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Evaluation of corporate environmental management approaches: A framework and application

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Abstract

This article proposes a framework to evaluate corporate environmental strategies. In the proposed framework, a company's environmental risks are analyzed on two dimensions. One dimension, the endogenous environmental risks, arises from the internal operations of the company. The other dimension, the exogenous environmental risks, are determined by the company's external world: its location, its ecological setting, and the demographic characteristics of the physical environment in which it operates. Four environmental management approaches are defined as a function of endogenous and exogenous environmental risks: reactive, proactive, strategic, and crisis preventive. The framework was applied in a survey of 141 company representatives in Hungary. A relationship was sought between the a priori defined environmental management approaches based on technology and location and the companies' environmental management characteristics defined by senior managers. Variables that differentiated among the four environmental management approaches were identified and ranked. The study concludes that there is a relatively well-defined relationship between the environmental risks of companies and the nature of their environmental management approaches. Implementing a strategic environmental management approach may not be the best option for all companies – although there is a growing pressure to do so.

Keywords: Environmental management; Environmental risks; Survey

1. Introduction

A general consensus is emerging among business managers and environmental protection advocates that the economic impacts of the worldwide movement toward environmental management are becoming increasingly important for international corporations [1]. Often, however, observers see the results differently. Environmentalists increasingly emphasize the strong business opportunities inherent in the growing concern with environmental protection and management while business executives often see the threats to their companies of diminishing market opportunities, rising costs, decreasing competitiveness,

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and increasing uncertainties and legal challenges [2].

The most direct impacts may arise from the fact that with greater frequency individual executives are being held responsible under criminal laws for their companies' environmental damage, especially in the United States and Canada. And as the concern with environmental issues spreads, governments in other countries are also beginning to impose legal liabilities on managers for the environmental degradation caused by their companies [3]. This generally results in defensive reactions from managers, who either demand changes in legal requirements or seek stronger personal protection against the potentially illegal consequences of their companies' activities [4].

The threat of criminal prosecution, however, is not the only force driving companies to create environmental management strategies. Increasingly, customers are reacting negatively to corporate environmental mismanagement, shareholders are abandoning companies caught in environmental crises, and financial institutions are including environmental risks in their assessments of loan requests [5]. The ISO 14000 standards now being drafted by the International Organization for Standardization (ISO) will set criteria for multinational companies to develop environmental management systems that are similar to the ISO 9000 standards for total quality management. But the compulsion to avoid legal liabilities that exists among executives and corporations is in itself a strong motivation to adopt environmental management strategies [6].

Developing a sophisticated, comprehensive, and well-documented environmental management strategy, usually with the help of outside experts seems, in most cases, to be the best (although not necessarily the safest) way for most managers to avoid legal liabilities [7]. A proper reaction to the environmental challenge is also crucial to ensure the survival of companies in an era of heightened environmental sensitivities. Bad environmental management, resulting in serious environmental damages or health hazards, can destroy a company as quickly as bad financial management. Moreover, the social risks of environmental mismanagement in a globalizing and increasingly competitive economy may be even greater. But there are also serious financial risks in developing an overly sophisticated and constraining environmental management strategy – even if it does protect the managers who demand it – when it is not really needed or justified.

This paper describes a framework to evaluate corporate environmental management approaches. We first discuss the issues that a company must address in developing an appropriate environmental management strategy and then provide a framework for choosing the best alternative. We test the framework in an international business setting by drawing on a survey of Hungarian companies to see how well the characteristics of companies and the perceptions of their executives about the importance of environmental challenges can predict the approaches that companies have adopted. We use two methodologies to test the validity of framework: one analyzes the management attitudes and characteristics of companies assigned to each group in the framework based on their technology and location; the other classifies companies into four groups using all variables and a new, powerful methodology of classification and regression trees (CART).

2. What is an appropriate environmental management approach?

Any corporation facing environmental management challenges must deal with two questions. First, what is the appropriate level of environmental standards to which a company should comply or the most prudent environmental management approach that a company should adopt? Second, at what level of the organization should environmental issues be addressed?

Companies can commit two types of errors in adopting an environmental management approach:

1. they can underestimate or overestimate the *business opportunities* offered by the growing worldwide concern for environmental protection; or

2. they can underestimate or overestimate the *costs and constraints* created by legal and market demands for environmental management.

Both mistakes can have serious impacts on a company's competitiveness and profitability. If management does not recognize the business opportunities created by increasing public demand for environmental protection, it may overlook a growing market segment and eventually lose market share to more sensitive and agile competitors. One report from the Organization for Economic Co-operation and Development (OECD) put the value of environmental-technology markets at $200 billion in 1990. The OECD projects that this market will grow to $300 billion by the end of the decade, and some experts are even more optimistic in predicting an enormous demand for clean-up services from fast-growing countries such as China, Taiwan and South Korea, and from the former Soviet Union as they clean up more than 40 years of industrial pollution [8]. On the other hand, overestimating environmental threats may result in unnecessarily costly expenditures or constrain the company from undertaking otherwise profitable activities. If the business opportunities offered by increasing demands for environmental protection are overestimated, a company may initiate projects that do not produce revenues. But if the company does not spend enough to comply with regulations, it may be unable to meet new or stricter requirements in the future, which could result in catastrophic costs, fines, penalties, or other legal liabilities that may threaten its competitiveness, profitability or survival [9].

Unfortunately, companies are often led to make such errors by regulatory experts or consulting firms that try to impose common guidelines on companies that do not all have the same characteristics and needs or that do not operate in the same economic and social environments. The growing movement toward adopting international environmental charters or standards that seek to impose universal principles of sustainable development and environmental management – which is a very positive development in itself – often push corporations to adopt environmental management approaches that may be either inappropriate or imprudent for their circumstances [10]. As Barthman points out, "no bright line standard exists for an environmental-compliance management framework" [11]. Legal requirements often impose on companies what regulators consider to be ideal universal standards. Although a sound environmental management approach should be based on widely accepted general principles, it must also be specifically designed to reflect the characteristics of the company and the external conditions that affect its operations.

