IMPACT INDICATORS IN THE ENVIRONMENTAL MANAGEMENT PROCESS OF REAL ESTATE COMPANIES – PROPOSED CONCEPT AND DISCUSSION OF APPLICABILITY

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Summary

In this paper, quantitative impact indicators are proposed as a means to follow up and develop the environmental management practice in real estate companies and to improve the environmental performance of the existing building stock. A main purpose is to problemize the concept of indicators to be used in this context and to discuss ideas of indicators that have a more direct relation to environmental problems than many of the indicators in use today. For instance, follow-up of energy use is today restricted to indicators like kWh/m^2, which tells us about quantities of energy use but not of it's environmental consequences. The suggested indicators in this paper cover environmental aspects as energy use, waste production, transports and built-in hazardous materials/substances. In order to test the practical application of such indicators case studies in three existing housing units has been carried out. Process data from these case studies was gathered and the possibilities of calculating impact indicators using this data was tried out. Results from these case studies are presented in the paper and discussed in the perspective of application areas within the environmental management practice of real estate companies.

1. Background

The use of quantitative environmental information is a significant component in environmental management systems (EMS) in order to describe and follow up continual improvement. Environmental performance indicators have developed as one such means to use quantitative information in this process mainly for evaluative purposes internally and for communication with external stakeholders (Thoresen, 1999; Olsthoorn et al, 2001). 90 % of the largest real estate companies in Sweden express that they today use or are about to introduce an EMS (Baumann et al, 2003). Despite such efforts the results in terms of reduced environmental impact are difficult to evaluate. It has been shown that little attention is paid to generating quantitative information for evaluation of the efforts in environmental terms and for decision-making. The reason is usually that there is a lack of knowledge or understanding in the companies of *what* to follow up and *how* to do it (Malmqvist, 2004). Apart from improving the internal EMS process, it can be argued that the handling of quantitative environmental information need to be developed due to on-going environmental initiatives in the business sector and by authorities. These include for instance proposed regulations about environmental classifications and/or declarations of buildings or eco-labelling and raise demands on better assembled knowledge on the environmental consequences of the managed buildings. Since such work is a quite new feature, no standardisation has been made on what to measure and how to do it.

Reviews and studies on the use of environmental performance indicators in business today conclude that the type of indicators used are commonly based on what aspects the organisation find possible to measure rather than what aspects are most important to measure in environmental terms (Olsthoorn et al, 2001; Ammenberg och Hjelm, 2002; Schaltegger och Burritt, 2000). The same conclusions are valid for real estate companies in Sweden (Malmqvist, 2004). Thus, it is relevant to study whether indicators that measure environmental impact or consequences can be found and used in practice in these organisations. Not at least since approaches like LCA, ecological footprints, etc are more and more adopted in society. The main scope for this procedure is to try out what quantitative information is possible to gather and how it can be used in the internal process to a wider extent than what is done today.

1.1 Aim of this paper

This paper aims at giving a proposal of environmental indicators to be used in internal processes of environmental management in real estate companies today. The proposed indicators are problem based, i.e. they intend to give a direct linkage to potential environmental impact and are therefore called *environmental impact indicators (EII)*. The paper further discusses how the use of such indicators and their associated information may develop the EMS process and the possibilities of practical application in real estate companies.

1.2 Method

Indicators will be proposed based on an approach for assessing environmental impact of buildings/real estates in Sweden, called the EcoEffect method (Glaumann and Malmqvist, 2004; Glaumann, 1999). The theoretical approach has been adapted for the use in environmental management processes in real estate companies. A qualitative study of nine real estate companies was used as a basis for this work and has been reported on earlier (e.g Malmqvist, 2002; Malmqvist, 2004). In order to discuss the possibilities of calculating different types of environmental impact indicators (EII) from process data in real estate companies, three case studies were conducted. Basic facts on the case studies, which consist of three different housing units, are presented in table 1 below.

