

# **Product Integrated Environmental Protection Strategies in the Textile Supply Chain: Source of Economic and Environmental Benefits**

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## **Abstract**

The crucial issue for the greening of small and medium-sized enterprises is the embedding into an overall supply chain management. In this context, transparency and communication are key factors. Analyzing environmental and economic impacts within supply chains, we distinguish three different levels: the process level, the plant level, and the product level. Within this research project, the economic and environmental benefits of product integrated environmental protection strategies are investigated. An example is given by the whole textile supply chain for wool. With respect to the issue of cooperation we show the importance of environmental information management and its effect on decentralized decision making.

## **1 Introduction**

Environmental protection shows to be a strategy factor of importance for enterprises. For enterprises with an active environmental protection strategy various advantages and opportunities can be pointed out [see e.g. Dyckhoff, Souren (1994); Gege (1994); Haasis (1996); Meffert, Kirchengorg (1994)]. Furthermore cooperations offer the ability to accomplish an effective environmental protection for small and medium-sized enterprises.

Such opportunities and advantages can have internal as well as external influences [Hasselmann (1995)]. Here an external factor is the challenge to be able to cope with environmental protection legislation. An active environmental protection strategy offers further possibilities. One of the possibilities of a foresighted environmental protection strategy is the opportunity to implement future developments of expected rules in a better way or for lower costs [Haasis (1996); Wicke et. al. (1992)].

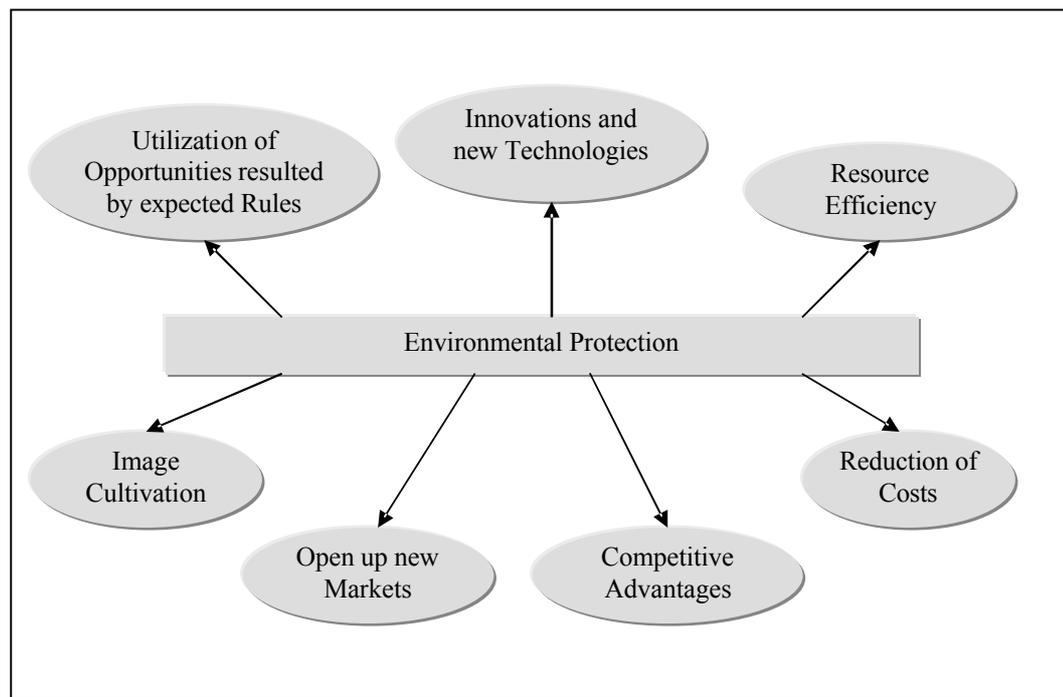
In addition, the chance to develop innovations and new technologies for small and medium-sized enterprises arises in cooperation. The utilization of raw materials can

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be reduced with an increased *resource efficiency*. This induces even *cost reduction potentials*. Without an active environmental protection strategy the cooperating enterprises are unable to achieve these *cost reduction potentials*. In total, active environmental protection strategies lead to competitive advantages.

