

THE CENTRE FOR SOCIAL AND ECONOMIC RESEARCH ON THE GLOBAL ENVIRONMENT



**FEASIBILITY STUDY OF WALL AND FLOOR COVERINGS
WITH A VIEW TO ESTABLISHING EU ECO-LABELLING
CRITERIA**

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Executive Summary

The aims and objectives of this eco-label feasibility study of wall and floor coverings in Europe are:

- to determine, for eco-labelling purposes, whether an eco-label should be established for wall and floor coverings;
- to establish what types of wall and floor coverings should be included in the product group;
- to have a preliminary understanding of the environmental impacts that occur in the lifecycle of the recommended product group and to inform the selection of the environmental criteria.

To achieve these objectives the following research has been carried: a market assessment to establish the market share of each product, the volume of sales and trade and the trends; a summary of the distribution systems; an assessment of the main characteristics of wall and floor coverings; a survey of eco-labelling competent bodies and other organisations evaluating consumer preferences; a summary of the production systems for the main products; and an assessment of the main environmental impacts that occur during the products lifecycle.

2. European market data on wall and floor coverings

The results of the market assessment and distribution systems found that:

- In monetary terms, the main wall and floor coverings **produced** in Europe are ceramic tiles (35%), carpets (30%) and wall paper (11%).
- In monetary terms, Italy and Spain **produce** the most ceramic tiles, while Belgium and Germany produce the most carpets.
- **Exports:** ceramic tiles (34%) have the greatest market share in **monetary terms**, followed by carpets (30%) and wood block flooring (11%). However when based on the **quantity** produced, the main exported products are carpets (46%) followed by ceramic tiles (31%).
- The strong intra-Europe export market for floor and wall coverings is particularly important as it indicates the potential for an eco-label. Carpets, ceramic tiles and plastic and linoleum are the main products exported to the intra-Europe market.
- The main countries exporting to the intra-Europe market are Belgium and Luxembourg and the Netherlands (carpets), and Italy for ceramic tiles and wood products.
- In general terms there are expanding intra-Europe export markets for most wall and floor covering products.
- The majority of floor and wall coverings are retailed direct to the consumer, thus giving ample scope for consumer choice to influence production processes.

3. Use and performance of wall and floor coverings

This section examines the characteristics, uses and standards of wall and floor coverings, consumer preferences and the lifetime of products. The results show:

- Jointless floor finishes are excluded from the study due to their technical and physical characteristics.
- The product group 'jointless resilient finishes' have a wide range of characteristics whereas jointed hard finishes and timber and timber products have more uniform characteristics.

- Product characteristics are not necessarily a measure of merit, it depends on the product use.
- Wall coverings include those providing a special surface and those selected for aesthetic appeal.
- Wall and floor coverings are often not used for the full duration of their technical lifetime. However some floor coverings such as ceramic tiles and wooden floors have a long technical lifetime and are regarded as long term products.
- A clear distinction can be seen between consumer preferences in northern, mid and southern Europe. However several products, such as paints, tiles, wood and vinyl, are widely used throughout Europe, independent of geographical characteristics.
- Apart from ceramic tiles different materials are generally used for walls or floors.
- Consumers select wall and floor coverings using a wide range of criteria such as cost, durability and appearance. Cost is beyond the scope of this study.
- Paints have already been awarded an eco-label and are therefore excluded from the study.
- Ceramic tiles and vinyl flooring are widely used throughout Europe for bathroom and kitchen floors, and other areas of high utility.

4. Production methods and environmental impacts

This section of the report examines manufacturing processes and the environmental impacts that occur in the production lifecycle. The following was found:

- Each covering material use very different production processes and raw materials.
- Some processes are relatively simple whilst others involve many production stages.
- Most production processes involve extensive transport of raw materials.
- Significant environmental impacts occur during the lifecycle of all wall and floor coverings.
- The use phase is particularly important for all products especially when vacuuming or contract cleaning is undertaken.
- The agricultural system associated with woollen carpets, the extraction of natural stone and the disposal of PVC vinyl flooring are stages that may have particular environmental impacts.
- Most production processes have opportunities for improvement in the environmental impacts that can be influenced by consumer choice. However some stages of the lifecycle, such as the extraction of natural stone and some agricultural systems, may not easily be influenced by consumer choice.

5. Discussion

The first objective for this study was whether an eco-label should be established for wall and floor coverings. The following areas have been considered:

Market share and trading: Carpets, ceramic tiles, wallpaper, wooden flooring, plastic and linoleum all have a significant internal market shares in Europe, while rubber flooring has a significant but smaller market share. The majority of these products are sold to the final consumer through large retail units. Paper flooring and textile wall coverings would appear to have a relatively small market share.

Environmental impacts: Significant environmental impacts occur during the lifecycle of all wall and floor coverings. Maintenance during the use phase is particularly important especially when vacuuming or contract cleaning is undertaken as these involve high energy and possibly water use. The use of chemical cleaners may also need consideration. Agricultural systems associated with woollen carpets, natural stone extraction, and the disposal of vinyl flooring may have large environmental impacts.

Scope for improvement: Opportunities for improving the environmental impacts of processes have been identified at most lifecycle stages. Areas that are more difficult to

improve on are those associated with the use phase, the extraction of natural resources and agricultural processes. The variety of products available to consumers allows them to base their choice according to the relative environmental implications from the production of coverings.

Competitive advantage: All the products have significant environmental impacts, but also have the potential for environmental improvements. In the main these improvements can be influenced through consumer choice. Therefore there is an incentive for manufacturers to reduce the environmental impacts from their processes (if necessary) in order to be granted an eco-label for their products and thus increase their competitive advantage.

5.2 Product Groups

The second objective is to establish what types of wall and floor coverings should be included in the product group:

The normal use of wall and floor coverings differs considerably with wall coverings mainly used for decorative purposes and some provide an easily cleaned surface. Floor coverings need to meet the requirements of a more challenging environment. They need different technical characteristics of wear resistance, durability and ease of maintenance. Therefore coverings for walls and floors have different uses and serve different purposes, so it would be logical to consider them as separate product groups.

Following this argument, floor coverings have a wide range of different characteristics some provide good insulation and warmth to the touch, whilst others provide an easily cleaned surface. The resilient flooring group, (Pye & Harrison, 1997) includes a very broad range of products, which ranges from carpets to PVC flexible flooring. Products in the groups, 'jointed hard finishes' and 'timber and timber products' are far less variable in their characteristics and form more uniform groups.

One distinction could be made between indoor and outdoor products. However many products can be used in both situations. Therefore it would seem better to include both indoor and outdoor products in the product group taking into account the different treatments outdoor materials may need.

A useful distinguishing categorisation is whether products are 'natural' (e.g. natural stone, timber) that simply require shaping and finishing or if they are the product of a manufacturing process. Manufactured products require extensive processing to make them into the final product. 'Natural' products offer producers very little scope for improvement. Timber can be sourced from sustainably harvested forests but this does not apply to natural stone products. Due to the major differences between natural and processed products it would not seem logical to have them in the same product group.

5.3 Environmental Impacts

Environmental impacts occur at most stages of the production of wall and floor coverings but the main problems occur at different stages for different products. Net energy use is significant for ceramic tiles, carpets and vinyl, although this is influenced by whether energy is recovered during waste disposal. The quantity and type of waste produced is a greater problem for carpets, linoleum and vinyl than for inert products such as tiles. Global warming potential is linked, to some extent, to energy use, though the use of natural products such as wool can also have global warming implications. Natural products can also have environmental implications relating to eutrophication emissions, whilst acidification is significant for woollen carpets, and to a lesser extent polyamide carpets, vinyl and wood.

Many of the environmental impacts of floor coverings were found to occur at the use stage, due to the energy and possibly chemicals used in cleaning. However it may not be possible

for manufacturers to influence this stage so it may not provide scope for improvement. Another impact area is transport which manufacturers also may not be able to influence.

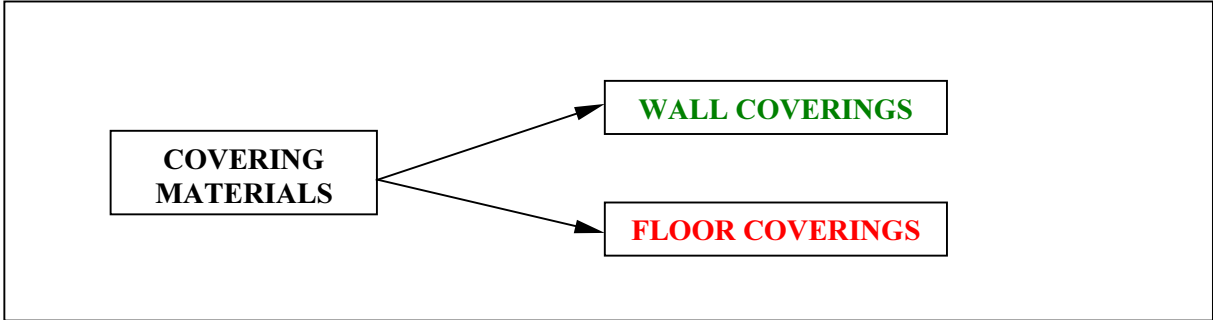
From the information that has been gathered it would seem likely that the environmental criteria for a recommended product group could be energy use, acidification, eutrophication and waste disposal.

6. Conclusions

This research has shown that there is certainly a case for an eco-label to be established. Most wall and floor coverings considered in this report: have a sufficient market share; are mainly sold direct to the final consumer; significant environmental impacts arise during the production cycles; and there is ample scope for improvement. Therefore in order to gain an eco-label and thus increase their market share there is an incentive for floor and wall coverings manufacturers to reduce the environmental impacts from their production processes.

However 'wall and floor coverings' include a very large number of products that are too diverse for a single eco-label. Therefore it is suggested that the wall and floor coverings group is classified further (fig. 24). The first stage is to exclude wall coverings from the potential product group. As discussed earlier wall coverings do not fulfil the same function as floor coverings and are therefore not equivalent in terms of use and consumer perception..

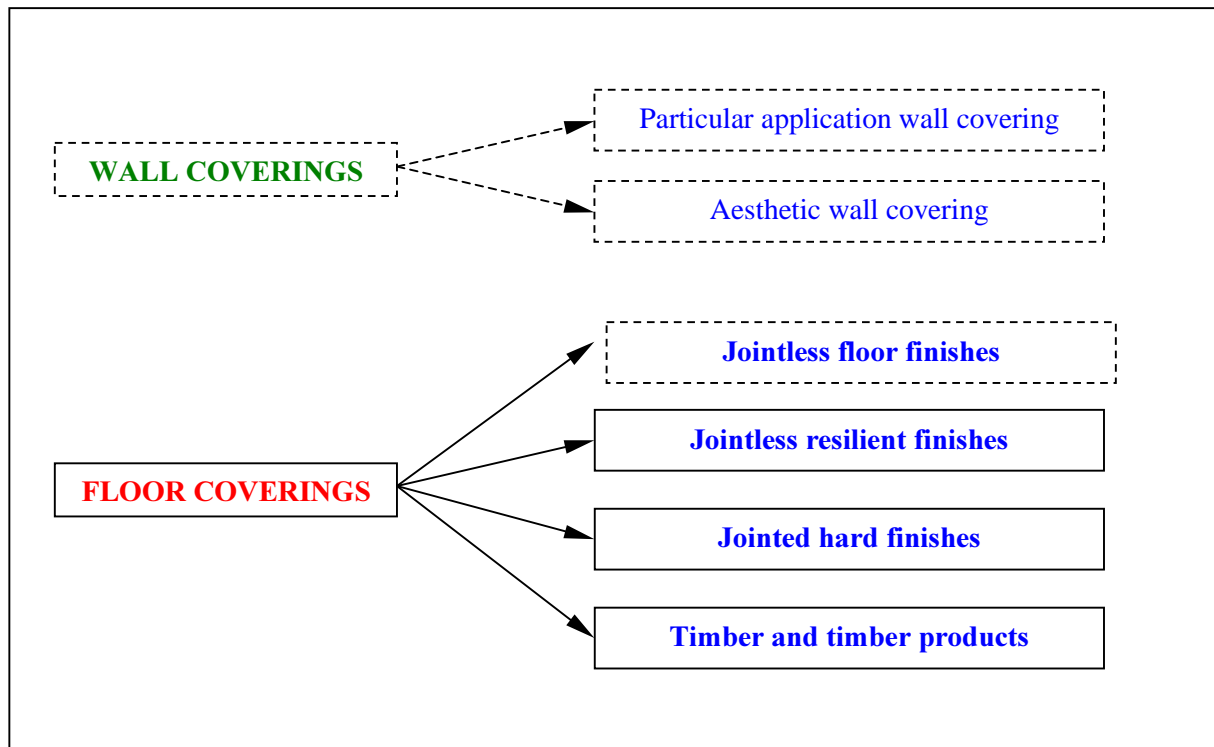
Figure 24: Covering materials division in accordance with their use destination.



A second classification can be made within the floor coverings group. Floor coverings can logically be classified according to their technical properties and performances (fig. 25). However this classification does not distinguish between natural and process products. From an eco-labelling perspective this is particularly important as natural flooring products offer producers very little scope for improvement due to most of the environmental impacts occurring at the extraction stage of the production, not at the manufacturing stage.

The classification of floor coverings also needs to take into consideration market share, the possibility of environmental improvements and consumers perception in order to determine the candidate product groups for an eco-label.

Figure 25: covering materials selection based on technical properties and performances.



On this basis, therefore, it would seem to the authors that floor coverings can be divided into five product groups that can potentially be considered for an eco-label:

Product group	Products
1. Resilient flooring	Textiles Linoleum PVC or vinyl Rubber Carpets
2. Processed hard flooring	Ceramic tiles Terrazzo
3. Natural hard flooring	Natural stone Marble
4. Processed timber flooring	Panel products Mosaic
5. Natural timber flooring	Board and strip Block Parquet

The first group, **resilient flooring**, is a logical selection, based on technical properties, that includes very soft surfaces, such as carpets and other textiles, and harder resilient surfaces. A problem with this product group is that it is very diverse and would need several sub-groups to accommodate the wide range of environmental impacts deriving from each product

type.

The second product group, **processed hard flooring**, is a logical and uniform group, easily understood by consumers. The products within this groups are made from similar raw materials and produced by similar manufacturing processes with lifecycle impacts occurring at the same lifecycle stages. The resources used to manufacture these products, although mostly non renewable, are relatively abundant compared with some of the natural flooring products which are not included in this group. Also excluded are brick paviers and concrete slabs, due to their presumed small market share, and bricks.

The third product group, **natural hard flooring**, such as stone, are considered a separate group from processed hard flooring. This is due to the environmental impacts of natural hard flooring mainly occurring at the extraction rather than the manufacturing stage. This results in there being less scope for environmental improvement. Natural hard floorings and processed hard floorings are in many instances perceived differently by consumers.

The fourth and the fifth group, **processed timber flooring** and **natural timber flooring**, are also uniform groups and they would seem a logical classification easily understood by consumers. The processed timber flooring group would provide a greater scope for environmental improvement, than natural timber flooring which includes relatively little processing.

For all groups both indoor and outdoor flooring products would be included.

1.0 Introduction

This feasibility study provides a more detailed view on the prospect of introducing an eco-label for floor and wall covering materials, extending and integrating on work previously carried out by ANPA & Centro Ceramica (1999).

The research by ANPA in 1999 was a feasibility study which sought to examine whether an eco-label could be awarded to ceramic tiles, as at the time, these were considered an individual product group. It was considered by the Ad Hoc Working Group (1999) that the study concentrated too much on ceramic tiles and did not sufficiently consider the markets and environmental impacts of alternative wall and floor coverings.

The European Commission therefore requested a more comprehensive analysis to elaborate further on the study by ANPA by taking into consideration other wall and floor coverings in addition to ceramic tiles.

Thus a feasibility study intended to be more comprehensive than its predecessor was commissioned; the resulting findings are presented in this report.

1.1. Aims and objectives

The aims and objectives of this feasibility study are:

- to determine, for eco-labelling purposes, whether an eco-label should be established for wall and floor coverings;
- to establish what types of wall and floor coverings should be included in the product group;
- to have a preliminary understanding of the environmental impacts that occur in the lifecycle of the recommended product group and to inform the selection of the environmental criteria.

To achieve these objectives the following research has been carried out on wall and floor coverings in Europe:

- a market assessment to establish the market share of each product and the volume of sales and trade [section 2.1]
- an assessment of the trends in these markets [section 2.2]
- a summary of the distribution system [section 2.3]
- an assessment of the main characteristics of wall and floor coverings [section 3.1]
- a survey of eco-labelling competent bodies and other organisations evaluating consumer preferences for alternative wall and floor coverings [section 3.2]
- a summary of the production systems for the main products [4.1]
- an assessment of the main environmental impacts that occur during the lifecycle of the products [section 4.2]

1.2. EU Eco-labelling Award Regulations

The objectives of the eco-label award scheme is “to promote products which have the potential to reduced negative environmental impacts, as compared with the other products in the same product group, thus contributing to the efficient use of resources and a high level of environmental protection. This objective shall be pursued through the provision of guidance and accurate, non-deceptive and scientifically based information to consumers on such products” (Council of the European Union, 2000). “The feasibility and market study will consider the various types of product groups in question on the Community market, the quantities produced, imported or sold and the structure of the market in the Member States.”

“Consumer perception, functional differences between types of products and the need for identifying subgroups will be assessed” (Council of the European Union, 2000).

Eco-label criteria are established by product groups. *A product group means any goods or services which serve the same purpose and which are equivalent in terms of use and consumer perception. A product group must fulfil the following conditions:*

- (a) it shall represent an overall significant volume of sales and trade in the internal market;*
- (b) it shall involve, at one or more stages of the product's life, significant environmental impacts on a global or regional scale and/or of a general nature;*
- (c) it shall present a significant potential for effecting environmental improvements through consumer choice as well as an incentive to manufactures or service providers to seek a competitive advantage by offering products which qualify for the eco-label; and*
- (d) a significant part of its volume of sales to be sold for final consumption or use.*

(Council of the European Union, 2000).

The eco-label criteria are selected on the following principles:

- (a) the perspectives of market penetration of the product in the Community shall, during the period of validity of the criteria, be sufficient to effect environmental improvements through consumer choice;*
- (b) the selectivity of a criterion shall take into account the technical and economic feasibility of adaptations needed to comply with them within a reasonable period of time;*
- (c) the selectivity of the criteria shall be determined with a view to achieving the maximum potential for environmental improvement.*

(Council of the European Union, 2000).

Other European environmental labels for flooring coverings already exist. The Nordic Swan or Nordic Environmental label includes seven flooring products; 4 linoleum, including a Forbo-Nairn floor covering, which is mainly manufactured from natural materials, 2 laminates and 1 solid wood flooring. In Germany the ‘Umweltzeichen’ or the ‘Blue Eco Angel’ is awarded to products with positive environmental features on the German market. Nearly 4,000 products now bear this mark including wallpapers and low-emission composite wood panels.

2. European market data on wall and floor coverings

One of the criteria for the award of an eco-label is that the product should have a *significant volume of sales and trade in the internal market*. Therefore a market assessment has been undertaken to establish the market share of each wall and floor covering product, including the volume of sales and trade. Unfortunately data on sales (or production) for domestic and non-domestic end-users are not available. Neither is there data on consumption. An assessment of the trends in the markets has also been undertaken, as has an assessment of the main consumer uses of the products.

Data has been sought on floor and wall coverings produced by, and exported into European Union countries. The floor coverings include ceramic tiles, other tiles, PVC (or vinyl), linoleum, natural stone, terrazzo, carpet and wood. The wall coverings include paper, textiles and wood. Coverings for both internal and external use have been included.