2.1. *Endogenous and exogenous elements of environmental risk*

The primary criterion for designing an appropriate environmental management approach is the company's ability to manage its environmental risks. A company's environmental risks can be defined as the probability of causing environmental damage and the seriousness of that damage. A company's environmental risk depends not only on its own activities but also on the environmental consequences of its activities that are determined by external factors. The broad environmental consequences include not only those influenced by the physical environment but also those resulting from the social environment in which the company operates. Public reaction to environmental damages is often shaped not so much by the facts as by the public's perceptions of the facts [12]. This difference explains much of the debate that takes place between managers and engineers and the rest of the population after environmentally damaging incidents. The "experts" and the public often perceive and evaluate the same facts differently because their knowledge of the facts, perceptions of damage, and "social environments" are different.

In reality, the environmental risk of an activity is always somewhat uncertain. As Wynne concluded from his studies of hazardous wastes:

"The scientific uncertainties about what happens chemically, physically, and biologically in a landfill site are huge, and the opportunities for examining and reducing them extremely limited. Thus, the effects of putting a given waste into a site can only be approximately known; these effects are not in any case determinate, but depend (*inter alia*) upon how the site is operated and managed. At which site a waste ends up, and in what

condition, also depends upon many social unknowns and contingencies" [13].

A similar level of uncertainty attends the environmental consequences of other company activities, and attempting to predict either the real impacts or the public reactions to them is often impossible for managers. However, in practice, due diligence and responsible care may be sufficient strategies for most companies; scientific exactness may not be required.

Based on these assumptions we propose that a company's environmental risks be analyzed on two dimensions, although we are fully aware of the multidimensional nature of the problem. One dimension – the *endogenous environmental* risks – includes the internal operations of the company, including the materials, technologies, and human resources used in the manufacturing process. The other dimension – *the exogenous environmental risks* – is determined by the company's external world: its location, the ecological characteristics (biodiversity, winds, topography) of the physical environment in which it operates, the demographics (population density, age, income distribution,), infrastructure (roads, telecommunication networks,), education levels of the population, and their attitudes toward environmental hazards. Political institutions play an especially important role in exogenous environmental risks. As Wynne points out, in analyzing hazardous waste practices of the United States and the United Kingdom, the impact of regulatory agencies in environmental risk is a function of political culture [14].

It is not always easy to decide if a company's suppliers and customers are part of the internal risks or the external risks. We can argue that suppliers are selected by a company and therefore it should be responsible for the potential damages caused by its transactions with them. The situation is different for customers because a company has far less influence on them. But if customers use a company's products (e.g., fertilizers) improperly it may cause significant pollution and destroy its environmental image.

Both endogenous and exogenous dimensions of environmental risk are complex, but they differ in their implications. Endogenous risks are more clearly under the control of management and regulatory authorities. Risks created by externalities usually are beyond the influence or control of either the company or regulators. As a result, environmentalists and managers debate whether multinational companies should comply with the requirements of the host country in which they operate or the home country of their headquarters [15].

The proposed framework does not evaluate the fine individual differences between companies, such as results of previous environmental projects. Its focus is rather general: it considers the technology used in the industry and the location and surrounding of the plant.

The importance of considering both endogenous and exogenous factors in determining a company's potential environmental risks can be illustrated by an example from Hungary. In Hungary, many chemical companies that had originally been located well outside of cities were later surrounded by the spread of urban centers into suburbs and rural hinterlands. At the beginning, even the heavily polluting companies did not cause a problem because they were relatively far from the city. Today even those companies that meet all environmental regulations but are now surrounded by a city may have environmentally related conflicts and problems. The 1987 explosion in a Budapest chemical plant – although the damage from the explosion did not go beyond the fence – produced serious conflicts with city officials. Many people in Budapest demanded that the plant be closed, whereas 40 years earlier people living in Budapest would not even have noticed that something had happened on the plant's grounds.

2.2. *Environmental management as function of environmental risk*

We propose four environmental management approaches – shown in Fig. 1 – as explanations of how companies respond to their endogenous and exogenous risks.

Endogenous environmental risks along the vertical axis and exogenous environmental risks along the horizontal axis are, for purposes of illustration, divided into small and large. The cells describe four

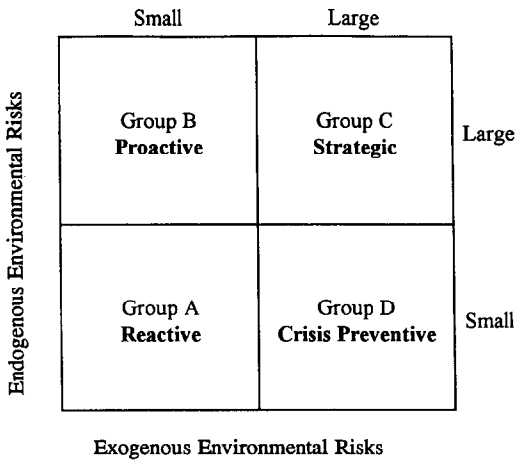

Fig. 1 Classification of environmental management approaches.

environmental management approaches with combinations of large and small exogenous and endogenous risks.

2.2.1. *Reactive environmental management approach (Group A)*

Group A would consist of those companies, for example, that are in an industry that has low levels of pollution emission in which the pollutants are not environmentally dangerous and the number of people affected is small. These companies may use nonexhaustible resources as raw materials, production is not energy-intensive, and their activities do not involve transportation of massive volumes of hazardous materials. Mass production industries that use well-developed technologies such as textiles, precision instruments, or some food producers (bakeries, for example) could appropriately adopt a reactive environmental management strategy. In these companies, environmental management calls merely for complying with local environmental regulations without taking extraordinary precautions to prevent highly unlikely environmental damages. This approach does not have a significant influence on the company's operations and responsibility for monitoring compliance can be carried out at middle management levels by an environmental and safety officer.

2.2.2. *Proactive environmental management approach (Group B)*

Group B consists of companies in industries whose technologies involve high levels of pollution or emit pollutants that are environmentally dangerous. However, because of location, climate conditions, or good environmental infrastructure, the adverse ecological and health consequences of these pollutants are small. Distilleries or sugar factories from the food processing industry, for example, might be assigned to this group. At these companies, the environmental function is more significant than in Group A; managers have to anticipate future changes in environmental regulations, technology, and public opinion. The environmental management of these companies is often highly decentralized to the plants where the critical technologies are concentrated. These plants, however, may be located in or around smaller towns where the inhabitants are less sensitive to environmental issues (in most cases the plant may be the only major employer in the town) and the population density is much smaller than in or around major cities.

