>“Communicate the problem and its importance, the artifact, its utility and novelty, the rigor of its design, and its effectiveness to researchers and other relevant audiences, such as practicing professionals, when appropriate.”</p>	<p>Communication to practitioners has been done through presentations at various practitioner conferences and through direct communication to individuals (IT managers, consultants) within the targeted constituency. Communication to researchers takes place through this paper.</p>

Table 3-1 DSR process. Adapted from Peffers et al. (2007)

4 Approach

The following approach focuses on how to assess the impact of IT on a supply chain at proposal stage. As mentioned before, existing methods are not appropriate for this undertaking, as the primary decision criterion in this case will be strategic and qualitative aspects like the drivers of the benefits and the distribution among the stakeholders and not economic terms. Special emphasis in our approach is thus given to the characterization of the identified benefits in order to uncover their actual drivers. The approach, as depicted in Figure 4-1, can be decomposed into two major steps: 1. Benefits identification and 2. Benefits characterization. However, it should not be perceived as a strictly consecutive process, but as iterative sequence of activities especially within the first steps but as well within the whole process.

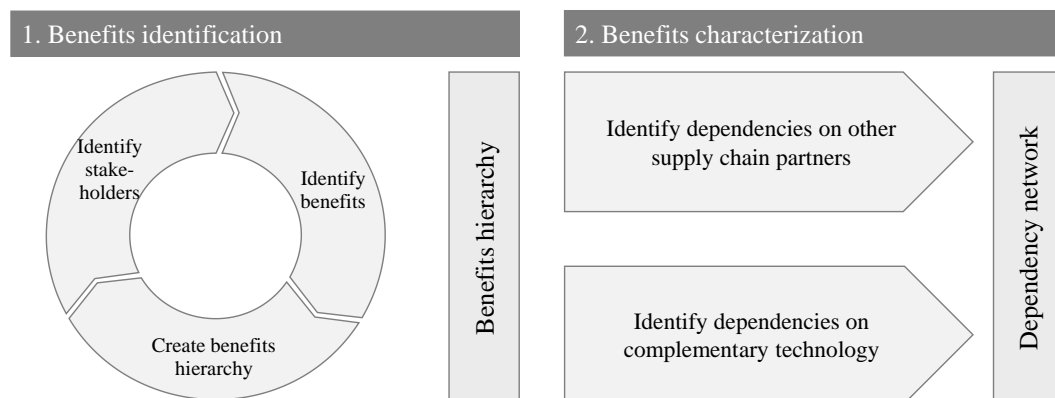


Figure 4-1 Two-step approach to assess the benefits of IT investments in global supply chains

4.1 Benefits identification

During the first step it is all about gathering information on the business impact of the respective technology. The goal is to create an exhaustive list of potential benefits along with complementary information on the related processes and potentially necessary investments. In order to collect the relevant data, semi-structured interviews with all potential beneficiaries and other third party companies are conducted. The first step comprises an iterative process of three activities: the identification of stakeholders, the identification of benefits through interviews and the categorization of these benefits into a benefits hierarchy. The iteration lasts until no new stakeholders or benefits can be identified anymore and saturation is reached.

Activity 1.1: Identify stakeholders

Stakeholder analyses are conducted for various strategic purposes with the common goal to extract knowledge about a group of stakeholders and their characteristics (Brugha and Varavsovszky 2000). Every analysis precedes a rigorous identification of all stakeholders who are relevant for the given purpose (Hatten and Hatten, 1988). According to Nutt and Backoff (1992) “all parties who will be affected by or will affect [the organization’s] strategy” (p. 439). In our approach everyone in the supply chain who can be affected by the new technology could be relevant. Bryson (2004) gives an overview of various techniques to guide the process of stakeholder identification and analysis for different purposes. Generally, it is reasonable to talk to the initiators of the new strategy in a small meeting first, and identify an obvious group of key stakeholders (Brugha and Varavsovszky 2000). Additional information on who might be relevant for the business case will come up during the interviews with the respective parties. It is important to iterate on this task several times and gradually expand the list of

potential stakeholders. It can be useful to visualize the identified stakeholders in a *value network* to grasp the relations among them (Bryson 2004). Potential interview partners might also include third party companies that might have valuable information on that topic (Thomas 1993).