2.1 European market shares

2.1.1 Production

Data have been collected on the production and distribution of all wall and floor coverings for most European Union countries. The data include indicators such as production, imports, exports, trade balance and turnover for each Europe Union country. Production data have proved to be particularly difficult to obtain as they are considered confidential by many countries and organisations. The trade data available are far more comprehensive. Production data are only available in Euros, whilst trade data are available in surface areas of production (m²) as well.

The only countries for which a complete data set of **production** of all wall and floor coverings are available are Italy, Sweden, France and Germany (1996). However partial data are available for Belgium, Denmark, Portugal, Spain and the UK. The total value of the wall and floor covering production in these countries is nearly 17 billion Euros (Table 1). In monetary terms the main wall and floor coverings produced in Europe are ceramic tiles (35%), carpets (30%) and wall paper (11%) (Figure 1).

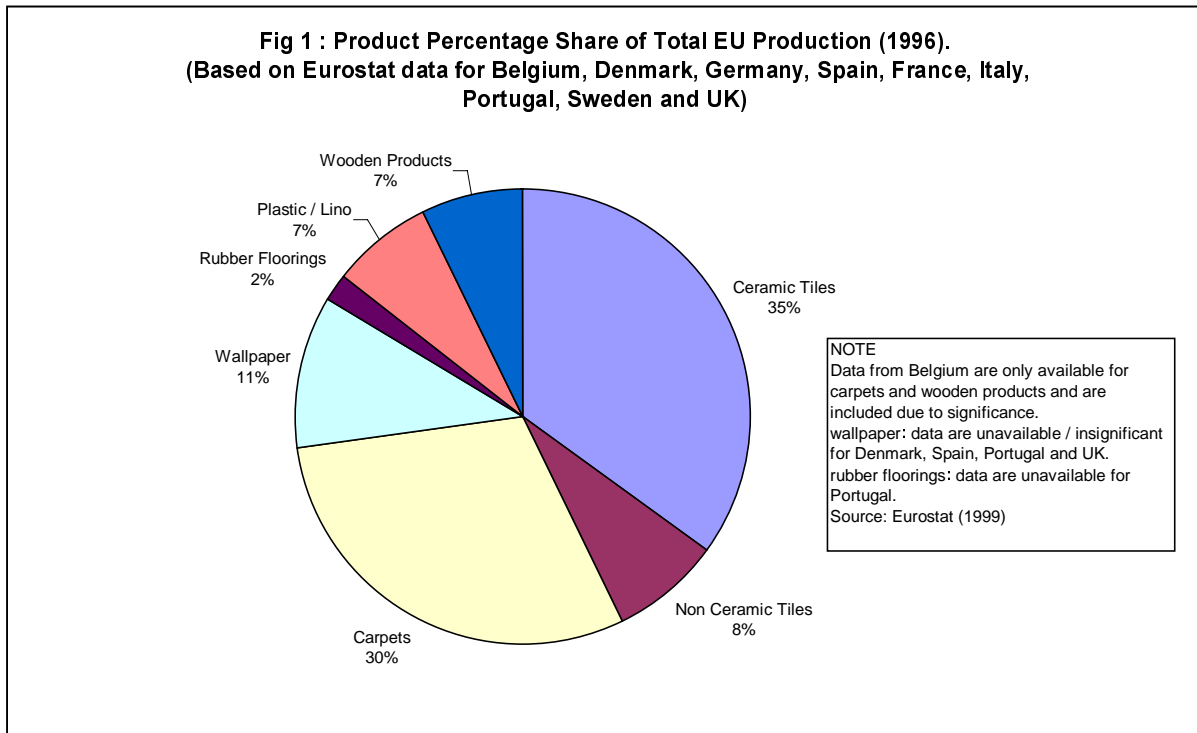
Table 1: Total EU production of floor and wall coverings (1996).

Material	Production Value – millions €
Carpets	5094
Ceramic Tiles	5918
Non Ceramic Tiles	1329
Plastic / Linoleum	1198
Rubber Floorings	359
Wallpaper	1806
Wooden Products	1235
Total	16939

Note:

- Data are based on production data for Belgium, Denmark, Germany, Spain, France, Italy, Portugal, Sweden and UK.
- Wallpaper data is unavailable / insignificant for Denmark, Spain, Portugal and UK.

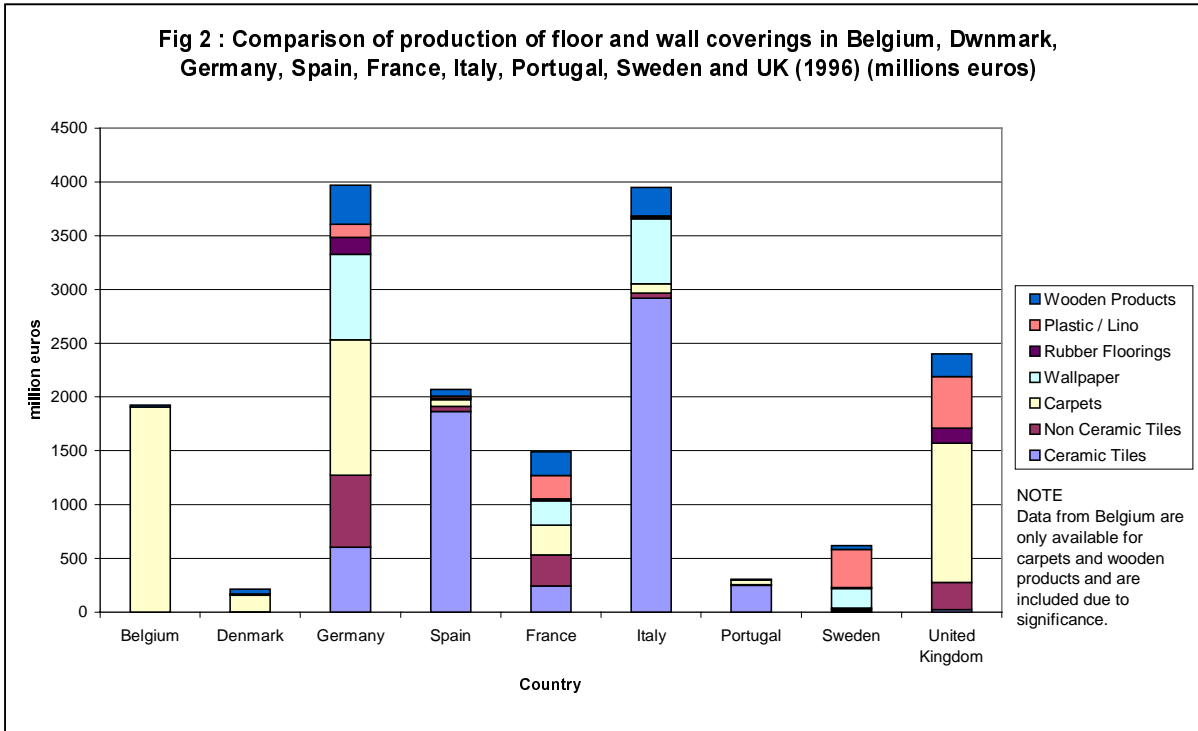
- **non ceramic tiles** include refractory tiles and tiles made of composite materials.
- Source: Eurostat (1999)



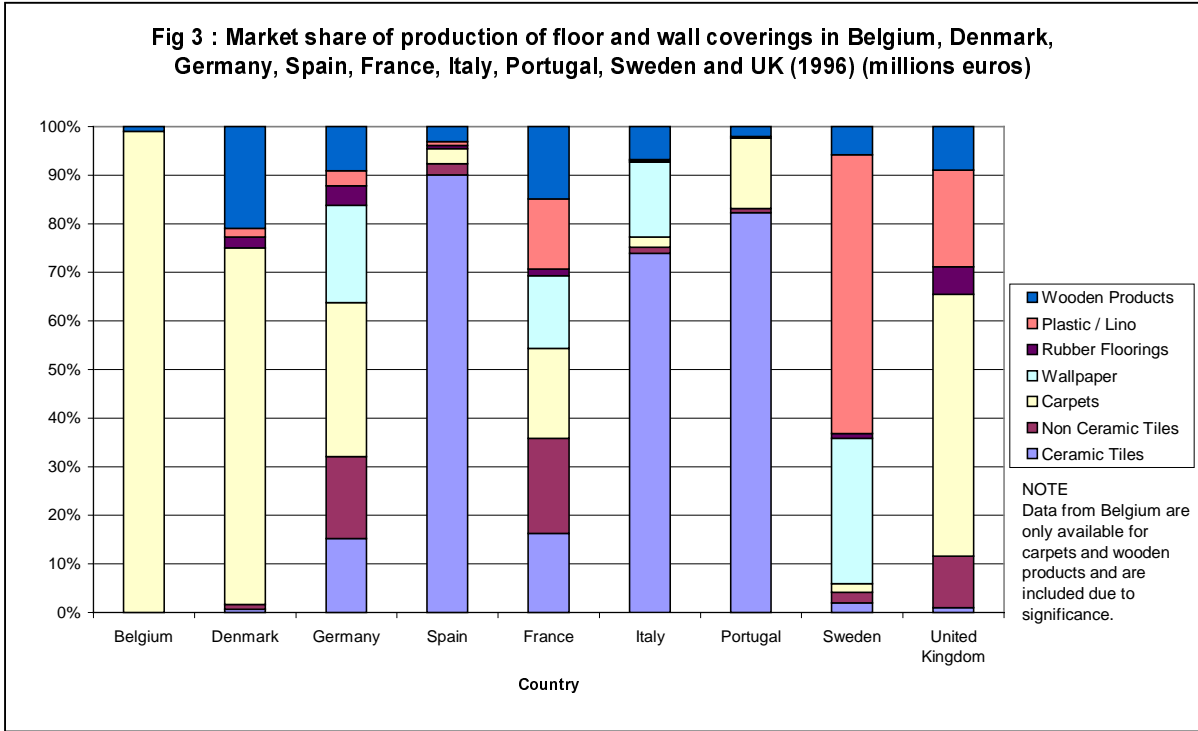
The total economic value of the production of wall and floor coverings in 1996 was worth 3.97 billion Euros in Germany, 2.07 billion Euros in Spain, 1.49 billion Euros in France and 3.95 billion Euros in Italy (Figure 2).

In a comparison of production in individual countries (Figure 2) it can be seen that Belgium, Germany and the UK are major producers of carpets, Spain and Italy the main producers of ceramic tiles, Germany and Italy the main producers of wallpaper, Sweden and the UK the main producers of plastic and linoleum, whilst Germany is the main producer of non-ceramic tiles. Germany, France and the UK have a spread of production whilst the other countries tend to mainly specialise in one or two wall and floor coverings.

The economic value of ceramic tiles production for 1996 was 2.9 billion Euros in Italy and 1.87 billion Euros in Spain, whilst the value of carpet production is 1.9 in Belgium and 1.26 billion Euros in Germany.



The proportion of production of wall and floor coverings in individual countries shows the importance of some wall and floor coverings even where total production is relatively small. For instance, although the absolute value of carpet production was relatively small in Denmark, Figure 3 shows its importance compared with the production of other wall and floor coverings. The same applies to the production of ceramic tiles in Portugal.



2.1.2 Exports

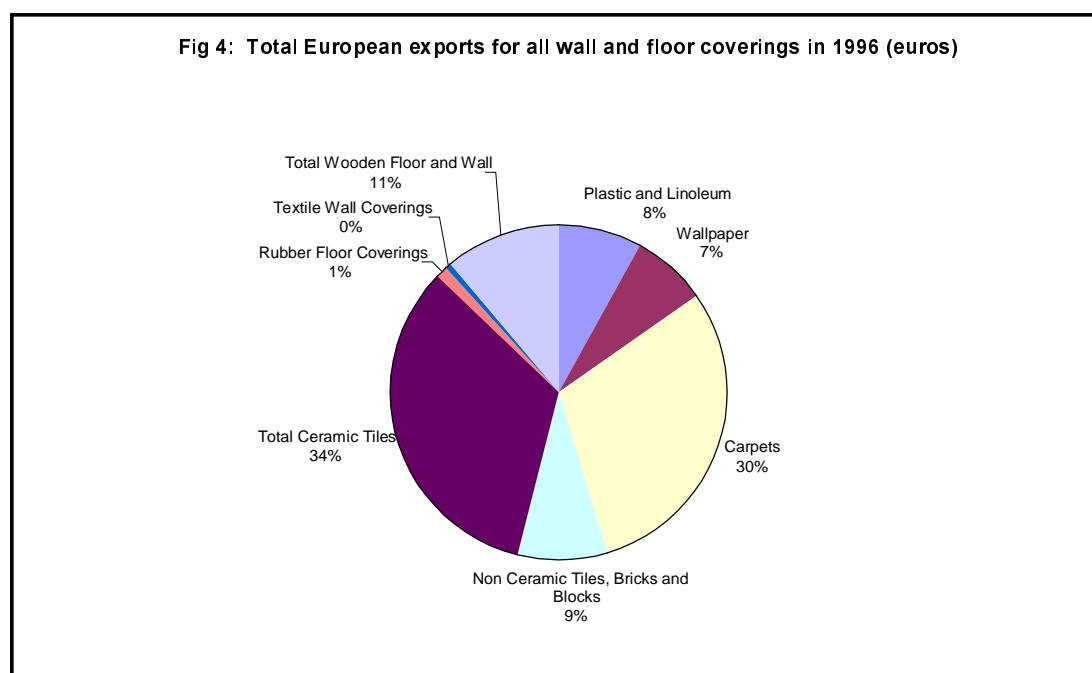
An estimated total of 2085 million m² of wall and floor coverings were exported by European countries in 1996, with a value of over 11 billion Euros (Table 2).

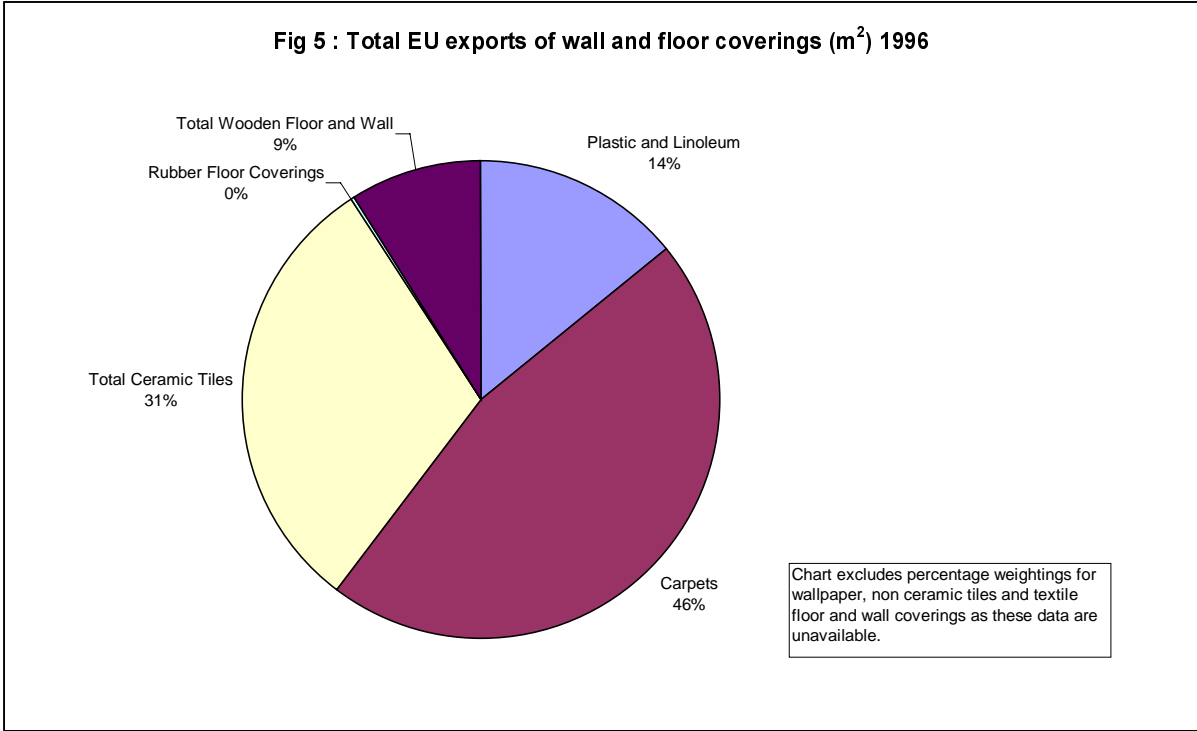
Table 2: Total European exports of wall and floor coverings for 1996.

Material	Total exported [million €]	Total exported [million m ²]
Carpets	3996	960
Ceramic Tiles	4449	637
Non ceramic tiles	1163	n/a
Plastic / Linoleum	1087	294
Rubber Floorings	154	9
Textile Wall Coverings	50	n/a
Wallpaper	959	n/a
Wooden Products	1490	185
Total	13348	2085

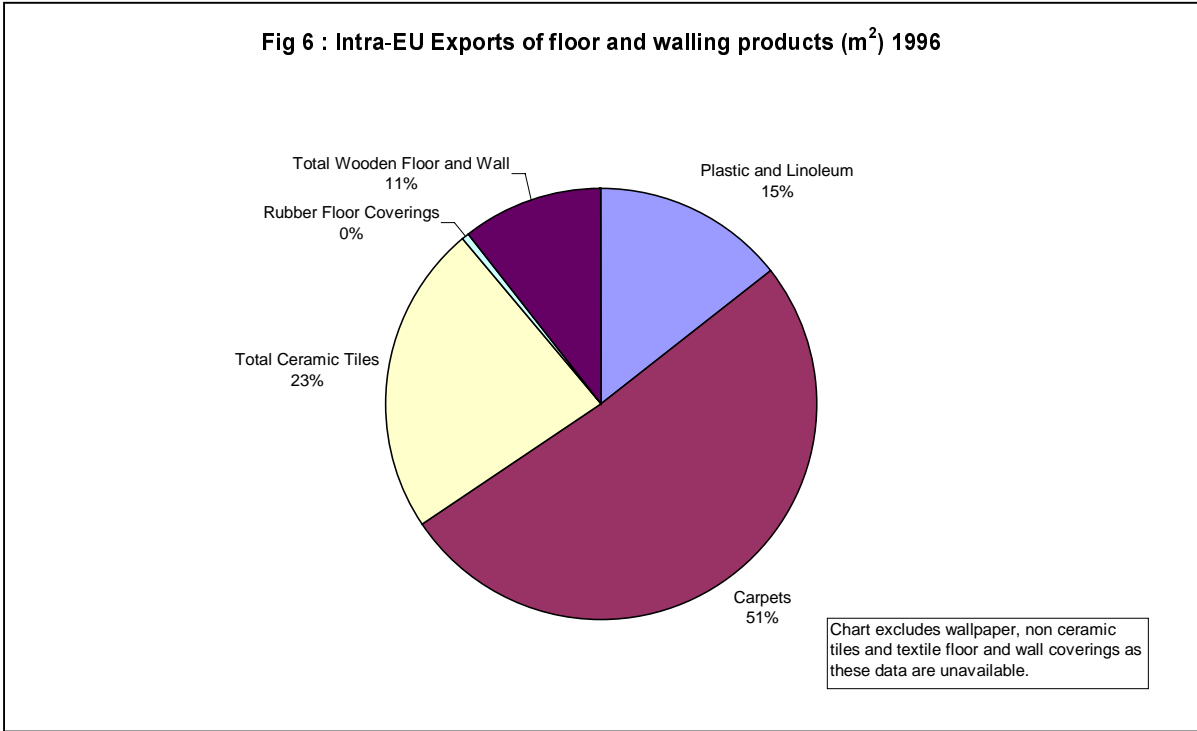
Note: n/a = not available

Based on the market value of these exports (Figure 4), ceramic tiles have the greatest market share (34%), followed by carpets (30%) and wooden flooring (11%). However when the analysis is based on the quantity produced (in m²), the main exported product is carpet (46%), followed by ceramic tiles (31%) and plastic and linoleum (14%) (Figure 5). However these data do not include wallpaper, non-ceramic tiles and textiles.

