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ENVIRONMENTAL OPERATIONS STRATEGIES: EUROPEAN APPROACHES AND RESEARCH CHALLENGES

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Abstract

Since the environment has very recently emerged as a strategic issue, work has only begun to investigate the conceptual linkages between strategic management and the environment. A thoroughly revision of both academic and professional literature evidences that such scarcity of research doubles, or even trebles, when the scenery of the European Operations Management Strategies is considered. The main objective of this paper is, therefore, to discuss the impact of the design of the environmental management strategy on the formulation of the Operations Strategy and its implementation. Since the majority of the literature has neglected to focus the European approaches to such formulation, we will try to overcome this gap by analysing a sample of 2882 European companies.

Keywords:
Green Operations Management, Solid Waste Treatment, Life Cycle Approach, Design for Recycling

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ENVIRONMENTAL OPERATIONS STRATEGIES: EUROPEAN APPROACHES AND RESEARCH CHALLENGES

Introduction

Different authors have empirically documented *that "[...] a small, but growing minority of business managers in different industries is beginning to see environmentalism less as a threat and more as an opportunity [...]*". In such a context, *[...]"To make money while at the same time protecting the environment not only demands the greening and cleaning of existing industry, but will also require a good deal of entrepreneurial creativity to turn environmental constraints into new and viable business opportunities [...]"* (Ulhøi, 1995,8).

The specifications for an Environmental Management System (EMS) suggest that its integration with all functional areas, primarily with operations management, can lead to the significant improvement of the overall competitiveness of a company. In that sense, Gupta (1995, 35) has defended that *"the operations manager should play a significant role in the development as well as implementation of an environmental management system "*. The EMS should prevent adverse environmental effects and improve environmental performance by institutionalising different environmental programmes and practices and developing green technologies, processes and products.

Azzone et al. (1997, 562) say that: *"The green pressures have forced managers to improve their companies' environmental performance, which has significant competitive implications and has added a new dimension to the process of strategy formation"*. Following the same line of reasoning, Klassen (1993, 82) states that "[...] *one perspective that offers a basis for exploring the linkage between environmental excellence and operations management is manufacturing strategy. Manufacturing*

strategy should be linked interactively to social and regulatory issues and, in particular, environmental issues.[...]

Due to the emerging nature of the environment as a strategic issue, work has only begun to investigate the conceptual linkages between strategic management and the environment. While these conceptual efforts have been essential, there has been a dearth of empirical studies on how organisations are responding to this new strategic issue. A thoroughly revision of both academic and professional literature evidences that such scarcity doubles, or even trebles, when the scenery of the European Operations Management Strategies is considered.

The main objective of this paper is, therefore, to introduce the concept of the design of the environmental management strategy, and discuss its impact on the formulation of the Operations Strategy. Since the majority of the literature has neglected to focus the European approaches to that formulation, we will try to overcome this gap.

Gupta (1995, 42) affirms that "The operations function of a company encounters environmental protection issues directly because it is the main source of operating emissions and thus, environmental management programmes and policies should be carefully developed to strengthen its Operations Strategy. Operations Strategy, guided by a specific business strategy, results in a consistent pattern in operations decisions so that the objectives are cost efficiency, quality, delivery and flexibility". So far, the introduction of environmental management practices has a significant impact on operations policy. Indeed, the improvement of a company's environmental performance may require at least a change in product planning and procurement policies, production, and logistics (Azzone et al., 1997). Thus, these authors are calling our attention to the issue of the implementation of the Environmental Operations Strategy. Since many

possible alternatives may emerge when the EOS is deployed, the second objective of this paper is to analyse the hierarchical cascade of environmental activities that are triggered by the implementation of the EOS. There is as yet a lack of published empirical evidence about most common European approaches to the allocation of environmental responsibility among the functional areas in a company, and this article aims to contribute to rescue that discontinuity.

The third objective of this article is to identify most common environmental treatment / remediation actions concerning the most outstanding environmental consequences of the manufacturing process across European companies. The fourth purpose refers to the isolation of those stages of a product life cycle from cradle to grave where environmental issues are most important for the European companies. Our final objective is to demonstrate that some topics about some European companies and countries are no more than mere topics, because both companies and countries are converging towards a common European approach.

Throughout this article we draw insights from an open-ended exploratory survey which was mailed in 1997 to strategic decision-makers in European companies[2], from a sample[3] that represents a very detailed variety of manufacturing activities. Our purpose was not to statistically test the existence of possible clusters of environmental initiatives at the different levels of the hierarchical chain for the deployment of the EOS, -at least unless valid and significant responses from all European countries were available. We were aiming at gathering knowledge for the formulation of future research questions and explanatory models. The responses have evidence some relationships, which are

[2] At the moment of writing this article, we have received a total of 2882 valid answers, i.e., the opinion of 2.882 European companies. Responses from the surveys distributed in UK, Finland, Germany and Ireland has not been processed yet,-such as German questionnaires, or the responses have not arrived as yet (like in the UK case).

[3] Countries in the sample are, in alphabetical order, the followings: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Norway, Portugal, Spain, Sweden, Switzerland, the Netherlands, and UK.

depicted along the article.

The rest of the article is organised into five major sections. The first section specifies our methodological approach, as well as the main features of our sample. The second section gives a panoramic view of the concept of Environmental Operations Strategy and highlights the relevance of full integration between the Corporate Strategy and the EOS, on one hand, and the functional areas and EOS, on the other hand. The third section seeks to identify the functional area most important for Europeans, and for every country in the study. The four section describes how European companies rank environmental treatment / remediation actions, together with some possible domestic or country-based particularities. The fifth analyses the attention paid by European companies to the different stages of the life cycle approach, and tries to identify domestic patterns whenever some hints suggest it. The final section draws some conclusions from the suggested converging common European approach and indicates future directions for further environmental –related research

The research set

A questionnaire was mailed to a representative sample of European companies. To encourage participation and provide some benefit to the respondents, an executive summary of the survey responses was offered to all the participants. Some of the participants have already requested this summary and it is in its way to been delivered before December 1998.

Given the international character of our study, the questionnaire employed was highly standardised and structured, so to avoid as many unnecessary mistakes as possible. The questionnaire contains 15 questions, addressing general information, -the first four ones, and directly considering environmental issues, -the remaining eleven questions.

The companies to receive the questionnaire were chosen according to statistical requirements for independence and normality. Thus, it is a representative sample of the companies belonging to the analysed European countries. By proceeding this way we were setting the conditions that will allow us to extrapolate the conclusions of our study to the European population. Table 1 depicts the countries and the number of valid answers of our sample. It also contains the number of firms answering the questionnaire, classified by company size (number of employees).