Activity 1.2: Identify benefits

The benefits are then collected through semi-structured conversations with all relevant stakeholders and third parties identified throughout step one of the analysis. The collection of benefits is facilitated by having a solid understanding of the business models of each of these companies. Hence, using a drafted business model, like the business model canvas, the companies are first asked to provide general information about their businesses in order to complement the understanding of the companies. Here already, it is important to keep the peculiarities of introducing IT into a supply chain in mind in order to gather information to the purpose: IT itself usually does not generate value, but the incorporation of the capabilities into the organisation and its processes does (Nevo & Wade, 2010; Wade & Hulland, 2004). The technology can be seen as a new resource added to existing IT systems that might affect the way the company's processes are run. In turn, more efficient processes might positively impact the value proposition, leading to higher-level benefits like improved customer services. Furthermore, a supply chain is characterised by plenty of interdependencies between the actors regarding the flow of goods and information. The influenced processes might involve more actors than just the analysed company itself. Therefore, it is necessary to create awareness about who the company is interacting with on both the goods and information flow levels. A solid understanding of the business models of the stakeholders should thus comprise the relevant areas for this analysis: *resources, core processes, value proposition, key partners* and of course *customers*.

Having discussed aspects about the company in general, the new technology is introduced by explaining all its features and capabilities. Depending on the level of knowledge of the interview partners, benefits can now be identified using two different methods: *requirements driven* or *technology driven*. In the first case the interview partner is assumed to have little knowledge about the technology. Here it is most effective to talk about current problems in their daily operations like waiting slots until goods are further processed and their value proposition that they try to deliver to the customer. Benefits can then be derived indirectly based on these requirements. After the interview, this list can be matched with the capabilities of the technology to see what problems can be targeted or what values can be enhanced. If the interview partner has solid knowledge about the technology, the benefits can be derived directly from the new capabilities. Here it is especially important to remember that these capabilities usually do not influence the performance of the company directly but through the adaption of business processes. Thus, the impact of a new capability should always be determined with respect to related process changes. During the conversations with affected stakeholders themselves it is important to let them also talk about the other stakeholders and get their perspective of how the technology might affect their supply chain partners. This external view can enrich the data of the benefits. The same effect is obtained by talking to third parties like the vendors of the technology who stand outside the supply chain and can provide their objective view on it.

Activity 1.3: Create benefits hierarchy

At the end of every interview, a benefits hierarchy is created and extended respectively for every potential beneficiary. The benefits are supplemented by information on the processes that might be affected and IT investments that might be necessary in order to achieve this benefit. The extra information is necessary in order to extract the desirable knowledge from the adjacent characterization in step 2.

The categories of the common key performance indicators (KPIs) of the respective actors in the supply chain can be a good basis to sort the potential benefits. In the literature one can also find plenty of generic benefits hierarchies (Auramo et al., 2005; Gunasekaran & Ngai, 2004) that describe the impact

of IT on a supply chain. As the iterative process is advancing, the interviews will be more and more facilitated by using the existing hierarchy as guidance until no further new information can be added.

4.2 Benefits characterization

The identified benefits alone are not sufficient to make a substantiated investment decision. Additional information is needed on how likely these benefits are to materialize. After all, this is dependent on what drives these benefits, i.e. what they are conditioned on. Walton and Gupta (1999) have pointed out that it is a particularly difficult task to explain the benefits that result from IT introduced into a supply chain on a general level: because the benefit might be dependent on more than just one supply chain actor. Craighead and Shaw (2003) as well argue that there can be indirect value or higher order benefits from IT in a supply chain stemming from the combined IT capabilities of several stakeholders in the supply chain. Furthermore, some effects might be driven by a combination of several technologies (Adomavicius et al., 2008) or could result indirectly from induced process changes rather than directly from the technology itself (Peppard et al., 2007). In order to assess the impact and to make an informed decision, it is thus indispensable to reveal exactly these dependencies and drivers of the benefits.

