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Competitive sustainable manufacturing - Sustainability strategies, environmental and social innovations, and their effects on firm performance

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ABSTRACT

It is important for practitioners, policymakers, and scholars to understand how the adoption of sustainability strategies and innovations influence firms' overall performance. Practitioners obviously seek knowledge of the likely financial outcome of the adoption of sustainability strategies and innovations. Policymakers need the knowledge to devise effective policies to reach sustainability goals, and scholars seek to understand firm behavior and their ability to create financial value in the sustainability shift. Even though an increasing amount of empirical evidence indicate that the sustainability-firm performance relationship is positive, much debate remains concerning how and under what conditions firm-level competitiveness is created though sustainability. This study contributes by examining how sustainability strategies influence the implementation of social and environmental innovations in manufacturing firms, and in turn, how these innovations affect firm performance. Firm performance is measured in terms of value creation, cost reduction, and risk reduction, in which both perceived performance and objective longitudinal financial data are used. The study adopts a quantitative research approach using survey data from a representative sample of Norwegian manufacturing firms combined with publicly available financial data. Hypotheses are tested by structural equation modeling (SEM). The results indicate that sustainability strategies elicit a positive effect on the implementation of environmental and social innovations. Furthermore, environmental innovations were found to give a positive effect on all measured firm performance outcomes, while social innovations yielded mixed effects. We discuss the findings in relation to stakeholder and resource-based-view theories and the implications for practice and further research.

1. Introduction

Manufacturing and other forms of industrial activities' consumption of resources and energy, waste generation and emissions are major sources of the current sustainability challenges. As these challenges have become more evident and pressing, manufacturing firms have started to integrate sustainability into their core businesses strategies (Ghassim and Bogers, 2019). Moreover, stricter regulations of negative environmental and social externalities from the industry, combined with growing consumer awareness and environmentalism are changing how business is conducted across industries (Lin et al., 2019). Firms increasingly acknowledge that to remain competitive, environmental and social considerations need to be integrated into their core business strategies (Leal-Rodríguez et al., 2018).

While early research suggested that managers predominantly viewed sustainability strategies as cost drivers (Christmann, 2000), more recent research suggest a shift towards perceiving the sustainability shift as an opportunity (Porter and Kramer, 2011). The latter is more in line with a recent review of published research on the sustainability innovation-firm competitiveness relationship, which supports the hypothesis that increased focus on sustainability also increases firm competitiveness (Hermundsdottir and Aspelund, 2021). Hence, from a policymaker's point of view, recent studies suggest that even though the manufacturing sector is one of the major sources for global sustainability problems, they also can be a key element of the solution (Fraj et al., 2015). Unfortunately, the sustainability challenge is multifaceted and there is little knowledge of which types of sustainability innovations – environmental or social – firms are financially motivated to adopt.

This leads us to the managerial problem. Even though multiple studies conclude that there is a positive relationship between adoption

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of sustainability and firm competitiveness, there must be limitations. Arguably, not all sustainability innovations create commercial value and the practical questions of how and under what circumstances sustainability is profitable remains largely unexplained (Hermundsdottir and Aspelund, 2021). Hence, because this relationship largely remains a black box and the limitations of the positive relationship remain unclear, managers are not very informed on how they can benefit from adopting sustainability innovations within their own industries. Practitioners needs more knowledge on what types of sustainability innovations have commercial potential for either increased value creation, cost or risk reductions.

From an academic perspective, many questions have arisen from the value-creation mechanism and limitations of the sustainability-firm performance relationship. Naturally, transition costs are associated with changes in products, processes, management approaches, and policies required to improve sustainability performance (Silvestre and Ţîrcă, 2019). But what is the corresponding value-creation mechanism that offsets the costs of change toward sustainability? Some scholars take a resource-based approach and argue that sustainability rents are offset by an internal focus on developing resource and environmental efficiency in production that lead to cost reductions and business efficiency (Gürlek and Tuna, 2018). Other scholars have taken an external stakeholder view and argued that the cost of sustainability changes is offset by better market performance through superior value creation or by eliminating market-related risks (Ghassim and Bogers, 2019).

This study contributes by offering some answers to these questions by providing new insight into the sustainability innovation-firm performance relationship with relevance for practitioners, policymakers and scholars. More specifically, this study investigates the question of whether the adoption of sustainability strategies leads to actual implementation of social and environmental innovations, or whether in only leads to ceremonial adoption. Further, it investigates the question of whether different types of sustainability innovations – environmental and social – have different effects on firms' ability to create value, reduce costs or reducing market risk. By adopting both inside-out (resource-based theory) and outside-in (stakeholder theory) perspectives (Kolk and Pinkse, 2007), the present study contributes to the ongoing scholarly discussion of how competitiveness is created from sustainability (Hermundsdottir and Aspelund, 2021). Finally, it poses the question of whether managers' perceived success for the adoption of sustainability strategies matches up to the actual long-term financial performance of the firm, addressing the common methods bias problem in previous studies (Lin et al., 2019; Wijethilake et al., 2018).

One key strength of the study is the empirical data. The analysis is performed on primary quantitative data of a representative sample of the whole manufacturing sector in Norway. The data is based on survey data collected in 2015/2016 on manufacturing firms' sustainability strategies, adoption of sustainability innovations and managers' expected economic outcomes. The survey data is combined with publicly available financial data on firm performance in the years from censoring (2015) to 2019.

2. Theory and hypotheses development

2.1. Sustainability - environmental and social innovations

In order to reach the United Nations' Sustainable Development Goals (SDGs), the manufacturing sector needs to adopt a range of sustainability innovations that lowers the sectors' environmental and social footprints. *Sustainability innovations* is defined in this study as innovations that *"improve sustainability performance, where such performance includes ecological, economic, and social criteria"* (Boons et al., 2013, p. 2). Thus, sustainability innovations can provide solutions to the conflict between environmental and social degradation and economic development (Lin et al., 2019).

Embedded in this definition of sustainability innovation is the distinction between environmental and social innovations. Due to the current focus on environmental problems and climate change, environmental innovations are most studied in recent years (Hermundsdottir and Aspelund, 2021; Seuring and Müller, 2008) and they primarily deal with innovations for energy efficiency, emissions, waste management, recycling, reuse, and durability (Amores-Salvadó et al., 2014).

