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SUSTAINABLE DEVELOPMENT AND ITS INTEGRATION IN BUSINESS DECISIONS: THE CASE OF THE PROCUREMENT OF OPERATING-ROOM TEXTILES IN GERMAN PUBLIC HOSPITALS

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ABSTRACT

Sustainable development as a main objective for our society is widely accepted. The breakdown of the concept from its macro level to the micro level from a company's perspective is, however, influenced by impairments. The integration of specific criteria in procurement is an important aspect for the realisation of sustainable development in business decision-making. Procurement has the potential to influence the production process, the application phase and the end-of life of goods and services, by determining environmental aspects over the whole life-cycle of a product together with economic aspects within the scope of the procuring organisation. This contribution analyses possibilities for the integration of sustainable criteria into business decision-making by means of a case on the procurement of operating-room textiles in German public hospitals integrating environmental aspects besides the "traditional" decision criteria of hygienic, technical characteristics and economic considerations. The relevance of all criteria for operating-room textiles will be discussed and presented with short examples. In addition focus is laid on the availability and acquisition of sustainability related information. This process includes the analysis of sources directly and indirectly related to operating-room textiles. By this the difficulty of the integration of Sustainable Development related criteria in decision making is shown. Finally, an approach for the Sustainable Development oriented procurement of operating-room textiles is proposed integrating all traditional decision criteria.

Keywords
Operating-room textiles, sustainability, green procurement, life-cycle assessment, hospital .

INTRODUCTION

The concept of sustainable development is widely discussed in our society today. How the concept can be realized in the daily operations of companies is still vague. Therefore this paper analyses the integration of sustainable development in a standard operational process in companies. As example the procurement of O.R.-textiles in hospitals is chosen. The authors do their research from the perspective of a procurer in a hospital directly evaluating the information available for O.R.-textiles and an assessment in terms of sustainable development.

Thereby, the paper is based on the assumption that the integration of sustainability into procurement is a sine qua non. Therefore it is also assumed that a supply policy and strategy integrating sustainability is in place for the analysis. The further considerations in this paper focus on the level of supply management. Following Zsidisin and Sifers green supply management is defined as: "set of purchasing policies held, actions taken, and relationships formed in response to concerns associated with the natural environment."[i]

In the first section the concept of sustainable development is defined. In the second section the importance of procurement as an important factor to integrate sustainable development in business operations is outlined. The third section of the paper describes the project the research presented here is based on. Thereafter, four aspects influencing the integration of sustainable development in procurement are analysed in the fourth section. Finally, in the fifth section an approach to integrate the dimensions of sustainable development in procurement processes is presented.

SUSTAINABLE DEVELOPMENT AND COMPANIES

Sustainable development as a main objective for our society is widely accepted. A breakdown of the concept from its macro level to the micro level is essential since companies are responsible for the largest portion of material flows within the societies as well as the exchange of materials and energy with the environment. At present the principle of the sustainability is not achievable without integration of the companies.[ii]

The well known and often cited Report of the World Commission on Environment and Development defines sustainable development as a development that meets the needs of the present without compromising the ability of future generations to meet their own needs.[iii] Dyllick and Hockerts (2002) transpose this idea to the business level and define corporate sustainability as meeting the needs of a firm's direct and indirect stakeholders (such as shareholders, employees, clients, pressure groups, communities etc), without compromising its ability to meet the needs of future stakeholders as well.[iv] Towards this goal, companies have to maintain and grow their economic, social and environmental capital base while actively contributing to sustainability in the political arena. From this definition, economic, ecological and social aspects can be identified as key elements of corporate sustainability.[v]

Economically sustainable companies guarantee at any time cash flows sufficient to maintain liquidity while producing a persistent above average return to their shareholders.[vi] The social part of corporate sustainability means that organisations are responsible to all stakeholders.[vii] They are responsible for the actions of employees working in the company as well as for actions that effect actors in and outside it. Social responsibility is about holding an organization accountable for its effect on the people around it. The third part of sustainable

responsibility can be seen as the idea that a company has even more responsibility to the environment and the world around it than an individual. Companies by nature act on a far larger scale than an individual could. Thus, their environmental impacts generally are far greater and have much further reaching impacts than those of an individual consumer. Therefore the pressure on companies to manage their environmental impacts positively is increasing. There are great efforts especially in the European Union towards useful legislative pressure, support as well as guidance to make companies consider their environmental aspects and therewith take their responsibility.[viii] This paper in its objective to analyse the integration of sustainable development into procurement decisions will focus on the environmental dimension of sustainable development. Nevertheless, as the paper aims at the development of a holistic assessment method for the procurement of O.R.-textiles also the economic dimension is addressed via the application of Life-cycle costing. The societal dimension is not specifically addressed[ix].

There is no clear solution how companies can integrate sustainability into their operations and there are numerous different possibilities.[x] Concepts for systematic management and monitoring of sustainable development that have gained global recognition are for example ecological management systems (EMS) applied for better ecological performance in firms as ISO 14001 and the corresponding system launched by the European Union, EMAS. There are also tools focusing on the environmental performance like Life cycle assessment (LCA)[xi] or ecological foot-printing (EF) and Factor X.[xii]

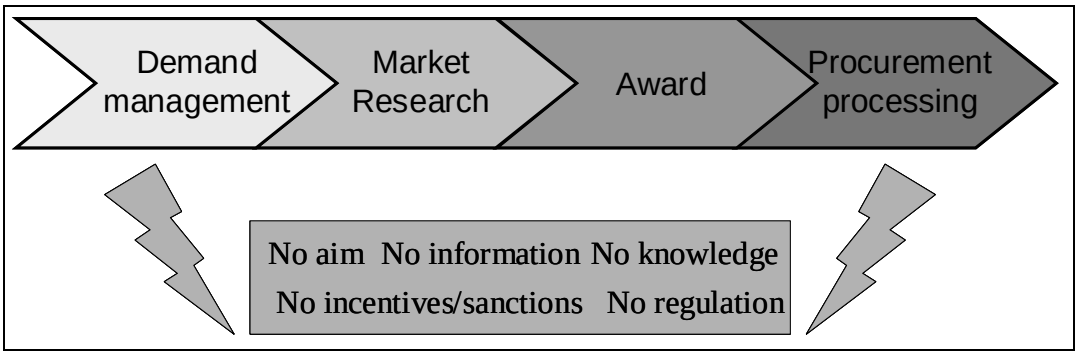
THE RELEVANCE OF PROCUREMENT

The integration of specific criteria in procurement as a function of supply management is an important aspect for the realisation of sustainable development in business decision-making. Procurement has the potential to influence the production process, the application phase and the end-of life of goods and services, by determining environmental aspects over the whole life-cycle of a product together with economic aspects within the scope of the procuring organisation.

That is why the potential of procurement is already considered by the European Commission, who promote green procurement widely.[xiii] In addition, companies also started to include corporate social responsibility into their supply processes.[xiv] Nevertheless the full possibilities of green procurement have not been integrated into decision making yet.
In procurement processes especially for the integration of sustainable development dimensions like environment the influence of hurdles is proven.[xv] Following the structure of the hurdles analysis developed at TU Dresden there are five major hurdles to be looked at: no aim of the organization or the individual, no regulation (internal or external), no knowledge, no information and no incentives. The research method applied following this research is based on secondary analysis, evaluating the perception of procurers. The research on hurdles in environmental procurement is extended to primary analysis in this paper. The background is provided by a project founded by the "Bundesministerium für Bildung und Forschung" ("German Ministry for Education and Research") with the objective to design a possible aid for the sustainable-oriented procurement of O.R.-textiles based on their whole life-cycle, further described in the next section. In order to reach this objective the authors aim at elaborating a best practice example for the procurement of O.R.-textiles. Therefore, the authors do their research from the perspective of a procurer in a hospital directly evaluating possible hurdles that might hinder a sustainability-oriented procurement of O.R.-textiles.

Procurement is a special decision process requiring a wide and detailed expertise of the decision-maker concerning the procurement object. Often decision makers are overextended by the consequences. The prerequisites assumed in this paper are on the one hand the existence of an aim to integrate environmental aspects on the organizational as well as personal level, and that there are no restrictions by missing incentives or possible sanctions, e.g. restricted time. Hence, excluding the two hurdles of missing aim and no incentives three main hurdles identified for the procurement are at the focus of research: no knowledge (development of decision criteria and data evaluation), no information (data availability) and no supportive regulation (legal constraints). Figure 1 summarizes the different steps in a procurement process and combines them with the identified hurdles existing for the process.

Figure 1: Structure of a procurement process and existing hurdles



The special importance of public procurement is underlined by its economic impact.[xvi] In 2002 more than 1.500 billion Euros were spent in the EU for public procurement. In Germany more than 10% of the GDP steam from public procurement. The case described in this article focuses on O.R-textiles procured by German hospitals that spent more than 21.5 billion Euros in 2004 for procurement. The procurement of O.R.-textiles, where no more detailed information is available, is included in this number. However, in 2003 almost 8 million operations were performed in German hospitals[xvii], all of them applying O.R-textiles and causing O.R.-textile related energy, material and financial flow. Assuming that four gowns and four drapes are used in each operation this equals 32 million gowns and drapes used annually, a number that indicates the large scale of environmental aspects caused by O.R.-textiles. Therefore the application of O.R.-textiles and their consequences are further elaborated in a project funded by the German Research ministry described in the next section.

