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Applying a network level in environmental impact assessments

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Abstract

Researchers and society devote increasing interest to environmental impact assessments. The study here discusses and questions current assessment models by relating them to inter-organizational network analyses, and demonstrates that single entities as the basis for environmental impact assessments may not be in the best interests of society. Three case studies focusing on logistical solutions illustrate environmental effects on a single-entity and a network level. The paper concludes that considering environmental impacts on a single-entity level disregards indirect effects, which in turn has consequences for the environment. The paper points to the importance of identifying the appropriate level for analysis of environmental impacts since the single entity as the basis for assessments may undermine environmentally friendly intentions.

Keywords: Environment; assessment; resource; behavior; network

Applying a network level in environmental impact assessments

1. Introduction

This paper demonstrates that network-level analyses better capture actual environmental consequences than do present assessment models based on single entities. Single-entity analyses only take direct effects into account, consider the entities as independent and may lead to inappropriate decisions that do not promote a sound environment. The network level recognizes actor embeddedness (Granovetter, 1985), resource interaction between parties (Gadde, 2004; Ford & Håkansson, 2006), and the inclusion of indirect effects in the analysis (Hertz, 1998; Halinen, Salmi, & Havila, 1999).

The study here takes its motivation from the increased societal focus on assessing environmental impacts to projects, investments, products, and companies. In this study, environmental impact assessment refers to the evaluation and allocation of biophysical effects. The assessment intends to foster environmentally friendly behaviors in companies, thereby minimizing the harm the companies cause to the environment. Present assessment models tend to regard triggers or stimuli for environmental impact as independent rather than embedded, and they consequently fail to acknowledge effects of other interrelated products, parties, or decisions. As an example, life-cycle assessment focuses on the impact of single products (Rebitzer, Ekvall, Frischknecht, Hunkeler, Norris, Rydberg, Schmidt, Suh, Weidema, & Pennington, 2004; Reap, Roman, Duncan, & Bras, 2008) and cost-benefit analyses concentrate on individual decisions (Webb, 1976; Pearce, 1998).

The study here demonstrates that single entities as the basis for environmental impact assessments may not be in the best interests of society. Thus, the focus is on what basis society should use for assessment: an independent single-entity stimulus, or embedded stimuli that result from the activities of several interacting parties. The basis for assessment will

affect company behavior, and if that basis does not reflect actual environmental impact, companies' behavior may even harm the environment. Previous research has brought attention to the difficulties in finding appropriate methods to assess environmental impact in terms of what quantities to charge and what items drive the cost (Bäckström, 1999; Walter & Stützel, 2009). However, less is known about how the assessment methods link to company behavior and the consequences of only analyzing single entities.

The study addresses the following questions. What company behaviors result from assessing environmental impacts on a single-entity level? What company behaviors result from assessing environmental impacts on a network level?

Logistics is one area where assessment of environmental impacts is important (Beamon, 1999; van Hoek, 1999) because transportation accounts for a large and growing portion of the environmental effects (Aronsson & Hüge-Brodin, 2006; González-Benito & González-Benito, 2006; McKinnon, 2008). This paper contributes to the literature on the assessment of environmental impact by discussing allocation effects on behavior as well as highlighting weaknesses of present assessment models. The paper further contributes to literature on resource interaction through its comparison of consequences from allocating resources on a single-entity or network level. While the empirical focus is on logistics, the paper's conclusions are also relevant outside the logistics sector.

The next section of this paper presents the theoretical points of departure: the single-entity and network levels of analysis and the assessment of environmental impact. The method section follows thereafter. Next is the empirical part of the paper consisting of three case studies on actors in the food and beverage sector. The ensuing analysis section discusses the cases in terms of present assessment methods and points to the importance of considering a network level in environmental impact assessment. The paper ends by presenting the conclusions, implications for theory and management, and suggestions for further research.

2. Theory

This section presents and discusses the link between resources and behavior, and refers to analyses on two levels: the single-entity and the network level. The section further introduces three frequent ways of dealing with environmental impact: non-allocation, life-cycle assessment, and cost-benefit analysis.

2.1. A single-entity or network-level analysis

A single-entity analysis constructs effects based on independent entities (cf. Hardin, 1968), which implies that decisions would affect only those involved in the decision-making process. The reason for studying only such direct effects or single-entity levels relates to the difficulties of making appropriate delimitations when deciding on the parties and effects to include in an analysis. Certain models further presume a direct link between stimulus and response without the involvement of other parties as affecting or being affected by that stimulus. However, results from such analyses may differ significantly from the results obtained when analyses consider the contextual embeddedness.

