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Review

Sustainability innovations and firm competitiveness: A review

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ABSTRACT

The purpose of this article is to map out the currently available research concerning the relationship between sustainability innovations and competitiveness and to identify the contextual factors that mediate and moderate this relationship. The present study is a systematic literature review that includes 100 relevant peer-reviewed publications. We examine the studies' methodology, industry, sustainability innovation terms, sustainability innovation variables, competitiveness variables, and findings to investigate if, and under what circumstances, there is a positive relationship between sustainability innovations and firm competitiveness. The study concludes that a vast majority of studies found positive relationships. Hence, the findings support the revisionist view that sustainability innovations can create win-win situations for a firm. However, the relationship is complex, and this study contributes with an overview of national-, market-, industry-, and firm-level factors that have a moderating or mediating effect on the relationship.

Contents

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1. Introduction

Resource use and emissions as a result of both population and economic growth have placed an amplified burden on the environment (UN, 2019). Mounting scientific evidence of the detrimental effects and the undesirable social and environmental consequences of this trend has increased the external pressure on firms to react to these challenges and to deal with issues related to climate change and social and environmental degradation (Cai and Li, 2018; El-Kassar and Singh, 2019; Lubberink et al., 2017). In addition to the external pressure of becoming more sustainable, businesses are facing growing competition due to globalization and new technologies (Aggarwal, 2011; Cherrafi et al., 2018). This combined pressure has increased the focus on green and sustainable value creation among businesses and led to focus on the question of whether sustainability innovations can solve both these problems—simultaneously increase both sustainability and competitiveness (Chu et al., 2018).

The relationship between corporate sustainability and competitiveness has gained much interest among scholars, but the findings have been fragmented and inconclusive (Cai and Li, 2018; Hussain et al., 2018; Rezende et al., 2019). For a long time, many firms viewed sustainability innovations predominantly as cost drivers (Dey et al., 2019). They were seen as innovations that required high initial investments, had long payback time, and produced only limited environmental benefits (Cai and Li, 2018; Hojnik and Ruzzier, 2016a). However, some recent research suggests a significant and positive relationship between sustainability innovations and a firm's competitiveness (Bacinello et al., 2019; Qiu et al., 2019; Suat and San, 2019). For example, it has been found that countries and businesses are showing an increasing tendency toward sustainability (Dey et al., 2019; Eurostat, 2020), and it is argued that this is happening because sustainability is associated with higher profitability, efficiency, and competitiveness (Cherrafi et al., 2018). These inconclusive and sometimes contradictory findings suggest that the relationship is complex and that more research is needed to establish how, and under what conditions, the relationship remains positive.

Some previous reviews have sought to clarify the research on the sustainability innovations–performance relationship. For example, Tariq et al. (2017) reviewed the drivers, consequences, moderators, and mediators of green innovations, but their study was inconclusive and called for more research on how organizational factors affect green innovations and their outcomes. More recently, Bitencourt et al. (2020) examined the drivers, consequences, and moderators of eco-innovation in a meta-study of quantitative studies in the field. They found a positive relationship, but the study lacked an investigation into the mediating and moderation effects. Further, review studies have been done on the success factors (De Medeiros et al., 2014) and drivers of environmental innovations (Hojnik and Ruzzier, 2016b). However, as Adams et al. (2016) note, theory development related to the topic in the literature shows characteristics of immaturity and fails to provide an explanation of the mechanisms and conditions associated with different environmental innovations and their effect on business performance.

Common to all previous reviews is that they predominantly focus on environmental innovations and exclude the social issues that fall within the definition of sustainability (Elkington, 1997). Moreover, as they show that the literature still points in different directions, there is an urgent need to examine the state of the art of the relationship between sustainability innovation and firm competitiveness (Hussain et al., 2018; Lopes Santos et al., 2019). In particular, they call for more studies on how different conditions, such as internal and external factors, affect the outcome of sustainability innovations (García-Sánchez et al., 2019; Ghassim and Bogers, 2019; Hojnik and Ruzzier, 2017; Rezende et al., 2019).

