Sustainability drivers, barriers and outcomes: Evidence from European High Performance Manufacturing companies

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***Abstract*— Implementing sustainability practices has become a requirement to be able to operate in several markets since the legal requirements are increasing and society (as well as customers) values sustainability behaviors more.**

The aims of this paper are (1) to analyze the impact that drivers and barriers have on Environmental practices implemented in the high performance manufacturing industries, (2) to identify the relevant drivers and barriers for these environmental practices, and finally, (3) to study the influence that Environmental practices have on companies´ Financial Performance.

To carry out our research, we shall consider a European database of companies involved in the High Performance Manufacturing project. Partial Least Squares (PLS) will be used to test our hypotheses.

Keywords*— *Environmental Practices; Drivers; Barriers; Financial Performance; High Performance Manufacturing Industries.

I. INTRODUCTION

Companies are increasingly more concerned with being environment-friendly due to pressures from several stakeholders and society [1]. They argue that firms have responsibilities and they have to reduce their impact on the environment [2], so environmental management should become a core part of the business.

Although there are lots of laws and regulations in most of countries to protect the environment, nowadays for firms it is not sufficient to comply with the law [3]. For this reason, organizations have been forced to change their environmental engagement and commitment exceeding the legal requirements and making significant investments that enable them to be eco-efficient.

The aims of this paper are (a) to analyze the impact that drivers and barriers have on Environmental practices implemented in high performance manufacturing industries, (b) to identify the relevant drivers and barriers for these environmental practices, and finally, (c) to study the influence that Environmental practices have on companies´ Financial Performance

Regarding first and second aims, the literature has made several efforts to try and identify sustainability barriers and drivers. Notwithstanding, there is not much research that quantifies the impacts of both on the sustainability practices implemented by companies.

Most of the literature on sustainability focuses on the outcomes, and mainly on their relationship with Financial Performance. However, the results are heterogeneous.

To carry out our research, we shall consider a European database of companies involved in the High Performance Manufacturing project. The Partial Least Squares technique will be used to test our hypotheses (PLS).

The remainder of the paper is organized as follows. In Section II, we focus on the debate around the drivers and barriers of environmental practices, and also Financial Performance. In Section III, we look more closely at the sample and variables used, as well as the methodology employed. Section IV presents the results of our study and the discussion. Finally, in Section V we present the main conclusions.

II. SUSTAINABILITY PRACTICES: DRIVERS, BARRIERS AND FINANCIAL PERFORMANCE

A. Drivers and Barriers

To identify the forces that are driving or blocking sustainability efforts in manufacturing plants is extremely important for being able to put appropriate policies in place. Notwithstanding, there is only limited research that quantifies the impacts of both of these on the sustainability practices implemented by companies.

Top management commitment, prompt implementation of a new law, cost savings due to environmentally-friendly behavior, and employee engagement have been identified in the literature as sustainability drivers [4, 5].

The literature states that the most relevant barriers are the high cost of implementing sustainability practices, resistance to change, the existence of insufficient resources (time and human) and the fact that environmental practices are not deeply-rooted in company strategy [6-10].

Considering the evidence, we expect:

H1: Drivers to have a positive impact on sustainability practices implemented by companies.

H2: Barriers to have a negative impact on sustainability practices implemented by companies.

B. Environmental practices and Financial Performance

The relationship between sustainability actions and financial performance has been the object of numerous debates and discussion in the literature due to the heterogeneous results found. Recently published literature reviews and meta-analyses are evidence of this intense discussion [1, 11-13].

In addition to the differences observed in the results of those research works, there is no consensus as to the direction of the causality (which factor is the cause and which the consequence), or even the sign of this relationship (positive, negative or no relation).

On the one hand, there is a group of studies that focuses on the effect that the company's financial situation has on the implementation of sustainability practices [14]. In this respect, it is reasonable to think that, depending on the availability of resources, companies will be more or less committed to these kinds of practices since their main objectives are to survive and satisfy shareholders´ needs (Lack of Resources Theory [15]).

A further step forward is taken when the agency problem is considered because simply having enough available financial resources is not a guarantee that they are invested in sustainability (Managerial Opportunism Hypothesis [16], and Agency Theory [17]). Managers are more linked to the short term, so their objective is to achieve maximum profitability every year. Nevertheless, reference shareholders are more concerned about long-term repercussions since their reputation is related to company image. Depending on who wields the power (managers or shareholders), this means an increase or decrease in sustainability actions.