The embeddedness of actors, resources, and activities is important to consider (Granovetter, 1985; Håkansson & Snehota, 1995; Waluszewski, Hadjikhani, & Baraldi, 2009). Because of scarce resources, organizations have to decide which functions to perform themselves — and therefore establish ties with other organizations for complementary resources (Aiken & Hage, 1968; Paulson, 1974; Håkansson & Snehota, 1989). Such ties lead to interdependencies. Actions by one party are both constrained by and affect other parties. Such effects can be direct or indirect, which means that they are mediated through third parties. A network approach provides the tool for analyzing the complexity of direct and indirect effects (Hallén, Johanson, & Seyed-Mohamed, 1991). Halinen et al. (1999) describe

direct and indirect effects in networks by pointing out how a change between two parties may spread to and affect other parties (see also Hertz, 1998), constructing a complex pattern of how an effect may have several stimuli and how one cause may affect several parties.

While researchers widely discuss direct and indirect effects in the domain of business relationships (Ritter & Germünden, 2003; Dubois, Gadde, & Hulthén, 2005), the assessment of environmental impacts has primarily targeted direct effects of single products or decisions. Desev and Dobias (1992) regard the environment as a resource to be allocated to those companies or individuals using the resource. Depending on the distribution of resources, different behaviors would result (White, 1974). Much economic and management literature refers to companies as rational utility maximizers or as makers of satisfying decisions based on accessible information (Simon, 1957). Such statements indicate that behavior is a consequence of a company perspective on how best to use resources and maximize return on them. Hence, if the resources or their allocation change, so may the company behavior (White, 1974). This paper refers to the environment as a resource that guides behavior (Desev & Dobias, 1992), but where the resulting behavior would be fundamentally different depending on whether society assesses environmental impacts on a single-entity level or a network level.

Figure 1 outlines the link between what levels society considers and how assessment affects behavior. On the single-entity level, the party causing the environmental effects is the same party to which these effects are assessed. On the network level, several interacting parties cause the environmental effects that are allocated to single parties.

Figure 1 here.

2.2. The assessment of environmental effects

The assessment of environmental impact is difficult (Munda, 1996; Bäckström, 1999; McKinnon, 2008). The non-ownership status implies that no individual or company has more inherent right to the environment (Walter & Stützel, 2009). Environmental use does not always deplete resources in a traditional sense (Elliott & Yarrow, 1977). At the same time, environmental impacts ultimately result from individuals' or companies' behavior. Assessing environmental impacts to products, for instance, intends to foster environmentally friendly behaviors (Ernzer & Wimmer, 2002). Governmental decisions and directives underpin such assessments (Heinelt, Malek, Smith, & Toller, 2001). For example, to reduce environmental impact from transportation, the European Commission (2001) suggests measures to make companies change transportation modes, reduce demand, and improve utilization of existing transportation.

While society has increasingly come to assess environmental impacts, several issues remain unresolved. The assessment raises questions about what amounts to charge, who to charge and what drives the cost underpinning a particular assessment. Bäckström (1999), Walter and Stützel (2009), and Piecyk, McKinnon and Allen (2010), for instance, discuss the difficulties of connecting environmental impact to cost drivers. The remaining part of this section presents three ways of dealing with environmental impact assessments: non-allocation, life-cycle assessment, and cost-benefit analysis. Literature on environmental assessment frequently refers to life-cycle assessment and cost-benefit analysis, and they represent different foci in assessment that make them relevant in comparison, whereas non-allocation becomes a means to capture what would happen if society does not assess the environmental impact.

2.2.1. Non-allocation

The difficulties of assessing environmental impacts properly (McIntyre, Smith, Henham, & Pretlove, 1998; Bäckström, 1999; Vasileiou & Morris, 2006) support arguments in favor of not allocating them at all. Traditionally, society did not charge companies or individuals for their environmental harm, nor did society distribute environmental impact in a non-monetary manner. Restrictions on the pollution volumes became a way to deal with environmental impact that created grounds for the trade of emission rights. For some time, however, societal initiatives to reduce environmental impact mainly appeared through laws and regulations about how to behave concerning pollution, waste water, and the like.

Non-allocation means that society treats the environment as a common good or a free resource. Companies would not consider the environmental impact they cause unless they voluntarily undertake to minimize environmental effects (Walton, Handfield, & Melnyk, 1998; Buysse & Verbeke, 2003; Stock, Speh, & Shear, 2006; Srivastava, 2007). Instead, companies would base their decisions on other issues with the potential risk of harming the environment if these decisions do not correspond with environmentally friendly behavior.

2.2.2. Life-cycle assessment

Life-cycle assessment, or life-cycle analysis, has become a way to analyze environmental impact (Curran, 1996; Spielmann & Althaus, 2007). Life-cycle assessment targets environmental impacts for a product from a cradle-to-grave perspective (Rebitzer et al., 2004; Reap et al., 2008). Basically, life-cycle assessment is a methodology that quantifies and evaluates environmental effects. This assessment includes emissions as well as the actual resources consumed during all phases of a product's life, including its user phase. The challenges of life-cycle assessment include problems with deciding what to measure, and

problems related to product boundaries (Weidema, 2001; Bare & Gloria, 2006; Reap et al., 2008). For example, Weidema (2001) discusses issues with environmental effects when a process results in several products.