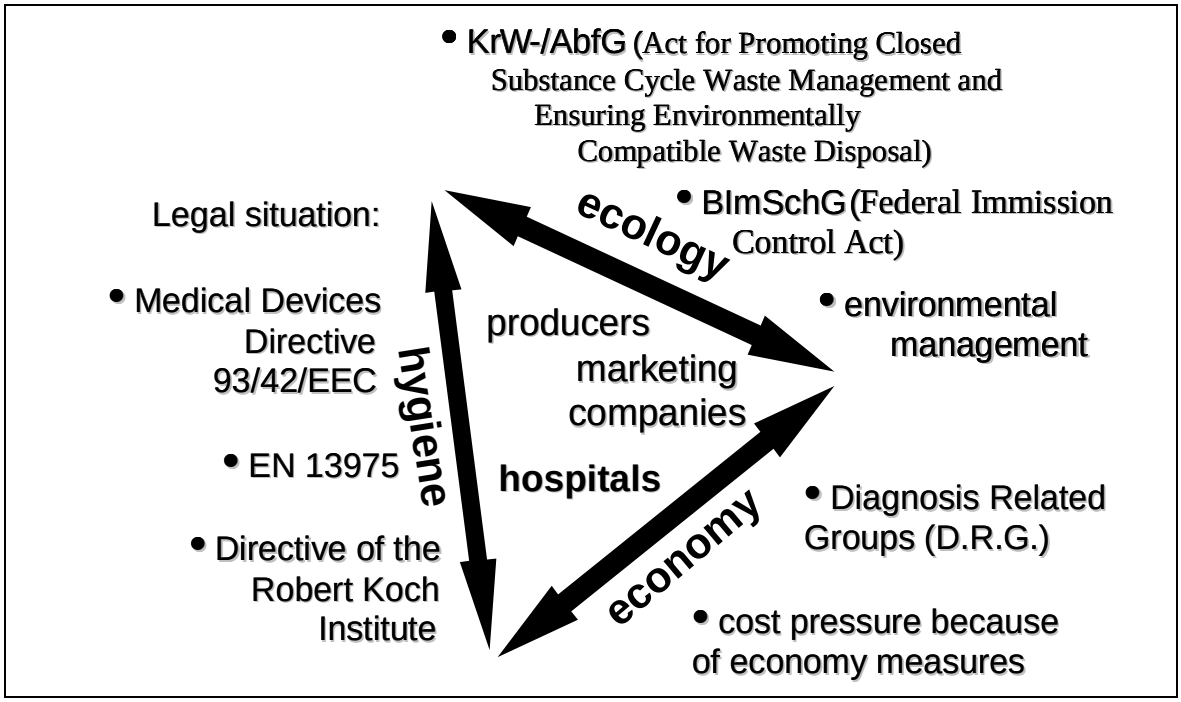
O.R.-TEXTILES – OUR PROJECT AT A GLANCE

The relevance of the project is among other based on the following factors. The risk of surgical site infections is always present in an operation. Approximately 160,000 cases, or 2% of all surgeries, are estimated to result in infection.[xviii] According to Plowman, R. et al. 1999 a case with an infection costs, on average, 2.9 times more than a case without infection.[xix] Therefore, the avoidance of surgical site infections is important from a medical and also an economic point of view for hospitals and health-policies.

One mean of reducing the risk of a surgical site infection is the use of innovative operating-room-textiles (O.R.-textiles) as an important prophylactic measure against infections within the operating room. The primary function of O.R.-textiles is their barrier-effect against pathogens, which was evaluated in different studies.[xx] In addition a number of legal requirements (e.g. Medical Device Directive 93/42/EEC, DIN EN 13975 etc., Directive of the Robert Koch Institute) have to be considered when assessing O.R.-Textiles.
Up to now, O.R.-textiles have been selected primarily according to their purchase price.[xxi] After the "diagnosis related groups" were introduced in Germany a great pressure has been put on hospitals, and full cost accounting has become vital. The assessment of different alternatives of O.R.-textiles – such as single-use and reusable ones – with there specific requirements to linen-management at the hospital, are part of that economic analysis.

On top of this, environmental protection measures also should be considered in product decisions in order to find the best alternative, as the negative health effects of pollution are known[xxii], the hospital itself is material- and resource consuming[xxiii] and legal requirements (e.g. KrW-/AbfG (Act for Promoting Closed Substance Cycle Waste Management and Ensuring Environmentally Compatible Waste Disposal), BImSchG (Federal Immission Control Act)) also must be followed.
All this leads to the conclusion that O.R.-textiles have to be analysed and compared from a hygienic, an economic and an environmental perspective integrating sustainable development criteria. Thereby the analysis has to distinguish between, single-use and reusable products and their individual life-cycles. The life-cycle includes all stages an O.R.-textile passes, from production, use, till disposal. The summarized criteria that have to be considered evaluating O.R.-textiles in Germany are presented in Figure 2.

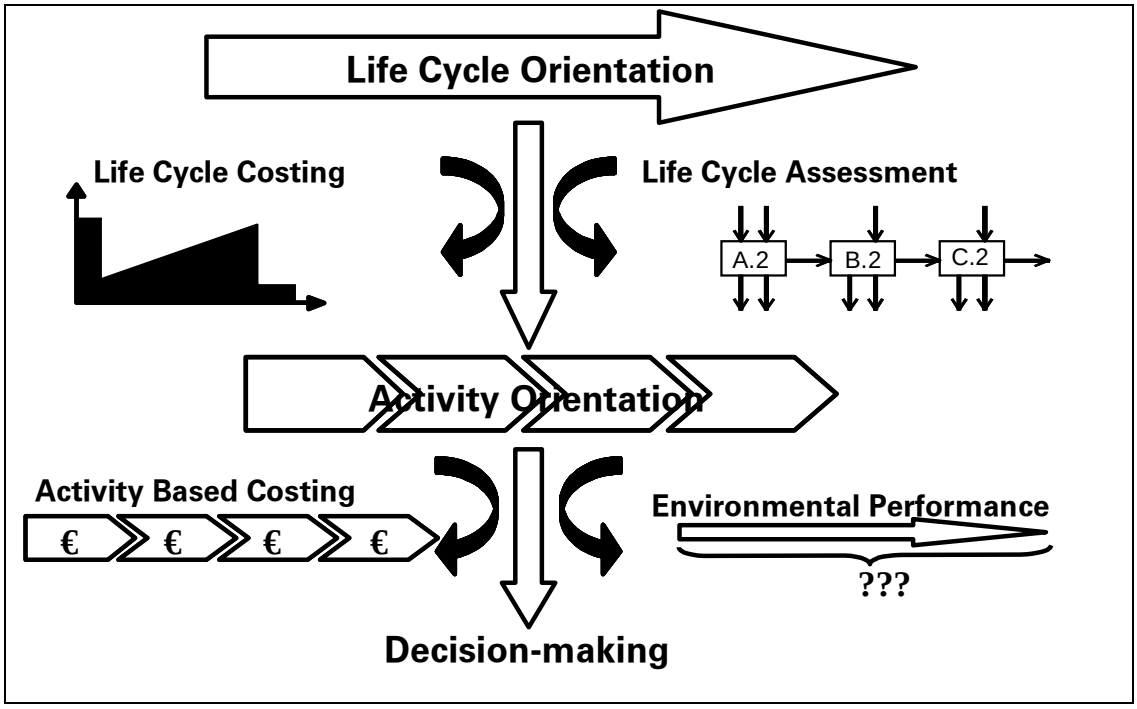
Figure 2: Criteria of a life-cycle oriented analysis



However, hitherto, a product-based life-cycle oriented analysis integrating the dimensions of sustainable development is mostly missing, and particularly in the case of O.R.-textiles, life-

cycle management regarding sustainable development in general and a holistic assessment approach in particular is almost impossible. This situation is further aggravated by a serious lack of publicly available information.
To put an end to this situation, the German "Ministry for education and research" is funding a study to assess O.R.-textiles over their life-cycle, as far as their hygienic, ecological and economic aspects are concerned. This interdisciplinary project involves clinicians, environmental economics, textile engineers and industrial partners, to enable a life-cycle oriented approach that introduces and fosters life-cycle management in this area.
The economic and environmental part of the project focuses on two perspectives. On the one hand the whole life-cycle of the O.R.-textiles is considered **(life-cycle perspective)**, and on the other hand single activities within the life-cycle are assessed **(activity perspective)**. For the different types of O.R.-textiles the life-cycle oriented analysis is split into an economic part, applying the instrument of Life Cycle Costing (LCC), and an environmental part, applying the instrument of Life Cycle Assessment (LCA). Following the activity perspective in the second step, LCC and LCA are brought down by the utilization of Activity Based Costing (ABC) and Environmental Performance Measurement (EPM) to the single activity. This allows the identification of important economic and environmental drivers that can be used as indicators for decision-making in procurement. Because of the fact that a life-cycle perspective allows for a holistic evaluation the integration of sustainable development criteria becomes feasible. These features of the project are summarized in Figure 3.

Figure 3: Instruments applied



Setting a focus on the Life Cycle Orientation, Life Cycle Costing and Life Cycle Assessment have to be taken into account. Thereby the application of Life Cycle Costing is determined by the following points.
The main objective of cost and management accounting is to provide users within a company with information for decision making. This objective can be broken down to three sub-objectives:

- cost allocation for internal and external profit reporting
- the support of better decision making
- the provision of information for planning, control and performance measurement.

In this regard the basic accounting system of a company has also to provide sufficient data for LCC as a method for planning, assessing and comparing investment alternatives as well as analyzing a system's or product's profitability[xxiv] or all other procurement decisions. LCC is particularly applicable when dynamic information, effecting performance, costs and time, is incorporated into decision making processes.[xxv] The primary aim of LCC is the optimization of costs, performance and time of a system over its life-cycle.[xxvi] As an instrument for cost management it is applied from the perspective of a costumer on an ad hoc basis for such decisions that refer for example to alternative products, machines, installations, maintenance strategies and suppliers.