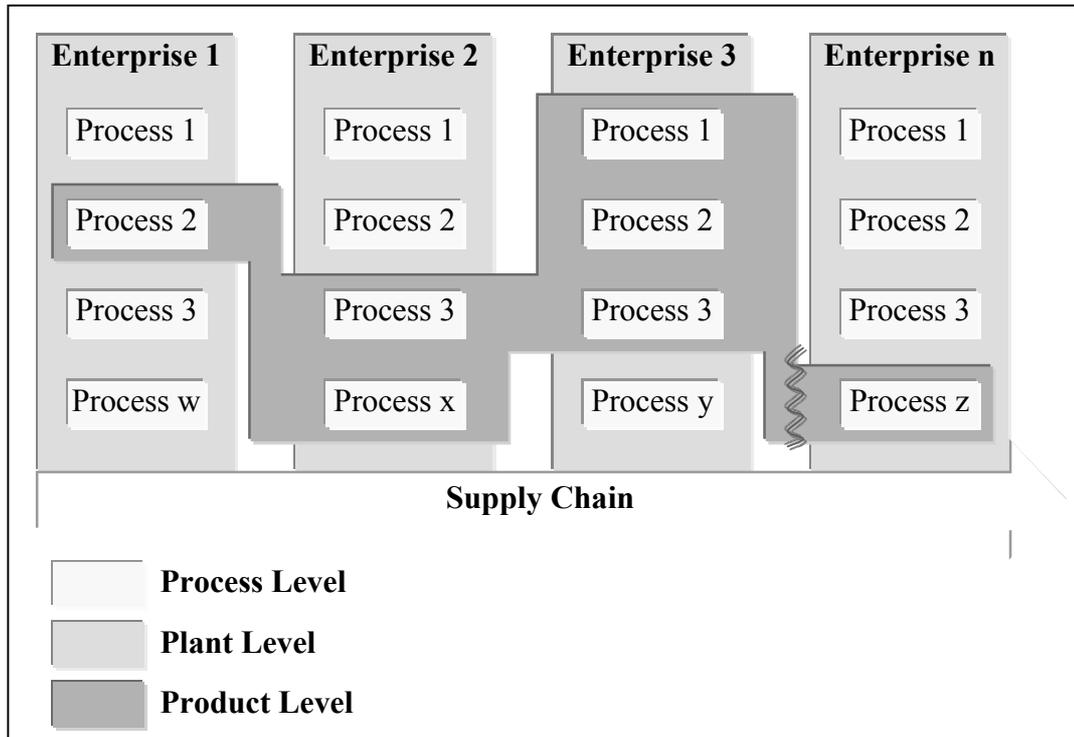
Figure 1 shows the most essential opportunities and advantages of an environmental protection strategy.



**Figure 1: Opportunities and advantages of an environmental protection strategy**

## **2 Integrated Environmental Protection**

It turns out that an integrated environmental protection strategy is better suitable, than the *end-of-the-pipe-solutions*. Integrated environmental protection strategies can be identified on three levels [Haasis (1994)]: the process level, the plant level, and the product level. Figure 2 shows the relationship between these three levels of integrated environmental protection strategies.



**Figure 2: Levels of integrated environmental protection strategies**

Integrated environmental protection strategies consist of measures which intervene in the process level, the plant level or the product level. The result of these measures is an increase in environmental-friendliness.

The goal of integrated environmental protection on the process level is to avoid or to reduce environmental pollution. This avoidance or reduction can be obtained by modulations of manufacturing plants [Wicke et. al. (1992)]. In this context all the environmentally relevant aspects of specific processes will be taken into account and reorganised to be more environmental-friendly. For instance, the noxious emission can be reduced as a result of replacing resources by substitutes.

The integrated environmental protection on the plant level takes into consideration all of the environmental-relevant aspects of the whole enterprise. In this case the environmental protection is not only concerned with single processes. The integrated environmental protection on the plant level represents the attempt to develop a more environmental-friendly production for the entire enterprise. Examples to achieve a more environmental-friendly production are the internal reprocessing of production materials or the reuse of materials in production processes. As a result gaseous emission, sewage and/or refuse can be reduced.