TAKE IN TABLE 1

We have classified the companies in the sample according to its country of origin and size. Figures 2,3, 4, and 5 illustrate this classification.

TAKE IN FIGURE 2

Figure 2 points out that most companies in the sample are small ones, -a 68%, with less than 250 employees. The remaining companies are equally distributed between medium and large firms, 16% respectively.

TAKE IN FIGURE 3

Figure 3 shows that the majority of small companies in the sample are located in The Netherlands, Belgium and Sweden, while the countries with a lower number of small companies in the sample are Spain, France and Portugal.

TAKE IN FIGURE 4

Figure 4, that considers medium size companies in the sample, draw a well balanced distribution among the different countries, although the Belgium, Dutch and Italian companies are the most frequent, -about a 14%, and French medium companies are the lowest represented in the sample, with a 5%.

TAKE IN FIGURE 5

Figure 5 show us that it is possible to distinguish among three categories of domestic

"patterns" in the sample:

i) Countries with a high number of large companies, such as France, Belgium, Austria, The Netherlands, Spain and Portugal;

ii) Countries with a medium number of large companies, such as Norway, Italy and Switzerland, and

iii) Countries with no large companies at all in the sample like Sweden.

Towards an European Environmental Operations Strategy

Managers need to recognise that all departments in the company contribute to the success of the EMS. Goodland et al. (1992) point out that *"in a corporate context, sustainable development will require concerted efforts to remould consumer preferences and steer wants in the direction of environmentally benign activities, while simultaneously reducing throughput per unit of the final product, including services"*. Thus, as stressed by Ulhøi (1995, 9) purchasing departments will look for new, sustainable sources of supply, and more environmental friendly materials produced in ways which have a diminishing impact on the environment; they will also have to think of new ways of reducing packaging and using more recycled materials. R&D can contribute by providing more efficient processes, as well as finding new uses for waste products, and creating longer-lasting products. Marketing departments can provide more information about consumer preferences for environmentally -friendly goods, define new market opportunities and develop marketing, distribution, and selling methods, which reduce environmental impact. Gupta and Sharma (1996, 40) say that the Operations Management Team is responsible for both the achievement of the desired products in terms of quality and quantity, and for controlling working practices, resource consumption, emissions, and the flow of hazardous materials. Thus, operations

managers are directly concerned with the environmental issue in their responsibilities.

An ample group of researchers have defended that the different functional group strategies must be integrated to collectively contribute to meeting corporate strategic objectives. According to Klassen (1993, 85), *"Environmental management is not exception; manufacturing strategy must not attempt to suboptimise environmental decisions introspectively. Integrated planning, with the involvement of each functional area, is necessary to factor environmental aspects into corporate strategic decisions. The input of different functional areas can provide insight into new competitive advantage because other functional areas often have access to information channels of relevance to, but outside the scope of, manufacturing."* This implies that, by ensuring that environmental issues are critically evaluated and weighed in the design, manufacture, product delivery and use, as well as post-consumption product disposition, senior management can position the firm for competitive leadership (ibid. 86)

Along this article, we would refer to the EOM as it has been defined by Gupta and Sharma (1996, 40), i. e., the integration of environmental management principles with the decision-making process for the conversion of resources into usable products. Such a definition has relevant strategic implications, since it primarily concerns product and process design. Smart (1992) says that some programmes and practices included in corporate environmentalism are the articulation of environmental policy statements, the development of environmental strategies, the creation of environmental staff functions, the implementation of aggressive pollution-prevention programmes, to initiate environment-related performance measures and to develop green technologies, processes and products.

Van Wassenhove and Corbett (1991) showed that environmental management has a significant impact on the operational objectives and thus can influence various operational decisions. The overriding reason for developing environmental management programmes and policies should be to support the operations strategy, and thereby help the operations manager to develop a distinctive competence and obtain a competitive advantage.

Prior to analyse the very likely deployment of any EOS, we should be aware of the existence of an EOS at all. For that purpose, we proceeded first to look for empirical evidence supporting the following hypotheses:

H1: European strategic decision-makers have already realised that environmental management is a competitive priority.

H2: European strategic decision-makers are more environmental pro-actively oriented than their US colleagues.

The natural environment sometimes offers significant new business opportunities (Angell, 1993). For example, some firms are discovering that by modifying the inputs, throughputs, and/or outputs of their systems, they can differentiate their goods and services from the competition and thereby gain a competitive advantage.

Newman and Hanna (1996, 70) cite the McKinsey report of 1991 on corporate responses to environmental challenges, pointing at the issue that *"over 400 senior executives world-wide, in various industries, revealed that the majority of corporations*

simply react when it comes to compliance with new regulations and the prevention of negatives incidents and crisis. Only 13 per cent of the executives indicated that environmental management goals are included in their corporate strategy".

Our study tries to identify whether or not the European managers are concerned by the environmental challenges and, if yes, we are interested on identifying national differences referring to the concern for environmental issues. Figure 6 illustrates our findings.

TAKE IN FIGURE 6

The European managers are very much concerned with the environmental challenges, as it is shown by the high scores that we obtained: an 84.62% of the managers in the sample said that their company considers the environment as one of the most important challenges for the firm. If we analyse the different countries in the sample, it seems that Portuguese managers are more concerned than the average, -showing a score of a 96%, while the Dutch are lagging behind, with an score of 61,3.

Our results reinforce previous suggestions made by Judge and Douglas (1998, 241) for a different sample of companies. They point out that: *" Many firms have discovered that the natural environment is a critically important strategic issue, and some of them are responding to the challenges posed by the natural environment by integrating it into their strategic management processes. One of the primary ways that firms respond to new strategic issues is to integrate those issues into their formal strategic planning process".*

Authors like Klassen (1993), Rondinelli and Vastag (1996), and Shrivastava (1995), among others, have stated that three elements are the leading factors in the design of the

Environmental Operations Strategy: the technological development, the market mechanisms and a very tough environmental regulation. Besides, Heaton et al. (1991) have documented that, since the technology to solve environmental problems will be developed almost exclusively by industry, management policies in this area are probably the single most important factor. As it regards to the regulatory framework, Klassen (1993,82) has alerted us that, increasingly, manufacturing is the subject of cradle-to-grave legislation -with restrictions, controls, and responsibility for the design, manufacture, delivery, use, and post-consumption fate of its products. Within the manufacturing process, air, water, and solid waste discharges also are subject to regulatory control. The same author considers that the complexity of interactions between environmental issues and manufacturing necessitates an integrated, co-ordinated effort to respond appropriately. Manufacturing must monitor complex and often confusing signals from the public, legislation, and other functional groups, and prioritise the opportunities with a systematic approach. In the other hand, very little research literature in operations management has focused on the interaction of manufacturing organisations and the regulatory climate en general.

