Environmental management in product chains

- theoretical and regulatory perspectives based on 25 Danish case studies

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Preface

This report presents the analyses of the shaping, implementation and embedding of eight types of environmental initiatives in product chains. The analyses focus on

- the role of the type of product and branch, of the size of the companies and of governmental regulation
- the focus of the environmental concerns and the reductions in environmental impact
- organisational changes which have been part of the embedding of the initiatives

The analyses are based on 25 cases from national and international product chains involving one or more Danish companies. Based on the analyses of the eight types of environmental initiatives, a number of recommendations for governmental regulation, which can support the further diffusion of environmental management in product chains, are developed. Furthermore, the report describes a number of theoretical perspectives from sociology of technology, organisation theory, network theory, innovation theory, competence development and political science, which are proposed as focus in future capacity development as part of governmental strategies, which aim at supporting emergence and stabilisation of environmental concerns as part of product chain dynamics.

The project has been financed by the Danish Programme for Cleaner Products and carried out by a project group at Department of Manufacturing Engineering and Management (now DTU Management) at Technical University of Denmark. The members of the project group have been Michael Søgaard Jørgensen, Marianne Forman and Annegrethe Hansen. Anette Christiansen from the Danish Environmental Protection Agency has been responsible for the link to the Programme for Cleaner Products.

The 25 cases, which was the empirical basis of the theoretical based analyses in this project, were written by four consultancy companies 2000-2002. As part of the development of the recommendations from the project, a workshop was organised with researchers from universities in Denmark, Germany, Sweden and United Kingdom and with participation from the Danish Environmental Protection Agency. At the workshop the draft of the case analyses were presented and discussed.

Summary and conclusions

This report analyses 25 cases of environmental initiatives in product chains involving companies and discusses the conditions for further diffusion of these types of environmental management in product chains.

0.1 Eight types of environmental management initiatives in product chains

The 25 cases, which are the empirical basis of the analyses in the report, have been described by four Danish consultancy companies and involve all at least one Danish company. In some of the cases, suppliers and/or customers are based in other countries. Based on the case descriptions eight types of environmental management initiatives have been identified. These types of environmental initiatives have been analysed with respect to the background of the initiative, the shaping of the initiative, the organisational and environmental impacts and the conditions for further diffusion of this kind of environmental management in product chains.
The different types of initiatives and the main company in each case are shown in the table.

Environmental initiative/management effort	Companies (activity, product or service)
1) Life cycle assessment	Technos A/S (paint manufacturer) Gabriel A/S (textile manufacturer) Jydsk Nylon (electroplating company) Danfoss Drives A/S (electronic product manufacturer) H+H Fiboment A/S (building materials)
2) Customer information, marketing	Bambo (production of nappies and sanitation products) HCI Nordic A/S (handling and distribution of chemicals) Danfoss Drives A/S (electronic product manufacturer) Skylight A/S (plastic product manufacturer) Jysk Nylon (electroplating company) Post Danmark (transportation) Brødrene Hartman A/S (packaging manufacturer) Levison + Johnson + Johnson A/S (printing company)
3) Green procurement policy or strategy	DSB (state owned railway company) Dan Rens A/S (distribution and sale of chemicals)
4) Recovery of materials and products	Danogips A/S (building material) Danfoss Drives A/S (electronic) Skylight A/S (plastic product manufacturer)
5) Supplier assessments and dialogues	Brødrene Hartman A/S (packaging mnufacturer) Novotex (textile manufacturer) Kompan A/S (playing ground equipment) Skanska Danmark A/S (contractor) HCI Nordic A/S (handling and distribution of chemicals)

6) Greening product development	Berendsen Tekstil Service (textile service company) Akzo Nobel Deco (paint manufacturer) Phønix Trykkeriet A/S (printing company) Trevira Neckelmann A/S (synthetic yarn manufacturer) Bambo (producer of nappies and sanitation products)
7) Eco-labels	Technos A/S (paint manufacturer) Berendsen Tekstil Service (textile service company) Novotex (textile manufacturer) Phønix and Kontrapunkt (printing company and graphic design company) Leika Danmark A/S (furniture distributor) Trevira Neckelmann A/S (synthetic yarn manufacturer) Levison, Johnson and Johnson A/S (printing company) ISS Danmark (cleaning service company)
8) Strategic co-operation	Phønix Trykkeriet A/S and Kontrapunkt (printing company and graphic design company) Leika Danmark A/S (furniture distributor) ISS Danmark (cleaning service company) Centre for concrete construction Berendsen Textile Service (textile service company)

0.2   Environmental improvements from the initiatives

Not all the cases make it possible to conclude whether environmental improvements actually were obtained. The cases show a focus on a number of different environmental impacts, which the initiatives aim at reducing. These impacts include:

- Reduction of resource consumption, including energy consumption
- Recovery of waste products and materials for new products
- Phasing out hazardous chemical substances and products in agriculture
- Phasing out hazardous chemical substances and products in products
- Phasing out hazardous materials in products
- Reduction of amount of monomers in paint
- Development and use of more biodegradable chemical substances and products

The cases have different types of focus on reduction of environmental impacts. It is not so that they all have focus on the reduction on all environmental impacts in a certain product chain. Rather, the product chain is an arena for the shaping and embedding of the management of some environmental impacts in the product. The cases show these different kinds of focus on environmental impacts:

- Impacts at a or more suppliers
- Impacts during manufacturing
- Impacts during distribution
- Impacts during the use of a product
- Impacts during product disposal and waste management
- Impacts throughout the whole product chain

The focus in a case may be on the reduction in one part of the chain, like the product use, but a substitution of a chemical will also give a reduced impact during the manufacturing of the product. The cases show how the reduction

of impacts in a certain part of a product chain may imply changes in another part, like when the reduction of environmental impacts from a paint in the use phase imply that changes take place during the manufacturing of the paint.

0.3 Interaction between environmental initiatives in product chains

The characteristics of the eight different initiatives show that environmental management in product chains is more than exchange of environmental information between supplier and customer. Several of the initiatives involve joint development projects and some of them strategic co-operation.

Several companies have been involved in more than one of the eight initiatives. Some of the combinations are:
- Supplier assessment and dialogue combined with information to customers
- LCA and information to customers
- Product development and information to customers
- Product development, eco-labelling and strategic co-operation

These combinations of initiatives shows that some companies have environmental-oriented relations as well upstream the product chain (to suppliers) as down stream the product chain (to customers).

0.4 Organisational aspects of the initiatives

The cases do not show a certain order of implementation of the different types of initiatives. For example, it is not so that all companies had implemented ISO 14001, before they initiated a change.
Most of the cases show integration of an environmental initiative into some of the existing business relations. This shows that integration of environmental concern and interaction is possible within existing business relations. Companies do not necessarily need to find new suppliers to get a change implemented. However, it seems like the mutual importance of supplier and customer has impact on the way the change process is organised. Changes seem to be organised as a mutual development process if the customer and the supplier are of equal strategic importance to each other, although the customer usually initiates the change. If the customer is not of strategic importance to the supplier, it may be more difficult to get a change implemented. Maybe the costumer have to choose a strategy that demand less of the supplier, like when one of the companies could not carry out a life cycle assessment, because the supplier was not willing to use the necessary resources to develop the data. The customer considered then to shift to go for a eco-labelling license instead because that would be less demanding of the supplier to answer questions about the ability of their product to fulfil some specific eco-labelling criteria.

Some cases show development of new organisational structures between the involved companies. One type of new structure is not directly part of the business relations (a centre for resource-saving concrete constructions). Although not directly mentioned in the case material also the so-called product panels, which involve different actors within a product or activity area (for example within textile, construction and freight transportation), have played a direct or indirect role in some of the cases. The panels can be

characterised as a kind of policy networks and involves typically manufacturers, users, and knowledge-based institutions like consultants, research institutions and NGO's.

Other new structures are directly part of the business relations. An example is a printing company, which gets a sales office at a graphic designer company as part of their strategic co-operation. Change in existing structures in seen, where the relationship between a detergent supplier and its customer (a cleaning service company) changes from a relation involving only sales and purchase persons to involving detergent chemists and cleaning technicians. This change was necessary in order to enable a change to less hazardous chemicals, which at the same ensured the quality of the cleaning service.

These experiences from the cleaning service case show the importance in greening of product development of a focus on the practice, which the product is supposed to support or become part of – and not only on the product or product component itself. In the cleaning service case, the important dialogue as part of developing guidelines for the practice with the new and greener detergent between the detergent chemists and the cleaning technicians focused on the roles of and interaction among the cleaning detergent, the equipment, the expected level of cleanliness and the expected level of costs.

Several cases show that environmental initiatives are embedded in an organisation through changes in different elements of the organisation, like

- Development of environmental management system
- New knowledge in the organisation from analyses
- Database about product components
- Database about chemicals
- Design handbook and guidelines
- Guidelines for procurement
- Tools for sales department
- Participation of environmental staff in sales and design activities in dialogue with customers

0.5   Product and branch aspects

Some conclusions concerning the role of the type of products and branches, which are in focus in the cases, are:

- In terms of the level of processing, the cases include raw materials, processes, products and services for professional users, and consumer products. The cases include also products of different types of materials: renewable materials, construction materials, metals, and chemicals. The complexity of the products is also different, from rather simple chemicals to complex construction projects.
- Demands are mostly passed upstream product chains from a customer towards the suppliers. Demands passed downstream (to customers) are only seen in two cases. One of them concerns the distribution of chemicals, where a multinational company demands of its customers that they audit their customers. This can be seen as a kind of extended producer responsibility from the manufacturer based on the inherent hazardous properties of the products and an attempt to avoid critique of the products the company manufactures.
- Some of the cases concern branches, where the Danish product-oriented policy has had a lot of focus: printing goods and textiles.

- The cases show one example of a branch at a mature level with respect to environmental initiatives: the printing branch. In one part of this branch eco-labels and environmental management systems seem to have become a business condition. The market is governmental institutions and stakeholder organisations. The experience from these cases show that the companies in a branch at a mature level of environmental management still has to be dynamic and innovative, because they have to try to position themselves in relation to the other pro-active companies. This might lead to strategic co-operation like between a printing company and a graphic design company, or it might imply that the environmentally improved methods become the daily manufacturing methods, because it is too time-consuming and expensive for the company to shift between different methods.

A comparative analyses of cases within three resource areas: furniture and clothing, construction and housing, and information and communication show more similarities than differences in the type of environmental initiatives. This implies that the type of product or service and the way the product chain is organised does not seem to decide the type of environmental management initiative, which is possible. The following characteristics across the product areas were found:

- Expectations from potential suppliers to public demand for more environmentally friendly products or solutions are in several cases not met (for example furniture for day-care institutions and cleaning), for example high priority environmental demands lack in tendering processes
- Branch specific business organisations and knowledge institutions are involved as initiators and mediators, whereby the conditions for widespread diffusion of experiences should be ideal
- However, only in one case, the use of recycled plasterboard for production of new plasterboard, the environmental demands seem to become a mainstream demand in business-to-business sales and purchase within a product or service area.

These characteristics show the need to analyse which conditions and regulatory measure, which can support further diffusion of the environmental initiatives.

0.6 Conditions and regulatory measures for the diffusion of environmental management in product chains

This paragraph summarises the conditions for each of the eight environmental initiatives and suggests regulatory measures, which could support the further diffusion and implementation of the environmental initiatives.

0.6.1 The conditions for implementation of the different types of environmental initiatives

The table shows the conditions, which are necessary for the support of each type of environmental initiative, and some proposals for regulatory measures, which can support the further diffusion of the different environmental initiatives in product chains.

Environmental initiative	Conditions related to initiative	Regulatory measures for diffusion and implementation
1) LCA	Procedure needs to be adapted to the knowledge resources of the companies Non-strategic suppliers reluctant to provide data Lack of branch data	Support to dissemination of more simple and more dialogue-based methods for lifecycle screening Support to the development of branch data
2) Environmental information to customers	Impact unclear when information is provided to customer without dialogue Easier for larger companies to collect and mediate environmental information	Regulatory demand for green accounts from all companies in order to provide easy access to environmental information about materials and products from suppliers
3) Green procurement	Easier for larger companies to make assessments of materials and products	Support to development and implementation of environmental declaration schemes for the provision of environmental information in business-to-business relations
4) Recovery of materials and products	Regulation like differentiated costs on waste handling supports recovery Dialogue about quality of the recovered materials necessary Differences in waste management regulation among municipalities a barrier to national recovery from waste products	Use of economic instruments in order to motivate to recovery of materials and products Encouraging joint initiatives which can support development of joint quality criteria for recovered materials and for integration hereof in future product development Development of more uniform municipal waste management regulation in order to enable recovery schemes for materials and products if they have been approved nationally
5) Supplier assessment and dialogue	Dialogue-based assessments of suppliers lead to more environmental improvement by the supplier and motivate joint projects Assessments are less formalised in business relations, where trust has been built	Support for the development and implementation of dialogue-based tools for environmental initiatives in product chains Support for the implementation of product-oriented environmental management systems Support for the systematic development of branch or product-oriented knowledge about business and innovation dynamics
6) Greening product development	Strategic business relations motivate joint environmental product development Eco-label criteria act as product development guidance	Support to competence development within integration of environmental aspects into strategic business relations Dissemination of experience with the application of eco-label criteria in strategy and product development
7) Eco-labels	Eco-label criteria act as product development guidance Environmental management system enables easy data provision to customers Public green procurement as driver but expectations to actual demand is often not met	Support to implementation of the public green procurement practice in governmental institutions in order to create more public demand for 'greener' products and services Support to the development and implementation of tools and schemes, which can support the dialogue between customer and supplier, like eco-labelling criteria,

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		green procurement guidelines etc.
8) Strategic co-operation	Co-operation might inspire to implementation of ISO 14001 Change in inter-organisational relations towards more focus on quality and function of products and services might be necessary Joint development of environmental initiatives seems motivating	Support to integration of strategic business aspects into environmental management systems Support to competence development through training and further education within environmental management Initiation of more product and branch based multi-stakeholder policy networks (product panels etc.)

The overview of the conditions for the application of the different types of environmental initiatives show that some of the initiatives may be easier to introduce for bigger companies with many resources and potentially bigger influence on their suppliers and customers than for smaller companies.

0.6.2 The role of environmental management systems

Several companies had implemented a formalised environmental management system, typically ISO 14001, before they initiated changes in product chain, while other companies have implemented ISO 14001 later on and some have not implemented an environmental management system. In a few cases, companies were planning to implement ISO 14001 after having been involved in one of the initiatives in a product chain. It looks like other companies' strategies inspire companies in some of the cases while they are co-operating with them.

Although formalised environmental management systems play a role in some of the cases, the cases clearly show that companies do not initiate environmental management in product chains as self-regulation, but often based on external demands. These demands might come from private or public customers, like through public green procurement, or inspired by regulatory measures aiming at substitution of chemicals and materials (like lists of unwanted chemicals and taxes on certain materials). Sometimes a regulatory measure, which a customer experiences, is raised as a demand to a supplier, whereby the product chain becomes an arena for mediation of regulatory demands among different geographical contexts.

These observations show the importance of governmental regulation as guidance for corporate environmental management systems and thereby for environmental initiatives in product chains. One of the reasons for the need for external guidance for companies with environmental management systems (and for companies without environmental management systems) is the large degree of interpretative flexibility in the ISO 14001 standard. This implies that the standard not automatically guarantees a certain scope of the environmental management - for example a focus on environmental impact in the product chains, which the company is part of. The flexible elements in the ISO 14001 standard include (Jørgensen et al 2007):
- The scope or boundaries of the activities covered
- The identification of environmental aspects and impacts of company activities
- The legal requirements which are recognised by the company
- The policy priorities of the company

- The focus in relation to suppliers, products and design, because it is up to the company to define those environmental aspects of activities, products and services, which the company believes it can control or influence.

0.6.3   The role of transnational environmental management

A few cases describe relations between Danish companies and either suppliers or customers from other countries. Some of these cases also show differences in the level of environmental protection or least different levels of environmental performance among companies in different countries, which are part of the same product chain. The examples include:
- Danish multinational companies that experience the Nordic market conditions as quite different from other countries, which give problems transferring the environmentally improved concepts to the other parts of the two companies' markets
- Danish company, which experiences demand from a professional customer from another country about a quality of the products, which fulfil eco-label criteria
- Danish company with suppliers in a number of other countries has developed its own supply chain management system based on questionnaires and training of own purchase persons in order to obtain a level of environmental protection, which acknowledge the local level of environmental capacity, but tries to develop the level of environmental protection among the suppliers further.

These cases show the importance for many companies of a policy, action plan and practice around transnational environmental management. The strategy need to include considerations about the level of environmental protection compared to the level of protection in Denmark and the present level of protection among suppliers and customers in these other countries. It is important that the companies do not assume that the environmental infrastructure, which they know from Denmark is available in other countries. This implies that it is necessary to get information about the environmental infrastructure, legislation and public debates and discourses around environmental issues in the other countries. The concept of script can used to consider what assumptions the company makes about the roles of the product, the user, the infrastructure, and the governmental authorities in those other countries, where present or potential suppliers and/or customers are located.

0.6.4   The role of governmental regulation

The cases have shown how a number of different types of regulatory measures have been important as occasions and driving forces for the development and implementation of environmental initiatives in product chains:
- Command and control regulation, for example restrictions on certain chemicals and materials like PVC, make a company exclude PVC products from their procurement
- Economic instruments, like taxes on the waste handling of construction waste etc. initiate the development of a recovery scheme for waste plasterboard

- Market based instruments, like eco-labelling and public green procurement inspire companies to develop products within their product area
- Competence development through the development and implementation of tools and training at branch or company level, like within the use of LCA
- Information-based tools, like the list of unwanted chemicals, for example used as background in the phasing out of additives in paint
- Policy networks within product areas and branches create joint initiatives - and thereby momentum or volume in eco-labelling campaigns or legitimacy behind guidelines for greener products, like the product panel on textiles.

Public green procurement is a driver for eco-labelling and product development in several cases. However, the anticipated market for the greener products does not materialise, in some cases, in an actual public demand (furniture and cleaning service). This shows the need for support for further implementation of public green procurement policies into actual public green procurement practice. The role of the public green procurement is bigger in relation to printed goods. However, the restricted budgets among the public institutions is also here a limiting factor, which implies that the public institutions want the eco-labelled product quality, but they do not want to pay the fee for the eco-labelled product, so they ask for not having the products eco-labelled.

Differences in municipal regulation have been a barrier to environmental initiatives. Two initiatives for development of national waste recovery schemes have only developed to a limited extent, because collection of waste materials and products as part of waste management needs approval from each of the municipalities. This practice has made a more widespread use of the schemes very time-consuming.

0.6.5 Regulatory support to environmental management in product chains though coherent policy regimes and policy patterns

The cases show the need for a careful development of the policy regimes, which are supposed to support the development of a new type of practice among companies, which means a focus not only on a law or a circular but also on the necessary policy instruments and competences among the civil servants that is needed. Furthermore, the experiences show the need for consistent policy patterns, which means that the different policy measures need to support each other. This implies that if the implementation of a certain measure, like public green procurement, is seen not to develop as expected and the demand for greener products do not develop, the background has to be found and changes in the policy measures developed. An important restriction to the development of public green procurement is the restricted budgets of the governmental institutions. It is important to analyse when and why these higher prices on eco-labelled products develop. Is it for example because better and therefore more expensive materials, components etc. are used or is it because the supplier expect that the users of greener products are willing to pay more for the product. In relation to printed products, the price difference between the labelled and the not-labelled product is sometimes only the eco-label fee, because the products are of the same quality. If the customer wants the products labelled, the printing companies want the public customer to pay the eco-label fee, but due to their

restricted budgets governmental institution seem often to decide not to get the products labelled.

The lack of diffusion of the environmental initiatives into more widespread practice in several of the case studies show the need for the governmental regulation to be more differentiated and have a focus on the different types of companies. There needs to be policy instruments, which encourage front-runners, but there need also to be instruments, which focus on the more reactive companies and also on the back laggards. The role of multi-stakeholder forums in some of the cases as a way of developing a successful strategy shows the need for support for this kind of initiatives. Examples are the product panels, the co-operation around development of waste management schemes and quality criteria in the use of recycled plasterboard in new plasterboard and the co-operation around a centre for resource-saving concrete constructions. Such multi-stakeholder forums can in some cases solve the dilemma whether the focus should be on developing the demand for or the supply of more environmental friendly solutions or products first, like eco-labelled products or products made from recycled materials. The need for these forums shows that also markets for more environmental friendly solutions and products need to be developed through a combination of policy instruments. This combination should include command-and-control regulation of for example chemicals, economic instruments like taxes and innovation supporting programs. It is necessary to develop these stakeholder forums with a broad selection of stakeholders in order to develop a broad legitimacy of the way the environmental problems and the solutions are framed.