The study of the relationship between sustainability innovation and competitiveness is not only necessary to fulfil our academic need for knowledge. It is also vital for managers who are seeking to leverage business strategies that are based on sustainability innovations (Bossle et al., 2016). In future decades, incorporating sustainability into businesses will likely be critical to preserve future businesses (Severo et al., 2017, p. 89). Moreover, more knowledge within this field is important for future policy making at the government level. Previous studies have suggested that stricter sustainability regulations can positively affect a firm's competitiveness and performance by driving innovation activities in firms (Porter and van der Linde, 1995; Zefeng et al., 2018). Hence, this understanding might give an idea of how regulations can stimulate sustainability innovation in firms (Hojnik and Ruzzier, 2016a) and how the private sector can contribute to solving sustainability challenges.

This study contributes by broadening the operational concept of sustainability innovations to include social innovations and reviews studies on the sustainability innovation–competitiveness relationship with special focus on determining the factors that mediate or moderate the relationship. Through this, we seek to contribute to clarifying and reducing the apparent complexity of the sustainability innovation–firm competitiveness relationship and to uncover the points of agreement in published studies, topics that remain disputed, and the most promising venues for further research.

2. Theoretical framework

Ever since the seminal work of Joseph Alois Schumpeter (in 1911/1934) firmly established innovation as the main engine for economic development, innovation has become the central economic term for what brings change to organizations, industries, and society as a whole. In Damanpour's words, "The adaption of innovations is conceived to encompass the generation, development, and implementation of new ideas or behaviors … Innovation is a means of changing an organization, whether as a response to

changes in its internal or external environment or as a preemptive action taken to influence an environment" (Damanpour, 1991, p. 556). Hence, innovation can take many forms and can be related to new products, processes, services, management methods, or organizational structures (Baregheh et al., 2009; Nohria and Gulati, 1996). While it is demanding for firms to constantly innovate (Tushman and Nadler, 1986), it is also crucial in order for them to adapt to rapidly changing competition and market demands and to be able to create a sustained competitive advantage (Baregheh et al., 2009). For these reasons, innovation remains a key economic concept that the business sector needs to adopt in order to contribute to societal changes related to the sustainability challenge.

The term "sustainability" is diverse in its definitions. Originally, it was defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 37). Later, a common operationalization became the triple bottom line, consisting of the economic, environmental, and social dimensions (Elkington, 1997; Engert et al., 2016; Seuring and Müller, 2008). In the same manner, Dyllick and Hockerts (2002) describe sustainability in three aspect—the business case, the natural case, and the social case. These three dimensions are considered to influence and to be interrelated with each other (Dyllick and Hockerts, 2002). At the firm level, corporate sustainability has been defined as "meeting the needs of a firm's direct and indirect stakeholders (such as shareholders, employees, clients, pressure groups, communities etc.), without compromising its ability to meet the needs of future stakeholders as well" (Dyllick and Hockerts, 2002, p. 131). Furthermore, corporate sustainability concerns a firm's activities that are directed toward solving environmental and social issues in a strategic and profitable way (Salzmann et al., 2005, p. 27). Hence, corporate sustainability requires firms to incorporate all three dimensions of sustainability into their business decisions and activities (Dyllick and Hockerts, 2002; Schaltegger et al., 2012) while simultaneously ensuring their profitability.

2.1. Sustainability innovation

To conduct a literature review concerning sustainability innovations, a clear and well-framed understanding of the concept is important. The terms "green," "eco," "environmental," "social," and "sustainability innovation" reflect the terms described above and are commonly used in describing innovations that reduce a firm's negative impact on the environment and society (Díaz-García et al., 2015, p. 22). Boons et al. (2013) define sustainability innovation as "innovation that improves sustainability performance" (p. 2), where performance includes all three dimensions of sustainability—environmental, economic, and social. Similarly, another well-cited definition of sustainability innovation is "a process where sustainability considerations (environmental, social, and financial) are integrated into company systems from idea generation through to research and development (R&D) and commercialization. This applies to products, services and technologies, as well as to new business and organizational models" (Clark and Charter, 2007, p. 99). This latter definition includes managerial innovations in addition to innovations that are generally associated with sustainability, namely, those related to products, processes, services, and business models (Schiederig et al., 2012).