As can be seen from Figure 2, the environmental protection on the product level contains inter-organisational aspects. In this context all necessary processes for the production of one good are taken into account. But not every department of the participating enterprises have to be examined. In general, enterprises vary in size. Thus it can be that only a few departments take part in the production of a specific good, considering e.g. a very large enterprise.

Often small and medium-sized enterprises do not have the same the possibilities and technologies as large companies. Single small and medium-sized enterprises do not have the chance to develop an effective environmental protection strategy. By means of cooperation, the product integrated environmental protection strategy offers a feasible environmental protection for the participating enterprises. In this context an inter-organisational information management is necessary. This shows the importance of communication and transparency for the success of product integrated environmental protection strategies.

Companies within the textile supply chain increasingly perceive the possibilities of environmental protection on the product level. The textile supply chain mainly consists of small and medium-sized enterprises [Gesamttextil (1998)]. Varied chances exist for product integrated environmental protection strategies, in this context. The product integrated environmental protection strategies are supported by the linear production process of the textile economy. The single processes within the textile supply chain can only be carry out in one predetermined sequence. Thus the production process within the textile supply chain is called *textile-pipeline* [compare e.g. with Hummel (1997); Wojaczek (1996)].

In order to make the production of textiles more environmental-friendly, it is necessary to act on an inter-organisational level within the textile supply chain. As mentioned above, small and medium-sized enterprises in cooperations have greater chances to respond to the challenges caused by environmental protection requirements. In combination, the interfaces between the individual enterprises should be examined. In such a way the interrelationship as well as the flow of information within the textile supply chain can be analyzed. Following these investigations, strategies for product integrated environmental protection can be developed. This shows, that environmental-oriented measures are not feasible without sufficient transparency and communication.

### **3 Actual Situation in the Textile Supply Chain**

#### **3.1 The Textile Supply Chain**

Fibre production, textile and clothing industry as well as wholesale and retail trade<sup>1</sup> for textiles participate in the textile supply chain. Varied fibres and mixtures of fibres are required for the production of textiles<sup>2</sup>. So the fibre production constitutes the basis for the textile supply chain.

Between 1900 (4 Mill. tns) and 1950 (9,4 Mill. tns) the world fibre production increased parallel with the population growth. The per-capita consumption on textiles rises since 1950 disproportionate to the world population [compare e.g. Hasselmann (1996)]. In 1995 the world fibre production amounted to 47.5 Mill. tns [Gesamttextil (1998)]. This means an enhancement of about 400% since 1950. Different forecasts consider varied trends at the per-capita consumption of textiles. One conclusion following this forecasts is the increase of fibre production in the next 30 years up to