An important prerequisite of the diffusion of the environmental initiatives is sufficient staff in the Environmental Protection Agency with competences about the dynamic interactions between environmental policy and product chain dynamics and innovation dynamics. These competences include competences about the different roles of governmental regulation in innovation processes, like the support for development of product standards, quality criteria, prototypes, experiments etc. in the development of demand and supply of more environmental friendly solutions. Consultancy companies may be important in supporting companies in some parts of an environmentally focused innovation process and consultancy companies are good at making relations to companies, if it is a demand for public funding in an innovation programme. However, several of the initiatives in the case studies have had problems being embedded, when the public funding to the consultancy companies ends. Some of these initiatives, like the role of eco-labelling in the textile sector and the role of public green procurement within furniture and cleaning services could probably have been embedded, if there had been enough resources in the Environmental Protection Agency to monitor the market development for more environmental friendly products and services. This monitoring should include analyses of the driving forces that seem to support or hinder the market development. This kind of analyses and organisational support is not supposed to be a kind of governmentally supported "picking the winners" in terms of what products to develop, but a critical support and monitoring of the complex dynamics in the different phases of innovation processes in market development.

This role of the Environmental Protection Agency need to be part of a stronger innovation focus in the environmental policy with focus on the need

for different instruments in research, innovation and diffusion at the market. Some elements in such a regulatory strategy should be:

- Research guidance based on environmental perspectives based on assessment of research strategies and potential outcomes, development of visions and objectives for areas of research
- Support for innovative activities focused on specific application fields, including support for development of prototypes, development of market structures and analysis of experiences from first-generation users
- Regulation of technology applications through the regulation of driving forces and institutional frames which determine the use of products in the development of specific consumption areas

0.7 Theoretical perspectives for analysis of the shaping and embedding of environmental management in product chains

The analyses of the 25 case studies have shown the value of theoretical perspectives in analyses of the shaping, embedding and diffusion of environmental initiatives in product chains.

The following theoretical perspectives have shown to be of value and are recommended as focus in future capacity development as part of governmental strategies, which aim at supporting emergence and stabilisation of environmental concerns as part of product chain dynamics:

- A social shaping approach to the analyses of the co-shaping of company strategies and practice on the one hand and societal environmental discourses on the other hand during the emergence and stabilisation of new issues within corporate practice

- A capacity-building approach to the development of environmental competences in companies, including a focus on the development of knowledge resources, internal and external communication channels and interpretive structures, which helps translate environmental concerns into design guidelines etc.

- A network relation approach to analyses of the type and role of existing and new relations between different actors, which are involved in the shaping and implementation of environmental initiatives in product chains. This should include a focus in the type of resources, which are useful or developed in this kind of relations, like knowledge, legitimacy, purchasing power or market access.

- An innovation dynamics approach to the development of new products and services within product chains, including interaction with other types of actors, like government, civil society organisations, knowledge institutions etc.

- A user-oriented innovation approach to the greening of products, where focus is on the anticipated or necessary *changes* in practice and in the roles of the different elements like materials, equipment, personal competence, societal expectations etc. The concept of script as the vision of the future practice can be applied in this type of innovation.

- A business strategy approach to the corporate practice in relation to customer – supplier interaction, where focus is on the degree of pro-activity, the role of short and long term relations between customers and suppliers and on the competence development within and among the different companies within the product chain.

- An international perspective on transnational environmental management with a focus on the dynamics behind corporate strategies between local adaptation and global integration and strategies for capacity building in transnational product chains.

- An environmental assessment perspective on the effect of the initiatives on the environmental impact. The approach is based on a life cycle screening approach combined with an assessment of the time perspective, the degree of prevention, the degree of holism and the changes in environmental impacts.

- A political science approach to the role of governmental regulation in the shaping and diffusion of environmental initiatives in product chains. This should include a focus on existing regulation as a barrier or support, the development of new regulatory regimes as part of the support for environmental initiatives in product chains and the role of coherence in the policy pattern, which shapes the practice within a certain product, service or technology area.

1 Introduction

1.1 The purpose and the structure of the project

The Environmental Council for Cleaner Products initiated in 2000-2001 a collection of experience from the environmental co-operation in 25 product chains (Ettrup & Bauer 2002). This collection of experience was to elucidate the concrete co-operation between suppliers, enterprises and purchasers, to go through tools and to report on opportunities and barriers for environmental efforts in the entire product chain (Ettrup & Bauer 2002).

The aim of this rapport is to give a comprehensive analysis of the experiences from the 25 case studies with focus on how environmental management in product chain management functions and how governmental regulation can support the further diffusion of environmental management in product chains.

All 25 cases take their point of departure in companies who have some kind of environmental management, where some activities to a smaller or larger degree have included parts of the product chain, and companies who the Danish Environmental Protection Agency (Danish EPA) had some knowledge about beforehand. Some of the companies have got resources from the Danish EPA's different environmental programmes. The Danish EPA chose to focus on the product chain perspective on environmental management in order to assess the possibilities for a expansion of the perspective of corporate environmental management to the whole product chain and thereby a greening of the whole product chain.

The analyses in the report of the 25 cases are based on a social shaping approach. The emergence and stabilisation of environmental aspects in the companies and their product chains are seen as shaped by the existing practice in the product chain with respect to the roles of supplier and customer, and the different actors' interpretation of the need for addressing environmental aspects. Explanations are sought on how actors give meaning to environmental concern within existing practice and the role of knowledge, aspects of product quality, environmental concern, customer demands and market opportunities, national and international schemes, personal relations and confidence etc.

The development of the environmental initiatives will be analysed as a co-shaping between direct and indirect demands, governmental regulation and product chain relations. The role of product chain relations and governmental regulation in stabilizing environmental management in product chains are discussed.

The phases in the project have been:
1. Reading cases and development of an analytical frame
2. Analysis of the 25 cases and development of perspectives on the conditions for the shaping and embedding of the environmental initiatives

3. Organising a small international workshop based a working paper with the developed perspectives with participation of researchers and representatives from the Danish Environmental Protection Agency
4. Development of strategic recommendations for governmental regulation which can strengthen environmental management in product chains
5. Writing the report

2 The empirical basis of the project

Four different consultancy firms carried out the 25 case studies for the Danish Environmental Protection Agency. The four consultancy firms are:
1. COWI
2. Dk-Teknik, Energi og Miljø in co-operation with DHI (Institut for vand og miljø) and Valør & Tinge
3. PlanMiljø
4. FORCE

The 25 cases have been published in an example collection and a short summary report:

- Bauer B. and Ettrup, B. 2002a, Environmental management in product chains (In Danish: Miljøledelse i produktkæder), Environmental Project no. 39, Danish Environmental Protection Agency

- Bauer, B. and Ettrup, B. 2002b, Environmental management in product chains (In Danish: Miljøledelse i produktkæder – en eksempelsamling), Environmental Project no. 41, Danish Environmental Protection Agency

The background description of each product chain case is based on a template with the following headlines (Ettrup & Bauer 2002):
- Start phase
- Product chain
- Environmental co-operation
- Environmental achievements
- Perspectives

All the consultancy firms have followed this template, but using different methods and different weighting of the elements in the template. The material represents a large pool of knowledge, but great caution with its heterogeneity should be taken.

The consultants have collected some figures about the involved companies, but the primary focus has been on more qualitative aspects of the environmental initiatives and their planning, implementation and embedding and the driving forces. The information collected by the consultants is primarily from interviews and from material from the companies about their environmental management systems, in case such systems were part of the environmental practice. Often the interviews have taken place in two steps. First with the initiating companies and then afterwards with external actors like suppliers or customers, which were identified in the first interview. The interview persons have been a mixture of environmental co-ordinators, sales persons, suppliers etc. The interviews have mainly been semi-structured interviews based on a list of tentative topics and questions. There have been differences in the focus in the case studies carried out by the different consultants. Some of them had the focus on the relations to the suppliers, while other consultants have included a focus on the internal organisation in the core companies.

The core companies in the case studies are from the branches shown in table 2.1.

Chemical industry	Technos A/S Akzo Nobel Deco HCI Nordic A/S Dan-Rens A/S
Textile and leather industry	Gabriel A/S Novotex Trevira Neckelmann A/S
Iron and metal processing industry	Jysk Nylon Danfoss Drives
Transportation services	Post Danmark DSB
Stone, clay and gypsum industry	Danogips
Paper and graphic industry	Brdr. Hartman A/S Phønix-trykkeriet A/S Levison + Johnson + Johnson
Cleaning, dry cleaning and laundry	Berendsen Tekstil Service A/S ISS Danmark
Concrete, tile covering etc.	Center for ressourcebesparende betonkonstruktioner (Center for resource saving (efficient) concrete constructions) Skanska HH Fiboment
Wood processing and furniture industry	Kompan
Napkins and hygiene products	Bambo
Plastic industry	Sky-Light A/S

Table 2.1: The distribution of companies on branches based on the categorisation done by the consultants in the case studies

Table 2.1 shows how the core companies are from very different types of branches and contribute to very different types of products and services. Also in terms of the number of employees are the core companies very different; from small and medium-sized companies to very big companies, as shown in table 2.2. Most of the companies are private, but a few are public owned companies. The environmental initiatives have in some cases focus on a specific part of a big company.

Company	Number of employees (at the time of the case study)
Technos A/S	200
Gabriel A/S	156
Jysk Nylon	6
Post Danmark	30.000
DSB	5786
Danogips	258
Danfoss Drives	750
Brdr. Hartman A/S	2300
Berendsen Tekstil Service A/S	1400
Akzo Nobel Deco	400
Novotex	50
Phønix -Trykkeriet A/S	73
Leika Danmark A/S	< 45 (an estimate)
Centre for resource saving concrete constructions	Project-based co-operation among companies
Kompan	500
Skanska	76.000
HCI Nordic A/S	3000
H+H Fiboment A/S	600
Trevira Neckelmann A/S	650
Bambo	322
Levison+Johnson+Johnson	85
ISS Danmark	16000 (Denmark) (250000 worldwide)
Cardodoor	7851
Dan-rens A/S	9
Sky-Light A/S	103

Table 2.2: The size of the core companies in the case studies

3 Theoretical perspectives for analyses of environmental management in product chains

3.1 Introduction: the concept of environmental management in product chains

Different notions are used for environmental management in product chains. "Life cycle management" is sometimes used as the name of this form of environmental management (see e.g. Garcia-Sanchez et al 2004). Kogg (2002) uses the term "environmental supply chain management" about efforts initiated by companies to improve and/or control environmental performance upstream and/or downstream in their supply chains. When the term "supply chain management" is used the focus of some authors is primarily on demands directed upstream the supply chain (which means towards the suppliers).

De Bakker and Nijhof (2002) use the term "responsible chain management" as a term for a continuous alignment of different internal and external expectations to a company. This term signals that today not only environmental demands are in focus in product chains, but sometimes also issues like social conditions, occupational health and safety, child labour etc. Some companies have started using the term "sustainability management" and reporting guidelines have been developed. An example is the Global Reporting Initiative (www.globalreporting.org).

In this report, "environmental management in product chains" is used as the general term. Environmental management in a product chain is defined as attempts to

- Address environmental problems in a product chain
- Convert the understandings of problems and the management hereof into changed practices in the individual companies in the product chain and/or the product chain as a whole.

Kogg (2002) stresses that much of the research in the field of environmental supply chain management has been based on case studies and that prescriptive recommendations often have been based on a limited number of cases, typically best practices, while little has been done in relation to theory building. This report is based on 25 case studies in Danish industry, which is a reasonable number for drawing some conclusions with respect to theory building and with respect to recommendations for governmental regulation. The report discusses:

- The interaction between environmental management and existing product chain relations and other external conditions like governmental regulation
- The development of environmentally related competencies and environmental achievements in the product chains
- The opportunities and barriers for a long-term and more widespread implementation of environmental management in product chains as

part of business strategies and how this can be supported by governmental regulation.

The following paragraphs present theoretical perspectives for the analyses of the above-mentioned aspects of environmental management in product chains.

3.2   A social shaping perspective on the analysis of environmental management in product chains

Traditionally analyses of changes of corporate practice are based either on a resource-based perspective focusing on the development of routines and resources inside the company or on a contingent perspective focusing on the corporate uptake of external demands and discourses. This report combines the two perspectives into a social shaping perspective, where the focus is on the co-shaping of companies and societal discourses during the emergence and stabilisation of new issues inside companies, as well as on the changes in routines and resources within the involved companies this might imply (Forman & Jørgensen 2001a & b).

The focus on the **shaping** of environmental management practice in product chains implies that the environmental activities in a product chain are seen as shaped by, on the one hand, existing traditions within the companies and among the companies in a product chain, and, on the other hand, by the pressure on the companies to introduce environmental efforts. This pressure may come through environmental requirements from external and internal actors, including governmental regulation. Existing traditions in a product chain and in the companies include the strategic orientation in the companies, the division of labour and communication in and among companies, and the methods of control companies use to achieve the fulfilment of the requirements to their suppliers, such as quality, delivery etc. The analyses of the social shaping of the environmental management practice focus on the change processes, the background (the triggers for the changes), the interaction with present business strategy and product chain and the outcome of the change processes. Changes in practice are understood as environmental changes, which means changes in potential environmental impacts, and organisational changes, which means changes in knowledge resources, values, routines and/or organisational structures (Forman & Jørgensen 2001a & b) (Hansen et al, 2002). Organisational changes can be seen as basis for the embedding of a new practice as the future practice. This perspective is very much in line with for example Kogg (2002), where focus in similar case studies is on triggers for greening, the greening objectives, the supply chain structure, the approach to environmental supply chain management and the consequences for the companies.

Also Bowen et al (2001) stress the importance of focusing on the corporate environmental activities as well as the strategic purchasing and supply, when analysing the shaping of what they call "green supply". Hall (2000) discusses environmental supply chain dynamics and highlights the importance of the buyer-supplier relations, including the degree of collaborative buyer-supplier relations and the degree of one actor's ability to control the decisions of the other actors, so-called ***channel power***. For the analyses of product chain relations Goldbach (2002) describes two extremes of relations in product chains as one characterised by co-operation, incentives, trust and win-win solutions and another characterised by confrontation, control, power and win-

lose solutions. Kogg (2002) identifies two aspects of environmental supply chain management approaches from two case studies. **One aspect** concerns whether environmental measures take place through direct interaction with each of the suppliers upstream or by approaching the nearest supplier, whom then is supposed, if necessary, to approach own suppliers, which could be called a kind of "mediated environmental management" with the product chain as arena. The **other aspect** concerns whether the initiatives are taken by a company alone in order to position itself on the market or collaboration is established with competitors in order to increase the pressure on the suppliers.

Since several companies within the same branch or product area are analysed it is possible to compare companies and look for similarities and differences in the issues they focus at, and the strategies they develop. This includes whether some companies can be seen as front-runners shaping new strategies, and others can be seen more as followers, who react to new strategies and thereby contribute to making these strategies a new path within a certain branch or product area.

Although the focus in the analysis is on environmental management in product chains, the analysis of the cases draws on a broader network analysis to supplement the product chain perspective. The broader societal "selection environment", suggested in the literature to increasingly play a role in product and industry greening, is not captured with a product chain analysis alone. Networks around a single part of the product chain, or networks addressing the whole product chain, can also contribute to the development of the selection environment.

3.3 Network relations in and around product chains

Inspired by Holm et al (1997) and Søndergaard et al (2004) a distinction is made between four types of networks, which companies, consciously or unconsciously, are part of:

- The business network – here called the product chain – the flow of material, capital and information from cradle to grave between suppliers and customers and users (see figure 3.1)
- The developmental network – sometimes also called the knowledge network – which focus on the development of new processes and products and which can include parts of the product chain and universities and other types of knowledge institutions
- The regulatory network, which includes public authorities from the local to the international level, but also civil society organisations which directly or indirectly address how companies should or ought to act
- The local network, which consists of the local supply of natural resources, infrastructure, staff, local governmental regulation etc.

This combination of innovation, product chain- and network approaches contributes to the analysis of the greening process as co-shaped by processes in and among the companies in the product chain and other types of networks. Figure 3.2 shows the combined focus on the different types of networks.
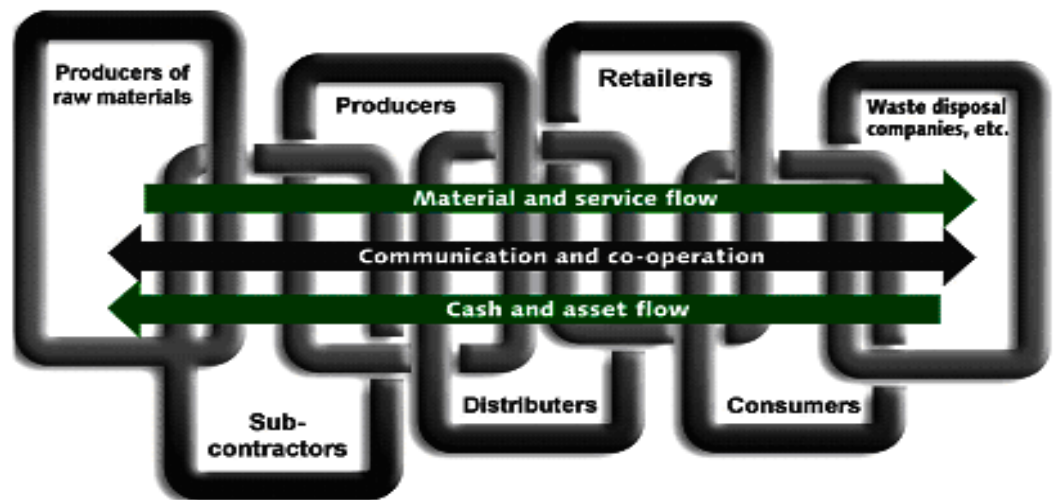
Figure 3.1: The structure and the flows in a general product chain (Jensen and Remmen (eds.) 2005)
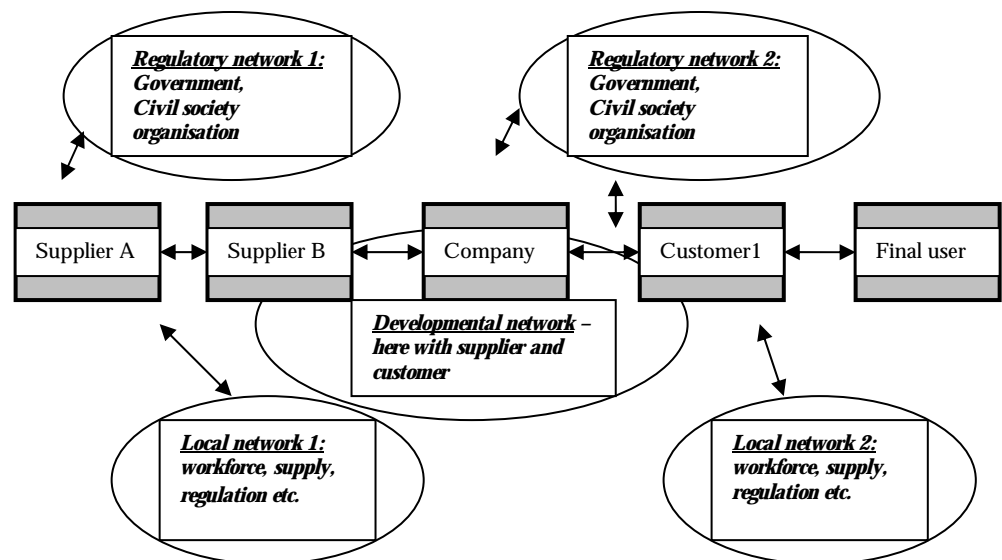
Figure 3.2: The focus of the case analyses combining a focus on the product chain, the developmental network, the regulatory network and the local networks. The arrows show the complex pattern of flows among the different networks of natural resources, information, capital etc.

Boons (1999) distinguishes in his typology for business networks between bilateral and multilateral networks and between networks with different level of integration (low level of integration meaning more autonomy to the members of the network). Table 3.1 gives an overview of different types of networks according to these aspects (Boons 1999).

In the analyses of the product chain relations and their interaction with environmental management practice Schary & Skjøtt-Larsen (2002) is used as background for characterising customer-supplier relations in product chains. According to Schary and Skjøtt-Larsen product chain relations can be found

on a continuum between market conditions and hierarchies. Market conditions imply that materials, services etc. are bought from time to time looking for the best

Degree of integration	Bilateral mechanisms	Multilateral mechanisms
Low	Market: contracts	Monitoring: information exchange, cartels
Intermediate	Obligational network: subcontracting, joint ventures	Promotional networks: R&D alliances, coalitions
High	Hierarchy: Vertical and horizontal integration	Association: trade unions, trade associations

Table 3.1: Typology of bilateral and multilateral corporate relations with different levels of integration (Boons, 1999)

price, and hierarchies imply that a company take over or integrate a certain competence into own organisation. In between these extremes are a number of so-called hybrid forms with some kind of competence hold by the supplier and some kind of specificity of the materials, services etc. the supplier offers. Schary and Skjøtt-Larsen refer to Andrew Cox' typology for product chain relations as shown in Table 3.2.

Product chain relation	Characteristics
Adversarial leverage	Focus on price comparison between different suppliers and short-term cost reductions. Merits when multiple suppliers and stable market conditions
Preferred supplier	Focus on longer contract periods with a limited number of suppliers and exchange of planning information. Relevant with products of low strategic importance
Single sourcing (Parallel sourcing)	Supply by a single supplier for a period for a certain good or service. Relevant with goods and services linked directly to the core competencies of the company. If there is more than one supplier within an area the practice is called "parallel sourcing"
Network sourcing	Focus on tiered supply structure, networking among suppliers, exchange of staff between buyer and supplier, high degree of trust and early involvement in design. Relevant with high specificity of goods and services
Strategic alliances	Focus on voluntary arrangements involving exchange, sharing or co-development of goods and services. Relevant when suppliers complement the customer's capabilities.