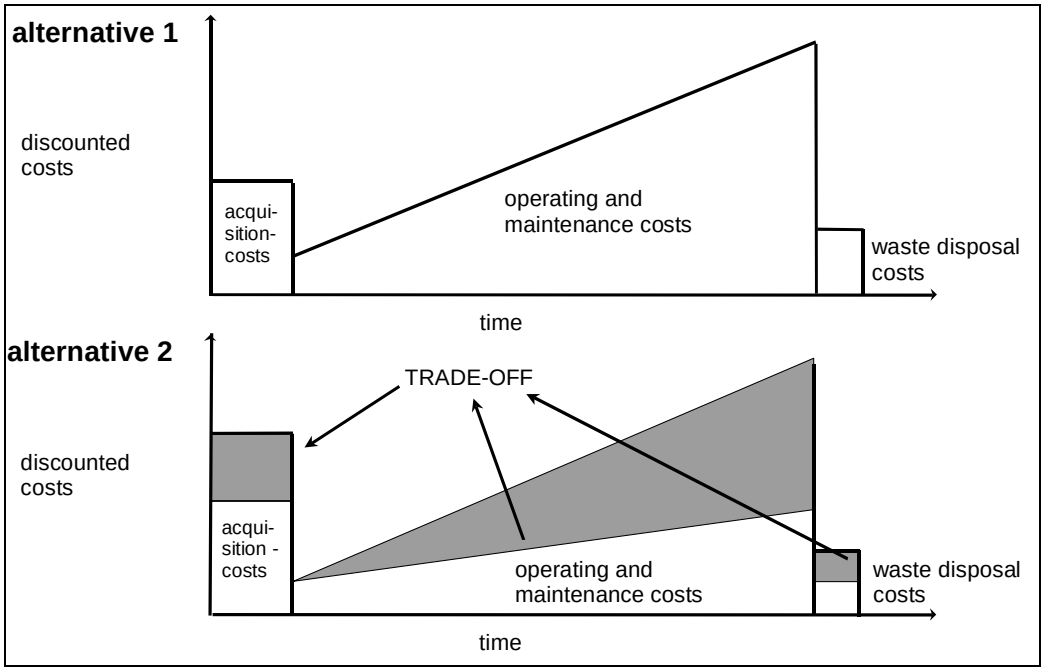
From the producer's point of view, LCC is suitable for decision making involving, alternative logistic concepts, price setting, make-or-buy decisions, product design, abandoning projects, setting budgets and the definition of cost drivers.[xxvii] LCC can lead to cost advantages and therefore competitive advantages. By measuring life-cycle costs and revenues from the producers point of view at an early stage, projects with poor chances to succeed can be identified and stopped, allowing one reallocate resources to other projects with better chances of success. Therefore LCC can be applied as a model for strategic planning, too. If a company uses the customer's point of view there are different possibilities for it to apply differentiation strategies and concentration strategies that can lower Life Cycle Costs for the customers. In addition, the customer's point of view, therefore, sets a bonus price for the company. Summarizing the points so far it can be concluded LCC is always focused on decision making and based on the specific environment of a specific company cannot be generalised. The results of a LCC-study are therefore always case dependent[xxviii] as also known from LCA with different system boundaries and specific assumptions.

For an LCC-based decision the following information is relevant:[xxix]

- cash outflows for the goods or services (in general for acquisition or designing, development and production, operation, maintenance and finally waste disposal)
- timing and amount of payment
- life cycle length (planning horizon),
- discount rate.[xxx]

After collecting this information, one, e.g. a procurer should be able to make an optimal purchasing decision. For a general description of the steps of LCC see for example Woodward, D. G. (1997). The step of data collection is considered as the one most time and resources have to be spent.[xxxi] If a customer knows the total life-cycle costs of alternatives, he or she can evaluate trade-offs between initial investment and follow-up costs, and chose the better alternative (see Figure 4). External costs can be considered as another cost category. However, they are not considered in conventional LCC. Therefore the concept of environmental LCC is introduced. Environmental LCC is defined by "Assessment of all costs associated with the life-cycle of a product that are directly covered by any one or more of the actors in the product life-cycle (supplier, manufacturer, user/consumer, EoL-actor), with inclusion of externalities that are anticipated to be internalised in the decision-relevant future."[xxxii]

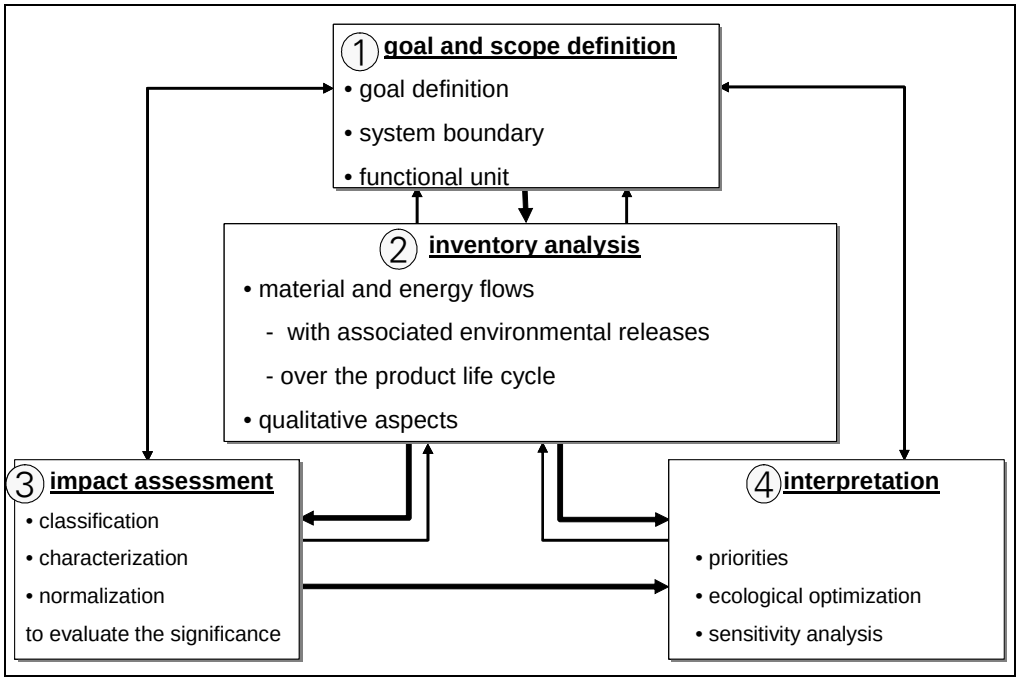
Figure 4: Trade-offs between initial investment and subsequent costs (source: Burstein, M. C. (1988), p. 257)



As one can see the information required by LCC is manifold. Therefore the source of this information that is in general the cost and management accounting system of the company running a LCC study is analyzed. Thereby the role of the accounting system is highly important as the result of a LCC study "is highly dependent on the accessibility, quality and accuracy of input data."[xxxiii] As a result of a survey Lindholm, A. and Suomala, P. state: "Inadequacies of the input data and non-uniform costing practices were considered problematic issues in many cases."[xxxiv] "However, it could be more reasonable to accept some inaccuracies in life-cycle cost calculation than not to try to evaluate life-cycle cost at all."[xxxv]. This paper goes not into describing the data sources of a cost and accounting system, which may be manifold for the purpose of an LCC.[xxxvi]

A life-cycle oriented analysis can consist of both an economical part as well as an environmental part applying the instrument of Life Cycle Assessment (LCA). Although, the term Life Cycle Assessment is associated with different instruments and methods, the overwhelming majority of publications agree on its task: Life cycle assessments should completely record and evaluate the impact on the natural environment (e.g., a manufacturing plant).[xxxvii] The life-cycle assessment can be defined as a four step operational method (see Figure 5).[xxxviii]

Figure 5: Life Cycle Assessment phases (according to: Deutsches Institut für Normung e.V. (2006), p. 15.)



In this first stage (goal and scope definition) qualitative descriptions of the issues raised by the product's or service's life-cycle are made. This includes defining a system boundary through which energy and material flows can be defined. At this stage the benefits of the product are identified as well as making an assessment of the benefits of applying the LCA.

Second, it records all environmental effects induced from a defined system (material demarcation) in a defined period of time (temporal demarcation) as completely and systematically as possible (inventory analysis). Concerning recording, only known perceivable environmental effects can be recorded. Current scientific knowledge about our environment restricts the recording of environmental effects.[xxxix] The completeness of a Life Cycle Assessment must be interpreted as a complete recording of only those environmental effects perceivable today. The life-cycle assessment must also satisfy the central criterion of transparency/objectivity (also called inter-subjective verifiability) deriving from the general requirements of a scientifically well-grounded method.[xl]

Third, it evaluates the ecological relevance of these effects (impact assessment).[xli] Thus the impact assessment identifies the (positive and negative) environmental effects caused by mass and energy flows and then determines their amounts.[xlii]

In the fourth stage (interpretation) an analysis of major contributions, sensitivity analysis and uncertainty analysis leads to the conclusion whether the ambitions from the goal and scope can be met. Also it is considered what can be learned form the LCA. All conclusions are drafted during this phase. Sometimes an independent critical review is necessary, especially when comparisons are made that are used in the public domain.

Frequently Life Cycle Assessments come along with difficulties. Table 1 summarizes the problems relating to Life Cycle Assessment.

Table 1: Criteria catalog for the assessment of an eco-balance
(with reference to: Böning, J. (1995), p. 49; Corino, C. (1995), p. 33; Günther, E. (1994), pp. 120 ff.; Günther, I. (1993), p. 20; Hopfenbeck, W.; Jasch, C. (1993), pp. 210 ff.; Schaltegger, S.; Sturm, A. (1992), p. 148)

Criterion	Recording Problems	Evaluation Problems
Completeness	Are all *environmental impacts* of the object under consideration recorded?	Are all *environmental effects* of the object under consideration recorded? Or. Which *environmental impacts* are included in the impact analysis and balance sheet?
Transparency/ Objectivity	Are the rules applied to the recording of the *environmental impacts* as well as to the analysis and evaluation of the *environmental effects* laid out, clearly formulated, and thus inter-subjectively verifiable?	
Continuity	Comparability between periods: Are similar set of facts at different points in time recorded similarly and evaluated similarly?	
Practicability/ Economic efficiency	Is the concept practical? How high are the expenses for recording and evaluation?	
Reliability	How are data collected? • position audit? • estimation? • calculation?	Does the evaluation method lead to the same result under repeated application?
Unambiguousness		Is it clear which alternative is the best?

As Table 1 shows the criteria involving problems are completeness, transparency, continuity, practicability/ economic efficiency, reliability and unambiguousness. The problem of data collection is also significant in the sustainable-oriented procurement process.