2.2.3. *Strategic environmental management approach (Group C)*

This group consists of companies in industries that are highly polluting and that operate in a social or physical context in which risks are further increased by external conditions or public attitudes toward environmental hazards. Large chemical companies in cities are good examples. In these companies, environmental management must be an important part of the company's overall business strategy and should be dealt with at the senior management level. These companies must often go beyond compliance with environmental regulations and take more aggressive safeguards to prevent or reduce environmental damage. Their environmental management strategy should be well defined, highly visible in company publications, and monitored carefully to protect managers against legal actions.

2.2.4. *Crisis preventive environmental management approach (Group D)*

In this group, the companies are not high-level polluters either because they do not use large

volumes of inputs or because the pollution happens indirectly (e.g., tourism, fast food chains) and the direct effect is not significant. Whatever pollution does occur, however, may be highly visible and affect large numbers of people or a wide territory. Other examples include electric energy plants using clean energy sources, nuclear plants, and hydroelectric stations (except flatland-based ones) or poultry processing plants located in big cities. The environmental management approach can be best characterized as crisis preventive where public education campaigns are combined with elaborate technical procedures to assure that neither the pollution worsens nor the public misperceives the dangers of the low-level pollution that is taking place.

2.3. *Comparing environmental management approaches*

The reactive and strategic environmental management approaches represent two extremes where the external and internal environmental risks are balanced, both of them are at the same qualitatively defined level (either low or high). In the former, there is no pressure to do anything beyond complying with regulations – there are no urgent environmental issues, and the companies can wait to adopt new management guidelines. In the latter, a company is under enormous pressure to go beyond compliance – environmental issues are extremely important; they cannot wait any longer to develop a strategy; and they cannot afford to make mistakes. In the other two approaches (proactive and crisis preventive), the environmental risks are unbalanced. In both cases, companies can wait; they are not pressed to do anything immediately. But this situation may change, and they may have to plan their moves very carefully.

This classification of environmental management approaches gives a static description of companies at a specific point in time. Obviously, their situations may change quickly.

Although there is a growing international pressure for companies to develop and use strategic environmental management approaches in all cases, it may not be necessary or profitable to move from *proactive* or *crisis preventive* approaches to the *strategic* management approach. Through technology modifications and better emission control (for companies in Group B) and through public opinion monitoring (for companies in Group D), moving toward a *reactive* environmental management approach may be another option. The difference in costs and requirements between the reactive and strategic environmental management approaches are enormous, as illustrated in Table 1.

Adopting a reactive environmental management approach does not mean that companies pay no attention to opportunities for emission reduction, waste management, or more stringent sanitary practices. But because they are not central to the operations of the company, they can be dealt with by middle managers or outside experts rather than by senior management. Problems normally do not require immediate intervention because their non-crisis nature leaves time to fix them. Not all employees would necessarily be given environmental education and training; it may be enough to have activities monitored by experts in the company. Pollution emission reduction using monitoring equipment or "end-of-pipe" filters is the primary goal of these companies. Demand for environmental investments comes from stricter regulations and norms. These regulations and norms are the main forces driving these companies to make environmental improvements.

At those companies where environmental performance is a crucial element of business activities, environmental management has to be part of the company's overall business strategy, formulated and implemented by top management. For this reason, companies like 3M, McDonalds, Volvo, Kodak, Allied Signal, and many of the world's leading chemical companies have adopted principles of industrial ecology and pervasive environmental management strategies [16]. A high-level environmental committee including outside experts should play an important role in environment-related decisions. The objectives of environmental management are derived from the company's long-term strategy and not from current environmental regulations. All employees should be educated about environmental hazards, and environmental investments should include state-of-the-art techno-

Table 1
Comparison of reactive and strategic environmental management

Reactive	Activity	Strategic
Middle level management involvement; environmental committee less critical	*Management seniority level*	Senior management leadership, environmental committee in key position
Low	*Environmental management reporting level*	Very high (Chairman or CEO level)
There is time to fix it	*Uneven performance of environmental management*	Serious and immediate intervention is required
Cost optimization is important	*Cost control*	Risk reduction is the critical issue; cost does not matter
Special training for experts and for middle management	*Training and education*	Corporation-wide, specific training for senior and middle management
Pollution reduction	*Management focus*	Outstanding environmental performance
Monitoring and control	*Main activity of environmental management*	Innovation and communication
Complying with regulations	*Regulatory focus*	To be the standard for the industry
A few years behind state-of-the-art technologies is acceptable	*Innovation in pollution prevention*	Innovation to state-of-the-art technologies is critical to stay in business; it is part of competitiveness

logy and intensive attempts to reduce waste and pollution in the manufacturing process rather than relying on end-of-pipe controls.

3. Testing the framework: Environmental management in Hungarian companies

The purpose of this section is to test empirically the validity of the proposed framework for assessing environmental management approaches. We have argued that the most appropriate environmental management approach chosen by a company should be a function of the company's environmental risks. Therefore, companies from different industries and in different locations may be better off following different paths. To measure the endogenous and exogenous environmental risks of a company – the basis of this framework – we use the industry (technology) and the location of its plants. A priori classification of a plant's processing technology will divide them into into "large" and "small" endogenous risk categories, while population density, closeness to cities, dominant winds, environmental sensitivity and attitude of neighboring communities will determine whether a plant faces large or small exogenous risk. Thus, plants from the same industry could be in different cells.

Central Europe and, specifically, Hungary, were chosen as test sites because executives there must operate in complex and uncertain economic conditions as their countries undergo a transition from socialist to market systems. The transition affects every segment of the society. One of the most critical challenges facing Hungarian managers, for example, is how to resolve the conflicting pressures of attaining financial stability for their companies while at the same time coping with potentially serious environmental risks [17].

A survey of corporate executives' perceptions of environmental challenges was carried out in Hungary in late 1992 and early 1993 and was based on a similar worldwide survey undertaken by McKinsey a year earlier [18]. The questions were translated from English to Hungarian, and some new questions about company ownership were added to those used in the McKinsey survey. The translation was made by a doctoral candidate at the Budapest University of Economic Sciences and was verified by one of the authors. Questionnaires were sent to 400 medium- or large-sized companies

that were on the membership list of the Hungarian Chamber of Commerce. The 42% response rate – 169 company executives, mostly senior managers – was itself an indicator of the strong interest in this topic among Hungarian companies. However, as is common in surveys, not all of the respondents answered all of the questions; and, thus, the actual number of respondents varies from question to question [19].

