

The role of knowledge development in manufacturing sustainability

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Abstract

The propensity of industrial firms to build sustainability strategies based on knowledge development is an incentive for strategies driven by environmental, social, and economic criteria. However, although firms are increasingly committed to sustainability, poor engagement may lead to strategic drifts. Energy efficiency is one of the most important targets in industrial firms for reducing emissions primarily generated directly by the firm—emissions that are created by generating electricity or heat needed by firms. We focus on energy efficiency, which—along with technological advancement—is the most critical factor in industrial decarbonization and is a pathway for improving economic competitiveness and sustainability. Advances in technological innovation and stakeholders' requirements provide a range of reasons for achieving environmental benefits. In our view, the outcomes of environmental strategies are influenced by the commitment of firms to sustainable business and their propensity for R&D. Our results show that 44.1% of firms claim to have an investment plan for energy efficiency. This percentage rises to 65% for firms investing more than 4% of their turnover in R&D. A similar trend can be noticed for investments in environmental, social, and governance (ESG) topics, in which 83.3% of the firms claim to have an investment plan of 4% of their turnover. We argue that ESG strategies require competencies and capability building among employees to be successful; otherwise, the risk of strategic drifts increases.

Keywords: ESG, SDG, energy efficiency, capability building, environmental management.

1. Introduction

Firms require business models capable of creating economic value from sustainable technologies (Bohnsack et al., 2014), services (Calabrese et al., 2018), and strategies, given that firms are asked to respond to environmental impacts (Hasan et al., 2019). Therefore, firms are in favor of adopting sustainable and socially responsible actions (Nikolaos & Eugenia, 2020).

The environmental, social, and governance (ESG) concept embraces a range of disciplines, from financial aspects, given that markets use ESG to evaluate organizations and foresee financial performance, to operations, because sustainability strategies heavily impact firms' routines and human resources. Given that knowledge and skills development are the strategic levers used to design, implement, and monitor ESG policies and strategies, it is hardly surprising that ESG policy has a positive impact on stakeholders (Finger & Rosenboim, 2022; Ortas et al., 2015).

The contribution that energy efficiency (EE) can make to business sustainability and competitiveness has been well documented and is likely to be one of the most topical and challenging issues in the coming years when business decarbonization will need to be accelerated to help meet the 2030 and 2050 agenda targets.

Dealing with changes in business sustainability requirements creates substantial challenges for managers due to the increasing complexity of strategy in rapidly evolving business environments. In addition, a capacity for change can help organizations navigate unpredictable environments (Mladenova, 2022).

Global commitments restated in the United Nations Agenda 2030 ambitious climate policies increasingly shape market conditions, for instance, by encouraging firms to include sustainability practices in their activities. Therefore, emission reduction and EE have become key levers for transforming industrial processes while increasing demand for products and services for sustainability (Di Foggia, 2021). Advances in technological innovation (Akyazi et al., 2022), global policy commitments, perspectives on ESG factors (Finger & Rosenboim, 2022) as well as business strategies provide a wide range of possibilities for achieving environmental benefits.

It is commonly assumed that the transition toward integrating EE solutions into products proceeds gradually. However, this transition also faces three barriers related to strategy, implementation, and market structure (Lütjen et al., 2017). Firms innovate their business models by integrating product-service offerings as a strategic response to market trends (Lightfoot et al., 2013) to generate value (Garcia Martin et al., 2019), suggesting that behavioral facts are very important (Goldbach et al., 2018).

Firms with a long-term strategic vision need to develop skills and equip themselves with experts capable of understanding opportunities and creating a suitable culture (Jin & Kim, 2022), specifically, the conditions for developing the environmental and energy skills to outperform in the market.

We analyze how firms approach the market by creating conditions for capacity development with special reference to EE strategies.

The research literature shows that it is important to start with the development of skills in the EE field because culture, strategy, and vision are needed to seize existing opportunities and develop new ones. The objective of our analysis is to identify which levers to focus on to develop a corporate culture favorable to implementing EE measures.

Our data collection method was a survey in which we identified 917 industrial firms and invited them to participate in the study by filling out an online questionnaire. Out of 130 completed questionnaires, 102 were completely answered, representing a probabilistically significant and nonbiased sample with firms of diverse sizes located throughout Italy.