ASPECTS OF INTEGRATION OF SUSTAINABLE DEVELOPMENT INTO THE PROCUREMENT OF O.R.-TEXTILES

Following the definition of different levels for the concept of Strategic Sustainable Development (SSD) by Korhonen (2004) procurement is a mean to realize the concept of sustainability by setting principles and defining specific actions to improve sustainability for example by reducing the environmental impacts.[xliii] In general there are two ways to realize a sustainable procurement. On the one hand environmental criteria can be integrated into product and process related decisions. On the other hand the optimization of the environmental friendliness of products can be an objective.[xliv] In this regard a strong focus on the life-cycle of products is needed.

In this paper four aspects important for the realization of SD in procurement with focus on the environmental aspects and impacts caused by the product are analyzed. The analysis of these aspects follows the primary analyses approach where the authors do their research from the perspective of a procurer in a hospital directly evaluating the information available for O.R.-textiles and an assessment in terms of sustainable development.

1. Development of decision criteria and assessment framework
2. Data availability for the criteria specified in process one
3. Data evaluation of the data acquired in process two
4. Legal framework for the realization of the procurement process

These aspects are relevant for all procurement processes presented in section two (see Figure 1). The following sections describe the aspects and discussed potential hurdles for an integration of SD in procurement.

1. Development Of Decision Criteria And Assessment Framework

The section identifies important criteria to assess O.R.-textiles from a theoretical point of view. The relation to existing models for supplier selection[xlv] is not further analysed as the focus of the paper is on the product relevant criteria. Nevertheless, the final assessment frameworks and its criteria in companies should be realized by means of such a model.

In reality the procurement of O.R.-textiles is often characterized by three criteria: price, price and price! However, there are other important aspects to regard when procuring O.R.-textiles. As the main criteria the hygienic i.e. prevention of surgical site infections function of O.R.-textiles should be considered as it serves as a k.o.-criterion. Since 2006 there is a European standard regulating the technical and hygienic properties O.R.-textiles have to possess.[xlvi] This standard is a great improvement as before those properties could not be evaluated by procurers. Right now the coherence to this standard is a requirement to obtain a CE-mark. The standard distinguishes between two performance-types of O.R.-textiles. The procurer has to decide individually which type to procure, as there is no standard concerning the application of O.R.-textiles in surgical operations.

Beside the hygienic criterion fulfilled by the technical properties of O.R.-textiles other criteria determined by technical properties can be applied as decision criteria, namely the comfort or quality of O.R.-textiles. As these are subjective issues, they are often assessed in tests in the O.R. with non- generalisable outcomes.

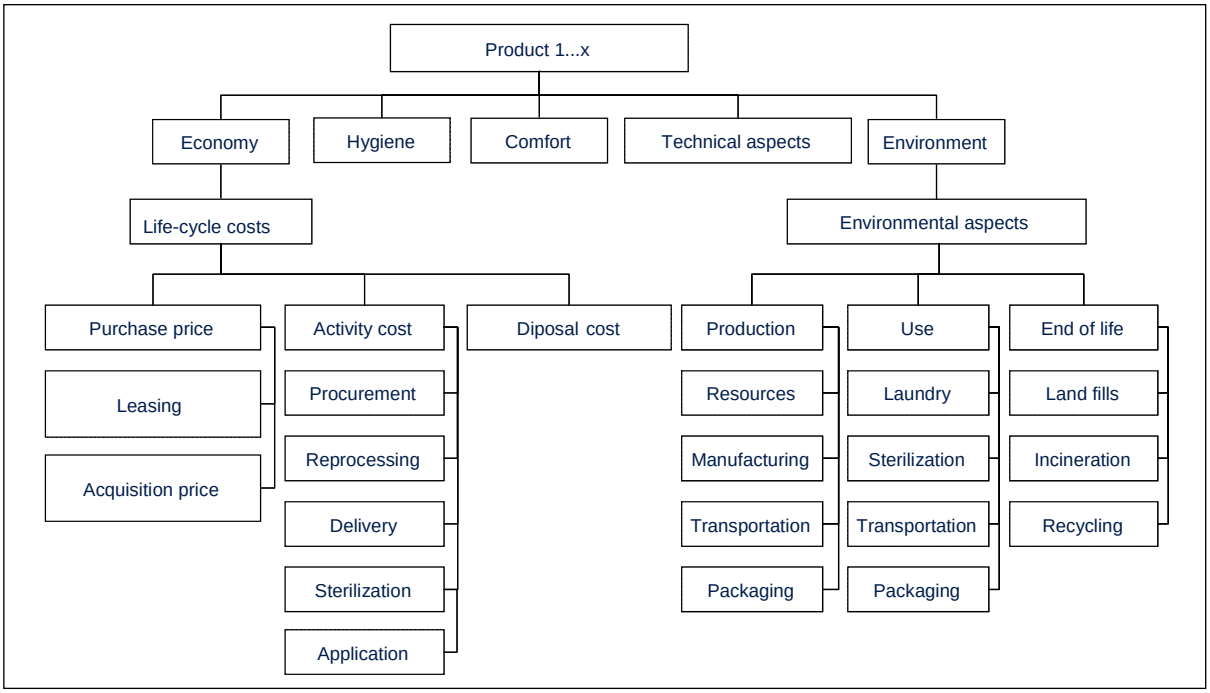
Assuming all O.R.-textiles offered on the market fulfil the hygienic criteria determined by the EN DIN 13975, economic aspects are chosen to evaluate different textiles. Very often only the purchase price is considered as no detailed information on the economic consequences caused by different offers are available in-house as detailed costing systems are often missing. However, the consideration of economic aspects is a sine-qua-non for the further survival of hospitals.

Legal obligations as the "Act for Promoting Closed Substance Cycle Waste Management and Ensuring Environmentally Compatible Waste Disposal" in addition to the consideration of economic criteria are obviously not influential enough to integrate environmental aspects into procurement of hospitals. In a sample of 22 tenders for O.R.-textiles drawn from the Tenders Electronic Daily (TED) database for the period May 2006 till January 2007, only one tender included the criterion environment. Therefore the existence of an objective to include environmental aspects when deciding on procurement decisions is needed. For this analysis as stated above such an objective is assumed to be in place and an environmental assessment necessary.

The assessment of environmental aspects of O.R.-textiles over their life-cycle embraces for example for reusable textiles the different steps presented in Figure 6 highlighting the relevant processes for making up and laundry. All the different production steps shown at the top of the figure ideally have to be taken into consideration when integrating environmental aspects in procurement.

To summarize, decision makers procuring O.R.-textiles need a profound knowledge on a large variety of criteria. Assuming this knowledge exists, the decision maker might set up an assessment framework as presented in Figure 7 in order to assess different O.R.-textiles and services provided by the distributors. This framework should be implemented in hospitals by means of procurement models (for examples see Humphrey, P. K. et al. (2003)).

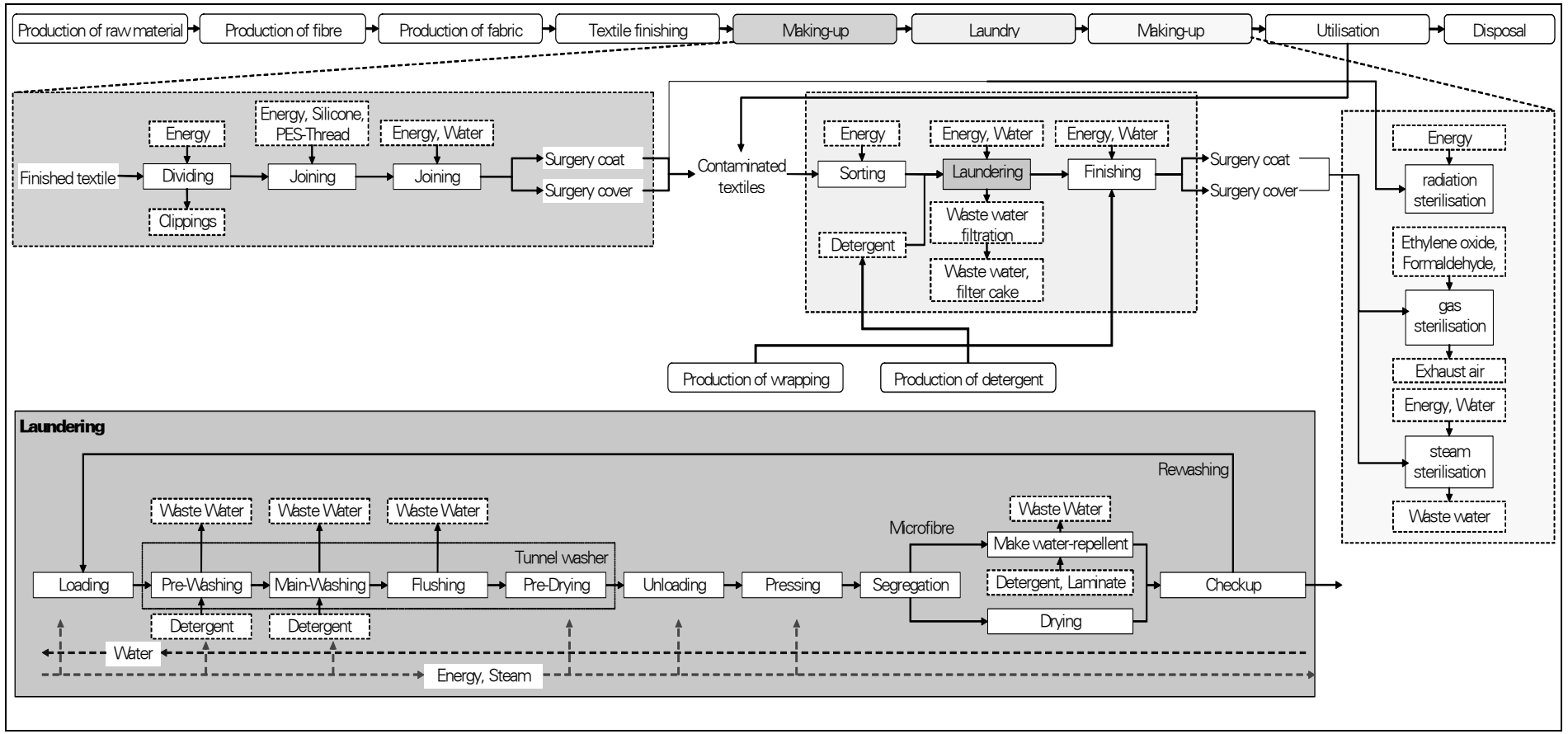
Figure 7: Assessment framework for O.R.-textiles



Based on the experience of several case studies in hospitals no detailed knowledge on all criteria described could be identified for procuring personnel. Hence, the identification of a broad criteria scheme seems to be a hurdle for a holistic procurement decision.

