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How Agility influences the impact of green practices on operational performance

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Abstract

This study aims to empirically verify the relationship between Green supply chain management practices, intended as the adoption of sustainable initiatives along the supply chain, and company operational performance. What I argue is that, all else being equal, companies that invest in green initiatives experience a stronger operational performance. Furthermore, I argue that companies that have high agility in promptly changing suppliers and accommodating changes in the production mix will experience stronger effects from green supply management on operational performance respect to companies that do not. Therefore, the investigated research questions are: "Do green supply chain management practices positively influence firms' operational performance?" and "Does a firm's agility moderate the relationship between green supply chain management practices and the firm's operational performance?"

The whole analysis has been conducted breaking down the two research questions into six different hypotheses tested one by one, using a sample of 172 European companies. The construct of green supply chain management was separated into three independent variables, recycling & recovering activities, green packaging and sustainable raw materials. Finally, the hypotheses were tested using an ordinary least square moderated regression. All the available data refer to the years 2019- 2020.

The results of the study provide empirical evidence that: Companies that implement recycling, recovering and reusing practices will experience a significant and positive impact on operational performance; companies that implent environmentally friendly raw materials and/or green packaging will not experience any significant increase in operational performance. Furthermore, the moderation analysis reveals that a firm's agility positively moderates the relationship between green packaging and operational performance, and that between environmentally friendly raw materials and operational performance. I therefore discuss the relevance of increasing agility to improve the operational performance through sustainability initiatives. The managerial implications of these results are: If a firm that implements green packaging and sustainable raw materials, lacks the ability to promptly adapt new product processes from new suppliers, it would likely experience disruptive effects on some components of operational performance, such as cost, lead time, time to market, and level of service.

Keywords: Green Supply Chain Management, Operational Performance, Firm's Agility

1. Introduction

Concerns about global temperature rising and waste pollution, raised by the scientific community and brought to the public perception through international treaties such as the Kyoto Protocol in 1997 and the Paris agreement in 2015, have brought environmental management to the center stage in operations and supply chain management. These environmental concerns have pressured companies to increasingly recognize the importance of becoming environmentally proactive and to take the initiative to develop and implement “green strategies" that preserve the environment (Gifford, 1997). Proactive environmental policies include developing green products and packages, conserving energy, using alternative energies, reducing material waste, reducing Co2 emissions, recycling, and creating a corporate culture that is environmentally sensitive.

Sustainability is profoundly changing the way companies conduct their business. Managers as well as researchers have reported various financial and non-financial benefits through green initiatives, such as operational performance improvements, increases in share prices, improved brand reputations, enhanced stakeholders/investors relations and even increased innovativeness (Russo and Fouts, 1997; Christmann, 2000; Pagell et al., 2004; Svensson, 2007; Pagell & Gobeli, 2009). However, while the advantages of investing in environmental practices are apparent, some managers and researchers still find it difficult to articulate a business motivation for it. In fact, from an economic and operational point of view it is very important to consider whether environmental initiatives save more money than they cost, or more energy than they consume. This is because, if we consider firms as utility maximizers, they will pursue environmental goals and minimize waste and emissions only if effective incentives for doing so exist. These incentives are of two natures: government regulations (firms will follow them to avoid fines) and economic incentives (if green initiatives save money with respect to traditional ones, companies will follow them for cost reasons alone). In order to achieve operational improvements, firms must adopt environmental practices that yield competitive advantages at the supply chain level and improve performance for individual supply chain partners (Green et al., 2008). To do so, the development of environmentally friendly processes, products, and services requires a unified effort by all members of the supply chain to avoid sub-optimization at the partner level (Vasileiou & Morris, 2006).

With the aim of contributing to the literature on the topic, this paper investigates the impact that green supply chain practices have on firms’ operational performance to understand their causal relationship. Furthermore, we are particularly interested in how agility, intended as the agility to which firms can promptly change suppliers and accommodate changes in the production mix, can change the nature of the relationship.

A sample of 2,000 European organizations, primarily with headquarters in Italy and France, was surveyed, with a response of 174 companies. The respondent sample was composed of top-level executives in the position of CEO/President/Vice President, Product Manager, Purchasing Manager, Logistics/SC Manager, and other high-level professionals. This paper explores the sample using a combination of statistical techniques. The hypotheses are tested using an ordinary least square moderated regression, where operational performance is used as the dependent variable, while recycling practices, sustainable raw material and green packaging are used as independent variables. The agility factors are represented into the regression as coefficient in order to explain how agility affects the main statistical relationship between the independent variables and operational performance.

The findings reveal that recycling, recovering and reusing practices have a significant and positive impact on operational performance, likely caused by a cost reduction during the manufacturing process (Tonjes, 2013) or by a boost in the company's public image and sales. However, the availability of an efficient technology for sorting and processing is crucial in determining the profitability of the initiatives. The results from the regression reveal no significant relationship between environmentally friendly raw materials and operational performance, and between green packaging and operational performance. The purchasing cost of sustainable raw materials for both manufacturing and packaging activities is usually initially higher with respect to more traditional and non-sustainable options. This causes the adoption of these sustainability practices to have an insignificant or negative effect on operational and economic performance (Zhu and Sarkis, 2004). The subsequent moderation analysis reveals that a firm's agility positively moderates the relationship between green packaging and operational performance, and the relationship between environmentally friendly raw materials and operational performance. This result indicates that if a firm that implements these practices lacks the ability to promptly adapt new product processes from new suppliers, it would likely have disruptive effects on some components of operational performance, such as cost, lead time, time to market, and level of service. The main managerial implication stemming from the results is that generally, the adoption of sustainable packaging and raw materials alone doesn't achieve better operational performance. In order to obtain optimal operational performance, a firm must first increase its agility and then invest in sustainability initiatives.

The paper is structured as follows: Chapter 2 lists our main hypothesis and summarizes the existing literature on the topic, displaying research findings from other scholars that either support or contrast our hypothesis. Chapter 3 describes the research hypothesis and the conceptual model. Chapter 4 deals with the research methodology that we adopted for testing the hypothesis;

questionnaire design and data collection are described, highlighting the characteristics of the empirical analysis. Chapter 5 displays the results of the ordinary least square moderated regression while Chapter 6 discusses our findings with a focus on managerial implications. Finally, Chapter 7 summarizes the paper's findings and draws conclusions.

2. Literature review

2.1. H1 Green supply chain management practices are positively associated with firm's operational performance

2.1.1. H1a: Recycling, recovering, reusing environmental practices are positively associated with firm's operational performance

Social and environmental changes have led to a managerial rethinking of the necessity for a firm to be not only sustainable from a performance viewpoint, but also from a social and environmental perspective (De Brito et al., 2008). As a result, stakeholders now increasingly tend to judge the success of a company no longer solely in terms of financial performance aspects, but also in terms of social and environmental performance (O'Brien, 1999; Linton et al., 2007; Montabon et al., 2007). Companies are increasing their efforts and investments towards practices related to energy savings, the usage of renewable energy, reduction of waste, and very importantly, recycling (WCED, 1987; Linton et al., 2007).

The impact of recycling, recovering, reusing and other environmental procedures along the supply chain on operational performance has been preliminary studied in the literature. However, the field has not yet reached a unique conclusion on the nature of the relationship and proposes diverse conclusions. Zhu and Sarkis (2004) argue that the most significant result of green supply chain management is to improve environmental performance. According to Rao (2002), economic gains following the greening of the supply are usually understood by companies as screening suppliers for environmental performance and certifications and then doing business with only those that meet regulatory standards. This implies that in a regulated market, enterprises that minimize the negative environmental impact of their products with recycling and reusing are likely to drive out competitors that fail to promote strong environmental performance and thus increase the size of their market share. Other scholars, like Klassen and Mclaughlin (1996), using financial event methodology and archival data of firm-level environmental and financial performance, empirically tested a model that links strong environmental management to improved future financial performance as measured by stock market performance.

Overall, it is complicated to assess and empirically test whether recycling and reusing, and more generally green supply chain management initiatives have a positive or negative impact on firms' operational performance. Many managers believe that a trade-off exists where increased level of environmental management results in increased cost (Walley & Whitehead, 1994).

From their viewpoint, the need to become environmentally sustainable needs to be balanced by the need to be economically sustainable, and this balance is not always achieved. Some scholars have found that green supply chain management has a negative impact on the economic and operational performance of enterprises. Horbach et al. (2012) believed that recycling and reusing activities in the production chain will increase the burden and cost of companies by increasing the cost of their production processes, thus damaging their economic interests.

Wiengarten et al. (2013) analyzed the data of European countries in the GMRG (Global Manufacturing Research Group) from 2006 to 2008 and found that implementing green supply chain management has a negative impact on the economic and operational performance of the supply chain. Miroshnychenko et al. (2017) found that the adoption of the ISO 14001 certification has a negative impact on the economic performance of companies. Gallop and Roberts (1983) conducted a study on the cost of operations in the electricity utilities industry and found that generally environmental regulations are associated with a decline in industry productivity.

On the other hand, many scholars have found the opposite result: Green et al. (2012) analyzed data from 159 manufacturing companies; the research results showed that the application of green supply chain management in manufacturing enterprises had a positive impact on environmental performance and economic performance, which in turn lead to an increase in operational and organizational performances. Tooru (2001) demonstrated, using a case study, that a recycling system can improve operational performance of a firm. Klassen and McLaughlin's (1996) built a theoretical model, linking environmental management to lower costs and increased income. Finally, De Giovanni and Zaccour (2013, 2014) highlighted the benefits of implementing a GSCM in the form of closed-loop supply chain in which the return rate is a proxy of both, the environmental performance (low discard in environment) and economic performance (lower production cost due to the usage of returned components).

In summary, the literature offers considerable evidence that recycling and reusing activities can positively influence economic and operational performance. These activities can bring cost savings by cutting the need for electricity and natural resources (Micks 2012). On the other hand, scholars warn us that, unless specific requirements are met, the cost of recycling and recovering might outmatch the economic and operational benefits. Specifically, the availability of an effective sorting and processing plant and efficient reverse logistics activities are crucial in determining whether the

cost saving is greater than the additional cost. Therefore, the increased costs brought by recycling and reusing activities is likely to be associated with the setup of specific sorting and processing plants, reverse logistics activities and the transference of externalities, such as pollution and material waste leftovers back to the firm.