Table 3.2: Typology of product chain relations (Schary & Skjøtt-Larsen 2002, pp. 183-193)

According to Schary and Skjøtt-Larsen, it should be expected that the closer a certain competence is to the core competence of a company, the more likely it is that this competence becomes more integrated into the dominating

company in the product chain. A company has often, however, a portfolio of product chain relations at different levels of integration. A number of factors influence the break away from past practice of simple procurement at market conditions: increased outsourcing, global sourcing, Just-In-Time purchasing, information technology development and increased focus on environmental supply chain management (Schary & Skjøtt-Larsen 2002).

3.4 The role of environmental issues in innovation

A focus on innovation dynamics is important in the analyses of environmental management in product chains of two reasons. On the one hand, several of the environmental initiatives in product chains, which were identified, involve development of new products or changes of existing products. On the other hand, existing innovation dynamics would also play a role in the shaping – according to the earlier mentioned co-shaping perspective to the development of environmental management in product chains.

A number of studies have analysed the role of customers, users, indirect stakeholders and general societal demands in innovation. The reasons for these concerns to play an increasing role include increasing concern over technological changes and their societal impacts. Such concerns are reflected in company policies as well as in governmental regulation. Increasing customer and consumer awareness of health, environmental and societal consequences is another sign of the societal role of these types of concern. (See e.g. (Forman & Jørgensen 2004), (Stranddorf et al2002), (Madsen & Ulhøi 2001), (Foster & Green 2000), (Stewart et al 2000), (Stewart & Conway1998), (Hansen1996) and (Lundvall1985).

These studies include innovation studies with an industrial economic perspective and studies with a more organisational perspective. The industrial economic perspective focuses on the structural conditions and driving forces for activities like environmental management in product chains. This literature focuses on productivity driven innovations, but also new products, new quality aspects and products implying less societal impacts. Seen from an environmental point of view, productivity driven innovations often also have an environmental dimension due to the use of fewer resources. This kind of innovations does not take place automatically, but maybe only if there is a strong economic incentive. This kind of innovations includes more efficient equipment and more efficient management (so-called "good house-keeping"). Other types of environmental innovations are based on substitution of chemicals, which implies less environmental impact during use or waste handling, longer lifetime etc.

The selection environment, as a term for the mechanisms behind the decision to focus on certain values, includes stakeholder groups and structures and regulation. Regulation is here understood both as specific governmental policies and as the result of negotiations balancing between different interests. Compared to the role attached to governmental regulation in economics of innovation as inhibiting innovation, the role of regulation with regard to "green innovation" is regarded as more positive. Regulation may reduce uncertainty about consumer acceptance, may draw attention to cost ineffective production methods and may add quality to the product (see e.g. (Hansen 2001)).

In a number of innovation studies regulation is found to be a strong motivator for environmental innovation, and according to (Foster & Green 2000), English companies seem only to develop so-called greener technologies if they are under regulation or if customers further down the product chain demand them. The only exception to this in their survey is, if companies have Scandinavian customers, which demand greener products.

In Stewart et al (2000) the role of broader societal "demands" and concerns for technology development and environmental innovation have been analysed. Broader social concerns are mentioned to be of increasing importance for innovation. Because of their less direct influence, terms such as "the selection environment" and "indirect stakeholder influence" have been used about them. These broader concerns are harder to demonstrate since the concerns are often more complex and involve several technical trait, links are indirect between e.g. NGOs and the company, and the consideration of the concerns are often not traceable in the company.

Hall (2000) refers to small companies as less responsive to general or indirect environmental concerns, whereas large and high profile companies are more inclined to address their environmental image in public. One reason why it may be more difficult to trace the responses in small firms, is the lack of an environmental person, a formulated environment policy etc. Hall also refers to small firms as enjoying less criticism, because they are small. He uses the notion "channel power" about the ability of a company to raise demands to its suppliers or customers.

Stranddorf et al (2002) conclude in a study of Danish textile companies and their environmental demands to suppliers that whether a company chooses to address an environmental issue depends on a number of factors including the present product chain relations and possible ways of integrating the topic into the business strategy. There may be different triggers for environmental initiatives in the same company. The triggering factors include:
- Governmental regulation of chemicals and materials
- Governmental regulation as public-private sector-based dialogue forum (developing plan for eco-labelled collection of garment)
- Governmental funding, including funding for eco-labelling and for joint development projects with suppliers in developing countries
- Public debate, especially in relation to child labour
- Customer demands
- Expectations to market opportunities

Foster and Green (2000) analyse in nine companies how environmental issues influence the research and development of companies. Focus includes the role of consumer demand, university research and governmental regulation. The hypothesis that demands play an important role is amongst other based on earlier studies on the co-construction of markets and anticipated markets for technology development. The awareness of this is seen as important for managing technical as well as economic uncertainties. Foster and Green (2000) argue that environmental innovation could get a bigger role if suppliers encouraged their customers more to have a dialogue about environmental potentials.

Madsen and Ulhøj (2001) see environmental innovation as the result of a very complex process involving not only suppliers and customers, but also a broad group of societal stakeholders or actors. Such studies demand a view on many

different types of relations of the companies and the dynamics of such relations.

In greening of product development, it is important to be aware of those changes that may be necessary in a future practice with a greener product, for example because the product maybe demand more of the user. Akrich (1992) uses the concept of "script" as a way of describing future roles in a practice. These roles are "played" by the objects themselves, their supporting infrastructure and the humans (e.g. users, governmental authorities). In a design approach the concept of script can be seen as a way of characterising those intentions or manuscript, which a designer builds (inscribes) into a technology through its material shape, its functions, the user guidelines etc. These intentions include the future roles, which the technology, the user, the surrounding infrastructures etc. are supposed to have. Whether the script afterwards is accepted and a stable practice is developed depends on the script and on the type of technology and the context and probably how much present and/or future users have been involved in the design og re-design of a greener product. The theory talks about "negotiations" between the inscribed possibilities and limitations the script gives the user. These negotiations take place in interaction with the economic, knowledge, technical etc. resources, which the user has access to when shaping the practice with the product (for example whether it is possible to use more time on a cleaning task, if the greener chemicals demands this. The technology is considered as "hard" if the users cannot change the technology, even if they feel restricted in the shaping of their practice. On the other hand, the technology is considered as "soft" if the users can shape their own practice. The so-called "prescription" refers to the room for action, which the script allows (Jørgensen et al 2006).

3.5   A typology of environmental management strategies in product chains

In the above-mentioned study of environmental management in product chains in the Danish textile sector three different types of environmental management in relation to suppliers are identified (Stranddorf et al 2002) and (Forman & Jørgensen 2004). The aspects, which showed the need for differentiating between different practices, were:

- The degree of pro-activity in the corporate environmental strategy
- The tradition for short or long term relationships and for control and/or co-operation with the suppliers
- The concepts used by the companies to plan and monitor demands to the suppliers
- The organisational impact of environmental initiatives on the product chain in terms of development of the competencies of the company itself and/or the supplier(s).

The three environmental supply chain management practices are:
- **The wake strategy**, where the company does not place requirements on suppliers, but follows in the "wake" of organisations, which already place these requirements.
- **The asymmetrical partnership**, where a company wants long-term relationships with a supplier. The customer is dominating the relationship, builds up a lot of competence itself and controls that the supplier met the requirements.

- **The symmetrical partnership**, where a company wants long-term relationships with a supplier and enters a mutual partnership with the supplier(s) and built the strategies in dialogue.

A company might have different supply chain strategies and different environmental management practices in relation to different suppliers, depending on the competence of the supplier. If a supplier is easy to substitute, which for example sewing companies in the textile industry in some cases seem to, the environmental supply chain management practice are more of an asymmetrical partnership. If the company is more dependent on the competence of a supplier, it seems like there is a tendency to build symmetrical partnerships.

The aspects of stabilisation of these three product chain practices can be viewed from both a customer and a supplier perspective (Forman & Jørgensen 2004). The wake strategy can make it easy for a company to switch to new suppliers, when for example the market for eco-labelled products has become mature. However, companies might face problems at that stage to find suppliers due to potential suppliers' agreements about not selling to more customers, because existing customers want to secure their own market position.

The most essential reason why suppliers decide to enter agreements to provide environmentally improved products or improve processes is that they can see competitive advantages in participating in these partnerships and a direct link to customer demands. An international retail chain is for example a potentially large customer for suppliers. Therefore, it is attractive to suppliers and they are more willing to co-operate with the company. It is, however, not only the size of the company, which makes it attractive as customer. A strategic alliance with suppliers of chemicals may be developed, because the customer buying the chemicals is well known for its in-depth testing of new chemicals.

Companies, which have outsourced their production activities, seems to need to pay attention to how they ensure their market position, as the essential competence building takes place by the supplier.

With respect to asymmetrical and symmetrical partnerships, it looks like that the more aspects, which have to be incorporated into the customer-supplier relations the more resource saving it might be to develop more long-term and closer customer-supplier relations. It takes time and human resources of the focal company if it too often has to develop new customer-supplier relations, including aspects of quality, environment and occupational health and safety. Forman and Jørgensen (2004) report the same dilemmas for customers and suppliers connected with these types of relations as Hall (2000) in his literature review. The customer is sure to have qualified suppliers, but might also find it difficult to shift suppliers due to the dependency of the supplier being developed, for example if external conditions like currency rates change and make it more profitable on a short term basis to find other suppliers. The supplier is getting more stable planning conditions, but might also be pushed by the customer to take the burden of a number of new activities like obtaining eco-labelling.

Asymmetrical partnerships are not necessarily capable of disseminating advanced environmental competence along a supply chain and develop a

multiplier effect, as a company that makes requirements at a supplier build up its own environmental competencies and do not expect the supplier is able to develop the similar competencies. Seen in a long-term perspective this might make the supplier very dependent of the customer and imply that the customer stays with the responsibility of updating knowledge about environmentally more sound opportunities. (Schary & Skjøtt-Larsen 2002) refer that multinational companies in some cases urge preferred suppliers also to have other customers in order to ensure more dynamic suppliers.

3.5.1   Transnational environmental management

Some product chains are transnational, which in most cases implies that there is a different level of environmental protection in countries along the product chain. Hansen(1999) argues that transnational environmental management typically will have at least the following elements:

- General principles for the environmental activities of the entire corporation
- More specific policies and programs applicable throughout the corporation
- A cross-border environmental management system with procedures for monitoring and controlling the practice of the foreign affiliates
- Training, education and information exchange programmes and activities
- A formal organisation where responsibilities and functions are delineated and allocated between different entities and persons – for example between headquarter, affiliates and suppliers.

Hansen (1999) argues that corporate environmental management practice in transnational product chains falls within the range from adaptation to the local regulation and practice in developing countries to global integration where a company is practising the same level of concern and responsibility as in the home country (Hansen 1999). Hansen (1999) refers to two types of product chains: management of controlled affiliates and management of non-controlled foreign entities (organised through franchising, licensing, subcontracting or strategic alliances). With reference to Bartlett's and Ghoshal's ideal types of cross border organisation in transnational corporations, Hansen (1999) describes four ideal types of cross-border environmental management: decentralised environmental management, international compliance, centralised environmental management and globally integrated environmental management. The most elaborated and environmental ambitious cross border environmental functions are seen in the centralised and globally integrated types. Table 3.3 gives an overview of the four types of practice.

	Decentralised environmental management	International compliance	Centralised environmental management	Globally integrated environmental management
Environ- mental manage- ment focus	Local adaptation	Host country legislation (country of affiliate)	Home country legislation (country of headquarter) and company standards	Internationally oriented company standards
Concept of environ- mental	Stand alone activities in affiliates.	Affiliates around the world take the necessary	The environmental management system of the	Initiatives to new measures form different facilities

manage-ment	Environmental management the responsibility of local managers. May take advantage of weak implementation of local environmental regulation	measures to operate in accordance with laws and regulations of the host countries	home country as the basis, regardless of the local requirements. Fear the regulation of the host countries is not sufficient.	in the company. Network among local environmental managers. Adaptation to local conditions allowed, within the corporate principles

Table 3.3: A typology of corporate environmental management in transnational product chains (based on (Hansen 1999).

According to Hansen (1999) the type of forces, which shape the environmental management in transnational product chains between local adaptation and global integration, seems to be:

- Regulatory forces: the type of environmental regulation shaping the cross border practice: international regulation, home country regulation and host country regulation
- Market forces: the quality and environmental orientation of the markets and the value chains
- Industry specific forces: the collaboration in the specific industry
- Company specific forces: the nature of the production technology, the environmental history from the home country, the international orientation of the company.

3.5.2 Competencies in environmental management in product chains

In addition, the networking inside a company might change as part of environmental management in a product chain. Lenox and Ehrenfeld (1997) suggest that when companies develop their ability to handle new problem areas there is interplay between the company's need and ability to explore and research the new problem area in relation to the company's business areas and the need to convert this knowledge into a new practice. They point out that the challenge is to develop the knowledge resources and secure integrating structures. Both aspects are important in relation to the corporate environmental competence. The integration of knowledge into practice is based upon co-ordination and communication between the various actor groups within the company and the external network of the company. Lenox and Ehrenfeld argue the following elements are necessary in order to develop the ability of a company to handle environment as an issue:

- ***Knowledge resources***: information and expertise residing in individuals, groups and technical artefacts

- ***Communication channels, both formal and informal***, which are the channels through which information flows and is exchanged in a given social system

- ***Interpretive structures***, which can help create mutual understanding and values among the involved stakeholders, because it is not enough to merely understand and agree on the information exchanged between groups. The groups must also have similar values and find the information meaningful in the context of their own work. This aspect influences what meanings are attached to the information during change processes, and thereby the results achieved.

Where Lenox and Ehrenfeld focus on the single company the focus in this report is on the product chain. The interesting aspect becomes where in the product chain what knowledge resources and changed structures and routines are developed.

From the earlier mentioned case studies about Danish textile companies and their interaction with suppliers a number of competencies necessary for the environmental management in product chains were identified (Stranddorf et al 2001) (Forman & Jørgensen 2004). These competencies are developed within the companies in the product chains as a part of the planning, the implementation and the monitoring of the initiatives in the environmental supply chain management. Depending on the environmental supply chain management practice, the various competencies are developed and anchored at 1) the company that sets the requirements, 2) the supplier and/or 3) a third party (e.g. an advisor or a certifying organisation).

Interpretation competence
Interpretation competence is partly the competence to understand external requirements from e.g. environmental agencies and customers, and partly the competence to translate those requirements into practice within the organisation itself – such as converting the requirements into actual practices for purchasers, production workers, designers, suppliers etc. In most cases, dialogue was established with suppliers in several parts of the supply chain and not only with the nearest supplier.

Technical environmental competence
Technical environmental competence refers to the insight into technical and chemical processes, etc., which is a prerequisite for the adjustment or reorganisation of a production process, a design scheme etc. in order to meet environmental requirements.

Documentation competence
Documentation competence is knowledge about how to build and operate documentation systems and document handling routines etc.

Control competence
Control competence refers to knowledge about monitoring systems, management systems, auditing etc., and the responsibility for or empowerment to maintain control. This competence can reside with the company, the supplier, or a third party – e.g. a certification agency.

Network competence
Network competence is the ability to create changes in a product chain through networking among customers and suppliers, including the ability to motivate the companies in the chain to enter a dialogue, as well as the ability to transfer technology and knowledge in or among product chains.

De Bakker and Nijhof (2002) have developed a capability assessment framework for responsible chain management, where they distinguish between internal and external capabilities and talk about four types of capabilities in a so-called capability cycle: interpretation, integration, monitoring and communication. The circular process, inspired by the Plan-Do-Act-Cycle, is too sequential, since the processes of interpretation, integration, monitoring and communication often occur more interwoven, but the four types of capabilities and the focus on internal and external capabilities seem relevant.

Four competencies identified by De Bakker and Nijhof (2002) (interpretation, integration, monitoring and communication) corresponds to those presented above, although Stranddorf et al (2002) identified a more detailed range of integration competencies: part of the interpretation competence, technical environmental competence and network competence.

3.6   Assessment of changes in environmental impacts

In analyses of the embedding of environmental initiatives in product chains, it is important to include whether and how environmental impacts are reduced in the product chains in focus. The analyses are based on a life-cycle screening combined with a concept for characterising changes in environmental impacts developed in (Forman & Jørgensen 2001b). This concept includes the following aspects, which are introduced briefly in the following paragraphs:

- Time perspective
- Degree of prevention
- Holistic orientation
- Effect on environmental impacts

3.6.1 Time perspective

The time perspective reflects that a problem solving process is a progressive process. It takes place in relation to surroundings that are not stable, but are constantly changing – whereby conditions for the solution of the problem may change. These conditions could include the development of new technological possibilities, new customer demands, new knowledge, new employees, etc.

At the company level, the time perspective relates to which possibilities the company focuses on in relation to concrete problems, both in the long and short terms. Short-term solutions are connected to local possibilities in departments, etc. Long-term solutions are connected to the company's strategic decision-making processes.

3.6.2 Degree of prevention

Prevention aims to solve the problem as close to its source as possible. The degree of preventive solutions can be described as one of three degrees of prevention:

- ***High degree of prevention:*** Solutions which remove or limit influences on the environment at the source, e.g. changing the way activities is organised and the way technology is used in order to achieve a cleaner technology, e.g. substitution of hazardous chemicals.

- ***Medium degree of prevention:*** Solutions that limit influences on the environment through cleaning processes, such as chimney filters or wastewater treatment.

- ***Low degree of prevention:*** Solutions that limit influences on the environment through encapsulation, e.g. depositing waste at controlled dumping grounds.

3.6.3 Holistic orientation

Holistic orientation problem solving processes are concerned with:

- All environmental impacts found in a product chain.
- The connection of environmental problems with other concerns, such as quality, work environment, operations and development in production or a product chain.

A holistic orientation can be seen as the opposite of a single-factored approach to a problem. With a holistic approach, several problems can be solved during the same process while ensuring that new problems are not introduced.

3.6.4 Effect on environmental impacts

The assessment of the effect focuses on whether the problem solving processes seems to reduce environmental impacts quantitatively and/or qualitatively.

In relation to the concrete environmental problems, the effect expresses the scope in which the implemented solutions work to remove or limit the environmental impacts. High effect is not the same as high degree of prevention. For example, a cleaning provision (medium degree of prevention) can significantly limit some type of impact on the environment, but might create new problems at the same time.

3.7 The role of governmental regulation

Governmental regulation has two roles in the analyses in the report. On the one hand, governmental regulation is seen as one of the possible driving forces behind the development of environmental management in product chains and, on one the other hand, proposals for future governmental regulation, which may support further development of environmental management in product chains, are developed.

3.7.1 Governance paradigms

In the literature, focussing on policy analysis and the study of policy impacts there has been a tendency in the recent years to emphasise the role and importance of government in a multitude of functions as a mediator, a provider of negotiation space, and as regulator in the field of environmental protection. New perspectives on government actions are described influenced by the changing views on regulation from viewing government primarily as a central authority to an actor in network-based governance. This shift does not imply that the roles of government are diminishing but rather that the roles change. Studies of environmental policies and protection measures show that successful environmental improvements in industry are found in the cases where government has played a consistent part by setting goals and timelines for improvements, by funding or in other ways supporting innovative changes, by setting taxes providing significant changes in cost structures, or by intervening with traditional legal requirements. In those cases where declared government policies were not followed by other supportive measures or a threat of future intervention in case of non-compliance with the policy objectives, not much happened (Jørgensen et al 2007) (De Bruijn & Norbert Boehm 2005). This indicates on one side the importance of government intervention and interaction, but demonstrates also the role of consistent series and generation of policies as opposed to an idea that a single policy should do the work.

In policy science a distinction is often made between three general governance paradigms (see Table 3.4) (Schot et al 2001):

- The traditional top-down model with a central role for (national) government and hierarchical relations,
- A bottom-up or market model with a large degree of autonomy for local actors,
- A policy network model of shared rule making and agreements between interdependent actors with diverging values and beliefs.

The three governance paradigms not only differ in their basic philosophy, but also in their instruments. Formal rules and regulations are common in the command-and-control paradigm, subsidies and taxes in the market model, and network management, learning processes, experiments, and interactive policy making in the policy network paradigm (Schot et al 2001).

3.7.2   Policy formation and implementation

The implementation and the impacts of policy interventions are difficult to study and difficult to plan. Not least because specific policy interventions most often do not stand alone, but are influenced by the policy discourse and the views and intentions expressed herein. Furthermore, other policy instruments with maybe different objectives influence the interventions. Overlapping policies coming from different fields of policy with very different objectives or even counter measures from involved actors might be as powerful as the policy action in focus. In a company, this includes the perspectives assigned by management to certain anticipated market and technology developments, which frame the strategic priorities and the types of innovations as response to the governmental regulation (Jørgensen et al 2007).

	Classic steering paradigm (top-down, command-and-control)	Market model (bottom up)	Policy networks (processes and networks)
Level of analysis	Relationship between principal and agent	Relationship between principal and local actors	Network of actors
Perspective	Centralised, hierarchical organization	Local actors	Interactions between actors
Characteri-sation of relationships	Hierarchical	Autonomous	Mutually dependent
Characteri-sation of interaction processes	Neutral implementation of formulated goals	Self organization on the basis of autonomous decisions	Interaction processes in which information and resources are exchanged
Foundational scientific disciplines	Classic political science	Neo-classical economy ('rational economic man')	Sociology, innovation studies, neo-institutional political science ('bounded rationality', uncertainty, learning, interacting)
Governance instruments	Formal rules, regulations and laws	Financial incentives (subsidies, taxes)	Learning processes, network management.