We wanted to know whether or not the European managers consider these three factors to be the more relevant ones, and, if yes, which one is the most important for them. Figures 7, 8, and 9 illustrate these questions.

TAKE IN FIGURES 7, 8, AND 9

Most managers believe that solutions that come out of technological development would be the most efficient ones in leading the company towards environmentally oriented corporate strategies, while the environmental regulations are seen as providing interesting incentives as a second force. Most European managers dislike the idea of market mechanisms influencing the Environmental Operations Strategy (EOS). Based

upon these findings, we suggest that European strategic decision-makers are more pro-actively oriented, as regards environmental issues, than their US colleagues.

Once that we have gather some exploratory evidence of the Environmental awareness of the European strategic decision-makers, we proceeded to identify possible hints signalling the existence of an Environmental Operations Strategy.

The following hypotheses were formulated:

H3: There is a European Environmental Operations Strategy

H4: The Environmental Operations Strategy is clearly defined, so it differs from other Strategies in the company

As an starting theoretical support, we considered what Sarkis and Rasheed (1995, 26) have previously said about manufacturing firms, i.e., that they are moving toward greater environmental awareness and responsibility and that compared to other functional areas, environmental concerns have greater relevance for manufacturing activity. They defend that environmentally responsible strategies should be an integral part of the corporate strategy and organisational philosophy permeating every functional area and activity within a firm. This is particularly important because of the many interdependencies across the functional areas. An integrated approach to environmental responsibility should encompass all stages of a product's life cycle-design, manufacturing, packaging, maintenance, and eventual disposal.

To test the hypothesis H3, we have used the A. Cronbach test to analyse the reliability

of the items employed to formulate the construct EOS. For this purpose, we took as reference the answers given to question 10 in our survey, which considers 20 possible environmental actions undertaken by the company along the last two years. 14 of these 20 questions relate to the domain of Environmental Operations Management, and the other 6 questions were closely related to the domain of Environmental Marketing Management. We obtained a A. Cronbach index of .8063 (maximum value is 1), thus implying that the items are very reliable and, then, they can be used to represent the EOS, no matter the sample being analysed.

We also tried with a complementary way to identify the existence of the EOS construct, consisting in measuring the level of agreement among the respondents. To evaluate such level of agreement, we used the Kendall coefficient. Our findings show that they do really agree ($p<0.000$) as regards the 20 items in the construct. However, the Duncan test show us that there are significant differences ($W = .20$) between the countries when we analysed the specific "tactical" initiatives that their companies undertake.

We have classified the domestic ESO according to their degree of deployment. The identified profiles are:

-Low level of deployment: Belgium and Italy,

-Medium level of deployment: Sweden, France, Norway, Portugal, The Netherlands,

-High level of deployment: Austria, Switzerland, and Spain

In order to test our fourth hypothesis, we have measured i) the correlation between our EOS measure and the values obtained from question 8 in the survey, i.e., environmental treatment / remediation actions taken by a company along the last two years, and

ii) The correlation between the EOS and the Environmental Marketing Strategy (EMS).

	Environmental Operations Strategy
Environmental Marketing Strategy	.2582**
Normal day-to-day Operations	.0245 ns

* Signif. LE .05 ** Signif. LE ,01 (2-tailed)

Since there is significant correlation between EOS and EMS (, 2582 **), it implies that the EOS is closer to a Business Strategy than to routinely actions aimed at remediating the consequences of products and processes. So far, we have found empirical support for H4.

The deployment of the EOS: the functional level

It has been suggested by Sarkis and Rasheed (1995, 20) that "*organisations should establish sub-strategies, structures and systems that can effectively help their managers in making environmentally responsible decisions without necessarily sacrificing the economic interest of the firm*".

The deployment of the EOS involves activities such as planning, developing and implementing manufacturing processes and technologies that minimise or eliminate hazardous waste and reduce scrap. Sarkis and Rasheed (1995, 18) propose that main emphasis in waste minimisation is on source reduction, and that most important source reductions activities include:

- Input changes;
- Operational improvement that leads to loss prevention;
- Production process changes,
- Product reformulation;
- Inventory control; and
- Administrative and organisational activities such as training

We have reformulated such suggestion in our questionnaire, so that the following question was included:

The company has taken environmental actions in the following areas:		
Procurement	*Yes*	*No*
Research and Development	*Yes*	*No*
Production	*Yes*	*No*
Marketing/Sales	*Yes*	*No*
Logistics	*Yes*	*No*
Recycling/Waste disposal	*Yes*	*No*

The main objective of this question was to gather an intuitive / preliminary insight of how the interaction of the different functional areas helps and drives the deployment of the EOS. We were also interested on identifying which functional area is more important for the European companies in the sample as they try to implement the EOS. Table 2 summarises the responses that we obtained.

TAKE IN TABLE 2

When only aggregate figures are considered, the ranking of "priorities", as related to the functional areas, is:

- Recycling and waste disposal;
- Production;
- Procurement;
- R & D;
- Logistics;
- Marketing and sales

However, if we go into further detail and look for a characterisation of domestic priorities, the responses indicate that "Production" is the functional area most frequently

cited by a majority of companies in the sample. Figure 10 illustrates this issue.

TAKE IN FIGURE 10

Since most countries' position is very close to the mean value of the scores, it is possible to suggest that:

1 Production is the functional area that preoccupies European managers the most

2 There is a high agreement among European countries as regards the relevance of this functional area.

Our results demonstrate the validity of previous theoretical suggestions, like the one by Newman and Hanna (1996, 70), that posits *"[...] Operations in some ways is assumed to be more directly responsible for many of the environmental problems we face than other functions [...]"*.

Descending on the hierarchy: Tactical initiatives (treatment and remediation actions)

In the following stage of data processing and analysis, we went into further detail aiming at studying the production function as the main responsible for the transformation process. For this purpose, we concentrate on analysing the answers to the following question that we had included in the survey.

In the last two years, the company has taken environmental treatment/remediation actions concerning

Waste water treatment	*Yes*	*No*
Soil remediation	*Yes*	*No*
Landscape action	*Yes*	*No*
Risk reduction	*Yes*	*No*
Treatment of air emissions	*Yes*	*No*
Solid waste treatment	*Yes*	*No*

Table 3 summarises the responses. It is relatively easy to notice that most European companies in the sample are paying their best attention to the challenge of solid waste treatment.

TAKE IN TABLE 3

The general ranking of environmental actions directly linked to the production functional area is:

- Solid waste treatment,
- Risk reduction,
- Waste water treatment,
- Treatment of air emissions,
- Soil remediation,
- Landscape action

This ranking represents very well domestic priorities as well, although there are a few exceptions, like the cases of France, Italy and Portugal, whose first priority is "risk reduction" initiatives. As it concerns the second priority, again France and Italy are more concerned with "Solid waste treatment", while Portugal pays more attention to "Water waste treatment" actions.