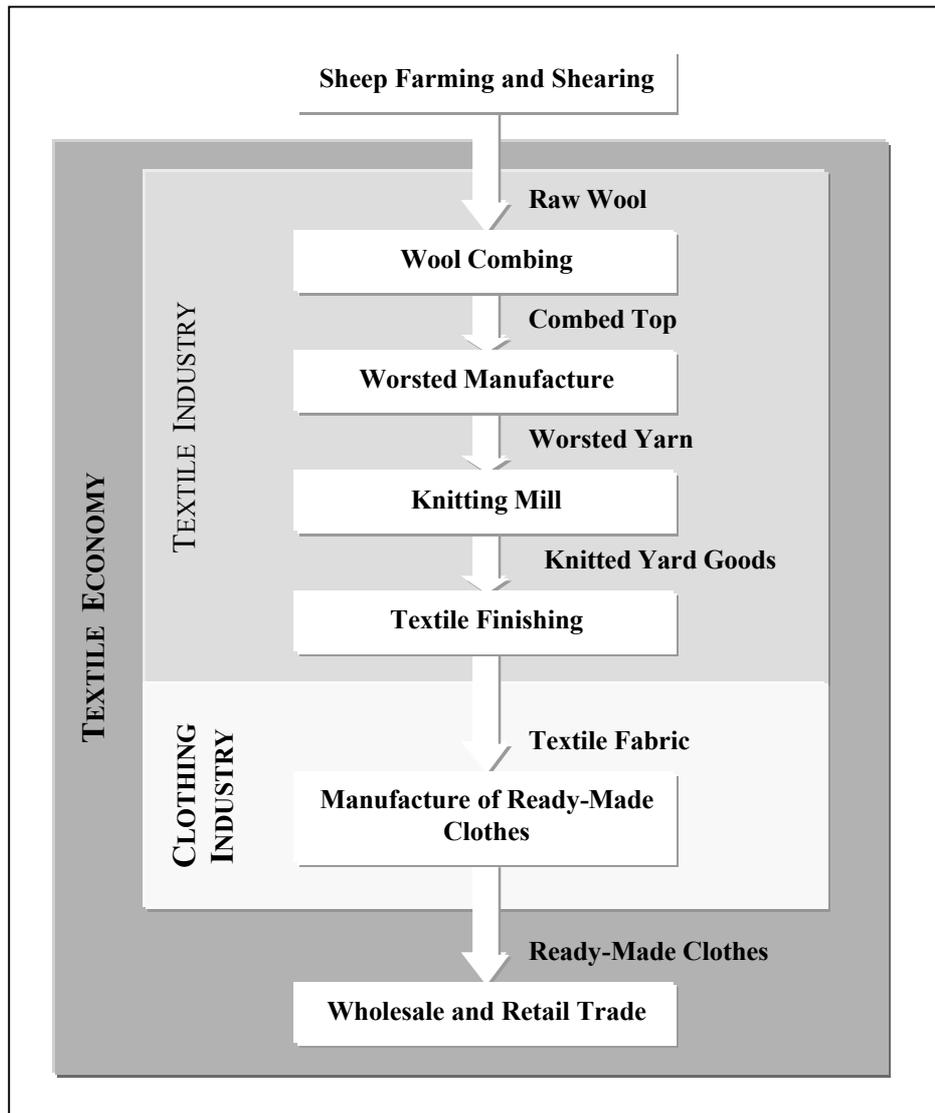
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<sup>1</sup> In the following the abbreviation 'trade' stand for wholesale and retail trade.

<sup>2</sup> For example the natural fibres and the various man-made fibres.

72 Mill. tns. (low-key forecast) or 120 Mill. tns. respectively. This increase corresponds to the supposed fibre consumption and indicates that an environmental awareness within the textile supply chain is necessary<sup>3</sup>. With the increase of per-capita consumption on textiles rises the environmental pollution resulted by the production of textiles.

Figure 3 illustrates the production stages within the textile supply chain with an example for wool textiles.



**Figure 3: Production stages of the textile supply chain for sheep's wool**

<sup>3</sup> Especially in terms of the fact, that the substances which are necessary to produce man-made fibres rank among non-renewable raw materials.

### 3.2 Environmental Pollution on the Production Stages of the Textile Supply Chain

On every stage of the textile supply chain different environmental impacts as well as varied kinds of pollution occur. Thus the possible environmentally oriented measures are called *production ecology*, *human ecology*, and *disposal ecology* [compare e.g. Hummel (1997); Kaiser (1996); Wojaczek (1996)].

The *production ecology* deals with the environmentally friendly production of textiles. Effects on humans such as the concentration of harmful substances in textiles are investigated by the *human ecology*. And furthermore the *disposal ecology* deals with the disposal of textiles. In the following a brief overall view about environmental impacts within the textile supply chain will be given.

#### a) Fibre Production

The man-made fibres are produced out of non-renewable resources. Beside this environmental impacts arise as a result of the production of natural fibres. This is due to the extreme use of pesticides, manures as well as defoliants. An improper use of these substances causes 1.500.000 poisonings, among them ca. 28.000 lethal yearly. Furthermore the draining of the Aral Sea<sup>4</sup> is attribute to the high water consumption on cotton cultivation [Visser (1997)].

#### b) Textile Production<sup>5</sup>

Old production plants cause environmental impacts within the textile production such as dust and a high noise level. Furthermore a great energy consumption results by fully automated production processes. In addition yarns will be treated with primer in the textile production. So the yarns are hardwearing. As a result the yarns can cope with the rotation speed of machines without damage. This aspect has an effect on the environmental impacts of the textile finishing. At the textile finishing the primer has to be washed out before further processing. In this way the primer pollutes the sewage of the textile finishing although it is assigned to the textile production.