		Information	E.g. experiments, demonstration projects, vision building, network building through seminars, public debates

Table 3.4: Three basic governance paradigms (based on Schot et al, 2001)

Analyses of impacts of policies open for a range of questions covering the intended and actual policy program that is initiated (see figure 3.3 based on Winther's model for policy formation and implementation (Winther 1990)). Such analyses include studies of

- the scope or the objective of the policy,
- the choice of measures and instruments,
- the implementation of these instruments in the daily regulatory practices of responses and enforcement from the street-level bureaucrats (front-line policy implementers),
- counter measures from the target group (so-called "counter programs"),
- the output and the outcome of the policy implementation.
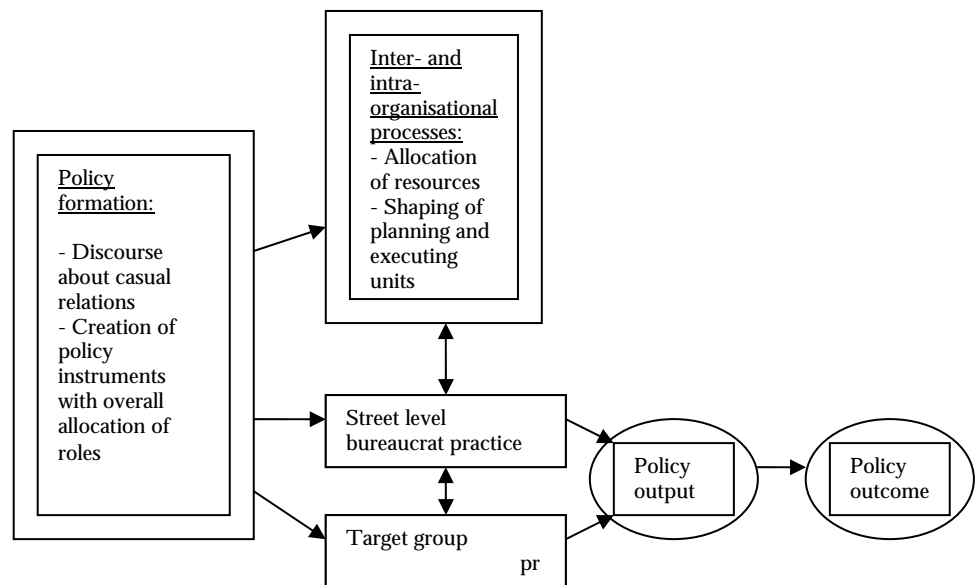
Figure 3.3: Aspects in policy formation and implementation (based on Winther 1990)

3.7.3 Regulatory regimes

Well-established policy paradigms, as the command and control based legal regulation of environmental permits based on emissions standards forms what can be phrased as "regulatory regimes". Such regimes develop from regulatory practice, but they also tend to shape future regulatory practice, as a regime forms a mix of institutions and practices easy to reproduce in new

areas of policy. This limits the specific possibilities of designing new policy measures in accordance with the objectives of new policy issues. This may imply institutional replication, which may limit the ability to regulate new policy issues (Jørgensen et al 2007).

The role of the institutional framework and the translations resulting from moving from the policy discourses and objectives to the choice of regulatory framework and again to the street level implementation can be analysed in an analytical framework focusing on the constitution of the regulatory regimes (Jørgensen 2005). The focus in analyses of regulatory regimes is the interdependency of actors, their knowledge, and their interactions in relation to specific forms of environmental regulation. The combination of specified environmental objects and the established practice and knowledge of the institutions, which are responsible for the implementation and use specified instruments, define the backbone of a regulatory regime. Regulatory bodies and the regulated companies are important actors, but also customers, suppliers, consultants, and knowledge institutions producing the criteria for regulating the specific environmental objects in question may be important actors (Jørgensen et al 2007).

Governmental regulation will often also refer to a set of elements used to enforce the regulation. These can vary from legal procedures for when and how the regulating body can dictate requirements to definitions of responsibility or negotiated agreements about the implementation of action plans. A traditional way of handling legal procedures in environmental protection is to identify a company not complying with a given environmental permit, and after having forwarded certain warnings, prosecute the company in court. The necessary type of information defines the specific character of the enforcement problem of a regulatory regime. As an example: If the regulation is dependent on continuous controls of pollution, it is necessary to have this information to maintain regulation and control. If the control procedure is left to companies by means of self-control, enforcement has to shift from control of specific pollutants to the control of process data and organisational procedures. When the environmental problems in question and the necessary type of knowledge are defined a distinct type of professionals will be needed to maintain the regime. A focus on ecological capacity shapes a regulatory regime primarily based on ecological knowledge, while a focus on cleaner technologies shapes a regime where also production and innovation knowledge become important competences (Jørgensen et al 2007).

3.7.4 Policy patterns

Where different policy measures or instruments are used in combination or influence the same field in society they can be characterised as a "policy pattern" as described by Jänicke (2000). Policy patterns are the sum of rules, manners of proceeding (practices and routines), and contexts of action within an area that is subject to government control or intervention. A policy pattern can be described with three dimensions (as shown in table 3.5):
- The structure of the instruments (or programmes) in relation to specific environmental goals.
- The policy style of government institutions on environmental issues.
- The political-institutional context of the actors and actions

Instruments	Policy style	Political-institutional context of action
• Dominant instrument in the mix • Degree of determining behaviour • Punctual versus strategic approach	• Form of target setting • Flexibility in applying the instruments • Timing of the measures • Orientation towards consensus • Legislation, bureaucratisation • Calculability	• Competence and the influence of the regulating body(s) • Role of other policies (policy integration) • Relation between regulators and the regulated • Role of non-governmental environmental institutions

Table 3.5: Policy patterns of environmental policy (Jänicke 2000)

This perspective on governmental regulation policy shifts the focus from the single instrument (and its regime) to the impact of parallel and sequential policies. This implies that the context of policy implementation also must be emphasised. This leads to a focus on the coherence of the different policy and the instruments: do the dynamics and synergies of policies contribute to sustained policy interventions with more or less identical regulatory regimes in a multitude of actions. The opposite implementation context would be conflicting policy measures and regulatory regimes and visions, which may lead to either shifts in the direction of the actions of the regulated or lack of impacts due to the lack of clarity and delayed responses.

3.8 Path dependency and path creation

When the conditions for a long-term and more widespread implementation of the environmental management practices in product chains are studied, the term "stabilisation" is used - with reference to the social shaping approach. The focus is on mechanisms that have implied that companies decide to continue with a certain practice, whereby the dynamics within for example. a product area change towards conditions, where environmental concerns play an important role in the competition. One of the mechanisms are what Preuss (2001) calls "the multiplier effect", when suppliers utilise experience from environmental measures, initiated by one customer, in relation to other customers.

The analyses of this kind of stabilisation are inspired by the concept of path creation at branch or product area level as developed by Karnøe and Garud in their analysis of path creation and path dependency in the development of the Danish wind turbine industry (Karnøe & Garud 1997). Karnøe and Garud see the shaping of new paths as an ongoing interaction between four systems: A production system, a consumption system, a knowledge system and a regulatory system. None of these systems are solely shaping the others, but changes in one system is from time to time changing the conditions for some of the other systems, which then change the conditions for some other systems and so on. One should for example not expect that the consumption system shape the production system. It might as well be the other way round or rather a co-shaping of the two systems, which maybe then make changes in regulation, research, education and training etc. necessary.

The path creation might imply use of existing technology, institutions etc. as well as shaping of new technology and new institutions. Seen over time as well reinforcing as restraining dynamics may occur. Within a social shaping perspective, it is not enough to identify the mechanisms it is also necessary to try to understand and explain why and how changes take place or why certain initiatives do not have an impact. Among the explanations might be the meaning actors give to certain changes. For example, whether a company sees an eco-labelling scheme as a tool for making previous product changes visible, as a chance to produce some high-price products to a certain market segment etc.

As part of path creation, boundary objects might be shaped as part of what can be called boundary practice (see for example (Wenger 2000)). The boundary objects are getting the role as translating environmental concern into corporate practice. This might take place as a co-shaping of the environmental concern and the corporate practice. Different companies within the same branch or product area may have different strategies. Some companies might be front-runners and contribute to the shaping of boundary objects, while others might react to the boundary objects as a condition for doing business. However, these more reactive companies might still contribute to the shaping of the boundary objects by the practice they develop and the meaning they thereby give the boundary objects. This means that the drivers behind for example eco-labelling in two companies might be different.

4 Methodology

On the background of the 25 cases described and analysed in (Bauer & Ettrup 2002a) and (Bauer & Ettrup 2002b), eight different environmental initiatives in product chains have been identified. The 25 cases have been categorised according to these environmental initiatives, but with several companies having introduced more than one of the identified environmental initiatives and, most often, with co-ordinated efforts between these initiatives. The eight types of initiatives and the main company and the type of product or service are shown in table 4.1.

Environmental initiative/management effort	Companies (activity, product or service)
1) Life cycle assessment	Teknos A/S (paint manufacturer) Gabriel A/S (textile manufacturer) Jydsk Nylon (electroplating company) Danfoss Drives A/S (electronic product manufacturer) H+H Fiboment A/S (building materials)
2) Customer information, marketing	Bambo (production of nappies and sanitation products) HCI Nordic A/S (handling and distribution of chemicals) Danfoss Drives A/S (electronic product manaufacturer) Skylight A/S (plastic product manufacturer) Jydsk Nylon (electroplating company) Post Danmark (transportation) Brødrene Hartman A/S (packaging manufacturer) Levison and Johnson and Johnson A/S (printing company)
3) Green procurement policy or strategy	DSB (state owned railway company) Dan Rens A/S (distribution and sale of chemicals)
4) Recovery of materials and products	Danogips A/S (building material) Danfoss Drives A/S (electronic) Skylight A/S (plastic product manufacturer)
5) Supplier assessments and dialogues	Brødrene Hartman A/S (packaging mnufacturer) Novotex (textile manufacturer) Kompan A/S (playing ground equipment) Skanska Danmark A/S (contractor) HCI Nordic A/S (handling and distribution of chemicals)
6) Greening product development	Berendsen Tekstil Service (textile service company) Akzo Nobel Deco (paint manufacturer) Phønix Trykkeriet A/S (printing company) Trevira Neckelmann A/S (synthetic yarn manufacturer) Bambo (producer of nappies and sanitation products)
7) Eco-labels	Teknos A/S (paint manufacturer) Berendsen Tekstil Service (textile service company)

	Novotex (textile manufacturer) Phønix and Kontrapunkt (printing company and graphic design company) Leika Danmark A/S (furniture distributor) Trevira Neckelmann A/S (synthetic yarn manufacturer) Levison, Johnson and Johnson A/S (printing company) ISS Danmark (cleaning service company)
8) Strategic co-operation	Phønix Trykkeriet A/S and Kontrapunkt (printing company and graphic design company) Leika Danmark A/S (furniture distributor) ISS Danmark (cleaning service company) Centre for concrete construction Berendsen Textile Service (textile service company)

Table 4.1: The identified types of environmental initiatives in the product chains in the 25 cases and the main company and the products or services

Within these eight types of environmental initiatives in product chains, the different activities are analysed with respect to
- What initiated these initiatives
- How these initiatives were organised and what activities were involved
- What the prerequisites in the companies were for these initiatives
- What the role of sector affiliation was
- How the initiatives were financed
- What organisational and environmental impact the initiatives have had

The initiatives are also analysed with regard to regulatory measures within the categories
- Demands, prescriptions and prohibitions
- Soft measures such as environmental labels, environmental standards and certifications
- Promotional measures such as support schemes, R&D policy etc.

Based on the analysis of the shaping of company practice in product chains from the cases, including the different regulatory measures, perspectives for future policy and the necessary preconditions for these to work as more widespread practice have been analysed. The aim is to analyse the specific company and product chain experiences (in chapter 5-10), and from the case analyses draw recommendations for future policy making (in the summary and conclusion at the beginning of the report).

5 The shaping and embedding of environmental management in product chains

In this chapter, the different type of environmental initiatives in product chains, which were presented in chapter 4 as a typology, is analysed as change processes. The analysis of the single initiative is based on an analysis of the different cases, which are referred to that type of environmental initiative. The analysis of the single cases includes a description of the activities and the organisational and environmental impact of the activities. Furthermore, the conditions for the embedding and diffusion of these activities are discussed.

5.1 LCA-activities including collection of data from the suppliers

LCA-activities is here understood as activities concerning: 1) Collecting environmental data about the product or the products in the supply chain or in the whole product lifecycle, 2) Environmental assessment on basis of the collected data, 3) Actions against a background of the environmental assessment.

This description is based on analysis of five companies, who have included LCA-activities in their environmental work.

5.1.1 Activities and impact

The experiences from the analysis show that the most common reasons why the companies carry out LCA-activities are customer demand or expected customer demand about environmental data. For companies who already have environmental management systems, the environmental management system seems to influence the decision about using LCA as the method to collect and assess the environmental data to meet the customer demand.

The table below gives an overview of the activities of the five companies and the effects of the activities on the organisation and the reduction on the environmental impact

Sector Company size	LCA activities	Organisational change	Change in environmental impact
Paint manufac-turer 200 employees	Involvement of suppliers and the customer to participate in a LCA-project Completion of a course about LCA method for the participants Collection of data in the supply chain Assessment of collected data	Increased co-operation between the company and the customer, (it was difficult to engage the suppliers in the project). Knowledge about LCA-method in the company and by the	The purpose was to make an environmental product declaration. Due to lack in the collected data, the companies decided to try to achieve an eco-label for their product. In this process they had to improve some of their production processes.

		others participants	
Textile manufac-turer 156 employees	Collection of data from suppliers with assistance from a consultant Assessment of the collected data with assistance from a consultant, Formulated demands to the suppliers.	Procedures for environmental focus on the product in the existing environmental management system.	Phase out of lead in the product.
Electronic product manufac-turer 750 employees	Development of a database with information of material content. Development of guidelines for product development and purchase. Development of guidelines for disassembly the end-of-life products. Distribution of material declarations and disassembly guidelines together with products to customers.	Integration of environmental guidelines in the existing procedures for product development and purchase.	This could contribute to production of cleaner products.
Building material 600 employees	Participation in making an environmental product declaration for a specified product group organised by the industry association. The participants collected data from activities within their own companies. A consultant collected data from all participating companies and complemented with data from literature etc. The consultant worked out a PC-tool, which the companies can use for making environmental product declaration.	Knowledge about environmental aspects in relation to their own production. Possibilities for comparing products. Possibilities for comparing the environmental profile for the same product manufactured at different sites within the company. The company uses this tool to focus on potentials for improvements.	This could contribute to spread cleaner products, as It makes it possible for customers to choose cleaner solutions/products This contributes to spread cleaner processes within the company.
Electropla-ting company 6 employees	Establishing of co-operation in the product chain. Selection of a product as an. example. Preparation of a flow diagram for the product's lifecycle. The flow diagram was based on the participants homework and meeting round a table. Assessment of the products environmental impact with assistance from a consultant.	Knowledge about the products environmental impact in the company and the rest of the product chain. Closer relation to suppliers and customer	Maybe none, maybe input to developing cleaner products

5.1.2 Conditions for the initiative in product chains

LCA activities can contribute to both development of organisational capacity to develop the environmental management into a product perspective and to reduce environmental impact. The experiences from the activities on the

companies from this investigation are, as shown in the previous table, that LCA activities can:

- Increase the companies' insight in the environmental properties of the product including the manufacturing of the product.
- Contribute to an increased knowledge about methods to work with environment in a product perspective.
- Promote development of the companies' procedures to keep an environmental focus on the product by, for example, integrating environmental guidelines in the existing procedures for product development or by integrating procedures for environmental focus on the product in the existing environmental management system.
- Contribute to develop the relations in the product chain to include environmental considerations about the product.
- Contribute to developing cleaner products, including cleaner processes, substitution and changes in the products.
- Contribute to diffusion of cleaner products on the market.

The experiences show some circumstances that need to be in focus when analysing LCA activities in companies.

LCA activities demand many resources in relation to economy, competence and time. The cases show that both large and small companies can promote the environmental focus on the product in the product chain by carrying out LCA activities. Important conditions to provide success seem to be adjustment of the use of the companies' resources. For the small company important conditions for realising the activities were financial support, local/national suppliers and customers, which made it possible in an easy way to meet and shape an overview, together with consultant support to the environmental assessment of the collected data. For the large companies important conditions were financial support and accordance between the choice of course of action and the internal long-term program. There were differences between the large companies' choice of course of action. It seems to be important to reflect, if the competences to carry out a LCA on the companies' products have to be built up in the company or in the companies' network by the consultants. This influenced the companies' choice of consultant support. The central point is not where the competence is building up, but it seems to be very important that the companies develop procedures in the companies to secure continuous maintenance of the data etc. and to follow-up the LCA activities with decisions and actions.

Completion of a LCA has to be an iterative process, where means and targets are adjusted all the time to the possibilities, which arise in the process. There is a big uncertainty connected to the collecting of data, as the collecting of data involves many suppliers. Even for large companies it is difficult to collect environmental data. Therefore it can be necessary to adjust both the way the collecting of data is done and the ambition of the activity. An example is the large chemical company, which had to adjust the ambition from making an environmental declaration to get the product eco-labelled. The cases show that even though the means and target are adjusted in the process, the LCA activities increase the environmental focus on the product in the product chain and reduce the environmental impact.

When LCA activities are going to lead to environmental focus in the product development, it is important that the core company is close to the end product. For instance, the company can be supplier to an end manufacturer

or be the end manufacturer itself. To be able to integrate an environmental focus in the product development process, real possibilities to influence the choices in the product development process are necessary. The large electronic company is an example of a company, where the possibility to develop a guideline for the development activities is present, because the company has its own development section.

When the LCA is carried out as a trade effort it is still important that the participants from the companies feel an ownership to the project. The experiences from the large building company shows, when the environmental employees are able to see the advantages in the developed tools the tools will be used. Otherwise, the results from a trade effort may be lost. In the building company the tool was not used until an interested environmental employee began systematically to use the tool to compare the environmental profile for the same product manufactured at different sites within the company. In this way, he could identify potentials for improvements.

In relation to a regulatory perspective, the experiences point at:
- LCA activities demand legislative requirement, which can motivate the customers or the end manufactures to set up demands upstream in the supply chain.
- Carrying out LCA activities is an iterative process, which demands many resources and flexibility for adjusting means and target on the way. It is therefore necessary that there are possibilities for financial support together with flexible frames for the projects.
- Development in the frame conditions for the companies, as for example implementation of EMAS and ISO 14001, increase the companies' possibilities for choosing LCA as the method, but increase also the possibilities to embed the results from the analysis and secure the follow-up processes

5.2 Environmental information to customers

5.2.1 Activities and impact

Environmental information to customers is here understood as different types of information activities to customers about the environmental properties of the product and /or environmental aspects in connection to the company's activities. This description is based on analysis of eight companies, who have all included information activities in their environmental work.

The experiences from the analysis show that the most common reasons why the companies carry out information activities concerning environmental issues are:

- To satisfy customers' demand. The background of the customers' demands are national and international legislation or expectation of green demand
- To differentiate the company on the market by making the company's environmental profile visible
- Public attention to the area

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The table below gives an overview of the eight companies with respect to their activities and the effects of the activities on the organisation and the reduction of the environmental impact

Sector Company size	Information to customers	Organisational change	Change in environmental impacts
Production of nappies and sanitation products Medium	Eco-label Participate in developing a portal for public customers	Co-operation between the sales-, quality- and environmental department, Broader advising in connection to the use situation	Spreading of labelled nappies on the market
Handling and distribution of chemicals 3000 employees in total Multinational company	Answer questions Forward green account to customers, who ask for it. Ad hoc co-operation about developing cleaner products	More focus on projects in co-operation with customer and suppliers about developing cleaner products. Auditing customers	Lesser risk (more safety transport), Lesser waste (more drain of container),
Electronic product manufacturer 750 employees	Distribute material-declarations and disassemble guidelines together with products, Answer questions	New routines in connection to the development of new products and by purchase	Substitution of critical materials
Plastic product manufacturer Medium-size	Annual customer audit, Distribute environmental standards together with products		
Electroplating company 6 employees	Concept of customer dialogue	Knowledge about environmental impact in the product chain Closer relation to suppliers and customer	Maybe none, maybe input to developing cleaner products
Transportation 30,000 employees	Interactive program on homepage, which can calculate the environmental impact of transportation, Answer questions	The sales department use the tool	No information about change reported
Packaging manufacturer Large Multinational company	Environmental declaration, Advise the customer about the best solution, Training activities for the customers Participate in projects	Sales work has been multidisciplinary New division existing of 3 sections: Environment, Human resource, and Dialog	Better environmental solutions by the customer,
Printing company 85 employees	Environmental label Advise the customers about the best solution,		Maybe better environmental solutions for the customer

5.2.2 Conditions for the initiative in product chains

The companies, who work with environmental information to customers, are all placed in the middle of a product chain so they both have suppliers and customers. The customer relation is a business-to-business relation. The most important drivers for companies to work with environmental information to their customers are demand from their customers for environmental information. The common reason for the demand is national or international legislation concerning different aspects of the end product or to the condition for the production processes. It is for example demands for the packaging, the product it self, to the disposal of the product after use or demands in connection to documentation or green account.