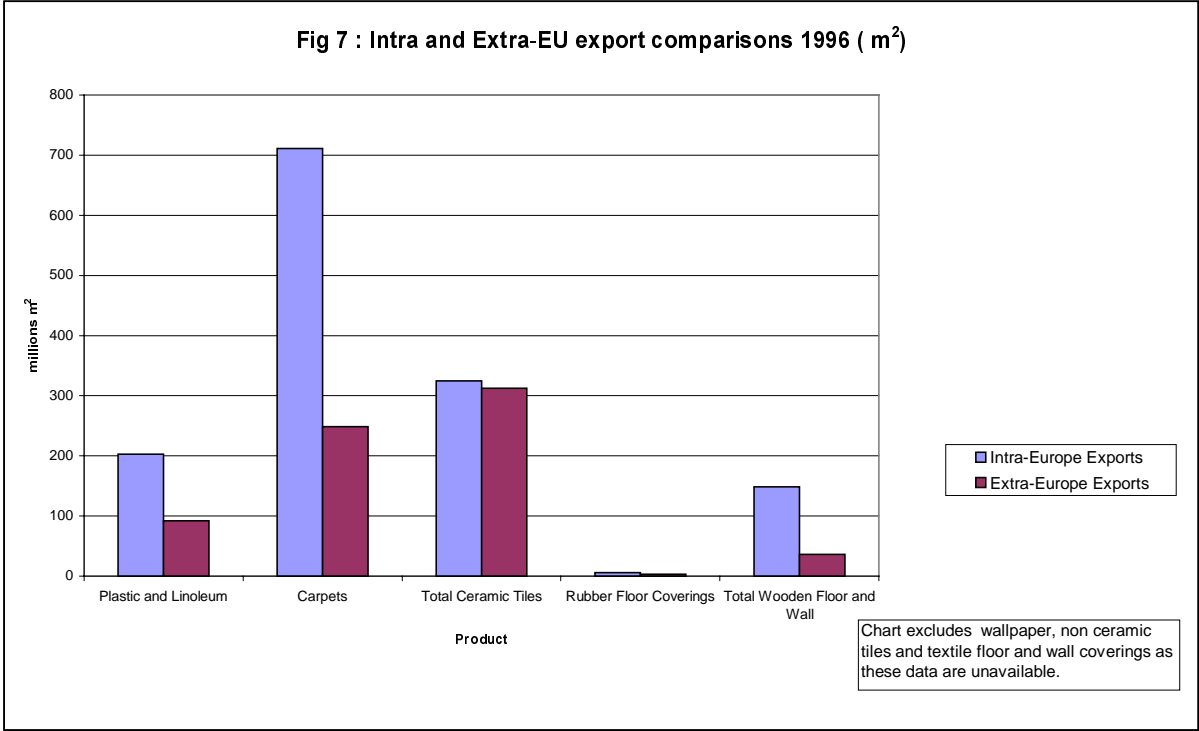




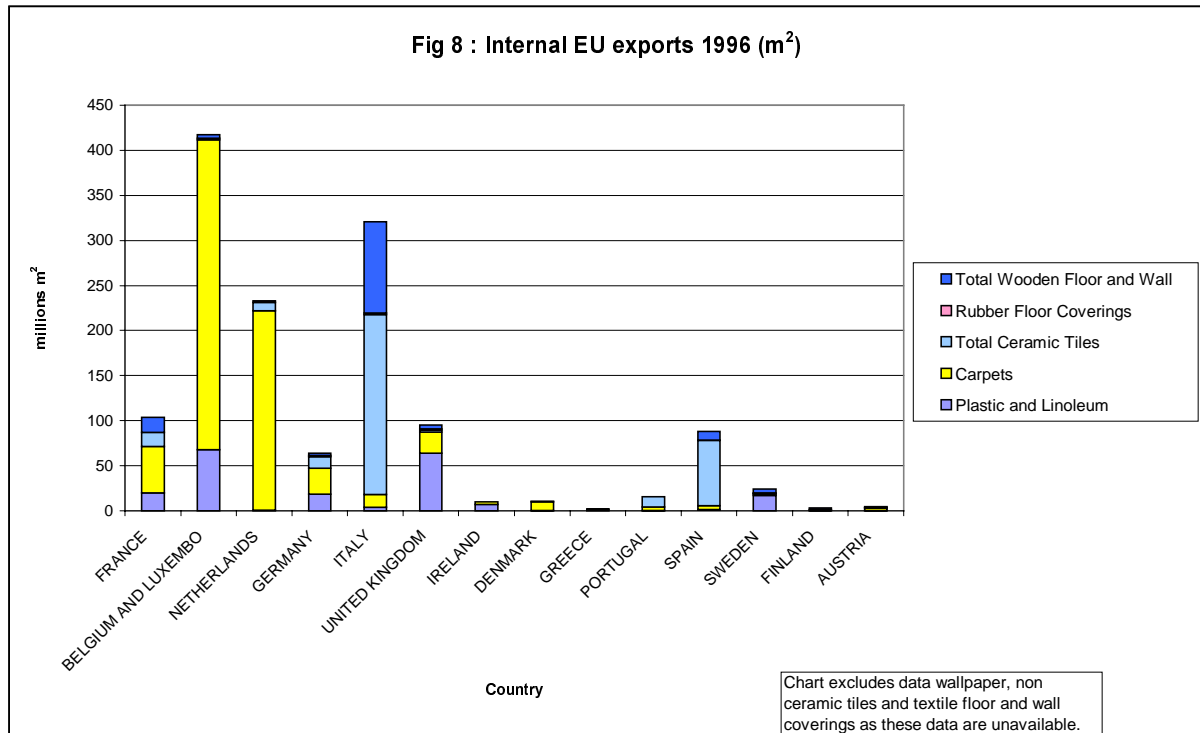
Although the total exports of products gives a good indication of the importance of the markets to individual countries, from an eco-labelling point of view the internal export market is more informative. As an eco-label is a European award its acquisition is a greater advantage to companies and countries that export products within Europe. The market share of intra-Europe exports differs from the total exports in that carpets have the main market share, followed by ceramic tiles, plastics and linoleum and wooden products (Figure 6).



When the intra and extra-Europe exports are compared (Figure 7) it can be seen that carpets have a major internal European market, whereas ceramic tiles are exported equally within Europe and to the rest of the world. Plastics and linoleum and wooden flooring also have a greater intra-Europe market.



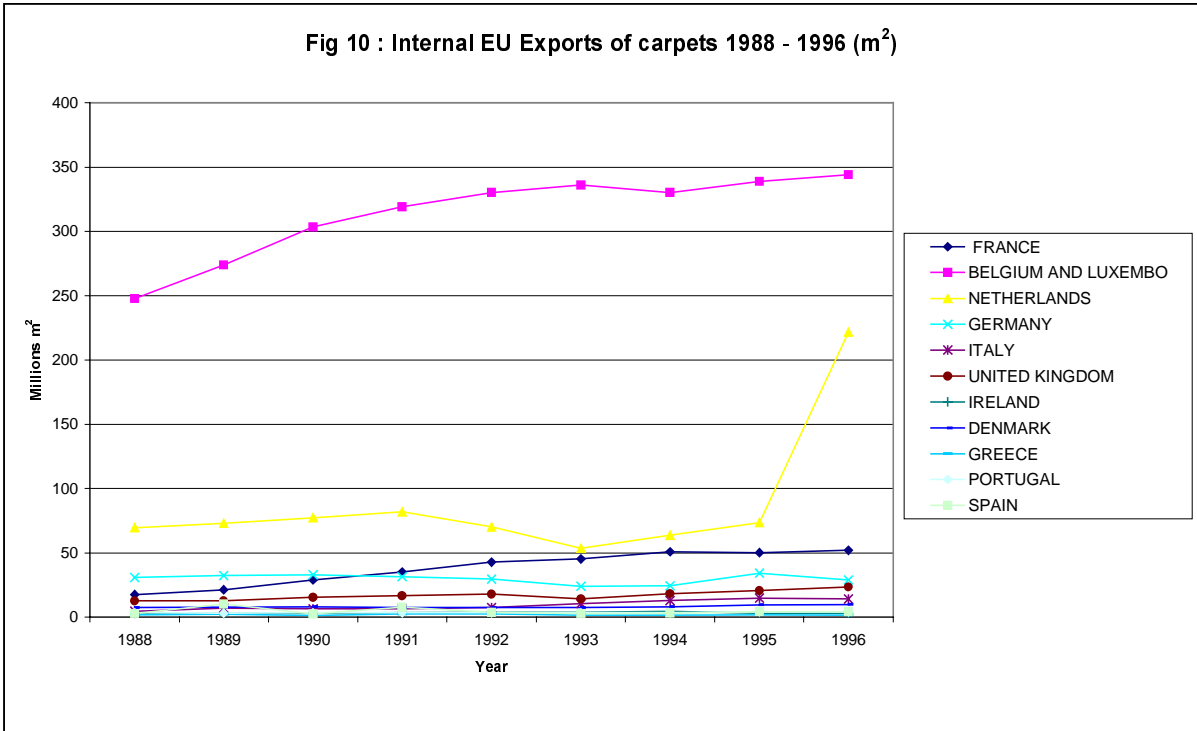
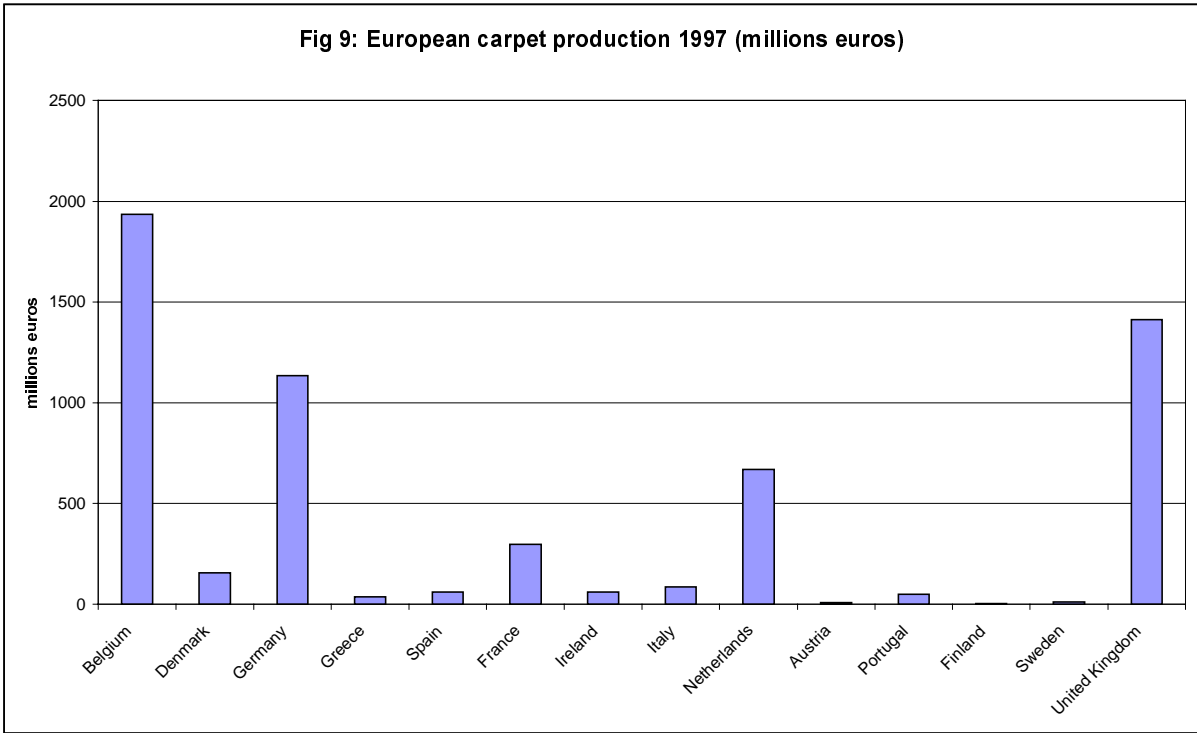
A further analysis on a country basis indicates the importance of the internal export market, and hence the potential importance of an eco-label for individual countries (Figure 8). It can be seen that Belgium and Luxembourg, and Netherlands have a major intra-Europe export market for carpets, while Italy has a strong intra-Europe export market for ceramic tiles and wooden flooring. However the data set on which these comments are based on does not include wallpaper, other tiles and textiles.



2.2 Analysis of markets

2.2.1 Carpets

The European production of carpets is concentrated in the Northern European countries; Belgium, The Netherlands, France, Germany and the UK (Figure 9). The production of carpets from 1993 to 1997 (in Euros) has remained fairly constant with Belgium and The Netherlands showing small increases, the UK a larger increase. The countries exporting the most carpets are Belgium and The Netherlands (table 9). The quantity and value of the export market of carpets from Belgium and Luxembourg, however, has increased considerably in the last decade (1988-1998) (Figure 10). The quantity of exports from The Netherlands increased greatly in 1996, while the French export market has gradually increased over the 10 years.



2.2.2 Ceramic Tiles

World-wide use of tiles has been estimated in approximately 3.5 billion m² in 1997, although only the market for 1.5 billion m² tiles are considered to be available for open competition. Italy, Spain and Brazil together produce most of tiles world-wide (Gill *et al.*, 1999). Of the markets the Italians hold a share of 25%, the Spanish 15% and the Turks 4% (Assopiastrelle and Prometeia, 1998). World-wide consumption of ceramic tiles is thought to have grown by 7.7% in 1998 (ASCER, 1998).

The European Union (EU) is the main producer and consumer of tiles in the whole world; its market share in 1996 amounted to 37.1%. Its production totalled 1189 million (M) m² in 1996, but has recently been severely affected due to a production growth in China and Asian countries (Gil *et al.*, 1999). Spain, Italy and Portugal have the highest per capita consumption of tiles due to a combination of culture, customs and climate (ASCER, 1999).

The main producers of ceramic tiles in Europe are Italy, Spain and to a lesser extent, Germany (Figure 11). In the years 1988 to 1996 both Spain and Italy considerably increased the quantity of tiles exported, whilst other countries remained at a similar level (Figure 12). Forecasts for 1999 had announced a growth of 3% in open-competition markets, partly due to incentives for residential restructuring, economic growth and lowering of interest rates (Assopiastrelle and Prometeia, 1998:7).

Figure 12 indicates that the Italian and Spanish export markets have increased considerably over the 1988 – 1998 decade. The German market seemed to decline but the other EU countries seem to have either remained stable or had small increases in their exports. However, it is speculated that by the year 2000 other Eastern and Oriental European countries may also have increased their share in some markets. This suggests that the Italian producers will be faced with competition from those countries with lower labour and production costs; however, Italian exports may still recover at the turn of the century (Assopiastrelle and Prometeia, 1998). In 1999, the ceramic tiles market share of Italy and Spain was very similar, which suggests that under this perspective the gap between both countries is narrowing (Assopiastrelle, pers. comm.).

The consumption of tiles is greatly dependent upon the variations in the construction industry. Looking back at the last two decades, the first half of the 1980s witnessed a recession and a decrease in the use of ceramic coverings, paralleled by a difficult situation in the construction industry. In the latter part of the decade, the construction sector recovered and so did the construction industry; these trends and variations have also been manifest throughout the 1990s (see Assopiastrelle and Prometeia, 1998; Assopiastrelle, 1999; Gil *et al.*, 1999). Generally, since 1998 the construction industry, especially in the home-sector, has slowly recovered and has positively affected the tile industry (Assopiastrelle and Prometeia, 1998), although trends of the construction industry in relation to ceramic tiling vary nationally.

Fig 11: European ceramic tiles production 1996 (millions euros)

