

FOI-R--0786--SE

January 2003

ISSN 1650-1942

Underlagsrapport

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Utgivare Totalförsvarets Forskningsinstitut - FOI Försvarsanalys 172 90 Stockholm	Rapportnummer, ISRN FOI-R--0786--SE	Klassificering Underlagsrapport
	Forskningsområde 3. Skydd mot massförstörelsevapen	
	Månad, år Januari 2003	Projektnummer E 1420
	Verksamhetsgren 5. Uppdragsfinansierad verksamhet	
	Delområde 35. Miljöfrågor	
Författare/redaktör Elisabeth Hochschorner Göran Finnveden	Projektledare Göran Finnveden	
	Godkänd av	
	Uppdragsgivare/kundbeteckning Försvarmakten	
	Tekniskt och/eller vetenskapligt ansvarig	
Rapportens titel (översättning) Användning av metodik för livscykelanalyser i upphandlingsprocessen av försvarsmateriel		
Sammanfattning (högst 200 ord) Enligt ett regeringsbeslut 1998 ska Försvarmakten (SAF) och Försvarets Materielverk (FMV) tillämpa "Riktlinjer för miljöanpassad försörjning av försvarsmateriel" i upphandlingsprocessens alla faser. Upphandling av försvarsmateriel är ett exempel på offentlig upphandling. Miljöhänsyn i offentlig upphandling skiljer sig från privat upphandling, beroende på skillnader i styrande lagar och föreskrifter. Den här rapporten innehåller en beskrivning av upphandlingsprocessen, aktörer, och styrande dokument vid upphandling av försvarsmateriel i Sverige. Eftersom upphandlingsprocessen genomgår förändringar idag, beskrivs den endast översiktligt. De miljökrav som, enligt Försvarmakten, bör ställas på den vara som skall upphandlas inkluderas i rapporten. Rapporten innehåller också preliminära förslag på hur livscykelanalyser (LCAer) eller livscykelänkande kan integreras i upphandlingsprocessen av försvarsmateriel. Mer fullständiga resultat kommer att presenteras i projektets slutrapport, 2003-2004. Vårt huvudsakliga förslag är att försvarssektorn arbetar systematiskt genom olika produktgrupper. För varje produktgrupp bör traditionella eller förenklade LCAer (i detta fall MECO) utföras för referensprodukter inom varje produktgrupp. Resultatet bör ge en identifiering av kritiska aspekter i produkternas livscykler. Dessa resultat bör användas vid utformningen av TTEM och kriterier för upphandling. Rapporterna bör vara offentligt tillgängliga för att tillåta granskning och diskussion av resultaten. För att arbetet ska vara kostnadseffektivt bör internationellt samarbete eftersträvas. SAF eller FMV bör ha ansvaret för att sådana LCA genomförs. SAF bör se till att miljökrav, baserade på ett livscykelperspektiv, inkluderas i TTEM. LCA kan också, i speciella fall, genomföras som en integrerad del av upphandlingsprocessen.		
Nyckelord Upphandling, Livscykelanalys, Förenklad livscykelanalys, Livscykel kostnad, Försvarsmateriel, Offentlig upphandling		
Övriga bibliografiska uppgifter	Språk Engelska	
ISSN 1650-1942	Antal sidor: 32 s.	
Distribution enligt missiv	Pris: Enligt prislista	

Issuing organization FOI – Swedish Defence Research Agency Defence Analysis SE-172 90 Stockholm	Report number, ISRN FOI-R--0786--SE	Report type Base data report
	Research area code 3. Protection against Weapons of Mass Destruction	
	Month year January 2003	Project no. E 1420
	Customers code 5. Commissioned Research	
	Sub area code 35. Environmental Studies	
Author/s (editor/s) Elisabeth Hochschorner Göran Finnveden	Project manager Göran Finnveden	
	Approved by	
	Sponsoring agency Swedish Armed Forces	
	Scientifically and technically responsible	
Report title (In translation) Use of life cycle assessment methodology in the acquisition process of defence materiel		
Abstract (not more than 200 words) <p>The Swedish Armed Forces and the Defence Materiel Administration shall take environmental consideration in all phases of the acquisition process, according to a decision made by the Swedish government in 1998. Acquisition of defence materiel is an example of public purchasing. Environmental consideration in public purchasing is somewhat different than in non-public organisations or purchasing by an individual consumer, depending on differences in regulating laws and regulations.</p> <p>This report includes a description of the actors, the regulating documents and the Swedish acquisition process of defence materiel. The process is today under development and is therefore briefly described. Environmental requirements that are to be taken under consideration in the acquisition process (according to the Swedish Armed Forces) are included in the report.</p> <p>The report also presents preliminary suggestions of how to integrate life-cycle assessment or life cycle thinking in the acquisition process of defence materiel. More complete suggestions will be presented in the final report 2003-2004. Our major suggestion is that the defence sector should work systematically through different product groups. For each product group, traditional LCAs or simplified LCAs (in this case MECOs) should be performed for reference products, within each product group. The results should be an identification of critical aspects in the life cycles of the products. This knowledge should then be used when writing TTEMs and setting criteria for purchasing. The reports should be publically available to allow reviews and discussions of results. To make the work cost-effective international co-operation should be sought. It should be the responsibility of either SAF or FMV that such LCAs are performed. SAF should make sure that environmental requirements, based on a life-cycle perspective is included in the TTEM. In addition LCAs can also be performed as an integrated part of the acquisition process in <u>specific cases</u>.</p>		
Keywords Purchasing, Life cycle assessment, Simplified life cycle assessment, Life cycle costing, Defence materiel, Public purchasing		
Further bibliographic information	Language Swedish	
ISSN 1650-1942	Pages 32 p.	
	Price acc. to pricelist	

Abstract

The Swedish Armed Forces and the Defence Materiel Administration shall take environmental consideration in all phases of the acquisition process, according to a decision made by the Swedish government in 1998. Acquisition of defence materiel is an example of public purchasing. Environmental consideration in public purchasing is somewhat different than in non-public organisations or purchasing by an individual consumer, depending on differences in regulating laws and regulations.

This report includes a description of the actors, the regulating documents and the Swedish acquisition process of defence materiel. The process is today under development and is therefore briefly described. Environmental requirements that are to be taken under consideration in the acquisition process (according to the Swedish Armed Forces) are included in the report.

The report also presents preliminary suggestions of how to integrate life-cycle assessment or life cycle thinking in the acquisition process of defence materiel. More complete suggestions will be presented in the final report 2003-2004. Our major suggestion is that the defence sector should work systematically through different product groups. For each product group, traditional LCAs or simplified LCAs (in this case MECOs) should be performed for reference products, within each product group. The results should be an identification of critical aspects in the life cycles of the products. This knowledge should then be used when writing TTEMs and setting criteria for purchasing. The reports should be publically available to allow reviews and discussions of results. To make the work cost-effective international co-operation should be sought. It should be the responsibility of either SAF or FMV that such LCAs are performed. SAF should make sure that environmental requirements, based on a life-cycle perspective is included in the TTEM. In addition LCAs can also be performed as an integrated part of the acquisition process in specific cases.