Our research hypothesis is relevant because, even though the academic literature provides evidence on the impact of green supply chain management on economic performance, it doesn't study in depth its effect on operational performance. Moreover, no other study highlights the specific relationship between recycling, recovering and operational performance, which as a result is largely understudied. This paper aim aims at contributing to the research pool on the topic.

2.1.2. H1b: Green packaging is positively associated with firm's operational performance

One of the most relevant aspects of a green supply chain is packaging, as it can be recycled or reused along all the steps of the chain, from purchasing to handling. This activity can have a significant environmental impact, as packaging materials account for the largest portion of the municipal waste stream[1] (Min & Galle, 1997). According to Lewis and Sonneveld (2004), packaging sustainability will need to reconcile consumer expectations regarding increasing needs for convenience, safety, and shelf life with the higher aspirations that consumers and companies alike have for a greater environmental sustainability of packaging. These requirements are reflected in the first official draft definition of sustainable packaging that was put forth by the Sustainable Packaging Alliance (SPA), utilizing the results from a stakeholder survey. Sustainable packaging is described as: effective, efficient, cyclic, and safe (Fitzpatrick et al, 2005). Sustainable packaging is effective, as it adds real value to society by effectively containing and protecting products as they move through the supply chain. Additionally, it is efficient, as it uses materials and energy as efficiently as possible throughout the product life cycle (storage, transport and handling). Furthermore, it is cyclic, as it is cycled continuously through natural or (industrial) technical systems, minimizing material degradation and/or the use of upgrading additives; or alternatively uses non easily degradable materials. Finally, sustainable packaging is safe, as its components do not pose any risks to human health or ecosystems.

The employment of green/recycled packaging can affect operational performance by reducing production cost; in fact, recent evidence links strong environmental performance to lower manufacturing costs, often by eliminating waste (Porter and van der Linde, 1995). Lower costs can

[1] consists of waste collected by or on behalf of municipal authorities and disposed of through waste management systems. Municipal waste consists mainly of waste generated by households, although it also includes similar waste from sources such as shops, offices and public institutions.

also result from the identification and reduction of inefficient processes that were used with more traditional packaging (Klassen & McLaughlin, 1996) and from better coordination with suppliers. In fact, a crucial phase for the implementation of sustainability initiatives that include green packaging is the procurement phase (Williams et al.,1994). This is because packaging activities are often outsourced, or packaging material often purchased from third parties. Purchasing managers can ask upstream members of the supply chain to commit to waste reduction goals and to design and provide the purchasing firm with the materials and components identified through the design for disassembly and life-cycle analysis. In order to ask suppliers to commit to waste reduction goals, the supply chain must be integrated and effectively communicating (Stock, 1992).
A real example of this cost reducing process is that of General Mills: the company has used recycled cereal boxes since the 1950s because of their low-cost related to virgin material. General Mills constantly evaluates the costs and benefits to set up recycling centers and reverse distribution infrastructures needed to receive supplies of packaging and containers (Carter et al., 1998). It is likely that, with the more recent environmental initiatives taken by many companies, recycled packaging has become available at lower costs due to the development of reverse logistics infrastructures, including recycling facilities (Stock, 1998).

According to the literature, practices that aim at reducing material waste, such as "package lightweighting" can impact on operational performance not only by reducing the cost of packaging, but also by reducing emissions and transportation costs by increasing the amount of product which can be shipped due to decreased weight. However, it is important to point out that blindly following a goal of package lightweighting that does not respect the effective, efficient, cyclic, and safe requirements can lead to increased damage and spills, which are more costly and harmful to the environment than the benefits accrued through packaging reduction (Gray and Guthrie, 1990). The academic literature highlights how green packaging can produce cost reductions for a company adopting it, but it also warns about the risk that an organization incurs by not taking into consideration the possible initial increase in purchasing cost or the core elements of effective packaging. To sum up, the main consideration is that companies should cut material waste in favor of recycling or alternative materials without sacrificing the packaging core function of protecting the goods it contains. With this tradeoff in mind, our hypothesis and our study are relevant, as the effect on operational performance is under researched, and more importantly, no other paper has highlighted the implications of firm's agility on the relationship between green packaging and operational performance.

2.1.3. H1c: Environmentally friendly raw materials are positively associated with firm's operational performance

When trying to assess how the use of sustainable raw materials impacts on a firm's performance, scholars stress how such effect will be insignificant or even negative on the company's short-term economic performance. At the same time, academic literature highlights how sustainable raw material use is likely to enhance economic and operational performance in the long-term. Rao and Holt (2005) focus on how firms that introduce sustainable initiatives, such as environmentally friendly raw materials will be remunerated only in the long run with benefits such as reduced risk and cost, enhanced corporate image and improved marketing advantages. In particular, the improvement in corporate image is likely to translate into higher sales and better economic performance (Jacobs et al., 2010). Minimizing waste, and therefore cost, will consequently result in a better utilization of natural resources, improve the efficiency and lead to higher productivity which ultimately translates into decreasing operational cost. On the other hand, some scholars like Zhu and Sarkis (2004) affirm that environmental management and green raw materials produce a stronger negative impact on economic performance due to higher investments and purchasing cost. Bowen et al. (2001) found that the positive impact of environmental performance on the economic performance cannot be attained within the short-term. Instead, firms engaging in greening the supply chain will provide the basis for long-term superior performance. To further elaborate, according to Rao (2002), integrated activities between supply chain members, such as collaboration, joint environmental programs and common planning are time and resource-intensive approaches that do not pay off instantaneously. However, some scholars argue that synergetic effects between traditional practices, such as lean and quality, and environmental practices, such as raw material waste reduction, are possible. Under this perspective, De Giovanni and Cariola (2020) affirm that lean practices facilitate the supplier collaboration on environmental programs. Furthermore, leanness positively contributes to environmental and operational performance, exerting a positive second order effect on economic performance, which should then be pursued as a long-term target. Wiengarten (2013) supports this theory arguing that the impact of lean and quality practices on operational supply chain performance can be amplified through environmental practices such as the ISO 14001 certification, pollution prevention, recycling of raw materials and waste reduction.

Our research hypothesis is relevant, as the academic literature provides plenty of evidence on the impact of green supply chain management on economic performance but doesn't study in depth the relationship between the GSCM and operational performance. Moreover, there seems to be a

research gap on the specific relationship between environmentally friendly raw material and operational performance.

2.2. H2 Firm's agility moderates the relationship between green supply chain management practices and firms' operational performance.

There is little evidence on whether and how a firm's agility changes the impact that green supply chain management practices have on operational performance, at least, as specifically as it is intended for the purpose of this paper. For this reason, the literature will be studied here using a single hypothesis that will later be divided into three different hypotheses addressing the single independent variables: recycling & recovering activities, green packaging and sustainable raw materials.

We identify the agility factor as "the agility to promptly change the quantity and the delivery time of suppliers' and customers' orders, to easily accommodate changes in production mix and customization, to facilitate rapid decision making, and to easily change suppliers and logistics strategies". If we take a more general approach, the academic literature offers considerable evidence linking green supply chain success to the ability of ERP information systems to facilitate information sharing among supply chain partners (Green et al., 2007). Because environmental sustainability is a supply chain level imperative (Vachon and Klassen, 2007), it is important that organizations develop information systems capable of integrating and coordinating environmental sustainability initiatives with suppliers and customers (Esty & Winston, 2006). This concept can be linked to our definition of a firm's agility, because to promptly change the quantity and the delivery time of suppliers' and customers' orders as well as to easily change suppliers and logistics strategies, a company needs a robust information network linking suppliers and customers. As the firm's SCM strategy expands to incorporate the environmental sustainability practices, that include purchasing environmentally friendly raw materials and packaging, or participating to joint environmental programs, the firm's ERP system must expand as well to monitor environmental efforts and outcomes in cooperation with customers and suppliers. Therefore, we can assume that a firm's agility must have a certain degree of impact on how green supply chain management practices influence operational performance.

According to Zelbst et al., (2012) green information systems provide the information necessary to make decisions about green purchasing, thus impacting on the ability to implement green supply chain practices. This in turn will impact on environmental performance, economic performance, operational performance, and organizational performance. In order to efficiently employ green

supply chain practices, Zelbst (2010) argues that most business processes such as purchasing, manufacturing, marketing, logistics must be integrated and coordinated, focusing on efficiency and responsiveness to market changes.

Some researchers have investigated sustainability issues within the context of supply chain management (Linton et al., 2007; Pagell et al., 2007; Pagell et al., 2010). Many sustainable supply chain studies focus on how procurement and supplier selection and management (e.g. Svensson, 2007; Walker and Brammer, 2009; Ehrgott et al., 2011). Pagell et al. (2007) behave as consequence of environmental investments. They found mixed results in terms of environmentally based performance impacts on cost and quality. Besides others, Paulraj (2011) identified that strategic purchasing is a key capability for the success of sustainable supply chains. Following this logic, our construct "agility to which firms can promptly change suppliers and accommodate changes in the production mix" results to be extremely relevant in determining the success of green initiatives. Previous research has demonstrated that sustainability aspects in procurement and supplier management clearly impact on various aspects of the supply chain. However, this only represents a limited view of supply chain management and performance. Despite these research efforts it is still relatively unclear how environmental investments impact on the supply chain as a whole, and not only from a demand side.

While many studies on the effects of green initiatives were conducted, the extent to which a firm's agility changes those effects remains unknown. Through our research we aim to study how a firm's agility moderates the relationships between specific factors such as recycling, sustainable raw materials and packaging and operational performance.

3. Research hypothesis and conceptual model

The analysis of the literature reveals a research gap composed of two main pieces of evidence. First, a unique conclusion on the nature of the relationship between green supply chain practices and firms' operational performance has not been reached yet. Therefore, our findings would contribute to the research pool on the topic. Second, how a company's agility moderates (impacts on) the relationship between the adoption of green supply chain management practices and the company's operational performance turns out to be under-investigated.