Interestingly, even though environmental sustainability gets most attention it is only directly related to 6 of the 17 SDGs. Most SDG's deals with social challenges, but they seem to have caught less attention in the sustainability business literature (Mulgan, 2006; Tabares, 2020). Social sustainability is perceived differently across different disciplines (Cajaiba-Santana, 2014). In this study, we define social innovations as innovations that contribute to increased life quality, social beneficence, and the overall public good (Dawson and Daniel, 2010; Pol and Ville, 2009).

This study seeks to investigate the differentiated effect of environmental and social innovations on firm performance. This makes sense as they are defined differently, interacts with different environmental and social factors, and receive different levels of attention in current society. It is therefore reasonable to assume that the potential for creating competitive advantage will differ too. Moreover, the distinction allows us to investigate whether type of sustainability innovation gives rise to different dimensions of firm performance. While the effect of environmental innovations has been examined in numerous studies there is still a question of what type of competitiveness is created and under what circumstances (Cai and Li, 2018). Social innovations' impact on firm performance, on the other hand, is understudied and remains largely unknown (Phillips et al., 2015; Hermundsdottir and Aspelund, 2021).

2.2. Sustainability strategies' influence on the adoption of sustainability innovations

Sustainability was for a long time kept separate from firms' core business strategies (Schrettle et al., 2014). This has changes in recent years and today most firms see sustainability strategies as important (Engert and Baumgartner, 2016) and are integrated with core business strategy (Burki et al., 2018; Ghassim and Bogers, 2019). The term *sustainability strategies* implies *"formalization of sustainability into businesses through implementation of new procedures for planning, evaluating, and reporting, in addition to new goals and responsibilities"* (Reyes-Rodríguez et al., 2016Reyes-Rodríguez et al., 2016, p. 195). Moreover, adopting sustainability strategies indicates proactive strategic behavior (Reyes--Rodríguez et al., 2016Reyes-Rodríguez et al., 2016) – that firms exceed complying standards from regulations and actively seek to improve their environmental and social performance by modifying products, processes, and technologies to reduce negative impacts (Fraj et al., 2015).

Consequently, strategic management includes both the formulation and implementation of strategies (Mintzberg and Waters, 1985), similarly to the distinction between strategic intention and actual behavior (Long et al., 2017). Hence, if there is – as hypothesized in this study – a potential to create competitive advantage in adopting sustainability, creating a sustainability strategy is not sufficient. The mobilization of resources, capabilities, managerial attention, and opportunity recognition are necessary for success (Long et al., 2017; Wijethilake et al., 2018).

There are at least two reasons why sustainability strategies might not be followed up with actual implementation. One is often referred to as ceremonial adoption – meaning that the strategy is implemented only in ceremony and not in practice. This is a well-known phenomenon from the literature of production systems (Netland and Aspelund, 2014) and in the sustainability literature it is most often referred to as "greenwashing" – the phenomenon that firms misleadingly communicate sustainability efforts without implementing them in practice (Vries et al., 2015). Second, non-execution can also stem from inability due to complexities in implementation. Implementation of sustainability strategies can be difficult and time-consuming if the organization is engrained in

unsustainable practices and the implementation requires significant changes in organization, practices, mindset and resource efforts (Engert and Baumgartner, 2016).

Still, if the underlying hypothesis of this study holds true – that there is a potential for increased firm performance through increased value creation or reduced costs or business risk – firms with ceremonial adoption of sustainability strategies or inability to implement sustainability for other reasons are not able to leverage those benefits. After all, strategy is ultimately about managing how resources and capabilities are employed in actual behavior (Bacinello et al., 2019; Long et al., 2017). Hence, we hypothesize:

H1a. Adoption of firm sustainability strategies positively affect adoption of environmental innovations.

H1b. Adoption of firm sustainability strategies positively affect adoption of social innovations.

2.3. Creating value: Sustainability innovations and firm performance

The sustainability – firm performance relationship has received increased attention in the academic literature the past few years (Hermundsdottir and Aspelund, 2021; Rezende et al., 2019). Despite the number of studies, the debate continues due to inconsistent and sometimes conflicting results (Fraj et al., 2015; Li et al., 2019). Two main reasons why there is still a debate despite the number of studies is that the relationship is complex and methodologically challenging.

2.3.1. Sustainability innovation – firm performance relationship: complexity and methodological challenges

The first reason why the sustainability – firm performance relationship is challenging to study is complexity. Sustainability innovations are often the result of significant investments in new technological solutions that require change on multiple levels of the organization and across supply chains (Fraj et al., 2015). Moreover, firm performance outcomes might depend on national, market, industry, and firm context variables outside of managers' control, which complicates the relationship even more (Hermundsdottir and Aspelund, 2021). Hence, the context in which the study is executed will influence the result.

Second, the relationship is methodologically challenging due to time lag, uncertainty of directionality, and common method bias (CMB). As for time lag, some argue that the findings are mixed because of a time lag between adoption of the innovation and economic results (Rezende et al., 2019). Uncertainty of directionality is also widely discussed (Martínez-Ferrero and Frías-Aceituno, 2015; Pätäri et al., 2012) and relates to the question of whether firms that adopt sustainability innovations perform better, or whether financially successful firms implement more sustainability innovations. To address both these issues, studies with longitudinal economic performance data are needed (Chu et al., 2019; Lin et al., 2019). Finally, CMB occurs when dependent and independent variables are measured using the same method. It is particularly problematic when measures are dependent on respondents' perceptions, or include topics in which the respondent intrinsically wants to be positive or sociable (Podsakoff et al., 2003). CMB is common in many sustainability studies and may affect their findings.

Due to these empirical and methodological challenges, the sustainability – firm performance relationship is often treated like a black box, providing both scholars and practitioners with limited insight into the mechanics of sustainability value creation. The present study seeks to contribute in investigating some of the mechanics of sustainability value creation using a method that avoids some of the challenges. But first we need to return to the rationale for how firm performance is created.

2.3.2. Stakeholder theory: increased value creation and reduced risk through sustainability

Stakeholder theory is the most used theoretical framework in studies that seek to investigate the sustainability innovations and firm performance relationship (Hermundsdottir and Aspelund, 2021). The theory emphasizes the influence of the firm's stakeholders in strategy formulation (Freeman, 1984), where stakeholders are defined as the groups and individuals who can influence and be influenced by the firm's performance or objectives (Freeman, 1984). The reason why this theory is so popular among sustainability researchers is that it broadens the view of business by considering the firm to be part of a bigger societal and natural environment in which the purpose is to create value for all stakeholders (Freeman et al., 2010).