Given the high level of coincidence as regards the importance given to initiatives aiming at improving the treatment of solid waste, we have gone further in our exploration of this issue. Figure 11 illustrates that:

TAKE IN FIGURE 11

1 European companies are very concerned with initiatives connected to Solid waste treatment, as shown by the high scores in Figure 11.

2 There is a generalised agreement in this point, as demonstrated by the fact that the majority of countries in the sample have scores quite close to the mean value.

The life-cycle approach: from cradle-to-grave in Europe

In the next step of our research we concentrate on identifying those activities developed by the companies in our sample, which are firmly attached to the so-called "from cradle to grave" activities. The theoretical support for our study comes, among others, from Gupta (1995,43), who stated that: *" [...] It is clear that Environmental Management affects various aspects of the operations function of a firm, from the purchase of various inputs through process control and changes to the output itself. From the point of view of operations management, environmentalism requires a thorough assessment of all processes and then strives for continuous improvement in various inputs' consumption, process and product efficiency [...]".* In order to gather such information, we focused on analysing the following question, which was included in the survey as well.

By proceeding this way, we were also trying to test whether or not European firms are taking into account that, as proposed by Van Weenen and Eekels (1989) *"[...] the environmental effects of the product are already largely fixed at the product and process design phases, because a product and its manufacturing process need to be designed before a product is manufactured. Therefore, product and process design decisions are the best possible initial point for operationalising environmental strategies. [...]".*

In the last two years, the company has taken environmental actions in the following areas		
Improved materials or non renewable resources efficiency	*Yes*	*No*
Substitution of environmental questionable materials	*Yes*	*No*
Choice of suppliers by environmental criteria	*Yes*	*No*
Urging/pressurising supplier (s) to take environmental actions	*Yes*	*No*
Taking environmental criteria into consideration	*Yes*	*No*
Design considerations	*Yes*	*No*
Optimisation of processes to reduce solid wastes:	*Yes*	*No*
To reduce water use	*Yes*	*No*
To reduce air emissions	*Yes*	*No*
To reduce noise	*Yes*	*No*
Use of cleaner technology processes to make savings	*Yes*	*No*
Recycling of materials internal to the company	*Yes*	*No*
Use of waste from other companies	*Yes*	*No*
Recovery of the company's end-of-life products	*Yes*	*No*

We have classified the answers to the precedent question in three main blocks. First block, which we have labelled as "INPUT", includes all activities related to the design initiatives, as well as procurement actions. By considering all of them conjointly, we were preparing the conditions for pre-testing whether or not concepts such as design for recycling, design for disassembly and design for serviceability have some predicament among European companies. As Remich states (1991) these concepts are not only related, but complementary as well, since current recycling technologies demand products easy to disassemble. Gupta (1995, 45) states that when it is easier to recycle the product, the labour and energy required to produce that product diminish. Thus, these product design concepts, when operationalised to some degree, have significant implications for subsequent operations decisions, including process design decisions.

The second block, that we have labelled as "production process", has grouped those activities in the precedent question, which could be considered as belonging to a so-called SP/R2 strategy, i.e., initiatives coupled with preventing pollution along the transformation process, rather than removing it after it has been created. Such initiatives are based on the fact that the pollution-control procedures and equipment consume significant amounts of natural resources, energy, human and capital resources yet they do not stop the creation of pollution.

In the same line of reasoning, Sarkis and Rasheed (1995,17) defends that *"environmentally conscious manufacturing involves planning, developing, and implementing manufacturing processes and technologies that minimise or eliminate hazardous waste and reduce scrap"*.

An interesting question to be addressed here is how to find the best and "greenest" technologies and production processes. It has been recently proposed that the traditional application of life cycle assessment can be broadened to include analysis of alternative processes and technologies that can be used to produce the same product.

The third block, labelled "Recycling", includes those actions joined to waste recycling initiatives that, by acting together with the production processes, allow the firms to recycle materials such as article, plastics, glass, aluminium, and chemical solvents. The waste products and emissions can be recycled as the raw material in either the same or a different production process, processed with the intention of recovering and reusing material, and used for a different useful application within the facility. In addition, reclaimed valuable material from the waste streams can also be sold to another company [Gupta (1995, 48)].

Table 4 summarises the obtained responses.

TAKE IN TABLE 4

The results are very appealing, since they show that European companies are first acting on the causes of the environmental problems, and very secondly on the effects of not-so friendly Operations activities. Most European companies seem to be looking for more environmentally efficient production processes, i.e., they are studying new technologies, alternative lay-out, order sizes, etc. Initiatives that aim at improving the selection of the inputs, closely follow this first order activities, and, at a certain distance we will find recycling activities.

Nevertheless, the results may also indicate that there are still relevant problems to be solved in the manufacturing processes, as well as in the products' design, and/or the procurement activities. Thus, further research is required to solve these questions.

Discussion and conclusions

Our study has shown that European strategic decision-makers do know that the manufacturing function plays the central role in enabling a company to gain competitive advantage in the marketplace, as the theory had suggested for other geographic and economic zones (Sarkis and Rasheed, 1995).

We have also provided empirical evidence signalling that, with a few exceptions, European companies are acting guided by "global" principles, rather than domestic rules. We show as well that there are also reasonable high levels of agreement as refers the importance attributed to production as a key functional area to support the EOS, and we have realised that Europeans, in general, are very concerned with actions aiming at treating the solid waste. What kind of actions are the most likely looked for? It seems that most countries are focusing on SP/R2 strategies, so that recycling efforts could be

very easy, if required.

In practice, our research can be used for benchmarking processes, i.e., to analyse whether the adopted pattern of environmental behaviour should be. It also may give support to corporate managers in identifying the most suitable green strategy for a given sector and country. According to the main characteristics of the natural environment, executives must first identify the type of tactical response to be tried on, and only them, select the strategic option which is both sustainable in the long term and consistent with the corporate management system, its strategic attitude, and the life cycle of their products.

It must be emphasised from the start, however, that what we today regard as sensible strategic environmental and resource management, including adequate pollution thresholds, change over time as our knowledge of the biosphere increases. There is therefore every reason to expect that our results have a very limited temporal interest.

In spite of this many limitations, we believe that this study can be useful in providing some clues for future research. For instance, a logical extension of this research would be to test the framework using a more European data set, if it were possible, including companies from new-developed market economies as well. Focusing on fewer industries and extending the number of environmental management characteristics can do this most effectively. Another extension could be to test the framework using a classification of companies in the sample grouped by size.

