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Number 31. The Economic Viability of Environmental Management Systems: an application of Analytical Hierarchy Process as a methodological tool to rank trade-offs

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The economic viability of Environmental Management Systems: an application of Analytical Hierarchy Process as a methodological tool to rank trade-offs

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Abstract

Environmental management systems [EMS] are now a well established management tool in the 'greening' of industry. There is a large body of literature on methodological procedures and application strategies for implementing EMS. Associated with this proliferation of 'how to' manuals has been a limited discussion of why a firm ought to implement a management tool that inevitably affects the bottom line of profitability. We argue that there has been much less by way of methodologically rigorous and academically objective analysis of the motivation for EMS application. Much of this literature is coined in terms of the potential benefits (social, ethical and financial) with arguably an insufficient emphasis on potential real cost burdens. This arises in part because researchers and analysts in the field want firms to adopt EMS. This can be motivated by environmental zeal and/or an enthusiasm to promote the sales of 'how to' manuals by accentuating the positive.

The aim of this research is provide an objective and methodologically robust motivational analysis in the field of EMS applications. The methodology that we apply - Analytical Hierarchy Process [AHP], a variant of multi criteria analysis- has not to our knowledge been applied in the 'greening' of industry. Most methodologies relating to semi-structured interviews of respondents who have applied environmental management tools are either open-ended or apply a 5 point Likert scale or equivalent, where 1-5 corresponds with how important the respondent considers a given factor(e.g. affect on long-run profitability) is in stimulating EMS adoption. The outcome of such studies in general is that many factors contribute but that the extent to which one factor is more or less important remains unresolved. Under AHP, respondents make pair-wise ratings of importance between various attributes (e.g. profitability, corporate social responsibility) as well as between the 'qualities' or levels within an attribute (e.g. long term profitability, short term profitability). The outcome of the AHP is a set of attribute and quality weights that reflect their relative importance as well as their implied ranking.

In this study, five attributes (profitability; compliance with legislation; competitiveness; social impacts and environmental impacts) with a total of 13 qualities were tested across a sample of respondents from SMEs that already had an EMS in place. The attributes ranged from financial (e.g. increases in production efficiency), social (e.g. improved public perceptions) to environmental (e.g. reduced emissions). We chose to investigate the motivations for on-going EMS adoption as managers would then have had the time to learn the extent to which the potential benefits had actually been realised and the costs incurred..

The results are interesting in that the most important factors were increased long term profitability and the opportunity to enter new product niches. The latter may arise owing to 'supplier challenges' applied by larger firms to their SME suppliers. A high scoring was achieved for improving local community relations. The highest score for the environmental attribute was reduced resource usage, linked to decreasing production costs. This score was significantly higher than CSR-type global concerns such as emissions reductions. However, overall environmental outcomes were not rated highly which perhaps suggest that the case that CSR stimulates the adoption of corporate eco-change might be overstated in the literature.

1.   Introduction

As a result of the environmental movement that began in the 1960s and the more recent global protests against corporate globalisation and power, there has been increased pressure on the corporate world to act in an environmentally and socially responsible and transparent manner (Dresner 2002, Moffat 1996, Porter 1991). The impetus to 'green' production systems has come from two quite distinct responses to this environmental agenda. First, the firms' fiduciaries might themselves be committed to reduce resource throughput and to reduce emissions on the (ethical) grounds that it is their social responsibility to do so. Davis (1991) states: "Managers should be the instigators and guardians of a societal change towards sustainable development [because] there is a notion of managerial duty towards the environment". Second, the 'greening' might arise as a response to changing market conditions. These include the 'stick' of regulation (and the associated penalties for non-compliance) as well as the 'carrot' of 'green' consumerism. The latter comes both from final consumers and (increasingly) from 'supplier challenges' from other firms. The two categories of responses to the environmental agenda might be categorised as corporate social responsibility (CSR) *versus* corporate social responsiveness.

The influential proposition of Michael Porter (1991) is that the presentation of a dichotomy between profits and improved environmental performance is empirically unjustified. A synopsis of his argument is that 'win-win' outcomes are prevalent but a behavioural change in the way firms go about searching for pollution offsets needs to be stimulated through state intervention. Porter argues that environmental regulation is often designed in "ways that deter innovation" and "companies, in turn, oppose and delay regulations instead of innovating to address them" (Porter and van der Linde 1995a). Porter argues that the problem lies within the regulations themselves and that "properly designed environmental standards can trigger innovation that may partially or more than fully offset the cost of complying with them" (Porter and van der Linde 1995b).