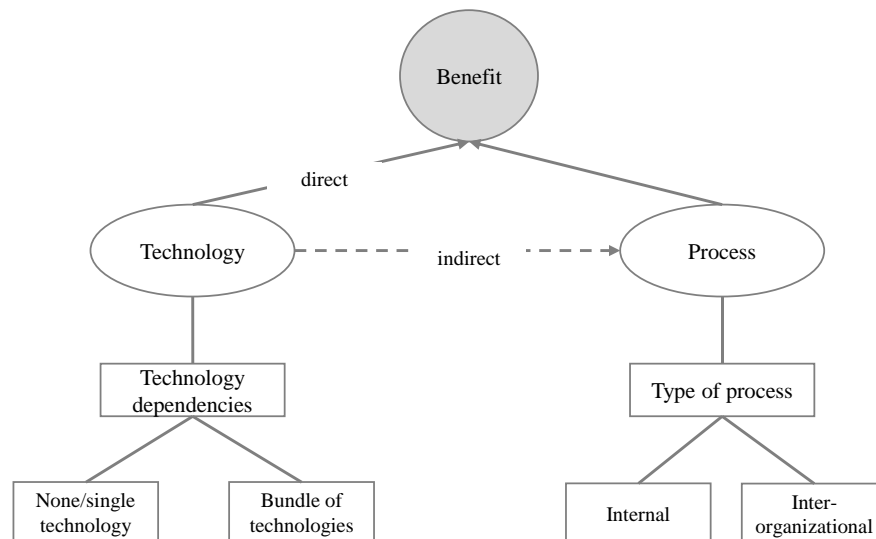


Figure 4-2 Characterization of benefits

Figure 4-2 displays the essential drivers that help to characterize each of the benefits, which then add up to a business potential for the entire supply chain. The dimension *technology* takes into account the peculiarities of an IT investment, whereas the dimension *process* relates to the supply chain setting and covers the drivers coming from potential interdependencies among the stakeholders.

It is first necessary to determine whether the benefit originates directly from the new capabilities or whether the positive effect is caused indirectly through changes in the business processes or activities. Furthermore, the benefit can be driven by one single technology or a bundle of technologies. During the step *Benefits identification* information on required investments in IT systems has been collected, which will be used to analyse this dimension. A major benefit might dramatically drop in value if it relies on substantial additional investments in order to upgrade the existing IT systems of the company or to buy complementary technology.

If the benefit results from a change in a business process, it needs to be assessed if the considered company interacts with other stakeholders within this activity. The type of the process indicates whether the advantage originates from the isolated use of the company within an internal process or whether it is dependent on several stakeholders. If an inter-organizational process needs to be adapted

in order to reap the benefit, the company relies on other stakeholders to go along with the change. Eventually, it is important to not only identify the independencies but also unambiguously name the involved supply chain partners. Furthermore different types of benefits result from different degrees of integration. The technology ultimately influences how strong the supply chain partners are integrated, whether it is simply used to share information or to coordinate higher-level, strategic interaction. A high dependency on other stakeholders comes along with a high uncertainty for the investment. The behaviours of the supply chain partners with regard to the new technology can be unpredictable. This needs to be considered as a big risk factor in the overall investment decision. The willingness of the partners to make complementary investments is based on a similar rational as it is for the primary investor. Depending on the results of the assessment, critical stakeholder dependencies will have to be looked at in detail to improve the basis of decision-making.