Some other issues to be addressed in future research include environmental performance of the European companies, the influence of the European stakeholders, main barriers to the deployment of the EOS, geographical and cultural clusters, etc.

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APPENDIX

Table 1: Valid responses, classified by country, and company size.

COUNTRY	N0 OF RESPONSES	COMPANY SIZE		
		SMALL (- 250)	MEDIUM (250 - 500)	LARGE (+ 500)
Austria	190	91	39	60
Belgium	481	356	61	64
France	191	78	21	92
Italy	181	99	59	23
Netherlands	527	401	64	62
Norway	313	242	42	29
Portugal	300	198	62	40
Spain	113	26	36	51
Sweden	336	293	43	
Switzerland	250	187	35	28
EUROPE	*2882*	*1971*	*462*	*449*

Figure 1: Responding companies, classified by size

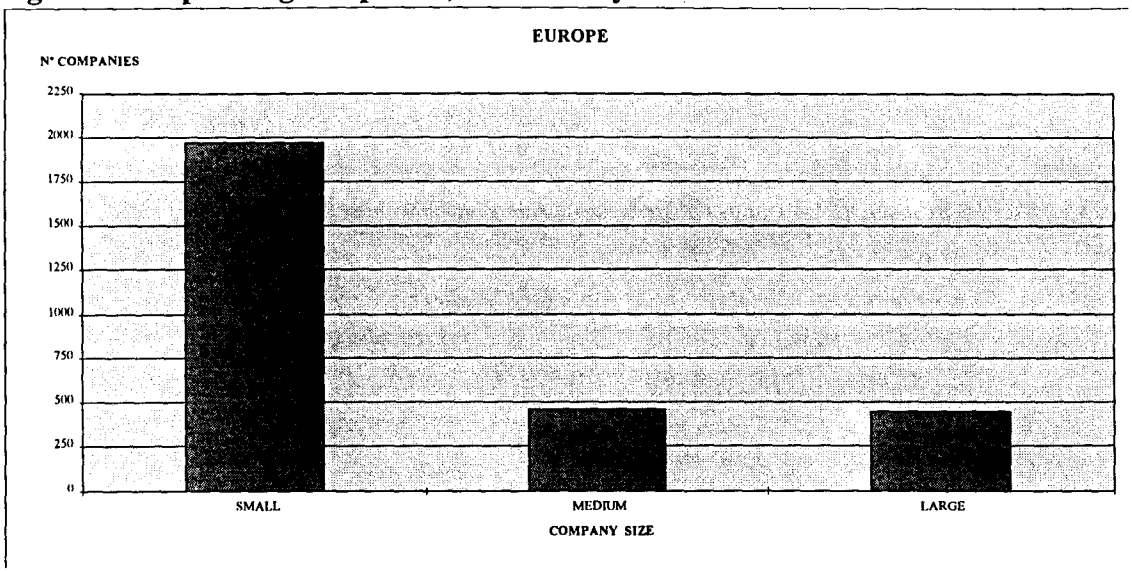

Figure 2: Small companies in the sample, classified by country

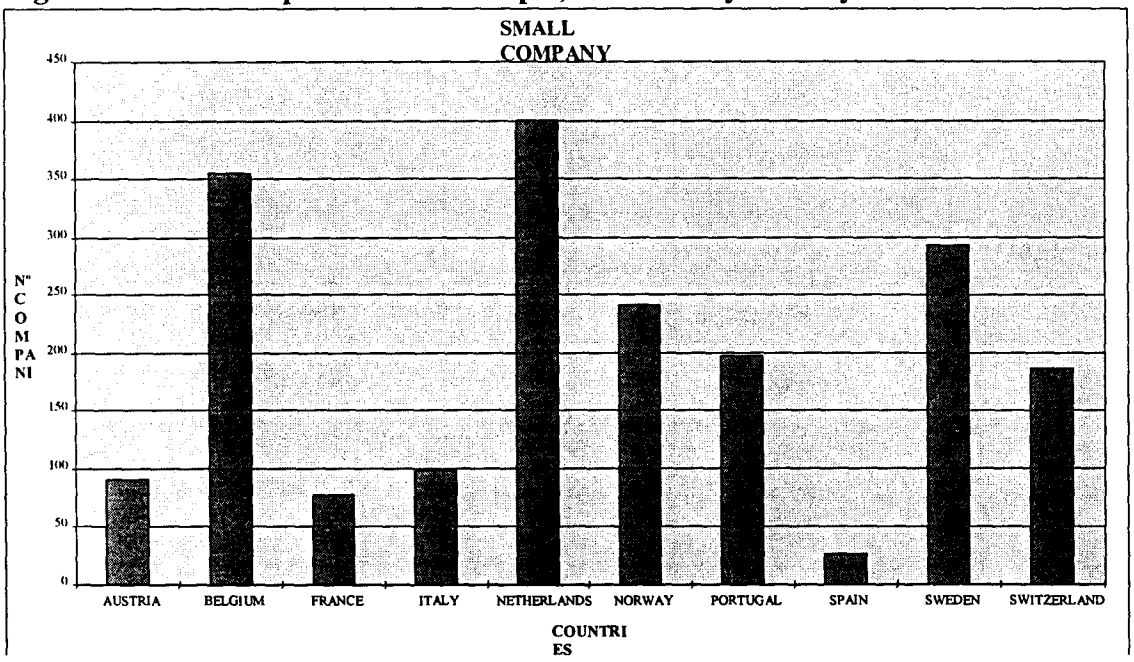

Figure 3: Medium size companies in the sample, classified by country

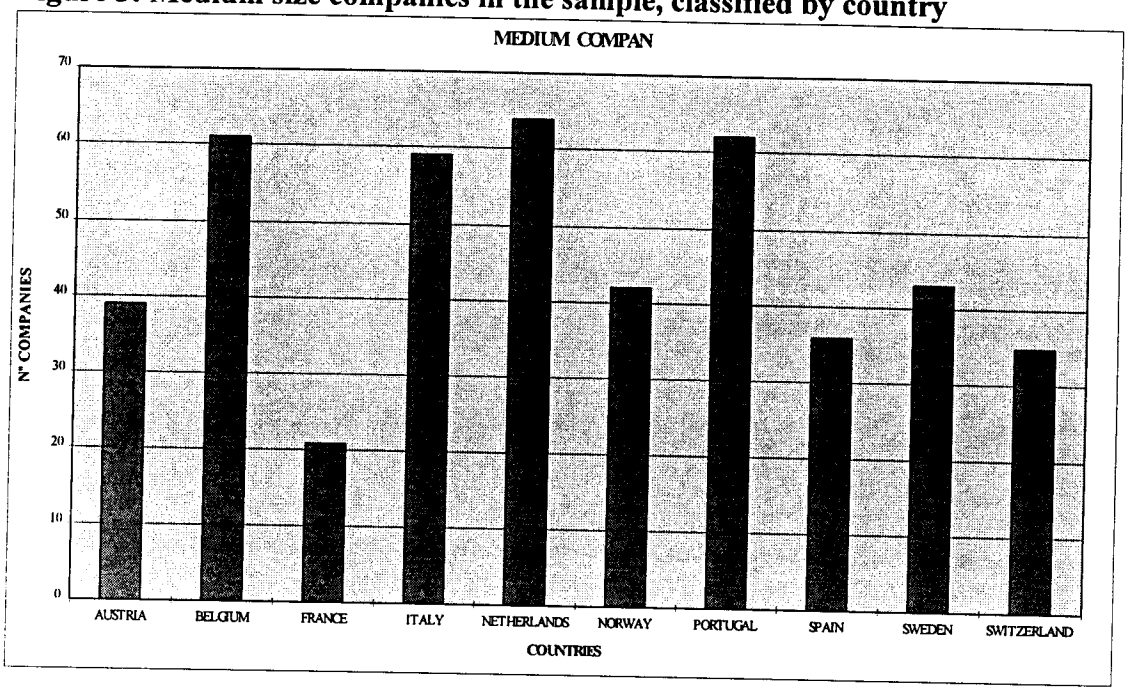

Figure 4: Large companies in the sample, classified by country

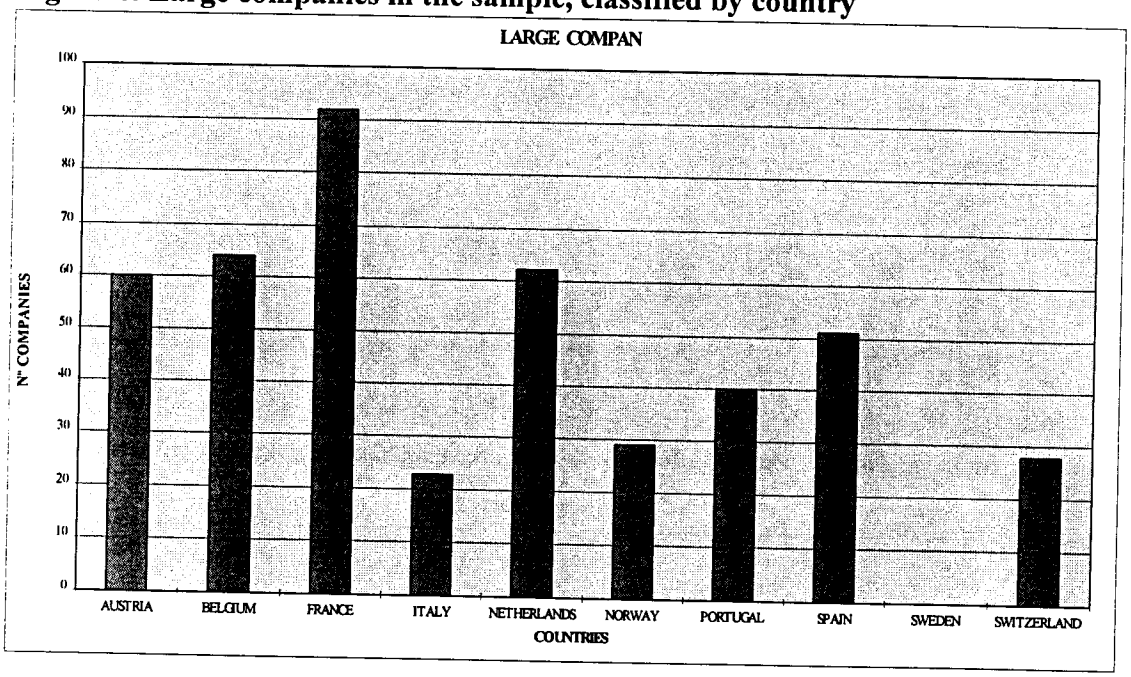

Figure 5: The environmental challenges

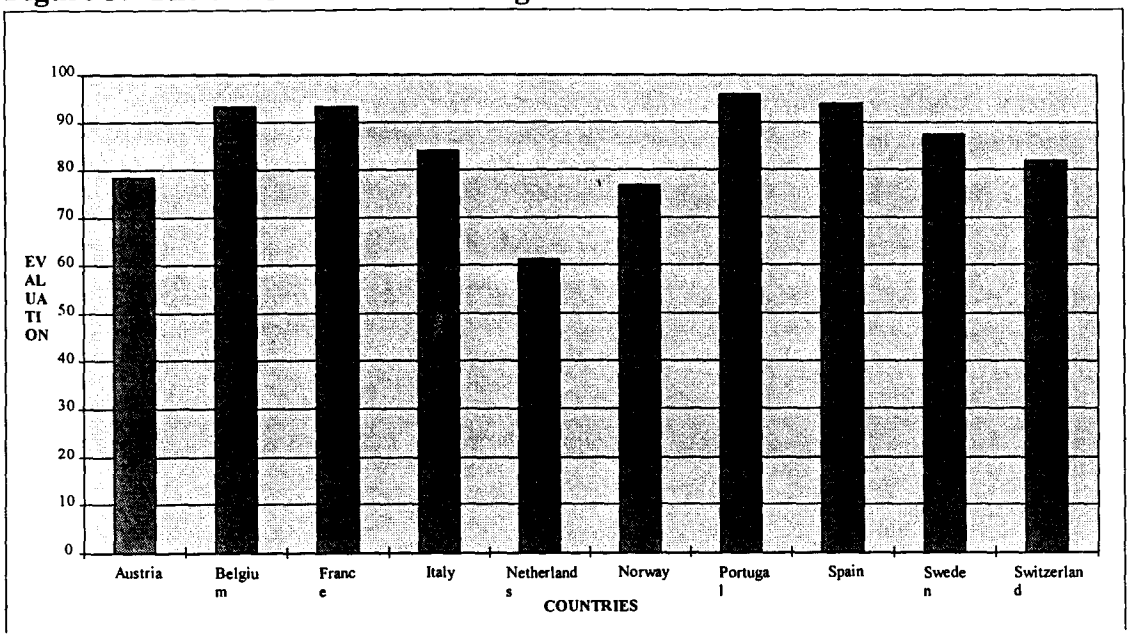

Figure 6: Technological development as a leading factor

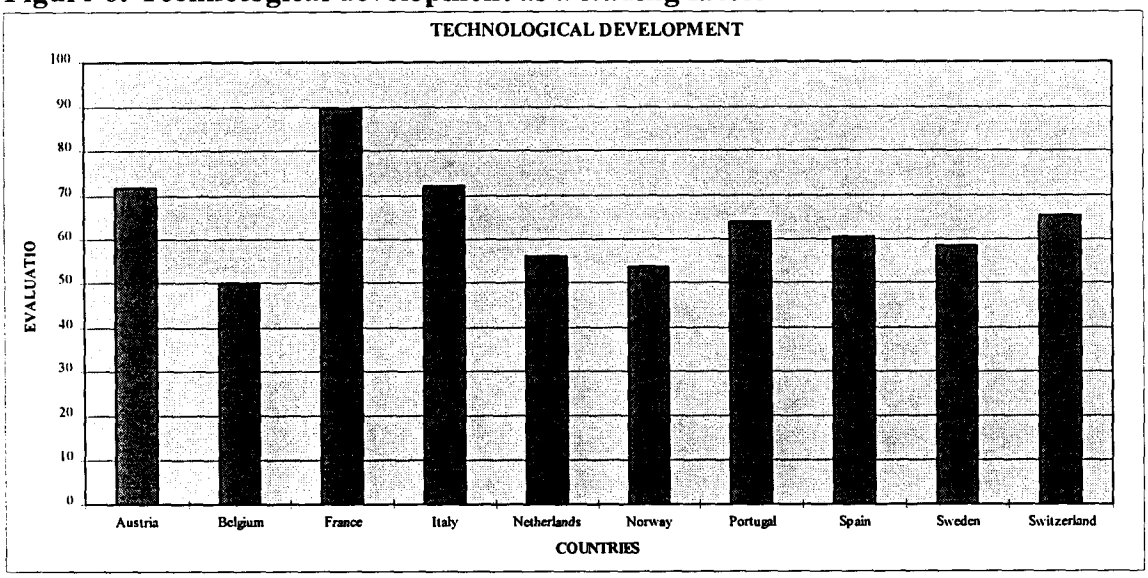

Figure 8: Market mechanisms as leading factors