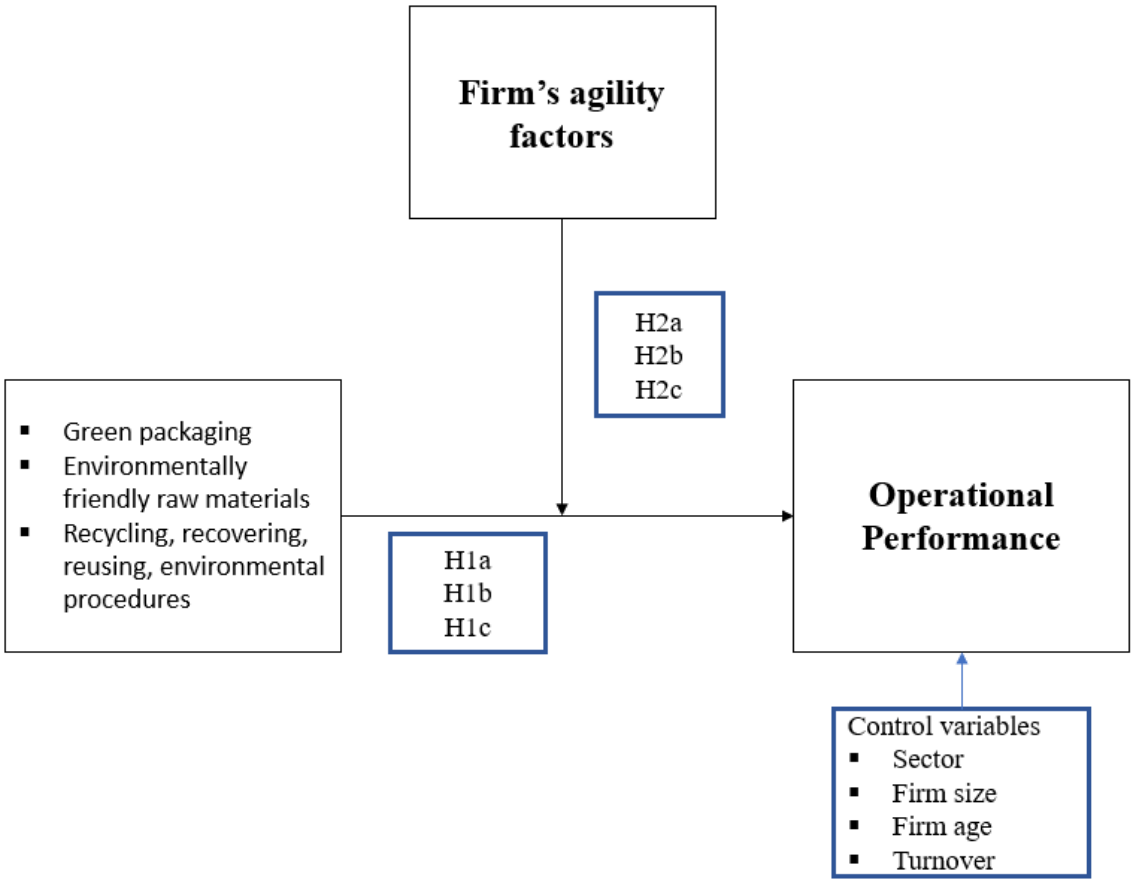
With the aim to fill this gap, this research addresses two main research questions:

"Do green supply chain management practices influence positively firms' operational performance?"

And

"Does a firm's agility moderate the relationship between green supply chain management practices and the firm's operational performance?"

Figure 1. Conceptual model



Therefore, I develop the following hypotheses:

H1a**:** Recycling, recovering, reusing environmental practices are positively associated with firm's operational performance.

H1b**:** Green packaging is positively associated with firm's operational performance.

H1c**:** Environmentally friendly raw materials are positively associated with firm's operational performance.

H2a: Firm's agility moderates the relationship between recycling, recovering, reusing environmental practices and firms' operational performance.

H2b: Firm's agility moderates the relationship between green packaging and firms' operational performance.

H2c: Firm's agility moderates the relationship between environmentally friendly raw materials and firms' operational performance.

4. Research methodology

4.1. Questionnaire design and data collection

A sample of 2,000 European organizations was surveyed by using among the partnering firms with the institutions involved in this research. The following tables display the details of the survey questions and the measures. Faculty members in the field of SCM and four production managers were contacted as experts to verify the content validity. We received 172 responses after 22 weeks. The effective response rate was thus 8.6 percent (172/2,000). To check the representativeness of the sample with respect to the population, we conducted the two-proportion t-test for each category. We find that the proportions in the sample for each category are not significantly different from the proportions in the population. In fact, *p*-values gives 0.75 regarding the size, 0.83 regarding the sales, and 0.92 regarding the sector. Therefore, the sample is representative of the population. The respondent sample can be considered appropriate for this study as it was composed of top-level executives in the position of CEO/President/Vice President (23.84%), Product Manager (27.33%), Purchasing Manager (21.51%), Logistics/SC Manager (12.21%), and other professionals (15.12%). The data collected was primarily from companies with the headquarter in Italy and France, 31.40% and 22.09%, respectively. The results reveal a heterogeneous industrial panorama with the 4 (22.09%) and 0 (19.19%) sectors predominating. All the characteristics of the organizations in the sample are shown in Table I. Respondents were asked to complete the survey with respect to their strategic business unit's supply chain. The survey was pre-tested on a pool of experts (e.g., academic faculty members, Ph.D students, professionals, managers) who were asked to comment on the wording, clarity, completeness and scaling of the survey instrument. Some improvement changes were made as a result of this feedback. Several approaches for non-response bias were carried out. The first approach consisted of comparing early to later respondents (i.e., first and second to third surveys). A one-way ANOVA was conducted on mean responses to each question. We also used size and total revenues, and we were unable to identify any statistically significant differences between the two groups.

Table 1. Sample composition

CompanyBirth	#	%	Number of employees	#	%	Tourover	#	%	Type	#	%	Headquarter	#	%	Sector	#	%	Professionals	#	%
>15 years	118	68.60	<200	39	22.67	<=20M	32	18.60	Manufacturer	127	73.84	Italy	54	31.40	Electronics	33	19.19	Production manager	47	27.33
10-15 years	8	4.65	200-499	58	33.72	20-100M	68	39.53	Distributor	39	22.67	France	38	22.09	Textile	20	11.63	CEO/director/vice-director	41	23.84
4-10 years	16	9.30	500-799	58	33.72	100-200M	59	34.30	Others	6	3.49	Portugal	17	9.88	Power	24	13.95	Logistics/SC manager	21	12.21
<4 years	30	17.44	>=800	17	9.88	>=200M	13	7.56				Germany	16	9.30	Automobile	8	4.65	Purchasing manager	37	21.51
												Spain	15	8.72	Electrical	38	22.09	Others	26	15.12
												Belgium	10	5.81	Chemical	18	10.47			
												UK	10	5.81	Petroleum	7	4.07			
												Netherlands	6	3.49	Pharmaceutics	11	6.40			
												Others	6	3.49	Agriculture	10	5.81			
															Others	3	1.74			
	172	100		172	100		172	100		172	100		172	100		172	100		172	100

4.2. Measures

The survey scales employed were either established scales or were developed and validated from the literature. All constructs are reflective and measured using a 7-point Likert scale, indicating the level of agreement with a certain question (where 1=strongly disagree and 7=strongly agree). In Appendix, we describe the items together with their means and standard deviations.

Operational performance: a six-item scale was used to assess the ability to perform in some operational tasks over the past 2 years. Respondents were asked to identify metrics relating to total cost reduction, lead time, time to market, quality standards, process improvements, and level of service.

Agility: a seven-item scale was used. Respondents were asked the extent to which they were able to promptly change the quantity and the delivery time of suppliers' and customers' orders, to easily accommodate changes in production mix and customization, to facilitate rapid decision making, and to easily change suppliers and logistics strategies over the past 2 years.

Environmental practice: the environmental practices were measured as single variables. Hence, respondents assessed the extent to which the firm invested in green packaging, green raw material, and recycling-related practices over the past 2 years.

Control variables: four control variables were included in the analysis. First, a series of dummy variables were used to control for industry sector, reflecting the different pressures and industry models within the sample. Second, we controlled for a firm's financial performance (turnover) as a dimension that may influence the operational performance. Third, we controlled for a firm's size because smaller firms typically have fewer resources for the implementation of supply chain management practices (Cao and Zhang, 2011). Finally, we controlled for the age of the firm because it can influence the implementation of supply chain management practices and therefore, impact operational performance (White et al., 1999).

5. Results

Exploratory factor analysis, using principal axis factoring with oblique-min rotation, was used to extract factors with eigenvalues greater than 1. Following Harman's one-factor test, since the total variance extracted by one factor did not exceed the recommended threshold of 50%, there was no

concern with common method bias (Podsakoff et al., 2003). The results of the exploratory factor analysis are presented in Table II and suggest a two-factor solution arising from the 13 items analyzed. Some items (i.e., "Level of service", "To easily change suppliers") have borderline loadings with loadings between 0.5 and 0.6. However, the results of the 5,000 resamples indicate that these loadings (and weights) are significant at 0.05 and constitute important items in terms of the content validity. According to Colicev et al. (2016), these items can then be retained. Finally, we removed all items with a loading below 0.5 (i.e., "To promptly change the delivery time of suppliers' and customers' orders", "To accommodate product customization"). The elimination of the "To promptly change the delivery time of suppliers' and customers' orders" from the construct Agility indicates that the sample might include many companies that operate on a wide geographical territory, and therefore need to consider factors such as order delivery time. The exclusion of the "To accommodate product customization" from the construct Agility suggests that the sample might include many companies that do not lean into product customization. Table III displays the results of the exploratory factor analysis after the exclusion of these two Agility's items.

Table 2. Exploratory factor analysis

	Factor	
Items/Cronbach's α	**1**	**2**
	Loadings	**Loadings**
Operational Performance (α=0.84)		
[…] Total cost reduction	0.62	
[…] Lead time	0.66	
[…] Time to market	0.60	
[…] Quality standards	0.83	
[…] Process improvements	0.81	
[…] Level of service	0.53	
Agility (α=0.81)		
[…] To promptly change the quantity of suppliers' and customers' orders considering the different market demand		0.81
[…] *To promptly change the delivery time of suppliers' and customers' orders*		*0.30*
[…] To easily accommodate changes in the production mix		0.86
[…] To facilitate rapid decision making		0.63
[…] To easily change suppliers		0.54
[…] *To accommodate product customization*		*0.46*
[…] To quickly adjust logistics strategies, react to changes		0.66

Table 3. Exploratory factor analysis after remotion

	Factor	
Items/Cronbach's α	**1**	**2**
	Loadings	**Loadings**
Operational Performance (α=0.84)		
[…] Total cost reduction	0.62	
[…] Lead time	0.66	
[…] Time to market	0.60	
[…] Quality standards	0.84	
[…] Process improvements	0.81	
[…] Level of service	0.52	
Agility (α=0.83)		
[…] To promptly change the quantity of suppliers' and customers' orders considering the different market demand		0.80
[…] To easily accommodate changes in the production mix		0.87
[…] To facilitate rapid decision making		0.64
[…] To easily change suppliers		0.55
[…] To quickly adjust logistics strategies, react to changes		0.63

The hypotheses were tested using an ordinary least square moderated regression. Control variables were entered, and independent variables were standardized before the multiplication of the interaction terms. Variance inflation factors (vif) were all below 10, indicating multi-collinearity was not a substantial concern (Maddala and Lahiri, 1992).