Life-cycle assessment thus focuses on individual products, and researchers regard these as the results of the key structure that accumulates environmental resources. The calculations built on life-cycle assessments take a bottom-up approach to the environment. Such calculations summarize environmental impact for a specific product rather than distributing environmental effects among all products from a top-down perspective.

2.2.3. Cost-benefit analysis

Cost-benefit analysis is a method to capture economic and other effects of resource usage decisions (Prest & Turvey, 1965; Webb, 1976; Sen, 2000). In addition to financial consequences, cost-benefit analyses take into account effects such as environmental impacts, risks to individuals' health, and so forth by expressing them in monetary terms (Boadway, 1974). The expression of environmental impact as costs means that the method defines environmental impact as resource consumption. The price of that consumption corresponds to the environmental restoration costs. The calculations discount costs and benefits into their present values. An investment is profitable if its benefits exceed its costs. The use of cost-benefit analysis dominates in the area of public spending such as railroad investments and in decisions regarding health issues. Specific projects are normally the basis for the calculation. With an explicit focus on environmental effects, researchers debated early on the use of cost-benefit analysis for environmental policies (Pearce, 1976; Elliott & Yarrow, 1977; Smith, 1977). The discussion concerned such issues as the difficulties of pricing environmental impacts and other methodological challenges of cost-benefit analyses (Munda, 1996; Ackerman & Heinzerling, 2002; van den Bergh, 2004). The research on how to use cost-

benefit analyses on environmental impacts often compares and discusses discount rates and the like (Mishan, 2002), primarily focusing on a single environmental effect (Bollen, van der Zwaan, Brink, & Eerens, 2009). As is the case with life-cycle assessment, cost-benefit analysis takes a bottom-up approach to environmental assessment.

Taken together, non-allocation anticipates that the environment is a free resource or a common good, while life-cycle assessments and cost-benefit analyses tie to a product or project those costs that correspond to their impact on the environment. Cost-benefit analyses focus on finding the right amount to charge by considering the cost of restoring the environment. Life-cycle assessment focuses on how to capture a product's environmental impact during its entire life span. The expectations from these two models are that a single entity, the product or project, affects the environment. The bottom-up approach and the focus on individual products or projects disregard network-level effects.

Neither cost-benefit analysis nor life-cycle assessment deals with behavioral consequences (Spielmann & Althaus, 2007; Walter & Stützel, 2009), nor do they reflect on the consequences of basing assessments on a single decision or product. This paper specifically concerns several companies as triggers of environmental impacts. The paper contrasts life-cycle assessment and cost-benefit analysis by concentrating on actors as those causing environmental harm, and also by seeing these actors as embedded and interrelated. Such a view also captures indirect effects (cf. Hertz, 1998; Halinen et al., 1999).

3. Method

The paper illustrates and compares how the assessment of environmental impacts affects companies' behaviors based on a single-entity or network-level assessment through three case studies of logistics solutions: ICA, a company here named Northern Baker, and Returpack. A central characteristic of case study research (Yin, 1994; Halinen & Törnroos,

2005; Dul & Hak, 2008) is that the method allows the researcher to capture resources and actors in their contexts rather than in isolation (Holmlund, 2004). While case studies have benefits in terms of details and the capturing of interconnectivities, the method may not allow for generalization of results. The expectation is, however, that the results will be transferable to other situations, which will thus create a wider source of knowledge (Hirschman, 1986; Guba & Lincoln, 1989).

In a multiple case study, individual cases may relate to one another in different ways: they may confirm common findings, build a comparative analysis, or, as in this study, bring additional aspects to a studied phenomenon. The cases demonstrate environmental solutions that meet the European Commission's (2001) transportation goals in different ways, which is to say that the cases have a practical representation set by these goals. From a single company perspective, the ICA case mainly deals with better utilization of existing transportation, the Northern Baker case deals with overall demand, and the Returpack case entails changes in transportation modes.

Data sources for the cases consist of interviews, observations and secondary data (Welch, 2000). Interviewees represent the studied companies and their suppliers, customers and contracted logistics firms; thus, for each case interviewees include representatives of the company under study and of external parties interacting with these companies. The choice of interviewees thus captures the single-entity and the network level. Interviewees held positions as logistics managers, procurement staff, CEOs, shippers, and financial managers. The authors conducted twenty interviews: eight in the Returpack case, four in the Northern Baker case, and eight in the ICA case. Each interview lasted between one and two hours and used a semi-structured question approach (McCracken, 1988). Observations include participation in company meetings and company visits. Secondary data consists of company reports, research reports, and official press releases. The authors or representatives of the companies calculated

the effects of assessing environmental impact on a single-entity and a network level. These calculations took into account transportation distance, weight of goods, fill rates and mode of transportation. The calculation results are confidential, and the paper therefore only discusses them in terms of greater or lesser environmental harm.