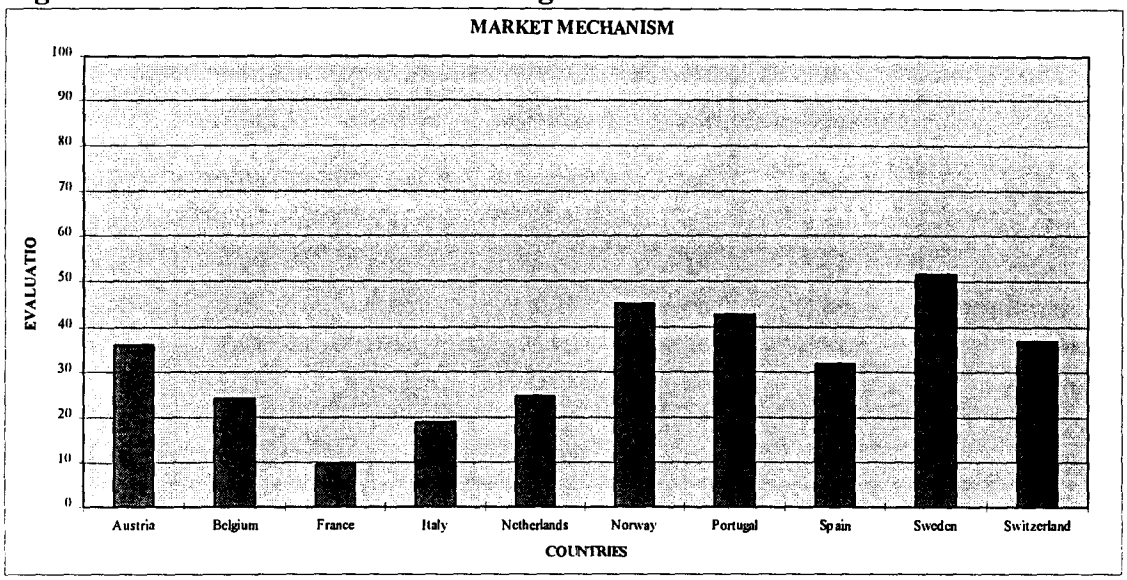

Figure 9: The regulatory framework as a leading factor

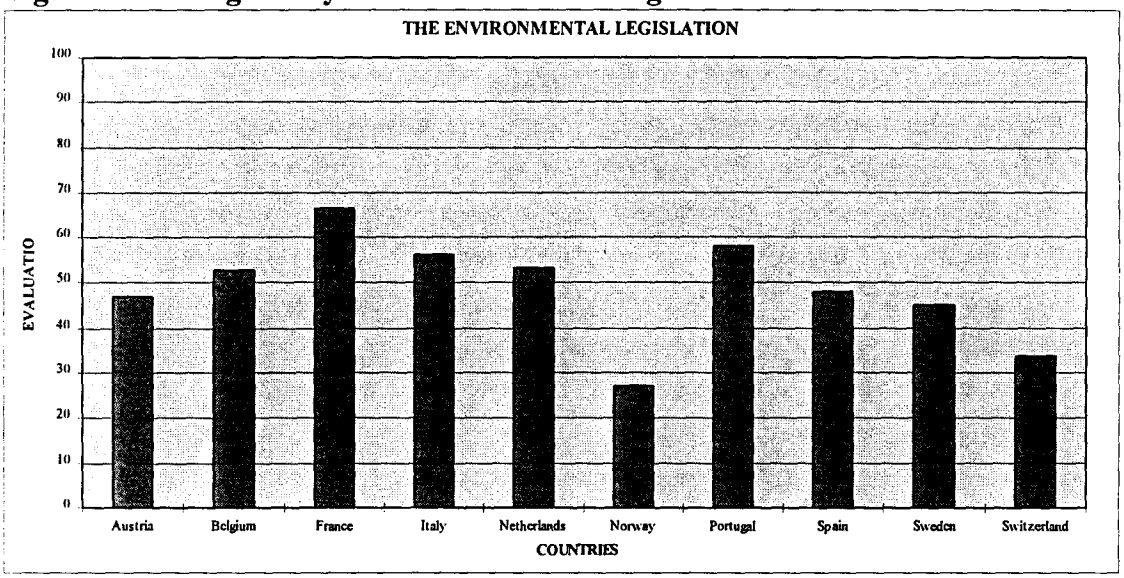

Table 2: Functional areas

COUNTRIES	ACTIONS					
	Procurement	R&D	Production	Marketing & Sales	Logistics	Recicling / Waste disposal
Austria	70.5	59.5	86.8	55.3	57.9	86.3
Belgium	61.8	70.1	92.2	48.4	54.5	88.5
France	40.2	48.6	76.4	24.3	29.2	71.5
Netherlands	68.8	55.8	88.2	33.9	50.0	94.8
Italy	57.5	55.5	89.3	26.3	39.8	87.4
Norway	58.0	42.2	80.0	33.2	41.2	83.3
Portugal	42.3	41.2	84.4	28.1	32.8	83.3
Spain	58.6	53.6	86.5	44.4	42.2	93.8
Sweden	70.6	54.6	93.0	54.9	53.1	92.2
Switzerland	65.0	60.7	88.2	54.9	60.4	85.0
EUROPE	*59.3*	*54.2*	*86.5*	*40.4*	*46.1*	*86.6*