Several studies have examined how stakeholder pressure from e.g. customers and regulators influence firms' efforts to implement sustainability (Ramanathan et al., 2014; Yu et al., 2017). The rationale is that failing to meet requirements from stakeholders – such as governments, customers, NGOs, and the media – can lead to economic and reputational loss (Guoyou et al., 2013) while meeting stakeholders' demands can lead to increased reputation, customer satisfaction, growth in market share, and stronger financial performance (Liao, 2018). In many ways, stakeholder theory, market orientation, and the positioning school within strategy are closely related, as all focus on the external environment (Leal-Rodríguez et al., 2018) and argue that firms who manage to satisfy customer needs and react to new requirements will gain a competitive advantage (Day, 1994).

Even in the instances where development and implementation of environmental innovations require significant investments, stakeholder theory can explain why it is still economic beneficial if increased revenues or margins offset the associated costs (Eiadat et al., 2008). This view has been supported in several studies where environmental innovations have been found to positively affect firm performance in terms of increased competitive advantage (Chang, 2011), market value (García-Sánchez et al., 2019), and firm profitability (Chan et al., 2016). Hence, we hypothesize:

H2a. Implementation of environmental innovations positively impact a firm's value creation in terms of growth in revenues and profitability.

Stakeholder theory also can explain how companies implement sustainability innovations to improve company reputation and reduce business risk, but this relationship has been less studied. However, some studies have found that environmental measures systematically reduce risk (Sharfman and Fernando, 2008). Likewise, Eiadat et al. (2008) and Tariq et al. (2019) found that green innovations reduce risk, in that firms become more prepared for future regulations and the increase in environmentally concerned customers. Hence, we hypothesize:

H3a. Implementation of environmental innovations reduce firms' overall business risk.

Research on social innovations' effect on firm performance is scarce, but the basic stakeholder rationale also applies to social innovations. The only difference is that the general stakeholder pressure for social innovations might have been less than for environmental innovations the past decade. However, the discussion is older and spans back to the early industrial revolution. The few studies on the topic conclude that social innovation is positively related to economic performance (Osei and Zhuang, 2020; Svensson et al., 2019), especially in terms of market related measures such as firm value, customer loyalty and stakeholder retention (Cacciolatti et al., 2020). Other studies find that social innovations increase legitimacy and as such implies reduced business risk (Cacciolatti et al., 2020; Li et al., 2018; Padgett and Moura-Leite, 2012). Based on these studies we hypothesize:

H2b. Implementation of social innovations positively impact a firm's value creation in terms of growth in revenues and profitability.

H3b. Implementation of social innovations reduce firms' overall business risk.

2.3.3. Resource-based theory: cost reductions and increased efficiency through sustainability

The second most used framework in research on the sustainability innovation – firm performance relationship is resource-based theory (Hermundsdottir and Aspelund, 2021). Resource-based theory (RBT) conceptualizes the firm as a bundle of resources and capabilities that create the basis for firm's competitive advantage (Barney, 1991). In this context, a resource is *"something that a firm possesses, which can include physical and financial assets, as well as employees' skills and organizational (social) processes"* (Hart and Dowell, 2011, p. 1465). Capabilities are resources and routines that the firm needs to accomplish a certain output that is important for the firm's survival and prosperity (Winter, 2000). In other words, RBT is an inside-out perspective, which means that a firm's strategy process departs from an analysis of internal resources and capabilities.

There is a long tradition to use RBT to analyze firms' sustainability strategies. Hart (1995) extended the RBV perspective to incorporate natural resources as they have become increasingly important for strategic outcome. Natural resource-based view (NRBV) states that in order for firms to achieve sustainable development they need to possess specific strategic resources and capabilities and result in desired outcomes (Hart and Dowell, 2011).

In the years after Hart's seminal work, RBT and NRBV have been used extensively in the literature to explain the relationship between sustainability innovations and competitiveness (Shin et al., 2018). Several studies have investigated how different kinds of resources and capabilities influence implementation of sustainability innovations (Albort-Morant et al., 2016; Huang and Li, 2017).

One particular strand of research has focused on how environmental innovations can lead to cost reductions and increased operational efficiency due to reduction in the use of input factors such as energy, materials and labor as well as reduction of waste costs (Chan et al., 2016; Christmann, 2000; Hojnik et al., 2017). This strand of research has been labelled *Lean and Green* (Garza-Reyes, 2015) as the effect of improvements in environmental performance occurs simultaneously as the firm is implementing a company-wide production system based on the lean manufacturing system (King and Lenox, 2001). A production system is a good example of a strategic company resource with implications for financial and environmental performance (Netland and Aspelund, 2013). The rationale is that generation of waste, emissions and other environmental footprints are simply symptoms of inefficient production and there is a potential for cost reductions by removing those footprints (Hojnik et al., 2017). The *Lean and Green* phenomenon is well established in the sustainability manufacturing literature and shows how firms can systematically reduce their environmental footprints through implementing and refining a key strategic firm resource such as a company-wide production system. Hence, we hypothesize:

H4a. Implementation of environmental innovations reduce firm's costs.

Extant research on the relationship between social innovation and cost reduction is sparse, but some researchers have discussed how specific types of social innovation can lead to cost reductions and minimize the use of resources for both manufacturers and customers. These types of innovations have been labelled frugal innovations and was initially used in the context of emerging economies. However, the concept has been broadened out to all innovations that fulfil three criteria: substantial cost reduction, focus on core functionality and optimized performance level (Weyrauch and Herstatt, 2017). Frugal innovations are argued to have potential for global socio-economic impact simultaneously as they deliver both reduced costs and environmental footprints for manufacturers (Agarwal and Brem, 2017). Hence, we hypothesize that there is a potential for cost reduction by adopting social innovations:

H4b. Implementation of social innovations reduce firm's costs.

In summary, both stakeholder theory and RBT offers substantiated, but complementary, arguments for how firm performance can be created from the adoption of sustainability innovations. We argue that the stakeholder view predominantly explains a path to increased value creation and risk reduction, while RBT offers the explanation for how cost reductions and operational efficiency can be achieved. Thus, these theories together can form the argument why firms are economically motivated to adopt sustainability innovations (Doran and Ryan, 2016; Kolk and Pinkse, 2007).

Based on the hypotheses above, we propose the following research model (Fig. 1):

3. Method

3.1. Research approach, data collection and sample

The main motivation for this study is to empirically test the path from adoption of sustainability strategies to implementation of sustainability innovations, and finally to firm performance. For this purpose, a quantitative research approach is appropriate.