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1. Introduction

This is a report of preliminary results from the first year of a two-year project, financed by the Swedish Armed Forces. The report contains suggestions of how to integrate life-cycle assessment (LCA) or life cycle thinking in the acquisition process of defence materiel. There are a large number of tools that can be used for assessing environmental impacts of different systems (e.g. Eriksson et al., 2001). LCAs are interesting to use in a purchasing process, since they focus on the product.

The project is a continuation from last years project, where a methodology for using simplified LCA as a complement to a traditional LCA was suggested, see Hochschorner et al (2002). This year's project also contains a LCA of a product used in the Swedish defence, for more information see Hägvall and Hochschorner (2002), and a suggestion of how LCA can be used in Life cycle costing (LCC). LCA, simplified LCA and LCC are described in section 1.1-1.3 below.

In 1998 the Government in Sweden decided that the Armed Forces and the Defence Materiel Administration (FMV) shall apply "Guidelines for environmental supply of defence materiel". Environmental consideration should be taken in all phases of the acquisition process. The present report briefly describes the acquisition process, the actors and regulating documents for environmental preferable purchasing of defence materiel. The Acquisition process of defence materiel is an example of public purchasing. Environmental consideration in public organisations is somewhat different than in private organisations, depending on for example The Act on Public Procurement. Differences and regulations is described in section 2.

1.1 Life cycle assessment

Life cycle assessment (LCA) is the compilation and evaluation of the inputs, outputs and potential environmental impacts of a product system throughout its life cycle. The life cycle includes mining of raw material, production, use and disposal of a product (i.e. from cradle to grave) (ISO, 1997). The term 'product' includes physical products as well as services. LCAs are often used as comparative studies. But it is not the products that are compared, rather the function of the products.

The assessment is standardised in the ISO 14040- series (ISO, 1998; ISO, 2000a; ISO, 2000b; ISO, 1997). A guide to the standards is made by Guinée et al (2001).

The analysis is performed in four phases, as described (according to Guinée et al 2001) and illustrated below. During the process it can be necessary to go back to earlier phases to improve them.

- **Definition of goal and scope:** The goal of the study should be explained, the intended use of the results, the initiator of the study, the practitioner, stakeholders and intended users of the results should be specified. A scope definition establishes the main characteristics of an intended LCA study, for example a technical or a geographical study. The function, functional unit alternatives and reference flows should be defined in this phase.
- **Inventory analysis:** The product system is defined in the inventory analysis. The definition includes setting the system boundaries, designing the flow diagrams with unit processes, collecting data for each of these processes, performing allocation phases for

multifunctional processes and completing the final calculations. The main result is an inventory table listing the quantified inputs and outputs to the environment associated with the functional unit, for example x kg carbon dioxide.

- **Impact assessment:** The results from the inventory analysis is further processed and interpreted in the Life Cycle Impact Assessment (LCIA). This phase includes classification, characterisation and the optional phases normalisation, grouping and weighting. A list of impact categories is defined that is used to classify the results from the inventory analysis, on a purely qualitative basis. The actual modelling results are calculated in characterisation phase. The optional normalisation serves to indicate the share of modelled results to a reference, e.g. a worldwide or regional total. The results can be grouped and weighted to include societal preferences of the various impact categories.
- **Interpretation:** The results from the analysis, all choices and assumptions made in the analysis are evaluated, in the interpretation, in terms of soundness and robustness. Conclusions are drawn and recommendations are made.

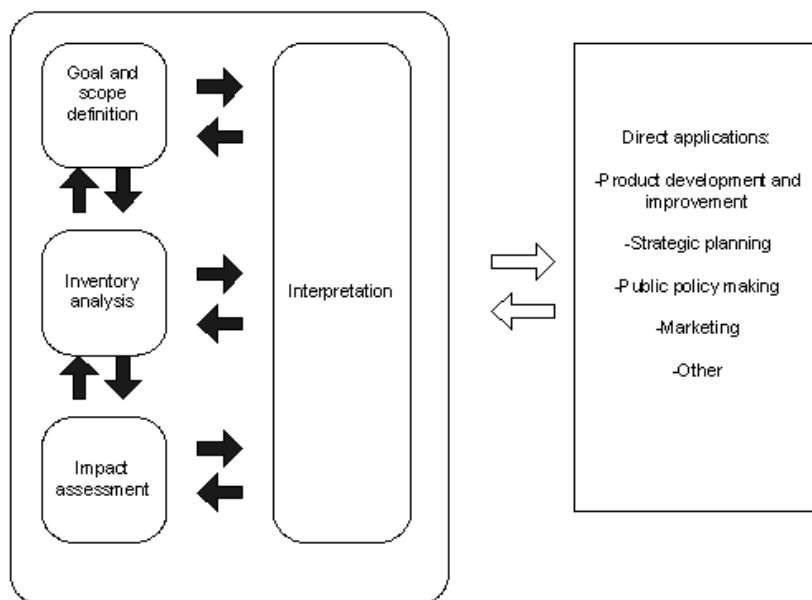


Figure 1. The framework for life cycle assessment, based on ISO 1997.

Since LCAs focus on products they are useful for product development and improvement. The tool is also feasible for purchasing, since it focuses on a product.

It is not possible to quantify everything, so qualitative data and estimations are therefore necessary to create a comprehensive picture even in a quantitative LCA. It is also possible to consider quantitative information in a qualitative LCA, when such is easily accessible (Johansson et al., 2001)

1.2 Simplified life cycle assessment

A complete, quantitative LCA has never been accomplished, nor is it likely to be (Graedel, 1998). It could therefore be practical to start with less detailed studies and work towards more detailed (Lindfors et al., 1995).

A simplified LCA is as a simplified variety of detailed LCA conducted according to guidelines not in full compliance with the ISO 1404X standards and representative of studies typically requiring from 1 to 20 person-days of work (Guinée *et al.*, 2001). (The terms “simplified” and “streamlined” are here used as synonyms, in line with earlier publications, e.g. Christiansen, 1997). It can be qualitative, quantitative or semi-quantitative. A large number of simplified LCA-methods has been developed, see for example reviews in Christiansen (1997), Graedel (1998), Todd and Curran (1999) and Johansson *et al* (2001).

Many of these methods are developed for a specific group of products and are not well documented. Two simplified LCAs, SLCA (Graedel and Allenby, 1995) and MECO (Pommer K. *et al.*, 2001; Wenzel, 1998), have been evaluated in an earlier project (Hochschorner *et al*, 2002, Hochschorner and Finnveden, 2002). The evaluation resulted in a recommendation to use the MECO principle as a complement to a traditional LCA.

1.2.1 The MECO principle

The Danish Institute for Product Development and dk-TEKNIK have developed the MECO principle in co-operation with a larger Danish project. The use of the principle is described in “Handbook for Environmental Assessment of Products” (Pommer *et al.*, 2001), which is intended for small and medium-sized companies. The principle divides the assessment into four areas in accordance with the underlying causes of the product’s environmental impacts. These areas, which have given the principle its name, are Materials, Energy, Chemicals and Others (Wenzel *et al.*, 1997).

The information on the studied product/ system is first structured in the MECO chart, see Figure 2. The analysis with the chart can be followed by a more detailed LCA, making a gradual evaluation of the product.