Table1 Basic characteristics on the housing units (cases) in the project

Name	Characteristics	Building year	Real estate manager
Sörsedammen	878 apartments/ 1485 users	1967-1971	A municipal company operating in the south of Sweden, ISO 14001-certified.
Östbergahöjden	1171 apartments/ 3153 users	1967-69	A municipal company operating in Stockholm.
Viken	126 apartments/ 333 users	2002	The same company that operates Östbergahöjden.

Process data from the three cases was collected; ie. annual quantities of energy use, household waste generation and data about built-in hazardous substances/materials. In one case, Sörsedammen, fuel quantities for transports due to operation of the housing unit was collected. In addition, environmental data on the local energy production and waste treatment plants was gathered. The combination of these two data types made it possible to calculate indicators showing environmental impacts.

By using real-life case studies as a basis for the calculation and analysis, a number of advantages are achieved. The perceived problem of data availability (e.g Malmqvist, 2004; Brunklaus and Thuvander, 2002) may be discussed and different theoretical approaches can be tried out in practice. Further, the presentation of the quantitative information that can be calculated can be discussed with the possible end-users, the real estate managers.

2. The notion of environmental impact indicator (EII)

In the ISO standard on environmental performance, ISO 14031, an environmental performance indicator is defined as a "specific expression that provides information about an organization´s environmental performance" (ISO, 2000). This is a vague definition. Further general criteria often mentioned on indicators to be used in the EMS process of business organisations include; easily measurable, connect company actions with environmental results, understandable and meaningful to the identified stakeholders, workable in practice, support benchmarking over time, inform decision making to improve the organisational performance and focus on areas of direct management influence (Verfaille and Bidwell, 2000; ACBE, 1992; Olsthoorn et al, 2001; Azzone and Manzini, 1994). The main idea is that an indicator ought to be a quantitative measure that can be seen as an approximate value on an explicit environmental problem. However, neither the ISO 14031 standard, nor other guidelines on the use of environmental indicators in business include a discussion on what would be a good approximate value. In general,the environmental indicators used in business are a result of what is easily measurable in the organisation and they hardly ever indicate changes in the environmental quality (Olsthoorn et al, 2001).

In LCA context, the potential contributions to certain environmental impact categories, measured as equivalents is often referred to as environmental indicators. Compared to indicators like energy consumption/year, an indicator expressed like emitted CO_2-equivalents/year due to energy use have a closer relation to an environmental problem, in this case climate change. In order to translate the energy use to CO_2-equivalents a calculation has to be made, resulting in a movement downstream in the cause-effect chain. CO_2-equivalents can thus be used as an environmental indicator that give an approximate value on the potential contribution to the problem of climate change related to the energy use in for instance a housing unit. Such indicators with a more direct relation to a certain type of problem will hereafter be referred to as *environmental impact indicators (EII).*

3. Indicating environmental impact in real estate management

3.1 Significant environmental aspects in real estate companies

The most commonly identified significant environmental aspects in real estate companies are lined up in table 2 below. Environmental impact indicators in this sector should at least cover these aspects.

Table 2 Significant environmental aspects in real estate companies

Based on case studies in nine swedish real estate companies (Malmqvist, 2002; 2004)	Based on the environmental review of the construction and real estate sector of Sweden (Byggsektorns kretsloppsråd, 2001).
Built-in hazardous substances and materials Material use	Material use
Energy use for heating Use of electricity	Energy use for operation
Construction waste Household waste	Waste treatment
Indoor environment	Indoor air quality Noise
Transports Use of water	

3.2 Proposal of environmental impact indicators for real estate companies

Environmental impact indicators that describe some of the environmental aspects according to table 2 and have been tried out, table 3. They may be used as they are as absolute measures or they may be normalised, for instance by dividing the CO_2-equivalents with amount of users or let out m^2 of the analysed housing unit.