We identify two main issues in the literature concerning the term sustainability. First, as several researchers have pointed out, the main issue with the current sustainability innovation-related research is that the term is often reduced to environmental improvements, turning it into a one-dimensional concept (Klewitz and Hansen, 2014; Seuring and Müller, 2008). Sustainability is, however, a broader concept as it includes the social aspect (Ben Arfi et al., 2018), and therefore researchers call for a more holistic approach, where the social dimension is taken into consideration (Adams et al., 2016; Engert et al., 2016). Hence, with this literature review, we aim to not only include the environmental pillar of sustainability but also the social pillar. The second issue with the sustainability–innovation definition is that the environmental pillar has a range of synonyms used in the literature (Bitencourt et al., 2020). In general, the terms "sustainable innovation," "environmental," "green," and "eco-innovation" are, to a large degree, used synonymously in the literature (Ben Arfi et al., 2018; Forsman, 2013; Hojnik and Ruzzier, 2016b; Karakaya et al., 2014). In recent literature reviews, it has been noted that there are only trivial differences between the terms and that they are often used interchangeably (Schiederig et al., 2012; Tariq et al., 2017). Because of the synonymous use of these concepts in the literature, we find it necessary to include all of them within our literature search, representing the environmental pillar of sustainability. Hence, for the purpose of this review, we have adopted the following broad definition: Sustainability innovations are innovations wherein all sustainability dimensions, including environmental, social, and economic, are considered during the whole innovation process. Hence, the aim is to avoid or reduce negative impact on the environment while considering social aspects in all steps of the innovation process and to simultaneously do this profitably to sustain the business. We argue that for all practical purposes, the innovations included in this study fall under this definition.

2.2. Sustainability innovation and competitiveness: why is this relationship reasonable to assume?

Previous research has identified a variety of drivers for the adoption of sustainability innovations. Díaz-García et al. (2015) argue that these drivers fall within two main categories: external pressure from governments and stakeholders (for example, in the form of regulations), and internal motivation to increase competitiveness (for example, through the reduction of operational costs). Several studies confirm that regulations are an important driver of sustainability innovation and that firms subjected to regulations are more likely to innovate for sustainability than firms that are not (Doran and Ryan, 2012; Horbach et al., 2012; Rennings and Rammer, 2009). Other studies have found drivers emerging from the motivation to increase competitiveness. For example, Clark and Charter (2007) found that market- and finance-related drivers, such as customer requirements, the brand and reputation of companies, and cost savings in terms of materials and energy, are important drivers for the adoption of sustainability innovations. Occasionally, regulations and the quest for competitiveness act together to drive sustainability innovations (Horbach et al., 2012). However, Yalabik and Fairchild (2011) find that competitive pressure from the market drives environmental innovation more than regulations and, hence, motivates more research on the role of sustainability innovations in increasing competitiveness.

To understand the sustainability innovation–competitiveness relationship, we need to understand how it is conceptualized in the academic and popular literature. From a broad perspective, there are two opposite views of how sustainability innovations and competitiveness are connected (Cai and Li, 2018; Hussain et al., 2018; Triebswetter and Wackerbauer, 2008). According to the traditionalist view, sustainability innovations are viewed as cost drivers (Cai and Li, 2018; Palmer et al., 1995; Walley and Whitehead, 1994). For example, Walley and Whitehead (1994) claim that the popular idea of environmental improvements creating win-win situations for firms is unrealistic due to the high costs and complicated solutions that are involved. The increasing costs, risks,