The cases show two different types of environmental information to customers:
- Information about environmental aspects for the company itself or the environmental characteristics for a specific product in terms of an eco-label or an environmental product declaration. This information addresses a need specified by the customer.
- Information that is supposed to influence and develop the customer to choose more environmentally friendly products. This could for example be in terms of advising or by a joint development project.

Information that addresses a specific need from a customer will often imply a demand to the supplying company itself to supply information. This could be the occasion of procedures in the company and downstream in the product chain that can throw light on the environmental aspects of the company and/or its products. This could also promote relations between different functions within the company and between the company and its suppliers.

The largest effect of the advising activities is with the customer. This type of activity will supply new knowledge and develop the organisational skills to deal with environmental aspects. Furthermore, the customers' choice of products could reduce the environmental impact from the product. The cases show that companies working with environmental information as an advising activity towards their customers, all belongs to trades where environmental issues have been in focus for a substantial number of years. These companies have a long history of environmental activities including implemented environmental management system.

In relation to a regulatory perspective, the experiences point at:
- Requirements for documentation etc. are of relevance as it promotes the customer demands for environmental information. It can support procedures upstream in the product chain, when the suppliers face the demands to generate the information.

- It seems like the companies need some resources to build up competence within their own organisation and upstream in the supply chain before they can influence the customers in a more environmentally friendly way.

- Use of environmental management system, eco-labels etc. within a product area seems to create new conditions for the environmental

activities within this area. When several companies have implemented environmental management system or achieved an eco-label it is no longer questioned among these companies if they should have control of their environmental aspects or if they should achieve the eco-label.

5.3 Green procurement policy or strategy

5.3.1 Description of the activities and impacts

Green procurement policy or strategy has been defined as companies, private as well as public, who have a general policy of favouring products with better environmental performance than their competitors. A circular from 1995 states that state institutions must consider the environmental and energy impacts in their procurement policy and consumption, whereas green procurement strategies in private companies are initiated on company basis. Two very different companies have been identified in this category: The Danish State-owned Railway Company (DSB) with several thousand employees and the small company Dan-Rens A/S with 9 employees. The table below gives an overview of the two companies with respect to their activities and the effects of the activities on the organisation and the reduction of the environmental impact.

Company	Activities	Organisational changes	Change in environmental impact
DSB Danish State-owned Railway Company Large	Demands to suppliers 'Green' assessment of tenders and supplies	Building of internal organisational procedures for handling the green procurement strategy and introduction of various environmental management schemes	Substitution of a large number of products
Dan-Rens A/S Distribution and sale of chemicals 9 employees	Incorporation of environmental requests in procurement policy	Building of internal organisational procedures for handling the green procurement strategy and implementation of green accounting	Not possible to see from the case material

5.3.2 Conditions for the initiative in product chains

Both companies initiated the green procurement policy "on top" of other environmental initiatives in the company. The circular on a state policy on green procurement is referred to have spurred the green procurement policy in the Danish State-owned Railway Company (DSB), though explicit initiatives had already been taken from 1992. The green procurement strategy in Dan-Rens A/S was spurred by resources from the Ministry of the Environment's 'environmental competence' programme.

Both companies have built up an internal organisation with environmental competencies for assessing the environmental aspects of their procurement and with responsibility for the environmental activities. As part of the environmental activities, both companies have made use of life cycle

assessments and environmental management system in Dan-Rens A/S is furthermore ISO 14001 certified and registered according to EMAS.

The green procurement activities are thus - in the case of DSB with "help" from the circular - to a large extent initiated and dependent on activities in the case company. If the purchased green products are not price comparative with alternative products, the extra costs have to be financed by the company itself. However, in the case of DSB, it is said that the green products often have the same price as the less environmentally friendly alternative, whereas Dan-Rens A/S refers to the more environmentally friendly alternatives as more expensive.

In DSB the green procurement strategy is referred to have changed the product portfolio in an environmental friendly direction, and the case description refers to the substitution of some of their toxic products, amongst other PVC containing products. A larger consciousness and knowledge on the contents of products has been obtained in Dan-Rens A/S, but a greener product portfolio is not mentioned.

To some extent, it is tempting to explain the apparent larger effect of green purchasing in DSB than in Dan-Rens A/S as related to its size or the monopoly situation giving less price competition, the role as a very large customer for many of its suppliers and a company with large investments.

The monopoly situation is, however, only a relevant aspect, if there is a strong internal environmental agenda, otherwise profits should be as relevant as for a market with competing companies. More important is the role of DSB as a large customer, which is referred to as conducive for suppliers' interest in meeting environmental requests. The size and time horizon of a large part of DSB's investments could further make environmental considerations an important consideration, especially in combination with the statement from DSB, that green procurement seldom is more expensive.

Adding to the role of company size for the capability to assess the environmental impacts, are the difficulties of the smaller suppliers of Dan-Rens A/S to meet Dan-Rens A/S's requirements.

Despite the minor success for Dan-Rens A/S, the green procurement strategy and other environmental initiatives are still seen as a potential advantage in the coming years by Dan-Rens A/S. The company still hopes to be able to market its green profile, although the green procurement among Dan-Rens A/S's customers is not as big as hoped.

5.4   Recovery of materials and products

5.4.1   Activities and impact

Recovery of materials and products is here understood as activities concerning recovery of materials from the production, establishing return systems for end-of-life products for recovery and preparation of disassembly guidelines to end-of-life products.

This description is based on analysis of three companies, who have included recovery activities in their environmental work.

The experiences from the analysis show that the most common reasons for the companies to carry out activities concerning recovery are:

- To reduce costs for raw materials and waste disposal,
- To make equal conditions for the companies in the branch,
- To satisfy customers' demands,

The table below gives an overview over the three companies with respect to their activities and the effects of the activities on the organisation and the reduction of the environmental impact

Sector Company size	Recovery activities	Organisational change	Change in environmental impact
Plastic product manufacturer Medium-size	Recycling of waste from own production. Recovery of waste from customers, who return defect products etc.	Procedure for recovery. This include preparation of demands of quality for the recovery material and control arrangement in connection to delivering the recovery material	This contributes to a reduction in use of raw material and reduction of waste disposal
Building materials Large	Establishing of co-operation in the branch about a return system for the end-of life products. This include 1) involvement of the other company in the branch 2) Putting forward quality parameters for the returned material, and 3) Establishing of agreement with waste companies and the municipalities, who are the responsible for the waste disposal in Denmark	Procures for and agreement about how to drive a branch return system in Denmark between relevant actors (companies, waste companies and municipalities	This contributes to a reduction in use of raw material and reduction of waste disposal
Electronic product manufacturer 750 employees	Developed a database with material information. Contact to recovery companies to get information about problematic aspects in connection to disassemble the products. Developed a disassemble guidelines, which follow the products	Knowledge in the company about problems in relation to disassembling their products.

Integration of environmental guidelines in the existing procedures for product development and purchase | This could contribute to better conditions for disassembling the products by the customer

This could contribute to production of cleaner products |

5.4.2 Conditions for the initiative in product chains

An effort for recovery of materials and products can contribute to both development of organisational capacity to develop the environmental management into a product perspective and to reduce environmental impact. The experiences from the activities in the companies from these cases are, as shown in the previous table, that the efforts can:

- Increase the companies' insight in materials and components used in products, the possibilities for recovery of materials and problems connected to disassembly of end-of-life products.

- Contribute to develop procedures for recovery of materials from the production, the suppliers and the customers. This includes preparation of quality demands for the recovered materials and control arrangement in connection to the delivery of the recovered material.

- Contribute to develop relations between companies in a product chain, between companies and disassembly companies, and between relevant actors in a broader network. In the example about the branch

return system the relevant actors were the companies in the branch, waste companies and municipalities.

- Contribute to reduce the consumption of raw materials and production of waste in the products life cycle.

- Contribute to develop better possibilities for disassembling end-of life products.

- Contribute to develop cleaner products.

The experiences show some circumstances that need to be in focus when analysing recovery of materials and products in companies.

It is very different in different companies/sectors how simple it is to recover materials in the product chain.

In relation to a regulatory perspective, the experiences point at:
- Companies' activities in relation to recovery and disassembly of end-of-life products are in close interaction with legislative requirements. For companies in trades, where it is possible directly to use the waste or the end-of-life products in the production, the cost of waste treatment have facilitated the development of infrastructure for recovery. The company, which could not directly recover their end-of-life products the expected requirement to producer responsibility, had a motivating effect for developing disassembly guidelines etc. In most cases, the requirements to the companies come from the customers.

- Recovery of waste and end-of-life products requires an infrastructure is established. There will be different needs for different product areas. This will depend on where the products are marketed, homogeneity of the product mix, the complexity of the products etc. It could require many economic resources to establish an infrastructure to handle the recovery in either a product chain or a wider network in order to determine technical possibilities, economy, responsibility, co-ordination etc.

Development in the business conditions of the companies, e.g. for implementation of environmental management, can facilitate the possibilities for handling recovery. This can also support the integration of the experiences from the recovery activities in other company procedures, e.g. procedures for product development. In the individual company, reuse in the production processes requires quality procedures to ensure the quality. The experience from one case company without an environmental management system is that it expects to establish an environmental management system and later replace the existing control procedures (in – and out controls) with supplier management. The experience from the large electronic company is that an environmental management system ensures that the experiences and results from the activities are integrated in the company procedures for product development.

5.5 Supplier assessment and dialogue

5.5.1 Activities and impact

The activities within supplier assessment and dialogue show different activities:
- Assessment of suppliers based on data from the supplier about their environmental performance
- Development of more formalised supply chain management systems
- Joint development projects between supplier and customer.

The five cases focus on supplier assessment and dialogue from five different branches: packaging, textiles, wooden products, construction and distribution of chemicals. The table below gives an overview of the five companies with respect to their activities and the effects of the activities on the organisation and the reduction of the environmental impact.

Sector Company size	Supplier-oriented activities	Organisational change	Change in environmental impact
Packaging manufac-turer Large Multinatio-nal company	Development of supply chain management (SCM) system based on questionnaires and training of own purchasers	Development of SCM based on the focal areas in the EMS Binding relationship by having the suppliers sign the questionnaires	Not described Focus on suppliers without EMS because the biggest environmental improvement is expected thereby
Textile manufac-turer 50 employees	Development of private green brand Development of supply chain management (SCM) system to ensure the credibility of private brand based on annual meeting with suppliers At a later stage joining branch campaign on EU eco-label on some products	SCM system gives overview of the environmental performance of the suppliers. The dialogue with the suppliers gives ideas for new issues and targets in the SCM system. Integrating public eco-label as part of the private brand strategy Some customers choose not to have the products eco-labelled due to the eco-label fee	Substitution of pesticides by using organic cotton Some textile production chemicals substituted
Playing ground tool manufac-turer 500 employees	Development of supply chain management practice as part of ISO 14001	Supplier assessment through questionnaires Integration of environmental dimension into strategic supplier relations	Substitution of PVC Substitution of heavy metal in paint Sustainable harvested wood
Contractor Large Multinatio-nal company	Development of supply chain management	Environmental friendly projecting Chemical database Integration into contracts Quality and environment plan	Recycling of gypsum waste from the construction sites A number of chemicals banned

		Inspections and audits	
Handling and distribution of chemicals 3000 employees in total Multinational company	Development of supply chain management, partly initiated by large chemical supplier as part of a extended producer responsibility strategy	Supply chain management scheme Auditing of suppliers and customers	Reduced chemical spillage and waste Improved efficiency of transportation

5.5.2 Conditions for the initiative in product chains

Two of the cases focus primarily on supplier assessments based on questionnaires. In both cases the suppliers seem to be interested in a more dialogue-based approach so that they know how the customer actually assess them based on the provided information and how they as supplier might improve their practice.
One case is based on a PC-based supply chain management tool, which integrates concerns for quality, environment and work environment (occupational health and safety). This system is dialogue-based, which helps the core company as a customer to find ideas for future focal points in the supply management system from the dialogue with the different suppliers. The scores are made public within the group of suppliers, which make some of them contact the customer to find out how they can improve their environmental performance, when they see that other suppliers score higher than they do.

One case is based on integration of environmental aspects into business contracts and project plans. The company has developed its own strategy for which chemicals not to accept. The strategy is partly based on a branch database developed, which the company has developed further. This company offers the suppliers dialogue around how they can improve their environmental performance and integrate environmental aspects into their project plans, if they are not able to develop sufficient good plans.

In most cases the mutual benefit and mutual importance of supplier and customer to each other is important for the supply chain management strategy. In several of the cases less control of strategic suppliers is seen, because the relationship is more based on trust developed through previous business relations and in some cases joint development projects. In some cases, the companies are not able to influence the relationship to some of the suppliers very much, either because the company is not important to the supplier or because the customer-supplier relationship is decided by a mother company, for example through long term business contracts about supply of certain raw material.

Seen from a regulatory point of view, support to the development of dialogue-based supply chain management could enable a more dynamic supplier-customer relationship, where the suppliers become more interested in improving their own performance or in joint development projects. Support to the development and implementation of tools for this kind of co-operation could be valuable, like it has been done in relation to tools for environmental

conscious projecting, which the contractor company seems to be using as part of their supply chain management.

5.6   Greening of product development

5.6.1   Activities and impacts

The focus in greening of product development as initiative is on "in house" resource reduction and substitution of specific materials or chemicals. Other parts of the supply chain may supply altered inputs as part of a greening of the product. Five cases include greening of product development. The table below gives an overview of the activities of the five companies and the effects of the activities on the organisation and the reduction on the environmental impact

Company	Product greening activities	Organisational changes	Change in environmental impact
Berendsen Textile Service Textile laundry service 1400 employees	Implementation of dispensers (for washing powder) Standardisation of washing procedures (Washing programmes, dispensing, choice of washing powder)	Joint development projects with suppliers Buying contracts Information of and at laundries Joint development with suppliers and customers of a further reduction in the environmental impact of washing and cleaning	Reduction in the use of washing powder with up to 20% Plans for reduction/substitution of certain agents (e.g. LAS)
Akzo Nobel Deco Paint manufacturer 400 employees Part of multinational company	Out-phasing of APEO and other unwanted agents	Dialogue with suppliers and with BST about additives. "Product steward" programme to collect demands/requests.	Reduction of APEOs with 90%
Phønix Trykkeriet A/S Graphic industry 73 employees (and Kontrapunkt 40 employees))	Phasing out of certain additives Reduction of resources (reduction of paper by choosing standard formats, reduction of colourants by using less colourful designs) Improved logistics (to reduce resources)	Information exchange between the two companies Implementation of eco-label and extension of the environmental profile	Potentially resource reducing (knowledge and awareness of how it can be done) Certain chemicals out-phased
Trevira Neckelmann A/S Synthetic yarn manufacturer 650 employees	Development of a thermo-stabile, biodegradable oil without NPE	5 environmental specialists Environmental education of employees Stationing of one of the environmental specialists at the supplier	Development of a thermo-stabile, biodegradable oil without NPE, and a extension of co-operation
Bambo	Reduction of synthetic	Co-operation with the	Reduction of synthetic

Nappy and sanitation products 300 employees	super absorbers in the fluff. (Better exploitation of the wood fibres in fluff production)	suppliers Eco-label, but assessed not to be recognised	super absorbers in the fluff. (Better exploitation of the wood fibres in fluff production) Further development of a wetness indicator to reduce no. of diaper changes

5.6.2 Conditions for the initiative in product chains

The product focus has a lot of focus on substitution initiatives, for example substitution of chemicals, which are known as hormone disrupters. The focus is on specific substances, like heavy metals, and on more complex chemical substances and products, like colorants and oils. In the nappy and sanitation product company, Bambo, resource reduction has been the focus of the product development activities, combined with substitution of materials.

The initiatives for a greening of product development were taken by company management, by individual (environmental) departments or by groups of employees. In one case, two companies jointly took the initiative. In addition, companies refer to supplier cooperation and dialogue as important for the companies' greening of product development.

Though companies took the initiatives, company external actors or factors raised the demand for greening or were expected to demand greener products. The request for substitution of chemicals with environmental or health effects were raised by:
- Customers under regulation (primarily foreign customers)
- Customers who expected regulation or who were expected to be under a green procurement profile or policy (a government circular from 1996 have introduced a green procurement policy in state and municipalities)
- Customers who wanted a green procurement strategy

Only in one case (Phønix Trykkeriet A/S), the activities were supported by public funding. In the other cases, prices and potentially higher market shares were expected to finance the activities. In the case of Phønix Trykkeriet A/S, the companys' product development strategy is referred to have been marketing oriented and the company under competitive pressure, whereas customer pressure and regulation were drivers for the four other companies. Public support could therefore be seen as a contributor to a green development, which is more vulnerable and risky, than a green development as response to customer demand or obligatory regulation.

With regard to the environmental effect, greener products were developed in four of the cases. In the fifth case, a basis for greener products was developed, but design and economic considerations may overrule the green agenda in the actual production. The greening activities have, as earlier mentioned, largely been substitution of unwanted substances: The chain perspective has been important for raising these issues, but a chain perspective on the greening is much less prevalent from the cases. Berendsen A/S is however an exception.

The very strong dependency between the different joints in the Berendsen product service chain may be an explanation for the 'chain greening' compared to product greening. Very strong commitments have been made between the companies in the chain, which has contributed to maintain the greening agenda; also the dominant role of one customer seems to have been decisive for this green agenda.

In the other cases, the customer demands and the regulatory obligations were conducive to the greening of the products. Both existing and new supplier cooperation contribute to keep green development on the agenda. The customers in these cases are however more varied, and therefore the green products do not necessarily have a broad customer base, except for the initial "green customer".

5.7 Eco-labelling

5.7.1 Activities and impact

The cases cover companies using public eco-labels or private green product brands as part of their environmental strategy. The cases cover seven companies at different stages of the eco-labelling process:
- A company in the beginning of the eco-labelling process,
- A company being asked to supply data to a customer as part of the customer's attempt to obtain an eco-label,
- Three cases with companies going through the eco-labelling process,
- A company with its own private green product brand and later joining a branch campaign on eco-labelling,
- Two cases with companies in a branch where eco-labelling is a common element of the environmental strategy.

The table below gives an overview of the eight companies with respect to their activities and the effects of the activities on the organisation and the reduction of the environmental impact.

Sector Company size	Activities related to eco-labelling	Organisational change	Change in environmental impact
Paint manufac-turer 200 employees	Attempt to make LCA on product fails due to lack of data from suppliers Based on the experience one customer decides to try getting furniture products eco-labelled	Company and customer agree to investigate the identified hot spots to see if it is possible to obtain eco-label on some of the customer's products	No environmental impact reported
Textile service company 1400 employees Detergent manufac-turer 4500 employees	Asked by strategic important customer to use eco-labelled detergents Co-operation with the strategic supplier about environmentally improved detergents. Different eco-label criteria used as guidance in the	Textile service company and detergent supplier agree to have frequent dialogue to keep a dynamic relationship in their long term business agreement	Reduced consumption of detergents due to improved equipment Substitution of some chemicals in the detergents

	product development		
Textile manufac-turer 50 employees	Development of private green brand Development of supply chain management (SCM) system to ensure the credibility of private brand based on annual meeting with suppliers At a later stage joining branch campaign on EU eco-label on some products	SCM system gives overview of the environmental performance of the suppliers. The dialogue with the suppliers gives ideas for new issues and targets in the SCM system. Integrating public eco-label as part of the private brand strategy Some customers choose not to have the products eco-labelled due to the eco-label fee	Substitution of pesticides by using organic cotton Some textile production chemicals substituted
Printing company 73 employees Graphic design company 40 employees	Development of product concept based on integrated graphic design and printing programmes for publications etc. based on the environmental standards of the printing company	Strategic alliance between the companies in order for the printing company to position itself among the other 'greener' printing companies Procedures for environmental considerations in the design phase Printing company gets sales office in the graphic design company's facilities	Environmental achievements unclear, since the procedures do not imply that the most environmental solution always is chosen due to quality demands from the customer
Furniture distributor and furniture manufac-turers Small-medium size	Joint development of product line of eco-labelled furniture for governmental institutions	Some of the suppliers want to implement ISO 14001 themselves	Yet no sale of the eco-labelled furniture due to the price focus of the potential public customers Some spin-off in one of the companies as reduced energy consumption based on a survey made as basis for focusing the product development
Synthetic yarn manufac-turer 650 employees Part of multinational company	Supplying data as sub-supplier to customer who wants eco-label on products Development of bio-degradable yarn oil based on customer demand	Own EMS makes it easy to collect and supply data to customer about own and suppliers' performance	Bigger market for bio-degradable yarn oil since it fulfils the EU eco-label criteria
Printing company 85 employees	Eco-labelling as part of market strategy	Dialogue with governmental purchasers about eco-labelling Customers can choose not to have the products eco-labelled, which some customers do because of the eco-label fee	Eco-labelled product quality as the ordinary product quality

Detergent manufac-turer 250 employees in Denmark Cleaning service company 16000 in Denmark 250000 worldwide Both multinatio-nal companies	Global strategic co-operation about detergents for professional cleaning Development of product assortment	Co-operation between the companies based on new relation between chemists and technicians in stead of sales persons and purchasers Supplier member of cleaning company's technical committee	Unclear whether there is bigger sale of the eco-labelled detergents

5.7.2   Conditions for the initiative in product chains

The cases show three different roles eco-labelling can have:
- Eco-labelling as a not so data-demanding strategy in relation to supply chain management
- Eco-label criteria as guidance in product development without developing eco-labelled products
- Eco-labelling as market strategy for products focusing especially on the market for public green procurement.