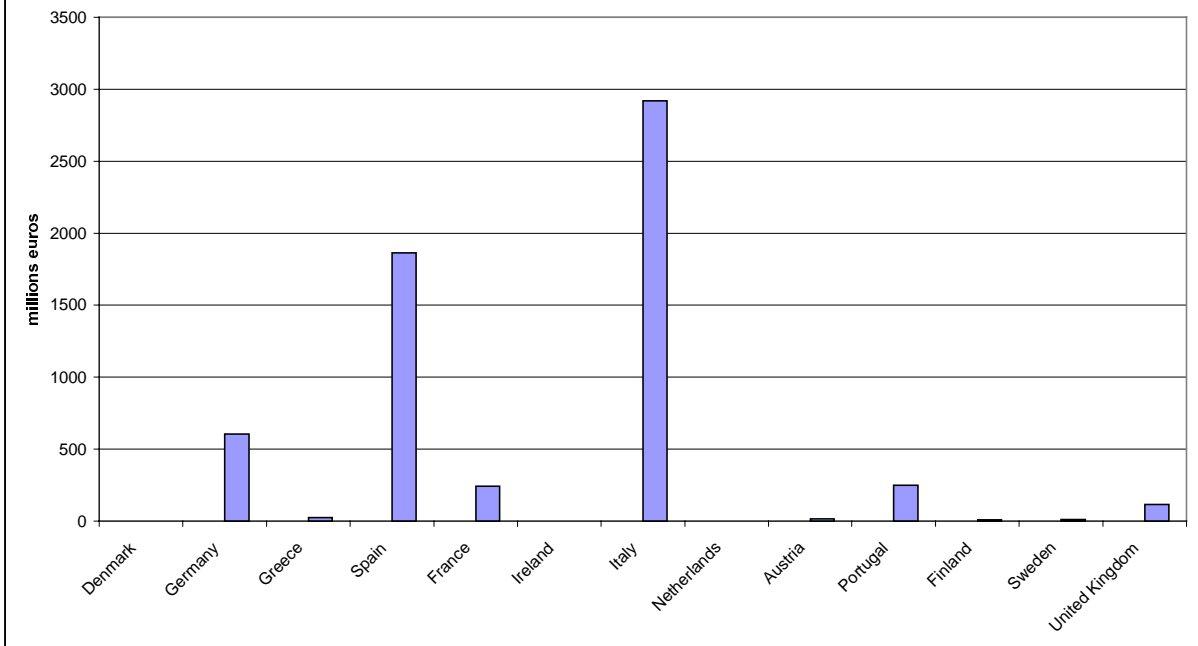
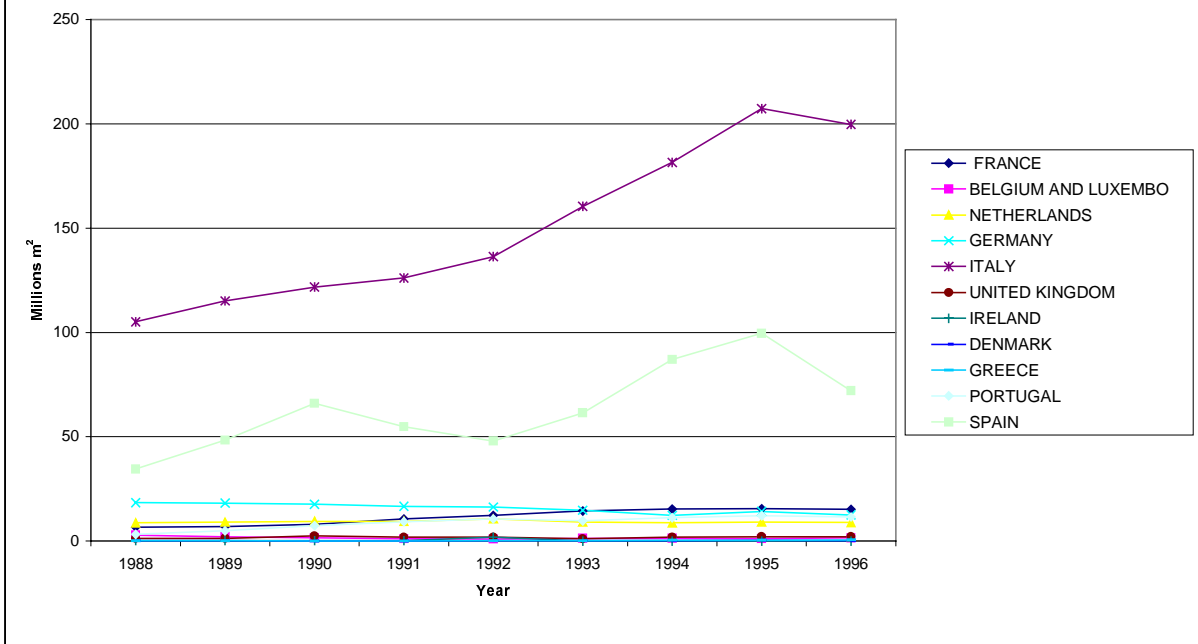
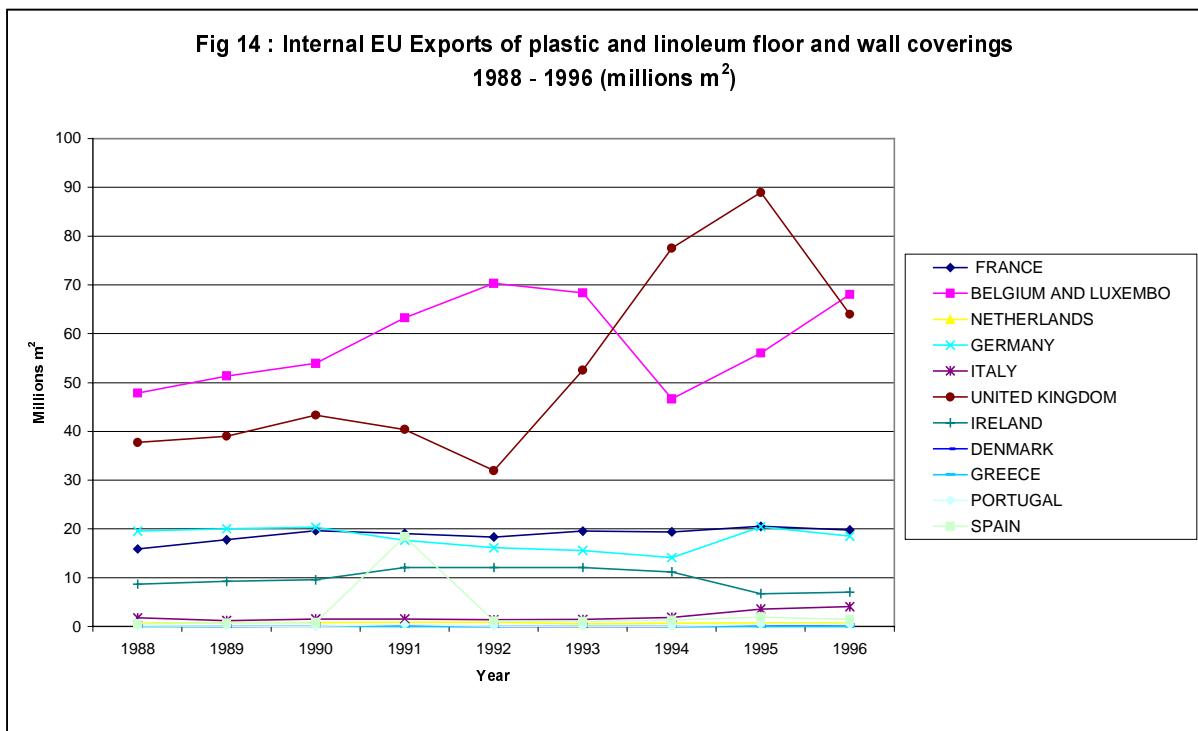
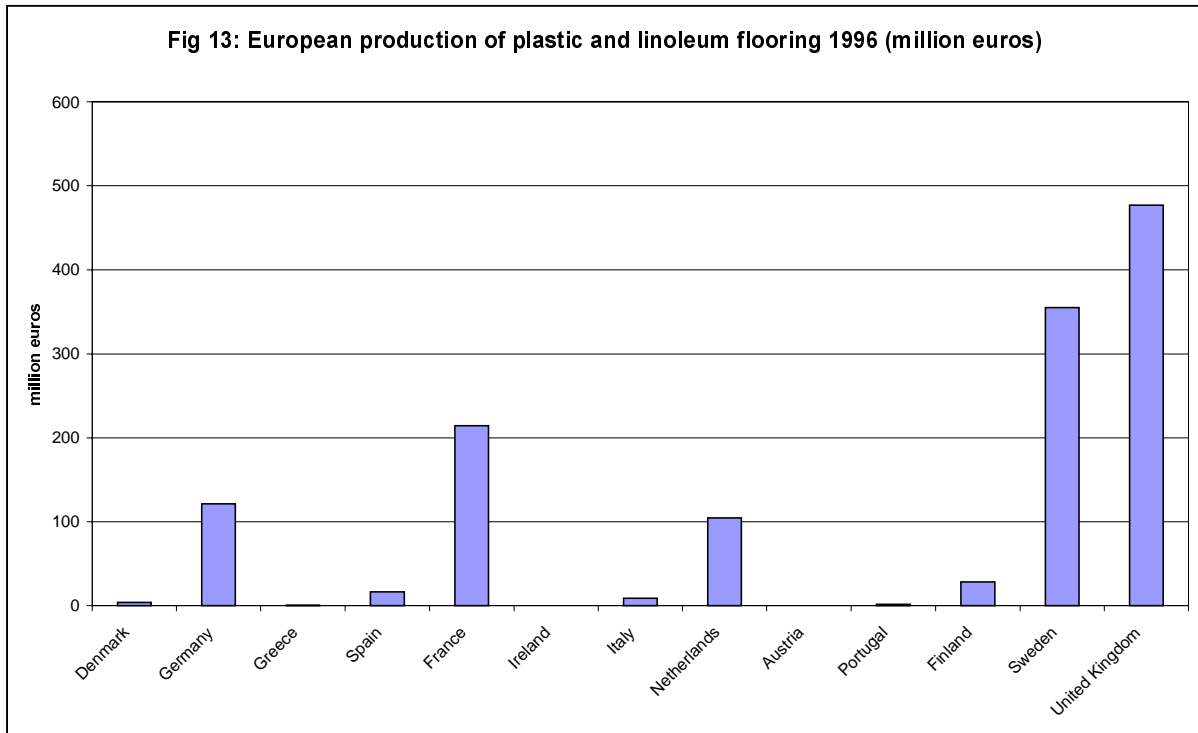


Fig 12 : Internal EU exports of ceramic tiles 1988 - 1996 (millions m²)



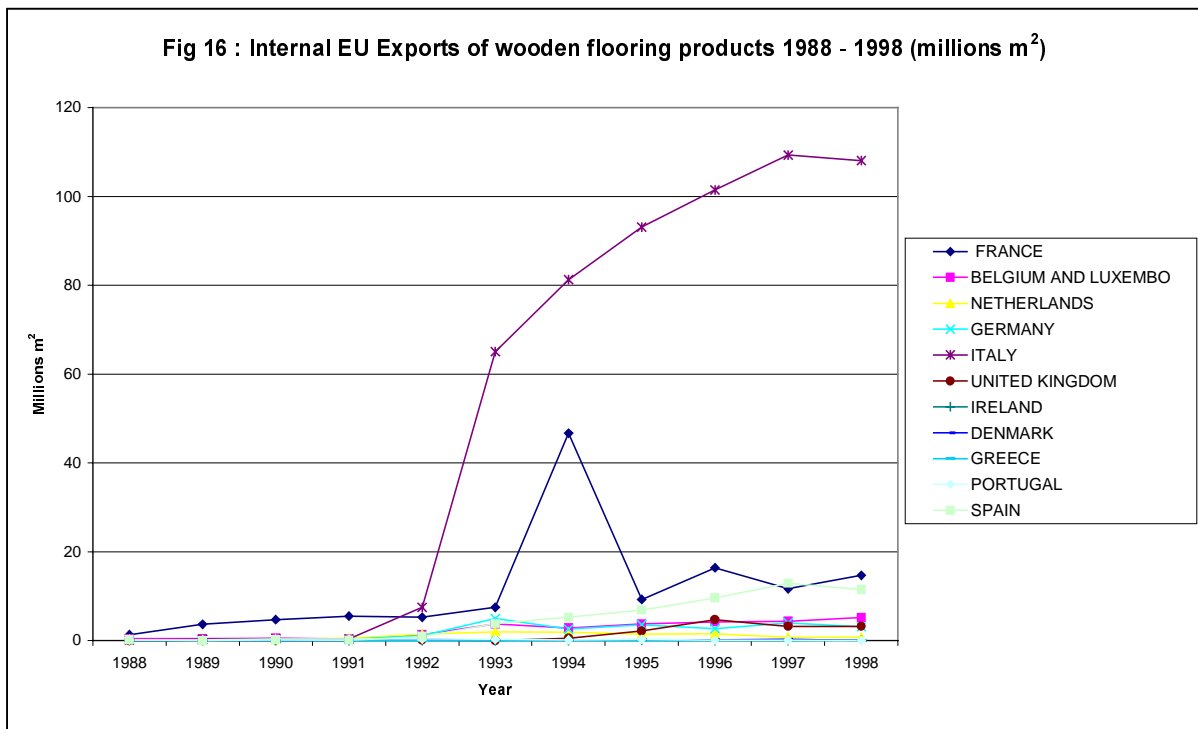
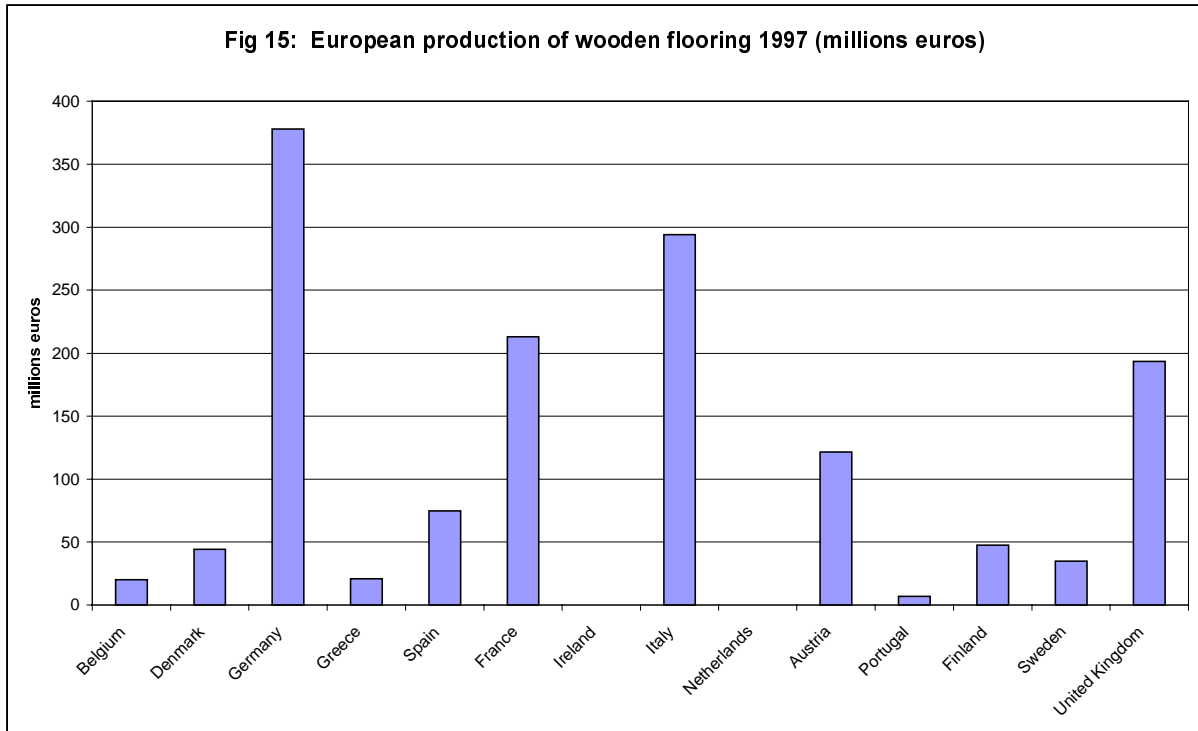
2.2.3 Plastic and Linoleum flooring

The main producers of plastic and linoleum flooring are the UK, Sweden, France and Germany (Figure 13). Data are not available for Belgium and Luxembourg production. All have increased their production in the years 1994 to 1997. The main countries exporting plastic and linoleum are Belgium, the UK, Germany and France (fig 14). The quantity of exports has increased in all five countries, particularly the UK and Belgium and Luxembourg (Figure 14).



2.2.4 Wooden flooring

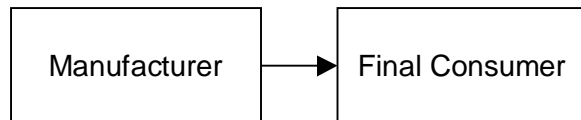
The main producers of wooden flooring in 1997 were Germany, France, Italy and the UK (Figure 15). The value of the production and export of wooden flooring has increased dramatically in Italy since 1992 (Figure 16). France, Spain and Germany also have a strong export market, with Belgium and most other European countries increasing their exports in the years 1993-1998.



2.3 Distribution systems

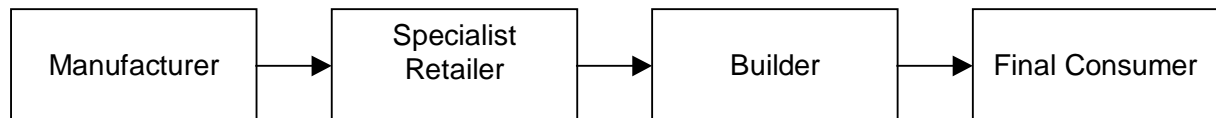
Several methods of distribution are used to retail wall and floor coverings to the final consumer. These systems are broadly similar across Europe, however it is recognised that there could be many national variations. The following figures represent the main systems in the majority of European countries:

(a)



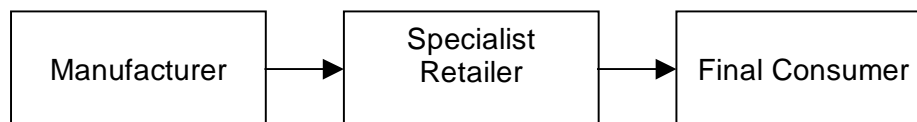
(accounts for very small amount of trade)

(b)



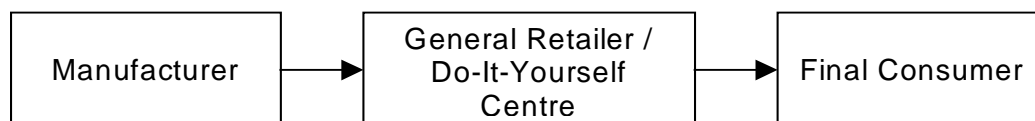
(small proportion of trade mainly for new properties)

(c)



(e.g. carpets, ceramic tiles)

(d)



(e.g. wallpaper, resilient flooring, ceramic tiles)

The type of system used is a key component in determining to what extent consumers can influence the production system through the choices they make. For example, if the product is principally purchased by builders for new and renovated houses, consumers will have very little influence over the product choice.

An advantage of general retailers is that they stock materials and products other than tiles, which allows the retailer to satisfy the client's wider demands (Gil *et al*, 1999). Specialist retailers however will be more able to give advice on the selection and installation of a product.

Some products such as wall paper and carpets have always mainly been retailed directly to the final consumer through general retail outlets. Other products, however such as ceramic tiles, used to primarily be sold directly to the building trade through specialist retailers. This has changed over the last few years with products such as ceramic tiles and vinyl flooring being sold by general retailers and Do-it-yourself centres. For example in France 69% of ceramic tiles were retailed in generalist retailers and 22% in Do-It-Yourself centres (Ceramazine, 1998 cited by ANPA & Centro Ceramica, 1999), whilst in Germany 30% were retailed in Do-it-yourself centres. In Italy 91 % of ceramic tiles are sold by production firms to consumers via retailers, whilst 3% are sold directly to consumers. Only 6% are sold to builders.

The majority of floor and wall coverings now appear to be retailed direct to the consumer, thus giving ample scope for consumer choice to influence production processes.

2.4 Summary

- In monetary terms, the main wall and floor coverings **produced** in Europe are ceramic tiles (35%), carpets (30%) and wall paper (11%).
- In monetary terms, the main countries producing ceramic tiles are Italy and Spain, while Belgium and Germany produce the most carpets.
- Ceramic tiles (34%) have the greatest market share in monetary terms of the export market followed by carpets (30%) and wood block flooring (11%). However when based on the quantity produced (m²), the main exported product is carpet (46%) followed by ceramic tiles (31%). Carpets, ceramic tiles and plastic and linoleum are the main products exported to the intra-Europe market.
- The strong intra-Europe export market for floor and wall coverings is particularly important as it indicates the potential for an eco-label.
- The main countries exporting to the intra-Europe market are Belgium and Luxembourg and the Netherlands (carpets), and Italy for ceramic tiles and wood products.
- In general terms there are expanding intra-Europe export markets for most wall and floor covering products.
- The majority of floor and wall coverings are retailed direct to the consumer, thus giving ample scope for consumer choice to influence production processes.

3. Consumer preferences and performance of wall and floor coverings

Wall and floor coverings vary as to their purpose, the use to which they put and how they perform (in terms of wear and durability) whilst in use. Consumers select wall and floor coverings using a wide range of criteria such as cost, durability and appearance (see section 3.2). Other aspects, such as the consumers budget, and the climate and culture of the region in which they live will also effect their choice.

3.1 Characteristics and standards of wall and floor coverings

3.1.1 Flooring

The Buildings Research Establishment (Pye & Harrison, 1997) divides flooring into four groups:

1. jointless floor finishes
2. jointless resilient finishes
3. jointed hard finishes
4. timber and timber products

The first group, **jointless floor finishes**, are floorings which are formed in situ from materials laid in molten, liquid or plastic form. They include:

- concrete wearing surfaces
- polymer screeds
- granolithic and cementitious wearing screeds
- in situ terrazzo
- synthetic resins
- paints and seals
- mastic asphalt
- pitchmastic
- magnesium oxychloride.

These floorings are essentially different from the other flooring types as they are materials used to make finished surfaces, rather than products with finished surfaces.

Jointless resilient finishes are thin sheet and tile floorings described in the British Standard BS8203. They include:

- textiles
- linoleum
- cork
- PVC flexible
- PVC semi-flexible or vinyl
- rubber
- thermoplastic.

Resilient flooring is versatile, economic and practical and can be used for domestic applications as well as in schools, nursing homes, healthcare facilities, retail shops, and offices. Resilient sheet flooring is manufactured in a continuous length of varying widths so it is possible to install it with few, if any, seams. This creates an impervious surface throughout the entire area of a room as there are no crevices or cracks where moisture and dirt can collect. This makes resilient sheet flooring the ideal product choice in rooms where protection from water and other fluids is an everyday occurrence and necessity. Although classified as 'jointless' this group can also include jointed resilient flooring such as self adhesive vinyl tiles

(Table A1 in appendices).

Jointed hard finishes include:

- ceramic tiles,
- brick paviors
- concrete flags
- natural stone
- terrazzo tiles

These products are used both internally and externally. Ceramic tiles are also used as a wall covering. Jointed hard finishes are often incorporated into homes and commercial buildings when they are constructed and are thus often considered more long term than other flooring materials (Table A2 in appendices).

Timber and timber products include:

- board and strip
- block
- parquet
- mosaic
- panel products (e.g. chipboard and plywood).

Wooden block flooring with a thin veneer and laminate block flooring could also be included in this group (Table A3 in appendices).