To test the validity of the approaches described in Fig. 1, 141 companies were selected from the 169 responses. The selection was based on readily available information about the location and technology of the company. Most of the companies had only one plant, but if the company had multiple plants then the most significant plant was selected to represent the company. Therefore, "company" and "plant" are used interchangeably in the paper. The authors then determined the exogenous risks based on the location of the plant and the endogenous risks based on prevalent technology in the industry. The exogenous risks were considered small if the company was located in or around smaller cities where the population density was low and the company was a major employer in the region. Similarly, if the company was in major cities with high population density and generally with higher levels of environmental awareness, the exogenous risks were considered large. The endogenous risks of mass production industries that use well-developed technologies with low emissions such as textiles, precision instruments, or bakeries, for example, were considered low. Chemical companies, distilleries, or sugar factories with high emissions of pollutants were considered to have large endogenous risks. The characteristics of the selected companies by group are shown in Table 2.

Based on their technology and location as surrogates for endogenous and exogenous risks, Group A included textile and some machine tool companies that manufacture precision instruments. Group B included companies that were heavy polluters, such as leather processing plants that emit high levels of chrome in their waste, and food, sugar, and distillating plants located outside of major urban centers. These companies are polluting but they are not perceived to be dangerous. Group C included pharmaceutical and heavy chemical companies, and waste incinerators with technologies that emit high levels of pollutants and located in or near cities. Food processing, wood processing and printing companies that do not have serious environmental problems now but could have in the future if public opinion about the environmental impacts of their operations changes or if regulations further constrain their significant emissions of wastewater fell into Group D. Generally, companies in groups C and D were larger than in the other two groups. The low foreign investment in group C, where companies needed it the most, can be explained by the fact that foreign investors in Hungary may at some time be required to assume liability for past environmental pollution – a risk that is very high for almost all investors.

Some industries include companies that fall into more than one category. In Table 2 there are companies from the food processing industry for example in all four groups. Food processing is a very broad category and it includes a variety of activities, nonetheless this scattered distribution of companies in all categories requires some explanation. The five companies in Group A are bakeries with no environmental problems. They did not pay any pollution charges in the past and their location is not really an issue. The seven companies in Group B are distilleries (3), sugar plants (3) and a canning plant – all located around small towns. All of them paid water pollution charges – there is high water consumption and potential or actual water pollution in these plants that is reduced by their remote location and the fact that they are major employers in the region. Three large dairy companies located in major cities were assigned to Group C. They require large amounts of water and if they have the infrastructural support (cleaning facilities for the waste water) they are environmentally safe. These plants did not have such facilities and paid high water pollution charges. Poultry and meat processing companies with slaughter houses located in major cities are assigned to Group D. Their situation may change at any time. Animal protection leagues may sue them for keeping the animals in unacceptable conditions, customers may boycott their products (smoked ham, for example), and water pollution is a threatening issue for them.

Table 2
Sample characteristics

Endogenous/exogenous risks	Small/small	Large/small	Large/large	Small/large
Characteristics	Group A reactive	Group B proactive	Group C strategic	Group D crisis preventive
Number of companies	38	12	50	41
Industrial sector				
Light industries (manufacturers of textiles, leathers, furs, shoes)	15	2	—	3
Machine factory	15	—	1	1
Food processing	5	7	3	13
Chemicals (oil refineries and manufacturers of rubber, cosmetics, and pharmaceuticals)	—	2	23	1
Construction materials	—	—	6	—
Mining	—	—	1	—
Metallurgy	—	—	7	—
Wood processing	—	—	—	4
Paper production	—	—	2	—
Printing	1	—	—	8
Other	2	1	7	11
Number of employees				
Did not answer	1	0	3	1
Fewer than 50	1	0	2	3
Between 50 and 250	14	0	5	2
Between 251 and 500	4	1	6	6
Greater than 500	18	11	34	29
Company sales (million HUF)				
Did not answer	1	0	2	0
Less than 50	1	0	6	5
Between 50 and 250	14	1	9	9
Between 251 and 500	10	3	6	7
Greater than 500	12	8	27	20
Average foreign ownership (%)	12.1	23.0	11.6	12.4

There are significant differences in environmental investments and pollution charges paid by the different groups. Table 3 shows the actual and anticipated percentages of environmental investments from total company investments in 1992 and in 2000 and the average air and water pollution charges in 1992. In 1992, the percentage of environmental investments from total company investments (which, in general, were much lower than in previous years due to the recession in the Hungarian economy) was significantly higher in Group C than in the other groups. These numbers show two clear trends: first, generally, with the notable exception of Group C, companies plan to spend more on environmental investments in the future; and, second, the differences between the groups are decreasing. As expected, a higher portion of companies in Group C paid fines than the others.

Table 4 shows that a senior manager (the respondent to this questionnaire) was responsible for environmental management in all groups.

The high level of direct participation of senior managers in Hungarian companies can be explained by past experience as well. Before 1989, the political forces in opposition to the government used environmental issues to legitimize their criticisms. As a result, company managers representing the economic power of the state learned early on

Table 3
Environmental investments and pollution charges

Characteristics	Group A reactive	Group B proactive	Group C strategic	Group D crisis preventive
Environmental investments (% of total investments)				
in 1992	3.7	4.6	19.0	5.1
in 2000	12.2	12.0	19.9	15.7
Pollution charges paid in 1992 (in Hungarian Forints)				
Average air pollution charge	135,250	905,000	3,679,867	293,833
(number of companies fined)	(4)	(2)	(15)	(6)
Average water pollution charge	23,126	1,060,000	118,883,000	3,763,931
(number of companies fined)	(3)	(3)	(17)	(6)

Table 4
Hierarchical level of environmental manager

Hierarchical level	Group A	Group B	Group C	Group D
CEO or President	12	3	14	10
COO or Chief Engineer	13	6	21	20
Middle manager	8	8	8	5
Did not answer	5	2	7	6
Number of responses	38	12	50	41

that they had to prove that they used due diligence and reasonable care in their operations to offset criticism from a relatively well-organized social environmental movement favored by the media.

If the initial theoretical classification described in Fig. 1 is a valid one, then the groups should show different environmental management attitudes and they should have different environmental management profiles. Considering the immediate and enormous pressure that managers in Group C face, it is reasonable to assume that this group should show a significantly different environmental profile from the others.