The study included analyzing initial case data and calculations individually. In order to confirm the validity of the case results, the researchers discussed preliminary findings among themselves to see whether or not they had made similar conclusions (Hirschman, 1986; Guba & Lincoln, 1989), and also findings were presented to the interviewees. The individual conclusions did not suggest any contradictions in the findings, indicating that the presented findings accurately represent the cases.

4. Case studies

This section presents the three case studies: ICA, Northern Baker, and Returpack. The companies are all actors in the food and beverage sector and represent companies that have actively worked to reduce the environmental effects of their operations. Anticipated or actual governmental assessments shaped these undertakings. Consequently, society formed the assessment schemes while the individual companies decided how to adjust their operations to minimize environmental impact. The presentations may suggest that cost-minimizing stimuli rather than environmental impact minimization triggered the companies, and in certain situations cost stimuli did coincide with the environmental assessment. The focus in this study, however, is on the different analytical levels (the single-entity versus the network level) of environmental assessment rather than whether and how the companies considered other costs.

4.1. ICA

ICA is a food wholesaling company with Royal Ahold N.V. in the Netherlands and Hakon Invest AB in Sweden as the owners. ICA consists of 2,230 stores in Sweden, Norway, and the Baltic states, where individual retailers act on a franchise basis or ICA itself owns the stores. The company mainly distributes food and other fast-moving consumer goods to the retailers, but ICA also manufactures its own products and distributes OEM goods with a private label. ICA's corporate responsibility report (ICA, 2008) refers to the company's aims of promoting greater environmental responsibility and sustainable development. Hence, the company actively works to reduce its environmental impact.

4.1.1. The single-entity level

Traditionally, ICA functioned as an umbrella organization, and food producers transported goods directly to the retailers. In the early 2000s, the company decided to rearrange transportation, made itself a coordinator, and centralized transportation of goods. ICA started to act as a node through which all transportation would pass. This in turn changed previous transportation routes. In practice, the reorganization of transportation meant that ICA managed the transport from food producers to a central warehouse and then to the individual retailers.

In the first stage, food producers continued to provide transport to the ICA central warehouses, but soon the company also wanted to provide the transportation from the food producers. Thus, ICA attained a better overview of the whole system for supplying the retailers and could also organize the logistics system more efficiently. With regards to environmental considerations, the new transportation routines contributed to better fill rates of transports for ICA, and thus from the single entity's point of view the change reduced both transportation costs and environmental impacts.

4.1.2. The network level

From the food suppliers' perspective, the new routes and ICA's management of transportation from suppliers through a central warehouse to retailers meant a significant change. While the new routes made ICA's transportation more efficient in terms of cost and environmental impact, they negatively affected such aspects for ICA's suppliers. In addition to ICA, the suppliers distributed food to other customers including independent retailers, restaurants, and industrial kitchens. ICA's choice to take care of its own transportation could be seen as a reason for the suppliers to reduce their transportation of goods. However, ICA's solution meant that the suppliers not only had problems coordinating their transportation, with the result that some transports ran half empty. Higher costs and increased environmental impact were also consequences of the lower fill rates. On an aggregated level, the inclusion of ICA and its suppliers in the calculation of environmental impact indicates that these consequences outbalanced the gains achieved from ICA's perspective. Hence, a network-level analysis suggests that from an environmental perspective no gains resulted from rearranging the transportation.

Thus, in this case assessing environmental impact on a single-entity level would, for the focal company ICA, mean that the company should centralize all transportation. Such assessments also drove the company to act in that way. Had society instead assessed environmental impact on a network level including ICA and the suppliers, the assessment would not have promoted a re-organization of ICA's transportation, which in turn would comply better with the actual environmental impact.

4.2. Northern Baker

Northern Baker is a family business that produces bread in three bakeries located in northern Sweden. Because of Sweden's demographic structure, the majority of its customers

are located in the southern part of the country. With production sites located in the north, the company transports its bread over long distances. Environmental awareness means that Northern Baker tries to minimize its environmental impact.

4.2.1. The single-entity level

In the assessment of environmental impact, Northern Baker's transportation accounts for a considerable part of the company's impact. This impact is a result of society's distribution of environmental effects per kilometer; that is, long-distance transport has a greater environmental impact than shorter distance hauls. In Northern Baker's ambition to minimize environmental impact, the company has considered moving south. From the single-entity level analysis of environmental impact, this move would be rational. Operating the business in the south would decrease the distance to customers and minimize negative environmental effects. However, assessing environmental impact per kilometer means that society does not pay attention to the actual transportation routes.