5 Demonstration and evaluation

We will illustrate the developed approach using a business case from a global supply chain for international trade. In order to enhance the efficiency of the shipping process, a container security device (CSD) is to be installed on the containers. This technology can provide valuable data via satellite communication which can then be fed into the information systems of those supply chain partners who have the right to access the data. The features include GPS tracking of the container as well as sensors that can capture any damage or tampering of the container (internal document). Today the stakeholders in this supply chain have very little transparency and insight in the events of international trade (Jensen & Vatrapu, 2015a). Such a CSD might have the potential to add value not only to the involved companies themselves but to the entire supply chain through increased visibility and integration. While the owner of the container will be the one to make the investment, it can be assumed that several stakeholders handling the container along the supply chain might profit from the data collected by the device. The enhanced efficiency of each one of the involved companies might in turn add up to an entirely improved logistics service for the customer. However, it is not obvious at first sight how these benefits are distributed across the stakeholders and where these benefits might come from. In the following the approach is illustrated in detail along with the major results from the conducted interviews.

5.1 Benefits identification

Activity 1.1: Identify stakeholders

In the beginning we consulted an academic expert on the industry to get an understanding of the entire supply chain. In his recent studies of a typical trade lane shipping roses from Kenya to the Netherlands, he identified about 20 actors to be involved in one shipping process (Jensen & Vatrapu, 2015b). From these actors we filtered all stakeholders that directly deal with the container. At a first glance, they presumably have the highest benefit potential from this new technology and are thus a good basis to start the interviews with (Figure 5-1). However, after each of the interviews, the list of potential beneficiaries has been adapted especially with regard to stakeholders that are only indirectly linked to the shipping process, but also handle the containers, actors like the repair yards or empty container depots.



Figure 5-1 Potential stakeholders

The shipper, i.e. importer or exporter, might use the services of a trader to coordinate the transport of the goods from the location of origin to the destination location. The forwarder can represent different types of transportation on land and is carrying the container to the port where the cargo is inspected by the authorities. Once released by the authorities, the terminal operators can start to unload the container from the truck or train and to store it in the transshipment port. As soon as the shipping vessel is ready for loading the container is loaded onto the vessel and transported by the shipping company to the port of destination where a similar procedure is taking place reversely. The shipper is not involved in the transportation process but as the one buying the services, he is ultimately affected by changes and improvements in the respective logistics services. Additionally, the smart container which is providing valuable data can be seen as a product as a service, which the shipper could even benefit from directly. In this sense benefits might not only comprise cost reductions but also gains from additional revenue streams. During the iteration several other third party companies have also been added to the list of potential interview partners in order to cover the external view on this business case. First of all, the manufacturers and vendors of the CSD are naturally a promising source for such a business case analysis. Additionally, insurance companies, repair yards and also empty container depots were interviewed.

Activity 1.2: Identify benefits

The interviews were semi-structured around the following three topics, with different focal points depending on the role of the interviewee – supply chain partner, third party company or shipper:

1. Business model
2. Problems in processes and contribution of CSD
3. Induced process changes and required investments

The first topic aims at getting an understanding of the company's business model. The business model canvas was used to structure the information received from these questions. The key partners of the stakeholders in various activities were to a great extent congruent with the potential beneficiaries identified in the first activity. This congruency will be interesting to pick up when analyzing the benefits afterwards. The value propositions already gave hints of what could be possible benefits for the shipping company from the technology, like reliability and short transit time. Especially the shipping company as initiator of this business case analysis and also the vendors and manufacturers of the CSD have had informed knowledge of the technology. Hence the conversation could be directed focusing on the new capabilities that will be available with the CSD and the resulting benefits. On the contrary, the other supply chain partners have had only little information on it and thus the benefits had to be derived indirectly through identifying current issues. For every benefit that was identified we made sure that it is not simply listed. Instead, we were eager to gain additional information about the process that needs to be changed in order to reap the benefit and on how the technological implementation for using the new capability can be realized. With the questions in focus area three we especially managed to get a feeling for the magnitude of the impact which then could be analyzed in a structured way in step two.