#### c) Textile Finishing

After textile production the textiles get a handling for specific characteristics or special appearance<sup>6</sup>. Various chemicals are needed for this process. Thus the textile finishing is the most environmentally hazardous production stage within the textile supply chain. In addition the water consumption, the concentration of harmful substances in the sewage, the energy consumption as well as the possible health hazard are further environmental impacts of the textile finishing.

#### d) Manufacture of Ready-Made Clothes

Ready-made clothes are made from the textile fabrics of the textile finishing. Losses by cutting to size causes a lot of refuse. This production stage causes only a lower level of environmental pollution.

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<sup>4</sup> In the last 30 years the Aral Sea lost  $\frac{3}{4}$  of his water.

<sup>5</sup> The Textile Production consist of the first three production stages of the Textile Industry. See for example figure 3 (Wool Combing, Worsted Manufacture, Knitting Mill).

<sup>6</sup> For example bleaching, dyeing, printing, washing, coating or making waterproof

#### **4 Environmental-Oriented Measures within the Textile Supply Chain**

As can be seen from previous chapters various environmental impacts arise within the textile supply chain. In this context environmental-oriented measures are required, in order to ensure an environmental-friendly production of textiles. This fact gains additional importance in view of chapter 3.1 *The Textile Supply Chain*. If there are no environmental-oriented measures in the textile economy, the environmental impacts will increase to the same extent as the per-capita consumption of textiles.

An environmental protection only on the plant level does not lead to effective results concerning environmental impacts within the textile supply chain. This will be shown by means of the following examples. Cooperations are necessary to develop the production of textiles more environmentally friendly. In addition, transparency and communication are required within the textile supply chain.

Already at the beginning of the textile supply chain it is possible to avoid environmental impacts. For instance by means of a lower use of pesticides or the use of biodegradable pesticides. On the one hand the following production stage (wool combing) has the possibility to wash out the concentration of pesticides with a lower use of surfactants. On the other hand the contamination of waste water will be lower and the sewage treatment can be executed by a minor effort. Especially in view of the German environmental legislation, this is a possibility to reduce costs. If enterprises in Germany dump their sewage into waters, they will be subjected to water pollution control regulations. In this case sewage taxes arise according to the concentration of harmful substances. As soon as the concentration of harmful substances is reduced, the sewage taxes will go down as well. Furthermore the wool combing needs fewer washing substances. All these facts lead to more environmental-friendliness and additionally to a reduction of costs.

Knitting mills are under pressure to produce their knits appropriate to the latest fashion. If an environmental-friendly fashion is on demand, then the knitting mill will need environmental-relevant information for the purchase. The knowledge on how work was done on the preceding stages has to exist in these enterprises, in order to declare the environmental-quality of the knitting yarn goods. Without cooperation and exchange of information, there are no possibilities to implement product integrated environmental protection-strategies.

The environmental-requirements for the manufacturing of ready-made clothes are similar to the requirements for knitting mills. The manufacturer of ready-made clothes has to fulfill conditions of trade as well as desires of consumers. Without knowledge about the treatment of textiles on the preceding stages the manufacturer of ready-made clothes not treat the requirements of consumers or trade respectively. These enterprises need environmental-relevant information to declare further details about their own environmental-quality.

The production processes of the textile finishing are the most harmful to the environment. Besides internal measures for the environmental protection, the textile finishing enterprises have the responsibility to ensure an adequate exchange of information. This relates to the production processes as well as the use of chemicals. Furthermore these enterprises recognize that a comprehensive environmental

orientation can only happen in cooperation with the preceding production stages of the textile supply chain [Meyer-Stork (1996)]. For example, the textile finishing needs information about the primer which were used at the preceding stage. With this information it is possible to wash out the primer in a more effective and environmental friendly way. Moreover, it is important for the trade to have information about the environmental impacts of the textile finishing. For the consumers the trade is the *'person to turn to'*. If the trade has the knowledge about the environmental impacts of preceding stages, they will have the possibility to inform the environmentally conscious consumer about the environmental-quality of the desired textiles.