The empirical investigation relies on combining two data sources – a survey and longitudinal financial data reports from the years after the survey. The logic is that the survey measures the extent firms are adopting sustainability strategies, innovations, and managers' expected financial outcomes of those, while the longitudinal financial data measures the actual financial performance of the firms in the years after censoring (2015–2019). This method provides a better indication of directionality than if historical financial data were used and contributes to the discussion of directionality in the literature.

The survey was conducted between November 2015 and February 2016. A list of the total population of Norwegian manufacturers (NACE Group C – Industry) was extracted from the Brønnøysund Business Register – a register mandatory for all businesses in Norway. This list returned approximately 4,300 manufacturing firms, which were reduced to 2,638 after removing companies with incomplete contact information and financial inactivity.

An online questionnaire was developed that included 110 questions about internationalization, growth strategies, sustainability strategies and innovations, managerial motivation, and expected financial effects from sustainability innovations. The questionnaire was pilot tested on 10 managers in manufacturing firms before it was e-mailed to the firms addressed to the CEO.

When data collection ended in February 2016, we had received 682 completed responses, which yields a response rate of 25.9%. To ensure that the sample was representative of the whole population of Norwegian manufacturers, the sample was compared with the population in terms of firm size, firm age, and industry code. No notable differences were found, indicating that the sample was representative of the population.

Longitudinal financial data records were collected for the years 2015–2019 from the online financial service provider Proff Forvalt. These records provide reliable credit and accounting data from all legal Norwegian firms in the Brønnøysund Business Register. We used financial information from the year of censoring (2015/2016) and the following four years. This is in line with the recommendations of Rezende et al. (2019), who found that the financial effects of green innovations peaked after two years, but remained significant for at least one more year. We could in principle also extract data from 2020 to 2021, but these data would be influenced by the pandemic as recent research has shown that the pandemic changed the extent that firm could benefit from sustainability innovations (Hermundsdottir et al., 2022).

Table 1 provides the characteristics of the final sample. On average, responding firms were founded in 1978 (SD = 30.9) and had 58 employees (SD = 144.3). Even though all firms are categorized as manufacturers, many offer a mix of products and services, with 83% reporting

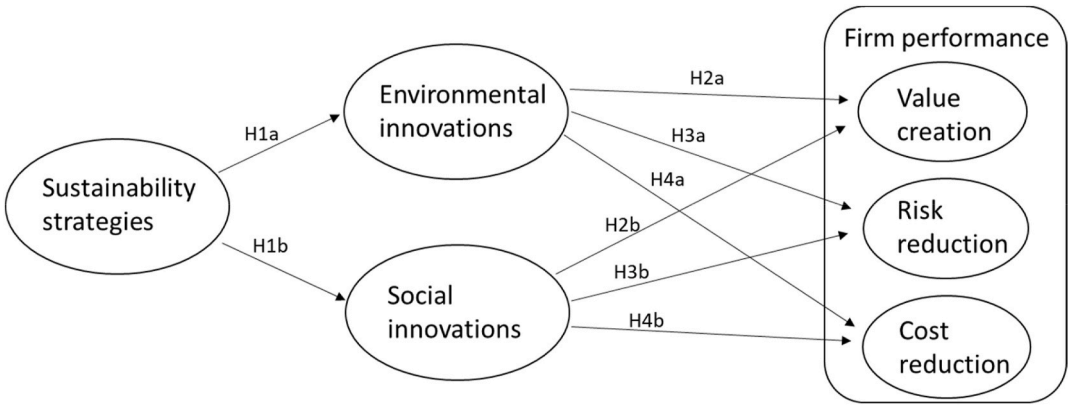

Fig. 1. Research model and hypothesized relationships.

Table 1
Descriptive statistics of sample.

Variable		Mean	Std. Dev
Establishment year		1978.06	30.906
Number of employees		57.55	144.34
		Percentage	
Type of firm			
	Goods-producing	82.9%	
	Service-delivering	17.1%	
International sales		48.7%	
International suppliers		77.5%	
International production		8.8%	

that they are mainly goods-producing firms, whereas the rest offer a mix in which services dominate. Most firms are exposed to international business, with about half involved in international sales, 78% describing themselves as international suppliers, and 9% operating international production facilities.

3.2. Variables

To the extent that it was possible, the variables are based on scales from previous research or established frameworks and adapted to the Norwegian manufacturing context. A description of the variables and their sources follows below. The specific survey questions including validity and reliability analysis can be found in the Appendix. Apart from the financial variables from the financial data records, responses were measured on seven-point Likert scales (1 = "Not at all" to 7 = "To a great extent").

Below, we provide a brief description of key variables:

Strategy for sustainability is a nine-item index and measures to what extent sustainability is integrated into the firm's general business strategy (adopted from Eide et al., 2020). The variable measures the extent to which sustainability is integrated in core business strategy, is a core value of the firm, is an ongoing discussion in top management and the executive board, is measured and published, incentivized, invested in, and something the firm seeks external collaboration to solve.

Environmental innovation is a four-item scale based on the FutureFit framework (see futurefitbusiness.org and Willard, 2012) and measures the extent to which the firm implements actual environmental innovations. The variable consists of items regarding firms' reduction of greenhouse gas emissions and other harmful emissions, design for recyclability and reuse, and access to recycling and reuse services.

Social innovation is a three-item scale also based on the FutureFit framework (Willard, 2012) and measures the extent to which the firm includes social considerations when implementing activities. Items are focused on ensuring standard of living for all actors in the value chain, fair working conditions, and transparent management of social concerns.

As mentioned above, the measuring of firm performance in sustainability research is marred with methodological challenges. One is the directionality challenge that we seek to ease by using longitudinal financial data. Another is the common methods bias problem that arise with subjective measuring of expected performance outcomes. To address this challenge this study uses self-reported perceived performance measures and objective financial data to measure firm performance. This strategy has been used before in similar studies (see e.g. Christmann, 2000; Wilderom et al., 2012). They argue that perceived performance captures a broader picture of performance and financial investments that have not yet produced returns – however, they are prone to rater bias. Objective performance is relevant, as it is something that all firms must consider and is crucial for their operation (Wilderom et al., 2012). Our main strategy to avoid CMB is to measure firm performance both subjectively and objectively like the two studies mentioned above. In addition, the present study's strength is that we have time series of objective financial data after the time of censoring. Thus, we observe whether perceived outcomes deviate significantly from the firms' actual financial performance during the following years. Perceived firm performance is measured as follows:

Perceived value creation comprises eight items and includes questions about how managers expect sustainability to influence value creation in their firms (adopted from Willard (2012), see Chang, 2011; Bacinello et al., 2019 for similar scales). The variable measures the extent managers believe their sustainability strategies will contribute to sales growth, higher perceived value, customer loyalty, ability to develop new products, services and avoid direct competition, as well as improving external relations to stakeholders, partners and gaining political goodwill.