Table 3 Proposal of environmental impact indicators (EII) for real estate companies

Activity/ env. aspect	Enviromental impact/problem	Environmental impact indicator	Internal process data needed	External data needed
Use of energy for heating Transports	Climate change Acidification Eutrophication Tropospheric ozone production	kg CO_2-equiv./year g SO_2-equiv./year g NO_3-equiv./year g C_2H_4-equiv./year	Quantities (kWh or MJ/year) of energy use for heating and electricity.	Emission data for the production of the energy used for heating and electricity.
Use of electricity	Ionising radiation	MJ equiv./year		
Waste production and treatment	Eco/human toxicity	kg waste to landfill/year	Quantities of waste to landfill.	Data on % of various waste fractions to landfill (incl. ash from waste combustion)
Built-in hazardous substances	Eco/human toxicity	kg carcinogenic substances kg reproduction toxic s. kg mutagen s. kg allergenic s. kg ecologically harmful s.	Quantities of built-in hazardous substances	List of officially classified of hazardous substances

4. Using the indicator information in EMS in real estate management

In this section examples will be shown of calculated impact indicators for the three case studies, along with some of the associated information they can provide. Examples and ideas of application in the EMS process will be discussed. The process of data retrieval will also be commented on since this issue is crucial for the practical use of the mentioned indicators and adherent quantitative information.

4.1 Comparisons between different housing units

Figure 1 shows the outcome of four of the proposed indicators for energy use for the three cases. The examples include energy use for heating and electricity for operation of the housing units (household electricity not included). Contributions to the problems are shown per user of the housing unit, thereby relating the environmental impact to a service produced. In the cases of Viken and Östberga, the energy for district heating and electricity are produced in the same way. The energy for district heating is to a great extent based on energy generated from waste combustion and the electricity is based on water power. However, in Viken solar heat collectors are also used for heating of hot water which has not been included in the indicators below. In Sörsedammen the district heating is based mainly on waste heat from a pulp industry. The electricity, however, is based on Swedish production mixture (mainly nuclear power and water power). Base data relates to actual quantity of energy use during one year. The external data used is not LCI-data but the most common emissions (basically CO_2, NO_x and SO_x) from the energy production. The quantities of these emissions are then multiplied with emission factors from EDIP (Hauschild et al, 1998) resulting in the equivalent contribution to a certain impact category. The calculation is thus quite simple.