For each control variable, the most common class was adopted as reference one. The estimated coefficients show effects relative to the reference class, and the intercept is the mean of the reference class for all the categorical variables. Then, for each coefficient of every level of the categorical variables, a Wald test was performed to test whether the pairwise difference between the coefficient of the reference class and the other class was significantly different from zero.

Table IV reports the results of the testing of our theoretical model. The second column of Table IV displays the results of the main effects. The regression equation is related to the hypotheses *H1a*, *H1b*, *H1c*, and expressed as follows:

$$\boldsymbol{Operational\ Performance} = \alpha + \beta_1 * Environmentally\ friendly\ raw\ material\ + \beta_2 * Implemented\ recycling, recovering, and\ reusing\ environmental\ practices + \beta_3 * Green\ Packaging + \varepsilon$$

H1b was supported with recycling, recovering, and reusing environmental practices positively related to operational performance (β=0.18, p=0.01). However, we did not find support for *H1a* and *H1c*.

The third column of Table IV displays the results of the interaction effects. The regression equation is related to the hypotheses *H2a*, *H2b*, *H2c*, and expressed as follows:

$$\boldsymbol{Operational\ Performance} = \alpha + \beta_1 * Environmentally\ friendly\ raw\ material * Agility + \beta_2 * Implemented\ recycling, recovering, and\ reusing\ environmental\ practices * Agility + \beta_3 * Green\ Packaging\ * Agility + \varepsilon + \beta_4 * Agility$$

While we did not find support for *H2a* and *H2b*, we did find support for *H2c*, in that firm's Agility positively moderates the relationship between green packaging and the operational performance (β=0.13, p=0.03).

Table 4. Results of multiple regression analysis

Variables	Operational Performance OLS	Operational Performance with Agility as moderator
Main effects		
Environmentally friendly raw materials	0.01	
Recycling, recovering, reusing environmental practices	0.23**	
Green packaging	-0.02	
Moderation		
Environmentally friendly raw materials x Agility		0.14*
Recycling, recovering, reusing environmental practices x Agility		-0.08
Green packaging x Agility		0.19***
Agility		0.06
Constant	-0.27	-0.25
R-squared	0.31	0.32
F (*p*-value)	5.11***	6.41***
Turnover – <=20M	0.21	0.22
Turnover – 20-100M	ref	ref
Turnover – 100-200M	0.04	0.04
Turnover – >200M	-0.17	-0.22
CompanyBirth – >15 years	ref	ref
CompanyBirth – 10-15 years	-0.06	-0.16
CompanyBirth – 4-10 years	0.38	0.32
CompanyBirth – <4 years	0.39*	0.48**
Size (employees) – <200	-0.23	-0.28
Size (employees) – 200-499	ref	ref
Size (employees) – 500-799	-0.32*	-0.24
Size (employees) – >=800	-0.01	0.13

*p<0.1; **p<0.05; ***p<0.01

6. Discussion

6.1 Control variables

For the sector control variable, the reference class is the electrical sector. From the confrontation, it emerges that there is a statistically significant difference with the sectors electronics and textile in both operational Performance and Operational Performance with Agility as moderator, with $p<0,01$.

Within the Turnover control variable, the reference classes being 20-100M, there is no significative difference, as all classes within the variable behave in the same way.

The size control variable adopts 200-499 employees as a reference class, variable shows a significance difference between the class 500-799 employees and the reference class. The negative coefficient could imply that medium-big enterprises experience more difficulties in managing operational performance respect to medium size enterprises, keeping everything else constant.

The company Birth variable shows a significance difference between the class <4 years and its reference class (>15 years) a result that is consistent with our initial assumption that firm's age can influence the implementation of supply chain management practices and therefore, impact operational performance (White et al., 1999). This result suggest that young companies can control operational performance more easily, ceteris paribus. This is probably due to the fact that they have a less complex supplier network.

6.2. Recycling, recovering, reusing environmental practices on Operational Performance

Table IV displays the results of the multiple regression analysis. Our findings reveal a very significant positive relationship between recycling, recovering and reusing environmental practices and Operational Performance ($\beta=0.23$; $p<0.05$). This significance could be explained by the cost reduction that a firm achieves trough recycling and reverse logistics practices or from reduced material waste and the identification and reduction of inefficient processes (Klassen and McLaughlin, 1996). Recycling scrap materials saves money by reducing the cost of production during manufacturing (Tonjes, 2013). For example, building products by using existing metals brought to recycling centers offers a lot of savings benefits, including eliminating the need to mine or manufacture new raw materials. Furthermore, recycling eliminates or reduces the need to create new materials from virgin materials, which also allows a company to conserve raw materials in the

event that recycled metals are not available. With certain materials, recycling and especially reusing can yield significant energy savings as well, by cutting energy requirements needed to make new products from scratch (Tonjes, 2013). In fact, reusing practices can be bring the most cost savings (Micks 2012), because reusable materials (mostly containers) only must be manufactured once for hundreds of uses. The energy cost between uses is approximately that of cleaning the container, a negligible expense compared to sorting, melting down, and pouring the material into a mold again.

For products with glass containers, such as bottles of water or light alcoholic drinks like beer, a deposit-refund system to encourage people to return the containers to the store for reuse seems more useful than recycling. Glass enjoys a great durability which allows for many uses that guarantee energy and cost savings respect to recycling or virgin material. However, it is important to point out that this method requires a great time commitment from consumers to clean these containers, and/or the inconvenience of carrying empty containers around, collecting them, and returning them. Therefore, it comes as no surprise that reuse practices do not work well for most products or materials, such as non-container metal, or plastic items such as electronics or packing material. Recycling is still the best option in most cases, since the used materials might be employed in a different way for their "second life" and therefore will need to be melted down to assume a different form.

There is considerable evidence that recycling, and reusing can be more efficient in terms of energy, money, and natural resources when compared to a system that manufactures everything from virgin materials (Micks 2012). However multiple factors play a pivotal role in determining whether the cost saving is greater than the additional cost. First, the availability by the firm of an effective sorting and processing plant is crucial, as well as efficient technology and reverse logistics. Furthermore, the sensibility of customers to the issue is not to underestimated, as well as their availability in taking part in reverse logistics activities, such as bringing used materials to a collection point or arranging a collection at their house.

The company Nespresso, for example, performs its main business selling coffee capsules. The capsules are made by aluminum, because it is the best material to protect the freshness, taste, and quality of coffee. Furthermore, it is a very robust material with no need for additional packaging to protect the product, and it can be infinitely and easily recycled. After use, Nespresso encourages the customers to dispose of used capsules by putting them in recycling bags, which are provided free of charge with online orders or picked up at local boutiques. The company offers various methods to retrieve the recycling bags: doorstep collection handled by either Nespresso or a third-party company or drop off at Nespresso boutiques or third-party collection locations (Nespresso.com).

After collection, the coffee pods are taken to a reprocessing plant in to separate the packaging from the used coffee grounds. The coffee grounds are used to create soil improver and renewable energy. The plastic and aluminum will be transformed into new products such as beverage cans or new capsules. Through this example it is easy to understand just how crucial customer collaboration is to the effective functioning of recycling and reverse logistics practices. A company needs to set up a perfectly functioning recycling process which ultimately bring cost savings to the company employing them.

An alternative explanation for the positive relationship between recycling practices and operational performance might be the causal loop between environmental performance and economic performance. The adoption of recycling practices by a company enhances its environmental performance and therefore, its public image. Under the assumption that customers prefer to buy products from environmentally friendly firms, the market share of companies adopting recycling practices will be boosted respect to less environmentally oriented competitors (Winsemius and Guntram, 1992). Then, as a consequence of having a bigger market share, sales and revenues will increase.

In summary, implementing recycling practices returns higher environmental performance through lower discard in the environment, and economic performance, through lower production cost due to the usage of returned components (De Giovanni and Zaccour, 2013). In a regulated market, sales will be boosted due to enhanced corporate image and higher economic and environmental performances in turn lead to an increase in operational performance (Green et al., 2012).

6.3. Environmentally friendly raw materials and green packaging on Operational Performance

Our findings reveal no significant relationship between Environmentally friendly raw materials and operational performance (β=0. 0.01; $p>0.1$) and between green packaging and operational performance (β= -0,02; $p>0.1$). Considering the previous result, linking recycling practices to operational performance, it is interesting to understand why this time no relationship was found.

According to the literature, this could be because firms that introduce sustainable initiatives, such as environmentally friendly raw materials and packaging will be remunerated only in the long run with reduced cost (Rao and Holt, 2005). Firms that develop new packaging solutions need to invest large sums of money though R&D to experiment the employment of a plastic-less, biodegradable, PHA

or fully circular containers for their products. Because of this large initial investment, environmental programs, such as the use of green packaging, require a resource-intensive commitment that does not pay off instantaneously (Rao, 2002).

Many companies in the Food & Beverage sector are working towards packaging solutions that are sustainable and feasibly implementable on a large scale: Kraft-Heinz, for example, is working to make its bestselling product, the Heinz Tomato Ketchup (www.kraftheinzcompany.com) plastic bottle, fully circular by 2022, meaning that is produced by specific PET that can be made back into food-grade packaging after usage (rPET). Similarly, companies that invest in research for new, more sustainable raw materials to make their final products, experiment on solutions that must succeed in reducing waste and in feasibly and competitively serve the market. For example, after years of research, Adidas is launching an alternative, mushroom-based version of the Stan Smith shoe in 2021. This new product is made using Mylo, a biodegradable material made from mycelium, and is created using a highly efficient grow process. The growth process takes advantage of a cutting-edge vertical agriculture technique, allowing it to be grown in a controlled lab environment that increases the yield per square foot. This kind of innovative, sustainable materials are usually developed through collaborative partnership with biotechnology or packaging companies and require time and financial resources. The purchasing cost of sustainable raw materials is initially higher respect to the more traditional ones and can impact negatively on economic performance (Zhu & Sarkis, 2004) until a more efficient production method is employed. Once the technology and the supply chain infrastructure are developed enough to translate into economies of scale, adopting sustainable materials and packaging will improve the efficiency and lead to higher productivity which ultimately translates into decreasing operational cost and superior performance (Bowen et al. 2001).