3.1. Environmental management profiles of the groups

To measure the managerial characteristics of the companies, respondents were asked about the following topics: general environmental attitude; key environmental concerns within the industry; seriousness of environmental issues at different phases of product creation; the most effective ways to protect the environment; the environmental policy component that is currently installed at their companies; and the familiarity of employees with company objectives in environmental protection. Most of the questions were worded as statements, and respondents were asked the extent of their agreement or disagreement with the statement on a five-point scale. Based on the proposed theoretical framework, several hypotheses about the environmental management profiles of the groups were tested. We hypothesized that Group C is more advanced in managerial characteristics related to the environment than other groups and that companies in Group C would be fundamentally different from the others. Table 5 gives more details about these questions and shows the hypotheses for each section.

Managers were asked about seven statements related to different aspects of environmental management. The *strongly agree* answers on a five-point Likert-scale showed a positive environmental attitude, while the *strongly disagree* answers reflected a negative attitude. First, using Cronbach's alpha coefficient, the reliability of the scale was analyzed. Cronbach's alpha for the seven statements was 0.64, which is slightly lower than the average of this indicator in psychology and

Table 5
Variables and hypotheses related to managerial characteristics of companies

Variable description	Hypothesis
General environmental attitude: Managers were asked about seven statements related to different aspects of environmental management. The scale ranged from 1 (strongly disagree) to 5 (strongly agree), where 5 showed a positive environmental attitude. The managers general attitude was measured as the average of the seven answers.	The environmental attitudes of Groups B and C (where the endogenous environmental risks are large) are more positive than those of Groups A and D.
Key environmental concerns within the industry: (1) Complying with regulations; (2) Preventing incidents; (3) Realizing new market opportunities; (4) Enhancing positive image; (5) Integrating environment into corporate strategy. The scale ranged from 1 (not important) to 5 (very important). The level of environmental concern was defined as the average of the five answers.	Overall, Group C has a higher level of concern about the environment than the other groups, which are about at the same level.
Seriousness of environmental issues at the following phases of product creation: (1) Sourcing of (raw) materials; (2) Production (including transportation, storage); (3) Product use; (4) Disposal/Recycling. The scale ranged from 1 (not serious) to 5 (very serious). The level of seriousness of environmental issues in product creation is the average of the four answers.	Group C faces more serious environmental problems in the broadly defined production process than the others. In the other groups, the seriousness of environmental issues are approximately equal.
Most effective options to protect the environment: (1) Improve manufacturing technology; (2) Improve end product; (3) Improve waste management. The scale ranged from 1 (not effective) to 5 (very effective).	Improving manufacturing technology and the end product are considered the most effective in Group C and are about equal in the other groups. Improvement in waste management is the most (and about equally) important in Groups A, B, and D and less important in Group C.
Environmental policy component that is currently installed at the company: (1) Written company policy statement; (2) Board member with specific responsibility; (3) Environmental performance evaluation of suppliers; (4) Hiring external experts in environmental affairs; (5) Public communication programs; (6) Environmental marketing program (e.g., green products, green labeling, special promotions, advertising). The options to answer this question were yes or no. The overall portion of yes answers shows the strategic content of the company's environmental policy.	Group C has the most strategic environmental policy content; the other groups are about equal.
Familiarity with company objectives in environmental protection: Managers were asked to indicate on a five-point scale the extent (1 = not at all, 5 = to a great extent) to which the employees are familiar with company objectives in environmental protection.	In Group C, employees are more familiar with the company objectives in environmental protection than in other groups, which are approximately at the same level.

marketing research but it is acceptable in preliminary research situations like ours [20]. Moreover, considering that we relied on an international survey instrument, this level of internal consistency is quite acceptable.

Second, the general environmental attitude of the groups (as the average of the answers to the seven statements) was tested. The hypothesis tested was that the environmental attitudes of respondents in Groups B and C (groups with large endogenous environmental risks) would be more positive than those in Groups A and D. Managers who know the environmental dangers of their technologies should be more sensitive to environmental issues than those working with environmentally safe technologies. Table 6 shows the average level of agreement with the statements in each group and the tests of our hypothesis.

Overall, as shown by the average of seven statements, managers in Groups B and C had a much

Table 6
General environmental attitude (1 = strongly disagree, 5 = strongly agree)

Statement	Group A	Group B	Group C	Group D
The environmental challenge is one of the central issues of the 21st century	4.5	4.9	4.7	4.6
The industry will have to re-think its entire conception of the industrial process if it is to adapt profitably to an increasingly environment oriented world	3.8	3.8	3.9	3.8
Where environmental or health considerations demand it, the sale of our products will be curtailed or their production halted, regardless of our economic interests	2.3	2.3	2.9	2.5
Pollution prevention pays	3.3	3.4	4.0	3.4
There is a need to assume responsibility for one's products even after they left the plant	4.7	4.8	4.7	4.7
In the long-term, our spending on environmental R&D will give us a competitive advantage	3.2	3.8	4.1	3.6
To minimize the chance of future (environmental) tragedies, we should pursue a partnership of government, industry and academia	4.3	4.5	4.3	4.2
General environmental attitude (average of the seven answers)	3.71	3.94	4.07	3.80
Does the hypothesis hold? (ANOVA results)		Yes[a] ($F_{128;1} = 3.726$; $p = 0.056$)		

[a] The significance level is slightly higher than the customary 5%, however, the difference is so small that we accepted the hypothesis that environmental attitudes in Groups B and C are more positive than in Groups A and D.

more positive environmental attitude than the others – our hypothesis holds at 5.6% significance level that is slightly higher than the customary 5%. The two areas where managers in Group C showed a far more positive attitude than the other groups were the willingness to stop production if environmental or health considerations demand it and their belief that "pollution prevention pays." All groups agreed at a very high level (minimum 4.5 on a scale of 1 to 5) that the environmental challenge is one of the central issues of the 21st century and companies should assume responsibility for their products even after they have left the plant.

Key environmental concerns included four areas (complying with regulations, preventing incidents, enhancing positive image, and integrating environment into corporate strategy) – all of them are very important for an environmentally conscious company. For these four statements the Cronbach's alpha was 0.72 – a generally accepted level of consistency. We hypothesized that, overall, group C would have a higher level of concern about the environment than the other groups. The overall level of environmental concerns was measured as the average of the four answers. Table 7 shows that there was a significant difference between Group C and the others.