Perceived cost reduction comprises two items and includes questions about how managers think sustainability will affect their costs (adopted from Willard (2012), see Chan et al. (2016) and Reyes-Santiago et al. (2019) for similar scales). The variable measures the extent managers believe their sustainability strategies will contribute to reduce operating costs and costs to hire and retain competent personnel.

Perceived risk reduction refers to the way managers perceive how sustainability can affect risk reduction. This is a three-item scale (adopted from Willard (2012), see Dyllick and Muff (2016) and Rasche et al. (2017) for similar scales). The variable measures the extent managers believe their sustainability strategies will contribute to reduced risk of reputation failure, decline in sales, or inability to meet future regulations.

The complementary objective firm performance measures from the 2015–2019 financial data records were measured as follows:

Profitability was measured using Return on Assets (ROA) according to previous literature (e.g., Rezende et al., 2019; Tariq et al., 2019). In this

study, profitability was calculated using the firms' mean ROAs from the years 2015–2019. ROA was calculated using the following equation:

ROA = operating profit + financial income/total capital, where total capital is the sum of equity and debt.

Cost margin is a measure of efficiency and productivity (Antonioli et al., 2016) and was measured using the firm's operating costs over operating revenues from the years 2015–2019. A small cost margin value indicates that the firms have small operating costs compared with operating revenues. Thus, the smaller value, the better.

Risk is calculated using the firm's standard deviation of ROA (SDROA), in line with other studies (e.g., Li et al., 2013; Tariq et al., 2019). Thus, this measures the overall risk imposed on the firm in terms of volatility of corporate earnings. Risk was calculated by the mean SDROA during the 2015–2019 period. A small risk value indicates that the firm has small variations in its ROA and, thus, low earnings volatility, thereby indicating low risk (Li et al., 2013).

If economic data from 2019 were missing, the time series were stopped in 2018.

3.3. Statistical analysis

For the statistical analysis, we used SPSS Statistics 26 for descriptive analyses and StataMP 16 for structural equation modeling (SEM). SEM was used to analyze causal relationships between the latent variables in the research model (Fig. 1) and is viewed as appropriate to use when one wants to estimate relationships between several independent variables and more than one dependent variable simultaneously, such as in this case (Hair et al., 2012).

In the SEM, we used latent path analysis (LPA), which is the most commonly used technique in the social sciences. LPA is used to investigate the structure of latent variables and to test the hypothesized relationships (Mehmetoglu and Jakobsen, 2017). The LPA was conducted in two parts: measurement and structural parts. The measurement part includes conducting a confirmatory factor analysis (CFA), which is used to *"assess a hypothesized latent factor structure containing a set of indicators and one or more latent variables"* (Mehmetoglu and Jakobsen, 2017, p. 296). Thus, CFA includes examining the relationships between the observed indicators and latent variables and is a way of measuring the reliability and validity of the measurement model (Mehmetoglu and Jakobsen, 2017). After establishing a valid and reliable measurement model, we proceeded with the structural part, in which the whole model was tested, including the relationships between the latent variables.

4. Results

4.1. Measurement model

The first step of the SEM analysis is to conduct a CFA to assess the measurement model's validity and reliability (Fornell and Larcker, 1981). Appropriate to this data, the CFA used a maximum likelihood estimation method with missing values (MLMV).

The measurement model's strength was assessed. Standardized factor loadings of latent variables should be above or equal to 0.4 (Mehmetoglu and Jakobsen, 2017), which was the case in this study (see Appendix). Next, we assessed the scales' reliability using Raykov's reliability coefficient (RRC), in which values over 0.7 indicate sufficient reliability (Mehmetoglu and Jakobsen, 2017). All RRC values exceeded 0.7 in this study. To assess discriminant validity, the latent variables' average variance extracted (AVE) values should be larger than the squared correlations between the latent variables (Fornell and Larcker, 1981). Furthermore, to claim convergent validity, AVE values should be larger than 0.5 (Fornell and Larcker, 1981). We observed that all squared correlations were less than the AVE values, indicating adequate discriminant validity, and that all AVE values exceeded 0.5 (see Appendix). Thus, we concluded that the measurement model had high reliability and validity.

Regarding CMB, the main methodological strategy to avoid the problem was to use two sources to measure performance (perceived and objective). In addition, we also performed a Harman's single factor test to check for CMB (Craighead et al., 2011). The unrotated principal axis-factoring analysis indicated that the first factor accounted for 37.97% of the variance, which suggest no significant issues with CMB in the data. A single-factor model was also tested using CFA. As the single-factor model showed poor model fit (CFI = 0.566, TLI = 0.532, RMSEA = 0.142), it confirms that CMB is not an issue in the data (Serrano Archimi et al., 2018).

Table 2 provides the mean values, standard deviations, and squared correlations among the latent variables.

4.2. Structural model

After testing the measurement model, we tested the structural model, in which the full LPA model was estimated (Mehmetoglu and Jakobsen, 2017). Like above, the LPA was run using the MLMV estimation method. In line with recommendations from Brown (2015) and Petrescu (2013), the unstandardized factor loadings of single indicators – profitability, cost margin, and risk – were set to 1, and these variables' error variances were set to 0, as they are actual financial numbers without known sources of measurement error. Model fit indices were RMSEA = 0.056, CFI = 0.917, and TLI = 0.908, which are acceptable. The LPA model's estimation results are provided in Table 3 and illustrated in Fig. 2.

The results in Table 3 provide us with an assessment of the proposed hypotheses' validity. First, and fundamentally, the results indicate that sustainability strategies elicit a positive and significant effect on both environmental innovations ($\beta = 0.81$; $p < 0.001$) and social innovations ($\beta = 0.49$; $p < 0.001$). Thus, firms that place a strong emphasis on sustainability strategies also implement environmental and social innovations in practice, thereby supporting Hypotheses H1a and H1b.

Moving on to outcomes, the results indicate that environmental innovations elicit a positive and significant effect on all perceived firm performance measures, including value creation ($\beta = 0.54$; $p < 0.001$), cost reduction ($\beta = 0.48$; $p < 0.001$), and risk reduction ($\beta = 0.54$; $p < 0.001$). These findings indicate that Norwegian manufacturing firms' managers have high expectations of economic gains from their sustainability innovations, supporting Hypotheses H2a (perceived), H3a (perceived), and H4a (perceived).