Figure 10: Production: the most important functional area

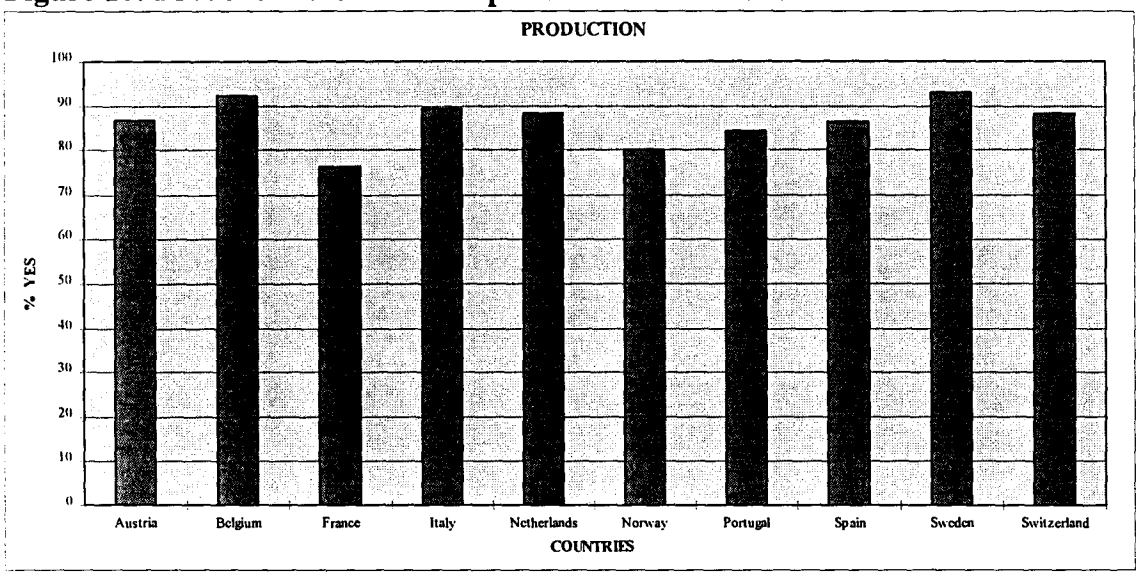

Table 3: Tactical actions emanated from the Production functional area

COUNTRIES	ACTIONS					
	Waste water treatment	Soil Remedia-tion	Action Landscape	Risk Reduction	Treatment of air emissions	Soild waste treatment
Austria	68.9	18.4	18.4	72.4	67.4	87.4
Belgium	74.2	40.4	35.6	73.9	59.8	82.2
France	59.5	16.0	21.9	69.3	58.9	66.9
Netherlands	56.9	39.5	6.6	75.7	57.1	86.5
Italy	54.3	31.0	4.8	78.7	65.1	74.3
Norway	52.4	10.0	26.1	78.8	53.0	81.0
Portugal	77.3	21.4	38.9	77.5	55.6	75.5
Spain	57.9	19.0	15.1	63.0	61.1	89.2
Sweden	64.4	23.7	11.4	76.1	69.9	90.9
Switzerland	68.1	31.8	22.4	80.4	68.9	87.8
EUROPE	*64.1*	*27.7*	*20.3*	*75.5*	*61.0*	*82.9*

Figure 11: Domestic concern with solid waste treatment

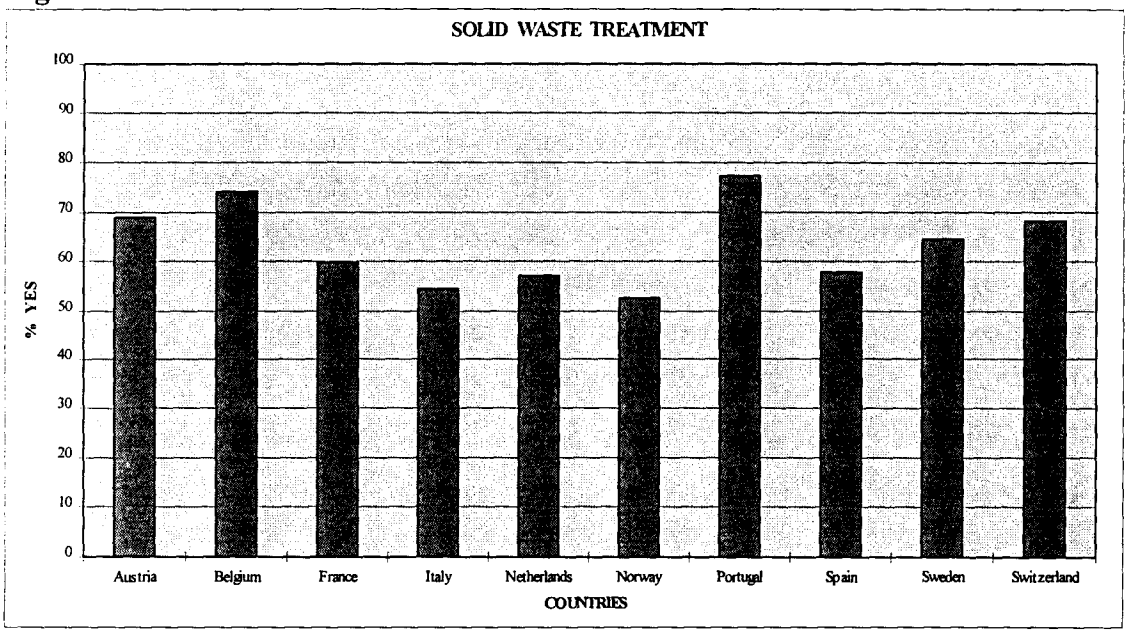

Table 4: The life-cycle approach: from cradle-to-grave

COUNTRIES	ACTIONS		
	Inputs	**Production Process**	**Recycling**
Austria	56.18	63.44	26.60
Belgium	47.95	63.71	22.8
France	47.05	52.86	14.55
Netherlands	54.78	62.93	17.00
Italy	47.68	67.03	18.65
Norway	53.45	57.76	22.50
Portugal	53.83	61.91	20.65
Spain	79.9	86.73	46.9
Sweden	60.00	56.05	23.65
Switzerland	39.68	80.15	46.25
EUROPE	*54.55*	*63.55*	*24.05*