	Material	Manufacture	Use	Disposal	Transport
1. Materials					
a) quantity					
b) resource					
2. Energy					
a) primary					
b) resource					
3. Chemicals					
4. Others					

Figure 2. MECO chart (Pommer *et al*, 2001).

All inflows and outflows must be considered for one category at a time with bases on the functional unit and the chosen life cycle phase.

The category ‘Material’ includes all the materials needed to produce, use and maintain the product. Materials that are being reused in the phase of disposal are entered in the Disposal box, marked with a minus sign. The use of materials is partly presented as quantity (1a) and partly as resources (1b).

The category 'Energy' includes all energy used during the product's life cycle, including the use of energy during the supply of materials. The use of energy should be indicated as primary energy (2a) and as use of oil resources (2b).

To be able to compare products, the use of material and energy should be calculated as consumption of resources, in millipersonreserve (mPR). One personreserve is resource consumption in proportion to the global reserves of a resource, available for one person and all future posterity. The use of energy is calculated as use of oil resources.

The category 'Chemicals' includes all chemicals in the product's life cycle. The chemicals are classified as type 1, 2, or 3 according to their environmental hazard level. Type 1 refers to very problematic substances, type 2 problematic and type 3 less problematic substances. The classification was made with help from EU directives on marking of chemicals (EU directive 67/548/EEG, European Commission, 1967) and Danish lists (Listen over farlige stoffer, Effekliste, Listen over uønskede stoffer, (Miljøstyrelsen, 2000 a,b,c). A chemical is classified as type 1, 2 or 3 depending on whether it is within both, either, or neither of these lists.

Environmental impacts that do not fit into the categories described above should be included in the category 'Other'.

For a detailed description of how to use the method, see Pommer et al (2001, in dansish) or Hochschorner et al (2002, in Swedish).

1.3 Life cycle costing

Life cycle costing (LCC) is a method for quantifying the costs related to a production system or a product during its life cycle (Dahlén and Bolmsjö, 1996).

LCC is not standardised like life cycle assessment. The costs included in LCC are somewhat different depending on the description of the method. White et al (1996) includes all internal and external costs incurred throughout the entire life cycle of a product, process or activity. External costs are, in contrary to internal costs, not borne directly by the organisation. One example is costs occurred in a forest through decreased production caused by emissions from a factory producing the studied product (Eriksson et al, 2001).

Life cycle costing is used today by the Swedish Defence Materiel Administration (FMV) in the acquisition process. It is not a requirement from the customer to perform a LCC, but it is often used when purchasing materiel of a large economic value and principal equipment (OE-materiel, organisations och effektbestämmande materiel) (Lewenhaupt, 2002).

FMV defines LCC as a measure of a materiel systems total economic consequence over the systems life length, i.e. costs occurring during development, acquisition, use, support and disposal. A materiel system is one or many materiel objects with complementary operation and maintenance. The life length refers to the number of years the system are to be used (FMV, 2002). LCC in FMV does not necessarily include the total actual cost for the material system. For example fixed costs and sunk costs (costs that will not affect future decisions) are often excluded from the analysis (FMV 2002).

LCC is used by FMV as a base for decisions when separating alternative solutions of materiel systems and maintenance. Other fields of application in the acquisition-process is:

- As a base for TTEM in the study-phase.
- As a base for decisions of modifications or reconstruction to improve already existing systems or to make them more cost effective.
- Analyses of the reliability-requirements cost- consequences can be used as a base for choosing a system.
- As a base for choosing supplier: LCC can be used both for choosing supplier when purchasing standard materiel and for evaluation of offers.
- As a base for prognoses of the budget

2. Environmentally preferable public purchasing

Acquisition of defence materiel is an example of public purchasing. Environmental consideration in public purchasing is somewhat different than in non-public organisations or purchasing by an individual consumer, depending on differences in regulating laws and regulations, for example The Act on Public Procurement (Lag (1992:1528) om offentlig upphandling).

Other differences, than regulating, between a public and individual consumer are for example (OECD, 2000):

- A public purchaser buys the product for use within or by another organisation.
- Public purchasing involves more participants in the decision.
- Considerable quantities or values may be involved in public purchasing
- Public purchasing is a highly structured and formalised process to determine the characteristics of the products and services to be tendered.

The Act on Public Procurement is based on EG-directives and GPA (Agreement on Public Procurement, within WTO that Sweden is affiliated to) and controls purchasing in Swedish public organisations. The Commission of the European Communities has made an interpretative communication on the possibilities for integrating environmental considerations into public procurement. (COM, 2001). The following description of environmental consideration in public purchasing is mainly based on COM (2001).

The main possibilities for performing environmentally preferable public purchasing are when making the decision on what to be purchased. These decisions are not covered by the rules of the public procurement directives, but are covered by the Treaty rules and principles on the freedom of goods and services, notably the principles of non-discrimination and proportionality. How far this will effectively be done depends on the awareness and knowledge of the purchasing entity, and also environmental or other legislation (COM, 2001).

The public procurement directives do not cover public procurement below certain economic threshold values (1,4 MSEK, for authorities) or secrecy materiel (Falkendal R., 2002). Contracts that are not covered by public procurement directives have a considerable larger freedom to impose desirable requirements. In such cases the purchasing authorities are free to impose requirements and define conditions that go beyond what is possible under the public procurement directives.

Contracts that are covered by the directives have two options for awarding the contract: the lowest price and the 'most economically advantageous tender'. As a general rule, the public procurement directives impose two conditions with regard to the criteria, which will be applied for determining the most economically advantageous tender. First, the principle of non-discrimination has to be observed and second, the criteria applied shall generate an economic advantage for the contracting authority. Awarding the contract is, of-course, also regulated by environmental or other legislation, either community legislation or national legislation compatible with Community law (COM, 2001).

Contracts that are covered by the directives also have to consider the following regulations, when taking environmental consideration in the purchasing process (COM, 2001):

- The technical specification of the article to be purchased shall according to Directives be included in the general or contractual documents relating to each contract. Technical specifications include all characteristics required by the contracting authority in order to ensure that the product or service fulfils the use for which it is intended. It is possible to include prescriptions of primary materials, production process, ECO-labels and use of variants in the technical specification, in cases where the subject of the contract may not be sufficiently precise and clear to all parties concerned. Such indications must be non-discriminatory and must always be accompanied by the terms “*or equivalent*”.
- The most economically advantageous tender will be evaluated considering criteria that the contracting authority has indicated beforehand, either in the contract notice or in the contract documents. It is possible to use other criteria, than the examples given in the directives, but they must not be discriminatory and they must be economically advantageous for the purchasing authority. Economic considerations can include aspects of environmental protection, like, for instance the energy consumption of a product. The evaluation of the most economic advantageous offer implies complex trade-offs, even without consideration to environmental characteristics (COM, 2001). Factors that can give arise to trade-off situations are for example: competition, functionality and social aspects (OECD).
- Environmental considerations are not explicitly mentioned in the current public procurement legislation. But, it is possible to consider for example the consumption of natural resources, by “translating” this environmental objective into specific, product-related and economically measurable criteria by requiring a rate of energy consumption.
- Costs incurred during the life cycle of a product, which will be born by the contracting authority may be taken into account for the assessment of the most economically advantageous tender. When evaluating tenders, a purchasing organisation can also take account of costs for treatment of waste or re-cycling.
- As a general rule, externalities are not borne by the purchaser of a product or service, but by the society as a whole and therefore do not qualify as award criteria as defined above. The Commission notes in this respect that contracting authorities retain the possibility to define the subject matter of a contract or impose conditions relating to the execution of the contract and to integrate their environmental preferences linked to eventual occurrence of external costs.