The percentage of firms claiming to have an investment plan for EE is 44.1%. This figure rises to 65% for firms investing more than 4% of their turnover in R&D. A similar tendency can also be observed in investments in EE: 83.3% of firms claim to have an investment plan of 4% of turnover.

This data analysis highlights evidence related to the current willingness to invest in strategic projects to achieve sustainable development goals through ESG strategies. Forty-one percent of respondents say they buy products or services for energy and resource efficiency in the circular economy, and among the 59% of firms that stated the opposite, approximately half are willing to do so.

Moreover, 74.5% of the firms consider the continuous monitoring of ESG factors as a crucial element in competitiveness. A total of 19.8% of the respondents declared that they do not have an energy audit system and that this is not an element required to increase the company's competitiveness.

A combined assessment of the factors used to evaluate skills development confirms that, as the proportion of positive responses to the skills development question increases, so does the proportion of investment in EE. Therefore, it is important to understand what firms think are both the priority actions that policymakers should implement to support market development and the professional knowledge base on which to develop training. This situation is also confirmed by the findings on the skills needed in the areas of economic regulation and technological innovation training.

Although investments in EE are seen as important, several barriers prevent their potential development. The overriding reality is that offering energy-efficient goods or services still needs to be seen as a competitive advantage due to the payback time of the investment. In some cases, the payback time expected by small- and medium-sized enterprises can be longer. This last consideration opens the door to policy considerations, although this is not the subject of this paper. For example, policymakers should select incentive instruments that contribute to the reduction in the return time of investments to give greater certainty, especially to small- and medium-sized enterprises.

Section 2 is the literature review, while section 3 describes the research methodology, sample of firms, and the survey. Section 4 presents the analysis results, followed by the discussion. The paper ends with a conclusion.

2. Background

Energy policy is one of the fastest developing areas in environmental management (Vavrek & Chovancová, 2020), given the importance and urgency of EE policies in sustainable development (Xu et al., 2020). The implementation of the sustainable development agenda requires the strong involvement of all members of society. Therefore, there is a need for environmental policies focused on sustainable development objectives and business.

Numerous studies have shown the potential for the industry to reduce its energy costs by installing more efficient equipment offering competitive payback periods (Brown et al., 2014). However, it should also be noted that despite several decades of government policies promoting EE, estimates of the costs and benefits of such policies remain controversial (Gillingham & Palmery, 2014). In this regard, scholars have developed methods to estimate the energy savings achieved by EE policies (Bertoldi & Mosconi, 2020). A recent study described the relationships between innovation and sustainable development goals in the industrial context. (Cordova & Celone, 2019).

In this paper, we focus on three aspects that are related and connected, and that help to contextualize the focus of this paper.

First, we examine how ESG commitment significantly impacts firms by focusing on environmental aspects (Susilowati et al., 2022). The contribution of firms to sustainable development goals is a major concern for investors, creditors, governments, and other stakeholders (Atan et al., 2018). Numerous studies have analyzed the impact of ESG factors on corporate performance. For example, corporate transparency about ESG information has been found to have a positive link to business efficiency (Xie et al., 2019).

The results of the analysis of another study show that resource use, environmental innovation, and corporate social responsibility strategy are indicators that significantly contribute to ESG performance (Rajesh, 2020). Another recent paper suggests a positive, statistically significant, but economically modest relationship between ESG performance and financial performance (Huang, 2021). Similarly, other empirical analyses suggest that the benefits of ESG disclosure outweigh their costs, and, therefore, ESG disclosure increases firm value (Yu et al., 2018). Much of the literature measuring the relationship between ESG and firm performance views the outcome of analyses as a measure of sustainability performance. Yet another study treats a firm's ESG score as a strategic choice in the level of transparency that results in increased firm performance (Minutolo et al., 2019).

Finally, a study that considers not only ESG factors but also the United Nations Global Compact (UNGC) reveals that the adoption of UNGC frequently leads to an organizational change that improves the ESG performance of firms. Furthermore, the results reveal that ESG performance has a significant impact on the financial performance of firms that have adopted the principles of the UNGC (Ortas et al., 2015).