Because of the external and internal factors described earlier, companies in Group C face more serious environmental problems in the production process than those in the other groups. The seriousness of environmental issues in the broadly defined production process was measured as the average of four answers, each related to one phase of production. The reliability of this scale was 0.73 – an acceptable level. Table 8 shows that this hypothesis holds.

We also discerned differences in the attitudes of respondents about the most effective ways to protect the environment. We hypothesized that improving manufacturing technology and end products – the most strategic options – would be considered the most effective in Group C and about equal in the other groups. Moreover, improving waste management – the most conservative approach – would be considered the most effective in

Table 7
Key environmental concerns (1 = not important, 5 = very important)

Statement	Group A	Group B	Group C	Group D
Complying with regulations	4.3	4.0	4.2	4.3
Preventing incidents	4.4	4.3	4.8	4.6
Enhancing positive image	4.4	4.6	4.6	4.5
Integrating environment into corporate strategy	4.0	4.1	4.6	4.1
Level of environmental concerns (average of the four answers)	4.31	4.25	4.55	4.36
Does the hypothesis hold? (ANOVA results)		Yes ($F_{132;1} = 4.661$; $p = 0.033$)		

Table 8
Seriousness of environmental issues (1 = not serious, 5 = very serious)

Phases of product creation	Group A	Group B	Group C	Group D
Sourcing of (raw) materials	3.2	2.3	3.2	2.7
Production (including transportation, storage)	2.9	3.0	3.6	3.0
Product use	2.0	1.7	2.4	2.4
Disposal and recycling	3.5	3.3	4.0	3.9
Seriousness of environmental issues (average of the four answers)	2.91	2.57	3.27	2.99
Does the hypothesis hold? (ANOVA results)		Yes ($F_{128;1} = 6.442$; $p = 0.006$)		

Table 9
Most effective options to protect the environment (1 = not effective, 5 = very effective)

Options to protect the environment	Group A	Group B	Group C	Group D	Does the hypothesis hold? (ANOVA results)
Improve manufacturing technology	3.9	4.0	4.4	3.9	Yes ($F_{132;1} = 4.412$; $p = 0.019$)
Improve end product	3.0	2.9	3.2	2.7	No ($F_{126;1} = 1.901$; $p = 0.085$)
Improve waste management	4.4	4.3	4.0	4.5	Yes ($F_{133;1} = 4.080$; $p = 0.023$)

all groups but C. Table 9 shows that at 5% significance level our hypothesis about the end product (the only exception) did not hold – it holds at an 8.5% significance level showing the same tendency.

Table 10 shows the scope of environmental programs currently adopted by companies in the four groups. The *yes* answers indicate a more strategic orientation in the company's environmental policy. In Hungary, as shown by the low percentage of *yes* answers in our sample, many of these strategic management approaches are not yet generally used. The overall proportion of *yes* answers to the six questions in the Hungarian sample is 25.7% with Group C having a significantly higher portion of

Table 10
Scope of environmental programs

Environmental policy component installed at the company	Percentage of *yes* answers			
	Group A	Group B	Group C	Group D
Environmental protection is part of the company (written) philosophy	52.6	66.7	76.0	46.3
Board member with specific responsibility	34.2	16.7	38.0	41.5
Environmental performance evaluation of suppliers	5.3	16.7	6.0	2.4
Hiring external experts in environmental affairs	10.5	8.3	32.0	9.8
Public communication program	5.3	0.0	10.0	2.4
Environmental marketing program	26.3	41.7	28.0	19.5
Scope of environmental programs (average of the six indicators above)	22.4	25.0	31.7	20.3
Does the hypothesis hold? (ANOVA results)		Yes ($F_{137;1} = 13.448$; $p = 0.000$)		

them. Our hypothesis about Group C as having the most strategic environmental management approach holds.

Managers were also asked to indicate on a five-point scale the extent (1 = not at all, 5 = to a great extent) to which their employees are familiar with company objectives in environmental protection. In Group C, employees are significantly more informed ($F_{129;1} = 18.873$; $p = 0.000$) than in the other groups (the mean in Group A was 2.91; 2.90 in Group B; compared to 3.80 in Group C, and 3.00 in Group D).

These analyses showed the validity of the proposed framework, namely that companies with different exogenous and endogenous risks – proxied as industry technology and location – follow different environmental management approaches. In all sections described in Table 5, companies in Group C have differentiated themselves from the others and expressed attitudes congruent with a strategic environmental management approach.

3.2. *Classification of environmental management approaches using all variables*

The objective of this section is to validate the proposed framework in a different way. In the previous section, we compared the environmental management characteristics of the groups and tested several hypotheses about the differences – variable by variable. In this section, we classify the companies based on their environmental management characteristics into the four groups predetermined by the company's environmental risks – using all variables at the same time. We are looking for a relationship between the physical characteristics of the company (exogenous and endogenous environmental risks) and environmental management characteristics, which – if the framework is valid – should match. However, there are serious limitations that dampened our expectations about this classification: (1) the original assignment was based on proxy variables, and there may have been some errors in assigning companies to different groups; (2) the variable set we used had only environmental management characteristics; and, moreover, it reflected the opinion of one senior manager from each company; and (3) the variable set contained only eight variables. A random classification would yield about a 25% success rate. This analysis could only be considered successful if it resulted in a significantly higher success rate.

The data base used in the analysis was relatively small (141 observations and 8 variables), but it had missing data points and a presumably nonhomogeneous data structure. A nonhomogeneous data structure means that relationships among

variables in different parts of the measurement space (for example, in different industries) are, or can be, different. Thus, we sought an approach that would help us to sort out these complexities and that would assist us in understanding the true nature of differences across environmental management approaches. We sought to answer three questions:

- How can companies be classified into the four environmental management groups (in other words, what is the recipe for classification)?
- What is the relative importance of variables making the classification?
- How accurate is this classification?

We used a binary recursive partitioning method, the CART procedure, to classify the data set of 141 observations into four groups and used all variables about environmental management characteristics as predictors. CART (Classification and Regression Trees) is an advanced statistical procedure for tree-structured nonparametric data analysis that performs about 10–15% better than stepwise logistic regressions or discriminant analyses [21]. The process is binary because parent nodes are always split into exactly two child nodes and is recursive because the process can be repeated by treating each child node as a parent.