6.4. Firm's Agility

When the moderation analysis is introduced, our findings reveal that a firm's agility positively moderates the relationship between green packaging and operational performance with great significance ($\beta=0.19$, $p<0.01$). At the same time, we find a smaller effect that positively moderates the relationship between Environmentally friendly raw materials and Operational performance ($\beta=0.14$, $p<0.10$). These results indicate that a firm that implements green packaging and sustainable raw materials practices will not experience an increase in operational performance unless its agility is sufficiently high.

In our survey, we defined agility as "the extent to which a firm is able to promptly change the quantity and the delivery time of suppliers' and customers' orders, to easily accommodate changes

in production mix and customization, to facilitate rapid decision making, and to easily change suppliers and logistics strategies over the past 2 years". This statement summarizes a firm's nimbleness to move efficiently through the market supply infrastructures. To implement sustainability practices that require collaboration and commitment from all parties involved, it is important to employ a transparent and integrated information system that guarantees quick reaction time to changes in procurement and logistics processes.

If a supplier is supposed to provide raw materials that are in line with specific sustainability requirements (such as biodegradability and compostability) and fails to do so, the firm expecting the materials must be able to quickly change suppliers and therefore adjust the production mix. Downstream firm will be immediately affected if an upstream supplier uses a material that does not respect the agreed sustainability features, which will require a new level of information exchange between supply chain partners, and to adjust production and logistics strategy. If firms are not agile, that is they are unable to easily find alternative suppliers, they will have to perform screening and evaluation processes for new ones, which are time and resource consuming. The lack of ability in promptly adapting new product processes from new suppliers would likely have disruptive effects on some components of operational performance, such as cost, lead time, time to market, and level of service.

Upstream firms have the biggest impact on the supply of raw material, as they provide focal companies in the middle portion of the supply chain with basic components to be assembled in finished products. To facilitate communication and avoid problems, upstream firms should emphasize emission rates and efficiency while being transparent with material selection and process design.

In the middle portion of a supply chain, transportation and assembly efficiency are critical, since they have the biggest impact on the cost effectiveness of the whole process. Core, middle portion firms have large responsibilities in ensuring material and process sustainability and usually are the lead promoters of these kind of practices.

Sustainable materials are usually developed through expensive R&D processes. Their purchasing and processing cost are initially higher respect to the more traditional ones, until a more efficient production method is employed. When the technology is relatively new, the focal company might be over reliant on a single supplier, because of patent or contract restrictions, or quite simply because is the only one available with that product. Here, agility factors play an important role because they avoid this over reliance enabling the firm to easily change suppliers and product

processes. However, it is difficult to develop agility in the short term, without a sound investment or developed market conditions; this could explain why no significance was found before introducing the agility factor.

Downstream firms tend to stress recycling and packaging; they account for the last step of the supply chain and serve the final customers. The same concept applies, as regardless of if they produce the packaging internally or procure it from third parties, their agility will determine whether operational performance is affected positively or not.

To further illustrate the effects of moderation, we plot the simple slope of the relationship between green packaging and the operational performance at high and low levels of Agility. High and low values are defined as ±1 standard deviation from the mean. Figure 2 illustrates that, while there is no overall effect, a cross-over interaction occurs, where high green packaging corresponds to higher operational performance only in the event of high agility. Figure 3 displays the interaction between environmentally raw materials and operational performance, where the same concept applies with minor significance respect to green packaging.

Figure 2. Moderation effect of Agility on green packaging and operational performance

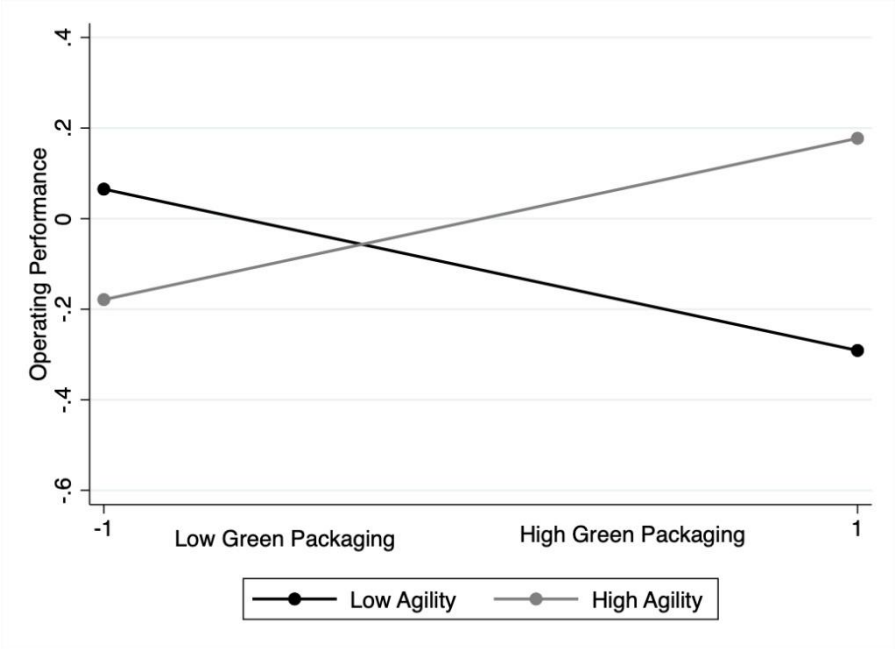
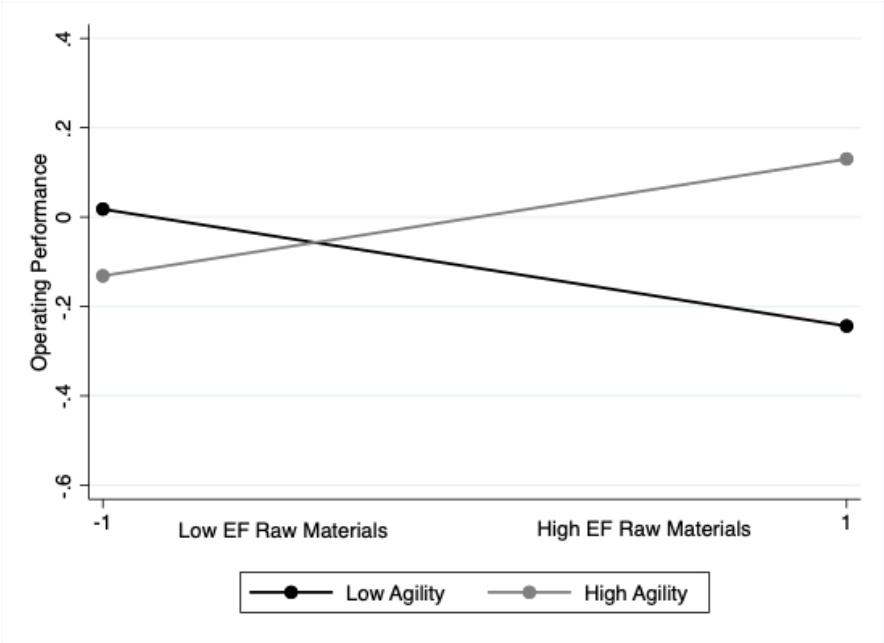


Figure 3. Moderation effect of agility on EF raw materials and operational performance



7. Conclusions

This research paper investigated the causal relationship between the employment of environmental practices and operational performance. The paper analysed three distinct sustainable initiatives: "recycling, recovering and reusing practices", "green packaging practices" and "sustainable raw materials practices".

We studied whether these factors impact on the firms' operational performance and whether the introduction of a moderation analysis with an agility factor affects the relationship between the variables. To pursue our research goals, we developed an empirical analysis by exploring a sample of 174 European firms and using a combination of statistical techniques. The interviewed respondents from the sample were top-level executive positions, such as CEO/President/Vice President, Product Manager, Purchasing Manager and Logistics/SC Manager.

Our first findings, stemming from a linear regression, demonstrated that the recycling, recovering and reusing practices have a significant and positive impact on operational performance. This relationship can be attributed to the fact that recycling scrap materials saves money by reducing the cost of production during manufacturing (Tonjes, 2013). For example, building products by using existing metals or other materials brought to recycling centers offers a lot of savings benefits,

including eliminating the need to mine or manufacture new raw materials. Furthermore, recycling eliminates or reduces the need to create new materials from virgin materials. Companies' programs to recycle materials, such as paper, glass, plastic, and metal, are one way to decrease the amount of resources (especially non-renewable ones) needed to produce a given amount of products. Furthermore, with certain materials, recycling and especially reusing can yield significant energy savings as well, by cutting energy requirements needed to make new products from scratch (Tonjes, 2013).

An alternative explanation to the positive relationship is that adopting recycling practices would boost the company's public image, which would consequentially increase market share, increase sales and reduce costs.

It is very important, however, to consider whether recycling and reusing programs save more money than they cost, or more energy than they consume. This may ultimately depend on whether the programs are run efficiently, with an effective technology for sorting and processing. This is because the financial and energetic costs of collecting, sorting, and processing the recyclables need to be considered in addition to the cost of producing final products from the recycled material.

Our findings revealed no significant relationship between environmentally friendly raw materials and operational performance (β=0. 0.01; $p>0.1$) and between green packaging and operational performance (β= -0,02; $p>0.1$). This could be because firms that develop new sustainable raw materials or packaging solutions often need to invest large sums of money though R&D to experiment the employment of new materials in containers or product components. The purchasing cost of sustainable raw materials is initially higher with respect to the more traditional and non-sustainable ones; until a more efficient production method that allows to reach economies of scale is employed, the adoption of these sustainability practices is likely to have insignificant or negative on operational and economic performance (Zhu and Sarkis, 2004). Once the technology and the supply chain infrastructure are developed enough to translate into economies of scale, adopting sustainable materials and packaging will improve the efficiency and lead to higher productivity which ultimately translates into decreasing operational cost and superior performance (Bowen et al. 2001).