insufficient government support, and regulations associated with sustainability innovations may have a negative effect on competitiveness (García-Sánchez et al., 2019). Hence, according to this view, sustainability innovations are considered a zero-sum trade-off between the environment and the economy. On one hand, strict regulations lead to social benefits, while on the other, they lead to additional costs for firms, higher prices, and reduced competitiveness (Frondel et al., 2007; Porter and van der Linde, 1995). In contrast to this view, the revisionist view dismisses the notion that it is a zero-sum game and argues that sustainability innovations can create win-win situations that create value for the environment and society while simultaneously increasing the competitiveness of firms (Porter and van der Linde, 1995). Porter and van der Linde (1995) argue that the traditionalist view is outdated and that the right environmental regulations make firms innovate for new solutions that increase value creation and operational efficiency. They further argue that firm managers should conceptualize the sustainability shift as a business opportunity rather than something that exclusively drives costs. This notion is supported by Boons et al. (2013), who debate that companies that invest early in sustainability innovations should be able to gain a competitive advantage—at least in the medium term. How these firms will fare in the long term is more difficult to predict because of fast-changing technologies, regulatory shifts, and path dependencies associated with the shift.

Associated with the revisionist view, there are several arguments as to why sustainability innovations can increase firm competitiveness. Firstly, sustainability innovations can lead to more efficient processes by reducing the use of raw materials as well as energy and resource consumption in terms of water, waste, soil, and oil (Chiou et al., 2011; Gürlek and Tuna, 2018). Secondly, they can improve product quality and efficiency through a reduction in material consumption, the use of less hazardous materials and less packaging, and an increase in the use of recyclable materials (Dey et al., 2019). Thirdly, they can improve managerial processes through the use of assessment methods such as environmental management systems that make it easier to identify and realize cost savings and productivity improvements (Hojnik and Ruzzier, 2017). Fourth, launching sustainability products is an efficient way of exploiting opportunities associated with the growing number of customers that are concerned for the environment and society. Hence, it may result in product differentiation, a growing customer base, and improved market and brand positioning (García-Sánchez et al., 2019; R. J. Lin et al., 2013).

Fig. 1 pulls together the theory section: external and internal drivers compel firms to conduct sustainability innovations. These innovations incorporate the three dimensions of sustainability: environmental, social, and economic. The effects of sustainability innovations are disputed in the literature. According to the traditionalist view, sustainability innovations ultimately lead to reduced competitiveness, whereas the revisionist view proposes that they lead to increased competitiveness.

Based on the definitions and theories proposed in the literature, the present review seeks to answer the following research question: What does current research say about the relationship between sustainability innovation and competitiveness, and what are the contextual factors that affect this relationship?

3. Method

To investigate the current research question, a literature review is appropriate as it summarizes previous studies (Fink, 2019, p. 254) and presents what is known, what varies across studies, and what gaps exist in the field of research. In this way, reviews are important not only to interpret and assess the strength of earlier research but also to guide the direction of future research (Gough et al., 2017). Following the procedures of other systematic literature reviews (Bitencourt et al., 2020; Klewitz and Hansen, 2014), the steps that were conducted in the review are presented below.

3.1. Step 1: Systematic literature search

This study used the following four research databases in the field of economics and management for the literature search: ABI/Inform Collection, Business Source Complete, Entrepreneurship Database, and Scopus. Based on the definition of sustainability innovations presented in section 2.1, which encompasses both environmental and social dimensions, we found it relevant to include terms related to both environmental-related innovations and social innovations in our keyword search. In addition, as pointed out in section 2.1., because of the synonymous use of the words sustainability, environmental, green, and eco-innovations in the literature (Forsman, 2013; Schiederig et al., 2012; Tariq et al., 2017), we found it necessary to include all different terms related to these types of innovations to fully capture the environmental pillar of sustainability. Hence, in our keyword search, we use synonyms for environmental sustainability in addition to including the social aspect of sustainability. This approach is also used in prior literature reviews concerning sustainability (e.g., Bocken et al., 2014; Engert et al., 2016; Klewitz and Hansen, 2014; Seuring and Müller, 2008).