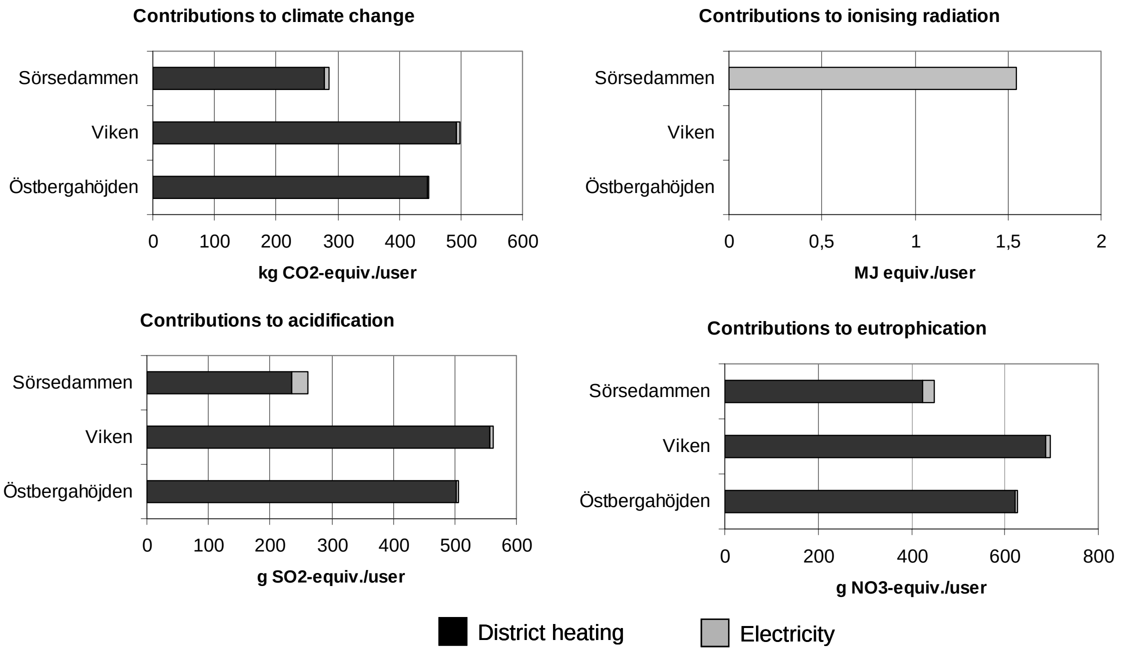

Figure 1 Outcome of impact indicators for energy use, calculated for three housing units 2003.

It can be seen that the district heating contribute significantly to climate change, acidification and eutrophication in all three cases. Even though Viken also uses solar heat collectors for heating of hot water, the energy use per user is higher than in Östbergahöjden which is expressed in the figures above. Sörsedammen, however; generally has lower contributions than the other two, which relates to a cleaner production of district heat. On the other hand, only Sörsedammen contributes to ionising radiation. The reason is that nuclear power is used for production of the electricity in this case. Environmental impact indicators, for instance presented like in Figure 1, give a wider understanding of the separate environmental impacts related to energy use than if just looking at the quantities of energy used.

Figure 2 shows the outcome of the proposed indicator for household waste treatment. Bulk waste that is directly landfilled and the landfilled ash and slag from the combusted household waste are included in the indicator. The data relates to actual quantities produced during one year and how it was treated in the individual case.

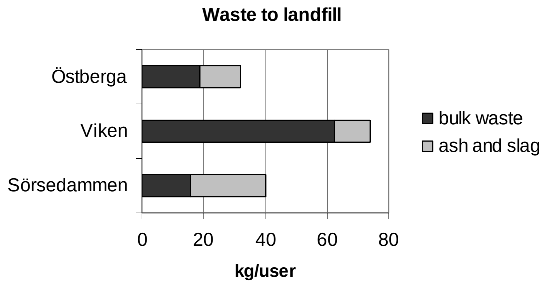

Figure 2 Landfilled waste per user from the three housing units.

The indicators shown in figure 1 and 2 could be used by external stakeholders, like sector organizations or authorities which is already done today with indicators like energy use/m^2 for different types of buildings. However, in the internal EMS process, the indicators can be used to follow-up environmental objectives formulated in the same way. Benchmarking with others can then be of interest in order to find out the relevant levels for stated, quantified environmental objectives.

4.2 Comparisons of the same housing units during a period of time

Common practice in real estate companies today in Sweden is to follow up energy use in time series. Figure 3 shows such information for the three housing units in this study for two subsequent years. Normalisation is commonly done with let out m^2 as shown in the right figure. For follow-up on a level of individual housing units, such information will normally serve as sufficient indicators for environmental targets since significant changes in the energy production mixture on this level are not common. However, to follow up the performance of the housing stock of the company as a whole on a yearly basis, environmental impact indicators may be more relevant since there might be changes each year somewhere in the housing stock. Such time-series follow up could be of interest when following up environmental objectives formulated like “contributions to climate change or ionising radiation” from energy use. Such formulations of environmental objectives may be important on company-level. A few real estate companies have also introduced such objectives in their EMS process (Malmqvist, 2004).