The importance of such studies is amplified by the fact that reduction in emissions can occur in diverse ways and depend on the scope involved. Scopes 1, 2, or 3 – i.e., emissions from activities not owned or controlled by the firm – use different calculation methodologies and objectives within the ESG criteria. Firms are implementing increasingly green strategies because they must respond to environmental impacts and are required to reduce their carbon footprint (Hasan et al., 2019). EE measures are among the main drivers of reducing business emissions. EE offers long-term benefits by improving sustainable competitiveness and reducing emissions (Atta Mills et al., 2021), and EE interventions primarily affect Scope 1 emissions and consequently Scope 2, given that Scope 1 is the direct emissions generated by the company whose source is owned or controlled by the company; Scope 2 is the indirect emissions generated by the energy purchased and consumed by the company.

Investments in EE often remain undecided, and there is great potential to improve EE in the industry (Cooremans & Schönerberger, 2019). The ability to innovate and improve EE is a key element in reducing industrial emissions and meeting international climate change mitigation targets. However, despite the urgent need for more knowledge of EE in the industry, more research on the subject is still required (Solnørdal & Thyholdt, 2017). Therefore, EE is considered one of the surest ways to address important and urgent global challenges, such as achieving energy independence and combating the negative effects of climate change (Román-Collado & Economidou, 2021). In general, pathways toward decarbonization must be accompanied by improvements in EE.

The third topic is the knowledge and development of the business skills and competencies needed to explore the opportunities in the EE market, to improve institutional relationships with all stakeholders, not just customers, and consequently to improve performance.

This last aspect is critical. We defend the idea that to take full advantage of the potential and opportunities derived from EE, it is necessary to develop a process within firms aimed at creating a team of people with different skills and roles and with the common goal of creating value in the long term.

Therefore, this article fills a gap in the previous literature. Our focus is on the ex-post evaluation of ESG factors on EE. We offer not only results from empirical analysis but also policy suggestions that can be useful for the industry for developing or improving knowledge and expertise in EE to deliver long-term value.

2. Materials and Methods

Measuring sustainability topics is both challenging and important for better decision-making concerning policies, programs, projects, and actions related to sustainability (Batalhao et al., 2019). Among other things, it is necessary that the understanding of the sustainability scope one wishes to measure is clear (Cetrulo et al., 2018), especially for estimating future impacts of policies (Beccarello & Di Foggia, 2022), thereby better addressing managerial choices.

In this sense, empirical surveys can help gain insights on specific topics according to the research purposes. Surveys can help gauge the representativeness of firms' experiences and can provide information that can be used to make important decisions. Following a series of interviews and discussions with industrial plant engineering experts, this paper is based on a survey distributed via a questionnaire containing open and closed questions. The questionnaire was constructed according to the accepted practices of questionnaire development and

administration, including the design and distribution of the questionnaire and its analysis (Rowley, 2014). The analyses were based on quantitative and qualitative methods; to this extent, the survey approach conformed to the purpose of this study. The survey was designed to guarantee clearness, correctness in question order, and effectiveness of the questions (Brace, 2004; Couper, 2008). Questions fell into different sections according to their main domains. Most of the questions were designed to get ordinal answers, typically using ordinal scale questions.

The best way to analyze strategies is through the analysis of the commitment to skills development in three macro areas. First, there is the importance of the analysis of the context and solutions—existing or planned—in identifying the potential arising from the evolution of the EE market. Second, there is the technology assessment and analysis of potential barriers. Here, it is important to be able to assess the degree of innovation of different EE solutions to understand the achievable environmental externalities and economic sustainability for firms at the level of individual EE intervention or purchase of EE services. Third, there are the energy scenario and policy analysis, the ability to forecast market developments, and the implications of environmental policies and regulatory authorities.

This is an especially important topic because, as is now clear, the efficient use of energy is a competitive factor that is growing in importance, and this topic can be studied using statistical methods given the type of information needed to investigate this topic. Particularly, the topic can be explored through empirical investigation.

Our analysis is based on stratified sampling, according to which populations can be divided into multiple groups that represent the entire population when put together (Singh, 2006). If all sample members are included in a stratum and all strata are sampled, the probability design is valid. During sampling, we selected a significant number of industrial plant firms. We extrapolated the sample from the AMADEUS database; 715 firms were selected.

The questionnaire was sent by email, and after seven days, we sent a reminder. At the end of this process, the response rate was 19.3%, 138 questionnaires of which 36 were incomplete, leaving us with 102 complete answers. This is a nonbiased probability sample since it includes different firms by number of employees and by geographic area.