The Porter Hypothesis (PH) has spawned a considerable literature (e.g. Mohr, 2002; Xepapadeas and de Zeeuw, 1999). Many economists (e.g. Palmer *at al*., 1995) argue that, although it is indeed the case that regulations should be designed so as to stimulate innovations through efficiency gains, the 'low hanging fruit' of 'win-win' outcomes that the PH infers is ubiquitous has in fact been picked. What seems to be irrefutably the case is that, although there are instances where 'win-win' still applies, there are industrial sectors where there is a trade-off between profitability and 'green' performance.

The aim of this paper is to apply a novel methodology to decipher the *motivations* behind (continuing) 'greening' corporate behaviour. In essence, we are trying to relative strength of corporate social responsibility *versus* corporate social responsiveness. There are few who would contend that *either* the ethical dimension alone *or* the profit-motive alone is the complete answer vis-à-vis why firms choose to adopt eco-innovations: the answer is a mix of the two. But there are two a distinct methodological problem that arises in attitudinal and motivational surveys in the 'greening' literature which our study methodology attempts to address. First, if a firm's environmental manager is surveyed and asked if

profitability is an important driver for eco-innovation and also if social responsibility is important, s/he is likely to simply respond in the affirmative in both cases. It is thus difficult to decipher the *relative importance* of the two broad drivers. Second, the majority of attitudinal surveys have sampled respondents from Fortune 500 trans-national corporations. Many of these (such as BP and Shell for instance) have a corporate marketing message that conveys an impression that their business respective activities are driven almost in their entirety by CSR, and not profits *per se*. A survey respondent adhering to this corporate 'spin' would thus either state that there is no conflict between responsiveness and responsibility (the PH position) or respond that the firm acts in an environmentally and socially responsible manner irrespective of the impact on the financial bottom line. This reported statement may be empirically fictitious and thus systematically skew the survey results.

Although this latter systematic bias probably still remains in our study, we attempt to ameliorate it through our choice of the sample of respondents. Specifically we survey small to medium-sized enterprises (SMEs) in Scotland with on-going applications of a particular management tool, i.e. environmental management systems. We have chosen SMEs with on-going environmental applications as a study base for several reasons. First, they are numerous and their collective impact on ecosystems is significant - and yet their behaviour vis-à-vis sustainability is relatively under-researched as compared with trans-nationals. Second, respondents are less likely to be feel required to provide responses that are conditioned by some corporate agenda/positioning/'spin' with respect to CSR. Third, respondents are probably in a (corporate) position such that the 'pinch' of the potential trade-off between profitability and CSR is felt personally to a greater extent than is the case for an environmental manager in a larger firm. Fourth, the fact that there are environmental management tools *in situ* for these SMEs means that they are responding in terms of real-life experiences. Although many corporate managers might be convinced to join the 'greening' bandwagon – there is an industry dedicated to getting them on board and selling them associated services/expertise – responses from those who have been at the sharp end, i.e. have maybe actually faced a negative impact on the financial bottom line, are perhaps more relevant.

Our survey methodology attempts to address the first aforementioned problem in motivational research, i.e. deciphering the relative importance of the two broad drivers (responsiveness and responsibility). The methodology is termed Analytical Hierarchy Process and is discussed in the next section.

2.   Analytical Hierarchy Process

The Analytical Hierarchy Process (AHP) is one variant of multi-criteria analysis (MCA). AHP uses a number of pairwise comparisons between quantitative or qualitative criteria to assess the relative importance of each criterion. These can be arranged in a hierarchical manner known as a 'value tree' to form sets of attributes, and qualities (levels) within these attributes. The simplicity of the AHP approach is that, unlike other 'conjoint' methods, the qualities (or levels) of different attributes are not directly compared. The AHP approach thus removes the need for complex survey designs and can be applied (in

an extreme case) with only a single respondent. Other conjoint methods such as choice experiments do not realise statistically robust results unless there is a sizable number of usable survey response.