The company, which is asked as supplier by a customer to collect data, because a customer further down the product chain wants to obtain an eco-label, experience that the routines for data collection developed as part of their ISO 14001 certification makes it easy to collect the necessary data. This case shows also interaction with another activity in the company. The company is asked to supply another yarn oil, because the ordinary does not live up to the eco-label criteria. They are able to supply another oil company because they for another customer had developed more biodegradable oil.

Two cases deal with companies in a branch, where eco-labelling has become a standard offer to governmental customers, why they decide to position themselves further in relation to this part of the branch (printing for governmental institutions and for stakeholder organisations). In one case, the printing company develops a strategic partnership with a graphic designer company in order to attract governmental institutions, stakeholder organisations and front-runner companies by offering a full design and printing program of their written materials. The other case shows a printing company, which develops its dialogue with the governmental customers in order to enhance their knowledge about environmental aspects of printing so they prefer to have printing done in eco-label quality.

Public green procurement seems to be an important driving force for eco-labelling. The experience with eco-labelling in relation to public green procurement shows, however, that governmental institutions often – or at least sometimes – choose to buy the cheapest products and not the most environmental friendly products. Within printed materials, however, it seems as eco-labelling is functioning as a strategy within public green procurement.

Another barrier is the eco-label fee, which companies selling eco-labelling products have to pay to the national eco-labelling secretariat. If the manufacturing company choose to put this fee on the top of the price (0.15 – 0.4 %, depending on the type of eco-label) it seems as it might prevent companies from buying the products. They might in stead prefer a product of the same quality, but without the label. This implies that the environmental impact from eco-labelling might be bigger than can be assumed from the sales figures for eco-labelled products. However, the lack of eco-label on products of eco-labelled quality implies also that these products are not functioning as a visible "advertisement" for the eco-labels among professional customers and households.

Two cases show that the quality of eco-labelled products (detergents and printed goods) in some cases might be different from the quality of "ordinary" products, which make some customers prefer the ordinary products. This could imply that it is important to organize dialogue with users about their perception of good quality as part of the development and sales activities.

5.8   Strategic co-operation

5.8.1   Activities and impact

Strategic co-operation as part of environmental management in product chains is understood as long-term business or network relations, which are based on environmentally improved products and services. Four of the five cases focus on the co-operation between two or more companies in a product chain and one case is a partly public funded centre with companies, consultancy companies and universities within the same product area (concrete constructions). In all the cases it seems as the environmental aspect is integrated into already existing business relations, including the partly public funded centre. All the cases concern development of environmentally improved products and services.

The table below gives an overview of the five companies with respect to their activities and the effects of the activities on the organisation and the reduction of the environmental impact.

Sector Company size	Initiatives	Organisational change	Change in environmental impact
Printing company 73 employees Graphic design company 40 employees	Development of product concept based on graphic design programmes for publications etc.	Strategic alliance between the companies in order for the printing company to position itself among the other 'greener' printing companies Procedures for environmental considerations in the design phase	Environmental achievements unclear
Furniture distributor and furniture manufacturers Small-medium size	Joint development of product line of eco-labelled furniture for governmental institutions	Some of the suppliers want to implement ISO 14001 themselves	Yet no orders on the eco-labelled furniture due to the price focus of the customers Some spin-off as

			reduced energy consumption
Detergent manufacturer 250 employees in Denmark Cleaning service company 16000 in Denmark 250000 worldwide Both multinational companies	Global strategic co-operation about detergents for professional cleaning Development of product assortment	Co-operation between the companies based on new relation between chemists and technicians in stead of sales persons and purchasers Supplier member of cleaning company's technical committee	Unclear whether there is bigger sale of the eco-labelled detergents
Actors within concrete constructions: production, R&D, governmental agency	Forming a R&D project consortium with focus on environmental improvements	Systematic dialogue about results and experience Concrete industry to co-operate on environmental declarations	(Guidelines for) resource savings through the use of waste material as raw material
Textile service company 1400 employees Detergent manufacturer 4500 employees Hotel chain 7000 employees All multinational companies	Asked by strategic important customer to use eco-labelled detergents Co-operation with the strategic supplier about environmentally improved detergents. Different eco-label criteria used as guidance in the product development	Textile service company and detergent supplier agree to have frequent dialogue to keep a dynamic relationship in their long term business agreement	Reduced consumption of detergents due to improved equipment Substitution of some chemicals in the detergents

5.8.2 Conditions for the initiative in product chains

In all but one case, the focus is on environmentally improved products and services. The case about the printing company and the development of strategic co-operation with a graphic design company focuses on implementation of procedures in the design company, which *considers* the possibilities for environmental concern as part of the design of the graphic products. These procedures are based on the production methods the printing company uses. The strategic co-operation with the design company implies, however, that quality demand from the customers might imply that these environmentally improved production methods might not be used every time, but environmental concerns seem to become more systematically addressed in the dialogue with potential customers in the design company.

All cases are to some extent market driven. One case is driven by a demand from a strategic customer, while two cases are driven by the assumption that environmentally improved products will give better market opportunities in the future (furniture and cleaning service). One case can be characterised as a market strategy in an environmentally mature branch. In the case about the strategic co-operation between the printing company and the graphic design company, the initiative seems to have been taken by this rather environmentally pro-active printing company in order to strengthen its position, compared to other environmentally pro-active printing companies. Since also these companies have implemented ISO 14001 and have eco-labelled printed goods as an important part of the market strategy, it is necessary for the case company to develop its environmental strategy further

and the company chooses to focus on strategic co-operation and a more specific market segment of more environmentally conscious companies and stakeholder organisations.

In a case involving multinational companies, the Nordic market conditions are referred as quite different from other countries, which give problems transferring the environmentally improved cleaning concept to the other parts of the two companies' markets (detergent manufacturer and cleaning service), while this does not seem to be a problem in the textile service case.

The cases show some organisational changes in the relations between the companies as part of the strategic co-operation. The printing company gets a sales office in the design company probably because this makes it easier to have a dialogue with the customers about the possibilities for integrating environmental concern into the design process. The detergent manufacturer and the cleaning service company have developed a relationship between detergent chemists and cleaning technicians. This shows that a change to more environmental friendly products and services might imply that new competencies are necessary in the relation between supplier and customer. The centre, which focuses on concrete constructions, can be characterised as a strategic organisational structure at branch level, which aims at developing guidelines for resource savings and use of waste products as part of the cement in concrete constructions. The participants expect that these guidelines might be the future guidelines within the sector and are therefore interested in participating in the centre.

In all cases at least one of the involved companies is ISO 14001 certified. In one of the cases, the focus on products seems to be inspired by the ISO 14001 certification, while the other cases do not mention the role of ISO 1400. Seen from a regulatory point of view support for the development of a product focus in ISO 14001 could be a strategy for disseminating a product-oriented environmental policy in companies. In two of the cases, where the focus especially is on the market for public green procurement, the companies do not succeed in actually finding a market for their products. In one of these cases price seems to be more important and in the other case the quality of the environmentally improved products seems not to convince the public customers. The detergent manufacturer in the latter case decides therefore to focus more on the fact that the new cleaning concept is cheaper, due its reduced consumption of detergents and water. More focus on support for the implementation of green public procurement in governmental institutions could be a regulatory strategy.

6 The environmental and organisational focus and impacts of environmental management in product chains

This chapter analyses the environmental and organisational focus and impacts across the analyses of the different initiatives in product chains in chapter 5. The aim of the analysis of the environmental impacts is to see whether there is a positive environmental impact from the different initiatives, the type of the environmental impact in focuss, and where in the product chains the reduction of environmental impacts are obtained.

The analysis focuses on

- the time perspective of the environmental initiatives and the impacts (whether they are short or long term oriented),
- the role of preventive measures like cleaner products and technologies (compared to for example end-of-pipe initiatives like waste management)
- the degree of holistic perspective (whether there is focus on for example the relation between environmental initiative and product quality)
- the changes in different types of environmental impacts (whether the focus is on reduction of the resource consumption, reduced emissions of greenhouse gasses etc.)

The analysis of the organisational focus and impact aims at identifying organisational structures, which have influenced the shaping of the initiatives, and organisational changes, which show that the initiatives have become embedded in some of the involved organisations. The analysis of the organisational embedding focuses on whether the initiatives seems to become embedded in terms of changes in tasks/activities, structures, competencies, tools and technologies etc., and where in the product chains or other types of networks such changes are seen.

6.1 Environmental focus and impacts of the initiatives

It is not possible in all the analysed cases to say whether reductions in environmental impact actually have been obtained due to the initiative. Some cases are more a description of initiatives without a report on the actual impact, for example whether customers actually choose to buy some cleaner products. Other cases are only reporting better knowledge about environmental impact of products as a result. Table 6.1 gives an overview of the actual and the potential reductions of environmental impact

Environmental initiative/ management effort	Changes in environmental aspects and impacts
Life cycle assessment	Reduction of electricity consumption and consumption of chlorinated solvent in manufacturing process Phasing-out the use of chemical with heavy metal for product *Possibility for cleaner products* *Possibility for reduced environmental impact from handling of electronic waste* *Possibility for internal dissemination of cleaner technology within company*
Customer information, marketing	Reduced wastage from distribution of chemicals Substitution of hazardous materials in electronic products Increased environmental choices in the purchase of printed matter *Possibility for customers to choose an eco-labelled product* *Possibility for customers to choose a product with less environmental impact* *Possibility for reduced environmental impact from handling of electronic waste*
Green procurement policy or strategy	Changes in procurement with substitution of several products with products with less environmental impact
Recovery of materials and products	Reduced amounts of waste and reduced resource consumption *Possibility for reduced environmental impact from handling of electronic waste*
Supplier assessments and dialogues	Substitution of chemicals in agriculture (through change to other suppliers) and in industrial processing Substitution of PVC and hazardous materials in paint. Change to certified wood
Greening product development	Reduced consumption of detergents in textile service Reduced use of hazardous chemicals and monomers in paints Development of more biodegradable chemical to textile industry *Possibility for customers to choose an eco-labelled product*
Eco-labels	Substitution of chemicals in agriculture (through change to other suppliers) and in industrial processing Energy savings in manufacturing process as spin-off Development of more biodegradable chemical to textile industry Increased use of eco-labelled detergents for cleaning *Possibility for customers to choose an eco-labelled product* *Possibility for customer to integrate environmental concerns in the purchase of printed matter*
Strategic co-operation	Reduced consumption of detergents in textile service Increased use of eco-labelled detergents for cleaning Increased use of waste materials in concrete leading to reduced CO_2 emissions from manufacturing *Possibility for customers to choose an eco-labelled product* *Possibility for customer to integrate environmental concerns in the purchase of printed matter*

Table 6.1: Actual and potential (in italic) reductions in environmental impact from environmental management in product chains

The reductions in environmental impacts from the analysed cases are described in the following paragraphs.

6.1.1 Time perspective

Many of the environmental initiatives have a long-term perspective since they focus on integration of environmental concerns into product development. Some of these initiatives have led to increased knowledge about the environmental impact of products, the possibility for customers to purchase eco-labelled products and design guidelines for integration of environmental concerns into the design of future products.

6.1.2 The type of environmental initiative, including the role of prevention

There are examples of changes at a number of different levels; reaching from more complex levels like products towards more simple levels like handling of wastes and emissions. The following levels have been in focus: products, production/manufacturing, processes and handling of specific wastes and emissions. The changes focus mostly on prevention of environmental impact, like
- reduction of resource consumption, including energy consumption
- reduction of the use of hazardous chemicals and materials
- reduced resource consumption through increased resource efficiency

A few initiatives focus on the handling of waste. One example concerns the handling of electronic waste and two other initiatives deal with the use of waste as resources for new products.

6.1.3 Holistic perspective

A few examples mention links to other areas of concern explicitly. The use of residual products as partly substitutes for cement in concrete has demanded many tests of the quality of the new material. There has probably also been focus on quality aspects in other changes of products, but these concerns have not been mentioned. One case with focus on substitution of hazardous substances in paints has its focus on the reduction of the chemical exposure in the use stage, but some of these substitutions will also imply reduced environmental impact.

6.1.4 Types of environmental impact in focus

Several of the cases focus on reduction of emissions of hazardous chemicals and materials without specific types of environmental compartment mentioned as specific concern. One case has focus on reduced emissions of greenhouse gasses and one case focuses on the biodegradability of a chemical. A few cases have a focus on reduced resource consumption using waste or residual products as materials for new products.

The overview also shows that environmental management initiatives in product chains do not necessarily imply a focus on the environmental impact in the whole product chain. The focus might be on the whole product chain, like in initiatives with focus on the use of life cycle assessments (LCA), but also here might the focus be limited later in the assessment, due to the initial screening of the environmental aspects and impacts in the product chain. In a discussion of the environmental focus in the product chain, it is useful to understand a product chain as having a material as well as an organisational dimension. As described in chapter 3, a product chain can be seen as a number of material activities implying flows of material resources, and as an organisational entity with flows of capital and information and with different

actors having different types of social relations interacting with the material flows. Furthermore, it is important to focus on the material and organisational interconnectivity of the different parts of a product chain and how the environmental aspects and impacts along the product chain are shaped during the different activities related to a product: design, extraction and processing of materials, manufacturing of products, use of products and disposal.

In an analysis of environmental initiatives in a product chain different perspectives can be applied:

1. A perspective where the focus is on those parts of the product chain where the changes in environmental impacts are wanted or are seen
2. A perspective where the focus is on those actors and those parts of the product chain, where changes in environmental aspects (technology, structures etc.) are taking or should take place in order to obtain the changes in environmental impacts (this could be called a direct influence on the environmental impact)
3. A perspective where the focus is on those actors and those parts of the product chain and other linked networks and product chains, where changes in driving forces are taking or should take place in order to obtain changes in the environmental aspects (this could be called an indirect influence on the environmental impact)

An example: In one of the cases, where a manufacturing company wished to reduce the environmental impact from its own painting processes (perspective 1) the paint supplier had to deliver paints with less organic solvents (perspective 2). Although the focus was not on the emissions of the supplier the emissions of the supplier were also reduced concurrently (although by far the biggest part of the emissions take place when the paint is applied) (perspective 1). The changes were partly inspired by enquiries for environmental issues from customers concerned about the environmental impacts along the whole product chain of the products, which they buy (perspective 3). Table 6.2 shows how the three perspectives on the product chain in some of the analysed cases sometimes involve actors in different parts of the product chain and sometimes actors in the same parts of the product chain.

Environmental initiative/management effort	Perspective 3	Perspective 2	Perspective 1
Life cycle assessment Textile yarn Electronic product	Customer Customer/ manufacturer	Supplier Suppliers/Manufacturer	Manufacturing Product disposal
Customer information, marketing Printing house	Customer	Suppliers	Suppliers/Manufacturing
Green procurement policy or strategy Public transport	Customer	Suppliers	Maybe throughout the product chain
Recovery of materials and products Reuse of construction waste	Actors along the product chain	Supplier	Manufacturing
Supplier			

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assessments and dialogues Playing ground equipment Chemicals	Customer Manufacturing	Suppliers/Manufac-turing Distribution	Throughout the product chain Distribution
Greening product development Textile service Printing house/designer Sanitation product	Customer Customer Customer	Supplier Designer/Manufac-turer Suppliers/Sale/Customer	Service provider Suppliers/Manufac-turing Suppliers
Eco-labels Textile Furniture Detergents/Clea ning service	Customer Customer Customer	Suppliers Suppliers Supplier/cleaning service	Suppliers Suppliers Supplier/cleaning service
Strategic co-operation Concrete constructions	Customer	Actors throughout the product chain	Supplier

Table 6.2: Actors involved in the three perspectives on some of the analysed cases (only cases where there is enough information to apply all three perspectives. Each case is only mentioned once although they might have been analysed within more of the initiatives

The overview shows that the choices of customers in many cases are important in order to obtain the environmental potentials, because many of the initiatives are offers to the customers for buying products or services with less environmental impact. Only in a few cases are environmental achievements obtained throughout the product chain. On the other hand there is a case within strategic co-operation which shows how it is necessary to involve actors throughout a product chain in order to obtain an environmental improvement from the practice of one of the suppliers (concrete manufacturing).

6.2 Organisational focus and embedding of the initiatives

This paragraph identifies and analyses organisational structures that has been important in the shaping of the initiatives and organisational changes that show embedding of the initiatives in involved organisations. Table 6.3 gives an overview of the organisational aspects in the shaping and in the embedding.

Environment al initiative/ma nagement effort	Organisational aspects as drivers and barriers in the shaping of the initiatives	Organisational structures in the embedding of initiatives
Life cycle assessment	LCA-model too time consuming and too data demanding Eco-label criteria easier to have suppliers to react to Too little importance as customer in relation to supplier in data enquiry for LCA Sales contact to customers provide	Knowledge about environmental impact of products Database with environmental information about components Design handbook and guidelines Implementation of a ISO 14001 environmental management system

	knowledge about customer needs Customer demand as driving force Use of consultant assistance in network of companies Pioneer inside company important	
Customer information, marketing	Long-term contracts made by mother company as barrier Same view on environmental issues in involved countries Too little importance as customer in relation to supplier Confidence with suppliers and customers Demands for written procedures barrier for small supplying companies Difficulties in finding alternative suppliers Distributor's customer contact important	Tool for sales department Procedures for customer enquiries Internal integration of specialist functions Participation of environmental staff in sales activities Closer relations to suppliers and customers Auditing of suppliers and customers Implementation of a ISO 14001 environmental management system
Green procure- ment policy or strategy	Different view on environmental issues in involved countries as barrier Environmental guidelines and eco- label criteria as guidance LCA-model too time consuming and too sophisticated Lack of recognition from public customers	Guidelines for green procurement
Recovery of materials and products	Limited support from municipal authorities to recycling scheme Differences in municipal regulation of waste management	Agreement among actors about procedures for recycling of waste as raw material Guidelines for customers for dismantling and recycling of product
Supplier assess- ments and dialogues	Confidence with suppliers provide access to (confident) data Mutual dependency between manufacturing company and strategic suppliers Easy data collection based on ISO 14001 system Providing environmental policy to supplier may initiate or disseminate environmental initiatives	Supply chain management as part of environmental management Dialogue with suppliers provides ideas and targets Chemical database Integration of environmental issues into contracts Inspections and audits of contractors/suppliers/customers
Greening product develop- ment	Demand from important customer Long term contract with important supplier provide confidence and commitment Small suppliers find it difficult to provide environmental documentation	Future development projects with strategic supplier Product steward programme for future collection of customer demands Design guidelines Supplier's environmental specialist at customer Customer's environmental specialist at supplier
Eco-labels	Demand from important customer as driving force Long term contract with important supplier provide confidence and commitment Easy data collection based on ISO 14001 system Expectations for public green	Supplier's environmental specialist at customer Design guidelines Suppliers inspired to develop ISO 14001 system Development of eco-labelled product assortment

	purchase as driver – and actual interest as barrier	
Strategic co-operation	Demand from important customer as driving force Long term contract with important supplier provide confidence and commitment Expectations for public green purchase as driver – and actual interest as barrier Long-term co-operation as basis for co-operation about joint resource centre and network measures	Future development projects with strategic supplier Design guidelines Supplier's environmental specialist at customer Suppliers inspired to develop ISO 14001 system Development of eco-labelled product assortment Experience from pilot project expected to become embedded into public standards

Table 6.3: Organisational aspects as drivers and barriers in the shaping of the initiatives.
Organisational structures in the embedding of initiatives

The overview shows how existing organisational relations to suppliers and customers can be a barrier as well as a prerequisite for an environmental initiative in a product chain. This is in line with Boons (1999), who points to network relations as a possible benefit as well as a possible barrier, when a company wants to take environmental initiatives in a product chain.

The cases also show how long-term co-operation (networking) among a company and its suppliers and customers can create mutual confidence and maybe dependency, which motivates participation in co-operation around environmental issues. A link to a customer might provide access to knowledge about future customer needs as a resource in future product development. On the contrary, too little importance in relation to a supplier might limit the willingness of a supplier to provide data for a life cycle assessment or an environmental declaration, if the data are not easily accessible or are considered as confidential. However, some of the analysed cases show that joint participation in a project activity, which several of the initiatives are, might create commitment for further co-operation in the future. In one case, a supplier transfers the "solution" provided to one customer to the case company. This shows how a product chain might be an arena for dissemination of environmental competence among different product chains.

Existing methods and criteria might provide guidance in this kind of initiatives. However, several cases show that a full LCA methodology is too time consuming, too sophisticated and too data demanding. Some companies have then chosen in stead to use existing eco-label criteria as guidance in the dialogue with suppliers. (In chapter 10, the role of governmental regulation as guidance is analysed further). In one case, an ISO 14001 system is highlighted as providing a good framework for collecting data to a supplier, who asks for information about the company and its processes and products.