On the other hand, most of the studies focus on the impact that implementing sustainability practices has on a company´s financial performance [18-20]. That is, *is it worth being green?*

The implementation of most environmentally-friendly actions undoubtedly implies a major investment in training and equipment [21]. The cost of most of these actions is easy to identify, while the profits are not as straightforward to evaluate [22] and are almost always subject to time lags [21]. Therefore, implementing Environmental practices has a negative influence on the firm´s performance (Trade-Off Theory [23]).

Nevertheless, some authors argue that environmentally-friendly practices could also involve cost savings (through a reduction in the resources used in the productive process [24, 3] and reduction in emissions [25]). Making large investments is not incompatible with obtaining profits from them (Eco-Efficiency Theory [26]).

In addition, profits could come from differentiation strategy (Win-win strategy [27]). Consumers are more and more aware and appreciate it when a company cares for the environment, and this drives up the company's reputation and differentiates its products from others.

Based on the information available on the database (we have the measure of the perceived impact that environmental practices have on the Financial Performance), we have to focus our research on the last direction of causality discussed. Consequently, our third hypothesis is:

H3: Environmental practices have an impact (+ or -) on companies´ Financial Performance

III. MATERIALS AND METHOD

A. Sample

The sample is composed of European companies from the machinery, electronics and automotive components industries which are involved in the High Performance Manufacturing international project (HPM project).

The HPM project database is an international database that has been built on the basis of responses given to a regular survey carried out of a sample of manufacturing plants. The questionnaire used to collect sustainability data has been developed on the basis of measures previously validated in the academic literature. All the sustainability items are measured by a Likert Scale of 1 to 5.

At the time of finishing this manuscript, data from four countries was available: Germany, Italy, Spain and Sweden. A total of 86 observations were considered. The distribution of the observations by country and industry is reported in Table I.

TABLE I. SAMPLE DISTRIBUTION

Country	Number of companies	Machinery	Electronics	Automotive components
Germany	26	6	12	9
Italy	29	7	17	5
Spain	22	5	6	11
Sweden	9	4	4	1

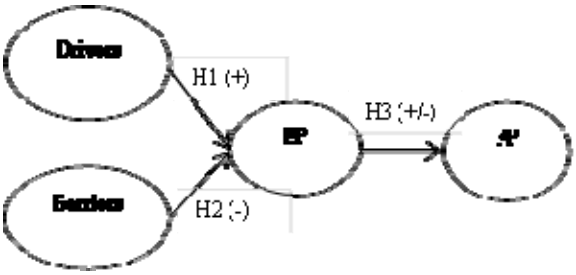
The variables included in the analysis are Drivers, Barriers, Environmental Practices and Financial Performance. The first three are latent variables that are composed of different indicators in the HPM project: Drivers (24 indicators- validity checked [4, 5]), Barriers (8 indicators- considering the qualitative evidence from [6-10]), and Environmental Practices (EP; 42 indicators- validity checked by [8, 9; 28-34].

In the case of the Financial Performance (FP) variable, it is only composed of one item range from 1 to 5 (Likert scale) which values "managers´ perception of the financial performance obtained by the company as a result of undertaking environmental initiatives".

B. Model

The model and the previously discussed hypotheses are shown in Figure 1.

Fig. 1. Model with hypotheses.



C. Statistical Method: PLS

Structural equation modeling (SEM) is a family of multivariate techniques that combine aspects of multiple regression and factor analysis to simultaneously estimate a series of interrelated dependence relationships. Data analysis through SEM has expanded rapidly in recent years in many fields of social and management sciences.

SEM analysis can be carried out using two different methods: covariance-based -LISREL, AMOS- and variance-based –PLS- [35]. Taking into account that our model considers the presence of formative indicators, the complexity of the model (a large number of indicators) and the small sample size, PLS is more suitable for our estimation [36, 37].

In all SEM models, the Measurement model (which shows how each latent variable is composed) and the Structural model (which presents the causality relationships between the latent variables) have to be evaluated.

Measurement/outer Model

Considering the previously mentioned literature, all the latent variables (Drivers, Barriers, and Environmental Practices) are built through formative indicators. This means that each indicator or item is a cause of the construct [38], and consequently they should present no collinearity. We carried out an analysis [39] to remove the collinear indicators: FIV>30 and that two or more proportions of variance are over 0.5.