In addition to the interpretative communication, the Commission intends to produce a handbook on green public procurement with examples on how to draw up green calls for tender in conformity with Community law (COM, 2002).

The Committee for Ecologically Sustainable Procurement in Sweden has developed guidelines to help public-sector organisations integrate environmental concerns into their purchasing of goods, services and contracts. This has been done in co-operation with representatives from government agencies, local authorities and county councils. The guidelines are Internet-based and includes proposals for environmental requirements that can be applied on about 70 different product groups such as batteries, food, furniture and cleaning services. The guidelines will be changed due to the interpretative document on environmental concerns in public procurement, described above. (EKU-delegationen, 2002)

3. Purchasing in the Swedish Defence

Since the end of the cold war the Swedish defence is undergoing changes. So is the procurement process (Hochschorner and Strömstedt 2002). Processes described in the below may therefore change during the next years.

3.1 Actors and regulating documents in the Swedish acquisition process

The acquisition process of Swedish defence materiel engage both actors from the public and industrial sectors (SOU, 2000). The process is regulated by a number of documents. The actors and the documents are briefly described below and illustrated in figure 3.

3.1.1 Actors in the Swedish acquisition process of defence materiel

The following actors in the Swedish acquisition process of defence materiel are described below:

- The Swedish Parliament
- The Swedish Government
- Swedish Armed Forces (SAF)
- Swedish Defence Materiel Administration (FMV)
- Swedish Defence Research Agency (FOI)
- Industry
- International organs and forms of co-operation

The Swedish Parliament's (Riksdagen) responsibility concerning materiel acquisition is to establish laws. Laws in force of materiel acquisition are e.g. *The law of war equipment* (Lag (1992: 1300) om krigsmateriel) and *The act on public purchasing* (Lag (1992: 1528) om offentlig upphandling) (SOU, 2001).

The Government informs the Parliament and makes suggestions for the decisions of the parliament. It controls the acquisition process by instructions, rules, general conditions, and formulation of assignments to the authorities. The government very strongly emphasis the need for international co-operation, especially when planning for new military systems.

The direction of the acquisition-process is controlled in *The Appropriation directions to the Armed Forces* (regleringsbrevet till försvarsmakten), where demands on aim and result are stated. A long-term control of the acquisition is also made by indication of the acquisitions alignment. The act on public purchasing controls the commercial activities (SOU, 2002).

Acquisition for the Armed Forces is made on the basis of *The plan for supply of materiel* (MFP, materielförsörjningsplanen). In the Appropriation directions the government gives directions for which systems in MFP that the Armed Forces should introduce to the ministry of defence, before ordering. This occurs, for example, when the total acquisition value for an individual system amounts to 50 millions SEK or more.

The preparation of acquisition matters is a joint effort between the Ministry of Defence, the Ministry of Finance and the Ministry of Foreign Affairs. The preparation includes contacts with industry concerning for example the strategic conditions for production of military systems in the country and different aspects of the internationalisation of the industry.

The Ministry of Defence has regular dialogues with the Armed Forces and the Defence Materiel Administration concerning acquisition and planning of support of materiel. The Ministry of Defence also contributes to a large extent to the international co-operation of security- and defence policy.

The Ministry of Foreign Affairs co-ordinates the Government Offices security policy aspects within the international co-operation. The ministry also co-ordinates matters of promotion and control of defence materiel export.

The Ministry of Finance co-ordinates aspects of economic policy of importance for the acquisition process. (SOU, 2001)

The Swedish Armed Forces (SAF)

The Armed Forces place an order for the requirements of a research-, development-, or acquisition assignment with attendant financing to the Defence Materiel Administration (SOU, 2002).

Procurement of the Armed Forces is made on the basis of the established terms of reference in *The plan for supply of materiel (MFP)* and *The plan for supply of land, installations and premises* (MAL (mark, anläggning och lokaler)- försörjningsplanen). Procurement can be made as step-by-step procurement or direct procurement (SOU, 2001).

The fundamental analysis -and planning activity is made within the *perspective plans*. The work with the plan is reported yearly to the Ministry of Defence and is a basis for the governments' long-term decisions.

The Swedish Defence Materiel Administration (FMV)

The Swedish Defence Materiel Administration (FMV) is from a system perspective responsible for cost-effectively providing the Armed Forces with military materiel. FMV acquires, maintains and phase out materiel and supplies on assignment from principally the Armed Forces, see paragraph 3.2.

The National Fortification Administrations (Fortv)

The National Fortification Administrations administer and rents out defence properties, and are responsible for management of the properties. It is a governmental agency under the Ministry of finance. This report will not focus on the work made by the National Fortification Administration.

The Swedish Defence Research Agency (FOI)

The Armed forces and the Defence Materiel Administration can get support for studies of the operational capabilities and structure of the materiel from FOI. The research made by FOI can help FMV to specify performance of the materiel. This is important in order to reduce risks and environmental impacts.

Industry

Swedish based contractors supplying systems to the Swedish Defence are for example SAAB AB, Ericsson Microwave Systems AB and VOLVO Aero Corporation. A number of large contractors are also found in the European Union, in the U.S. and elsewhere in the world.

International organs and forms of co-operation

The Swedish Defence co-operates with many organizations within the area of defence materiel, for example Western European Armaments Group (WEAG). The actor in charge of the co-operation is the Swedish Government represented by the Swedish Defence Materiel Administration (SOU, 2000).

3.1.2 Regulating documents in the acquisition process of Swedish defence materiel

The acquisition process is regulated by a number of documents, these are:

- The perspective plan (perspektivplanen)
- Tactical Organizational Economic Goal (TOEM)
- Tactical Technical Economic Goal (TTEM)
- Appropriation directions (Regleringsbrev)
- The plan for supply of materiel (MFP, materielförsörjningsplanen)
- The Objectives Handbook (Handbok MÅL)
- The plan for supply of land, installations and premises (MAL-försörjningsplanen)

The perspective plan:

The perspective plan is made by the by the Swedish Armed Forces. Perspective studies cover a period of 15-20 years into the future and result in *perspective plans* with proposals for the future goals of the military defence and war organization. The development of the Armed Forces over a maximum of 5+5 years, is directed by *programme plans*. These are discussed annually and are elaborated on the basis of the existing war organization and with a direction towards the long-term aim indicated.

Tactical Organizational Economic Goal:

Type units should have a unit goal called *Tactical Organizational Economic Goal (TOEM)*. With TOEM for units as a basis, the necessary *Tactical Technical Economic Goals (TTEM)* for supplies is prepared. TOEM is written by the Swedish Armed Forces.