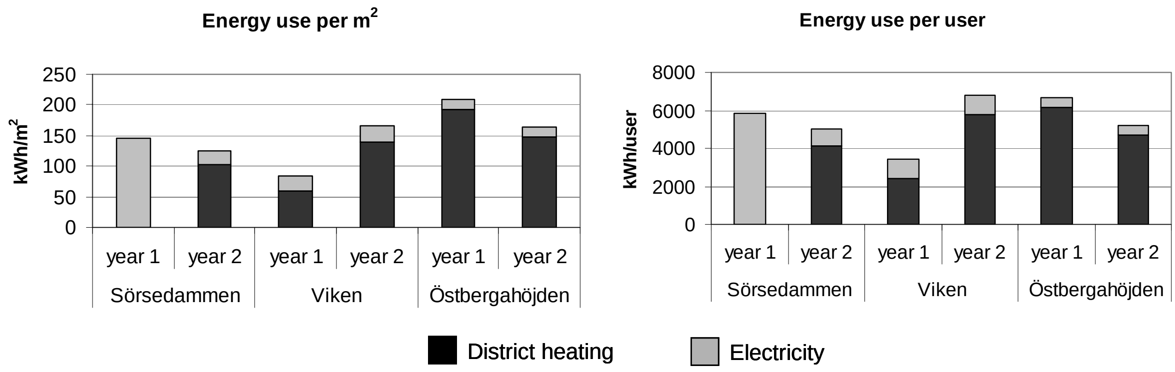

Figure 3 Change in energy use per user and per m^2 in the three housing units between two years.

Environmental impacts ought to be followed up in both absolute and normalised figures. Normalisation is necessary for comparison between housing units with different sizes. If normalised, we recommend dividing the environmental impact with number of users (in buildings for housing) or use-time (in buildings for schools or offices) since the environmental impact thus is linked to the function or service generated. However, amount of let-out m^2 can also be used. As shown in figure 3, the denominator used will play some role. It can for instance be seen that the electricity use in Viken and Sörsedammen is higher than in Östberga if related to the amount of users instead of m^2. This is also the reason why the new housing unit Viken has a higher value on the presented EII´s in figure 1 than Östbergahöjden even though Viken uses solar heat collectors and has been designed to have a low energy use per m^2. Viken is designed to accommodate less people per m^2 than Östbergahöjden.

4.3 Comparison between different environmental aspects

For one of the cases, Sörsedammen, data of fuel quantities was gathered for the transports related to operation and maintenance of the housing unit. These data could then be used for calculation of the same EII´s as for energy use. In figure 4 the contributions to these impact categories from the housing unit Sörsedammen are shown, separated on contributions from the different sources.

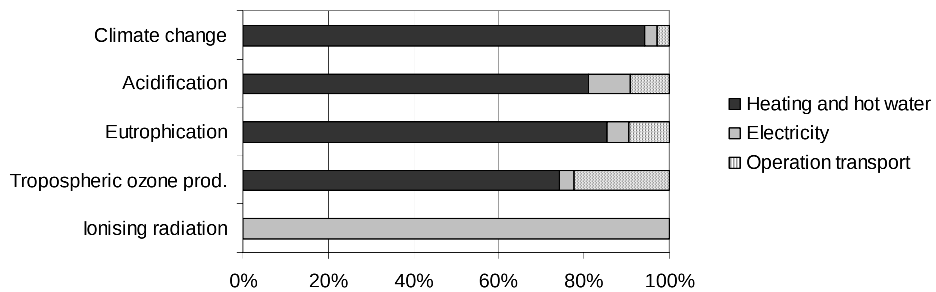

Figure 4 Contributions to environmental impact categories, Sörsedammen housing unit 2002, in %.

Compared like this, the impact indicators can be used for comparing different environmental aspects in the real estate management with each other. The environmental aspects in this case are thus heating and hot water, electricity use and operation transports. Such information can be used when assessing what environmental aspects are the most significant in different parts of the housing stock but also in order to understand the environmental problems related to different activities in an organisation. Note that the figure gives information about what environmental aspects are contributing to different problems. However, it does not tell what problem would be the most important to work with, nor if the contributions are high or low if compared with other housing units. But, it gives information about the district heating being a major contributor to four of the problems and for instance that the transports for operation gives a significant contribution to the problem of tropospheric ozone production.