In order to evaluate all criteria for the decision-making process appropriate instruments have to be selected. In the related project life-cycle assessment for the evaluation of the environmental criteria, life-cycle costing and activity-based costing for the evaluation of economic criteria and technical analysis as well as user surveys to assess hygienic and technical criteria were chosen. Ideally, the selection of data follows the assessment method. Before the data concerning the different decision-criteria can be identified and gathered, the method for evaluation and interpretation has to be selected. However, to derive an overview the next section focuses on the different criteria in general and not on the data needs of a specific method.

Figure 6: Stages of the O.R.-textile life-cycle with a special reference to laundering



2. Data Availability Of SD Related Information For O.R-textiles

When the assessment framework and the assessment methods are defined the identification of data is necessary. For this process the range of internal and publicly available information is evaluated. In this section focus is laid on the availability and acquisition of sustainability related information. By this the difficulty of the integration of Sustainable Development related criteria in decision making is shown.

Concerning economic data the acquisition price is normally available from offers of possible suppliers of O.R.-textiles. When collecting further economic data O.R-textiles, a decision-maker has to consider a wide range of information with examples as: type of needed O.R.-textiles, infrastructure of the hospital and type of linen management (all part of demand management).

Moreover, before procuring O.R.-textiles the fundamental question whether single-use or reusable textiles will be used in the O.R. has to be taken into account. Both types of O.R.-textiles can be mainly distinguished by the applied textile management as single-use textiles are disposed after their use and reusable textiles are reprocessed after their use. In addition there are many possibilities to design the linen management for both types. Table 2 gives a general overview over different types of linen management that might be applied by a hospital. Grey fields indicate a process done at a hospital, dotted fields show processes that might be part of the linen management by a hospital and finally white fields indicating processes outsourced to textile service providers.

Table 2: Types of linen management (In adaptation to: Rothfuß, T. (2004); Lipphaus, A. (1998))

		Reusable O.R.-textiles				Single-use O.R.-textiles
		Owned by hospital	Commission	Rental	Full Service	Delivery
Acquisition	Procurement					
	Investment in textiles					
Use	Disposititon					
	Stock Keeping					
	Internal Logistics					
	O.R. use					
	Investment into machinery					
	Reprocessing					
	Sterilization					
	Repair					
End-of-life	Disposal					
Related activities	Cost ontrol					
	Cost allocation					

To achieve a process-oriented comparison of different offers, the availability of data concerning internal processes of the hospital is vital. Thereby, internal data availability highly depends on the design and performance of the cost accounting system applied within an organisation. To realise an economic evaluation by means of life cycle costing the points discussed in section 3 have to be taken into consideration.

As O.R.-textiles are a minor cost factor in hospitals the level of information available is assumed to be low. A decision-maker might therefore turn towards publicly available information concerning the economics of O.R.-textiles. The information in journals on this topic is scarce. Most publications identified by the authors were published by companies selling O.R.-textiles or by consulting companies that have to be contacted in order to obtain a

detailed report. The general accessibility of such information is at least questionable and the number of publications still small. The authors could identify only nine publications analyzing the economic consequences of the use of O.R.-textiles in some depth. The majority of these sources identify single-use textiles as the most cost-efficient variant. This is shown in Table 3 where the study results are normalized for the cost for single-use textiles.

Table 3: Comparison of economic studies

Source	Object	Single use	Combined	Reusable (Leasing)
K-M-C GmbH (2002)	Drapes	100%	102%	130 %
K-M-C GmbH (2003)	Gowns	100%	156%	n.a.
Martec (2001)	Gowns (hospitals > 500 beds)	100%	n.a.	Micro-fibre: 106% Laminates: 125%
Martec (2001)	Drapes (hospitals > 500 beds)	100%	n.a.	111%
Boisvert, P. H. (2002)	Drapes	100%	n.a.	82% - 230%
Vincent-Ballerau, F.(1989)	Gowns	100%	52% - 74%	75% - 100%
Riegel, G. F. (2000)	Gowns	100%	107% - 161%	

Concerning the technical and hygienic criteria the decision-maker can rely on the DIN EN 13975, defining the properties an O.R.-textile has to have. Nevertheless, the decision whether "standard" or "high"-performance O.R.-textiles should be used, has to be taken by the procurer.

The evaluation of subjective criteria as comfort is not as easy, as this criterion is mentioned in the DIN EN 13795 but not specified with measures. Therefore a practical test is often applied in which O.R.-textiles are rated by the O.R.-personnel. The results of such test are subjective and are therefore not always unanimous. Those tests are seldom published. Therefore many hospitals run their individual tests.

The availability of environmental data for O.R.-textiles is also restricted. When the complete life-cycle is considered many phases, depending on the service level chosen by a hospital (Table 2), of the life-cycle are situated outside the boundaries of the procuring hospital. Therefore internal as well as external information are relevant. In-house there are normally only data concerning the amount of waste produced readily available, not allowing a holistic environmental assessment. The amount of publicly available information is as for economic data limited, too. For the data acquisition process (e.g. literature reviews) special knowledge is needed as most data is not reported in journals. Most environmental data are included in special reports by research institutions or industry associations and as a consequence normally not directly available. Nevertheless, the authors could identify seven LCA studies with regard to environmental aspects summarized in Table 4. The assessment of the content of the LCA studies is part of the next section.

Table 4: Summary of LCA studies for O.R.-textiles

Author	**Year**	**Functional unit**	**Objects of investigation**		**Environmental winner**
			Reusable	**Single-use**	
Brune, D.	1988	1 kg textiles	Laminate Cotton/Polyester Microfiber	Coated Pulp/CTMP	Reusable > waste, waste water,
Schorb, A.	1990	1 Operation	Cotton incl. Packaging	Coated pulp/PE Pulp/PE	Single-use > energy, water
Jäger, W. R.	1996	O.R.-set	laminate	Pulp/PE incl. Packaging	Reusable > energy, resource use, waste
IFEU	1996	Drapes gown	Cotton Cotton/PES Microfiber	Pulp/PE/PES	Single-use (drapes) > waste water, CO2, waste = energy, resource use Reusable (Gowns)
Schmidt, A.	2000	1 Gown	Cotton/Polyester Polyester Laminate	Pulp/Polyester incl. Packaging Pulp/Polyester with PE foil incl. Packaging	Reusable
Dettenkoffer, M. Grießhammer, R.	1999	1 Operation	Cotton/Polyester incl. Packaging	Pulp/PE incl. Packaging	Reusable
Erikson, E.	2003	1 gown	Laminate	Pulp/PE with PE foil	Reusable

In addition the LCAs specific to O.R.-textiles can be supplemented by data on specific processes within the life-cycle (see Figure 6 for an overview of the whole life-cycle and

details for the life-cycle modules of making up and laundry for reusable textiles) of O.R.-textiles. The results of a thorough literature review process resulted in almost 400 sources containing data for one or more modules relevant for the life-cycle of O.R.-textiles, summarised in Table 5.

The literature review process is based on a web search and the application of special subject and literature databases. The availability of these sources may be limited for procurers in hospitals. In this case further time and resources needed to gain access to these sources has to be considered.

Table 5: Literature synopsis life-cycle of O.R.-textiles

Life cycle inventory phases	*Process steps*	*Sources No.*
Production of raw material	Pulp	8
	Cotton	7
	PES	4
	LDPE	6
	PP	5
	PU	2
	PTFE	1
	Hydrofloric acid	1
	Methanol (materialh)	1
	Energy production mix Germany	1
Production of fibre	PES fibre direct spinning	2
	PES fibre direct spinning	4
	PP fibre	2
	Cotton fibre	7
	Viscose fibre	2
	Production PES thread with upstream processes	1
	Production cotton fibre with upstream processes	1
Production of fabric	PE nonwoven	2
	machine knitting	5
	Weaving	2
	Filament weaving	2
	Extrusion foil	1
	Blown film	1
	PET foil	1
	PVC foil	1
	LDPE foil	1
	LDPE foil direct extrusion	1
	PP foil direct extrusion	1
	Glueing of paper and foil	1
	Glueing of paper and PP foil	1
Textile finishing	cotton and blended cotton fabric	3
	cotton fabric	3
	cotton nitted fabric	1

	PES and cotton yarn	2
	PES yarn	4
	Knitted synthetic fabric	3
	Synthetic fabric	1
	Viscose yarn	1
	Finishing general	4
	Alcalic cooking	3
	Desizing cotton	3
	Bleaching	3
	Drying stenter frame	1
	Mercerizing cotton and blended cotton	1
	pigment printing	1
	pad fix machine	1
	pad steam machine	1
	pad dry econtrol	1
	Dying of cellulose and blended cellulose	1
	Dying of cotton and blended cotton fabric	1
	Daing of knitted cotton and blended cotton fabric	1
	Dying of cotton and blended cotton yarn	1
	dyeing PES	1
	PES	1
	Cotton	1
	Finishing general	1
	Waste water treatment	1
	Ultrafiltration sizing residue	1
Making up		5
Sterilisation		2
Laundry	Laundry household	1
	Laundry industrial	9
	Textile drying	1
	Waste water treatment	2
Laundry deteregents production	laundry deteregents	1
	building set deteregent	1
	deteregents (industrial)	2
	detergent booster	1
Laundry chemicals production	alkyl benzene sulphonate	3
	fatty alcohol ethoxylen (FAEO)	2
	laundry chemicals total	2
Packaging	Corrugated cardboard	1
	Cardboard	1
	Hygienic tissue	1
	Tissue	1
	Paper	1
	Kraft paper	1

	synthetic bag ready making	1
Disposal	incineration household waste	2
	incineration synthetic packaging	1
	incineration composite	1
	incineration paper	1
	Incineration textiles	1
	Incineration plastics	1
	Incineration	1
	Total	169

From the numbers of sources available for the modules the heterogeneity of the data base for an environmental assessment becomes obvious. The literature found for the different modules is based on 62 references. As some sources report data on multiple modules the number of sources for all modules is 169. The data quality of the references is evaluated and rated. Three categories are distinguished: low data quality with 16 references, medium data quality with 25 references and 19 references containing data with a high quality. The rating criteria are based on the following points:

- Low data quality: Process description not in the focus of the reference, measures and parameters are only partially available or as black box.
- Medium data quality: Not all Processes are described in a quantitative way
- High data quality: Detailed process description, detailed measures

Concerning the literature review the question of language has to be addressed too, because many publications are only available in English causing further impairments to a non English-speaking procurer. Overall, the availability of data concerning the identified criteria seems to be limited, therefore restricting the information accessible to a procurer. This causes a further hurdle for a holistic procurement decision.