The development step by step is normally:

1. Draft goals (UTOEM)
2. Preliminary goals (PTOEM)
3. Final goals (TOEM)

Tactical Technical Economic Goal:

Tactical Technical Economic Goal (TTEM) is based on TOEM and a standardized, for the object or system, description of the aggressor with tactical, technical, economic, combat and environment studies and investigations. The goal expresses the relation between effect and costs of procurement, support and disposal respectively. It also serves as a basis for specification of performance characteristics, quality and capability to meet the units' needs and serves as a basis for contract with suppliers (through FMV).

According to The Objectives Handbook (SAF, 1997) is TTEM used as a basis for:

- Specification of performance, quality and capacity to provide the units need,
- Making an offer and ordering (from FMV, FORTV and others),
- Contract with suppliers (made by FMV, FORTV and others),
- Studies, investigations, projecting, development and production and also liquidation of materiel and constructions.

TTEM is written by the Swedish Armed Forces and should be available when a decision for investment is made and before the procurement is initiated (SAF, 1997).

TTEM should be prepared and decided by a central production leader. If necessary, co-operation is initiated with the authorities concerned outside the Armed Forces.

TTEM exists in three versions:

1. UTTEM (draft) indicates the direction for industrial studies and system plans.
2. PTTEM (preliminary) serves as a basis for investigation and development activities and long-term planning. PTTEM should be at hand when a decision for development is taken.
3. STTEM (approved) serves as the operational and tactical requirements in the assignment to FMV.

Appropriation directions:

The Government controls the direction and financing of the acquisition process, by the Appropriation directions. A long-term control of the acquisition is also made by indication of the acquisitions alignment (SOU, 2002). The Ministry of Defence writes the Appropriation directions.

The plan for supply of materiel, and the plan for supply of land, installations and premises:

Acquisition for the Armed Forces is made on the basis of *the plan for supply of materiel (MFP)*. In the Appropriation directions the government gives directions for which orders in MFP that the Armed Forces should introduce to the ministry of defence, before ordering. The Swedish Armed Forces establishes terms of reference for procurement in MFP and *the plan for supply of land, installations and premises (MAL)*. (SOU, 2001)

The Objectives Handbook:

This handbook gives direction for the development of the military organization, on the basis of conditions and demands from the Armed Forces operative planning and production in peace. It describes, among other things, goals for units, supplies and constructions, the process and co-ordination of the acquisition process and the work with TOEM and TTEM.

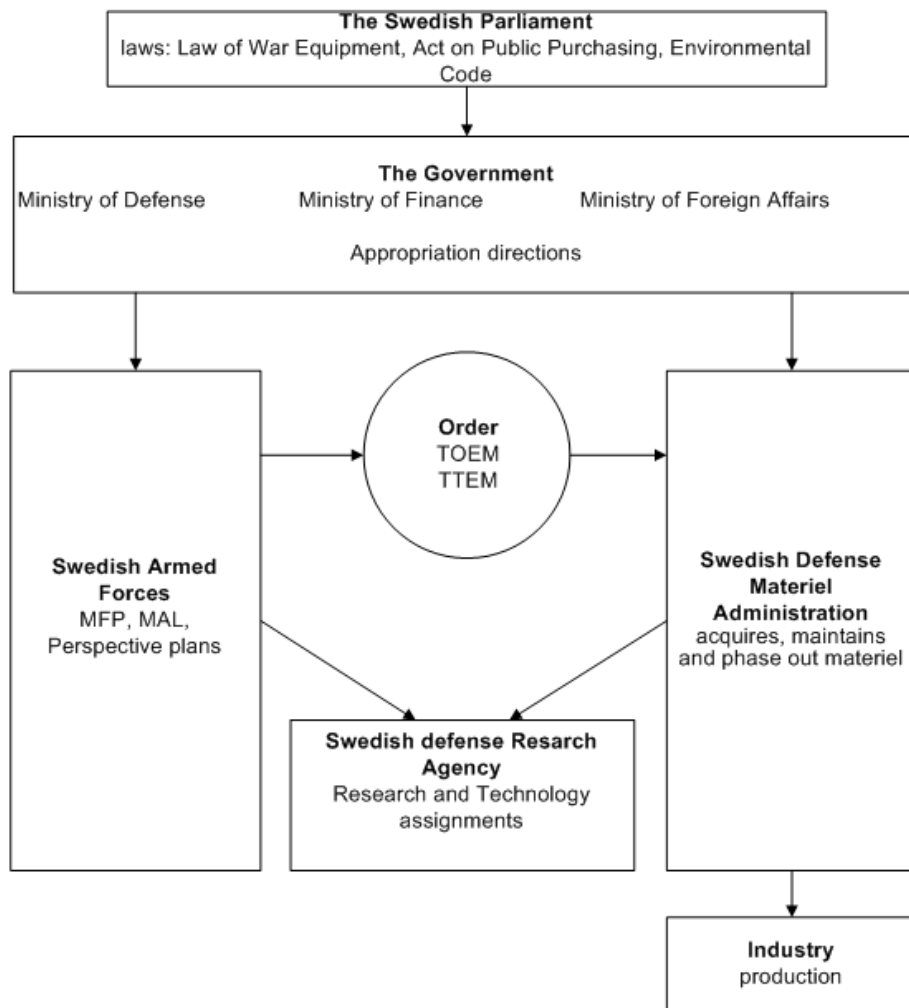


Figure 3. Actors in the Acquisition process (Based on SOU, 2002).

The arrows indicates decisions, information for the decisions often goes in the opposite way.

3.2 The Acquisition process

The Acquisition Process is under development and will be changed during the following years. There is no approved documentation describing the process available at this time. The process described below is thereby an assumption, made by the author, of the main phases that are most likely to be included in the acquisition process. The assumption is made with help from a general acquisition process for public purchasing in OECD countries (OECD, 2001), the main-phases in the American defence acquisition (Defence acquisition university, 2001), the ISO standard 15288 (ISO/IEC, 2002), and also information from FMV (Strömstedt, 2002) and SAF (Östberg, 2002). There is a number of documents regulating the acquisition process of defence materiel in Sweden, these are described in section 3.1.2 and Appendix A.

When purchasing materiel that does not have to be developed especially for the customer, the development and production phases are not included in the process, e.g. direct procurement (SAF, 1997).

The following phases are the main-phases in the acquisition process that will be discussed in the coming paragraphs:

1. The customer orders materiel

SAF orders the materiel systems or constructions that should be purchased by FMV. Purchasing requirements (environmental requirements included) are set in the TTEM and these should, when needed, be further developed by FMV (SAF, 2001). Materiel can already exist on the market or be developed especially for the customer.

2. Studies

Further development of requirements on the materiel system. This work should include the environmental requirements (SAF, 2001). The following actions are assumed to be included in this step:

Generating concepts: FMV generates, describes and analyzes the technical solutions with abilities that SAF desires,

Evaluating concepts: Analyze, evaluate and recommend feasible technical solutions.

Defining a system: Define the system with respect to interfaces and system architecture
Operational target, System design and Specification (Strömstedt, 2002).

3. Development, tests and trials

This step includes design, development tests, trials and further development of the materiel. FMV defines a more detailed system architecture and specification of the technical solutions. In some cases the product already exists on the market.

4. Purchasing

Selection of supplier: invitation and supplier selection, proposal/offer application, and evaluation. The requirements developed under the second phase are suggested to be used in this phase.