Some cases point to the important role of an internal or external change agent in carrying through a project. In one case, such an internal change agent is called a pioneer. There is not enough information to analyse the role of such change agents closer. Broberg and Hermund (2003) point to the political, reflective navigator as a connotation for a change agent and mentions several possible roles: expert, process consultant, facilitator, and network and alliance builder with the ability to adjust the strategy as an important competence.

Several of the initiatives have been embedded in one or more of the participating companies as new knowledge, guidelines or new or changed organisational structures. Lenox and Ehrenfeld (1997) show that a prerequisite for good environmental design capability is access to environmental knowledge resources, the ability to exploit these knowledge resources by making them available in the organisation through persons, databases and/or guidelines. Furthermore, that there need to be interpretative structures which support the actual application in for example product development of the environmental knowledge. This could be gatekeepers between the environmental community and the more technical communities in for example product development for example through training of technical staff or through environmental specialists as members in for example design teams. All together, the cases show these types of embedding strategies. Knowledge resources are developed as specialists and as databases; guidelines (for example a design handbook or tools for sales persons) and/or persons acting as interpretative structures. New internal organisational structures are created, where for example different so-called specialists functions are integrated in one function (environment, human resources and dialogue), because they are all seen as important in management of environment and work environment, including the dialogue with customers. In a few cases environmental competence has been integrated by creating new organisational structures across two companies, when either a supplier provide environmental competence to a customer or a customer provide environmental competence to a supplier. The temporal centre within concrete construction is an example of a structure built among a number of companies with high degree of mutual experience, aiming at extending the co-operation into the environmental field. These examples show an extension to the analysis of Lenox and Ehrenfeld who only analyse inside companies and not analyse the relations to customers or suppliers.

It is not possible to point to a blueprint for embedding of environmental initiatives. Organisation development literature highlights the importance of recognising the relationships between tasks, actors and their competencies, structures, and the tools and technologies available. If a change process is having one of these four elements as primary focal point, it is important to focus on the impact on the other three elements and to assess whether they are able to adjust to the change or they need to be adjusted in order to make the change process successful. It is for example not enough to develop a design handbook or guideline (tool/technology), if it is not clear who (actors) is going to use the guideline as part of which task (for example product development) and as part of which organisational structure (for example a product development team).

7 The occasions and driving forces behind the environmental initiatives in product chains

This chapter analyses the occasions and the driving forces, which in the case studies have been referred to as important, when the changes in the product chains were initiated.

With occasions, we refer to specific events or possibilities, which initiate an attempt to change something, like the possibility to become involved in a project, because a consultancy company is looking for case companies to a public supported project. With driving forces we refer to the aims or expectations behind the initiative, like cost saving, new market opportunities. In some cases, the occasion and the driving force may be the same.

In chapter 3 the following triggering factors were mentioned:
- Governmental regulation
- Governmental funding
- Public debate
- Customer demands
- Expectations to market opportunities

7.1 Relations between occasion and environmental initiative

Table 7.1 shows the relations between the environmental initiatives and the occasions and driving forces described in the case studies. In some case studies, more than one occasion and driving force were found. The table gives a qualitative assessment of the relations, and not a quantitative assessment, due to the limited number of cases. The table shows that for all types of environmental initiatives more than one occasion and driving force is seen. In several cases, the occasion seems to be an internal initiative. However, such statements could in most cases probably be translated into an internal interpretation of societal discourses. This implies that some, more pro-active companies see a certain discourse as an occasion or even an opportunity, while other, more reactive, companies only take such an initiative if it is a customer demand.

A more detailed assessment of the occasions and driving forces show the following:
- Only the initiatives information for customers and green product development have **not** been reported as internal initiatives
- Customer demand is seen as occasion within all initiatives except recovery of products and materials
- Economic support and consultant support is mostly initiating initiatives within life-cycle assessment, where project activities have been initiated by the possibility for governmental funding of consultant projects under the condition that companies are involved

- Demands are almost exclusively mediated upstream in product chains, which mean as customer demands to suppliers. Only in one case, a multinational chemical manufacturer, is a company setting demands to its customers (about the use of responsible distribution companies) , because the chemical company want to avoid that problems during the distribution become a critique of the manufacturing company and its products
- The product chain as structure is sometimes used to mediate governmental regulation of a company in one country into demands to its suppliers in another country.

7.2　Relations between occasions and industrial branches

With respect to the relations between the occasions and the driving forces and the industrial branches involved it could be expected that

- Governmental regulation would be one of the occasions within the chemical industry
- Governmental funding would be the occasions in cases where a governmental programme was targeting an industrial branch
- Green procurement policies would be the occasion for companies having public customers
- Eco-labelling would be the occasion in consumer-oriented companies (and not in companies oriented towards professional customers)

Cost savings could be expected to be important in companies with big resource consumption.

Table 7.2 shows the relations between the occasions and the driving forces and the industrial branches. Two chemical companies, two companies in the iron- and metal processing industry and one company in the plastic industry refer to governmental regulation as the occasion. Furthermore, customer demands are in some cases governmental regulation of the customer and their products, which is mediated to the suppliers (which are the company described in the case)..

There has not been support for specific branches involved in the case studies, although this kind of funding is known from several of the cleaner technology and cleaner products programmes in Denmark.

There is only one public company involved, the Danish Railway (DSB). For this company the public green procurement policy implied that the environmental focus around procurement was strengthened. It was a condition that the green procurement did not give increased costs. Public green procurement and expected market opportunities were the driving forces in four companies from four different branches supplying public customers: iron and metal processing, printing, cleaning and hygiene. However, it looks like the expectations were not met as actual changes in the public procurement.

Public debate is only mentioned in one case – the phasing out of PVC among the suppliers to a company, which is manufacturing playing ground equipment. However, as earlier mentioned, it could very well be so that public debates have played a role in more cases, but the public debate is not enough

to initiate product changes. Governmental regulation may be a driving force, which also need to be in place besides public debate.

Occasion / Environmental initiative	Internal initiative	Customer demand	Economic support and consultant support	Public green pro-curement	Govern-mental regulation of materials etc.	Develop-ment of eco-labelling scheme	Cost savings	Public debate	Mediation of govern-mental regulation of customer	Supplier demand
LCA	X	X	X		X					
Information for custo-mer		X	X							
Green procure-ment	X	X			X					
Recovery of products and mate-rials	X				X	X				
Supplier assess-ment and dialogue	X	X								X
Green product develop-ment		X			X	X		X	X	
Eco-labelling	X	X		X		X	X (at customer)		X	
Strategic co-opera-tion	X	X	X			X	X (at customer)			

Table 7.1: Relations between the environmental initiatives and occasions and driving forces

Occasion / Branch	Internal initiative	Customer demand	Economic support and consultant support	Public green pro-curement	Govern-mental regulation of materials etc.	Develop-ment of eco-labelling scheme	Cost savings	Public debate	Mediation of govern-mental regulation of customer	Supplier demand
Chemical industry	X	X			X			X	X	X
Textile and leather industry	X	X	X						X	X
Iron and metal industry	X	X	X		X	X				
Transportation servi-ces	X	X								
Stoneware, ceramics and glass industry	X						X			X
Paper and graphic industry	X			X						
Cleaning, dry clean-ing and laundry	X	X				X	X			
Marketing company						X				
Concrete, tile covering etc.	X		X				X			
Napkins and hygiene products				X		X				
Wood processing industry	X	X		X						
Plastic industry	X				X					

Table 7.2: Relations between the occasions behind and driving forces behind the environmental initiatives and the industrial branches involved

Occasion / Branch	Internal initiative	Customer demand	Economic support and consultant support	Public green pro-curement	Govern-mental regulation of materials etc.	Develop-ment of eco-labelling scheme	Cost savings	Public debate	Mediation of govern-mental regulation of customer	Supplier demand
Less than 10 employees		X	X							
Less than 50 employees	X				X					X
Less than 250 employees	X	X	X			X				
More than 250 employees	X	X	X	X	X	X	X	X		X

Table 7.3: Relations between the occasions behind and driving forces behind the environmental initiatives and the size of the core company

7.3 Relations between occasions and size

With respect to the role of the size of the initiating company, it could be expected that bigger companies with own research and development and own environmental competence more than smaller companies would be initiating changes themselves. Table 7.3 shows, however, that it is not only bigger companies but also small and medium sized companies, who indicate that initiatives were taken internally.

Customer demands have been one of the most important occasions and driving forces in bigger companies as well as in small and medium sized companies. It could be expected that this mainly would be the case in small and medium sized companies. It could also be expected that companies, who depends a lot on one or a few major customers had to meet or enter into dialogue about the demands from the customers. A few cases show this kind of relationships, but without customer demands are mentioned as an occasion or driving force behind the initiatives.

7.4 How can environmental management in product chains be supported by influencing the occasions and the driving forces?

Although the occasion in a case study often is referred as an internal initiative, another occasion or rather driving force is often also mentioned, like expectations about future governmental regulation, customer demand, the possibility to achieve an eco-label on products etc.

If the driving force is an expected productivity gain, it would be a good idea to support the development of competence that makes the company able to assess alternatives. This could be cost savings through reducing resource consumption or substituting to chemicals or processes with less environmental impact, where reduced wastewater treatment costs or waste management costs could give the company reduced costs.

Customer demands from Danish, but more often foreign, customers are in several cases referred as an important occasion and driving force. This implies that pressure from a part of the product chain, which is closer to the final users or the consumers in many cases play a role in the initiation of environmental initiatives in a Danish company in another part of the product chain (more upstream). Big as well as small and medium sized companies refer this kind of driving force. At the same time, other cases refer to **lack** of customer demands or lack of interest in environmentally better products among the customers among Danish and foreign customers.

The increased focus on public green procurement has been an important occasion and driving force for environmental initiatives in several companies. However, the companies did not see any interests among the public institutions for the environmentally improved products. One reason may be that the more environmentally friendly products were more expensive, which prevented the public institutions from buying them. There is need for more in-depth research into price mechanisms for this kind of products, including why they often are more expensive. Can this increased price be justified because of more expensive materials? Or is it rather an expectation from the manufacturing company that more environmentally focused users and

consumers probably are willing to pay more for a product? Or is it because the more environmentally friendly product only is produced in small amounts and the company let this product "carry" all the extra costs from smaller batches?

In two cases, the suppliers set demands to the customers further **down** the product chain. In one case, a big multinational chemical manufacturer demands that the customer uses responsible distribution companies because accidents or other types of environmental impacts among the customers or the consumers also could imply critique of the manufacturing company. In another case, a supplier tries to sell its development of a more environmental friendly solution to customers. In the case with the chemical company, the occasion becomes supplier demands, which are based on a fear for the public debate about chemical products.

8 The role of the product area and branch

This chapter analyses the role of the product area and the branch in the environmental management initiatives in the case studies. The aim is to understand the role of these characteristics in the environmental management of companies in a product chain..

The analysis is based on a so-called resource area analysis. Resource areas are groups of companies, which are contributing to and thereby dependent of the same markets, the same market conditions or linked together in product chains (Erhvervsfremmestyrelsen 2000). A resource area is a scientific construction, which is not tying companies, branches, knowledge institutions etc. within a resource area together. However, many networks will be established within a resource area – e.g. as a product chain. The analytical question is whether there are specific market conditions and other business conditions within a resource area, which influence the choice and the role of environmental management initiatives. Another question is how the role of a company in a product chain influences its role in environmental management in the product chain.

By comparing the environmental management initiatives with the practice in the resource area they are part of it should be possible to identify not only the business specific prerequisites, but also the need for changes in the business conditions to support environmental management in product chains within that area.

When companies are part of the same product area there is a possibility to organise joint environmental initiatives. A resource area could be the frame for a joint product oriented environmental initiative, which needs changes in laws or rules, new education and training opportunities, changes in the distribution system, development of product labelling etc. A resource area could also be the frame for dissemination of experiences with environmental management. An environmental initiative organised according to resource areas are the product panels, which the Danish Environmental Protection Agency has developed within a number of product areas or sectors during the 1990'ies and also after 2000.

Different resource areas have different traditions for the development of new competencies. These traditions and existing structures may on the one hand limit the companies in the development of environmental initiatives and on the other hand, they may make it easier to organise joint initiatives.

A focus on resource areas may also show the role of structural conditions and the existing innovation strategies and thereby that path dependency, which may be seen in initiatives within an area. This may at the same time show the need for structural changes in order to support development and diffusion of environmental management in product chains and thereby the need for path creation within that area.

Analyses are done for the following resource areas: 1) Furniture and clothing, 2) Construction and housing, and 3) Information technologies and communication. A number of Danish resource areas are not represented in the case studies or are only represented by one or two case studies and analyses have not been made for those resource areas.

8.1   Furniture and clothing

This resource area is characterised by small, medium-sized and big companies. Especially the chemical suppliers are big multinational companies. The products are material products, and a number of chemicals are used in the manufacturing of the products and the final products contain chemicals and chemical residues. This has implied that the focus in environmental discourses in relation to the products has been on the use of chemicals in manufacturing and on the chemical residues in the products. The focus in the initial demands and governmental regulation was on limits to waste water discharges from the manufacturing. Later the possibility of obtaining eco-labelling on products was developed. The products are used by private as well as governmental users. Compared to other resource areas this area is characterised by a big export percentage, but at the same time also a high import percentage of the domestic consumption. The product chains are often long and are characterised by different degrees of stability in terms of customer-supplier relations. Global competition has put, for long time, a strong pressure on the costs in the sector and outsourcing of labour intensive processes to countries with lower wages has been a dominating strategy since the 1980'ies. Many companies have mainly the design, development and management activities located in Denmark while the manufacturing takes place in other companies in other countries (Erhvervsfremmestyrelsen 2000).

In relation to environmental management, one aspect is whether the suppliers are asked to live up to certain environmental demands and if so, how these demands are managed in the interaction with the suppliers. The experiences show that the more demands textile companies have to their suppliers, the fewer suppliers they tend to co-operate with, because it is time and resource consuming to find suppliers, when it is not only the lowest possible price that is in focus, but also environmental demands (Stranddorf et al 2002).

Seven cases can be referred to this resource area. Table 8.1 shows the role of the companies in their product chains and the environmental management initiatives.

Supplier companies		Final product companies	
Company / Initiative	Funding and knowledge transfer	Company / Initiative	Funding and knowledge transfer
Technos A/S LCA Eco-labelling (of customer product)	Governmental funding Consultant: training Consultant: providing LCA software tool	Novotex Supplier assessment and -dialogue Eco-labelling	Environmental knowledge in own organisation
Gabriel LCA	Consultant: 1) Initiator 2) Coordination in relation to suppliers 3) Conducting assessments with software tool when it	Kompan Supplier assessment and -dialogue .	Environmental knowledge in own organisation

	becomes too complex to the textile company		
Trevira Neckelmann A/S Green product development (Substitution) Eco-labelling (of customer product)	Environmental knowledge in own organisation Suppliers which got environmental demands hired consultants and received training	Leika Eco-labelling Strategic co-operation	Funding Consultant: In relation to implementation of environmental management system: 1) Mapping 2) Priorities behind the choice of measures In relation to eco-labelling: 1) Collecting information from suppliers 2) Development of work plan
Jysk Nylon LCA Information to customers	Funding Auditor: 1) Initiator 2) Coordination Consultant Data analysis		

Table 8.1: Characteristics of companies and initiatives within the resource area furniture and clothing

The companies among these cases, which manufacture final products, have a focus on the possibility to achieve eco-labels on their products and expectations to a growing public green demand as part of an increasing focus on public green procurement. The customers of these companies are businesses and public institutions. The public customers are very important in two of the three companies. The initiatives are primarily eco-labelling and supplier assessment and dialogue.

Eco-labelling is seen as an opportunity to be recognised at the market. Supplier assessment and dialogue is seen as an element in an outsourcing strategy to transfer demands for environmental protection and quality and to achieve certainty for suppliers' delivery. The driving forces for the companies are a combination of customer demands and own interpretation of the societal discourses. The companies placed more upstream in product chains and with other manufacturing companies as customers have initiated life cycle assessment and documentation or improvements in order to meet demands from customers, who are qualifying for an eco-label license. The possibility to get public funding is mentioned as another driving force. Within the textile and clothing sector, relations with focus on environmental competence have been developed among consultants, schools and colleges, the trade organisation and the more pro-active companies. The Danish Environmental Protection Agency launched a product panel with stakeholders within industry, retail and civil society organisations among the members. The panel developed a strategy with a strong focus on a joint effort to develop supply and demand of eco-labelled products. Unfortunately, the public funding ended and the activities were stalled, because the sector was not committed enough to continue the funding of the activities itself. Recently a new public funded initiative has been launched, this time with funds from the Ministry of Economy and Business.

Within the furniture and clothing resource area, it seems like the important driving forces have been expectations among the manufacturers of final products of an increased demand for eco-labelled products. The dialogue about environmental issues in the product chains has been influenced by existing types of agreements about delivery and about quality between the textile companies and their suppliers. Where companies already had stable relations to suppliers based on price and quality, environmental issues have been included as a new theme. For companies more upstream in the product chains, the possibilities for public funding seem to have been a important prerequisite. It looks like the expectations of increased demand for eco-labelled products were not met, neither among the consumers, nor among the professional public customers. It seems to be a characteristic for the area that initiatives are organised by single companies, as well as by joint initiatives involving manufacturing, sales, knowledge institutions and civil society organisations.

8.2   Construction/Housing

This resource area is characterised by many small and medium-sized companies and a few very big companies. Especially the raw material suppliers, the consultancy companies and the contractor companies are among the big companies. The products are physical products with a relative long lifetime and big numbers and amounts of materials and chemicals are used during the construction and are part of the finished building or other type of construction. Other activities focus on maintenance and refurbishment of existing buildings. The big resource consumption has implied a focus on waste management and recycling of construction materials, since the waste management costs are high due to the governmental regulation.

The consultancy companies have had an important role in the environmental initiatives within the resource area as initiators, evaluators and mediators of experience and knowledge. The market has a public and a private part and is characterised by big investment companies, foundations etc. The resource area as such has had a relative low productivity improvement compared to the similar sector in other countries .Despite this, the Danish companies have had a positive economic development because of increased domestic construction activities (Erhvervsfremmestyrelsen 2000). However, foreign companies have bought a number of Danish construction companies. The resource area is much more project-based than other resource areas, and the product chain relations seem to be less stable and formalised than within other areas. However, more long term partnerships among the companies are seen, but less formalised than in more industrialised resource areas. Demands for changes come from the building owners' demands and from the demand for increased productivity in the different companies. Environmental demands do not play an important role in public construction projects, due to lack of demands from the public building owners. New, more formalised partnerships, so-called partnering relationships, are considered in order to increase the productivity (BAT-Kartellet 2001) (Bonke & Kristensen 2000).

Seven cases are from this resource area. Table 8.2 shows the role of the initiating companies in the product chains and the environmental initiatives.

Supplier companies		Final product companies	
Company / Initiative	Funding and knowledge transfer	Company / Initiative	Funding and knowledge transfer
Akzo Nobel Deco Green product development (Substitution)	Environmental knowledge in own organisation. Customers have used occupational health service centres to develop the demands to the company	Skanska Supplier assessment and -dialogue	Consultant: Building contractors' occupational health service centre 1) Development of chemical assessment tool 2) Assessment of products
Technos A/S LCA Eco-labelling (of customer product)	Public funding Consultant: Training activities Consultant: Introduction of LCA software tool	Cardodoor Information to customers Environmental product declaration	Supplier (Technos) used a consultant
Danogips Recycling	Business organisation 1) Development of demands for recycled gypsum 2) Development of collection scheme		
Centre for resource saving concrete constructions Strategic co-operation	Funding Consultants and universities initiated the co-operation		
H+H Fiboment A/S LCA	Funding Business organisation initiated Consultant: 1) Data collection 2) Development of software tool 3) Advice		

Table 8.2: Characteristics of companies and initiatives within the resource area construction and housing

One of the contractor companies has initiated supplier assessment and – dialogue in co-operation with the suppliers. The contractor company sees this initiative as one of its obligations within its environmental management system and at the same time as an opportunity to improve their own planning.

For the companies more upstream in the product chains the initiatives have focused on improvement of products and resource savings through recycling of products and the use hereof in new products. The main driving forces have been governmental regulation with focus on higher taxes on waste management and possibilities for cost savings and public funding of initiatives.
The initiative for recycling of plasterboard waste was organised as a branch initiative with co-operation among competing companies. The initiative implied major changes in the waste management schemes and development of standards for the handling of the waste materials. The companies saw it as an advantage to organise the new framework themselves.

Market forces are not seen as important driving forces within this area. Only few companies highlight customer demands as the occasion or driver for environmental initiatives. Market forces are mainly focused on the productivity of the companies. It seems to be a characteristic for the area that initiatives are organised by single companies, as well as by business organisations.

8.3   Information technology and communication

The companies within this resource area support other resource areas with information and communication services. The resource area includes the electronic industry. The resource area covers small, medium-sized and big companies. The products include very different types of products from immaterial products to materiel products, like electronic devices and printed goods. There has for many years been focus on the use of chemicals and substances in the manufacturing in the electronic and the printing industry, but also on the content of these chemicals in the final products. The markets include private and professional users, including public institutions. In the printing industry, the driving forces for environmental initiatives have been governmental regulation of chemicals and substances, expectations of increased public demand for eco-labelled products and increased competition from digital products. The business organisation and the educational institutions became a number of years ago initiators and mediators of environmental initiatives.