4.2.2. The network level

In Sweden, transportation routes run primarily from south to north due to the infrastructure of Swedish industry. Transportation statistics indicate an imbalance in Swedish domestic transportation, with approximately twice the amount of goods transported from the south to the north than the converse. Consequently, if society takes the imbalance in transportation between the north and the south of Sweden into account, the environmental impact in the Northern Baker case becomes less clear. Currently, Northern Baker uses truck space that would otherwise be empty when transports from the northern part of the country return to the south. The use of empty space in trucks increases the fill rate without resulting in more vehicle movements.

Consequently, decisions other than those indicated by a single-entity analysis would benefit the environment based on a network-level analysis. The use of return transport that would otherwise run empty minimizes environmental impact. As in the ICA case, the network-level analysis demonstrates that no environmental gains result if the company makes changes that are consequences of the assessment of environmental impact on a single-entity level.

4.3. *Returpack*

Returpack is a company that adheres to supplier responsibility in the area of soft drinks. The company processes bottles and cans that consumers return to retailers in order to receive a deposit return. The owners of Returpack are retailers, actors in the brewery sector, and manufacturers of packages for soft drinks.

4.3.1. The single-entity level

In order to optimize the use of current vehicles, Returpack used retailers' and breweries' empty return transports to move the items that consumers had returned from the retailers to the manufacturers of such items. Trucks transported empty bottles and cans, reloaded them in the reverse flow from retailers to central stores, and sent them on to breweries and manufacturers of packages for soft drinks. For each company this solution allowed for a good utilization of transports, since the solution entailed the use of return transports that would otherwise run empty. On a single-entity level, each company trying to minimize its environmental harm thus had the result of short-distance trips between individual parties and frequent reloading at the different destinations.

4.3.2. The network level

The incorporation of the entire reverse flow of bottles and cans indicates that transporting such items should take place directly from the retailer back to the manufacturer. With such a solution, the individual companies cannot use their return trips, but instead exchange these for more efficient transportation on a network level that includes shorter transport distances in total and less work in terms of reloading. The solution also allows for changed transportation modes where the more environmentally friendly option of trains replaces trucks. If transportation by rail is not possible, the coordination of transports results in an overall improved fill rate, which reduces the overall environmental impact. Through the changed routes, the total cost including transports, warehousing, handling, and packages used is only 62 percent of the solution based on the single-entity approach. At the same time, the environmental impact measured in terms of CO₂ decreases by 25 percent. The change in the transportation mode impacts the environment positively while the change does not contribute as clearly toward lowered costs.

The Returpack case illustrates that environmental impact assessments on a network level would result in different company decisions than would single-entity level analyses. As in the ICA and Northern Baker cases, the network-level solution in the Returpack case indicates that assessing environmental impacts by single entities may lead to inappropriate decisions in terms of the environment.

5. Analysis

This section relates the case studies to the different assessment models presented in the theory section and discusses the importance of considering the network level in environmental impact assessments.

5.1. Assessment models

The theory section refers to non-allocation, life-cycle assessment, and cost-benefit analysis as possible methods for allocating environmental effects. How would the case companies have acted based on these three types of assessment?

Non-allocation means that society does not charge for or otherwise distribute environmental impact, and companies would presumably not plan for solutions that minimize their operations' effects on the environment, provided that the companies do not undertake that choice for other voluntary reasons (Walton et al., 1998; Buysse & Verbeke, 2003; Stock et al., 2006; Srivastava, 2007). Other costs would guide company decisions. For ICA, the company's decision to coordinate transports reduced other costs. This fact indicates that in that particular case, non-allocation would lead to coordination and centralization. Northern Baker would base its decision on the costs of transport and location, where location is generally less expensive in the north than the south. Returpack would make its decision based on a more complete picture as a result of retailers, breweries, and manufacturers of bottles and cans owning the company. Transportation costs are cheaper for the network-level alternative; hence, Returpack would theoretically replace the individual short-term solution for the coordinated one.

Life-cycle assessment refers to environmental impact assessment on individual products (Rebitzer et al., 2004; Reap et al., 2008). For ICA, the environmental impact would follow individual products through the supply chain without taking co-transportation of various products into account (cf. Weidema, 2001). This fact implies that life-cycle assessment would support coordinated transport, that is, the single-entity option, as the better alternative since this option more closely follows the product. For Northern Baker, the environmental effects for bread production would accumulate from raw material to end-customer, and possibly include treatment of the waste. Unless shippers transport the actual raw material for the company's bread from the south to the north, the imbalance of

transportation remains excluded from the analysis. If the transports contain the actual raw material, life-cycle assessment would promote staying in the north. The more probable solution is that the life-cycle assessment would not consider the network level in the Northern Baker case. For Returpack, based on whether assessment schemes include the returned bottles and cans as new products or as an extension of the original ones (cf. Huge-Brodin & Anderson, 2008), life-cycle assessment would in the former case promote the network-level solution (cf. Weidema, 2001; Bare & Gloria, 2006; Reap et al., 2008) while in the latter, the focus would be on the single-entity solution. The life-cycle assessment would not consider volumes of transports and would consequently exclude environmental impacts from low fill rates and return transport use, unless the initial transport of goods targets the same product.