In our case, the latent variables have been built through the indicators provided by the HPM international project database. Finally, the weights of the indicators should be valued to understand which have a strong influence on each of the latent variables.

Structural/inner Model

This model has to quantify the measure of the causality relationship between constructs. The PLS algorithm shows the path coefficient for each relationship and the R^2 for each dependent construct. To see the significance of the parameters, bootstrapping analysis was performed considering 500 resamples (at is recommended in the literature). Finally, the *Stone-Geisser test* was run through a blindfolding procedure to study the predictive relevance of the dependent constructs of the model [40, 41].

IV. Results and Discussion

A. Measurement Model

Firstly, the collinearity tests have been run, since the indicators of the three latent variables are formative. Once they were completed we had to eliminate 2 indicators from Barriers (6 included), 7 from Drivers (finally 17 included). None were eliminated from Environmental Practices (35 included).

The results of the measurement model analysis and the weights of each indicator on its latent variable are presented in Table II.

For the Drivers variable, the items which show a greater effect are (1) top management commitment to a sustainability approach, (2) the current environmental regulations, and (3) the desire for cost savings brought about by any implemented Environmental practices.

The indicator that has a strong influence on the Barriers variable is the cost of implementing environmental projects or practices. Finally, the items that most influence Environmental Practices are (1) giving preference to materials with third party certifications and (2) those related to the suppliers, particularly their involvement in the re-design of internal processes and to visits to ensure that they are not using sweatshop labor.

B. Structural Model

Once the measurement model had been positively evaluated, the existence of the relationships was tested with the structural model. The results are shown in Table 3. It could be deduced from these that hypotheses 1and 2 were statistically supported, while the relationship between Environmental Practices and Financial Performance shows no significance at all.

TABLE II. Structural Model Results

	Expected sign	Path Coefficient	R^2	Q^2
H1: Drivers > EP	+	0.427 ***	0.558	0.043
H2: Barriers > EP	-	-0.473 **		
H3: EP > FP	+/-	-0.677	0.459	0.500

*** p-value <0.01; ** p-value <0.05. H1 and H2 significance is based on one-tailed t-student distribution. H3 significance based on a two-tailed t-student distribution.

The model shows good goodness of fit of the Environmental Practices, since the R2 is higher than 0.5 (R2=0.558). Furthermore, the predictive measure for the

endogenous construct also achieves a value higher than 0 (Q2 =0.043), indicating that the model has predictive relevance.

In the case of Financial Performance, the model presents better predictive relevance (Q2 =0.500) with good explained variance (R2=0.459).

V. CONCLUSIONS

Considering the aims of the paper, it can be concluded that drivers have a positive effect on Environmental Practices, while barriers have a negative influence on them.

The most influential drivers are those linked to the engagement of company directors, and new regulations. The most significant barrier is the cost of implementing this kind of practice.

Finally, regarding the relationship between Environmental Practices and Financial Performance, it can be concluded that managers do not perceive that Environmental Practices have any significant impact on Performance.

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TABLE III. INDIVIDUAL ITEM WEIGHTS.

	Drivers	Barriers	Environmental Practices
D1	-0.0515		
D2	-0.3315		
D3	-0.1206		
D4	0.6002		
D5	0.0494		
D6	-0.0914		
D7	0.2289		
D8	0.1353		
D9	0.3127		
D10	0.0899		
D11	-0.5161		
D12	-0.3631		
D13	0.1129		
D14	0.2131		
D15	0.2442		
D16	0.4535		
D17	-0.5763		
B1		0.9919	
B2		-0.394	
B3		0.3337	
B4		0.2869	
B5		-0.1604	
B6		-0.2302	
EP1			0.3757
EP2			0.4186
EP3			-0.0776
EP4			-0.1492
EP5			-0.1431
EP6			0.1411
EP7			0.5235
EP8			0.0376
EP9			0.1266
EP10			-0.061
EP11			0.0158
EP12			0.102
EP13			0.3819
EP14			-0.181
EP15			0.1723
EP16			-0.5045
EP17			0.5047
EP18			0.0765
EP19			0.3093
EP20			-0.3374
EP21			-0.157
EP22			-0.3063
EP23			0.0766
EP24			-0.7482
EP25			0.0028
EP26			-0.3665
EP27			-0.3895
EP28			0.5085
EP29			-0.241
EP30			0.3802
EP31			0.0336
EP32			-0.2818
EP33			-0.1317
EP34			-0.2902
EP35			0.6104

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