Finally, the research questions aim to identify how firms approach the need to increase their capacity to manage projects, processes, and investments in EE at a strategic level. First, we investigated the propensity of firms to invest in EE competencies and services and the relation with investment in R&D as a positive correlation is hypothesized. Second, the linkage between knowledge development and sustainability investments is tested.

3. Results

To assess the role of EE knowledge development in the implementation of ESG strategies, a good starting point is the propensity of firms to adopt and implement EE activities, including products, systems, and services, as Table 1 shows.

Table 1. Propensity for implementing EE activities

		%	Std.err	95% Conf. Int.	
EE investments plan	No	55.9	0.049	0.460	0.653
	Yes	44.1	0.049	0.347	0.540
Scope 1 and 2 emissions	No	42.2	0.049	0.328	0.521
	Yes	57.8	0.049	0.479	0.672
ESG certification	No	75.5	0.043	0.661	0.830
	Yes	24.5	0.043	0.170	0.339
Energy consumption measurement	No	65.7	0.047	0.558	0.744
	Yes	34.3	0.047	0.256	0.442
Energy performance measurement	No	45.1	0.050	0.356	0.550
	Yes	54.9	0.050	0.450	0.644
ESG Governance	No	52.0	0.050	0.422	0.616
	Yes	48.0	0.050	0.384	0.578

The percentage of firms that declare having an investment plan for EE is 44.1%. However, this rises to 65% for firms that invest more than 4% of their turnover in R&D. A similar trend can be observed with investments in

ESG: 83.3% of firms declare having an investment plan of over 4% of the turnover. The factor referring to communication grows in both cases and reaches 91.7% when firms declare investing more than 4% of the turnover in EE products.

For the measurement of energy consumption, the data show a low percentage of positive answers, whereby 34.3% of the firms declared having a system of energy consumption measurement, a percentage that reaches 50% with the highest of the three levels of investment in EE. We note an analogous situation in relation to energy performance management, but with an increase of approximately 20% in positive responses. The key element here is the awareness of the firms of the importance of energy audit systems as competitive factors. As expected, all firms with considerable investments in EE consider the audit as an element that improves the competitiveness of the company. A detailed assessment can be made by dividing the sample into classes based on the percentage of R&D and EE investments; Table 2 shows the distribution. Of the respondents, 50% indicated that their investments in EE were less than 1% of turnover, and 34.4% of them stated that their R&D investments were less than 1% of turnover.

A total of 30.9% of respondents declared investing less than 1% of turnover in both R&D and EE; 30.4% declared investing between 1% and 4% of turnover, and 8.9% declared investing more than 4% of turnover in R&D and EE.

Table 2. Distribution by level of investment

		EE			Total
		< 1%	1–4%	> 4%	
R&D	< 1%	31	3	1	35
	1–4%	15	30	2	47
	> 4%	5	6	9	20
	Total	51	39	12	102

Tables 1 and 2 show that the percentage of positive responses is positively correlated for all factors related to the development of skills.

To achieve sustainability targets, firms are increasingly integrating EE solutions into their production processes to reduce emissions. Emissions can be classified according to their source (Ganda & Milondzo, 2018), whereby, in Scope 1, emissions are from company-owned and controlled resources; in Scope 2, they come from the consumption of purchased electricity, steam, heat, and cooling; and, in Scope 3, they are the result of activities from assets not owned or controlled by firms. Therefore, firms especially aim to reduce Scope 1 and Scope 2 emissions.

However, there is an increasing focus on Scope 3 emissions. In this sense, several EE services are being commercialized to help firms monitor not only suppliers’ “activities and compliance with environmental legislations but also their efforts and commitment to sustainability.”

Analysis of the data highlights further evidence related to the current use and willingness to purchase EE products and services: 61 out of 102 respondents stated that they do not currently purchase EE services, although only 26 out of 102 are not willing to purchase them, including 18 that do not purchase them. However, 43 firms that do not purchase EE products would be willing to purchase them.

Table 3. Use and willingness to buy of EE products and services

		Willingness to buy EE services		
		No	Yes	Total
Use of EE services	No	18	43	61
	Yes	8	33	41
	Total	26	76	102

Table 4 represents a comparable situation in which 76 firms consider the evaluation of the efficiency of the energy-saving management system an important factor for competitiveness, while 42 implement it. One-fifth of the

respondents declare that they do not have an energy audit system and that it does not represent an element intended to increase the competitiveness of the company.