Cost-benefit analyses include environmental impacts as costs priced to restoration values. The focus of cost-benefit analyses is normally individual projects or decisions and their consequences (Prest & Turvey, 1965; Webb, 1976; Sen, 2000). If the decision takes only their own company into account, decisions would follow the single-entity level analyses. ICA would consequently weigh the benefits of coordination against its costs, account for environmental impact based on its own operations, and conclude that the company should act as the coordinator. Northern Baker would choose to move south, and individual companies at Returpack would continue with individual, short-distance trips based on the single-entity analysis.

Table 1 summarizes the different assessment methods by case. The table indicates that none of the assessment methods explicitly targets a network level.

Table 1 here.

5.2. The importance of a network-level analysis

The fundamental idea of environmental impact assessments is not to achieve revenues from such operations but to foster company behavior that matches society's (governments') environmental ambitions. The three cases of ICA, Northern Baker and Returpack demonstrate that, depending on whether the analysis practices a single-entity or network level approach, different environmental effects appear. On a single-entity level, environmental impact refers to the direct effects of individual parties, products, or decisions; these also guide the company's behavior. For example, attempts to reduce environmental impacts include making a company's own transportation more efficient and reducing the area covered by transportation (cf. European Commission, 2001).

ICA managed to increase its fill rates by making itself a coordinator of transport. For Northern Baker, the single-entity level indicates that the company should move south. Returpack would use individual return trips rather than a coordinated solution, including the different owner companies, if the assessment focuses only on single, independent entities.

On a network level, the environmental impacts result from several parties' interrelated activities (cf. Håkansson & Ford, 2002; Ritter & Germünden, 2003). The ICA case reveals that the inclusion of other parties in the analysis outbalanced the gains from coordinating transportation. The Northern Baker case indicates that balancing the inward and outward flow of goods is more important than the actual transportation distance. The Returpack case highlights that the inclusion of several actors' transportation routes alters the transportation mode and routes to more environmentally friendly ones. Thus, the network level means that different company behaviors would apply. Table 2 summarizes the single-entity and network levels of environmental impact for the three cases.

Table 2 here.

As the cases illustrate, resource decisions, such as society's assessment of environmental impact, affect company behavior, and the resulting behavior affects such resources as the environment. The links between assessment and behavior, as well as between behavior and environmental impact, make the network level important in the allocation of environmental effects. A comparison between single-entity and network levels leads to the conclusion that if society assesses environmental impacts based on single entities, companies may well make decisions that do not comply with society's overall environmental intentions.

The single-entity level means that each party would attempt to minimize *its* environmental impact and only consider direct effects of its own activities. Society's distribution of taxes, emission rights and costs based on such parameters as per-kilometer charges underpin those decisions. Cost-benefit analyses and life-cycle assessments similarly emphasize environmental impact from individual products or projects. Consequently, the stimuli are based on single, independent entities, and the assessment does not capture indirect effects, and thereby does not consider imbalances with return trips, for instance.

Since the intention is to guide behavior, society should base environmental assessments on analyses that capture actual consequences in total, rather than for individual products or projects. The inclusion of additional parties in the analysis of environmental effects may remove the advantages accounted for on a single-entity level or alter decisions about the most appropriate activities for each party.

In order to minimize environmental harm, society hence needs to consider stimuli on a network level and include indirect effects in analyses (cf. Halinen et al., 1999). This reasoning refers to a recognition of the non-ownership status of the environment (Walter & Stützel, 2009), that its use does not always deplete resources in a traditional sense (Elliott & Yarrow, 1977), and the embeddedness and interaction of companies (Ritter & Germünden, 2003; Ford

& Håkansson, 2006). Table 3 summarizes the consequences of regarding the environmental impact on a single-entity and a network level.

Table 3 here.

6. Conclusions

This study demonstrates that current assessment models based on single-entity analyses may not lead to appropriate decisions from an environmental point of view. As indicated by the empirical examples, inter-organizational network analyses may help to capture indirect effects and consequences of company interaction, thereby also guiding companies to make more appropriate decisions with regards to the environment. The introduction section addressed two questions which are further elaborated below.

6.1. What company behaviors result from assessing environmental impacts on a single-entity level?

If environmental impact assessment focuses on single entities, the identified effects would only be those caused by the entity in question. Such assessment means that a company considers only the effects of its own actions or, as in cost-benefit analysis and life-cycle assessment, the impact of a particular project or product. The assessment treats the company, project, or product as an independent stimulus. ICA's decision to coordinate and centralize transports resulted from the fact that the company saw how this solution would decrease the company's impact on the environment. The per-kilometer assessment in the Northern Baker case suggests a move to the south for the company. The individual companies in the Returpack case would consider the use of short-distance return transports to be the most

favorable option. The companies in the three cases would base their decisions on the environmental impact allocated to them.