Under AHP, respondents first make pair-wise comparisons of the qualities within each attribute before comparing each of the attributes (Saaty, 1980). By way of an example, one of the attributes in our survey is 'profitability' but qualities *within* this attribute include 'long term profitability' and 'short term profitability'. After the pair-wise comparisons between qualities, there is a pair-wise comparison across attributes, e.g. 'profitability' and 'compliance with legislation' in our survey.

Other forms of conjoint analysis place quite a high 'cognitive burden' on respondents in that they are asked to make comparisons across options that have a large bundle of attributes *and* levels of these attributes. Under AHP, respondents are not asked to make choices between *all* criteria (such as in the 5 point Likert Scale). Such choices may not deliver enough discrimination between motivations to make the results significant – and that is the reason that we have chosen not to use such methods. As a consequence of the methodological structure, respondents in an AHP survey are less likely to adopt mental short cuts by concentrating disproportionately on one attribute or level.

Table 1   Scoring system used to determine relative importance between AHP criteria.

Rating	
1	Two options are equally important
2	Between 1 and 3
3	Chosen option is slightly more important
4	Between 3 and 5
5	Chosen option is moderately more important
6	Between 5 and 7
7	Chosen option is much more important
8	Between 7 and 9
9	Highest possible degree of importance of chosen option over the other

The pair-wise comparison is framed in the form of a question: how important is criterion A relative to criterion B? The responses to these questions are typically coded (as is the case in our study) along a nine-point scale as set out in Table 1. If, for example, B is considered to be 'much more important' than A, then the reciprocal of the relevant rating is assigned (i.e. $^1/_7$ as opposed to 7 if A were 'much more important' than B). As it is assumed that a respondent is consistent in judgements about any one pair of criteria, this use of the reciprocal allows only $n(n-1)/2$ comparisons to be made where there are n criteria. The ratings, and their reciprocals, are then collected in a comparison matrix:

$$\begin{bmatrix} 1 & 7 & 9 \\ 1/7 & 1 & 2 \\ 1/9 & 1/2 & 1 \end{bmatrix}$$

Weights are then estimated which are consistent with the relativities between the attributes or qualities contained in the matrix. Although there is consistency in the judgements made between any one pair of criteria, this is not guaranteed in judgements between pairs. The estimated weights aim to provide the "best fit" for the observations (DTLR, 2001). This can be achieved by calculating the geometric mean of each row and normalising these by dividing by the sum geometric means for each row. For the above matrix the weights would be:

	Geometric mean			Weight
Criterion 1	$(1 \times 7 \times 9)^{1/3}$	=	3.9791	0.7926
Criterion 2	$(1/7 \times 1 \times 2)^{1/3}$	=	0.6586	0.1312
Criterion 3	$(1/9 \times 1/2 \times 1)^{1/3}$	=	0.3816	0.0760
Sum		=	5.0193	1.000

Since its inception in the 1970s AHP has been used as a tool in complex decision-making in all sorts of fields due to the straightforward and convenient nature of the pair-wise comparison form of data input and analysis (Zahedi, 1986; Golden *et al*. 1989; Shim, 1989). Users of AHP for academic, economic, and governmental research (Saaty 1980, Saaty 2001, Zahedi 1986, Hassam 1978) find that allowing respondents to choose between two clearly demarcated choices and then to determine to what level they prefer one choice over another helps to reduce the number of null responses (Hassam, 1978).

The main criticism of AHP as a methodology is what is termed a 'role reversal phenomenon' which can occur: "simply by adding another option to the list of options being evaluated, the ranking of two other options, not related in any way to the new one, can be reversed" (Dogson *et al.*, 2001). This criticism is a valid one but one that we have attempted to ameliorate in our study through the careful selection of attributes and qualities.

The majority of the small number of existing applications of AHP to environmental and natural resource management issues have involved small samples of experts, resource managers and stakeholders. The

aim of such studies has been to reach consensus on management decisions and priorities in a manner similar to Delphi exercises, but in a way that also elicits the relative 'utilities' of different management options. For instance, AHP has been incorporated into studies to determine the relative preferences concerning land use for tourism in Australia (Proctor, 2001) as well as the perceived quality of wilderness areas in various ecosystems (Ananda *et al.* ,2002). To our knowledge, AHP has not been applied to the 'greening' of industry. We outline below our application of the methodology to a small sample of Scottish SMEs with extant environmental management systems in place in the next section.