One also can argue that these expectations are justified, as the objective measures on financial outcomes have been found to affect profitability positively ($\beta = 0.65$; $p < 0.001$) and negatively impact cost margin ($\beta = -0.78$; $p < 0.001$) and risk ($\beta = -0.53$; $p < 0.001$). Please note that due to the manner in which cost margin and risk are measured in this study, a negative effect on cost margin and risk means reduced costs and risks. Therefore, in our study, the findings fully support Hypotheses H2a, H3a, and H4a (both objective and perceived).

Social innovations also elicited positive and significant effects on perceived value creation ($\beta = 0.15$; $p < 0.05$), perceived cost reduction ($\beta = 0.10$; $p < 0.1$), and perceived risk reduction ($\beta = 0.20$; $p < 0.001$), supporting Hypotheses H2b (perceived), H3b (perceived), and H4b (perceived), although the effects for social innovations systematically are statistically weaker than for environmental innovations.

The final set of investigated relationships concerns objective outcomes from implementing social innovations, and the results differed from those of the environmental innovations. Social innovations negatively affect profitability ($\beta = -0.89$; $p < 0.001$), and leads to increased cost margin ($\beta = 0.89$; $p < 0.001$) and risk ($\beta = 0.86$; $p < 0.001$). Due to the way cost margin and risk are measured, positive coefficients indicate that social innovations increase cost and risk. Thus, Hypotheses H2b (objective), H3b (objective), and H4b (objective) were not supported, leading to Hypotheses H2b, H3b, and H4b only being partially supported. Actually, the analysis suggests a significant opposite relationship

Table 2
Factor means, standard deviations, and squared correlations among latent variables.

	Mean	St. dev	1	2	3	4	5	6
1. Sustainability strategies	3.41	1.37	1.000					
2. Environmental innovation	4.83	1.58	0.432	1.000				
3. Social innovation	6.18	0.89	0.045	0.054	1.000			
4. Value creation	4.31	1.04	0.220	0.127	0.040	1.000		
5. Cost reduction	3.95	1.04	0.104	0.065	0.014	0.303	1.000	
6. Risk reduction	4.44	1.13	0.237	0.121	0.026	0.313	0.394	1.000

After assessing the measurement model for sufficient validity and reliability, we performed a model fit indices assessment (Mehmetoglu and Jakobsen, 2017), which returned model fit indices of RMSEA = 0.062, CFI = 0.922, and TLI = 0.912, which were all at acceptable levels.

Table 3
Results from the LPA model.

Model link	Std. coefficients	Hypotheses supported
Direct effects		
Sustainability strategies - > Env. Inno.	0.81***	H1a: Supported
Sustainability strategies - > Soc. Inno.	0.49***	H1b: Supported
Env. Inno - > Perceived Value Creation	0.54***	H2a (perceived): Supported
Env. Inno - > Profitability	0.65***	H2a (objective): Supported
Env. Inno - > Perceived Risk Reduction	0.54***	H3a (perceived): Supported
Env. Inno - > Risk	−0.53***	H3a (objective): Supported
Env. Inno - > Perceived Cost Reduction	0.48***	H4a (perceived): Supported
Env. Inno - > Cost margin	−0.78***	H4a (objective): Supported
Soc. Inno - > Perceived Value Creation	0.15**	H2b (perceived): Supported
Soc. Inno - > Profitability	−0.89***	H2b (objective): Not supported
Soc. Inno - > Perceived Risk Reduction	0.20***	H3b (perceived): Supported
Soc. Inno - > Risk	0.86***	H3b (objective): Not supported
Soc. Inno - > Perceived Cost Reduction	0.10*	H4b (perceived): Supported
Soc. Inno - > Cost margin	0.89***	H4b (objective): Not supported

***: $p < 0.001$; **: $p < 0.05$; *: $p < 0.1$; NS: non-significant. Note: Due to the manner objective risk and cost margin are measured, negative values indicate reduced risk and cost margin.

among the hypotheses, in which increased emphasis on implementing social innovations led to poorer performance in terms of both profitability, cost margins, and risk. Fig. 2 provides the research model's results.

5. Discussion

Before we go into the details, implications and limitations, it makes sense to take an overall assessment of the findings. This study finds, from a representative sample of the whole population of Norwegian manufacturers, that adoption of sustainability strategies leads to implementation of sustainability innovations. Furthermore, the adoption of environmental innovations leads to improved firm performance in terms of increased value creation, reduced risk and cost. For social innovations, the picture is more complicated as subjective and objective measures are conflicting. However, overall this study provides further evidence that the environmental sustainability shift should be an opportunity for firms that seek to improve financial performance (Hermundsdottir and Aspelund, 2021; Porter and Kramer, 2011), and as such, improved performance can be created along several dimensions. In the following, we will discuss implications and limitation for each step in the model in more detail.

5.1. Sustainability strategies' influence on the adoption of sustainability innovations

The study's findings indicate that sustainability strategies positively affect the extent to which firms conduct environmental and social innovations. The correlations are especially strong for environmental innovations, but also significant for social innovations. This shows that when sustainability is integrated with the overall firm strategy (Banerjee, 2002), it has consequences for business development and investment decisions (Papagiannakis et al., 2014). The finding also indicates that there is limited ceremonial adoption or 'greenwashing' among the firms. The correlation to environmental innovations is surprisingly high (std. coefficient 0.81***), while the correlation to social innovations is lower, but still significant (0.49***). The latter can be explained by the context as social concerns are highly institutionalized in the Norwegian manufacturing sector. Consequently, the score on social innovations is very high (mean value 6.18 on a scale to 7) and variance is low indicating that social concerns are to a high degree taken care of. We will return to the role of the context below, but the difference can also be a sign that manufacturers prioritize environmental innovations, because social issues to a great extent are solved and offers little opportunity for strategic differentiation. Environmental innovations are currently more potent for strategic differentiation because it remains unsolved. Regardless, the results imply that firms with sustainability strategies develop specific capabilities that make them better equipped to deal with future sustainability issues (Papagiannakis et al., 2014; Schrettle et al., 2014).

5.2. Creating value: Sustainability innovations and firm performance

5.2.1. Environmental innovations on firm performance

The results reveal that environmental innovations elicit a significant and positive effect on both perceived and objective firm performance in terms of value creation, cost reduction, and risk reduction. These findings are strongly statistically significant (all p-values below 0.001) and surprisingly consistent and robust across different ways of measurement. Positive findings for improved financial performance (Scarpelini et al., 2019), cost reduction (Chan et al., 2016), and risk reduction (Rezende et al., 2019) have been found independently in recent studies, but this is the first study to our knowledge with such robust findings across a whole population of manufacturers.