If society only distributes direct effects based on single-entity analyses, the companies would behave as if the environment was an isolated resource the individual companies could control. Company decisions resulting from society's environmental impact assessment based on a single-entity level may, as a network-level perspective reveals, lead to increased environmental harm among other companies.

6.2. What company behaviors result from assessing environmental impacts on a network level?

Assessing environmental impact based on a network-level analysis would mean that different stimuli guide company behavior. The same link applies as in the single-entity analysis concerning how resources guide behavior and possible shortcomings in that reasoning (cf. Harrison & Easton, 2002). The network level, however, reflects the fact that the environment is a resource to which no single party has more rights, and that environmental impact reaches beyond company boundaries. A network-level analysis reduces the risks of misappropriation as companies make their decisions based on how they affect the environment in total, rather than as single independent parties. Therefore, assessments on a network level provide a more complete picture of the actual consequences of activities, creating a foundation for company decisions that takes into account their effects on other parties. In the ICA case, society would distribute environmental impacts among the parties and ICA would not see any gain in centralizing transportation. Society would only assess Northern Baker for the possible added environmental impact of using the return transports and would not refer to them as independent transportation routes. As a consequence, the company would not move to the south. In the Returpack case, society would account for the

entire flow, realizing that the company would indeed reduce its environmental impact through coordination and use of trains instead of trucks. In general, environmental impact assessments on a network level capture the need for balance in a geographical sense as well as between customers and suppliers rather than benefitting individual parties. As illustrated by the case studies, balance, the inclusion of other parties and indirect effects in the analysis reduce the risk of companies making decisions that will actually increase the environmental harm.

6.3. Theoretical implications

The study illustrates how different foci in resource allocation result in different company behaviors. The paper further indicates that considering entities as independent (the single-entity level) or embedded (the network level) has consequences for the resource. The explanation relies on the concept of direct versus indirect effects, where the single-entity level only captures direct effects while the network-level analysis also takes into consideration indirect effects in relation to other parties. Previous research on resource interaction in networks has emphasized the interconnectivity among actors and their embeddedness (Gadde, 2004; Gressetvold & Wedin, 2005; Ford & Håkansson, 2006). The study contributes to that literature by demonstrating how external stimuli such as third-party decisions (here, the governmental assessment) to the actual interaction impact behavior, and how such behavior in turn has consequences for the external resources (here, the environment). The study also illustrates that the chosen analytical level of resource allocation (the single-entity or the network level of environmental assessment) impacts how companies behave, and that behavior based on single-entity analyses may be sub-optimal. The paper emphasizes balance as an important parameter in interaction decisions.

The study introduces an inter-organizational network level of environmental impact, and thereby contributes to the body of research on environmental effects (Faruk, Lamming,

Cousins, & Bowen, 2002; Rebitzer et al., 2004; Aronsson & Huge-Brodin, 2006; McKinnon, 2008). Previous assessment models have mainly concerned descriptions of independent stimuli (McIntyre et al., 1998; Vasileiou & Morris, 2006) and have not focused on assessment as an embedded activity with consequences for interaction.

Furthermore, previous research has not focused on the resulting behaviors, their consequences, or placing actors in the central role in the assessment. The paper demonstrates that the analytical level has consequences for the environment, indicating that undesired environmental effects may result if assessment mechanisms focus on single entities. To a greater extent, the network level captures the fuller picture of environmental impact and decreases the risks of environmental harm caused by inappropriate behaviors. The resource embeddedness in this study challenges the research on transport and environmental consequences (Abukhader & Jönsson, 2004) to pay more attention to resource interaction as well as to link assessment to company behavior and its resulting consequences for the environment.

6.4. Managerial implications

Environmental effects and social responsibility are increasingly important for companies. This study indicates that being environmentally aware implies being able to see beyond the own company's boundaries. The inclusion of additional parties in the analysis of environmental effects may lead to quite different behavior than an analysis focusing on evenly divided environmental impacts at a single-entity level. For a company, important considerations concern what environmental harm the company might cause, and also the comparison of different alternatives from a holistic view on the environment. Such considerations might entail understanding how other companies respond to a change, and

interacting with other parties when designing solutions that aim to reduce the environmental harm.

For society, important considerations include analyzing the effects that taxes and emission rights have on a company's behavior. The measures to assess environmental impact need to comply with the desired outcomes, not for individual companies, but for society as a whole. This study indicates that society would benefit from assessment based on a network level rather than on single entities. A top-down approach of assessment could be one way to assess more complete effects, as would accounting effects on the margin, and would take into consideration the capturing of balances between parties.