4.4 Evaluating the outcome of environmental measures taken

The EII shown in figure 2 gives indication on the problematic issue of waste being landfilled. It can be assumed that better organisation of recycling facilities in the housing unit will reduce this problem. The same basic data as for figure 2 can also be used for information about the proportions of the waste treated in different ways in the investigated housing stocks. Figure 5 shows information that can complement the waste indicator in this respect. The combined information in figure 2 and 5 can be used in order to evaluate if the taken measures to achieve the environmental objective of waste treatment has been efficient. In all three cases recycling facilities are well organised in the housing unit. In Sörsedammen and Viken organic waste is collected and therefore included in the staple for recycling. A reason for the higher quantity of waste per user in Viken might be that there are a number of restaurants in this housing unit.

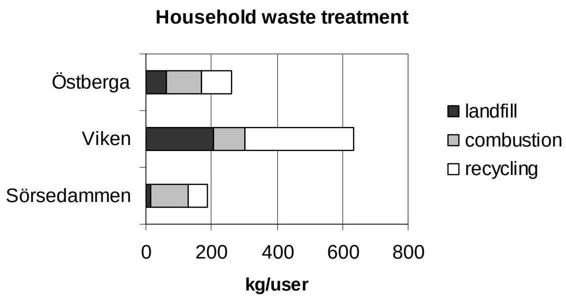

Figure 5 Proportions of waste treated in different ways in the three housing units.

4.5 Displaying built-in environmental and health risks

Figure 6 shows the outcome of the proposed EII´s for built-in hazardous substances. The indicators are based on the actual built-in amount in kg of substances that are officially classified as possessing inherent hazardous properties (carcinogenic, etc.). It was only possible to calculate these for one of the housing units; Viken. The reason is that Viken is newly produced and the quantities of built-in hazardous substances were documented. Such data seldom exists for older buildings. The idea with the indicators is to show some of the potential problems related to built-in hazardous substances that are not evident to common people. The indicators does, however; not tell anything about what problem is the most important, nor if this is a high or low figure. There are also other issues to consider looking closer at such information. One is that substances may for instance be more or less carcinogenic. Such information is not shown in the indicators in figure 6. A very small amount of a very carcinogenic substance can constitute a much higher risk than a larger amount of a less carcinogenic substance. Another problem is that only a few chemical substances are today classified. Potential problems of tomorrow will therefore not be shown.

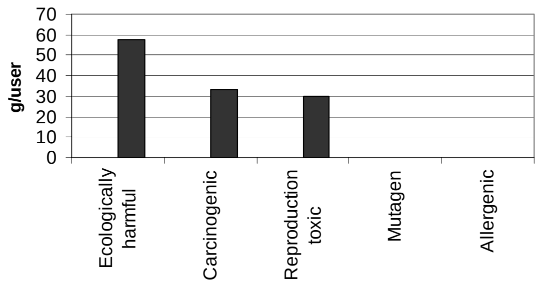

Figure 6 Outcome of proposed environmental impact indicators for built-in hazardous substances, the housing unit Viken.

Figure 6 shows an example of how the problem of built-in hazardous substances could be displayed. For a real estate manager it is, however; probably not a tempting presentation since it might raise fear and worry if displayed to the users of the buildings. Fear that may be groundless since the figure neither considers where in the building the substances are built in. It should therefore be seen as an example rather for further discussion. The main issue at stake is that procedures are introduced for better documentation on quantities on built-in potentially hazardous substances/materials and where in the buildings they exist. Such documentation can then ground for various ways to present the data. In Sweden, such initiatives are discussed at the moment.