The moderation analysis revealed that a firm's agility positively moderates the relationship between green packaging and operational performance, and that between environmentally friendly raw materials and operational performance. This result indicates that if a firm that implements these practices lacks the ability to promptly adapt new product processes from new suppliers, it would

likely have disruptive effects on some components of operational performance, such as cost, lead time, time to market, and level of service.

The managerial implications that can be drawn from the results of this research paper are two: the first one is that, under the assumption that a company is operational in a regulated market where efficient processing centers and infrastructures are available, project managers are justified in pushing for increased product recycling and recovery for cost effectiveness reasons alone. Both practices reduce the cost of production during manufacturing, bring energy savings and ultimately boost corporate image, thus increasing sales and bringing down the cost structure in the long run.

The second implication is that a firm that implements green packaging and sustainable raw materials into its production cycle will not experience an increase in operational performance unless its agility is sufficiently high. Therefore, if managers want to introduce these measures in an economically sustainable manner, that is they weigh less on the company's cost structure respect to the adoption of classic non-sustainable materials, they need to increase at the same time the firm's agility to promptly change the quantity and the delivery time of suppliers' and customers' orders, to easily accommodate changes in production mix and customization, and to facilitate rapid decision making, and to easily change suppliers and logistics strategies.

Finally, it is important to acknowledge the practical limitations of this research paper. While the sample includes a very heterogeneous industrial landscape, covering many sectors, the data collected was primarily from companies with headquarters in Italy and France. These countries possess highly regulated markets, operational in the European Union, which imposes a high environmental standard on companies under its influence. The results from this research work under two fundamentals assumptions: the market in which the company operates is regulated, and efficient sorting technology and network for recycling and reusing are available. If the market is not regulated sufficiently, there may be a strong economic incentive to keep using unsustainable and non-recycled raw materials and packaging. Therefore, our conclusions may not work in a still developing, poorly regulated market. Similarly, if an efficient sorting technology and network are missing, it would be too expensive to implement recycling measures, removing any economic incentive, and ultimately affecting negatively operational performance. Company birth may affect the relationship between variables, with younger firms (below 4 years of life) having less difficulties in implementing economically sustainable measures, ceteris paribus.

To conclude, our results include data from the last two years; the accuracy of the findings would benefit from the portrayal of a longer time span. A continuous monitoring of the behavior patterns

of these companies will ultimately provide a more precise representation of long-term results stemming from the adoption of sustainability measures.

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Appendix

Construct	Items	Question	Mean	Standard deviation
		Over the last two years:		
	EP1.	We have realized green packaging	4.064	1.658
Environmental	EP2.	We have used environmentally friendly raw materials	4.651	1.695
Practice (EP)	EP3.	We have implemented recycling, recovering, and reusing environmental practices	4.552	1.598
		Over the last two years, we were able:		
	A1.	To promptly change the quantity of suppliers' and customers' orders considering the different market demand	4.273	1.767
	A2	To promptly change the delivery time of suppliers' and customers' orders	4.256	1.626
Agility (A)	A5.	To easily accommodate changes in production mix	4.436	1.655
	A6.	To facilitate rapid decision making		
	A10.	To easily change suppliers	4.221	1.702
	A11.	To accommodate product customization	4.006	1.656
	A13.	To quickly adjust our logistics strategies, react to changes	4.227	1.803
			4.198	1.536
		Over the last two years, we were able to perform:		
	OP1.	Total cost reduction	4.285	1.667
	OP2.	Lead time	4.186	1.679
Operational	OP3.	Time to market	4.064	1.734
Performance	OP4.	Quality standards	4.384	1.738
(OP)	OP5.	Process improvements	4.564	1.707
	OP6.	Level of service	4.041	1.742

Appendix - Descriptive statistics of the selected items.

***H*:** The environmentally friendly raw materials practices are positively associated with firm's total cost reduction. ***Hm*:** How firms are promptly to change the quantity of suppliers' and customers' orders considering the different market demand moderated the relationship between environmentally friendly raw materials practices and total cost reduction.

H: The environmentally friendly raw materials practices are positively associated with firm's lead time. ***Hm*:** How firms are promptly to change the quantity of suppliers' and customers' orders considering the different market demand moderated the relationship between environmentally friendly raw materials practices and lead to time.

***H*:** The environmentally friendly raw materials practices are positively associated with firm's time to market. ***Hm*:** How firms are promptly to change the quantity of suppliers' and customers' orders considering the different market demand moderated the relationship between environmentally friendly raw materials practices and time to market.

H: The environmentally friendly raw materials practices are positively associated with firm's quality standard. ***Hm*:** How firms are promptly to change the quantity of suppliers' and customers' orders considering the different market demand moderated the relationship between environmentally friendly raw materials practices and quality standard.

H: The environmentally friendly raw materials practices are positively associated with firm's process improvement. ***Hm*:** How firms are promptly to change the quantity of suppliers' and customers' orders considering the different market demand moderated the relationship between environmentally friendly raw materials practices and process improvement.

H: The environmentally friendly raw materials practices are positively associated with firm's level of service. ***Hm*:** How firms are promptly to change the quantity of suppliers' and customers' orders considering the different market demand moderated the relationship between environmentally friendly raw materials practices and level of service.

Variables	Total Cost Reduction	Lead Time	Time to Market	Quality Standards	Process Improvement	Level of Service
Control variables						
Sector	-1.4**	-0.10*	-0.14*	0.00**	0.03*	
Tourover						
Main effect						
Environmentally friendly raw materials	-0.18*					
Recycling, recovering, reusing environmental practices	-0.19*		0.19*	0.00**		
Green packaging						
Agility 1		-0.58*		0.01*	0.00**	
Moderation						
EF raw materials x A1	0.05*					
RRR environmental practices x A1	0.03*					
Green packaging x A1				0.04*		0.00**
R2	0.15	0.11	0.14	0.20	0.12	0.29
F	4.83	2.68	3.43	6.22	3.87	10.39

*p<0.05; **p<0.01; ***p<0.001

Table. Results of multiple regression analysis with A1 as a moderator

A1: To promptly change the quantity of suppliers' and customers' orders considering the different market demand

Variables	Total Cost Reduction	Lead Time	Time to Market	Quality Standards	Process Improvement	Level of Service
Control variables						
Sector	-0.12*			0.14*		0.00***
Tourover						

Main effect						
Environmentally friendly raw materials						
Recycling, recovering, reusing environmental practices						
Green packaging						
Agility 2						
Moderation						
EF raw materials x A2						
RRR environmental practices x A2				0.21*		
Green packaging x A2					0.09*	
R2	0.16	0.15	0.21	0.20	0.15	0.30
F	4.99	4.25	7.55	7.53	4.93	12.65

*p<0.05; **p<0.01; ***p<0.001

Table. Results of multiple regression analysis with A2 as a moderator

A2: To promptly change the delivery time of suppliers' and customers' orders

Variables	**Total Cost Reduction**	**Lead Time**	**Time to Market**	**Quality Standards**	**Process Improvement**	**Level of Service**
Control variables						
Sector	-0.16*		-0.12*	-0.15**		0.00***
Tourover						
Main effect						
Environmentally friendly raw materials						
Recycling, recovering, reusing environmental practices			0.17*	0.22*		
Green packaging	0.18*					
Agility 5		-0.70*			-0.57*	
Moderation						
EF raw materials x A5						
RRR environmental practices x A5						
Green packaging x A5	0.10*					0.11*

R2	0.15	0.12	0.16	0.18	0.11	0.28
F	4.13	3.02	3.63	4.97	3.32	8.83

*p<0.05; **p<0.01; ***p<0.001

Table. Results of multiple regression analysis with A5 as a moderator

A5: To easily accommodate changes in production mix

Variables	**Total Cost Reduction**	**Lead Time**	**Time to Market**	**Quality Standards**	**Process Improvement**	**Level of Service**
Control variables						
Sector	-0.13*		-0.14*	-0.14**	-0.11*	0.00***
Tourover						
Main effect						
Environmentally friendly raw materials	-0.18*					
Recycling, recovering, reusing environmental practices				0.20*		
Green packaging	0.18*					
Agility 6		-0.60*				
Moderation						
EF raw materials x A6						
RRR environmental practices x A6						
Green packaging x A6	0.09*					
R2	0.13	0.12	0.15	0.21	0.12	0.28
F	2.86	2.67	3.19	5.29	2.43	7.12

*p<0.05; **p<0.01; ***p<0.001

Table. Results of multiple regression analysis with A6 as a moderator

A6: To facilitate rapid decision making

Variables	**Total Cost Reduction**	**Lead Time**	**Time to Market**	**Quality Standards**	**Process Improvement**	**Level of Service**
Control variables						

Sector Tourover	-0.13*		-0.15*	-0.16**	-0.12*	0.00***
Main effect Environmentally friendly raw materials	-0.19*					
Recycling, recovering, reusing environmental practices			0.21*	0.24**		
Green packaging	0.19*					
Agility 10					-0.48*	
Moderation EF raw materials x A10						
RRR environmental practices x A10						
Green packaging x A10						0.09*
R2	0.14	0.12	0.15	0.17	0.11	0.28
F	3.18	2.63	3.02	4.03	2.68	7.12

*p<0.05; **p<0.01; ***p<0.001

Table. Results of multiple regression analysis with A10 as a moderator

A10: To easily change suppliers

Variables	**Total Cost Reduction**	**Lead Time**	**Time to Market**	**Quality Standards**	**Process Improvement**	**Level of Service**
Control variables Sector Tourover	-0.13*			-0.12*		0.00***
Main effect Environmentally friendly raw materials	-0.22*					
Recycling, recovering, reusing environmental practices			0.19*	0.23**		
Green packaging	0.18*					
Agility 11		-0.52*				

Moderation						
EF raw materials x A11						
RRR environmental practices x A11						
Green packaging x A11	0.11*	0.09*		0.10*		
R2	0.15	0.12	0.16	0.20	0.12	0.26
F	3.36	2.63	3.54	5.34	2.86	6.10

*p<0.05; **p<0.01; ***p<0.001

Table. Results of multiple regression analysis with A11 as a moderator

A11: To accommodate product customization

Variables	**Total Cost Reduction**	**Lead Time**	**Time to Market**	**Quality Standards**	**Process Improvement**	**Level of Service**
Control variables						
Sector	-0.14*		-0.12*	-0.16**	-0.11*	0.00***
Tourover						
Main effect						
Environmentally friendly raw materials	-0.19*					
Recycling, recovering, reusing environmental practices			0.19*	0.21*		
Green packaging	0.20*					
Agility 13						
Moderation						
EF raw materials x A13						
RRR environmental practices x A13						
Green packaging x A13	0.15**	0.10*				
R2	0.16	0.13	0.15	0.19	0.10	0.29
F	4.31	3.45	3.16	4.76	2.52	8.90

*p<0.05; **p<0.01; ***p<0.001

Table. Results of multiple regression analysis with A13 as a moderator

A13: To quickly adjust our logistics strategies, react to changes

Summary

This study aims to empirically verify the relationship between Green supply chain management practices, intended as the adoption of sustainable initiatives along the supply chain, and company operational performance. The results of the study provide empirical evidence that: Companies that adopt recycling, recovering and reusing practices will experience a significant and positive impact on operational performance; companies that adopt environmentally friendly raw materials and/or green packaging will not experience any significant increase in operational performance.
Furthermore, the moderation analysis reveals that a firm's agility positively moderates the relationship between green packaging and operational performance, and that between environmentally friendly raw materials and operational performance.