3 Case Study: drivers for the continuing 'greening'

3.1 Experimental design

The study consisted of a round of telephone interviewing of potential firms selected from a database provided by Midlothian Enterprise Trust in Scotland in summer 2005 in order to determine availability and desire to take the survey. The final sample consisted of seven SMEs. As mentioned above, a potential methodological issue with AHP applications is omitted and/or inappropriate attribute selection. In order to ameliorate this problem, a pilot survey was drafted and comments received (and amendments made) based on the responses of two independent consultants who each specialise in corporate sustainability/CSR issues and who each had extensive experience in EMS applications for small firms. The final format of the questionnaire is outlined in brief below:

- Section 1: *Nature of the firm*
  General information was collected about the firm such as number of employees, current sales and major product lines.

- Section 2: *Nature of the firm's EMS*
  Information collected on the length of EMS application, the type of certification (if any), and environmental reporting and auditing issues.

- Section 3: *Drivers for incorporation of EMS into business plan*
  This section determined the relative importance of 22 potential internal and external drivers using a six point graduated scale to deliver qualitative data on the relative importance of each driver. Questions also posed to determine the intra-firm and external business environment at the time of EMS adoption, i.e. how important was each of these 22 drivers in terms of the decision to adopt?

- Section 4: *AHP application*
  This section is the AHP application and there are 5 amenities considered: 'profitability'; 'compliance with legislation'; 'competitiveness'; 'social'; 'environmental'. The amenities and (sub-section) characteristics/qualities are summarised in Table 2.

Table 2   AHP amenities and characteristics/qualities

Amenities of EMS	Characteristics of Amenities
Profitability	• Short-term increase in profits • Increase in production efficiency • Long-term increase in profits
Compliance with legislation	• Compliance with current legislation • Avoiding fines for non-compliance • Compliance with pending/future legislation
Competitiveness	• Increased competitiveness in present market • Opportunity for products to enter new market niches • Improved public perception
Social	• Improvement in relations with local community • Improvement in relations with regulators
Environmental	• Environmental benefits from decrease in resource use (energy and raw materials) • Environmental benefits from reduced emissions to air

The two/three characteristics in each amenity were presented as a pair-wise comparison applying the 1-9 AHP scale. A pair-wise comparison was then made between each of the 5 amenity groups, i.e. 10 such comparisons. A final section asked for any further comments.

3.2   Study results

Table 3 provides a synopsis of the seven firms in the survey. 6/7 respondents were either general managers or owners, whilst the remaining respondent was environmental/HR manager. Only 2/7 respondents chose to discuss turnover and so these results are not presented. None of the firms had an allocated R&D budget although one firms intended spending 3-4.5% of gross 2005 turnover on efficiency improvements.

Table 3   General firm characteristics

Firm	Type of Firm	Employees	EMS ISO certified
Firm 1	Courier Service	16	N/A
Firm 2	All wood custom-fitted office furniture	80	2002
Firm 3	Upholstered furniture and foam products	34	2003
Firm4	Custom fabric creation and dying	18	N/A
Firm 5	Conference and Retreat Centre	61	1998
Firm 6	Shop-fitters	13	2000
Firm 7	Custom-fitted cabinetry, shelving, and wardrobes	31	1999

In terms of the extant EMSs, 5/7 were certified under ISO 14001, with 1/7 have a certification pending and the last firm choosing not to certify. 5/7 produced a periodic environmental report, with 4/5 being

yearly and 1/5 every two years. 4/5 reports were externally published, with the fifth respondent being in the process of deciding whether or not to do so.

Table 4 summarises the means and standard deviations of the responses pertaining to the drivers for adopting the EMS in each respective firm. A graduated 6 point scale was applied with 1 being highly insignificant and 6 being highly significant.