Contracting: The supplier(s) are chosen and a definition of agreement(s) is made.

Ordering: FMV orders the materiel from the supplier and supplies the customer (usually FM) on an agreed point in time with the correct number of technical systems holding the agreed quality. (OECD, 2000)

5. Manufacture/ Production: the supplier produces the materiel systems. FMV makes sure that the materiel is delivered to the customer, SAF.

6. Maintenance and support: The Armed Forces has the main responsibility for supporting and maintenance.

7. Phasing out: FMV has the main responsibility to guarantee that the system is phased out of the customers operations.

8. Disposal, recycling: FMV has the main responsibility in the disposal phase.

The responsibility between participants in the systems life cycle, can be illustrated with the following figure (Strömstedt 2002):

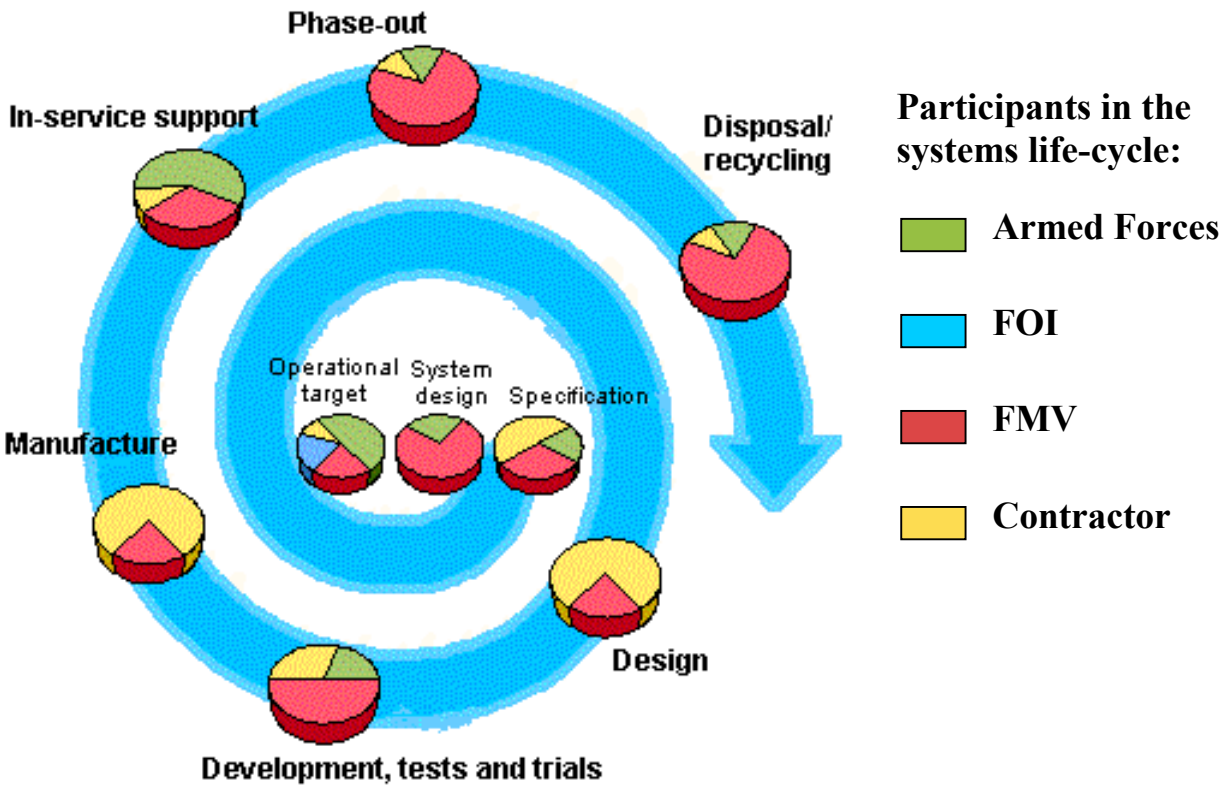


Figure 4. The Responsibilities between participants in the systems life cycle. (Strömstedt, 2002)

4. Environmental requirements in the acquisition process of defence materiel

The Swedish Government decided in 1998 that the Armed Forces and the Defence Materiel Administration should apply "Guidelines for environmental supply of defence materiel". Thereby environmental considerations are to be taken in all phases of the acquisition process (SAF 2001).

A working-group with participants from SAF and FMV has given the following suggestions to approve the work with environmental acquisition (SAF 2001):

- Environmental requirements should be initiated in the TTEM,
- Relevant environmental demands for operation of the materiel should be asked when purchasing.
- Requirements on the industry to give instructions of environmentally preferable dismantling of defence materiel.

These suggestions have been further specified in co-operation with FOI, the Swedish Environmental Protection Agency and the Industry. The co-operation resulted in the following environmental requirements for studies, long-term planning and materiel acquisition for the Armed Forces. The requirements are to be used as a base for studies, aim, long-term planning and acquisition for the Swedish defence. The requirements are suggested to be incorporated in *The Objectives Handbook (HMÅL)*, to describe which environmental requirements that should be included in the TTEM. It is going to be examined if the corresponding requirements should be incorporated in the agreement between SAF and FMV. The work in the study-phase should be completed and adjusted to integrate a future objective for the outer environmental in the threat assessment. (SAF, 2001)

The environmental requirements shall be formulated so the materiel-systems:

- Should have **low resource consumption**, by low energy consumption, use of renewable sources of energy and effective materiel consumption during the whole life-cycle of the system.
- Gets **recyclable** by construction for future phase out, use of as few types of materials as possible and marking for facilitating separation of materials and also establishments of material-specifications.
- Contains a minimum of **hazardous substances** by reducing the quantity of chemical products, by minimizing the use of environmental hazardous chemicals, by minimizing the use of solvents and products with solvents, by eliminating the use of CFC, HCFC and Halon. New chemical products shall be reported to the defence chemical group before introduction into service. All chemical products used shall be registered in the defence index over hazardous substances.
- Contains a **minimum of radioactive substances** by minimising or avoiding these form substances.
- Has **low levels of emissions** during operation, by reducing emissions of:
 - nitric oxides, hydrocarbons, sulphur oxides, carbon dioxide and particles to air.
 - hydrocarbons, nitrogen, phosphorous compounds and discharge to water from ships and boats, nitrogen and phosphorous compounds and also petroleum spill to ground.

- Has low **noise levels** while running ships, vehicles and aeroplanes and also while firing guns.
- **Minimisation of other environmental impacts** e.g. minimisation of damage on land, seashore and sea bed.

The requirements are intended to be discussed and balanced during the acquisition process, like the other requirements such as tactical, technical, and economic requirements. FMV are suggested to elucidate and develop the environmental requirements for each materiel-system, where appropriate (SAF, 2001). The working-group suggests that life cycle assessments (LCA) can be performed for some reference products in different materiel systems in order to identify considerable environmental aspects and facilitate the work with environmental requirements for specific materiel systems. The use of LCA in the acquisition process is further discussed in the next paragraph.

The manuals for use, maintenance and storage for a material system shall, according to the working group, include environmental information. The manual for maintenance should include environmental risks that can arise in a possible crash, for example dangerous gaseous in case of fire. A risk assessment on the environmental impacts can be needed to complete the manual (SAF, 2001).