Literature review

The impact of recycling, recovering, reusing and other environmental procedures along the supply chain on operational performance has been preliminary studied in the literature. However, the field has not yet reached a unique conclusion on the nature of the relationship and proposes diverse conclusions. Many managers believe that a trade-off exists where increased level of environmental management results in increased cost (Walley & Whitehead, 1994). Some scholars have found that green supply chain management has a negative impact on the economic and operational performance of enterprises. Horbach et al. (2012) believed that recycling and reusing activities in the production chain will increase the burden and cost of companies by increasing the cost of their production processes, thus damaging their economic interests.

Wiengarten et al. (2013) analyzed the data of European countries in the GMRG (Global Manufacturing Research Group) from 2006 to 2008 and found that implementing green supply chain management has a negative impact on the economic and operational performance of the supply chain. Miroshnychenko et al. (2017) found that the adoption of the ISO 14001 certification has a negative impact on the economic performance of companies.

On the other hand, many scholars have found the opposite result: Green et al. (2012) analyzed data from 159 manufacturing companies; the research results showed that the application of green supply chain management in manufacturing enterprises had a positive impact on environmental performance and economic performance, which in turn lead to an increase in operational and organizational performances. Tooru (2001) demonstrated, using a case study, that a recycling system can improve operational performance of a firm. Klassen and McLaughlin's (1996) built a theoretical model, linking environmental management to lower costs and increased income. Finally,

De Giovanni and Zaccour (2013, 2014) highlighted the benefits of implementing a GSCM in the form of closed-loop supply chain in which the return rate is a proxy of both, the environmental performance (low discard in environment) and economic performance (lower production cost due to the usage of returned components).

One of the most relevant aspects of a green supply chain is packaging, as it can be recycled or reused along all the steps of the chain, from purchasing to handling. The employment of green/recycled packaging can affect operational performance by reducing production cost; in fact, recent evidence links strong environmental performance to lower manufacturing costs, often by eliminating waste (Porter and van der Linde, 1995). Lower costs can also result from the identification and reduction of inefficient processes that were used with more traditional packaging (Klassen & McLaughlin, 1996) and from better coordination with suppliers.

According to the literature, practices that aim at reducing material waste, such as "package lightweighting" can impact on operational performance not only by reducing the cost of packaging, but also by reducing emissions and transportation costs by increasing the amount of product which can be shipped due to decreased weight. However, it is important to point out that blindly following a goal of package lightweighting that does not respect the effective, efficient, cyclic, and safe requirements can lead to increased damage and spills, which are more costly and harmful to the environment than the benefits accrued through packaging reduction (Gray and Guthrie, 1990).

When trying to assess how the use of sustainable raw materials impacts on a firm's performance, scholars stress how such effect will be insignificant or even negative on the company's short-term economic performance. At the same time, academic literature highlights how sustainable raw material use is likely to enhance economic and operational performance in the long-term. Rao and Holt (2005) focus on how firms that introduce sustainable initiatives, such as environmentally friendly raw materials will be remunerated only in the long run with benefits such as reduced risk and cost, enhanced corporate image and improved marketing advantages. In particular, the improvement in corporate image is likely to translate into higher sales and better economic performance (Jacobs et al., 2010). Minimizing waste, and therefore cost, will consequently result in a better utilization of natural resources, improve the efficiency and lead to higher productivity which ultimately translates into decreasing operational cost. On the other hand, some scholars like Zhu and Sarkis (2004) affirm that environmental management and green raw materials produce a stronger negative impact on economic performance due to higher investments and purchasing cost. Bowen et al. (2001) found that the positive impact of environmental performance on the economic performance cannot be attained within the short-term. Instead, firms engaging in greening the

supply chain will provide the basis for long-term superior performance. To further elaborate, according to Rao (2002), integrated activities between supply chain members, such as collaboration, joint environmental programs and common planning are time and resource-intensive approaches that do not pay off instantaneously. However, some scholars argue that synergetic effects between traditional practices, such as lean and quality, and environmental practices, such as raw material waste reduction, are possible. Under this perspective, De Giovanni and Cariola (2020) affirm that lean practices facilitate the supplier collaboration on environmental programs. Furthermore, leanness positively contributes to environmental and operational performance, exerting a positive second order effect on economic performance, which should then be pursued as a long-term target.

There is little evidence on whether and how a firm's agility changes the impact that green supply chain management practices have on operational performance, at least, as specifically as it is intended for the purpose of this paper. We identify the agility factor as "the agility to promptly change the quantity and the delivery time of suppliers' and customers' orders, to easily accommodate changes in production mix and customization, to facilitate rapid decision making, and to easily change suppliers and logistics strategies."
If we take a more general approach, the academic literature offers considerable evidence linking green supply chain success to the ability of ERP information systems to facilitate information sharing among supply chain partners (Green et al., 2007). Because environmental sustainability is a supply chain level imperative (Vachon and Klassen, 2007), it is important that organizations develop information systems capable of integrating and coordinating environmental sustainability initiatives with suppliers and customers (Esty & Winston, 2006). This concept can be linked to our definition of a firm's agility, because to promptly change the quantity and the delivery time of suppliers' and customers' orders as well as to easily change suppliers and logistics strategies, a company needs a robust information network linking suppliers and customers. As the firm's supply chain management strategy expands to incorporate the environmental sustainability practices, that include purchasing environmentally friendly raw materials and packaging, or participating to joint environmental programs, the firm's ERP system must expand as well to monitor environmental efforts and outcomes in cooperation with customers and suppliers. Therefore, we can assume that a firm's agility must have a certain degree of impact on how green supply chain management practices influence operational performance.

Some researchers have investigated sustainability issues within the context of supply chain management (Linton et al., 2007; Pagell et al., 2007; Pagell et al., 2010). Many sustainable supply chain studies focus on how procurement and supplier selection and management (e.g. Svensson,

2007; Walker and Brammer, 2009; Ehrgott et al., 2011). Pagell et al. (2007) behave as consequence of environmental investments. They found mixed results in terms of environmentally based performance impacts on cost and quality. Besides others, Paulraj (2011) identified that strategic purchasing is a key capability for the success of sustainable supply chains. Following this logic, our construct "agility to which firms can promptly change suppliers and accommodate changes in the production mix" results to be extremely relevant in determining the success of green initiatives.

Research hypotheses and conceptual model

The analysis of the literature reveals a research gap composed of two main pieces of evidence. First, a unique conclusion on the nature of the relationship between green supply chain practices and firms' operational performance has not been reached yet. Therefore, our findings would contribute to the research pool on the topic. Second, how a company's agility moderates (impacts on) the relationship between the adoption of green supply chain management practices and the company's operational performance turns out to be under-investigated.

With the aim to fill this gap, this research addresses two main research questions:

"Do green supply chain management practices influence positively firms' operational performance?"

And

"Does a firm's agility moderate the relationship between green supply chain management practices and the firm's operational performance?"

With these in mind we formulate the following hypotheses:

H1a**:** Recycling, recovering, reusing environmental practices are positively associated with firm's operational performance.

H1b**:** Green packaging is positively associated with firm's operational performance.

H1c**:** Environmentally friendly raw materials are positively associated with firm's operational performance.

H2a: Firm's agility moderates the relationship between recycling, recovering, reusing environmental practices and firms' operational performance.

H2b: Firm's agility moderates the relationship between green packaging and firms' operational performance.

H2c: Firm's agility moderates the relationship between environmentally friendly raw materials and firms' operational performance.

Research methodology

A sample of 2,000 European organizations was surveyed. Faculty members in the field of SCM and four production managers were contacted as experts to verify the content validity. We received 172 responses after 22 weeks. The respondent sample can be considered appropriate for this study as it was composed of top-level executives in the position of CEO/President/Vice President (23.84%), Product Manager (27.33%), Purchasing Manager (21.51%), Logistics/SC Manager (12.21%), and other professionals (15.12%). The data collected was primarily from companies with the headquarter in Italy and France, 31.40% and 22.09%, respectively. Respondents were asked to complete the survey with respect to their strategic business unit's supply chain. The survey was pre-tested on a pool of experts (e.g., academic faculty members, Ph.D students, professionals, managers) who were asked to comment on the wording, clarity, completeness and scaling of the survey instrument. Some improvement changes were made as a result of this feedback. Several approaches for non-response bias were carried out. The first approach consisted of comparing early to later respondents (i.e., first and second to third surveys). A one-way ANOVA was conducted on mean responses to each question. We also used size and total revenues, and we were unable to identify any statistically significant differences between the two groups

Results

The hypotheses were tested using an ordinary least square moderated regression. Control variables were entered, and independent variables were standardized before the multiplication of the interaction terms. Variance inflation factors (vif) were all below 10, indicating multi-collinearity was not a substantial concern (Maddala and Lahiri, 1992).

For each control variable, the most common class was adopted as reference one. The estimated coefficients show effects relative to the reference class, and the intercept is the mean of the reference class for all the categorical variables. Then, for each coefficient of every level of the categorical variables, a Wald test was performed to test whether the pairwise difference between the coefficient of the reference class and the other class was significantly different from zero.