Table 4   Drivers for EMS adoption

External/Internal Drivers	*Means: range 1-6 (Standard Deviation)*
Change in firm's organizational structure	1.00 (0), N=7
Change in firm's upper management	2.14 (1.68), N=7
Change in firm's location	1.29 (0.76), N=7
New technology	1.00 (0), N=7
New supply challenges	2.29 (1.50), N=7
Emergence of new industry niches	3.86 (1.07), N=7
New national regulations	3.43 (0.79), N=7
New EU regulations	2.29 (1.11), N=7
Voluntary agreements with regulators	1.00 (0), N=7
Increased competition, nationally	4.29 (0.76), N=7
Increased competition, internationally	1.00 (0), N=7
New or changing customer needs, nationally	5.00 (0.58), N=7
New or changing customer needs, internationally	1.14 (0.38), N=7
Change in suppliers' needs or values	3.86 (2.19), N=7
Change in distributors' needs or values	2.86 (2.19), N=7
Change in shareholders' needs or values	1.00 (0), N=7
Change in financial service providers' needs or values	2.57 (1.27), N=7
Change in insurance providers' needs or values	2.86 (0.90), N=7
Change in consumers' needs or values	5.29 (0.49), N=7
Increased pressure from non-governmental organizations	1.57 (0.79), N=7
Increased pressure from the local community	2.71 (1.70), N=7
Suggestions for improvements or changes from employees	2.43 (1.40), N=7

N= number of respondents

(##)= standard deviation

The small sample size of 7 firms limits the extent to which we can make robust generic observations from the results of this section of the survey, but a few observations can be made. First, the intra-firm drivers appear to be weak i.e. changes in structure, management and location. Case study analyses in the 'greening' literature (e.g. Schot and Fischer, 1993) often present a 'Road to Damascus' type awakening

in upper management that propels the firm towards the sustainability paradigm. Our results do not support this model of eco-reform, but the sample size also means that we cannot reject it with any degree of certainty. A second finding is that national drivers (competition, regulation, customer needs) are far stronger than international. Given the geographical focus of the firms surveyed, this is perhaps predictable and not an outcome that we would generalise to other (larger) firms.

The strongest drivers are on the demand side, in terms of changes in/new consumer needs and values, scoring means of 5.29/6 and 5.00/6 respectively. The next most important drivers are increased national competition (4.29/6) and new industry niches (3.86/6). It is perhaps noteworthy that these market forces (the 'carrot') are more dominant than the 'stick' of regulation (3.43/6 for national and 2.29/6 for EU regulations). This is in part perhaps because SMEs have been shielded to an extent by governments from the added regulatory burden of environmental compliance. Another means of categorising the drivers is 'internal' (intra-firm) *versus* 'external'. The mean score for the former is 1.69/6 whereas for the latter it is significantly higher at 2.79/6, implying that external drivers are more important for this sample of SMEs.

Table 5   Results of AHP survey

| Characteristics of Amenities	Means
Profitability	
Short-term increase in profits	0.076 (0.046), N=7
Long-term increase in profits	0.224 (0.047), N=7
Increases in production efficiency	0.063 (0.024), N=7
Compliance with legislation	
Compliance with Current Legislation	0.054 (0.041), N=7
Compliance with Future Legislation	0.0507 (0.0204), N=7
Avoiding fines for non-compliance	0.0489 (0.064), N=7
Competitiveness	
Increased competitiveness in present market	0.11 (0.073), N=7
Opportunity for products to enter new market niches	0.173 (0.141), N=7
Improved public perception	0.0469 (0.0255), N=7
Social	
Improvement in relations with local community	0.0729 (0.058), N=7
Improvement in relations with regulators	0.028 (0.021), N=7
Environmental	
Environmental benefits from decrease in resource use	0.038 (0.018), N=7
Environmental benefits from reduced emissions to air and/or water and waste generation	0.0116 (0.0107), N=7

N= number of respondents

(##)= standard deviation

As we have stated above, the small sample size for the 'drivers' section of the survey limits the strength of our findings. However, the outcomes of the next section of the survey – the AHP application – are less constrained by the low sample size owing to the nature of the methodology. The overall results from the AHP section of the survey are set out in Table 5. As discussed above, AHP is a three-stage process vis-à-vis the survey design. First, the respondent is informed of the attribute categories in the survey design (five in this case). Second, pair-wide comparisons are made between each of the qualities within each attribute category. Third, pair-wide comparisons are made between attribute categories.