3.1.1.1 Discussion of characteristics of floor coverings

Pye & Harrison (1997) provide a useful and logical division of the different types of flooring, which reflects both the physical attributes of the products and the uses to which they are put. The first group, jointless floor finishes, however are different from the other groups in that they are a material used by builders to create a floor covering rather than a finished product. The acceptability and durability of the flooring is therefore dependent on the quality of the workmanship (Pye & Harrison, 1997) rather than the product. Therefore we consider them to be outside the remit of this report, as eco-labelling criteria can only relate to products and not to the actions related to their physical installation.

The characteristics of the remaining flooring types are summarised in Table 3, with further details in the full tables (Tables A1, A2 & A3) in the appendices.

Flooring with **jointless resilient finishes** have a wide range of characteristics. Most are combustible, have good strength and stability and have good slip resistance when dry. But the wear resistance, thermal properties, warmth to touch and sound insulation all vary considerably. Flexible PVC scores well on many characteristics, including maintenance, but it is not warm to the touch. Carpets are of course warm to the touch and also score well in the other characteristics.

Flooring with **jointed hard finishes** are far less variable in their characteristics and generally form a more uniform group. All have good strength, stability, wear resistance and durability, fair to good slip resistance and are non combustible. Most are cold to touch, have fair or poor sound insulation characteristics, and are fair to good to maintain.

Timber and timber products also naturally form a uniform group with similar characteristics. Strength, stability and wear resistance varies with the species used, slip resistance is good if dry and unwaxed, all are warm to the touch, are combustible and have poor to fair sound insulation. They have good durability, especially when sealed but can be difficult to maintain.

The use of specific wall and floor coverings therefore depends not only on consumer preferences but also on the characteristics of the product and the use that it will be put to in a building or structure. As finishings, floor and wall coverings therefore deserve attention as there are several characteristics which may influence the choice of one over another. Oberti (1995) outlines the negative factors to look out for in deciding which materials should be used for construction, given that it may pose some risk to the human users of that space: chemical-physical composition of the material, potential release of toxic substances, location and method of laying the material, use and extreme use of the material, reaction of the material to fire, corroding agents and degree of maintenance (Oberti, 1995).

As wall and floor coverings occupy a vast area of the volume of the room they are used in, this can potentially favour the release of toxic substances resulting in increased exposure by the people using that space. The frequent use of coverings, especially on floors, may also contribute to the release of contaminants. In addition, other damage to the users of a certain space may arise from secondary products used to lay down wall and floor coverings (e.g. glues, solvents). These issues would have to be further examined in the next stage of the study when the environmental criteria are selected.

A short checklist may therefore prove useful when considering which floor or wall coverings to be included in a certain building (Oberti, 1995):

1. Identify materials and products for external and internal use of the building fabric
2. Determine the quantity and use of each material / product
3. Determine if the material will be exposed to movements of air (which may increase toxic substances emitted)
4. Determine if the users of the building will be in direct contact with the material
5. Identify the surface area of "soft" materials
6. Identify materials which require the use of liquid components for their maintenance.

One characteristic not considered by Pye & Harrison (1997) is the distinction between 'natural' and 'processed' products. Natural products such as quarried stone are simply quarried and shaped, whilst 'processed' products are extensively manufactured either from 'natural' raw materials such as wool and clay and/or from oil based products. The distinction is important when considering the environmental impacts of a product.

3.1.2 Types of characteristics of wall coverings

Compared with flooring there are very few, if any studies, on the characteristics of wall coverings. This is probably due to their having a far less demanding role to play, particularly in domestic premises. Wall coverings can be divided into two types:

- Firstly, those that provide a surface for a particular application. For example a surface that is easy to clean or that protects the structure of the wall from damage.
- Secondly, wall covering that are generally selected for their aesthetic appeal, although a limited amount of protection may also be provided.

The first group consists almost entirely of ceramic tiles which protect the wall from damp and are also used in areas that require frequent cleaning (e.g. kitchens). They may, however also be used on walls for aesthetic purposes. The other product in this category are specific types of paint that are easy to clean, and vinyl coverings which are used in institutions such as hospitals.

The second group includes wallpaper, textiles and wood. Each have very different characteristics, although the first two are naturally absorbent and are difficult to clean. All have poor acoustic qualities and are combustible.

Table 3: Summary of Buildings Research Establishment (BRE) Flooring Characteristics (adapted from Pye & Harrison, 1997).

Criteria Flooring material	Reflectivity	Strength and stability	Wear resistance	Slip resistance cof¹	Thermal properties	Warmth to touch	Sound insulation	Fire	Durability	Maintenance
Timber and Timber Products	0.20 - 0.35	varies - species and use dependent	poor - good, dependent on species.	good when dry	0.14 W/mK	good	poor - fair	combustible	good when sealed	difficult
Jointed hard finishes	0.10 - 0.50	good	fair - excellent	fair – good when dry	1.8 W/mK	poor	poor - fair	non - combustible	very good	good
Textile	0.10 - 0.45	some will stretch	can be good	very good	0.055 W/mK	very good	very good	combustible	poor	fair - good
VINYL and resilient	0.10 - 0.45	poor - good	fair - excellent	good when dry	0.22 - .5 W/mK	poor - good	poor - good	combustible	good	gen. good

Explanation of criteria used in the table (Source: Pye & Harrison, 1997) on the next page.

Explanation of criteria used in Table 3 (adapted from Pye and Harrison, 1997)

- **Reflectivity:** The reflectivity of a flooring material affects the distribution and quantity of light in a space. As light enters a space it falls generally to the floor, and thus the illumination of the space is dependent upon the lightness of the flooring material.
- **Strength and Stability:** This characteristic is subdivided into: loading - the support of loads placed upon a floor; lateral support and restraint - level of support required by structure; impact resistance; vibrations - dynamic movements induced by human traffic.
- **Wear Resistance:** Floorings are subject to wear from foot and wheel traffic, and other factors such as the movement of furniture. Wear is measured both as the quantitative loss of surface and the qualitative assessment of the condition.
- **Slip Resistance:** This is significant in the avoidance of accidents. Generally, slip resistance is measured by assessing the horizontal force (H) applied by placing a foot on the floor, and the frictional force (F) between the foot and the surface. Thus to avoid slipping the force must be less than the friction, so $F > H$.
- **Thermal Properties:** This measures the rate of heat loss through a floor. Thermal insulation values reduce with moisture content, thus materials that do not absorb water are necessary where prolonged wetting is likely.
- **Warmth to Touch:** The rate at which bare or thinly shod feet lose heat to a floor is often an important consideration in the choice of flooring material, particularly in domestic usage. The European Union of Agrément suggests a formula for considering thermal comfort requirements: $\sqrt{k/\rho c}$ where k is the thermal conductivity, ρ the bulk density (kg/m^3) and c the specific heat of the material.
- **Sound Insulation:** If buildings are occupied by more than one group, it is important that floors provide adequate insulation to noise. Noise can be defined as airborne noise, and impact sounds. The type of material will have a large influence on the ability of a floor to absorb such sound.
- **Fire Resistance:** This simply measures the ability of flooring materials to resist high temperatures and their combustibility.
- **Durability:** Floor coverings provide three main functions: protection of structural floor, improved appearance, increased comfort and safety
The life of a floor is influenced by wear, water and liquids, loads and impacts, sunlight, insects, mould / fungi and temperatures. Different floor coverings are thus more or less susceptible to the above factors.
- **Maintenance:** Maintenance assesses the level and ease of repair that is required to ensure that a floor is kept in safe and satisfactory condition.

3.1.3 Quality and safety industry standards

Standards are not laws but fulfil the role of strong objective recommendations, and can assume a reference value in cases of litigation (Ford, 1996). They can be classified into five types:

- a) design standards
- b) material/product/component standards
- c) execution standards, i.e. standards for installation
- d) test standards, e.g. European standard (EN) test methods.
- e) Glossary standards, e.g. BS 6100.

(Ford, 1996)

Tables A1 to A3 include the BS standards for the individual products. Classifications a), b) and c) above are generally covered by ISO standards.

The *ISO standards are documented agreements containing technical specifications or other precise criteria to be used consistently as rules, guidelines, or definitions of characteristics, to ensure that materials, products, processes and services are fit for their purpose*¹. Relating to

¹ ISO website <http://www.iso.ch/infoe/intro.htm>

floor and wall coverings there are numerous ISO definitions and guidelines. These include general construction industry information through to documentation aimed at assisting in the application of Environmental Management Systems (EMS - ISO 14001 and 14004), which represent the ISO standard equivalent of the more restrictive EU Environmental Management Audit Systems (EMAS).

Examples can be drawn from most of the product areas in the scope of this report. In textile floor coverings for example, standards detail aspects such as *Carpets - determination of number of tufts and /or loops per unit length and per unit area*, (ISO 1763:1986), and *testing for floor soiling* (ISO 11377:1997). Similarly over 20 standards exist specifically for ceramic tiles, determining most aspects of production, installation and use. Similar ranges of ISO standards exist in most specific product areas.

More general guidelines also exist in determining global issues relating to floor and wall products. For example ISO 9239-1:1997 details fire resistance characteristics (*horizontal surface spread of flame on flooring systems*) and concerning waste ISO 11932:1996 covers *activity measurement of solid materials considered for recycling, re-use or disposal*. Furthermore, standards exist for environmental aspects such as ISO Guide 64 (1994) and more specifically ISO/TR 14061 (1998)

3.2 Lifetime of products

In general, wall and floor coverings are not used for the full duration of their technical lifetime. They are often replaced earlier mainly due to the desire to change the appearance of a room to suit new occupants or changing taste in decor. For instance, the most important reason for replacing floors in The Netherlands seems to be changing residences (Potting & Blok, 1995). The performance and lifetime of flooring in particular is affected by different consumer habits and other non systematic variations (Günther & Langowski, 1997). Table 4 gives published estimates of the lifetimes of flooring. It is recognised however that many types of flooring can last considerably longer depending on the quality and the type of traffic it is subjected to.

Table 4: Lifetime of alternative types of flooring.

Type of flooring	Lifetime [years]	Reference
Carpets, vinyl	8	Forbo Novilon (1993); Caesar (1992) cited by Potting & Blok (1995)
Vinyl	20	Hydro Plast AB & Tarkett AB. (1993-4) cited by Jonsson <i>et al</i> (1997)
Linoleum	15 25	Forbo Krommenie (1993) cited by Potting & Blok, (1995) Forbo Krommenie (1993) cited by Jonsson <i>et al</i> (1997)
Solid wood	7 - 40	Hydro Plast AB, & Tarkett AB (1994) cited by Potting & Blok (1995) Günther & Langowski (1997)
Textile	5	Günther & Langowski (1997)
Parquet	50	Günther & Langowski (1997)
Ceramic tiles	ca. 50	Günther & Langowski (1997)

In a similar way to solid wood flooring, ceramic tiles are often considered to be a long term feature in a home and in other, commercial applications than alternative cheaper products which are likely to be changed with changing tastes. Clearly the environmental impacts over the life of a product vary considerably with the different lifetimes.

3.3 Consumer preferences for wall and floor coverings in Europe

The uses of floor and wall coverings considerably within Europe, especially among countries characterised by different climatic regimes.

In order to understand national and individual consumer preferences for the alternative floor and wall coverings available in Europe, we undertook a survey of EU Eco-labelling Competent Bodies, other European Eco-labelling Bodies and European producer associations. A short questionnaire was formulated to include:

- floor and wall coverings used in domestic and non-domestic premises in three broad subdivisions of Europe (Northern, Mid and Southern), and
- criteria used by consumers when choosing which products/materials to use at home.

The response rate to date is 66.6%, corresponding to sixteen completed questionnaires (twelve from EU competent bodies, two from non-EU bodies on eco-labelling, and two from European associations).

The following criteria were suggested by our respondents as being the most likely to influence consumer choice for covering materials (Table 5).

Table 5: Criteria used by consumers when choosing covering materials.

Criterion	Example
Cost	the most important factor especially for floor coverings
Fitness	for use and designated purpose
Durability/ quality	how long the product / material is expected to last
Use of the premises	bathroom, living room, etc., hence the characteristics of the materials (warmth, non-slippery surface, noise absorption, temperature insulation, hygiene)
Cleaning facilities	water resistance
Maintenance facilities	stain resistance to mechanical wear
Aesthetic quality	matching with other décor, fashion
Practicality	non –allergenic materials
Comfort	warmth, softness
Geographical and cultural characteristics	climatic variability

A clear distinction can be seen between the consumer preferences for different floor and wall coverings in northern, mid and southern Europe (Tables 6 and A5). However some products are widely used through out Europe, for example ceramic tiles are widely used for flooring in bathrooms and kitchens. It can be seen from the tables that a wide variety of products are used on floors in Northern Europe than in the South. In the North, although ceramic tiles are

seen as a desirable quality product this is tempered by the need for a product either with more insulation qualities (e.g. carpets) or with a warmer surface. For example linoleum and vinyl flooring are the most widely sold flooring materials in Sweden (Jonsson *et al.*, 1997). Ceramic wall tiles are extensively used in bathrooms and kitchens; in Northern and Mid-Europe however, they are usually used on the area of wall space that is likely to get splashed or need frequent cleaning. The remaining walls are often painted or wallpapered. In Southern Europe, tiles generally cover the entirety of kitchen and bathroom walls and floors.

The respondents to the survey gave comprehensive information on the domestic situation but very little information on the non-domestic situation. However from the information given and from other sources it is considered that covering materials used in domestic and non-domestic premises do not vary greatly: generally those used in non-domestic premises have to be more durable and easier to clean, according to the responses from our survey.

This means that for the exteriors on non-domestic premises more concrete, natural stone, mosaic (terrazzo), plaster and paint are used all across Europe. In Mid-Europe, one respondent maintained that “nothing special [is used on hotel/restaurant walls]; coverings are for show and maintenance”.

For instance, the Finnish Competent Body for the European Community Eco-Labeling Scheme suggested that the most common division of flooring products is: hard floorings (parquet, wooden flooring, laminates, ceramic tiles and stone flooring) resilient floorings (plastics, linoleum, rubber and cork) and fitted carpets. Details of the responses on consumer preferences for the non-domestic situation are given in the appendices (Table A6).

The use of specific wall and floor coverings is not only decreed by geographical characteristics of a region, but obviously depends also on consumer preferences. Some of these are persistent due to cultural uses of certain materials or the simple availability of products. Preferences can also be more ephemeral, especially if dictated by fashion which is increasingly taking place. For example, in the UK there is a current trend for wood block flooring mainly in living rooms. This trend is fuelled by the recent availability of cheap veneer wood blocks and laminate block flooring that can be self laid. In Southern Europe, traditional ceramic floor tiles are often a permanent feature of a home; these can however still be changed according to preferences by, for instance, overlaying rugs on ceramic floors to add variety. A high standard of living in The Netherlands has meant that many people can afford to buy better quality coverings; thus there has been a growth in the tile and marble market. In some regions there are cultural heritage laws that regulate the types of exterior coverings that can be used.

Another factor to bear in mind is the influence of associations on consumer choice. For instance, the European Environmental Bureau maintain that there is a market for all the materials referenced in the tables (Tables 6, A5 and A6), but greater emphasis should be on the use of carpets and textile wall coverings from natural fibres; the paints for the interiors of domestic premises should follow the eco-label criteria. In addition, some environmental organisations do not agree with the use of vinyl tiles.

One of the EU Ecolabelling Competent Bodies responding to our survey indicated that consumers decide which coverings are used in their houses in “do it yourself” areas and when undergoing refurbishing. Do it yourself retailers and architects often have a great say in which types of products are used, and according to the respondent, “can act as prescriptors of the ecolabel”.

In response to the survey the European Carpet Association stated that their members do not wish to be involved in a wall and floor covering eco-label. The European Carpet Association represents all the national carpet associations in Europe, equivalent to more than 90% of total production. They have their own environmental standard operated by their environmental division GuT. GuT is the Association for Environmentally-friendly Carpets; the members of this organisation make up more than two thirds of Europe’s carpet

manufacturing capacity. GuT members are committed to complying with the environmental standards prescribed by GuT and are subject to periodic monitoring. The European Carpet Association maintains that having an eco-label for carpets would serve no purpose and this was supported in a European Commission decision (1999/178/EC) whereby “establishing the ecological criteria for the award of the Community eco-label to textile products” would exclude floor coverings.

Cerame-Uni, the liaison office of the European ceramic industry, has also stated that the ceramic tile producers it represents do not want an eco-label for its products, as the European Ceramic Tile Manufacturers’ Federation has developed its own environmental standards. However the industry may, in the future, have sufficient time to be able to support activities concerning eco-labels.

Table 6: Alternative types of wall and floor coverings used in domestic premises in Europe (based on responses to the questionnaire)

FLOOR	Bathroom	Kitchen	Living room	Bedroom	Halls	Exteriors
Northern Europe (incl. Sweden)	ceramic tiles natural tiles terrazzo vinyl carpet (UK)	ceramic tiles vinyl carpet (in dining area) linoleum wood	carpet wood (laminated) ceramic tiles	carpet wood (laminated) linoleum	carpet wood ceramic tiles	stone conglomerate wood concrete
Mid Europe (incl. Holland)	ceramic tiles linoleum vinyl cork	ceramic tiles linoleum vinyl cork	carpet ceramic tiles wood	carpet ceramic tiles wood	carpet ceramic tiles stone wood cork	ceramic tiles stone
Southern Europe	ceramic tiles marble stone	ceramic tiles marble	ceramic tiles wood marble	wood carpet ceramic tiles	ceramic tiles marble wood	stone conglomerate ceramic tiles wood

WALLS	Bathroom	Kitchen	Living room	Bedroom	Halls	Exteriors
Northern Europe	ceramic tiles paint vinyl	ceramic tiles paint wallpaper	paint wallpaper wood	paint wallpaper wood	paint wallpaper wood	bricks plaster whitewash
Mid Europe	ceramic tiles paint wallpaper	ceramic tiles paint wallpaper	wallpaper paint cork textiles	wallpaper paint textiles	wallpaper paint	bricks plaster lime whitewash roughcast
Southern Europe	ceramic tiles paint	ceramic tiles paint	paint wallpaper	paint wallpaper	paint wallpaper	ceramic tiles

Note: carpet is intended as wall-to-wall

Based on the above tables and the observations that the respondents have made on consumer preferences and use of floor and wall coverings, some conclusions can be drawn from this section:

- There are several products / materials that consumers and builders can choose for

indoor/outdoor environments of domestic and non-domestic premises.

- There are several products which are widely used in most of Europe, independently of the geographical characteristics. These are paints, tiles, wood, natural stone, carpet and vinyl.
- Paints have already been awarded an eco-label and can therefore be excluded from the progression of the study.
- The remainder are to be considered in terms of what purpose consumers buy them for, whether internal or external to the premise and so on. Ceramic tiles are generally most widely used for a variety of purposes and can substitute other products.

3.4 Summary

- Jointless floor finishes have been excluded from the study.
- The product group 'jointless resilient finishes' have a wide range of characteristics whereas jointed hard finishes and timber and timber products have more uniform characteristics .
- The product characteristics are not necessarily a measure of merit, they depend on the product use and location.
- A distinction can be made between 'natural' and 'processed' products.
- Wall covering products can be split into two types; those that provide a special surface and those that are selected for their aesthetic appeal, with some products meeting both criteria.
- Wall and floor coverings are often not used for the full duration of their technical lifetime. However some floor coverings such as ceramic tiles and wooden floors have a long technical lifetime and are also regarded as long term products.
- A clear distinction can be seen between consumer preferences in northern, mid and southern Europe. However several products, such as paints, tiles, wood and vinyl, are widely used through out Europe, independent of geographical characteristics.
- Apart from ceramic tiles different materials are generally used for walls and floors.
- Cost is the most important factor in choosing products but this is beyond the scope of this study.
- Paints have already been awarded an eco-label and can therefore be excluded from the study.
- The European Carpet Association which represents companies producing more than 90% of total carpet production have stated that their members do not want an eco-label for carpets as they have their own environmental standard.
- Cerame-Uni, the liaison office of the European ceramic industry, have also stated that the ceramic tile producers it represents do not currently want an eco-label for their products, as the European Ceramic Tile Manufacturers' Federation has developed its own environmental standards. However they may be able to support activities in the future.
- Either ceramic tiles or vinyl flooring are widely used throughout Europe for bathroom and kitchen floors, and other areas of high utility.