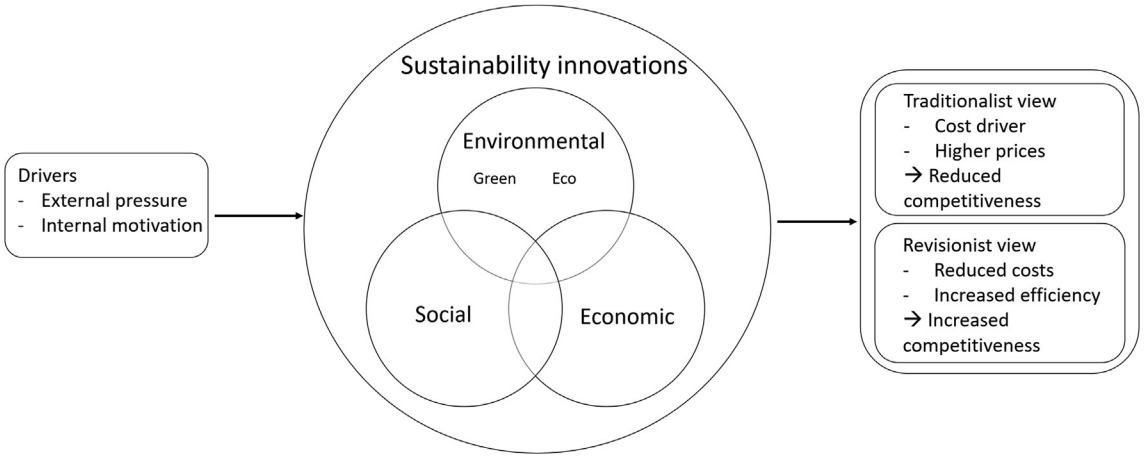

Fig. 1. Theoretical framework.

Following Pittaway et al. (2004), keywords and their synonyms were combined with "OR" and "AND" to create the following search algorithms:

- Sustainable/sustainability innovation – green innovation – eco-innovation – environmental innovation – social innovation – societal innovation
- Competitiveness – firm performance – organisational performance – organisational performance - corporate performance – financial performance - firm organisational performance – firm organisational performance – organisational results – organisational results – firm results – corporate results – company result – competitive advantage – economic performance

To avoid selection bias caused by the use of synonymous words, we also used the databases' thesaurus function to identify synonyms and common words used in the database. In addition, we used wildcards (i.e. *, ? N3, N/3) in the keyword search to find as many relevant articles as possible. The criteria for inclusion were the use of the keywords in the abstract, an empirical research design, and publication in peer-reviewed academic journals.

3.2. Step 2: Choice of relevant articles

In line with Pittaway et al. (2004), the relevant articles were chosen through two rounds of screening. First, the title and abstract of the articles were roughly scanned, and the articles that seemed relevant were saved. In the second round of screening, the papers were read more thoroughly, and the articles that were not relevant enough were removed based on the exclusion criteria—that is, duplicates, non-English articles, non-empirical research, and research that did not focus on the theme at the firm level were removed. In addition, articles that did not specifically focus on sustainability innovations and competitiveness were removed. This included articles that studied, for example, sustainability strategies, sustainability performance, environmental capabilities, or environmental disclosure instead of sustainability innovations. In other words, the studies had to specifically study innovation. This strict exclusion was necessary to keep the individual assessment of what were relevant articles to a minimum. This exclusion step was also necessary to sufficiently narrow the scope of the literature review to include only sustainability innovations. Finally, to ensure sufficient quality (Tariq et al., 2017), articles published in journals that did not appear in the Academic Journal Guide (AJG) or the Scimago Journal & Country Rank (SJR) were removed.