The CART method looks at all possible splits for all variables included in the analysis. Since there are, at most, 141 different values for each variable in this data set (one for each case) and eight variables, CART has to consider up to 141×8 splits; and it conducts searches through them all. The process is considerably simplified because CART always asks questions that have a yes or no answer. The next step is to rank each splitting rule on the basis of a goodness-of-split criterion. One criterion commonly used is a measure of how well the splitting rule separates the classes contained in the parent node. Once a best split is found, CART repeats the search process for each child node and continues recursively until further splitting is impossible or stopped for some other reason (e.g., the node has too few cases). Because each node has the potential for being a terminal node, a class assignment is made for every node whether it is terminal or not. Considering that we did not have any a priori information about distribution of group memberships in the population, the classes were treated as they were uniformly distributed in the population regardless of the observed sample proportions.

We chose CART because it offers many advantages over traditional discriminant analysis: (1) it is a nonparametric procedure; (2) it can handle data sets with complex, nonhomogeneous structure; (3) it is extremely robust in identifying the effects of outliers; (4) it can use any combination of categorical and continuous variables; (5) it can adjust for samples stratified on a categorical dependent variable; (6) it can reveal context dependence and interactions by using the same variable in different parts of the tree; and (7) it can process cases with missing values for predictors because it develops alternative splits (surrogates), which can be used to classify an object when the primary splitting variable is missing.

We used the CART procedure to classify the data set of 141 observations into four groups described earlier using all eight variables related to environmental management as predictors. Fig. 2 shows the resulting classification scheme.

Fig. 2 is drawn in the form of an inverted tree and is read like a flow chart. The trapezoids are nonterminal nodes denoted by a positive number. The ellipsoids show the terminal nodes and are denoted by negative numbers. The number of terminal nodes depends on the selected tree, and it is not related directly to the number of groups to be classified. At the beginning, all companies, in this case 141, are in node 1. This node is classified as Group A because this is the first group and we assumed that the groups are uniformly distributed in the population so the misclassification rate would be the same independently of the group chosen. The first variable selected to make the first split was the general environmental attitude of the company measured by the average of seven variables. For each company, the question asked at node 1 is the following: Is this variable, the general environmental attitude of the company, less than or equal to 3.64 measured on a five-point scale where 5 represented the positive extreme? If the answer to this question is *yes*, then the company is assigned to the first terminal node (node-1). If the answer is *no*, then node 2 follows where the seriousness of

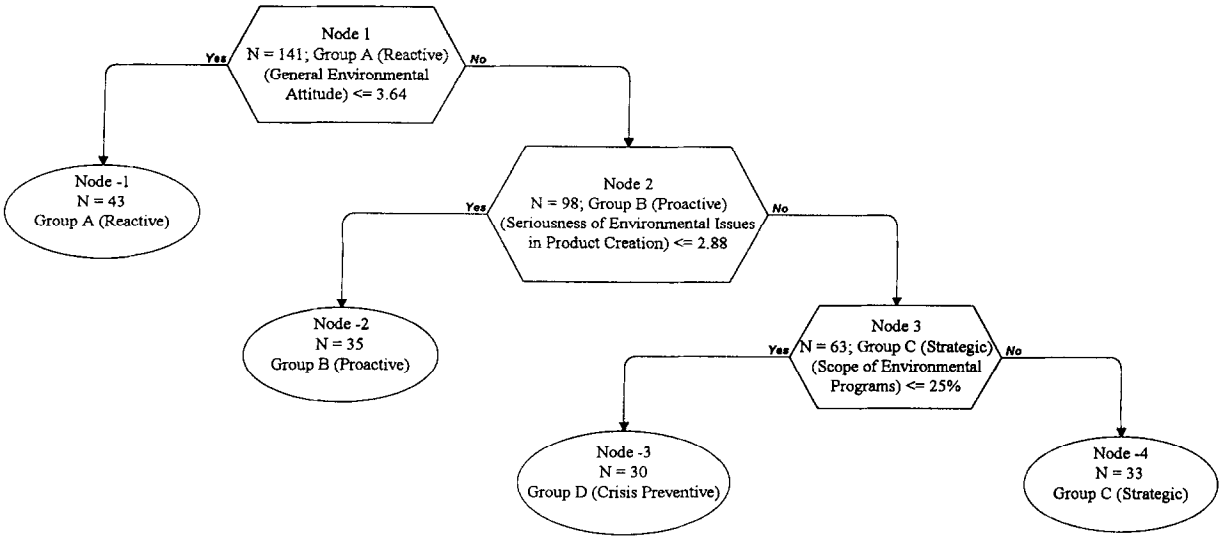

Fig. 2 Classification of environmental management approaches.

Table 11
Relative importance of variables

Variable name and description	Relative importance
Familiarity of employees with company objectives in environmental protection	100.0
General environmental attitude	94.2
Seriousness of environmental issues in the broadly defined production process	82.9
Strategic content of the company s environmental policy	79.3
Improving the end product is the most effective way to protect the environment	70.9
Improving manufacturing technology is the most effective way to protect the environment	59.3
Level of environmental concerns	24.3
Improving waste management is the most effective way to protect the environment	7.6

environmental issues in product creation is questioned. Companies are assigned to node -4 – classified as Group C or Strategic – if the general environmental attitude is greater than 3.64, the seriousness of environmental issues in production is greater than 2.88 and the scope of environmental programs is greater than 25%. Table 11 shows the relative importance of variables. This list should be read as a checklist for diagnosis: *these variables differentiate between the four environmental management approaches.*

In this table, we can find variables that did not show up in Fig. 2 as primary splitting variables (familiarity of employees with company objectives in environmental protection, for example). The reason for this is that CART tracks surrogate splits in the tree-growing process and the contribution a variable can make in prediction is not determined only by primary splits. The phenomenon of one variable hiding the significance of another is known as masking and is addressed in CART's variable importance measure. Table 11 shows, for example, that the employees familiarity with environmental objectives of the company is the most important variable and it is about four times as important as the level of environmental concerns.

Table 12
Classification table of companies

Actual Group Membership	Predicted group membership				Actual total
	Group A: reactive	Group B: proactive	Group C: strategic	Group D: crisis preventive	
Group A: reactive	19	10	11	5	38
Group B: proactive	1	7	3	1	12
Group C: strategic	9	8	25	8	50
Group D: crisis preventive	14	10	1	16	41
Predicted total	43	35	33	30	141
Correct (%)	50.0	58.3	50.0	39.0	47.5

The most important issue of any classification is the accuracy of the prediction. In this case, the question is whether there is a fit between a classification based on exogenous and endogenous environmental risks and the company's environmental management characteristics. Table 12 shows the results of the CART classification.