4. Production methods and environmental impacts

4.1 Production methods

Manufacturing processes are obviously very complex. In the following flow charts a simplified process is shown.

4.1.1 Carpets

About 85% of carpets are made by the tufting process, using polyamide or woollen pile. Polypropylene is used for the backing cloth and styrene butadiene rubber and limestone used for the adhesive and the foam backing. The manufacture of tufted carpet can be split into three processes: tufting, dyeing and backing. In the tufting process a multi needed tufting machine is used to form the pile in the backing cloth. The product is then dyed unless the yarn was dyed beforehand. The backing is then coated in adhesive and a foam or secondary backing applied. A flow chart of the manufacturing processes are given in Figures 17 and 18. Polyamide pile carpets weigh 600 g/m² and wool carpets 950g/m².

Figure 17: Flow chart of polyamide carpet manufacture

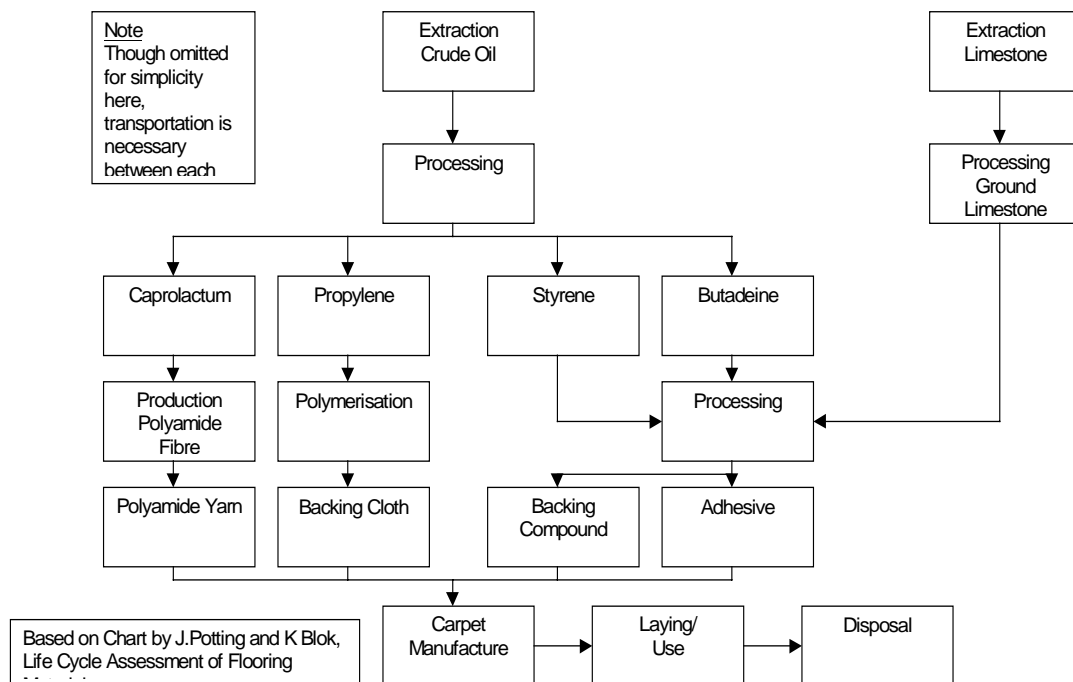
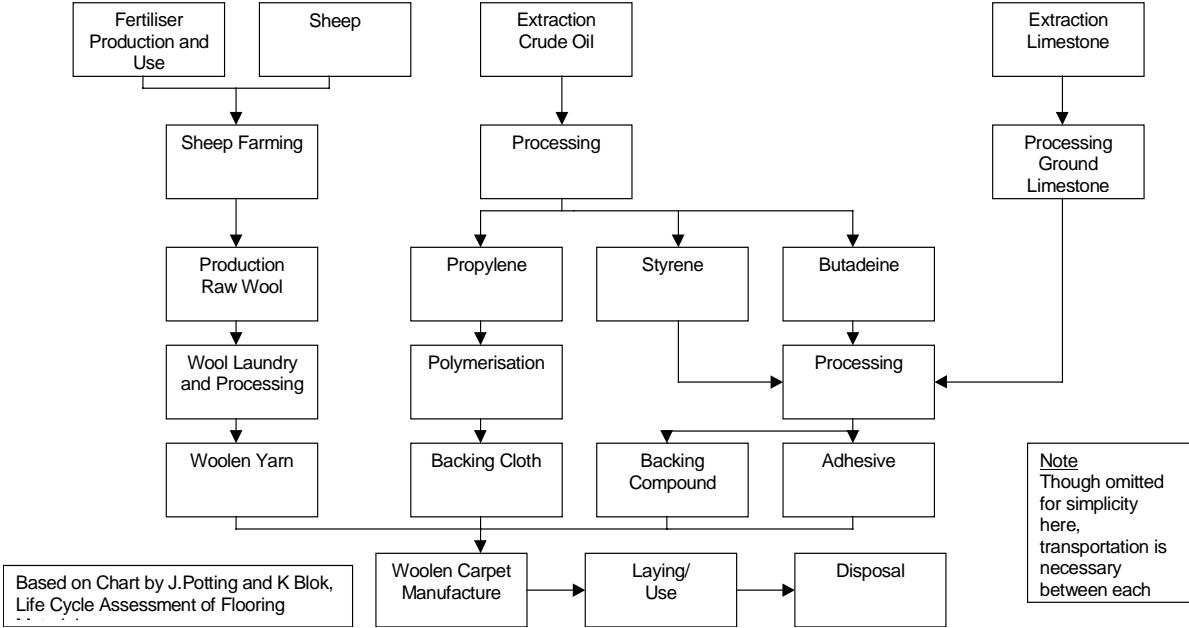


Fig 18: Flow chart of woollen carpet manufacture



4.1.2 Ceramic tiles

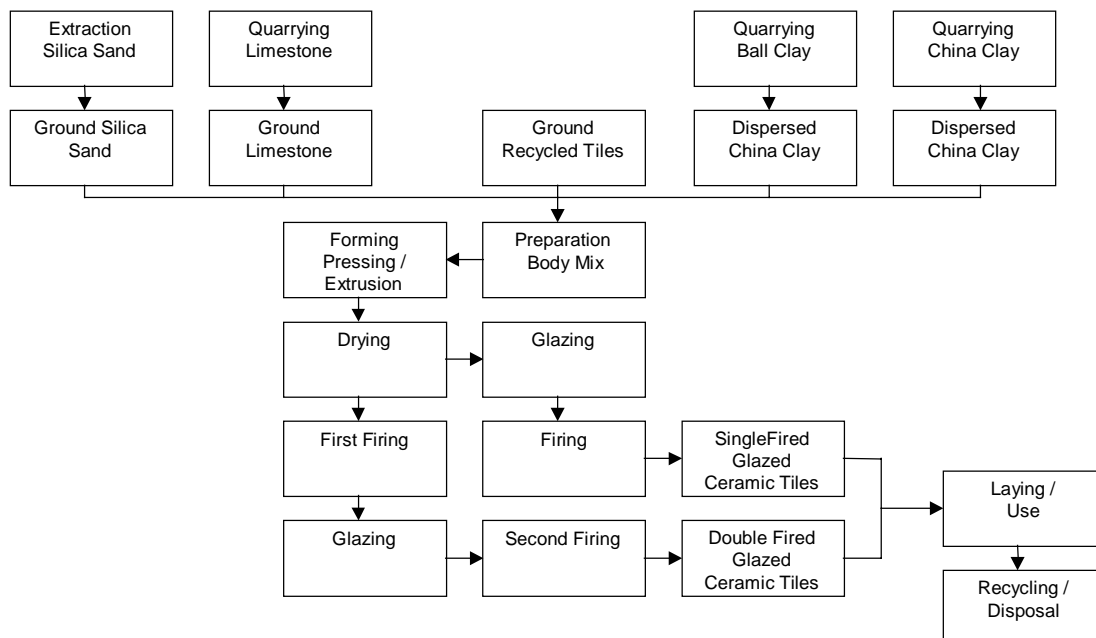
Ceramic tiles are thin slabs made from clays and/or other inorganic raw materials, generally used for coverings for floor and walls. They are usually shaped by extruding or pressing at room temperature. They are then dried and subsequently fired at temperatures sufficient to develop the required properties. Tiles can be glazed or unglazed and are incombustible and generally unaffected by light (ASCER, 1999).

The ceramic tile manufacturing cycle includes the following phases: preparation of the body mix, preparation of glazes, forming/shaping (by dust pressing or extrusion), drying, glaze application, firing and sorting. The body of the tile is produced by a mix of a clay fraction, quartz sand and carbonates or feldspars. The proportions are roughly 50 % of clay, 25 % sand and 25 % fluxes. Two different technologies are used for glazed tiles (Figure 19):

- **Double firing:** the dried tiles are fired, and then the glaze and decorations are applied to the so-called bisque ware; the cycle is concluded by a second firing, whose function is to stabilise (fire) the glaze.
- **Single firing:** the glaze is applied directly to the dried tiles; then the glaze and body are fired together in just one firing where the “sintering” of the body and stabilisation of the glaze take place at the same time.

Tiles are manufactured in many different formats. Rectangular and square tiles are the most common. Side lengths range from few centimetres to 90-100 cm. Thickness ranges from around 5 mm for wall tiles to around 10-25 mm for floor tiles. The production unit of ceramic tiles is 1 m² with the weight ranging from 10-12 kg/m² for wall tiles to 18-22 kg/m² for floor tiles. For glazed tiles, the weight of the glaze applied is around 0.700-1.200 kg/m².

Fig 19: Glazed Ceramic Tiles Flow Chart



4.1.3 Linoleum

Linoleum consists of a very hard layer of linoleum compound on a backing cloth of jute. The compound is a mixture of linseed oil (27%), colophonium (a resin from coniferous trees) (8%), limestone (10%) ground wood (10%) ground cork (10%) and pigment (5%). Linseed oil and colophonium are oxidised and then mixed with the other ingredients (Potting & Blok, 1995). Titanium dioxide is used as the main pigment (Jonsson *et al*, 1997). The mixture is pressed with a roller onto a woven backing of jute and dried. It is then finished with a acrylate dispersion layer (Potting & Blok, 1995). The cutting waste is recycled into the process of linoleum manufacture. A flow chart of the process is shown in fig 16. For domestic use linoleum has a weight of 2300g/m².

Fig 20: Flow chart of linoleum manufacture

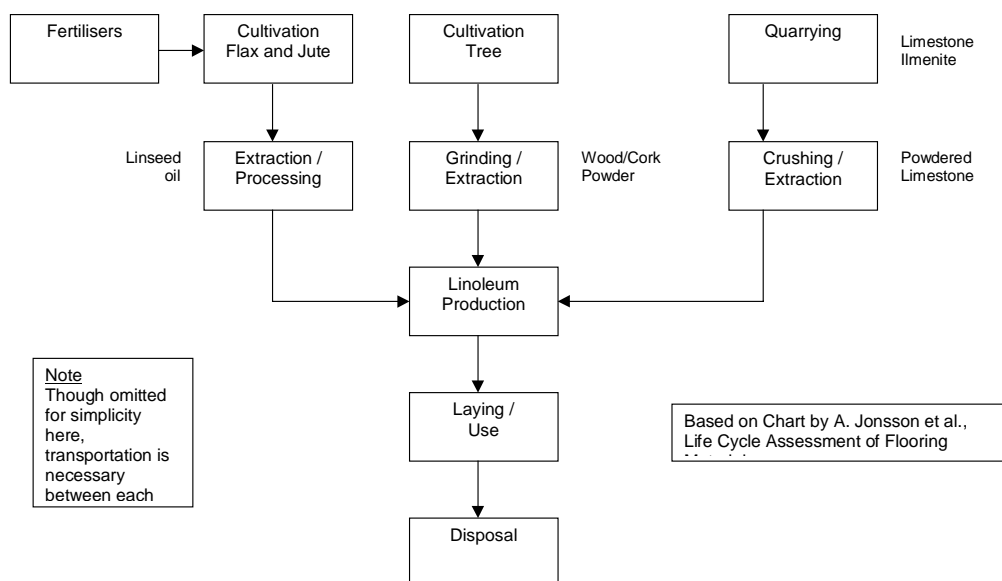
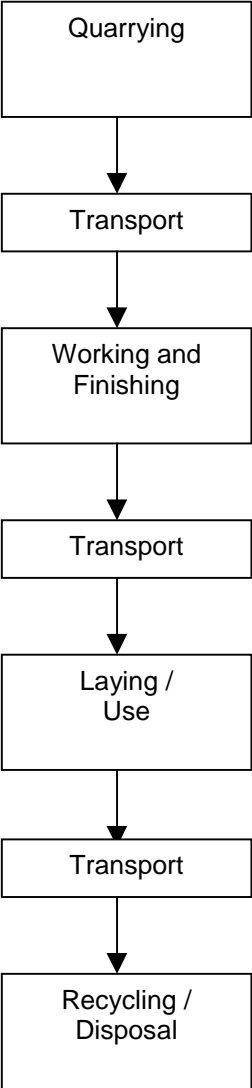


Fig 4.1.4 Natural Stone

The production of natural stone for flooring is a simple process in that following quarrying it simply requires shaping and finishing. For some products the finishing may include polishing. There are obviously many variations in production process but fig 21 provides a simplified flow chart.

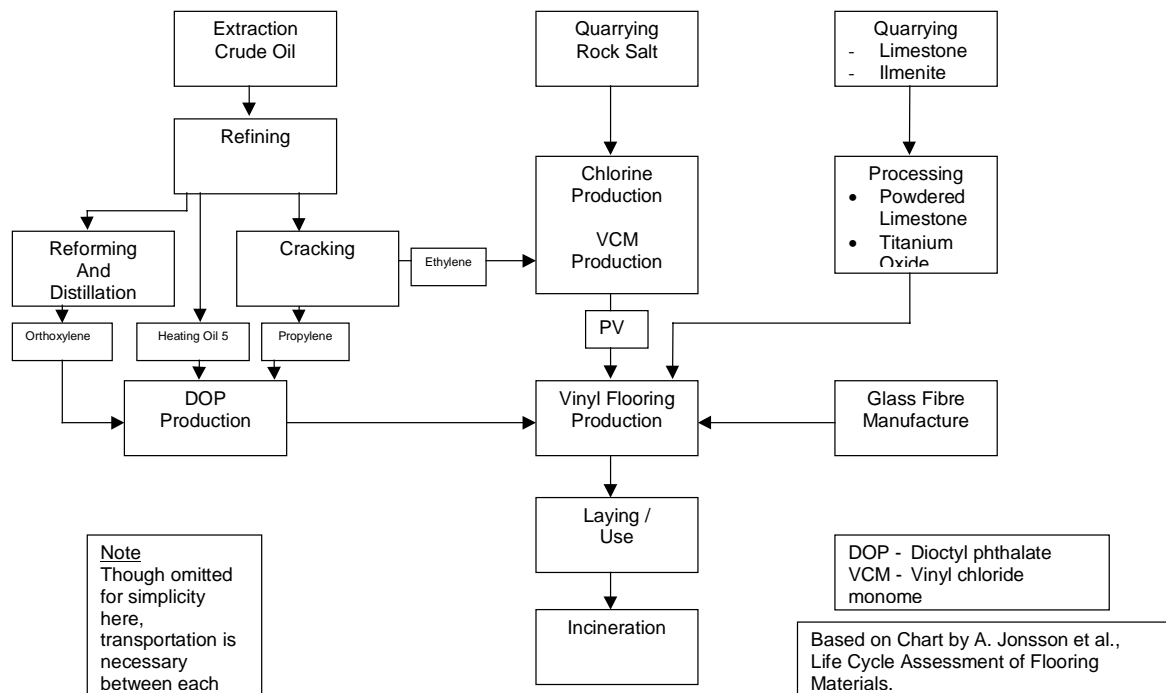
Fig 21: Flow chart of production of natural stone slabs



4.1.5 Vinyl flooring

Vinyl is made from mixtures of polyvinyl chloride (50%), plasticiser (30%), limestone (15%), stabilisers (3%), pigments (0.3%) and other additives (Potting & Blok, 1995). Polyvinyl chloride is made from sodium chloride, ethylene and electrical power. The plasticiser mainly used in the product studied by Jonsson *et al* (1997) is dioctyl phthalate, while the main pigment used is titanium dioxide and calcium carbonate is the main filler. The mixture is applied to a non-woven layer of glass fibre and baked. Cushioned vinyl consists of several layers of foam vinyl also on a non-woven layer of glass fibre. A design is usually applied by deep pressure using a solvent (Potting & Blok, 1995). Some products have a final surface layer of polyurethane. The cutting waste is recycled into other products. A flow chart of the main processes are shown in fig 17. The average weight of cushion vinyl is 1700 g/m².

Fig 22: Flow chart of vinyl manufacture

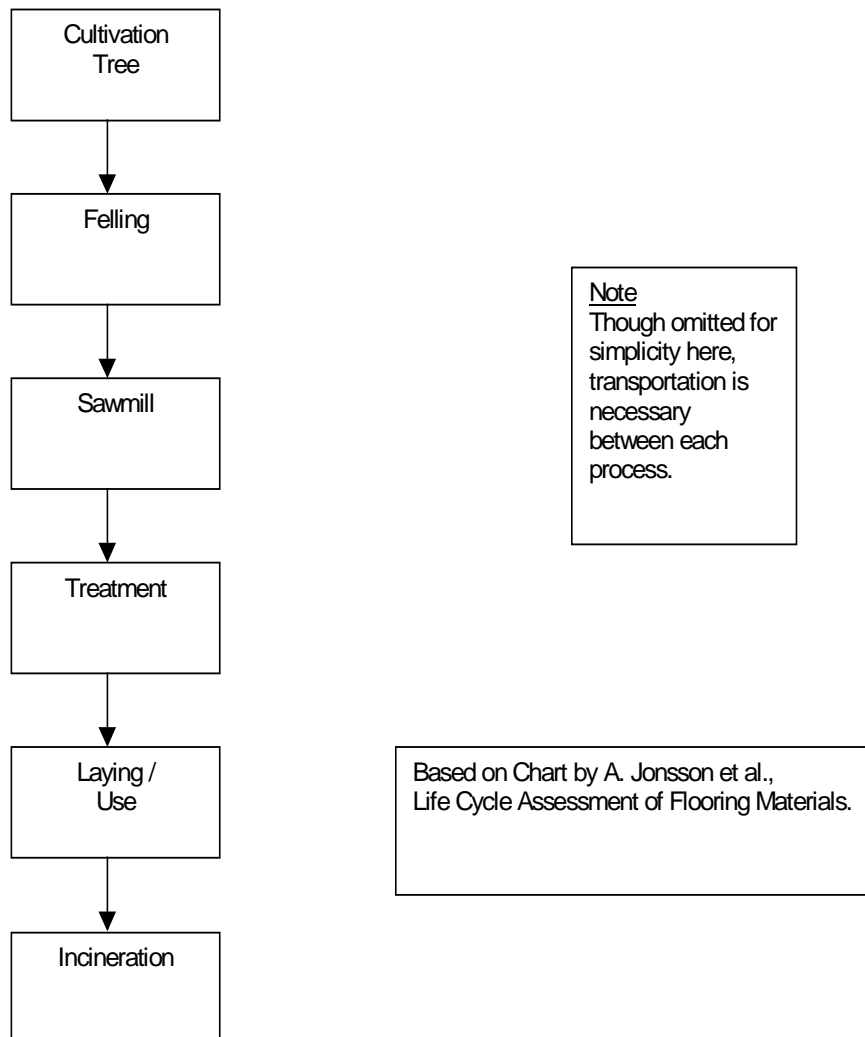


4.1.6 Wooden flooring

The manufacture of wooden flooring is relatively simple (Figure 22). However the timber has to be planted, grow, thinned, felled, soil-cultivated and re-planted. After felling the trees are transported to sawmills where barking, sawing to the desired dimensions and drying take place (Jonsson *et al*, 1997). The type of solid wooden flooring studied by Jonsson *et al* (1997) was not treated further but transported to the customer and laid. However some types of wooded flooring would require an intermediate processing/treatment stage. This may include the application of oil or lacquer.