Environmental impacts in the disposal phase should, according to the working group, be observed when developing and designing the materiel system. If environmental hazardous substances can not be avoided in some components, such components shall be marked and it should be possible to dismantle and take care of them separately. Specifications of the materiel systems should include materials and hazardous substances that are used in the materiel. (SAF, 2001)

5. Life cycle methodology in the acquisition process

One of the major difficulties when performing environmentally preferable purchasing is the lack of reliable information about the environmental characteristics of the product or service (OECD, 2000). Different tools developed for environmental consideration in product development can contribute with some knowledge and help to set up feasible requirements on a product. Examples of such tools are life cycle assessment (LCA), guidelines and checklists. Another way is to choose eco-labelled products, for example products labelled with the Nordic Swan label (OECD, 2000). This section will discuss useful tools in the acquisition process, considering a products life cycle. Support from different tools and trade-offs situations in the procurement process are discussed in a separate paper (Byggeth et al., 2002).

The term “life cycle” is often used with different meanings in LCA, LCC and when describing the life of a product in the acquisition process. The differences are illustrated in figure 5.

In LCA the term life cycle includes production, use and disposal of a product (i.e. from cradle to grave) (ISO 1997), see the dashed line in figure 5.

The term “life length” of a materiel system is used in FMV description of LCC as the number of years the system shall be used (FMV 2002), this is from purchasing to disposal see the dotted line in figure 5.

The economic lifetime of the investment is the time horizon in LCC (Norris, 2001), in this case research, development, purchasing, use and disposal (FMV, 2002).

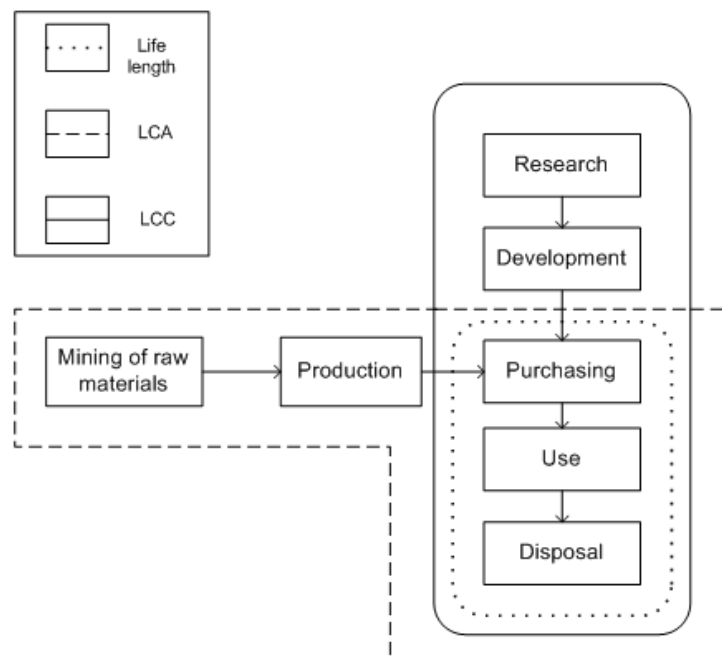


Figure 5 Life cycles in LCA, LCC and materiel systems. The steps are examples and simplifications of what can be included (based on discussions with M. Overcash).

5.1 Life cycle assessment methodology in the acquisition process

LCAs can be used in different ways in the acquisition process. Here we will discuss and suggest different ways of doing that. A first distinction can be made between performing a LCA and using the results from an LCA. Since it often is time-consuming to perform a traditional LCA it is useful if results from already made LCAs can be used in the acquisition process. A concrete proposal is therefore to perform LCAs of reference products. These should be, in some sense, typical examples of products in different product groups. The results from these LCAs can then be used when setting up environmental requirements. In Sweden it could be the responsibility of either SAF or FMV that such LCAs are made.

Data generated from a LCA or a MECO assessment can be used when developing, purchasing and recycling a materiel system (step 3,4 and 8 in figure 6). Such data can help to facilitate a choice between different alternatives, for example materials, processes (in the development and disposal phase) and to set up environmental requirements on products (in the purchasing phase).

Since it is often time consuming to perform a traditional LCA from scratch, it is a good idea to use easily accessible data. Therefore is it recommendable to perform LCAs on different types of product groups to achieve a good database. These data can then be used when performing a new LCA or a MECO assessment, or when setting up environmental requirements. In the acquisition process of defence materiel, the environmental requirements should be a further development of the general requirements stated in the operational handbook (SAF, 2001), se section 4. They shall include noise, emissions to air, water and ground and also requirements on land use (SAF, 2001). Except for noise and land use are these environmental impacts normally included in a traditional LCA. All of the impacts can be included in MECO. This is one of the reasons that MECO is recommended as a complement to a traditional LCA in Hochschorner et al (2002).

When performing a LCA in the acquisition process this is preferably done in the study phase. However, often the product will not be specified in enough detail to allow a detailed LCA early in the process. It may therefore be necessary to complete or perform the LCA later in the process, e.g. in the purchasing step. When the product already exists on the market it can be sufficient to perform a MECO analysis, preferably using data from an already made LCA or MECO. When purchasing material that will be developed especially for the customer a LCA can be performed to require knowledge of the products total environmental impact. If the product resembles a product for which a LCA has been performed, the already existing LCA can be adjusted for the new product or the LCA data can be used in a MECO analyses.

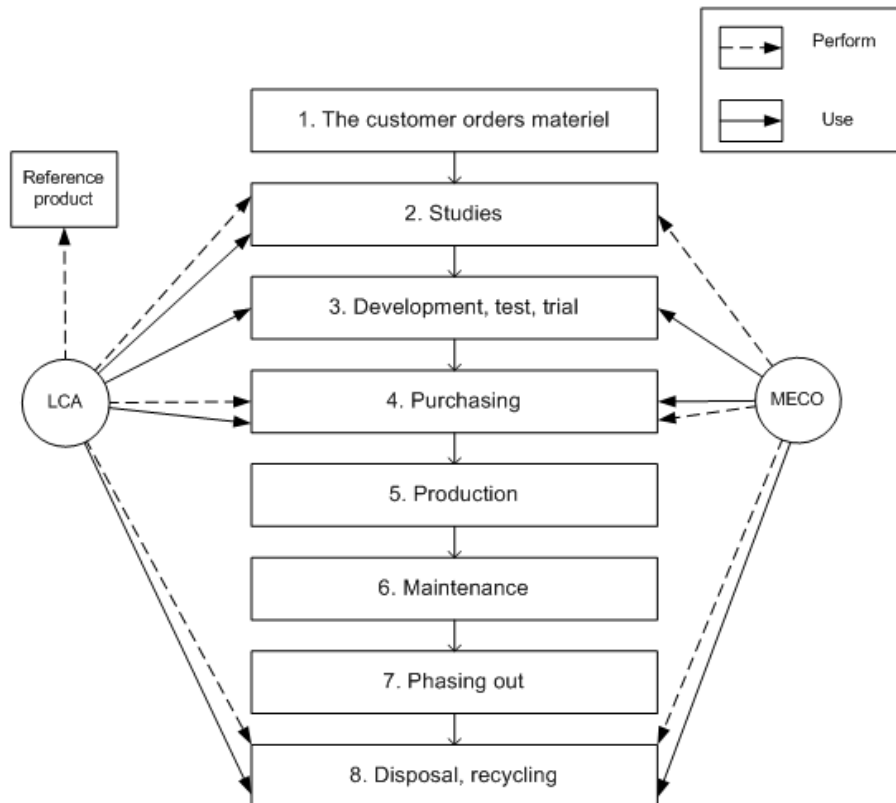


Figure 6. Life cycle methodology in the acquisition process.