The overall correct classification rate of 47.5% is good considering the difficulties of this task and the fact it was a four-group classification problem. The most problematic group was the crisis preventive Group D where only 39.0% of the cases were classified correctly. Classification rates for the other groups were 50% or higher.

4. Conclusions

Based on survey results, we can conclude that there is a relatively well-defined relationship between companies environmental risks and the nature of their environmental management approaches. The external and internal physical characteristics of companies determine their exogenous and endogenous environmental risks, which in return have an impact on a company s environmental management characteristics. This impact is the most significant on companies with strong and immediate environmental pressures, companies that have to have a strategic environmental management approach to avert risks. Although there is pressure to develop and use strategic environmental management approaches in all companies, it may not be necessary or profitable to move from proactive or crisis-preventive management approaches to the strategic management approach. Through technology modifications and better emission controls (for companies using a proactive approach) and through public opinion monitoring (for companies using crisis preventive approach), moving toward a reactive environmental management approach may be another option. There is little debate over the fact that for a hazardous waste incinerator, environmental management is of strategic importance. On one hand, stricter environmental regulations may mean new business opportunities for the company because demand for the incinerator grows. On the other hand, because of the stricter regulations, requirements for technologies used in the incinerator change and the emission limits are set at lower levels. In order to remain a competitive player, the company has to meet these requirements, have a good environmental performance record, and maintain good communications with people living in the surrounding areas.

A logical extension of this research would be to test the framework using an international data set, including companies from developed market economies as well. This can be done most effectively by focusing on fewer industries and extending the number of environmental management characteristics.

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[4] Price, K.S., 1992. What gets measured gets done – the criminalization of technical decision-making. Proc. 47th Ind. Waste Conf. Lewis Publishers, Boca Raton, FL, pp. The penalties resulting from criminal law procedures in the United States against managers of companies with violations of environmental regulations have reached tens of millions of dollars a year. In 1992, for example, penalties of more than $38 million were imposed, not counting the $125 million in fines and more than 37 years in prison sentences levied against those found responsible for the Exxon Valdez incident. As these penalties have grown, however, so too have the debates over their legitimacy. Bartman reflects a widely shared opinion in pointing out that "... the standard for imposing criminal liability on an individual employee or officer and on a corporation for environmental offenses is low, requiring proof only that the employee intended to place a drum of waste where he placed it, not that the employee knew the law was being violated, nor that the waste was regulated." Even an employee's negligent discharge of a nonhazardous pollutant into a waterway can be criminally prosecuted and officers of the corporation can be held liable for employee error. Richard Harris, President of KPMG Environmental Services, concluded after the Bata Industries case was decided in Canada that "the public has become less tolerant of environmental misdeeds, and regulators ... are increasingly looking for ways to make examples of corporate polluters." Considering these circumstances, Harris concluded that managers had only one option and that was to protect themselves against environmental risks. "Company owners, directors and managers need to show that they have exercised all reasonable care to prevent any environmental problem from occurring." He argued that every company will have to establish a system of environmental management that provides the documentation needed to defend the company's executives against government prosecution.
See T.R. Barthman, Dodging Bullets. Fortnightly, Vol. 131, Issue 18 (October 1993): 21–25, quote at p. 21, and Richard Harris, ignoring the Environment is Bad for Business. Canadian Manager, Fall 1993, quote at p. 21.

[5] Business International and Arthur D. Little Inc., 1992. Managing the Global Environmental Challenge. Business International, New York.

[6] The case of Bata Industries in Canada generated a strong public debate in 1993 over the environmental responsibilities of senior management. At one extreme, some lawyers argued that company directors should become totally proficient in all matters relating to Ontario regulations on air and water standards. Others countered that in order to comply with Canadian law every director would have to have a strong science background to understand the environmental implications of the company's operations. Still others asserted that directors should personally review for accuracy and completeness the environmental audits routinely conducted for Canadian corporations. Although these obligations have never been formally imposed on directors, either before or after the Bata case, the courts demanded that directors "understand what due diligence means and establish policies and systems to ensure the corporation remains in compliance with environmental laws." (See E. Rovet, Making Sense of Due Diligence. CA Magazine, Vol. 126, Issue 9 (October 1993): 55–57, quote at p. 55.

[7] In the United States, "to attain a high level of environmental compliance (recognizing that the breadth and complexity of environmental compliance requirements make 100% compliance unattainable for most utility and industrial companies), their [companies'] efforts must proceed beyond what is specifically required," one legal expert argues. See Barthman, "Dodging Bullets," quote at p. 22.

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[14] Wynne, Uncertainty and Environmental Learning, p. 72.

[15] An issue that became critical after the Bhopal accident, for example, was "whether the Union Carbide affiliate was operating with equivalent procedures, safeguards, and equipment to those at comparable facility in the United States." But even if Union Carbide had implemented the American standards in India it would have been inadequate because of the lower levels of education of the workers, less developed infrastructure, and other factors creating higher exogenous environmental risks for a chemical company operating in this region of India. To lower the environmental risks of the Bhopal plant, Union Carbide would have had to adopt a more stringent and constraining environmental management strategy than in its American plants in order to compensate for the differences in infrastructure and education levels in India. The education level and training of people living around a plant are at least as important as the internal operations of the company in determining environmental risks. The Bhopal accident or the Chernobil incident in the former Soviet Union would have caused much less damage if the neighboring population had been more concerned about environmental hazards and better trained in emergency procedures.
For the quotation see Union Carbide Fights for its life. Business Week, December 24, 1984.

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[17] The stereotype of managers from third world or formerly communist countries as being oblivious to or unconcerned about the dangers of environmental degradation arises from the belief that the government and the private sector continue to avoid the costs of environmental protection and cleanup. Although Hungary's economy is just emerging from a long period of stagnation and its GNP per capita ranks only 52 among the 173 countries for which the United Nations Development Program provides comparative economic statistics, its human development index (the combination of GNP per capita, adult literacy rate, average number of years spent in school and life expectancy at birth) ranks 28, higher than some Western European countries. Because education levels and environmental awareness are correlated, the concern for a clean environment should be relatively high in a country like Hungary. Given Hungary's human development index and its desire to become a member of the European Economic Community, its corporate executives should be willing to adopt higher environmental standards as quickly as possible.

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