Table 4. Existence and importance of energy audits

		Perception of energy audit as competitive advantage		
		No	Yes	Total
Presence of an energy audit system?	No	21	39	60
	Yes	5	37	42
	Total	26	76	102

Similarly, the situation regarding communication can be assessed by comparing the answers of those who state that they communicate their EE initiatives and the requests coming from stakeholders—mainly customers—as shown in the following.

A joint assessment of the factors used to assess skill development confirms that as the proportion of positive responses increases, the proportion of investments made in ESG increases, in turn positively impacting EE and R&D investments as in Figure 1..

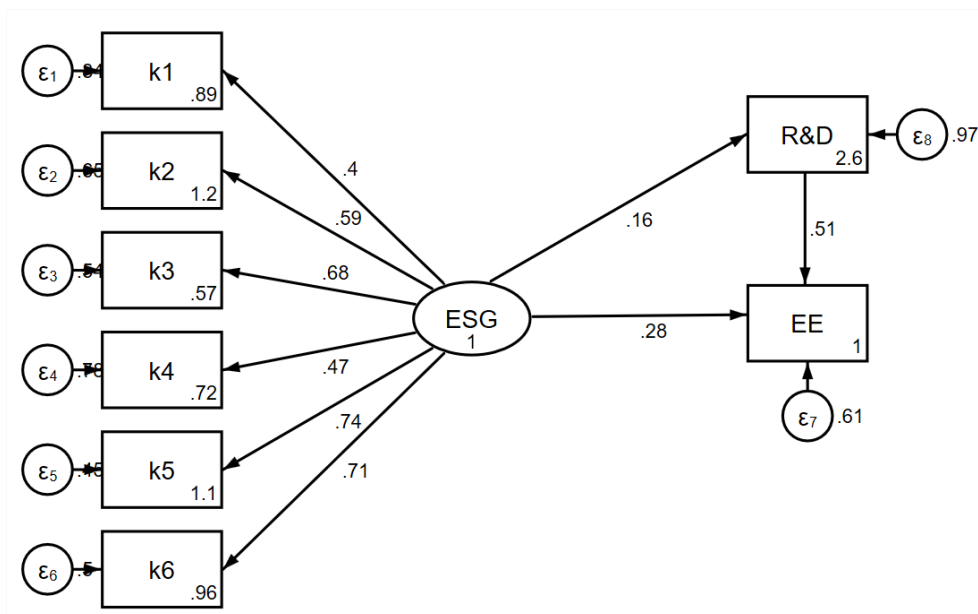


Figure 1. Relation to knowledge development and sustainability investments

Therefore, it is important to understand what firms regard as priority actions that policymakers should implement to support market development and the professional knowledge base on which to develop training courses.

Although investments in EE are perceived as important, there are barriers preventing full sector development, whereby offering EE goods or services is often not considered a competitive advantage, because the payback time for EE measures exceeds the expected payback time. Table 5 summarizes the importance the firms attributed to actions to be taken to support the implementation of EE measures.

Table 5. Actions

Description	Mean	Standard deviation
Incentives	3.716	1.038
Standard	3.686	1.062
Communication	3.539	0.804
Training	3.755	0.906
Network and cooperation	3.167	1.156
Audit	2.971	0.989
Regulatory framework	3.941	1.003

Description	Mean	Standard deviation
Technologies, products, and services	3.922	0.817
Evaluation criteria	3.618	0.758
Financial valuation criteria	3.843	0.829
Market analysis	3.794	0.916

Table 5 shows what is already known in the literature, namely, the need for tax incentives, training, and specific skills related to the financial evaluation of investments, and the technologies available on the market.

Finally, Table 6 reports the results of the regression analysis aimed at shedding light on the impact of significant business variables on EE activities.

Table 6. Regression analysis

EE	Coefficient	Std. err.	t	[95% conf. interval]	
ESG	0.108***	0.033	3.29	0.043	0.173
R&D	0.45***	0.076	5.93	0.299	0.6
Governance	0.182*	0.074	2.45	0.035	0.329
Payback	-0.084	0.077	-1.08	-0.237	0.07
_cons	0.414	0.202	2.05	0.013	0.814

As Table 6 shows, all the variables taken into consideration positively impact EE, except for the variable related to the expectation on the payback time of investments. In this case, there is an inverse relation between the importance of short payback time expectations and EE activities. This result also confirms the importance of public incentives to boost EE investments, as identified in existing research (Di Foggia et al., 2022).