3. Data Evaluation Of The Data Acquired

Public data on the technical properties of O.R.-textiles is only available in a limited number of sources. Examples for these sources are Feltgen, M., et al. (2000) and Werner, H. P. et al. (1998, 2003).

However, a complete assessment of O.R.-textiles under practical conditions is yet missing. Here the technical part of the described project (section 3) will deliver further insight.

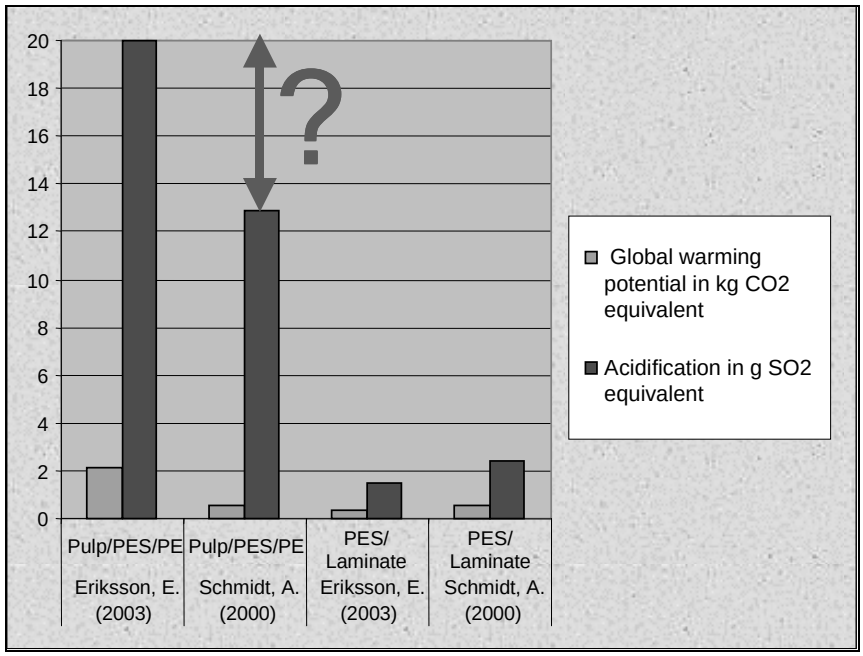
The economic data available is characterized by a lack of a detailed description concerning the methods applied for evaluation as well as for data used or assumptions applied. Because of this the results are not generalizable and most often might only function as benchmarks.

The data evaluation for O.R.-textiles should be based on the two instruments of ABC and LCC. Whereas ABC provides the internal cost data needed for the LCC. The instrument of LCC allows a direct connection to the environmental criteria as it is also based on the life-cycle of object of investigation.

Based on the data availability described before, the application of life-cycle costing seems not to be feasible. Here a hospital has to collect a large amount and variety of in-house data. The requirements to fulfil in order to allow for a detailed Life Cycle Costing application for O.R.-textiles are described in section 3.

The environmental data on O.R.-textiles is mostly available in form of life-cycle-assessment studies including the steps of goal and scope definition, inventory analysis, impact assessment and interpretation as given by the ISO standard 14040. The level of detail for different publications and also the methods applied vary widely. Sometimes, in an academic style, all assumptions and decisions are transparent and references given, allowing a complete understanding of the studies. In other cases references are not given and no details available. As reason for this obligations to maintain secrecy are mentioned at the best. Because of this the interpretation of data is cumbersome. For example when comparing the results of different studies there is sometimes a large difference between the results, as illustrated in Figure 8, where the results of two LCAs with regard to the impact categories 'Global warming' and 'Acidification' are shown. The cause for the gap between both studies might not be easily understood by a procurer.

Figure 8: Comparison of LCA results



In addition the following point could be identified that might be problematic for the interpretation of data on environmental aspects and impacts of O.R.-textiles presented in LCA studies:

- Different product systems studied e.g. laminate-gown vs. micro-fibre gown
- Different system boundaries e.g. including transportation or not
- Different functional unit's e.g. whole gown vs. grams
- Different data sources and data quality e.g. measuring, estimating, calculating
- Different forms of impact assessment e.g. choice of eutrophication as impact category

The evaluation of data contained in other sources as LCA studies requires a high level of specific knowledge in order to identify relevant data. Furthermore, the allocation of data for O.R.-textiles itself and the process of setting up a detailed life-cycle inventory based on such a heterogeneous data set might be too time and resource consuming for a procurer.

The way data are presented in publications and the knowledge needed to evaluate it might cause a further hurdle for a holistic procurement decision.

4. Legal Framework

When the problems of criteria identification, data availability and data evaluation are overcome and the decision-maker has a profound understanding about the criteria for a holistic procurement decision, his knowledge still has to be applied and integrated into the tendering process. This process is vital as all former steps cumulate in the writing of a tender and the interpretation of incoming offers related to the criteria defined in the tender.

At this stage the legal framework, all public German hospitals are subject to, might proof to be a further hurdle. The application of environmental criteria in public tenders is still determined by the possibilities the legal framework offers. The integration of environmental aspects is regulated and not easily done for, it requires special know-how. In general there are points, where to include environmental aspects in tenders, which are[xlvii]:

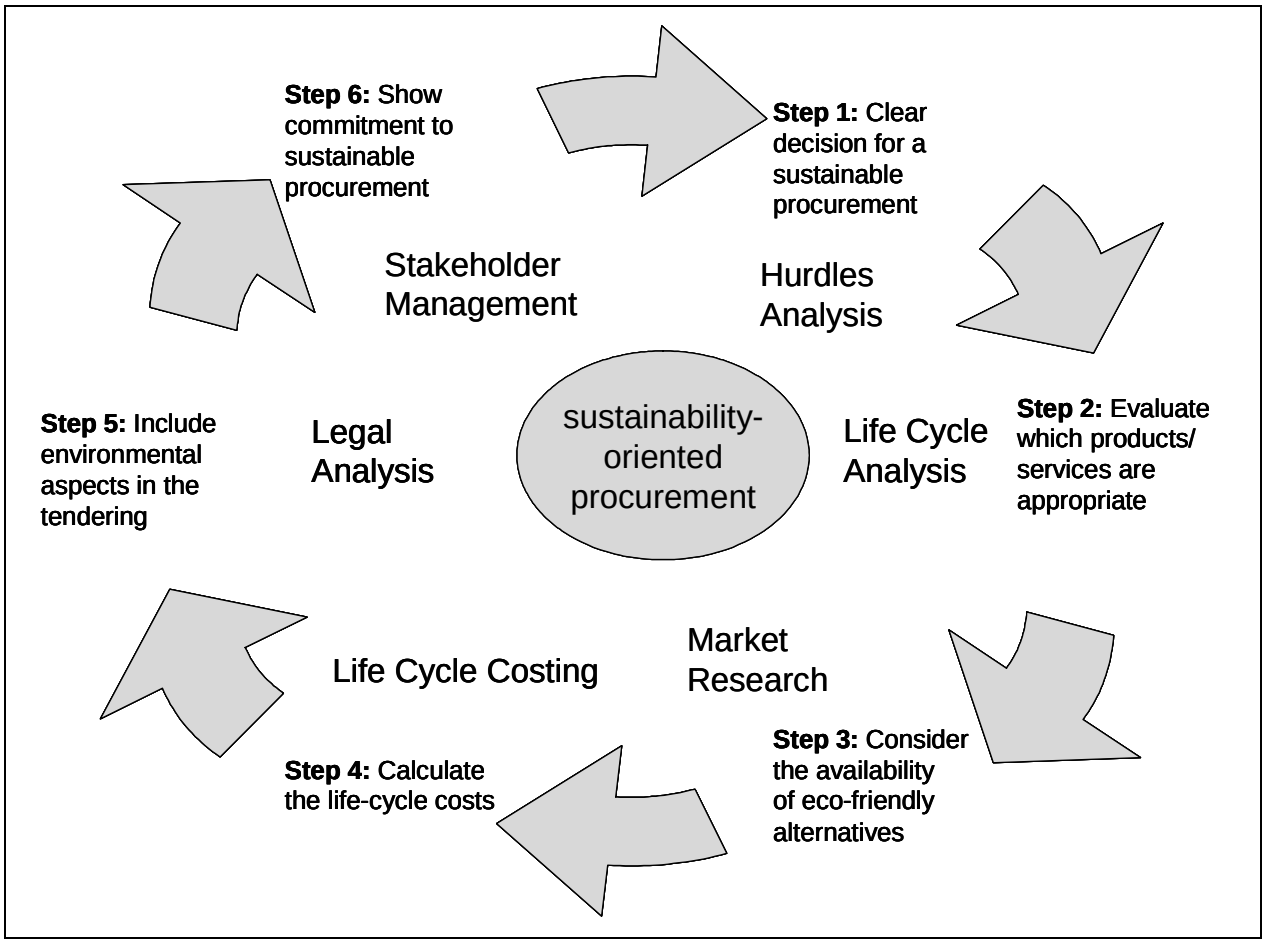
- Definition of the contract subject,
- Drawing up of technical specifications,
- Selection of tenderers (suitability criteria),
- Evaluation of tenders / Contract award (award criteria),
- Conditions for the performance of contracts.