In the purchasing step, a distinction can be made between two phases:

- a) setting up requirements
- b) choosing between suppliers

LCAs can be used for setting up requirements. It is however not likely that LCAs can be used today for choosing between different suppliers. This is because it is not likely that the suppliers can provide the relevant information.

The MECO-method can be further developed to suit the acquisitions process of defence materiel better. For example by using other lists than the ones suggested in Pommer et al (2001). FMV has developed lists of hazardous chemicals. These lists are not available at the time. Depending on the performance of these lists, they may be interesting to use in a MECO analysis.

A major difference between traditional LCAs and simplified LCAs such as MECO is that the former is more suitable when choosing between alternatives. Simplified LCAs can primarily be used for identifying critical aspects. This latter function is of relevance in the acquisition process, it is therefore suggested that MECO can be useful for identifying critical aspects and setting requirements.

There are guidebooks and checklists developed for environmentally preferable purchasing in other public organisations, both in Sweden and in other countries. One example is developed by the Norwegian defence logistics organisation that will be available next year. We will take

some of these tools in consideration in the future work when completing the suggestions made in this report.

Another part of this project is to perform a LCA of a military product. This has been made on the grenade 40/48 KULSGR 90 (the international name is 40 mm L/70 PFHE mark two). The preliminary results are presented in Hägvall and Hochschorner (2002). More detailed results will improve the work with suggesting a Life Cycle Methodology in the acquisition process.

Our major suggestion is that the defence sector should work systematically through different product groups. For each product group, traditional LCAs or simplified LCAs (in this case MECOs) should be performed for reference products, within each product group. The results should be an identification of critical aspects in the life cycles of the products. This knowledge should then be used when writing TTEMs and setting criteria for purchasing. The reports should be publically available to allow reviews and discussions of results. To make the work cost-effective international co-operation should be sought. It should be the responsibility of either SAF or FMV that such LCAs are performed. SAF should make sure that environmental requirements, based on a life-cycle perspective is included in the TTEM. In addition LCAs can also be performed as an integrated part of the acquisition process in specific cases.

Appendix

A. Documents and laws governing environmental acquisition in Sweden

A.1 Examples of governing documents for environmental preferable acquisition of defence materiel:

The Environmental Code (Miljöbalk 1998:808)

(Available at: http://miljo.regeringen.se/pressinfo/pdf/ds2000_61.pdf)

Guidelines for environmental acquisition of defence materiel: a decision from the Government 98-12-03. These are available in Swedish at:
<http://www.fmv.se/environ/index.asp?K=003001&L=SE>

Appropriation directions for the defence sector

(The Swedish Government (2002): Regleringsbrev för budgetåret 2002 avseende försvarsmakten)

Aim for the defence sector

(Swedish Armed Forces (1999): Miljömål för försvarssektorn och arbetet för ekologisk hållbarhet, HKV-rapport 24 100:70349)

System Safety Handbook by the Swedish Armed Forces

(Försvarsmakten (1996): Försvarsmaktens handbok för Systemsäkerhet, H SystSäk)

Environmental Handbook by the Swedish Armed Forces

(Försvarsmakten, Högkvarteret. 1998: Handbok miljö för Försvarsmakten, H Miljö, Stockholm, Sweden, In Swedish)

Environmental policy of the Armed Forces

(Available at: <http://www.mil.se/ovrigt/miljosek/policy-e.html>)

Environmental policy of the Defence Materiel Administration

(Available at: <http://www.fmv.se/environ/index.asp?K=001&L=UK>)

Nordic Agenda 21 for the defence sector

NATO-PFP Guidelines on the acquisition of environmentally sound defence procurement (see document: NATO-PFP Environmental Guidelines.pdf)

A.2 Examples of Swedish Environmental legislation:

The Act on Public Procurement (Lag (1992:1528) om offentlig upphandling): The act is based on EG-directives and GPA (Agreement on Public Procurement, within WTO that Sweden is affiliated to).

The act is available in Swedish and English at the Internet page:
<http://www.nou.se/loueng.html>

Commission interpretative communication on the Community law applicable to public procurement and the possibilities for integrating environmental considerations into public procurement

Commission of the European Communities (2001). Commission interpretative communication on the Community law applicable to public procurement and the possibilities for integrating environmental considerations into public procurement (Brussels). Available at: http://europa.eu.int/eur-lex/en/com/cnc/2001/com2001_0274en01.pdf

The Swedish Environmental Code (Miljöbalk 1998:808):

The Swedish Environmental Code was adopted in 1998 and entered into force on 1 January 1999, bringing together 15 existing central environmental laws. The aim of the Environmental Code is to promote sustainable development based on the understanding that nature is worthy of protection in its own right, and that man's right to exploit nature carries with it a responsibility. The Environmental Code is further elaborated and specified in the form of ordinances, regulations issued by public authorities and decisions taken in individual cases. (Swedish Environmental Protection Agency, 2002)

The code is available in english at: http://miljo.regeringen.se/pressinfo/pdf/ds2000_61.pdf

The Act on Product responsibility (Produktansvarslag (1992:18)):

The act includes compensation for injuries and damages occurred from lack in securities in an article. Lack in security of an article includes defects depending on construction, production or unclear directions.

This law is available (in Swedish) at: <http://www.notisum.se/rnp/SLS/LAG/19920018.HTM>

Ordance of chemical products and biotechnical organisms (Förordning (1998:941) om kemiska produkter och biotekniska organismer):

This ordinance is available (in Swedish) at:
<http://www.notisum.se/rnp/SLS/LAG/19980941.HTM>

B. Abbreviations

EU	European Union
FMV	Swedish Defence Materiel Administration
FOI	Swedish Defence Research Agency
Fortv	National Fortification Administrations
GATT	General Agreement on Tariffs and Trade
GPA	Agreement on Public Procurement
ISO	International Organization for Standardization
LCA	Life Cycle Assessment
LCC	Life Cycle Costing
LCIA	Life Cycle Impact Assessment
MAL	Plan for supply of land, installations and premises
MECO	Material, Energy, Chemicals and Other, the name of a simplified LCA method
MFP	Plan for supply of materiel
mPR	Millipersonreserv, used as a base for evaluation in the MECO principle
OECD	Organisation for economic co-operation and development
PTTEM	Preliminary Tactical Technical Economic Goal
SAF	Swedish Armed Forces
STTEM	Final Tactical Technical Economic Goal
TOEM	Tactical Organizational Economic Goal
TTEM	Tactical Technical Economic Goal
UTTEM	Draft Tactical Technical Economic Goal
WEAG	Western European Armaments Group

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