6.5. Limitations of the study and future research

Studies on environmental issues using the network approach are limited, and few studies in logistics focus on environmental assessments. This absence of research suggests the need to further explore the issues of environmental effects. This paper specifically studies the single-entity and network levels as related to logistics solutions. Furthermore, the number of cases was limited to three. Future research should include additional cases as well as cases outside the logistics sector.

Research on improved ways to assess environmental impacts is of key concern to the field of environmental assessment. Such studies may explore strengths and weaknesses with different assessment models and practices of environmental effect distribution. Research focusing on developing and evaluating assessment models is of interest, along with research investigating policies and governmental decision-making related to environmental impact assessment.

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Table 1. Assessment methods per case.

<i>Assessment method</i>	<i>ICA</i>	<i>Northern Baker</i>	<i>Returpack</i>
<i>Non-allocation</i>	Centralization as it means lower costs for ICA.	Staying in the north as location costs are lower in the north.	Coordination as a result of the shared ownership.
<i>Life-cycle assessment</i>	Centralization as it follows individual products more closely.	A move to the south, unless material transported from the south is included in the analysis.	No coordination if initial transportation would be included in the analysis.
<i>Cost-benefit analysis</i>	ICA would centralize if calculated for the individual company as decision maker.	Northern Baker would move to the south if long-distance transports and their environmental effects exceed benefits of cheaper location in the north.	Transports would not be coordinated if analysis performed at single-entity level.

Table 2. Environmental impact in cases studied.

<i>Environmental effects</i>	<i>ICA</i>	<i>Northern Baker</i>	<i>Returpack</i>
<i>The single-entity level.</i>	Increased fill rates for ICA if centralized transports.	Shorter transport routes if moving south.	Individual return trips positive for utilization of transport.
<i>The network level.</i>	Lower fill rates for suppliers. No overall gain of ICA's centralization.	Use of return transports meant no additional environmental effects. No gains from moving south.	Coordinated transportation was a better choice and allowed other transportation modes.
<i>Consequences of choosing the network level rather than the single-entity level.</i>	The network level demonstrates that no gains were achieved following the centralization of transports.	The network level demonstrates that nothing would be gained if the company moved to the south.	The network level demonstrates decreased environmental impact.

Table 3. The single-entity vis-à-vis the network level of environmental impact.

<i>The single-entity level</i>	<i>The network level</i>
Focus on optimizing for the single entity.	Focus on finding a fair solution for the individual actor as part of the network.
The individual company as carrier of environmental impact.	Interacting parties (the network level) as agents of environmental impact.
Environmental impact is divided per unit (e.g., per kilometer). Bottom-up analysis.	Environmental effects can be distributed as marginal (rather than absolute) effects. Top-down rather than bottom-up analysis of environmental effects.

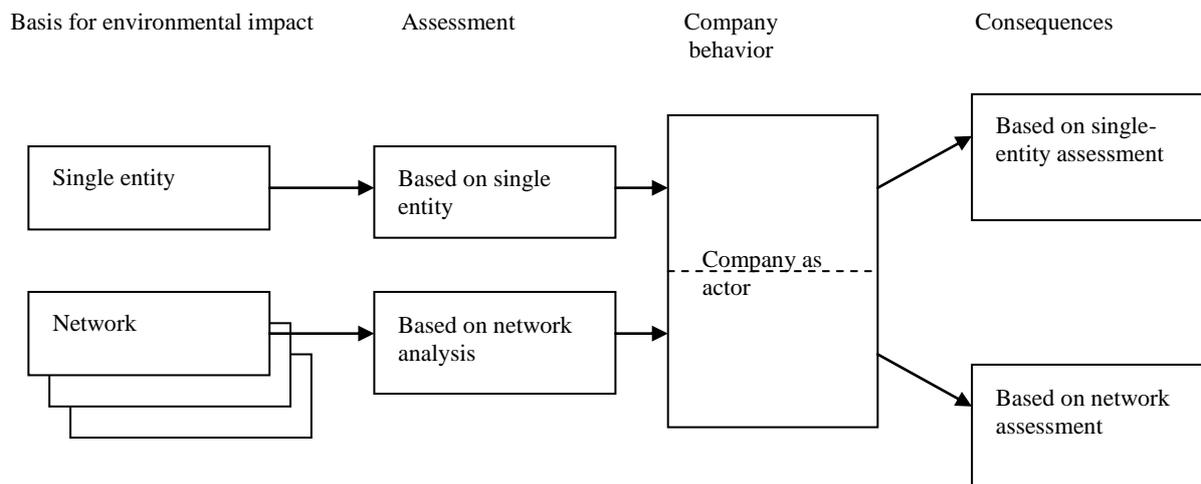


Figure 1. Link between assessment, behavior, and resulting environmental impact.