The third stage provides an overall weighting for the category. This overall weighting is then split between the qualities within that attribute category based on the second stage results. The ordering here is important in that the demarcation between qualities may be less than absolute, e.g. 'increased competitiveness in present market' (within the 'competitiveness' attribute) might overlap with 'short term increase in profits' (within the 'profitability' attribute). If the respondent is familiar with what the attribute categories are constituted by then the third methodological stage is less prone to error/confusion that might otherwise arise from this overlap. However, if qualities *within* an attribute category overlap significantly then the results will be biased.

Figure 1   Weightings from AHP results: attribute categories
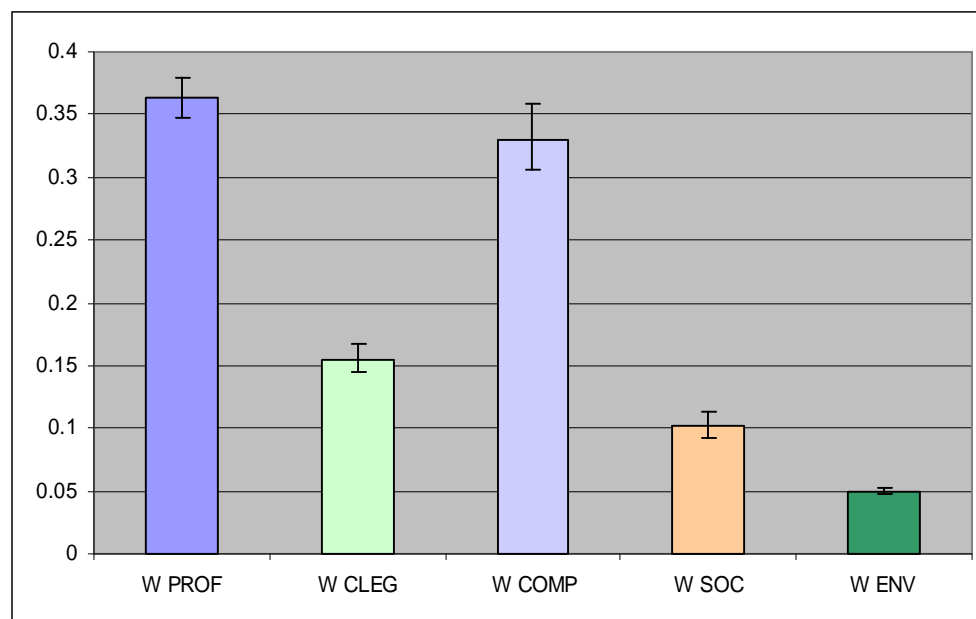
W=Weighting   PROF=Profitability   CLEG=Compliance with legislation
COMP=Competitiveness SOC=Social   ENV=Environmental

The results presented in Table 5 are the overall findings, i.e. the means presented in the second column are the contribution that that particular quality has on the respondent's decision to continue with his or her firm's EMS. A bar chart representation of these overall results is given in Figure 2. Figure 1 provides a similar bar chart but with the results from only the third stage of the AHP, i.e. the relative weightings

applied to the 5 attribute categories. In both figures, 95% confidence intervals are shown by the narrow vertical bar, although the small sample size implies that such a parametric test may not prove reliable.