Activity 1.3: Create benefits hierarchy

In order to categorize the benefits, pertinent literature has been searched for general benefits categories or attributes describing the impact IT can have on a supply chain. Additionally, core KPIs provided by one of the supply chain parties have been used to set up the initial hierarchy. The main categories are *costs*, *efficiency*, and *reliability* and are similar for most of the stakeholders and thus form a good basis to categorize the potential benefits that have been identified during the interviews. However, some benefits could not be properly allocated to the three initial categories and thus the categories *account-*

ability and *flexibility* were added during the process of the step 1. Table 5-1 is an example of a benefits hierarchy which was built for the shipping company.

Maersk Line – Shipping company			
Category	Benefit	Related process	Complementary IT
Costs	Reduced # of stolen container	Direct	Existing IT infrastructure
Costs	Reduced labor costs	Direct	Existing IT infrastructure
Costs	Reduced inventory	Empty container repositioning	Existing IT infrastructure
Efficiency	Reduced lead time	Shipping process	Existing IT infrastructure + mobile application
Efficiency	Optimize capacity utilization	Network optimization	Existing IT infrastructure
Efficiency	More efficient container piling on vessel	Loading/unloading vessel/ Planning process	Existing IT infrastructure + mobile application
Efficiency/ Accountability	Tracking of customer usage	Claims handling	Existing IT infrastructure
Accountability	Improved accountability in case of container damage	Claims handling	Existing IT infrastructure
Flexibility	Faster damage handling	Repair process	Existing IT infrastructure + mobile application
Reliability	Higher on-time delivery	Shipping process	Existing IT infrastructure + mobile application

Table 5-1 Benefits resulting from the introduction of a CSD for a shipping company

5.2 Benefits characterization

Following the approach, the benefits are now characterized according to the dimensions technology and process. By looking at the example in Table 5-1 it stands out that especially the low level benefits related to direct cost reduction can be directly linked to the technology. By using the GPS signal the number of stolen containers for example can be reduced leading to direct cost cuttings. However, the majority of benefits is achieved through the adaption of the related processes. The inventory of empty containers in stock can be reduced using the new technology. But, this requires the incorporation of the newly available data into the process of empty container repositioning and an adaption of the current algorithms. While in the case of the container repositioning for example only an internal process is affected, the shipping company is dependent on the terminal operators in order to reach an improved on-time-delivery. When shipping from port to port, the terminal operators on each end also need to use the data in order to ensure a purposeful handling of the containers. Customs especially profit from the information about whether the door of the container has been opened unscheduled. Thereby the hit-rate in fraud detection can be dramatically increased. In order to allow for more targeted and quicker inspection, though, coordination and an equal knowledge basis is required between customs and the terminal operator.

During the interviews it appeared that the potential beneficiaries mostly have the ability to effectively use the new data stream with their current IT infrastructure. It is more complex when processes or activities are affected where such kind of technology has not been used before. This is mostly the case

with the primary processes, like the actual shipment. In such cases additional investment is required in order to provide the people with new applications that will support their daily operations and with the appropriate training.

While all of the main actors in the supply chain can benefit partly from optimizing their internal processes by using the data provided through the CSD, many benefits are driven by the interplay with partners upwards or downwards in the supply chain in using the technology. However, to achieve strategic benefits, i.e. significantly improve the entire supply chain performance all stakeholders have to contribute. Only through an integrated use of the available data, the benefits gained by each supply chain partner on the way add up to an improved product. If one single stakeholder manages to reduce the lead time, this benefit will be mitigated by the other stakeholders who don't achieve the same effect on their side.

When showing the results to the IT manager of the shipping company he was very pleased by our approach especially as it highlights the investment decision from a different angle. He also found that the graphical tools were very helpful to communicate the findings in a comprehensible way other concerned parties. It was striking for him to see how his company would be dependent on so many different partners in the supply chain especially in order to not only achieve efficiency gains but also increase revenue streams by providing better services to the end customer. On the other hand, however, the benefits weren't equally distributed across the different stakeholder which might make them not very likely to actually use the technology in the end.