4. Discussion

The opportunities and importance of consolidating new business procedures, services, and EE technologies necessary for the development of ESG strategies are evident and require knowledge development paths to create or boost internal culture. The potential of ESG is not yet fully understood as a strategic lever for the performance of firms, as it is still considered an environmental compliance topic. In this context, a recent paper found no significant relationship between ESG and firms' profitability or value (Atan et al., 2018). In addition, in firms where emissions are difficult to reduce, the financial benefits of ESG compliance are even more difficult to estimate, as is their integration into strategic plans. The main reason is that ESG compliance is often measured by accessing carbon credits markets; see (Michaelowa et al., 2019) for a resume of the expected benefits, or guarantees of origin in energy buying; see (Ragwitz et al., 2009) for a review of advantages and drawbacks in Europe, which, at first sight, could be considered ad hoc costs.

In addition, often, the payback time for ESG investments does not match the expected payback time, and this is considered to be a bankability issue. Investments in technological or process innovation for EE and reduction of emissions become interesting when combined with other advantages such as financial aspects or compliance for participation in public tenders, to name two particularly relevant reasons. However, with respect to tenders and procurement, there are still many doubts as to how to effectively incorporate sustainability requirements into procurement programs, although firms are willing to increase their spending with suppliers that have environmental expertise (Mukandwal et al., 2020).

Another emerging insight is that firms believe that the main driver for increasing competitiveness is to raise the quality of products, and the role of EE in making products more attractive is underestimated. To this end, there is a need to increase standards and certifications. Public incentives remain particularly important for the implementation of EE interventions, although there is an awareness that they are not sustainable in the medium and long term. The development of EE in production processes and the introduction of innovations aimed at achieving significant energy savings are necessary tools for achieving the objectives of sustainable development and decarbonization. In the medium term, these energy cost savings would contribute to making firms more resilient and competitive in international markets.

This paper contributes to the scientific literature on ESG factors by reporting empirical evidence from a sample of firms, highlighting the fact that ESG strategies require a commitment from firms, especially in terms of staff training. In contrast, one-off actions cannot be successful, since the ESG market is going through a period of

stalemate in which investors are evaluating in more detail the strategies of firms, especially because of the many cases of greenwashing that have recently emerged.

Starting from the well-known emission scope classification, the development of green management knowledge and competencies refers to Scope 1 and Scope 2, while the problem of Scope 3 remains. Scope 1 includes the direct emissions generated by the company, and their source is owned or controlled by the company; Scope 2 includes the indirect emissions generated by the energy purchased and consumed by the company; and Scope 3 includes all other indirect emissions that are generated by the company's value chain and therefore tend to be outside the direct control of firms.

Our results are based on an Italian industry sample. Therefore, the results of these analyses should be treated with caution, as external validity is not achievable without data from a similar sample of firms elsewhere.

Future research should focus on the effectiveness of investments in EE in light of international commitments, decarbonization targets, and different costs of emission reductions.

5. Conclusion

The paper empirically analyzed the impact of business propensity in building sustainability strategies based on knowledge development. The importance of ESG factors has led to a paradigm shift in the financial markets: an increasing number of investors are sensitive to sustainability when it comes to deciding the sector in which to invest, as firms become increasingly committed to undertaking ESG strategies. The paper focused on EE because, along with technological advancement, it is the most critical factor in industrial decarbonization and a pathway to improving economic competitiveness and sustainability. Advances in technological innovation, stakeholders' requirements, and global policy commitments provide a range of possibilities for achieving environmental benefits by developing ESG strategy outcomes, depending on how much firms are committed to ESG and their attention to R&D. The percentage of firms that declare to have an investment plan for EE is 44.1%. However, this rises to 65% in firms that invest more than 4% of their turnover in R&D. A similar trend can be observed with investments in ESG: 83.3% of firms declare having an investment plan of 4% of the turnover. We have argued that ESG strategies require competencies and capability building among employees to be successful. Otherwise, the risk of strategic drifts increases.

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