Form a practitioner and policy-maker point of view this finding shows that a shift towards more sustainable practices in the manufacturing sector actually should be conceptualized as a business opportunity (Porter and Kramer, 2011) more than a threat to industry or firm survival. That said, the limitation of these types of studies is that we only study those innovations that firms have actually decided to adopt, and it is reasonable to assume that firm prioritize innovations with the highest expected return. Hence, a statement such as sustainability is profitable in general is unreasonable. A more fitting statement is that the green transition offers so many business opportunities and innovations that they offset the associated costs of transition (Hermundsdottir and Aspelund, 2022), and this is also the finding from this study.

For an academic point of view, this study renders support both to the

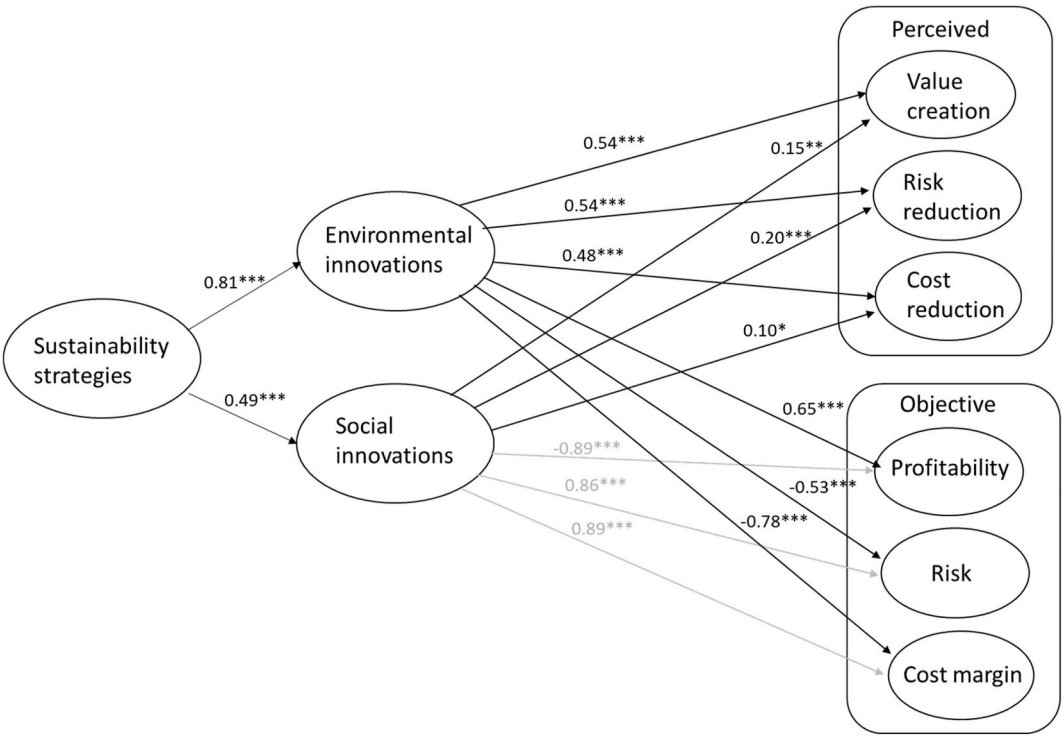

Fig. 2. The results from the research model. Black arrows represent supported hypotheses, while gray arrows represent unsupported hypotheses. Note: Due to the manner objective risk and cost margin are measured, negative values indicate reduced risk and cost margin.

outside-in stakeholder perspective and the inside-out resources-based perspective. According to the outside-in perspective market value is created by the ability to respond to the external environment (Wijethilake et al., 2018). In the green transition, external stakeholders are creating business opportunities that proactive firms can leverage either through first mover advantages (Pryzhodsen et al., 2019), differentiation advantages (Fraj et al., 2015; Liao, 2016), or by going beyond stakeholders' expectations (Buysse and Verbeke, 2003). According to the inside-out perspective, firms can build strategic resources and capabilities around new environmental innovations and enjoy efficiency and cost advantages (Hojnik et al., 2017). Our findings suggest that environmental innovations can be leveraged equally well by taking a strategically beneficial market position which pleases stakeholders (Liao, 2018) and by developing internal resources and capabilities that increases efficiency (Chan et al., 2016).

5.2.2. *Social innovations' effect on firm performance*

Maybe the most intriguing finding in this study is that social innovations had a positive effect on all perceived firm performance measures of value creation, cost and risk reduction, while regarding the objective performance measures they are found to negatively affect profitability, and increase risk and cost margin. These results not only contradict previous research (Svensson et al., 2019; Osei and Zhuang, 2020), but the difference between perceived and objective performance outcomes indicates that firm managers are highly optimistic about the effects from social innovations, while when objectively measured the effects are negative. This demands further reflection and can stem from several effects:

First, the optimism about social innovation could be a consequence of high stakeholder pressure. In Norway, firms generally score high on social sustainability (Fonseca and Lima, 2015; Mulgan, 2006) and we also observed very high scores on social innovation (see Table 2). Socially responsible behavior is regulated and institutionalized in the Working Environment Act and cannot be a differentiation strategy the way environmental innovations potentially can. Thus, assuming that social innovations follow the "S-curve" (Mulgan, 2006), we assume that they have reached maturity level in the Norwegian context, and hence such innovations no longer lead to significant positive returns.

Second, it could be that what we are observing here is the result of social desirability in which variables can be influenced by respondents wanting to gain social acceptance and approval (Podsakoff et al., 2003). This might be the case in questions regarding social innovations as they involve the extent the firm seeks to contribute to social prosperity.

Third, environmental and social innovation have different objectives (Mulgan, 2006) and there are also different value creating logics. For social innovations, the key purpose is to create social value by interacting more with other social actors and institutions (Phillips et al., 2015; Dawson and Daniel, 2010). For environmental innovations the logic is opposite. One seeks to reduce the interaction with natural resources to reduce environmental footprints. As such environmental innovations are closer to a business performance logic of reduced costs (Hojnik et al., 2017) and social innovations represents less of a business case (Porter and Kramer, 2011).

Finally, social innovations are dynamic and complex (Silvestre and Ţîrcă, 2019), and can span across sectors and disciplines, requiring collective learning among different actors and often resources and capabilities found outside of the firm's expertise and environment (Phillips et al., 2015). The firm's learning capacity and the social system in which the social innovations are conducted are important for success (Phillips et al., 2015). Hence, it could also be a result of the complexity issue explained above – that firms fail to implement social innovations properly because they are too complicated to handle (Engert and Baumgartner, 2016).