The production methods of associated products, such as laminate flooring and cork, are not shown as they were not available.

Fig 23: Flow chart of wooden floor manufacture



4.2 Environmental Impacts: lifecycle assessments

The most complete method used to assess the environmental and resource implications of product manufacture is lifecycle assessment. Ideally this technique determines the environmental impacts of a product throughout its entire lifecycle from the mining of the raw materials and energy resources to the final disposal of the product. However lifecycle assessments are also undertaken by manufacturers of the cycle just within the factory gates. These assessments, which are usually to compare alternative production processes, are often confidential. Full lifecycle assessments include all inputs into the lifecycle including secondary products such as adhesives used in laying the flooring.

Four published lifecycle assessment studies are available on floor coverings:

- Günther, A. & Langowski, H-C. (1997) Life Cycle Assessment Study on Resilient Floor Coverings. Includes: PVC, cushioned PVC, polyolefin, rubber, linoleum, textiles and parquet.
- Jonsson, A. Tillman, A-M. & Svensson, T. (1997) Life Cycle assessment of flooring materials: case study. Includes: linoleum, vinyl and solid wood.
- Jonsson, A. (1999) Including the use phase in LCA of floor coverings. Includes linoleum, vinyl and solid wood.
- Potting, J. & Blok, K. (1995) Life-cycle assessment of four types of floor covering. Includes linoleum, cushion vinyl, woollen tufted carpet, polyamide tufted carpet.

A summary of the results of these studies are given in table A4 in the appendices. The results are not comparable as their boundaries are different and different assumptions are made. For example some LCAs include the use phase (Günther & Langowski, 1997) whilst others do not (Potting & Block, 1995). Also, different assumptions are made about the disposal of the end of life product. Jonsson *et al* (1997) assume that the waste products are incinerated with energy recovery; the Potting & Block (1995) study reflects the Dutch situation and assumes 60% landfill and 40% incineration; Günther & Langowski (1997) also include incineration and landfill. The studies also include different transport distances and energy sources. It is not known if any of the studies include the energy stored in the product in the net energy data.

Different impact assessment methodologies were also used. Jonsson *et al*, (1997) and Jonsson (1999) compared the results of three methodologies; the *Environmental Priority Strategies in Product Design method* (EPS) developed in Sweden (Steen and Ryding, 1993); the *Environmental Theme Method*, developed in the Netherlands (Heijungs *et al*, 1992); and the *Ecological Scarcity Method*, developed in Switzerland (Muller Wenk, 1994). Günther & Langowski (1997) aggregate the inventory data into eleven impact categories but do not use a weighting methodology, whilst Potting & Blok (1995) use a Dutch approach.

The functional unit of two of the LCA studies is 1m² of flooring with the values presented firstly for the total lifetime (total/m²) then distributed per year on the lifetime of each flooring materials (total/year, m²) (Jonsson *et al*, 1997). Günther & Langowski (1997) however use 'the typical use of 20m² flooring over a period of twenty years, whilst Potting & Blok (1995) use 'one m² of floor surface in a normal Dutch house over a period of 15 years.

However, although the studies cannot be compared it is useful to use the results to highlight the main environmental impacts. The Günther & Langowski (1997) study found that no one resilient flooring product was better or worse than the others in environmental performance. There were greater differences within the material groups due to the different formulas for individual products. However significant environmental improvements were possible for all products and in all parts of the lifecycle.

Significant for this eco-label study is the finding that the actual achieved lifetime of a flooring

has major impact on the environmental performance. The premature disposal of the flooring, either due to inappropriate selection or due to a decision to replace the floor because of changes in consumer taste, can have a greater environmental impacts than most other options for improvement. The assumptions regarding the lifetime of a flooring type can also have a significant effect.

The Potting & Blok (1995) study found that linoleum makes the smallest contribution to almost all types of environmental impact. Woollen tufted carpet made a high contribution to eutrophication, global warming, stratospheric ozone creation and non-hazardous waste. However the authors were concerned about some of the data used in their study so some of the results may be much less severe. If this is the case tufted carpet with polyamide pile and cushion vinyl together make the largest contribution to non hazardous waste and maybe to tropospheric ozone creation. The polyamide carpet had the greatest energy requirement but the woollen carpet and cushion vinyl had the largest contribution to acidification. Apart from linoleum the authors thus found that it was impossible to conclude which flooring product had the least environmental impact without weighing up the various types of environmental impacts, one against another, in an LCA valuation. However this was considered to be outside the scope of the study.

Two publications reported by Potting & Blok (1995); Reijnders (1991) and Fraanje (1991) also concluded that linoleum had the least environmental impact and cushion vinyl the greatest. They based the latter conclusion on the safety risks associated with the production and transport of chlorine. Risk aspects are not usually included in LCA studies.

Several of the studies mentioned that there was considerable scope for improving the environmental impacts of the products. Potting & Block (1995) considered that improvements could be made in all the production processes, while Günther & Langowski (1997) thought that improvements could be made for all flooring at all lifecycle stages. This is particularly important when considering eco-labels as there needs to be scope for improvements that can be influenced by consumer choice.

The studies that included the use phase found that it made a significant impact on the overall results. Günther & Langowski (1997) found that the energy used in cleaning the flooring, i.e. the electricity consumption of a vacuum cleaner, exceeded the gross energy value in the production and disposal phases. Similarly the water demand in the use phase greatly exceeded that used in production and disposal.

Before the main environmental impacts can be evaluated it will be necessary to carry out LCA studies on each product with a standardised methodology, boundaries and assumptions so that the results are comparable. These studies would need to include secondary products such as adhesives and metal fixing strips.

Based on the LCA studies and other environmental information table 7 gives an indication of the main environmental impacts from the production, use and disposal of floor coverings. Using the same data sources, Table 8 identifies at which lifecycle stages the main environmental impacts occur.

The environmental impacts from several products such as laminate flooring are not included as the data were not available. It is understood that the main impacts from laminate flooring are energy consumption and the emission of formaldehyde (personal communication Danish Competent Body).

Toxic emissions have also not been included in this study due to a lack of data. This would need to be addressed in the next study on the criteria selection.

4.3 Summary

- Wall and floor coverings use very different production processes and different raw materials, both natural and oil based.
- Some processes are relatively simple whilst others involve many production stages including the manufacture of feedstock chemicals.
- Most production processes involve the extensive transport of raw materials.
- Significant environmental impacts occur during the lifecycle of all wall and floor coverings.
- In the use phase the environmental impacts arising from floor maintenance is particularly high especially when vacuuming or contract cleaning is undertaken.
- The agricultural system associated with woollen carpets, the extraction of natural stone and the disposal of vinyl flooring are also stages that can have high environmental impacts.
- Most production processes have opportunities for improvement in the environmental impacts that can be influenced by consumer choice. However some stages of the lifecycle, such as the extraction of natural stone and some agricultural systems, may not easily be influenced by consumer choice.

Table 7: An indication of the environmental impacts from the production, use and disposal of wall and floor coverings

product	Net energy MJ	Global warming potential kg CO ₂ equiv.	Acidification SO ₂ equiv.	Tropospheric ozone creation (g ethylene equiv.)	Eutrophication g phos equiv.	Waste hazard/ non-haz (g)
ceramic tiles	XXX	XXX	n/a	n/a	n/a	X
carpet-woollen	XX	XXX	XXX	XXX	XXX	XXX
carpet – polyamide	XXX	XX	XX	XX	X	XXX
linoleum	X	XX	X	X	XX	XXX
polyolefin	X	XX	X	n/a	n/a	n/a
rubber	X	XX	X	n/a	n/a	n/a
vinyl	XX	XX	XX	XX	X	XXX
wood	X	X	XX	n/a	n/a	n/a

Note: source: based on LCA studies and other general environmental information

- X = minor environmental impact
- XX = medium environmental impact
- XXX = major environmental impact
- n/a = information not available

Table 8: Identification of the lifecycle stages where the main environmental impacts occur

	agricultural system	extraction	manufacture	transport ³	use ¹	disposal
carpets – woollen	XXX	X	X	XX	XXX ²	XX
carpets- polyamide	-	X	XX	X	XXX ²	XX
ceramic tiles	-	X	XX	X	XX	X
linoleum	X		X	XX	XX	X
natural stone	-	XXX	X	X	XX	X
vinyl	-	X	X	X	XX	XXX
wood	X	XX	X	XX	XX	X

source: based on LCA studies and other general environmental information

XXX very large environmental impact

XX large environmental impact

X small-medium environmental impact

¹contract cleaning of floors was thought to require more energy over the lifetime of flooring than the production stage (Günther & Langowski, 1997)

²the energy requirement from vacuum cleaning carpets can be considerable (Potting & Blok, 1995)

³transport can have a large impact but it is location specific

5. Discussion

The three main objectives for this feasibility study were defined as whether an eco-label should be established for wall and floor coverings; what types of wall and floor coverings should be included in the product group; and to have a preliminary understanding of the environmental impacts that occur in the lifecycle of the recommended product group

5.1 A wall and floor coverings eco-label?

The first objective has been addressed by determining:

- if the wall and floor coverings represent an overall significant volume of sales and trade in the internal market and that a significant part of sales are directly to the final consumer
- if there is an incentive for manufacturers to seek a competitive advantage by offering products which qualify for the eco-label.
- if the products involve significant environmental impacts
- that there is a significant potential for influencing environmental improvements through consumer choice.

Market share and trading:

This study has shown that carpets, ceramic tiles, other tiles, wallpaper, wooden flooring, plastic and linoleum all have a significant market share internally to Europe, while rubber flooring has a significant but smaller market share [section 2.1]. The majority of these products are sold to the final consumer through large retail units [section 2.3], although rubber flooring may involve a specialist market. Paper flooring and textile wall coverings would appear to have a relatively small market share. Concrete flags, composition blocks and brick paviors are also thought to have a small market share but data are not available to support this view.

Environmental impacts:

Significant environmental impacts occur during the lifecycle of all wall and floor coverings [section 4.2]. Maintenance during the use phase is important for all products especially when vacuuming or contract cleaning is undertaken as these procedures involve high energy use and may also involve the consumption of large quantities of water. The agricultural system associated with woollen carpets, the extraction of natural stone, and the disposal of vinyl flooring are also stages that may have particular large environmental impacts [section 4.2].

Scope for improvement:

Opportunities for improving the environmental impacts of processes have been identified at most lifecycle stages [section 4.2]. The few areas that are difficult to improve on are those that involve the extraction of natural resources in areas of outstanding natural beauty (for example the extraction of natural stone such as marble involves direct extraction from the mountainside causing damage to ecosystems). and those stages that involve agricultural processes, such as sheep farming [section 4.2]. Floor maintenance, in the use phase, is also difficult to influence although an easily maintained surface may reduce the intensity of cleaning. The variety of products available to consumers (for instance, within the same type of wall and floor covering and between different types of coverings that meet similar requirements [section 3.3]), allows them to base their choice according to the relative environmental implications from the production of coverings.

Competitive advantage:

This report has shown that all the products have significant environmental impacts, but also have the potential for environmental improvements [section 4.2]. In the main these

improvements can be influenced through consumer choice [section 3.3]. Therefore there is an incentive for manufacturers to reduce the environmental impacts from their processes (if necessary) in order to be granted an eco-label for their products and thus increase their competitive advantage [section 2.1].

5.2 Product Group

The second objective of this feasibility study is to establish what types of wall and floor coverings should be included in the product group;

As discussed at the beginning of this report, in eco-labelling terms a product group includes products that serve the same purpose and which are equivalent in terms of use and consumer perception. Although all of the products discussed in this report are wall and floor coverings, the normal use of these products differs considerably. Thus it cannot be said that products for wall and floors are equivalent in terms of use. The characteristics of wall coverings are not easy to define but in general they are used mainly for decorative purposes. The exceptions being ceramic tiles and to a lesser extent vinyl, which are used to provide an easily cleaned surface such as in bathrooms and kitchen areas [section 3.1.2]. Floor coverings need to meet the requirements of a more challenging environment. Therefore they have very different technical characteristics such as wear resistance, durability and ease of maintenance [section 3.1.1.2]. It can be seen therefore that wall and floor coverings have different uses and serve different purposes, so it would be logical for wall and floor coverings to be considered as separate product groups.

Following this argument, within the floor coverings group the products have a wide range of different characteristics some, such as carpets provide good insulation and warmth to the touch, whilst glazed tiles provide an easily cleaned surface that is water and chemical resistant [section 3.1.1]. The useful classification of floor coverings by Pye & Harrison (1997) underlines that products within groups of floor coverings may also have different characteristics, such as differing levels of resistance to water penetration. The resilient flooring group includes a very broad range of products, which ranges from carpets to PVC flexible flooring. Products in the other groups, 'jointed hard finishes' and 'timber and timber products' are far less variable in their characteristics and form more uniform groups [section 3.1.].

One distinction could be made between indoor and outdoor products. However many products can be used in both situations depending on the climate and frost resistance of the product. Therefore it would seem better to include both indoor and outdoor products in the product group taking into account the different treatments outdoor materials may need.

A useful distinguishing categorisation is whether products are 'natural' or if they are the product of a manufacturing process. For example natural stone such as marble and solid timber floors are natural products that simply require shaping and finishing. Manufactured products, although they may be made from natural products such as wool and clay, require extensive processing to make them into the final product. 'Natural' products offer producers very little scope for improvement. Timber can be sourced from sustainably harvested forests but this does not apply to natural stone products. Due to the major differences between natural and processed products it would not seem logical to have them in the same product group. This is discussed further below.

To distinguish between natural and processed flooring the Pye & Harrison (1997) categories can be further divided:

Original category ¹	New category	
• jointless floor finishes	jointless flooring	excluded from study [section 3.1.1]
• jointless resilient finishes	resilient flooring	all processed products e.g. vinyl
• jointed hard finishes	natural hard flooring	e.g. natural stone
	processed hard flooring	eg ceramic tiles
• timber and timber products	natural timber flooring	e.g. solid wood flooring
	processed timber flooring	e.g. chipboard

Note: 1 Pye & Harrison (1997)

Many of the characteristics and uses of jointless resilient flooring, such as vinyl, and processed hard finishes (e.g. ceramic tiles) are similar in that they are both widely used in bathrooms and kitchens for protective as well as decorative purposes [section 3.1.1]. The main difference in the consumer perception between the two products is the colder, hard surface of tiles and the relative cost. In hot countries, where a cold surface is considered a benefit, ceramic tiles are also used in living areas, whereas vinyl flooring is not. However in commercial premises and hospitals ceramic tiles and vinyl flooring are used interchangeably, although vinyl flooring maybe preferred due to lower cost [section 3.3]. Initially it maybe considered that there is sufficient equivalency between these two products (vinyl and tiles) for them to be attributed to the same product group. However the environmental impacts arising from the production and disposal of these products are very different.

The walls of kitchens and bathrooms are generally covered by ceramic tiles (particularly in areas of high maintenance), water resistant paint and occasionally wallpaper [section 3.3]. Paints have already been awarded an eco-label and can therefore do not need to be considered by this report.

5.3 Environmental Impacts

The third objective to be addressed in this report is to have a preliminary understanding of the environmental impacts that occur in the lifecycle of the recommended product group and to inform the selection of the environmental criteria.

In an evaluation of the lifecycle assessments of floor coverings and information from other environmental sources it was found that broad environmental impacts occur at most stages of the production of wall and floor coverings [section 4.2]. However the main problem areas occur at different stages for different products. The resource use implications varies between products with some using renewable materials (e.g. wool), others using non renewable but abundant raw materials (e.g. clay), whilst for some products scarce non-renewable resources (e.g. marble) are being consumed.

Net energy use is a significant problem for ceramic tiles, carpets and vinyl. However this is affected by the disposal option used, i.e. if there is energy recovery from the waste. The quantity and type of waste produced is a greater problem for carpets, linoleum and vinyl than for inert products such as tiles. The global warming potential follows, to some extent, the

energy used though the use of natural products such as wool can also have global warming implications. Natural products can also have implications for the environment relating to eutrophication emissions. Acidification is also significant for woollen carpets, and to a lesser extent polyamide carpets, vinyl and wood. This may partly be association with energy use but also other production processes [section 4.2 and table 7].

Many of the environmental impacts of floor coverings were found to occur at the use stage, due to the energy used in cleaning, especially the use of the vacuum cleaner. The use of chemical cleaners and polishes will also need consideration. However, providing the flooring is already easy to maintain, it is difficult for manufacturers to further influence this stage so there is relatively little scope for improvement at this stage. Another impact area is transport, mainly of raw or manufactured materials used in production [section 4.2 and table 8]. For some products it may be possible for manufacturers to source their materials closer to the place of production (thus reducing environmental implications) but in other cases this may not be so.

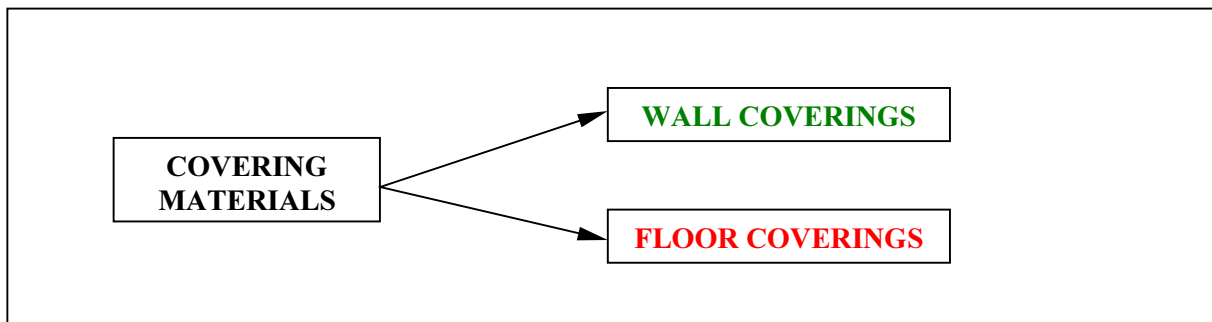
From the information that has been gathered it would seem likely that the selection of environmental criteria for a recommended product group could centre around energy use, acidification, eutrophication and waste disposal.

6. Conclusions

It would seem to the authors that this research has shown that there is certainly a case for an eco-label to be established. Most wall and floor coverings considered in this report: have a sufficient market share; are sold directly to the consumer; significant environmental impacts arise during the production cycles; and there is sufficient scope for improvement; Therefore in order to gain an eco-label and thus increase their market share there is an incentive for floor and wall coverings manufacturers to reduce the environmental impacts from their production processes.

However 'wall and floor coverings' include a very large number of products that are too diverse for a single eco-label. Therefore it is suggested that the wall and floor coverings group is classified further (fig 24). The first stage of classification is to exclude wall coverings from the potential product group. As discussed earlier [section 5.2] the technical characteristics of wall and floor coverings are very different, with floor coverings having to meet the requirements of a more challenging environment. Therefore wall coverings do not fulfil the same function as floor coverings and are not equivalent in terms of use and consumer perception..