The results of the assessment serves as decision support that can change the whole point of view on the overall investment. In the beginning, the shipper initiates the benefits assessment for an investment that he might consider valuable to his company. However, once the dependencies on other stakeholders and the asymmetric distribution of costs and benefits become obvious, new ways of financing the technology need to be considered. The shipper can come up with business models that financially exploit the value of the new collected data, or he might consider a joint investment with other big beneficiaries.

6 Discussion and Conclusion

In this paper we addressed the lack of a suitable approach to assess the business benefits of an IT investment in a global supply chain. While there exist plenty of methods to evaluate the costs and benefits of IT investment, these approaches are generally based on the explicit or implicit assumption that benefit realization from IT investments involves a single stakeholder and is produced by the technology as an isolated product. Relaxing these assumptions, we develop and demonstrate a novel approach where the inter-organizational and technological dependencies of an IT investments were brought to the forefront.

The developed approach consists of two main phases, benefit identification and benefit characterization. The benefit identification is an iterative process comprising of the activities stakeholder identification, benefit detection and benefit hierarchy creation. The output of this phase is a hierarchical structure depicting all possible benefits across the supply chain from an IT investment. This hierarchy does not make any consideration about the contingencies of those benefits.

The second phase, benefit characterization, has as objective to unearth the inter-organizational and technological dependencies of the identified benefits. Here, each benefit is characterized by how it requires active involvement of supply chain partners for manifestation as well as which existing and future technologies are required to materialize the benefit.

The usefulness of the approach was demonstrated through an ex-ante assessment of the business benefits associated with the investment in digital container devices to monitor shipping containers while en route. Using the approach, we identified a range of benefits and characterized the contingent dependencies of these benefits.

The practical use of our approach we see as two fold. First, actors in global supply chains can use the approach as a basis for estimating if the benefits for the supply chain can motivate the cost of the IT investment. As shown by our approach, only a fraction of the benefits from the investigated container device are located directly within the investing actor. Second, our approach provides essential information for developing plans for the realization of these benefits. Benefits located at another stakeholder, or contingent on complimentary technological investments cannot be expected to materialize with targeted strategies. Although our approach does not list the strategies required to recover costs, the output of an assessment following the approach depicts a starting point for developing such strategies.

To improve the practical usefulness of our approach, further testing and refinement is required. Here we only demonstrate and validate the usefulness with one particular technology. In the terminology of Adomavicius et al. (2008) the container device depicts a 'product technology' that in the technological ecosystem builds on infrastructure technology and enables component technology. Further research should validate the approach with different types of technologies and also seek to refine the approach with insights about the interplay between different types of technology categories to better apprehend the technological dependencies of benefits. This is also true for the dependencies among the stakeholders which depict a major risk factor. To account for the uncertainty in the behaviours of the supply chain partners, enhancements of the approach should allow for a risk analysis. Thereby the chance that the related stakeholder will make complementary investments needs to be measured.

The theoretical and academic implications of this research rest in the confirmation of the overall assumption that benefits of IT investments in global supply chains are contingent on coordinated stakeholder actions and complimentary effects by individual technologies forming technological systems with specific systemic properties. Here we showcase through the analysis of a specific IT investment that the benefits of IT are highly contingent and need to be considered in the benefit realization management. However, we cannot expect that the coordinated action to materialize these benefits are straightforward and easily achieved. In contrast, previous research has shown that the process of coordinated action is highly political and collective action is far from being easily achieved (Rukanova et al., 2009).

Therefore, future research along behaviouristic strands with explanatory objectives should further explore the inter-organizational dynamics surrounding benefit realization in global supply chains. Such research could focus on the business models that would enable coordination of asymmetric cost and benefits, as well as the roles of different interest organizations in enabling coordinated action for a common good.

Finally, the issue of complementary investments is not limited to the maritime industry or even supply chains in general. In many industries like finance or health care, the nature of technologies is rapidly shifting from being used within the boundaries of a single organisation to the joint use across organisations. Thus, we encourage further research to test the applicability of the approach in other contexts.

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