Table IV reports the results of the testing of our theoretical model. The second column of Table IV displays the results of the main effects. The regression equation is related to the hypotheses *H1a*, *H1b, H1c,* and expressed as follows:

$$\boldsymbol{Operational\ Performance} = \alpha + \beta_1 * Environmentally\ friendly\ raw\ material\ + \beta_2 * Implemented\ recycling, recovering, and\ reusing\ environmental\ practices + \beta_3 * Green\ Packaging + \varepsilon$$

H1b was supported with recycling, recovering, and reusing environmental practices positively related to operational performance (β=0.18, p=0.01). However, we did not find support for *H1a* and *H1c*.

The third column of Table IV displays the results of the interaction effects. The regression equation is related to the hypotheses *H2a, H2b, H2c,* and expressed as follows:

$$\boldsymbol{Operational\ Performance} = \alpha + \beta_1 * Environmentally\ friendly\ raw\ material * Agility + \beta_2 * Implemented\ recycling, recovering, and\ reusing\ environmental\ practices * Agility + \beta_3 * Green\ Packaging * Agility + \varepsilon + \beta_4 * Agility$$

While we did not find support for *H2a* and *H2b,* we did find support for *H2c*, in that firm's Agility positively moderates the relationship between green packaging and the operational performance (β=0.13, p=0.03).

Discussion

Our findings reveal a very significant positive relationship between recycling, recovering and reusing environmental practices and Operational Performance (β=0.23; p<0.05). This significance could be explained by the cost reduction that a firm achieves trough recycling and reverse logistics practices or from reduced material waste and the identification and reduction of inefficient processes (Klassen and McLaughlin, 1996). Recycling scrap materials saves money by reducing the cost of production during manufacturing (Tonjes, 2013). For example, building products by using existing metals brought to recycling centers offers a lot of savings benefits, including eliminating the need to mine or manufacture new raw materials. With certain materials, recycling and especially reusing can yield significant energy savings as well, by cutting energy requirements needed to make new products from scratch (Tonjes, 2013). In fact, reusing practices can bring the most cost savings (Micks 2012), because reusable materials (mostly containers) only must be manufactured once for hundreds of uses. The energy cost between uses is approximately that of cleaning the container, a negligible expense compared to sorting, melting down, and pouring the material into a mold again.

However, reuse practices do not work well for most products or materials, such as non-container metal, or plastic items such as electronics or packing material. Recycling is still the best option in most cases, since the used materials might be employed in a different way for their "second life" and therefore will need to be melted down to assume a different form.

There is considerable evidence that recycling, and reusing can be more efficient in terms of energy, money, and natural resources when compared to a system that manufactures everything from virgin materials (Micks 2012). However multiple factors play a pivotal role in determining whether the cost saving is greater than the additional cost. First, the availability by the firm of an effective sorting and processing plant is crucial, as well as efficient technology and reverse logistics. Furthermore, the sensibility of customers to the issue is not to underestimated, as well as their availability in taking part in reverse logistics activities, such as bringing used materials to a collection point or arranging a collection at their house.

An alternative explanation for the positive relationship between recycling practices and operational performance might be the causal loop between environmental performance and economic performance. The adoption of recycling practices by a company enhances its environmental performance and therefore, its public image. Under the assumption that customers prefer to buy products from environmentally friendly firms, the market share of companies adopting recycling practices will be boosted respect to less environmentally oriented competitors (Winsemius and Guntram, 1992). Then, as a consequence of having a bigger market share, sales and revenues will increase.

Our findings reveal no significant relationship between Environmentally friendly raw materials and operational performance (β=0. 0.01; $p>0.1$) and between green packaging and operational performance (β= -0,02; $p>0.1$). Considering the previous result, linking recycling practices to operational performance, it is interesting to understand why this time no relationship was found.

According to the literature, this could be because firms that introduce sustainable initiatives, such as environmentally friendly raw materials and packaging will be remunerated only in the long run with reduced cost (Rao and Holt, 2005). Firms that develop new packaging solutions need to invest large sums of money though R&D to experiment the employment of a plastic-less, biodegradable, PHA or fully circular containers for their products. Because of this large initial investment, environmental programs, such as the use of green packaging, require a resource-intensive commitment that does not pay off instantaneously (Rao, 2002). The purchasing cost of sustainable raw materials is initially higher respect to the more traditional ones and can impact negatively on

economic performance (Zhu & Sarkis, 2004) until a more efficient production method is employed. Once the technology and the supply chain infrastructure are developed enough to translate into economies of scale, adopting sustainable materials and packaging will improve the efficiency and lead to higher productivity which ultimately translates into decreasing operational cost and superior performance (Bowen et al. 2001).

When the moderation analysis is introduced, our findings reveal that a firm's agility positively moderates the relationship between green packaging and operational performance with great significance ($\beta=0.19$, $p<0.01$). At the same time, we find a smaller effect that positively moderates the relationship between Environmentally friendly raw materials and Operational performance ($\beta=0.14$, $p<0.10$). These results indicate that a firm that implements green packaging and sustainable raw materials practices will not experience an increase in operational performance unless its agility is sufficiently high.

In our survey, we defined agility as "the extent to which a firm is able to promptly change the quantity and the delivery time of suppliers' and customers' orders, to easily accommodate changes in production mix and customization, to facilitate rapid decision making, and to easily change suppliers and logistics strategies over the past 2 years". This statement summarizes a firm's nimbleness to move efficiently through the market supply infrastructures. To implement sustainability practices that require collaboration and commitment from all parties involved, it is important to employ a transparent and integrated information system that guarantees quick reaction time to changes in procurement and logistics processes.

If a supplier is supposed to provide raw materials that are in line with specific sustainability requirements (such as biodegradability and compostability) and fails to do so, the firm expecting the materials must be able to quickly change suppliers and therefore adjust the production mix. If firms are not agile, that is they are unable to easily find alternative suppliers, they will have to perform screening and evaluation processes for new ones, which are time and resource consuming. The lack of ability in promptly adapting new product processes from new suppliers would likely have disruptive effects on some components of operational performance, such as cost, lead time, time to market, and level of service.

Sustainable materials are usually developed through expensive R&D processes. Their purchasing and processing cost are initially higher respect to the more traditional ones, until a more efficient production method is employed. When the technology is relatively new, the focal company might be over reliant on a single supplier, because of patent or contract restrictions, or quite simply

because is the only one available with that product. Here, agility factors play an important role because they avoid this over reliance enabling the firm to easily change suppliers and product processes. However, it is difficult to develop agility in the short term, without a sound investment or developed market conditions; this could explain why no significance was found before introducing the agility factor.

Conclusions

This research paper investigated the causal relationship between the employment of environmental practices and operational performance. The paper analyzed three distinct sustainable initiatives: "recycling, recovering and reusing practices", "green packaging practices" and "sustainable raw materials practices". We studied whether these factors impact on the firms' operational performance and whether the introduction of a moderation analysis with an agility factor affects the relationship between the variables. Our first findings, stemming from a linear regression, demonstrated that the recycling, recovering and reusing practices have a significant and positive impact on operational performance. This relationship can be attributed to the fact that recycling scrap materials saves money by reducing the cost of production during manufacturing (Tonjes, 2013). Companies' programs to recycle materials, such as paper, glass, plastic, and metal, are one way to decrease the amount of resources (especially non-renewable ones) needed to produce a given amount of products. Furthermore, with certain materials, recycling and especially reusing can yield significant energy savings as well, by cutting energy requirements needed to make new products from scratch (Tonjes, 2013).

An alternative explanation to the positive relationship is that adopting recycling practices would boost the company's public image, which would consequentially increase market share, increase sales and reduce costs.

It is very important, however, to consider whether recycling and reusing programs save more money than they cost, or more energy than they consume. This may ultimately depend on whether the programs are run efficiently, with an effective technology for sorting and processing. This is because the financial and energetic costs of collecting, sorting, and processing the recyclables need to be considered in addition to the cost of producing final products from the recycled material.

Our findings revealed no significant relationship between environmentally friendly raw materials and operational performance and between green packaging and operational performance. This could be because purchasing cost of sustainable raw materials is initially higher with respect to the more

traditional and non-sustainable ones. Once the technology and the supply chain infrastructure are developed enough to translate into economies of scale, adopting sustainable materials and packaging will improve the efficiency and lead to higher productivity which ultimately translates into decreasing operational cost and superior performance (Bowen et al. 2001).

The moderation analysis revealed that a firm's agility positively moderates the relationship between green packaging and operational performance, and that between environmentally friendly raw materials and operational performance.

The managerial implications that can be drawn from the results of this research paper are two: the first one is that, under the assumption that a company is operational in a regulated market where efficient processing centers and infrastructures are available, project managers are justified in pushing for increased product recycling and recovery for cost effectiveness reasons alone. Both practices reduce the cost of production during manufacturing, bring energy savings and ultimately boost corporate image, thus increasing sales and bringing down the cost structure in the long run.

The second implication is that a firm that implements green packaging and sustainable raw materials into its production cycle will not experience an increase in operational performance unless its agility is sufficiently high. Therefore, if managers want to introduce these measures in an economically sustainable manner, that is they weigh less on the company's cost structure respect to the adoption of classic non-sustainable materials, they need to increase at the same time the firm's agility to promptly change the quantity and the delivery time of suppliers' and customers' orders, to easily accommodate changes in production mix and customization, and to facilitate rapid decision making, and to easily change suppliers and logistics strategies.

Finally, it is important to acknowledge the practical limitations of this research paper. While the sample includes a very heterogeneous industrial landscape, covering many sectors, the data collected was primarily from companies with headquarters in Italy and France. These countries possess highly regulated markets, operational in the European Union, which imposes a high environmental standard on companies under its influence. The results from this research work under two fundamentals assumptions: the market in which the company operates is regulated, and efficient sorting technology and network for recycling and reusing are available. If the market is not regulated sufficiently, there may be a strong economic incentive to keep using unsustainable and non-recycled raw materials and packaging. Therefore, our conclusions may not work in a still developing, poorly regulated market. Similarly, if an efficient sorting technology and network are missing, it would be too expensive to implement recycling measures, removing any economic

incentive, and ultimately affecting negatively operational performance. Company birth may affect the relationship between variables, with younger firms (below 4 years of life) having less difficulties in implementing economically sustainable measures, ceteris paribus.

To conclude, our results include data from the last two years; the accuracy of the findings would benefit from the portrayal of a longer time span. Further monitoring of the behavior patterns of these companies will ultimately provide a more precise representation of long-term results stemming from the adoption of sustainability measures.