Figure 24: Covering materials division in accordance with their use destination.

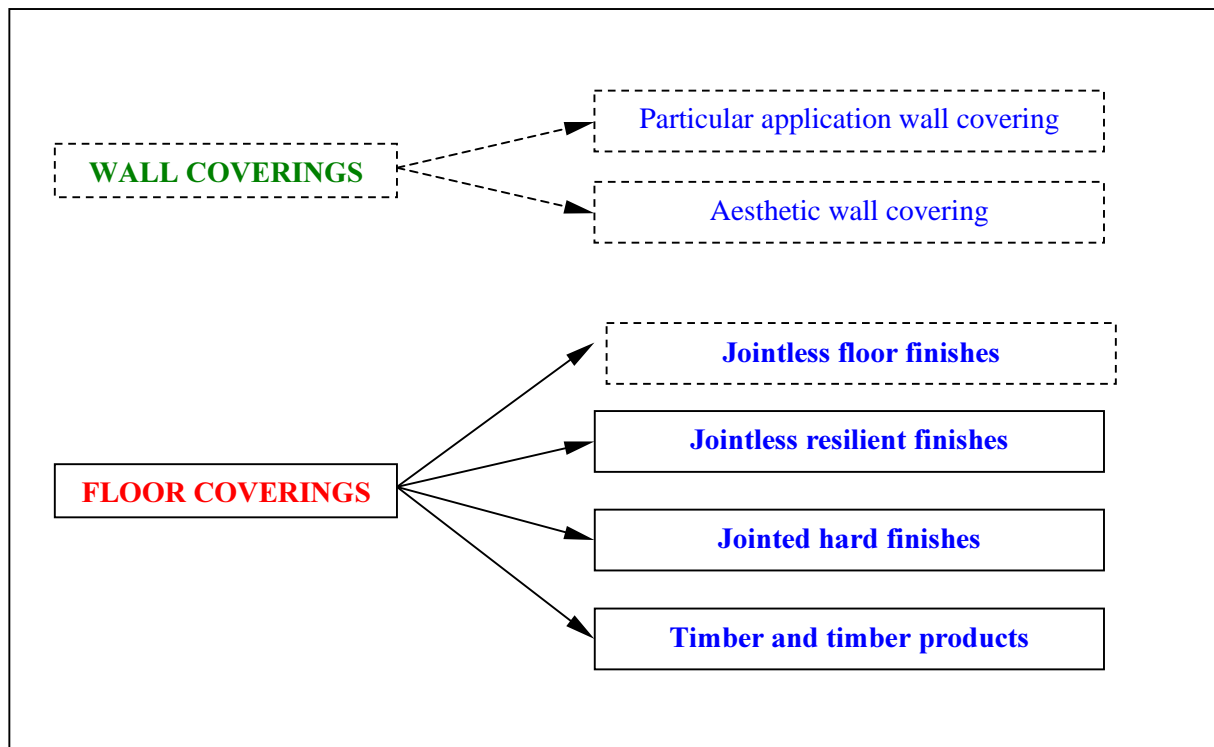


A second classification can be made within the floor coverings group. As discussed in section 5.2 floor coverings can logically be classified according to their finished surface, based on their technical properties and performances (fig. 25) as undertaken by the Building Research Establishment (Pye & Harrison, 1997).

However this classification does not distinguish between natural and process products. From an eco-labelling perspective this is particularly important as natural flooring products offer producers very little scope for improvement due to most of the environmental impacts occurring at the extraction stage of the production, not at the manufacturing stage.

The classification of floor coverings also needs to take into consideration market share, the possibility of environmental improvements and consumers perception in order to determine the candidate product groups for an eco-label.

Figure 25: covering materials selection based on technical properties and performances.



On this basis, therefore, it would seem to the authors that floor coverings can be divided into five product groups that can potentially be considered for an eco-label:

Product group	Products
1. Resilient flooring	Textiles Linoleum PVC or vinyl Rubber Carpets
6. Processed hard flooring	Ceramic tiles Terrazzo
7. Natural hard flooring	Natural stone Marble
8. Processed timber flooring	Panel products Laminate Mosaic
9. Natural timber flooring	Board and strip Block Parquet

The first group, **resilient flooring**, is a logical selection, based on technical properties, that includes very soft surfaces, such as carpets and other textiles, and harder resilient surfaces.

A problem with this product group is that it is very diverse and would need several sub-groups to accommodate the wide range of environmental impacts deriving from each product type.

The second product group, **processed hard flooring**, is a logical and uniform group, that would be easily understood by consumers. By their very nature hard floor coverings differ substantially from resilient flooring and soft surfaces such as carpets and cushioned vinyl. The products within this groups are made from similar raw materials and produced by similar manufacturing processes with the environmental impacts occurring at the same lifecycle stages. The resources used to manufacture these products, although mostly non renewable, are relatively abundant compared with some of the natural flooring products which are not included in this group. Also excluded are brick paviors and concrete slabs, due to their presumed small market share, and bricks. Although bricks in general have a large market share the application is for construction rather than for flooring.

The third product group, **natural hard flooring**, such as stone and marble, are considered a separate group from processed hard flooring. This is due to the environmental impacts of natural hard flooring mainly occurring at the extraction rather than the manufacturing stage. This results in there being less scope for environmental improvement. Natural hard floorings and processed hard floorings are in many instances perceived differently by consumers.

The fourth and the fifth group, **processed timber flooring** and **natural timber flooring**, are also uniform groups and they would seem a logical classification easily understood by consumers. As with groups 2 and 3 the processed timber flooring group would provide a greater scope for environmental improvement, than natural timber flooring which includes relatively little processing.

For all groups both indoor and outdoor flooring products would be included.

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APPENDICES

Table A1: Characteristics of flooring with jointless resilient finishes

Criteria Flooring material	reflectivity	Strength and stability	Wear resistance	Slip resistance cof ¹	Thermal properties	Warmth to touch	Sound insulation	Fire	durability	Maintenanc e	BS Number
textile	.45-.10	Some will stretch	Can be good	Very good dry >.7 wet .4 - >.6	0.055 W/mK	very warm	very good	combustible	10 – 20 years	Fair - good	Working: BS 5325 ⁽²¹⁵⁾
linoleum	.45 - .1	Good	fair	dry >.7 wet .2 - <.35	0.22 W/mK	warm	good	combustible	10 – 25 years	easy	BS 6826 ⁽²⁰⁵⁾
cork	0.2	Good	fair	good when dry >.7, wet .3- >.5	0.085 W/mK	very warm	very good	combustible	Poor - fair	Difficult	Working: BS 8203 ⁽³⁵⁾
PVC flexible	.45 - .1	Gen. good	Good - excellent	good when dry >.7, wet .3- >.45 ²	0.40 W/mK	fairly warm	Felt backed good	combustible	15 – 30 years	easy ³	BS 5085 BS 3260 BS 3261 Working: BS 8203
PVC semi-flexible or vinyl	.45 - .25	Gen. good	fair	good when dry >.7, wet .2- >.35	.40 W/mK	cool	poor	combustible	15-30 years	Gen. OK some problems	EN 654 ⁽²¹⁹⁾ Working: BS 8203 ⁽³⁵⁾
Rubber	.45 - .1	Very good	Very good	good when dry >.7, wet .2- >.3	.40 W/mK	warm	Very good	good	10 years	En OK	BS 1711 ⁽²²⁰⁾ Working: BS 8203
Thermo-plastic	.1	Poor	fair	good when dry >.7 wet .2- >.35	.5 W/mK	cold	poor	combustible	poor	Fair-good	BS 2592 ⁽²²³⁾ Working: BS 8203

Source: derived from Pye & Harrison (1997) BRE p223 Notes: **1** coefficients of friction **2** slip resistant grades **3** safety

Table A2: Characteristics of flooring with jointed hard finishes

Criteria	reflectivity	Strength and stability	Wear resistance	Slip resistance cof ¹	Thermal properties	Warmth to touch	Sound insulation	Fire	durability	Mainten- ance	BS Number
Flooring material											
Ceramic Tiles and Brick Paviers	0.10 - .5	Gen. Good depending on thickness	Good-V. good	Fair - Good when dry >0.6, wet 0.2 - 0.3	1.8 W/mK	Cold	Fair	Non - Combustible	50-65 years	Gen. Good	BS 1286 ⁽²²⁴⁾
Concrete Flags	0.25	N/a	Good - Excellent	Fair - Good Dry >0.5 Wet 0.2 - 0.3	1.8 W/mK	Cold	Poor	Non - Combustible	Variable, Gen. Fair	Good - Gen. Not necessary	BS 7263: part1 ⁽²³⁴⁾
Natural Stone	0.10 - 0.45	Gen. Good depending on thickness	Fair - Excellent	Fair- Good when dry >0.5, wet 0.2 - 0.45	1.8 W/mK	Cold	Poor	Non - Combustible	Poor with moisture, otherwise fair	OK, Some problems (Staining)	Working: BS 5385: part5
Terrazzo Tiles	0.10 - 0.45	Gen. Good depending on thickness	Fair - Good	Good when dry >0.5, wet 0.2 - 0.3	1.0 -1.8 W/mK	Cold	Poor	Non - Combustible	50 - 65 Years	Good, some staining	Working: BS 5385: part5
Composition Block	0.10	Good	Fair	Poor when polished. Data N/a	0.3 -0.5 w/m/K	Fair	Poor	Combustible	40 Years	Fair - resealing after 10 years	Working; BS 5385: part5
Metal	.010 - 0.45 Rust can be problematic	Gen. Good	Very Good	Fair - Good	Alu. 160 W/mK Steel 50 W/mK	Very Cold	Poor	Good - Some sparking	Poor - fair, dependent on environment	Difficult	N/a

Source: derived from Pye & Harrison (1997)

Table A3: Timber and Timber Products

Criteria	reflectivity	Strength and stability	Wear resistance	Slip resistance cof^1	Thermal properties	Warmth to touch	Sound insulation	Fire	durability	Mainten-ance	BS Number
General	0.20 - 0.35	Varies - Species and use dependent	Poor - Good, dependent on species.	Good when dry >0.5, wet 0.2 - 0.4	0.13 W/mK - 0.15 W/mK	Warm	Poor - Fair	Combustible	Good (When sealed)	Difficult	BS 8201 ⁽²³⁹⁾
Board and Strip	0.20 - 0.35	Varies - Species and use dependent	Poor - Good, dependent on species	Good when dry >0.5, wet 0.2 - 0.4 Poor when waxed.	0.13 W/mK - 0.15 W/mK	Warm	Poor	Combustible	Good - dependent on care.	Difficult	BS 8201 ⁽²³⁹⁾
Block	0.20 - 0.35	Varies - Species and use dependent	Poor - Good, dependent on species	Good when dry >0.5, wet 0.2 - 0.4 Poor when waxed.	0.13 W/mK - 0.15 W/mK	Warm	Poor	Combustible	Good	Difficult	BS 8201 ⁽²³⁹⁾
Parquet and Mosaic	0.20 - 0.35	Varies - Species and use dependent	Poor - Good, dependent on species	V. Poor if waxed	0.13 W/mK - 0.15 W/mK	Warm	Poor	Combustible	Good (When sealed)	Difficult	BS8201 ⁽²³⁹⁾
Panel Products	0.20 - 0.35	Varies	Fair	V. Poor if waxed	0.13 W/mK - 0.15 W/mK	Warm	Fair	Combustible	Reasonable (if kept dry)	N/a	BS 5669, BS 6566

Source: Derived from Pye & Harrison (1997)

Table A4: A summary of the results of LCA studies on floor coverings: (functional unit 1 m2 flooring)

product	Reference:	Net energy: elec+fossil - recovered energy MJ	Global warming potential g CO ₂ equiv.	Acidification g SO ₂ equiv.	Tropospheric ozone creation g ethylene equiv	Eutrophication g phos equiv	Waste hazard/ non-haz g
ceramic tiles	5	62-158	9664	14			
carpet- woollen	2	109	64300	170	44	1550	600/3400
carpet – polyamide	2	175	13500	80	17	14	650/2800
	1	195 ^e	8000 ^e				
linoleum	3,4	13	1600	13			
	2	39	2600	10	4	60	400/1500
	1	3.8 ^e	18000 ^e	1.2 ^e			
polyolefin	1	7.5 ^e	8000 ^e	1.3 ^e			
rubber	1	7.3 ^e	10000 ^e	3.8 ^e			
vinyl/PVC cushion vinyl	3,4	28.7	4206	32			
	2	105.9	9500	21	18	2	600/2000
	1	8.8 ^e	12500 ^e	2.3 ^e			
	1	6.8 ^e	10000 ^e	2.1 ^e			
wood, solid parquet	3,4	-99.24	4240	24			
	1	3.5 ^e					

e = estimated from graph;(1) Günther & Langowski (1997); (2). Potting & Blok (1995); (3) Jonsson *et al* (1997); (4) Jonsson (1999); (5) Italian Ministry for Environment (1993)

Table A5: Alternative types of wall and floor coverings used in domestic premises in Europe (based on responses to the questionnaire)

FLOOR	Bathroom	Kitchen	Living room	Bedroom	Halls	Exteriors
Northern Europe (incl. Sweden)	c.tiles vinyl PVC cork wood nat. stone carpet	c.tiles vinyl wood linoleum carpet laminates nat. stone cork	carpet wood c. tiles vinyl parquet laminates linoleum	carpet wood vinyl parquet laminates linoleum	carpet wood c. tiles vinyl parquet laminates linoleum nat. stone	stone bricks conglomerate wood concrete cobblelock
Mid Europe (incl. Holland)	c. tiles linoleum vinyl carpet (UK) stone cork	c.tiles linoleum bricks stone vinyl carpet wood cork	carpet c.tiles stone wood vinyl laminates cork	carpet c.tiles wood vinyl laminates cork	carpet c.tiles stone linoleum wood carpet vinyl laminates cork	c.tiles stone concrete gravel wood
Southern Europe	c. tiles marble mosaic granite vinyl	c. tiles stone marble mosaic vinyl	c. tiles stone wood marble carpet	wood carpet c. tiles marble	c.tiles marble wood carpet granite	stone conglomerate mosaic terrazzo c. tiles marble wood
WALLS	Bathroom	Kitchen	Living room	Bedroom	Halls	Exteriors
Northern Europe	c.tiles paint plaster vinyl (PVC) wood wallpaper	c.tiles paint wallpaper vinyl wood plaster bricks	paint plaster wallpaper bricks wood	paint plaster wallpaper wood	paint plaster wallpaper c. tiles wood panel	bricks plaster whitewash paint wallpaper wood
Mid - Europe	c.tiles paint plaster wallpaper	c.tiles paint plaster wallpaper bricks	wallpaper paint plaster wood cork bricks textiles roughcast	wallpaper paint plaster wood textiles	wallpaper paint plaster bricks c.tiles roughcast	bricks plaster lime whitewash roughcast
Southern Europe	c. tiles paint plaster marble stone	c.tiles paint plaster marble stone	paint plaster wallpaper	paint plaster wallpaper	paint plaster wallpaper	bricks lime whitewash plaster c. tiles stone marble paint concrete

Note: 'c. tiles' indicates ceramic tiles

Note: carpet is intended as wall-to-wall

Table A6: Alternative types of wall and floor coverings used in non-domestic premises in Europe (based on responses to the questionnaire)

FLOORS	Hotels/ restaurant	Retail outlets	Public buildings	Hospitals	Gyms	Public transport premises (e.g. underground)
Northern Europe	wood carpets stone bricks terrazzo carpet linoleum parquet laminates <u>Kitchens:</u> vinyl c.tiles	wood terrazzo p. tiles vinyl rubber linoleum c.tiles parquet laminates nat. stone carpet	carpets p. tiles vinyl rubber linoleum c.tiles wood parquet laminates nat. stone	p. tiles wood vinyl c.tiles linoleum rubber parquet laminates nat. stone	p. tiles wood carpets vinyl	bricks stone terrazzo p. tiles rubber
Mid Europe	wood carpets stone brick terrazzo c.tiles linoleum vinyl	p.tiles terrazzo stone wood vinyl	carpets p. tiles wood terrazzo vinyl	p. tiles wood vinyl linoleum	p. tiles carpets wood vinyl	bricks stone terrazzo p. tiles rubber
Southern Europe	stone wood marble mosaic terrazzo carpets vinyl c.tiles	p. tiles wood terrazzo vinyl c.tiles	carpets p. tiles marble wood terrazzo vinyl c.tiles rubber	p. tiles terrazzo vinyl c.tiles	p. tiles carpets wood vinyl	bricks stone terrazzo p. tiles rubber
WALLS						
Northern Europe	paint wallpaper plaster wood c.tiles vinyl	paint vinyl plaster wallpaper c.tiles concrete	paint vinyl plaster wallpaper stone c.tiles wood	paint vinyl c tiles plaster nat.stone	paint c. tiles, mirrors plaster wood	c.tiles concrete bricks stone
Mid Europe	paint wallpaper textiles plaster wood	paint plaster concrete	paint plaster concrete c.tiles	paint c. tiles plaster	paint c.tiles mirrors wood plaster	c.tiles concrete bricks stone
Southern Europe	c.tiles paint wallpaper wood marble granite	paint plaster c.tiles vinyl	paint plaster c.tiles vinyl	paint c.tiles plaster	paint plaster c.tiles mirrors wood	c.tiles concrete bricks

Note: 'c. tiles' indicates ceramic tiles; 'p.tiles' are plastic tiles.

Glossary

Products involving a manufacturing process:	
Carpets	Knotted, woven, tufted, flocked or felt coverings, whether or not made up, including hand-woven rugs.
Ceramic tiles	Flat cladding or building material of relative thinness, composed of clays and fired to hardness. Includes flags, paving, hearth, wall tiles, mosaic cubes and filler tiles, whether or not on a backing. May be glazed or unglazed.
Unglazed ceramic tiles	Ceramic tiles which are left untreated after firing.
Glazed ceramic tiles	Ceramic tiles with an opaque or transparent coating that has been fused to the tile body by firing, creating a smooth impermeable surface. [†]
Linoleum floor coverings	Floor coverings of linoleum, including those consisting of a coating or covering applied to a textile backing, whether or not cut to shape.
Non ceramic tiles	Refractory bricks, blocks and tiles other than those of siliceous fossil meals or similar siliceous earths.
Plastic floor and wall coverings	Floor and wall coverings of plastics, whether or not self-adhesive, in rolls or in the form of tiles.
Rubber floor coverings	Floor coverings and mats of vulcanised rubber other than hard rubber.
Terrazzo tiles	Tiles produced from a man-made composite of crushed marble set in a cement matrix with added colour pigment. [‡]
Textile floor coverings	Knotted, woven, tufted or flocked floorings of textile, whether or not made up.
Vinyl floor and wall coverings	Tiles and sheets of PVC resins, plasticisers, stabilisers and extenders, forming a rubber-like material which varies in consistency between hard and soft. [‡]
Wallpaper	Wallpaper and other similar wall coverings, with or without a binder, whether or not surface coloured, decorated or printed, in rolls or in sheets.
Natural products (not involving a manufacturing process):	
Natural stone	Tiles formed directly from quarried material, such as marble, slate limestone, sandstone, quartzite and granite.
Wooden wall and floor coverings	Blocks, strips and friezes for parquet or wood block. Whether or not assembled, planed, moulded, grooved, tongued, rounded or similarly worked.

Sources:

All definitions from Eurostat product descriptions except [†] (from 'The Italian Ceramic Tile Dictionary', 1999, Edi.Cer S.p.A) and [‡] (from Pye and Harrison, 1997, BRE Building Elements Report).

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Tile manufacturers in Italy (several; see full list)
Tile manufacturers in Spain (several; see full list)
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