The other parts of the resource area have grown, which have implied bigger resource consumption, including increased consumption of environmental hazardous chemical substances and products, and increased amounts of waste from electronic and electrical products. Two directives have been issued by the European Community, one with focus on waste management (WEEE – Waste from Electronic and Electrical Equipment) and one with focus on the reduction of the use of hazardous substances and restrictions to the import and sale of electronic products containing hazardous substances (RoHS – Reduction of Hazardous Substances). The actual implementation of the two directives may be difficult because of the frequent product changes, long product chains and big manufacturers of basic components, which may make it difficult to smaller companies to set demands and get them accepted.

Five cases are from this resource area. Table 8.3 shows the role of the initiating companies in the product chains and the environmental initiatives.

Supplier companies		Final product companies	
Company / Initiative	Funding and knowledge transfer	Company / Initiative	Funding and knowledge transfer
Danrens A/S Green procurement policy	Funding Consultant: Occupational health service centre: Approving data sheets	Levison Johnson + Johnson Information to customer Eco-labelling	National eco-labelling secretariat: Approves new suppliers
Danfoss Drivers LCA Information to customer Recycling	Environmental knowledge in the organisation	Phønixtrykkeriet A/S (printing house) Green product Eco-labelling Strategic co-operation	Consultant: Analysing how printing companies may improve their environmental practice

Brødrene Hartman A/S Information to customers Supplier assessment and -dialogue	Environmental knowledge in the organisation		

Table 8.3: Characteristics of companies and initiatives within the resource area information technology and communication

The case companies, which manufacture final products, are printing companies. Their initiatives are directed at their customers – especially the public customers. The initiatives include provision of information and eco-labelling licenses. The main driving forces seem to be the environmental management systems of the companies and the expectations of increased public demand.

The suppliers within the resource area, which are not printing companies, have focused on information to customers, green procurement policy, recycling, and life cycle assessments as a way of providing information about the conditions for recycling of the final products. The main driving forces have been direct customer demands and expectations to the new EU directives during the period, when the directives were shaped.

8.4   Comparative analysis of the resource areas

Despite the rather different types of products supplied within the three areas, a comparative analysis of the three resource areas shows similarities in the environmental dynamics among the areas:

- Expectations to public demand for more environmentally friendly products or solutions in several are often not met, including a lack of high priority environmental demands in tendering processes
- Branch specific business organisations and knowledge institutions are involved as initiators and mediators, whereby the conditions for diffusion of experiences should be ideal
- Environmental demands in business-to-business sales and purchase have a limited extent

Within all three resource areas chemical substances and products give environmental impacts throughout the product chains, although maybe to different extent within the different parts of the product chains, and within all the three resource areas the chemical impacts has been in focus of some of the environmental initiatives. Eco-labelling is seen as a strategy within all three areas, although with different degree of success. Especially the expectations to increased public demands are not met or only partly met, which is due to higher prices of the eco-labelled products.

Within the textile and clothing area, the development of a national strategy for eco-labelling gave the opportunity to differentiate the products at the market through eco-labelling. Within furniture eco-labelling was also seen in one of the cases, but here with expectations to increased public green procurement as a driving force. These expectations, however, were not met because the eco-labelled products were more expensive. Within the construction and housing area, one supplier company also focused on eco-labelling of construction

materials. Also within the printing industry, eco-labelling has played an important role as environmental initiative. Within this area, it has mainly been driven by expectations to increased public green procurement. These expectations were met to a higher degree although some public customers seem not to want the products labelled, they only want the environmental quality of the labelled product, because they do not want to pay the extra cost for the labelling, which the manufacturer allocate to the customer as an extra cost.

Within a part of the printing industry the eco-labelled production concept become the only quality, because it is easier only to produce according to one concept, but not all customers choose to get the products labelled, due to the fee on eco-labelled products, which the printing companies choose to ask the customer to pay. It looks like these fees, the pricing strategies in companies and the restricted public economic frames all together restrict the diffusion of eco-labelled products.

Also in relation to the integration of environmental concerns into construction projects, the lack of demand from public customers seems to be a barrier. The public tendering process and lack of environmental criteria may be one of the important structural barriers.

Some professional building owners, like one of the big municipalities, are aware of this lack of demand and have – at least for some years – built internal competence to make it easier to get environmental demands included in construction projects. One of the multinational contractor companies with affiliates in Denmark seems to initiate some kind of environmental management with focus on chemical substances and products. It is not clear, however, how widespread this practice is used, whether it automatically becomes a part of a construction project, or it still is necessary for the customer to demand specific concerns to be taken.

Within electronic and electrical products, focus is on chemical substances and products as environmental issue. The public regulation has been developed as international regulation, like EU Directives, probably because of the bigger amounts of products and the bigger problems during waste management.

All three areas show participation and initiatives from business organisations and from knowledge institutions, in most cases organisations and institutions, which already are part of the resource area. Only in relation to LCA other, more generally focused, knowledge institutions got involved.

Development of information to customers is seen within two of the resource areas within rather different product areas: electromechanical products, packaging, printing goods and building products.

Although business organisations and branch related knowledge institutions have been involved within all three areas, it looks like the diffusion of the role of environmental demands in business-to-business sales and purchase is limited, like with respect to public green procurement.

9 The role of the size of the companies

This chapter focuses on the role of company size in the shaping and implementation of environmental initiatives in product chains. The aim is to see whether there is a need for recommendations developed according to the different size of companies. The basis has been the case studies and data about the size of the initiating companies.

The companies represented by the case studies are relative big, compared to the Danish business structure[1]. This implies that there is a bias in the analyses towards the initiatives of medium-sized and big companies, while initiatives by small companies (below 50 employees only is covered by the cases to a limited extent). The material covers one company with less than 10 employees, maximum three companies with less than 50 employees, while the remaining initiating companies are medium-sized (50 – 250 employees) or big (more than 250 employees). The distribution of companies is seen in Table 9.1.

	Micro Companies (less than 10 employees)	Small companies (less than 50 employees)	Medium-sized companies (less than 250 employees)	Big companies (more than 250 employees)
LCA	Jysk Nylon Dan-Rens A/S		Technos Gabriel A/S	Danfoss Drives HH Fiboment A/S
Customer Information	Jysk Nylon		(Brdr. Hartman A/S) Levison+ Johnson+ Johnson Skylight A/S	Post Danmark HCI Nordic A/S Bambo
Green procurement	Dan-Rens A/S			DSB (Danish Railway)
Recycling			(Danogips) Skylight A/S	
Supplier assessment and -dialogue		Novotex	(Brdr. Hartman A/S)	Kompan Skanska HCI Nordic A/S
Green product development			Phønix trykkeriet A/S	Berendsen tekstilservice A/S Akzo Nobel Deco Trevira Neckelman A/S Bambo

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[1] 213.149 of the 229.976 companies in Denmark (excluding agriculture and fishery) had in 2001 less than 50 employees. The total number of employees in this 93% if the companies had around 50% of the total number of employees (Statistical Yearbook 2003)

| Eco-labelling | | (Leika Danmark A/S) | Technos A/S Levison+ Johnson+ Johnson | Berendsen Tekstilservice A/S Trevira Neckelman A/S ISS Danmark |
| Strategic co-operation | | (Leika Danmark A/S) | Phønix trykkeriet A/S | Berendsen Tekstilservice A/S ISS Danmark |

Table 9.1: The size of the companies, which initiated the different types of environmental initiatives in product chains

9.1 LCA

LCA is referred in the cases as a relative comprehensive effort, which may include training and technical knowledge about the methodology and the organisation of the activities. Furthermore, LCA is described as a relatively new tool, where not much experience has been obtained, compared to other environmental management tools.

The expectation is therefore that rather big companies, which have the knowledge and the economic resources to conduct a LCA, will initiate the use of LCA. The table shows, however, that not only bigger companies have applied LCA, since also a micro company and a small company are among the companies, who has initiated a LCA. The cases show that all the LCA's, except one conducted by a big company, were based on public funding of the activity.

The cases show that the companies see themselves as more innovative and focused on environmental concerns than, what they consider, the average than their competitors. Furthermore, that their customers also are more environmentally concerned. The environmental concerns together with the possibilities for public funding, seems to explain the interest in LCA.

The cases also show that in big as well as in smaller companies, LCA often is applied together with other initiatives, especially in connection with documentation of a certain environmental performance or the practice around certain chemical substances.

9.2 Customer information

Information to customers about environmental aspects of production or processes is here understood as information, which is given directly to the customers through business-to-business dialogue or through written information about the company. Eco-labelling is discussed in paragraph 9.7.

A number of the medium-sized and big companies refer to customer information as an element in their environmental management. These companies also produce or sell products, which are seen as having certain environmental advantages, compared to the products of the competitors. It seems like a characteristic of the companies that they are selling to professional customers.

9.3 Green procurement

Green procurement has as point of departure that the same product or the same service can be purchased in versions, which include different levels of environmental concerns. Two of the companies among the cases, have a green procurement policy, which have been the background for other initiatives like supplier assessments and LCA. Green procurement is a concept, which has been developed as part of the environmental management in governmental companies and institutions. The only public company among the case companies are together with a private company the two companies with a green procurement policy among the cases. According to the other cases, the implementation of public green procurement policies in governmental companies and institutions is limited, since the cases within green product development all show lack of success, because the governmental institutions do not buy the greener products.

Size may influence the use of green procurement. Smaller companies may find it difficult to make the necessary information or doubt whether they can influence the practice of bigger suppliers. According to Stranddorf et al (2002) it is, however, possible for smaller companies to make bigger suppliers interested in co-operation around their environmental demands; for example if the supplier sees the demands as a possibility to get access to a certain customer segment..

9.4 Recovery of materials and products

The cases include two cases where companies initiate the development of recycling schemes, one focused on plasterboard and one focused on plastic. Both schemes start out as internal schemes, which should enable internal recycling of production waste. Later on, the schemes were developed to have a broader basis. The scheme for plastic is developed to include plastic waste from other companies and the scheme for plasterboard is developed to include waste plasterboard from construction sites as raw material for new plasterboard.

In the plasterboard case the development of the scheme into a more national scheme and the dialogue with competitors etc. about quality demands has probably only been possible because the company is a substantial actor on the market and also has organisational resources to devote to this task. This perspective is mentioned in the cases, but it seems to be a reliable conclusion that establishing such schemes is only possible in companies with an important role within the area in focus.

9.5 Supplier assessment and -dialogue

Supplier assessments have primarily been used when companies based on information from suppliers make an assessment of their environmental performance. Supplier dialogues have been organised when a company enter into dialogue with existing and potential suppliers about changes in the supplied products or services. When a company is conducting supplier assessment or entering into dialogue with existing and potential suppliers the outcome is not necessarily a change in the practice of the supplier.

Small, medium-sized and big companies from the cases have conducted supplier assessment or supplier dialogue. Based on the cases it is not possible to conclude whether the size of the company is important in relation to this environmental initiative. The cases seem to show that companies with many suppliers assess their suppliers (Skanska, HCI Nordis A/S), while companies with fewer or very specialised suppliers tend to enter into dialogue with the suppliers (Novotex, Bdr. Hartmann, Kompan).

9.6   Green product development

As earlier mentioned, green product development may have an economic focus, where the new product is supposed to enable cost reductions due to reduced resource consumption, or may have a focus, where the product itself has less environmental impact and maybe at the same time is a more expensive product.

The reason why green product development with focus on resource savings are not more widespread may be that the company lacks knowledge about its current resource consumption or about alternative materials or methods and lacks the organisational capacity to conduct this kind of assessments and surveys.

The barriers to the development of products, which have less environmental impacts, seem to be lack of demand or the need to engage in development of this kind of demand. This may also introduce uncertainty whether it is possible to develop this kind of demand.

With respect to both types of green product development, it could be expected that bigger companies would have better possibilities to devote organisational resources for this kind of activities. The cases include four big companies and one medium-sized company, which have been able to develop greener products and develop demand for these products. The cases seem to show that the companies need a certain size to devote the necessary resources and furthermore that the companies need to have a certain position on the market to establish demand for the product. The cases where the product development takes place based on expectations to future public green procurement, seem to show that economic considerations among the public institutions, as mentioned earlier, are a barrier to development of demand for this kind of products (Bambo, Phønix, ISS Danmark).

9.7   Eco-labelling

Different types of eco-labels have been in focus in the cases, including public initiated and controlled eco-labelling schemes and eco-labels based on private organisations. The aim of eco-labels are to document that the products fulfil certain requirements to the product itself, to the manufacturing of the product and maybe also to the waste management of the products.

Since eco-labels are based on specific demands they are more based on societal expectations to environmental documentation, compared to supplier assessments and LCA's where the customer may have to develop the criteria for the assessments. This may enable smaller companies to use eco-labelling as a tool, since the assessments are based on a limited number of already known criteria. The company Technos A/S changed its environmental

management from LCA to eco-labelling because (some of) its suppliers were not willing to provide the necessary information for a LCA; apparently because Technos was a customer of limited importance compared to the amount of work that the development of the LCA data would demand. Furthermore, the eco-labelling only implied a limited scrutiny of the practice of the supplier, which may have made it more acceptable to the supplier to engage in dialogue about it.

Maybe the type of customer also influences the choice of eco-labelling as tool, since it may be seen as easier for smaller or less advanced customers to handle this kind of information. However, the cases do not make it possible to draw a conclusion in relation to this hypothesis.

9.8 Strategic co-operation

The cases with focus on strategic co-operation include two big companies and one medium-sized company. The cases have focus on development of the environmental competence of the companies and development of a stronger market position through development of new products or services.

The cases show development of more committed co-operation between customer and supplier. One case shows development of co-operation between two companies of the same size. In another case, the customer makes an agreement with a smaller company, which probably is more depending on the customer than vice versa.

10 The role of governmental regulation

This chapter analyses the role of different types of governmental regulation in the shaping of environmental management in product chains. By governmental regulation is also meant regulation issued by other actors than local or national governmental authorities. The cases show several examples where different types of governmental regulation has been important as driving force or barrier in the shaping and embedding of the environmental initiatives in product chains.

The analyses of the cases have identified the following types of governmental and international regulation as important in the shaping and embedding of the initiatives:

- Public funding for innovation, competence development etc.

- Regulation of chemicals

- Waste management regulation

- Product standards

- Public green procurement

- Eco-labelling

- Product panels

- ISO 14001 standard

- The Kyoto-protocol

The following paragraphs analyse the role of the different types of regulation, including interaction between the different types of regulation.

10.1 Public funding for innovation, competence development etc.

Some of the initiatives have been started because of public support for development projects within the Danish cleaner products programme and support for implementation of environmental management. Three of the initiatives with implementation of life cycle assessment have been supported through funding for dissemination of life cycle assessment as part of the efforts from the Danish Environmental Protection Agency for the further development and application of life cycle assessment as tool in environmental management and product design. However, the results of the two of the cases seems limited in terms of LCA achievements, since the partners in two of the projects found the provided LCA-model too time-consuming and too data

demanding. One important barrier was the problems with collection of the necessary data from suppliers due to the limited role of the companies as customers with several of their suppliers. One company decided in stead to focus on an eco-label for a product, because it turned out to be easier to make the suppliers answer rather specific questions concerning their use (or non-use) of specific chemicals.

The programme for cleaner products also supported a project developing a supply chain management system (focusing on environment, work environment and quality) in a textile company. Earlier on, projects on environmental management and cleaner technology in the printing industry were supported by a programme for cleaner technology and for employment of unemployed academia in business as environmental coordinators. There was a strong interaction between these projects and the initial phase of public green procurement, where printed products were an important product group in focus.

A project with development of environmental product declarations for a certain type of concrete products was supported by the programme for implementation of environmental management funded by the Danish Agency for Development of Trade and Industry and the Danish Environmental Protection Agency. This project seems to have been part of a branch project, since the programme only supported branch-oriented projects and not specific companies unless it was aiming at providing experience for the whole branch.

Finally, there is one example of governmental support from a non-environmental programme. A centre for so-called resource-saving concrete constructions with a number of the companies and consultants within design and manufacturing of concrete and the Danish Agency for Roads were supported by a programme for centre contracts managed by the Danish Agency for Development of Trade and Industry. The programme aimed at supporting targeted and strategic innovation projects. The aim was to develop and test new forms of concrete using rather high amounts of residual products as a substitute for a part of the cement in the concrete, whereby the amount of greenhouse gasses from the production of cement for a concrete construction was reduced. The project was seen a contribution to the fulfilment of Danish target for reduction of Danish emissions of greenhouse gasses according to the Kyoto protocol. This project shows interaction between two types of governmental regulation. An international agreement (although not officially sanctioned at that time) acted as guidance for environmental innovation activities, which were supported by an innovation programme. The project shows also another (intended) interaction with governmental regulation, since it was the expectations of the participants in the centre that the experience with the new forms of concrete would inspire changes in the Danish rules for construction of roads and bridges, the co-called Road Rules. These rules act as a kind of standard for the public tenders within the area.

10.2 Regulation of chemicals

The Danish regulation of chemicals, in terms of the so-called list of unwanted chemicals, has provided guidance for some companies focusing on substitution of hazardous chemicals applied in the manufacturing of their products.

Another way that regulation of chemicals has shaped some of the cases is through demands from foreign industrial customers in order for them to meet demands for the application of chemicals in their manufacturing processes and/or in their products.

10.2.1 Waste management regulation

The increased fees on waste management have shaped two cases. A national initiative on recycling of waste plasterboard material from construction sites was initiated based on a wish for recycling of plasterboard waste to a manufacturer of plasterboard material from a big renovation project. This wish from the renovation project might have been inspired by the fees on waste for landfilling, like the manufacturer's efforts for reduction of landfilling from their own production. Due to the wish from the renovation project, the manufacturer of plasterboard decided to initiate a project on the development of a national scheme for collection of plasterboard waste. Guidelines for the quality of the waste, which should be accepted for recycling, were developed in co-operation with the other major manufacturer of plasterboard and two inter-municipal waste management companies. However, the need for every municipal administration to allow this form of collection for recycling as part of their local waste management regulation turned out to be a weak point in the implementation of the scheme, since only a few municipalities have signed the agreement. However, the development of the scheme with respect to logistics and the type of plasterboard, which is recyclable, has continued. The barrier with the differences in the municipal waste management schemes has been a barrier to the other initiative within recycling of residual materials, in this case a project on recycling of plastic waste.

10.3 Product standards

The role of standards for construction materials (concrete and plasterboard) has already been mentioned as an important condition for integration of quality aspects into the development of products (partly) based on use of residual products as raw materials. Another example is the role of the European Directive on Construction Products, which initiated an enquiry from a big Swedish company to a Danish manufacturer whether a number of chemical products were included in the components the company was delivering to the Swedish company. This enquiry inspired the Danish company to further develop their database with information about the many components, which the company is selling, and develop guidelines for integration of environmental concerns into the development of new products.

10.4 Public green procurement

The demand for public green procurement in national governmental administrations and institutions, and the focus on this in municipal and regional administrations and institutions, has implied an interest for the development of "greener" products in a number of the cases. In several of these cases there is an interaction with eco-labelling. Several companies, within printed goods, furniture, sanitation products and detergents, have used eco-labelling criteria as guidance in their product development. However, most of the cases show no or very limited interest from the governmental institutions for buying these products. The problem seems to be an increased price (in some cases) and the turnover fee for eco-labelled products. Often the

manufacturer add this turnover fee to the product price, which make some customers ask for the eco-labelled quality, but without the label on the product in order to avoid the turnover fee. Only within printed goods there is some demand for eco-labelled products, but also here governmental customers ask for products without the label. The two printing houses print only eco-labelled quality, but the lack of the physical eco-label on a part of the products reduces the visibility of the eco-label and reduces thereby the potential dissemination of the eco-label.

The restricted governmental budgets and the surplus price on many eco-labelled products limit together eco-labelling as environmental strategy. It is not clear to what extent the eco-labelled products are more expensive – apart from the turnover fee – and whether surplus prices mirror actual surplus product costs. The case with eco-labelled napkins shows extra product costs of around 4%.

10.5   Eco-labelling

Besides the interaction with public green procurement as described above, eco-labelling has also had a role in one of the initiatives, where eco-labelling criteria together with the list of unwanted substances acted as guidance for the development of an environmental declaration on metal products. The list and the eco-labelling criteria help identifying criteria for what information to include in the environmental product declaration.

10.6   Product panels

The product panels are not mentioned in any of the cases, but in relation to the dissemination of the eco-label within the textile and clothing sector the textile product panel played an important role in bringing together actors within the supply side (the manufacturers and the designers), the demand side (the retailers) and the knowledge system (NGO's). These panels can be seen as a case within the policy network governance paradigm. As mentioned, it has had an important role in the interaction with eco-labelling as strategy within the sector, although the actual market share still is very limited. The product panels have similarities to the centre on concrete constructions, which also included demand, supply and the knowledge system.

10.7   ISO 14001 standard

The standard on environmental management systems has played a role in a number of cases. Some companies have engaged in initiatives in product chains as part of their implementation of an environmental management system. One company describes how the environmental management system was helpful in the data collection when answering an enquiry from a customer. Some other companies have implemented an environmental management system as part of their involvement in one of the product chain initiatives.

10.8 The Kyoto-protocol

The role of the Kyoto protocol as an example of an international environmental agreement inspiring specific initiatives for fulfilment of national targets has already been mentioned in relation to the development of concrete products with a high content of residual products (from incineration of waste water sludge).

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