4.6 Discussion of data availability in real estate units

In particular if benchmarking is used for external purposes, the comparability between results must be discussed. The case studies in the project show that there are differences between different companies and also between different housing units in companies with respect to in what form process data is presented. Statistics of energy use is easy to retrieve since data usually is collected on a monthly basis in a database using a special software for this purpose. However, attention has to be paid to what is included in the data. For instance, in the case of Sörsedammen the electricity use include both electricity for operation of the houses and for the households. For the other two cases, household electricity is not included.

The data needed for figure 2 is not commonly saved in data bases since follow-up of waste indicators are scarce today in the investigated companies. The units in which the data is presented vary in the housing units. In Sörsedammen and Viken combustible waste is weighed when collected and the data is therefore quite reliable. The data for Viken was, however; not retrieved in the real estate company, but had to be demanded for from the company collecting the waste. In Östbergahöjden the weight had to be estimated from the volume of the bins in the area. The bulk waste was weighed when collected at Östbergahöjden and Viken, but not in Sörsedammen where it had to be estimated from the volume collected. To conclude, if economic systems exist for charging media use, waste production, etc per quantity, sufficiently reliable process data can quite easily be gathered and used for calculation of EII´s.

Finding data on built-in hazardous substances is faced with other problems. Data on quantities are rare with small exceptions of new buildings where high demands were put on this issue, as was the case with the housing unit Viken. For older buildings it is very uncommon that data exist on what hazardous substances can be found. This was not historically documented and such information only exist if special inventories has been made during recent years. However, even though inventories were made (as was the case for some of the houses included in the housing unit Östbergahöjden), built-in quantities are very seldom estimated. This is practically only done for PCB today. It can thus be concluded that the proposed indicators may only be calculated for new houses. Since construction materials often are mixtures of different chemical compounds, substantial and trustworthy material declarations are also necessary to be able to do this. For old houses indirect indicators are necessary, like percentage of the housing stock for which inventories were made and percentage that has been decontaminated.

The case studies also show that the companies are not always aware of what data they possess that could be used for calculation of impact indicators. Documentation of the existing data needs to be organised better if to be used for calculation of environmental indicators that can become a tool in the EMS process. It is also evident that the person who compiles such information has to be observant to figures that are not trustworthy.

5. Conclusions

This paper has proposed and discussed practical examples of environmental impact indicators, EII´s, to be used for a more efficient EMS process in real estate companies. One of the aims was to present ideas on indicators that have a direct relationship with certain environmental impact categories. Such indicators are theoretical since they need to be calculated using information both from the investigated housing units and from external data sources. The study shows that the routines for collecting existing quantitative information are not well developed and needs to be better organised. Better knowledge on what data exist in the companies and how it can be used in the EMS process is necessary and one driving force for such improvements is to find indicators that are experienced to be trustworthy enough to be used in practice. The experiences of this study also show that the data from external sources, like necessary emission data needs to be more readily available and also more trustworthy if the proposed indicators will have a more extended use. A development in this direction can be expected.

There are several parts of the EMS process in which quantitative environmental information, for instance the environmental impact indicators suggested in this paper, can be useful. A better linkage between building performance and company activities with environmental impact ought to be useful in order to decide on what environmental aspects should be prioritised, what types of targets and objectives should be stated and to evaluate the outcome of measures taken in the environmental practice. If wider used it could be important also in improving the consciousness in the organisations about the environmental impacts related to the houses and their operation.

We argue that the EMS practice in the sector can benefit from establishing methods to calculate such environmental impact indicators even though they at first sight may not seem relevant. Such measures may provide more information about the environmental problems and risks faced by the sector than common practice today. This does not mean that such indicators are best suited for all types of situations in the internal process, however; they may provide important complementary information to other indicators. The increased debate and interest in life-cycle thinking and supply-chain management (e.g Wrisberg and Udo de Haes, 2002) is a result of the increased insight that upstream and downstream processes may sometimes be more important in environmental terms than the direct production of goods and services of a company. To broaden this view also in the real estate and building sector is therefore important.

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