Figure 2   Weightings from AHP results: individual attribute qualities
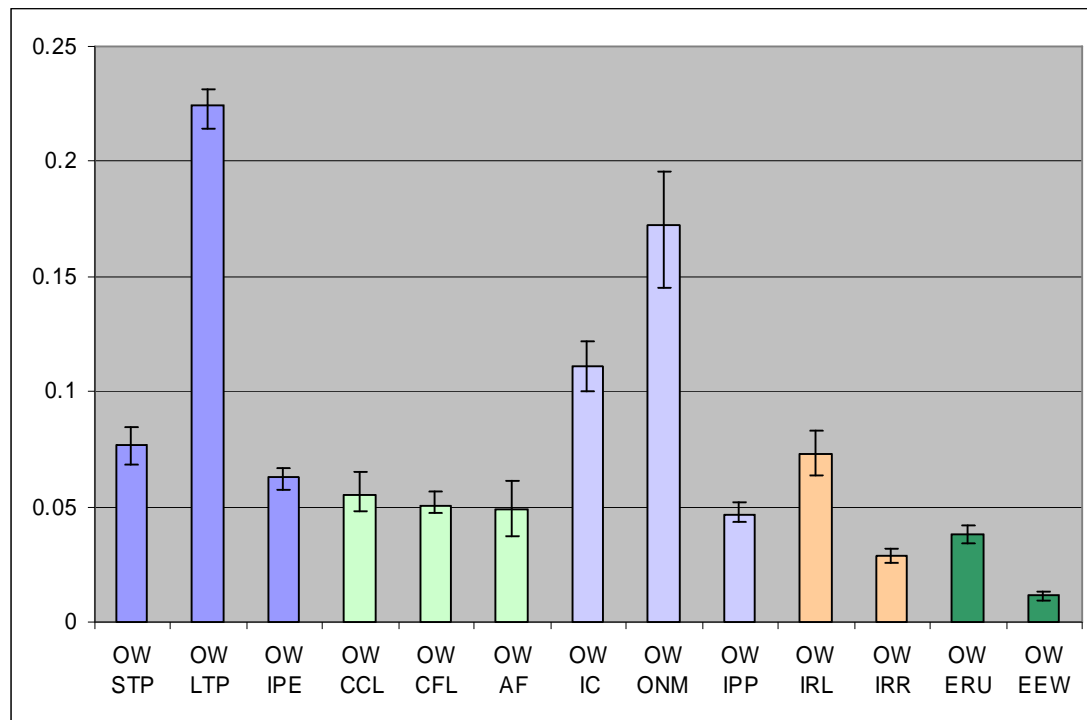
STP=Short-Term increase in Profits   LTP=Long-Term increase in Profits
IPE=Increase in Production Efficiency   CCL=Compliance with Current Legislation
CFL=Compliance with pending/Future Legislation   AF=Avoiding Fines for non-compliance
IC=Increased Competitiveness in present market   ONM=Opportunities for Niche Markets
IPP=Improved Public Perception   IRL=Improved Relations with Local Community
IRR=Improved Relations with Regulator   ERU=Environmental benefits decreased Resource Use
EEW=Environmental benefits from reduced Emissions to Environment and Waste generation

The quality with the strongest contribution is clearly long-term profitability, whereas the contribution of the qualities within both the 'environmental' and 'social' attributes are all very low in terms of global influence. In particular, an EMS is in fact designed to reduce (through the installation of a management system) a reduction in impacts on the natural environment, both in terms of resource use and waste generation. And yet the two qualities within the environmental attribute score as the *lowest* (and the third lowest) contributors as drivers to on-going EMS adoption. The four qualities that are clearly stronger influences than the others are *all* market forces, i.e. short and long-term profitability, increased competitiveness and niche markets.

# 4	Conclusions

The empirical validity of the Porter Hypothesis (PH) has been the subject of much debate in both academic circles as well as the public policy arena. The contention that 'win-win' outcomes are omni-present but simply require the stimulus of stringent (well-designed) environmental legislation has been challenged. In this paper, we have investigated attitudes to environmental performance enhancement in the corporate world in terms of the drivers for the 'greening' of industry. What we are asking is essence is this: if there is a trade-off between corporate social responsibility (CSR) and corporate social responsiveness then which force is likely to dominate, and to what extent does this apply? This discussion is important in that many would argue that the 'low hanging fruit' of win-win outcomes professed by the PH have been picked and there is now (or soon will be) a trade-off.

The majority of such attitudinal surveys in the past have, in our view, floundered in that the methodologies used do not force the respondent to make a choice between attributes, i.e. to define how important one driver for eco-reform is *relative* to another. The nature of the methodology used in this paper - Analytical Hierarchy Process (AHP) - forces this choice on the survey respondents.

The firms surveyed were SMEs with extant EMSs. Since these firms are not in the public eye to the same extent as Fortune 500 companies and are less likely to have a CSR 'position' to report, the responses are perhaps more meaningful owing to this survey selection. The strongest finding from the results is that the drivers that might be linked to CSR (the environmental and social benefits arising from the EMS) were amongst the least significant drivers whilst both long term profitability was clearly the strongest driver. In instances where there is a trade-off between responsibility and responsiveness, the results of our survey suggest that the 'greening' bandwagon may come to a halt, despite the almost prophetic protestations to the contrary from some authors in the literature.

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