An adequate advertising or supply of information enables for the trade to increase the interest of consumers in environmental-friendly textiles. The trade can realize measures to improve the demand for environmental-friendly textiles. In all cases they need information about the environmental impacts of the whole textile supply chain.

As mentioned above, cooperation, communication as well as transparency are necessary for environmental-oriented production within the textile supply chain. Environmental impacts can be reduced by means of an appropriate registration, assessment/treatment, and passing on of environmental relevant information.

## **5 Valuation of measures**

In order to reduce the environmental impacts on a long term basis, it is necessary to improve transparency and communication within the textile supply chain. Although new difficulties which have to be solved might occur. Economic and capacitive limits of business partners as well as the complexity of material flows rank among these difficulties [Schneidewind (1998)]. A further challenge is the global distribution of the production locations within the textile supply chain. This means different economic, social, and ecological conditions for the individual production stages.

In addition the effects on the environment resulted by the used chemicals are unknown. The fear to lose competitive advantages is the reason why information about used substances will not be transmitted. In this context a significant aspect is the readiness for cooperation within the textile supply chain.

Moreover, common research and development projects are essential for an effective environmental orientation. It is necessary to show ecological advantages as well as economic advantages which will be developed by product integrated environmental protection-strategies. The abilities of partners as well as an appropriate transparency and communication are the foundation of cooperation within the textile supply chain.

An *environmental certificate* can be able to increase transparency and communication. Such an environmental certificate should have uniform evaluation criteria. Often, existing labels relate only to specific concentration of harmful substances (e.g. *'Oeko-Tex-Standard 100'*). Further the labels are related to possible health hazards. Hardly any label gives further details on environmental impacts resulted by the production. A certificate which shows the environmental demands on

each production stage could improve the flow of information<sup>7</sup> within the textile supply chain.

For enterprises, the advantage of such a certificate is to adjust their production processes according to the information they got out of this certificate. Thus an environmental-oriented development of production processes is possible. In addition, consumers as well as enterprises can compare the environmental-friendliness of different textiles by an environmental certificate with uniform evaluation criteria. This could be an important step towards an environmental-orientation within the textile supply chain.

## **6 Conclusions**

In the future an environmental oriented strategy offers decisive advantages for enterprises. An inter-organisational cooperation is necessary for an effective environmental-orientation within the textile supply chain. Only with knowledge about the environmental-relevant treatment of textiles it is possible to redesign the production more environmental-friendly. Information about used chemicals or environmental-relevant production processes allows to coordinate the production in view of an environmental-orientation.

In this context it is obvious that the readiness for cooperation has to exist in order to increase transparency and communication in the required way. Nevertheless, there are still different difficulties which impede such cooperations. As a result it is essential to develop concepts for an inter-organisational cooperation. The method to solve the problem could be an environmental-certificate which collect environmental-relevant information on every stage.

It has to be clarified, which information are needed and in which way (Information-acquisition, -valuation, -treatment, and -forwarding). An additional question is: to what extent are specific information necessary for the whole textile supply chain? It can be possible that only the following production stage need specific information to fit their production processes in view of an environmental-orientation. Thus an additional forwarding of further details can be unnecessary. From that point of view it can be enough to pass the environmental-relevant information on to the next production stage. The single production stages can implement processes in view of an environmental-orientation. After that they adjust the certificate with their own results of the implementation of environmental-friendly production processes. In such a way it would be achieve that this environmental-certificate not contains a lot of unnecessary information in the long run.

Additionally can these aggregated information customized for consumers. Thus they can be plausible informed about the environmental friendliness of a specific textile. By means of classification it can be possible to compare the environmental-orientation of the production of different textiles.

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<sup>7</sup> The following information should be included (as far as they are environmental-relevant): water consumption, energy consumption, used chemicals (sort and quantity) etc.

Furthermore, enterprises have the opportunity to improve their environmental protection strategies in a continuously process. One thing is for certain, an '*on and on as always*' is not desired on account of environmental impacts resulted by the production of textiles. In view of an environmental-orientation within the textile supply chain it is necessary to develop instruments, measures and conceptions in order to support enterprises to enter into cooperations.

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