So far, there is no decision aid supporting the integration of environmental aspects in tenders for O.R-textiles causing another hurdle for a holistic procurement decision. The realisation of the mentioned possibilities, the legal framework offers, is still limited because of a high level of uncertainty concerning their application. However the legal framework offers a latitude of judgement referring to the integration of environmental aspects in tendering and is part of the following guideline for sustainability-oriented procurement.

GUIDELINE FOR SUSTAINABILITY-ORIENTED PROCUREMENT

The paper analyses the hurdles of information, legal framework and knowledge in procurement decisions for O.R.-textiles. The primary research method, picturing the process from the perspective of a procurer, describes the possible problems that might occur. First and foremost the complex process for the identification of a holistic criteria set and assessment framework is shown. Additionally, the limited data availability for a large range of criteria is identified. Moreover the problems in data interpretation are highlighted. Finally, the possibilities to include environmental aspects in tenders, which have to be conforming to the legal framework, are difficult to identify and realize. To summarize, based on this research the elaboration of a decision-aid for a sustainable-oriented procurement of O.R.-textiles is deeply needed. The decision aid has to deliver solutions to the identified hurdles. Therefore a guideline for sustainability-oriented procurement shall be introduced. Figure 9 shows the six steps of a new approach. It was developed by the TU Dresden to integrate sustainability aspects in the procuring process by providing practitioners a decision aid. The approach comprises implications for procurement of operating room textiles as well as general recommended action.

Figure 9: Sustainability-oriented procurement process



The particular steps of the sustainability-oriented procurement are stated subsequently:

1. Clear decision for a sustainable procurement

The top management commitment to sustainable development is a precondition of sustainable procurement. As a consequence procurers do not have to legitimate their environmental friendly decisions. In many organisations there is not enough commitment support for sustainable procurement. Another hurdle is the responsibility of different departments for procuring decisions. A feasible way to cope with the discussion of environmental friendly procurement is the earlier mentioned Hurdles Analysis Method.[xlviii] This instrument shall assist organizations to identify hurdles and to find reasons for their emergence. Also it is supportive to classify the hurdles as well as to identify a strategy.

2. Evaluate which products and services are appropriate

Procurers should compare the environmental performance of products and services, to be able to choose the least burdensome one. For evaluating the environmental impacts of the products to be procured a Life Cycle Assessment is promising.

3. Consider the availability of environmentally compatible alternatives

After evaluating the environmental impact of purchasing products or services procurers should consider the availability of environmentally compatible alternatives. For procurers it is very helpful to do market research to ensure a sustainable procuring decision. Pertinent publications and web sites such as www.eco-label.com can be used as a decision support.

4. Calculate the costs over the whole lifecycle of products and services

Another requirement for a sustainability-oriented procurement decision is an examination of the product's whole life-cycle. As in the case of energy-saving lamps eco-friendly alternatives are more expensive but have a longer lifespan and lower disposal costs. Hence it is promising to use life-cycle costing to evaluate the alternatives.

5. Include environmental aspects in the tendering

Public procurement law is very sophisticated. For many procurers it is difficult to assess whether and how to integrate environmental criteria in the particular phases of the tendering. The European law offers a broad scope for sustainability-oriented tendering. Up-and-coming are in particular the definition of contract purpose, the disposition of technical specification and the choice of tenderers, the acceptance of a tender and the preconditions of a contract's conformance.

6. Communicate your commitment to sustainable procurement

The last step is to communicate commitment to the stakeholders such as publicity or media. Also an exchange of Know-how with other procurers as important stakeholders is eligible.

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REFERENCES

Armstrong, F. 2005 Do no harm? Health Care and the environment. In: Australian Nursing Journal, 12, 7, 2005, pp. 18-21.

Back-Hock, A. 1992 Produktlebenszyklusorientierte Ergebnisrechnung. In: Männel, W. (ed.): Handbuch Kostenrechnung, Wiesbaden, 1992, pp. 703-714.

Bea, F. X.; Dichtl. E.; Schweitzer, M. (eds.) 1997 Allgemeine Betriebswirtschaftslehre. Band 1: Grundfragen. 7. Auflage, Stuttgart, 1997.

Behrens-Egge, M. 1991 Möglichkeiten und Grenzen der monetären Bewertung in der Umweltpolitik. In: Zeitschrift für Umweltpolitik und Umweltrecht, 14. Jg., Heft 1, 1991, p. 71-94.

Berlin, C.; Brimson, J. A. 1988 Cost Management for Today's Advanced Manufacturing; The CAM-I Conceptual Design, Boston 1988.

Beuermann, G.; Halfmann, M.; Böhm, M. 1995 Ökologieorientiertes Controlling (I). In: wisu - das Wirtschaftsstudium, 24. Jg., Heft 4, 1995, p. 335-343.

Bleis, C. 1995 Öko-Controlling - betriebswirtschaftliche Analyse zur systematischen Berücksichtigung von ökologischen Aspekten durch Unternehmenscontrolling, Diss. Frankfurt am Main, 1995.

Böning, J. 1995 Methoden betrieblicher Ökobilanzierung, Diss. 2. Auflage, Marburg, 1995.

Bowen, F.; Cousins, P.; Lamming, R.; Faruk, A. 2001 The role of supply chain management capabilities in green supply. Production and Operations Management, Vol. 10, I. 2, pp. 174-189.

Burstein, M. C. 1988 Life Cycle Costing. In: National Association of Accountants Conference Proceedings (ed.) Cost Accounting for the '90s: Responding to Technological Change, Montvale, New Jersey, 1988.

Coenenberg, A. G.; Fischer, T. M.; Schmitz, J. 1994 Target Costing und Product Life Cycle Costing als Instrument des Kostenmanagements. Zeitschrift für Planung, Vol. 5, I. 1, pp. 1-38.

Cole, R. J.; Sterner, E. 2000 Reconciling theory and practice of life-cycle costing. Building Research & Information, Vol. 28, I. 5/6, p.368-375.

Commission of the European Communities Commission interpretative communication 2001 on the Community law applicable to public procurement and the possibilities for integrating environmental considerations into public procurement, 4.7.2001, COM(2001) 274 final.

Corino, C. 1995 Ökobilanzen - Entwurf und Beurteilung einer allgemeinen Regelung. Düsseldorf, 1995.

Deutsches Institut für Normung e.V. (Ed.) 2006 Environmental management – Life cycle assessment – Principles and framework (ISO 14040:2006). German and English version EN ISO 14040:2006. Berlin. October 2006. P. 15.

Drenk, D. 2005 Sustainable business – a success story for small and medium sized enterprises? Paper presented at the 45 Congress of the Regional European Science Association (ESRA), Amsterdam, 23-27 August 2005.

Dyllick, T.; Hockert, K. 2002 Beyond the Business Case for Corporate Sustainability, In: Business Strategy and the Environment 11, p. 130-141 (2002).

Elmakis, D.; Lisnianski, A. 2006 Life Cylce Cost Analysis: Actual Problem in Industrial Management. In: Journal of Business Economics and Management, Vol. VII, No. 1, 2006, pp. 5-8.

Environmental Protection Agency (EPA) (ed.) 2000, Healthy hospitals: environmental improvements through environmental accounting. Boston, 2000. online: http://www.epa.gov/opptintr/acctg/pubs/hospitalreport.pdf.

Etterlin, G.; Hürsch, P.; Topf, M. 1992 Ökobilanzen - ein Leitfaden für die Praxis. Mannheim, 1992.

European Commission (ed.) 2004 Bying green! A handbook on environmental public procurement. 2004.

European Parliament (ed.) 2001 Regulation of the European Parliament and of the Council (EC) of 19 March 2001 allowing voluntary participation by organisations in a Community eco-management and audit scheme (EMAS), http://eur-lex.europa.eu/LexUriServ/site/en/oj/2001/l_114/l_11420010424en00010029.pdf, date of access: 23.05.2007.

European Parliament and the Council 2006 *REGULATION (EC) No 1907/2006* of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC, version 18th December 2006, Brussels 2006.

Eriksson, E; Berg, H. 2003 Livscykelanalys av operationsrockar, Göteborg 2003.

Feltgen, M.; Schmidt, O.; Werner, H.-P. 2000 The Human being in the spotlight: Surgical drapes and surgical gowns are medical devices. In: Infection Control and Healthcare (Hygiene und Medizin), Vol. 25(2000) Suppl. 2.

Freeman, R. E. 1984 Strategic Management: A Stakeholder Approach. Boston 1984.

Graafland, J.J. 2002 Sourcing ethics in the textile sector: the case of C&A. In: Business Ethics: A European Review, Vol. 11, Number 3, 2002, pp. 282-294.

Günther, E. 1994 Ökologieorientiertes Controlling - Konzeption eines Systems zur ökologieorientierten Steuerung und empirische Validierung, Diss. München, 1994.

Günther, E.; Scheibe, L. 2005 The hurdles analysis as an instrument for improving environmental value chain management. In: Progress in Industrial Ecology – An International Journal, Vol. 2(1), 2005, pp. 107- 131.

Günther, I. 1993 Praktische Beispiele ökologischer Bilanzierung. In: Beck, M. (ed.): Ökobilanzierung im betrieblichen Management. Würzburg, 1993, pp. 14-88.

Günther, T.; Kriegbaum, C. 1999 Life Cycle Costing: Ein Instrument zur Unterstützung der ökologieorientierten Kostenrechnung. In: Baum, H.-G./ Coenenberg, A. G./ Günther, E. (1999): Betriebliche Umweltökonomie in Fällen, Band 1, München: Oldenbourg, 1999.

Hopfenbeck, W.; Jasch, C. 1993 Öko-Controlling - Umdenken zahlt sich aus. Landsberg/Lech, 1993.