To sum up, there could be different explanations to the conflicting finding on social innovations in this study. Either it could stem from the context, the methods or the business logic or complexities connected to the concept itself. Still, none of these explanations explain why managers have such positive expectations of the firm performance potential of social innovations. We call for more research on the firm performance implications of social innovations.

5.3. Limitations and further research

This study's key strength is in the data. It is based on a representative sample of the whole manufacturing sector in Norway combined with longitudinal financial data. The biggest limitations are that it draws empirical evidence from the Norwegian manufacturing context alone. First, we call for more research to investigate how well these finding transfer to other industries and country settings. Second, even though the findings related to the firm performance effects of environmental innovations seems clear and robust, it fails to provide the same clarity and robustness about the effects of social innovations. Considering that social innovation is an important part of sustainability, and that businesses ultimately operate in market-based economies (Baumgartner, 2014), we specifically recognize the need to examine how social innovations create shared value and what innovations are solely philanthropic. Third, as we only examined environmental innovations as a whole, it would be interesting to study how different types of environmental innovations contribute to firm performance. This knowledge is valuable in better understanding different innovations and how to manage them successfully (Silvestre and Ţîrcă, 2019). Finally, regarding resource-based theory, future case studies should be conducted to better assess how capabilities and resources for sustainability develop, what kinds are most effective, and how they contribute to successful implementation of sustainability innovations.

6. Conclusions

This study investigate the extent Norwegian manufacturing adopt sustainability strategies and innovations, and how this ultimately influenced firm performance over time. We conclude the adoption of sustainability strategies positively influence implementation of both environmental and social innovations. This implies that sustainability strategies work as a driver and catalyst for the development of sustainability innovations. Furthermore, we find clear and robust evidence that environmental innovations positively affect both perceived and objective firm performance measures in terms of value creation, risk and cost reduction. Social innovations, on the other hand, were found to positively affect perceived performance measures, whereas they negatively affected objective firm performance measures.

These findings carry important implications for theory and practice. For theory, they deliver a robust empirical argument for the positive relationship between environmental innovations and firm performance. This increased firm performance through environmental sustainability can be created in a variety of ways – increased value creation, cost reductions or risk reductions, which indicates that both outside-in perspectives such as stakeholder theory and inside-out perspectives such as resource-based theory can be valuable complementary frameworks to explain the phenomenon.

Another important theoretical contribution is the incorporation of social innovations, answering the call for more holistic sustainability studies (Silvestre and Ţîrcă, 2019). We find that social innovations' effects on firm performance are ambiguous dependent on subjective or objective measures. There can be several explanations for this result, but more research is needed before we can arrive at similar robust answers as for environmental innovations.

Finally, the study contributes methodologically by including both objective and perceived performance measures and longitudinal financial performance data, and as such, contributes to solving some of the methodological challenges on topics such as causation and directionality (Chu et al., 2019) and the problem associated with common methods bias.

For practitioners and policymakers, this study demonstrates beyond any doubt that the sustainability shift does not represent industry death, but rather that the number and size of business opportunities that comes with the green shift overcome the transition costs. There are openings to increase competitiveness for firms that seek those opportunities by implementing strategies and adopt environmental innovations to pursue them (Porter and Kramer, 2011). For social innovations the picture is more complicated, especially in countries like Norway where almost all social concerns related to industry are regulated and institutionalized. We argue that the business opportunities related to social challenges are minimized because Norwegian industry is socially sustainable. This is not the case for environmental sustainability. There will be business opportunities in environmental sustainability until it is as mature and institutionalized as social sustainability is today. Unfortunately, there in a long way to travel until we are there.

CRediT authorship contribution statement

Fanny Hermundsdottir: Conceptualization, Methodology, Formal analysis, Visualization, Writing – original draft. **Arild Aspelund:** Conceptualization, Investigation, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix

Factor loading, Raykov's reliability coefficient (RRC), and average variance extracted (AVE).

	Standardized factor loading	RRC	AVE
Sustainability strategies (SS)		0.940	0.638
Sustainability (environment and society) is integrated into our business strategy – we see new business opportunities in sustainability	.797		
Sustainability (environment and society) is a fundamental value for our business – we want to change the industry we work in	.800		
Sustainability (environment and society) is an ongoing discussion within our top management team	.886		
We have established clear objectives and indicators concerning sustainability for our company	.868		
We publish our sustainability activities' results	.710		
In our company, incentives are offered to employees to achieve results concerning sustainability (environment and society)	.657		
We use capital and resources in such a way that our sustainability goals (environment and society) are reached	.849		
Sustainability (environment and society) is an ongoing discussion on our board	.845		
We work with other actors to solve the major challenges related to sustainability (environment and society) in our industry	.744		

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(*continued*)

	Standardized factor loading	RRC	AVE
Environmental Innovation (EI)		0.848	0.581
We strive to reduce or eliminate emissions of potentially harmful substances	.675		
We strive to reduce or eliminate emissions of greenhouse gases	.751		
We strive to have all products and packaging designed to be recycled or reused	.82		
We strive to provide customers with access to recycling and/or reuse services for all our products and packaging	.795		
Social Innovation (SI)		0.752	0.523
Everyone who contributes in our value chain is paid in such a way that it provides them an adequate standard of living	.726		
Everyone who contributes to our value chain has fair working conditions	.796		
Everyone's concerns are solicited actively, judged impartially, and addressed transparently	.638		
Value Creation (VC)		0.900	0.580
How does the company's commitment to sustainability (environment and society) affect the company's …			
Sales growth (increased volume)	.797		
Perceived value for the customer (willingness to pay)	.883		
Customer loyalty	.872		
Ability to avoid direct competition	.745		
Ability to introduce new products and services	.813		
Political goodwill for allocations of social resources (regulations, licenses, permits)	.512		
Relationship with company stakeholders	.723		
Position as an attractive partner	.678		
Cost Reduction (CR)		0.742	0.597
How does the company's commitment to sustainability (environment and society) affect the company's …			
Operating costs	.702		
Costs of hiring and retaining competent personnel	.837		
Risk Reduction (RR)		0.885	0.724
How does the company's commitment to sustainability (environment and society) affect the company's …			
Risk of damage to reputation	.876		
Risk of a sales decline	.876		
Risk of not being able to meet future regulatory requirements	.798		

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