Humphreys, P. K.; Wong, Y. K.; Chan, F. T. S. 2003 Integrating environmental criteria into the supplier selection process. In: Journal of Materials Processing Technology, 138, pp. 349-356.

Kolk, A.; Tudder, R. V. 2002 The effectiveness of self-regulation: Corporate codes of conduct and child labour. In: European Management Journal, Vol. 20, I. 3, pp. 260-271.

Koplin, J. 2006 Nachhaltigkeit im Beschaffungsmanagement: ein Konzept zur Integration von Umwelt- und Sozialstandards, Wiesbaden 2006.

Koplin, J.; Seuring, S.; Mesterharm, M. 2007 Incorporating sustainability into supply management in the automotive industry – the case of the Volkswagen AG. Journal of Cleaner Production, Vol. 15, pp. 1053-1062.

Korhonen, J. 2004 Industrial Ecology in the strategic sustainable development model: strategic applications of industrial ecology. Journal of Cleaner Production, Vol. 12, pp. 809-823.

Lindholm, A.; Suamala, P. 2005 Present ad Future of Life Cycle Costing: Reflections from Finnish Companies. In: LTA, 2, 2005, 282- 292.

Lipphaus, A. 1998 Konzentration auf das Kerngeschäft. In: Jeschke, H. (ed.): Outsourcing im Klinikbereich. Kulmbach 1998

Noci, G. 1997 Designing 'green' vendor rating systems for the assessment of a supplier's environmental performance. In: European Journal of Purchasing & Supply Management, Vol. 3, No. 2, pp. 103-114.

Normenausschuss Medizin (NAMed) im DIN Deutsches Institut für Normung e.V. (ed.) Surgical drapes, gowns and clear air suits, used as medical devices, for patients, clinical staff and equipment (DIN EN 13975 1-3).

Plowman, R. et al. 1999, "The socio-economic burden of hospital acquired infection.", place n. a., 1999, online: http://www.dh.gov.uk/assetRoot/04/08/97/25/04089725.pdf.

Rebitzer, G.; Hunkeler, D. 2003 Life Cycle Costing in LCM: Ambitions, Opportunities, and Limitations. Discussing a Framework. In: International Journal of Life Cycle Assessment, Vol. 8, No. 5, pp. 253-256.

Robert Koch Institut (ed.) 2000 "Nosokominale Infektionen.", Gesundheitsberichtserstattung des Bundes Heft 8, Berlin, 2002.

Robert, K.-H. 2000 Tools and Concepts for sustainable development, how do they relate to a general framework for sustainable development, and to each other? In: Journal of Cleaner Production 8 243-254 (2000).

Rothfuß, T. 2004 Textilservice – ein Gewinn? In: Infodienst Berufsverband Hauswirtschaft. Heft 5, Oktober 2004, pp. 13-16.

Rutula, W. A.; Weber, D. J. 2001 A review of single-use and reusable gowns and drapes in health care. In: Infection Control Hosp. Epidemiology, 22, 2001, 4, pp. 248-252.

Schaltegger, S.; Sturm, A. 1992 Erfolgskriterien ökologieorientierten Managements. In: Zeitschrift für Umweltpolitik und Umweltrecht, 15. Jg., Heft 2, 1992, p. 131-154.

Schaltegger, S.; Sturm, A. 1994 Ökologieorientierte Entscheidungen in Unternehmen - Ökologisches Rechnungswesen statt Ökobilanzierung: Notwendigkeit, Kriterien, Konzepte, Diss. 2., aktualisierte und erweiterte Auflage, Bern, 1994.

Schmidt, A. 2000 Simplified life cycle assessment of surgical gowns – Second draft, Brüssel 2000.

Statistisches Bundesamt (ed.) 2004 Gesundheitswesen: Diagnosedaten der Krankenhauspatientinnen und –patienten, Wiesbaden, 2004.

Werner, H.P.; Feltgen, M. 1998 Qualität von OP-Abdeckmaterialien und OP-Mänteln. In: Infection Control and Healthcare (Hygiene und Medizin), Vol. 23(1998), Suppl.1, pp.1-36

Werner, H.P.; Feltgen, M. et. al. 2003 Charakterisierung von OP-Abdeckungen und -Mänteln aus Einwegmaterialien mittels hydrostatischem Drucktest EN 20811. In: Infection Control and Healthcare (Hygiene und Medizin), Vol. 28 (2003), pp. 292 – 296

White, G. E.; Ostwald, P. F. 1976 Life Cycle Costing. Management Accounting, Vol. 57, I. 7, pp. 39-42.

Wingard, H. C. 2001 *Financial performance of environmentally responsible south African listed companies*, Pretoria 2001, p. 65, online available: http://upetd.up.ac.za/thesis/available/etd-08312001-154421/, date of access: 08th May 2007.

Woodward, D. G. 1997 Life cycle costing – theory, information acquisition and application. In: International Journal of Project Management, Vol. 15, No. 6, pp. 335-344.

World Commission on Environment and Development (1987), Our Common Future, Oxford: Oxford University Press (1987).

Wübbenhorst, K. L. 1984 Konzept der Lebenszykluskosten, Grundlagen, Problemstellungen und technische Zusammenhänge. Darmstadt, 1984.

Zsidisin, G. A.; Siferd, S. P. 2001 Environmental purchasing – a framework for theory development. In: International Journal of Purchasing and Supply Management. Vol. 7, I. 1, pp. 61-73.

ENDNOTES

[i] Zisidan, G. A.; Siferd, S. P. (2001), p. 69.
[ii] See Drenk, D. (2006), p. 6.
[iii] See WECD (1987), p. 43.
[iv] See Dyllick, T.; Hockerts, p. (2002), p. 131.
[v] See Dyllick, T.; Hockerts, p. (2002), p. 132.
[vi] See Dyllick, T.; Hockerts, p. (2002), p. 133.
[vii] See Freeman, R. E. (1984), p. 25.
[viii] Wingard, H. C. (2001), p. 67f, European Parliament and the Council of the European Union (2006), European Parliament and the Council of the European Union (2002).
[ix] For a discussion on the social aspects of textile procurement see for example Graafland, J. J. (2002).
[x] See Koplin, J, (2006), p. 98.
[xi] ISO 14040 Norm
[xii] See Robert, K.-H. (2000), p. 234.
[xiii] see for example:
http://europa.eu.int/comm/environment/green_purchasing/html/general/links
[xiv] See the examples given by Kolk, A.; Tudder, R. V. (2002).
[xv] See Günther, E.; Scheibe, L. (2005)
[xvi] See EC (2001)
[xvii] See Statistisches Bundesamt (ed.) (2004)
[xviii] See Robert Koch Institut (ed.) (2002)
[xix] See Plowman, R. et. al. (1999)
[xx] See Feltgen, M. (2000); Rutula, W. A.; Weber, D. J. (2001).
[xxi] This is not only the case for O.R.-textiles as Humphreys, P. K. et al. (2003) identify that none of the historically methods for evaluating, selecting and monitoring suppliers takes into account environmental factors.
[xxii] See Armstrong, F. (2005)
[xxiii] See EPA (ed.) (2000)
[xxiv] See Back-Hock, A. (1992), p. 704; Wübbenhorst, K. L. (1984), p. 71; Coenenberg, A. G.; Fischer, T. M.; Schmitz, J. (1994), p. 29
[xxv] See Wübbenhorst, K. L. (1984), p. 2
[xxvi] See Günther, T.; Kriegbaum, C. (1999), p. 241
[xxvii] See Berliner, C.; Brimson, J. A. (1988), p. 11; White, G. E.; Ostenwald, P. F. (1976), p. 39
[xxviii] See Lindholm, A.; Suamala, P. (2005), p. 286
[xxix] See Coenenberg, A. G./Fischer, T. M./Schmitz, J. (1994), p. 30.
[xxx] The customer might also consider possible cost savings, by subsidies or tax relief. However that regards to LCC in the broader sense.
[xxxi] See Elmarkis, D.; Lisnianski, A. (2006), p. 7
[xxxii] Rebitzer, G.; Hunkeler, D. (2003)
[xxxiii] Cole, R. J.; Sterner, E. (2000), p. 372
[xxxiv] Lindholm, A.; Suamala, P. (2005), p. 289
[xxxv] Lindholm, A.; Suamala, P. (2005), p. 283
[xxxvi] See Woodward, D. G. (1997), p. 341.
[xxxvii] See representatively: Beuermann, G.; Halfmann, M.; Bohm, M. (1995), p. 340; Schaltegger, S.; Sturm, A. (1992), p. 147; Etterlin, G.; Hürsch, P.; Topf, M. (1992), p. 15.
[xxxviii] See also Böning, J. (1995), p. 29; Schaltegger, S.; Sturm, A. (1994), pp. 69 ff.

[xxxix] See for this Schaltegger, S.; Sturm, A. (1994), pp. 51 f.; Behrens-Egge, M. (1991), p. 75.
[xl] See Bea, F. X.; Dichtl. E.; Schweitzer, M. (Eds.) (1997), p. 67.
[xli] See Bleis, C. (1995), p. 274; Corino, C. (1995), p. 8; Hopfenbeck, W.; Jasch, C. (1993), pp. 213 ff. For the necessity of a material and temporal demarcation see Günther, E. (1994), pp. 121 f. The Fraunhofer Institute defines the term eco-balance more strictly: Only the recording of environmental effects is included. See Günther, I. (1993), p. 75.
[xlii] See Corino, C. (1995), p. 70; Schaltegger, S.; Sturm, A. (1994), p. 51.
[xliii] See Günther, E.; Scheibe, L. (2005) p. 110.
[xliv] See Koplin, J. et al (2007) p. 1055; Bowen, F. et al. (2001)
[xlv] For a discussion on models for supplier selection see for example Noci, G. (1997).
[xlvi] DIN EN 13975 part 1-3
[xlvii] European Commission (ed.) (2004)
[xlviii] For further information see www.tu-dresden.de/wwbwlbu/forschung/abgeschlossene_projekte/relief/, www.iclei.org/ecoprocura/relief/.