The final screening resulted in 100 articles in total (see Fig. 2 and Table 1), which were published between 2005 and 2020. The journal that included most of the selected articles was Journal of Cleaner Production (23 articles), while Business Strategy and the Environment, Journal of Business Ethics, Corporate Social Responsibility and Environmental Management, Technological Forecasting and Social Change, and European Journal of Innovation Management contributed three to six studies each. The rest of the sample came from a broad range of journals that spanned a variety of disciplines, but each journal contributed only with a few studies on the relevant topic.

3.3. Step 3: Analysis of articles

As the aim of this article is to investigate the relationship between sustainability innovations and competitiveness reported by studies, several aspects had to be analyzed. The analysis can be divided into descriptive and thematic analysis (Tranfield et al., 2003). The first step was a descriptive analysis, which includes reporting the content of the papers into several categories (Tranfield et al., 2003). We found this necessary to better answer our research question and to be able to compare and assess the overall strength of the findings. In line with Seuring and Müller (2008), several descriptive dimensions were assessed, including the research methodology, publishing year, conceptualizations of sustainability innovation, and operationalization of *sustainability innovation* and *competitiveness*. In addition, to answer the second part of the research question, we included an analysis on the moderators and mediators of the sustainability innovation–competitiveness relationship. The descriptive data from the studies are presented in the results section below.

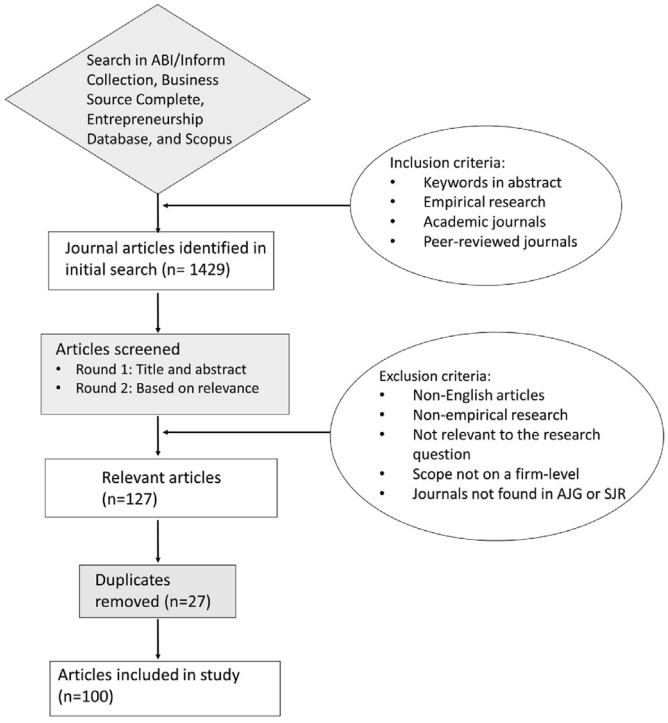

Fig. 2. Illustration of the literature review process.

The thematic analysis includes identifying key findings, the consensus, and emerging themes from the data (Tranfield et al., 2003). More specifically: "the aim is to systematically categorize the content of the papers and identify relationships" (Klewitz and Hansen, 2014, p. 61). In line with Lane et al. (2006), our thematic analysis went through the initial steps of coding and grouping similar codes together to eventually distill several emerging themes from the articles. This led to the results shown in Fig. 3 and Tables 4–7 in the results section.

4. Results

The present study starts with a systematic analysis of the methodology, conceptualization, and operationalization of the key terms and conclusions related to the sustainability innovation–competitiveness relationship in each article. First, we present a description of the sample of studies, and following this, we move on to addressing specific findings related to the research question.

4.1. Description of the studies included in the review

Of the 100 studies that were finally included in the review, 64 reported a positive relationship between sustainability innovations

Table 1
Number of articles found in the included databases.

Database	ABI/Inform Collection	Business Source Complete	Entrepreneurship Database	Scopus
Number of articles in the initial search	412	230	143	644
Relevant articles	27	8	3	89
Duplicates		27		
Total		100		

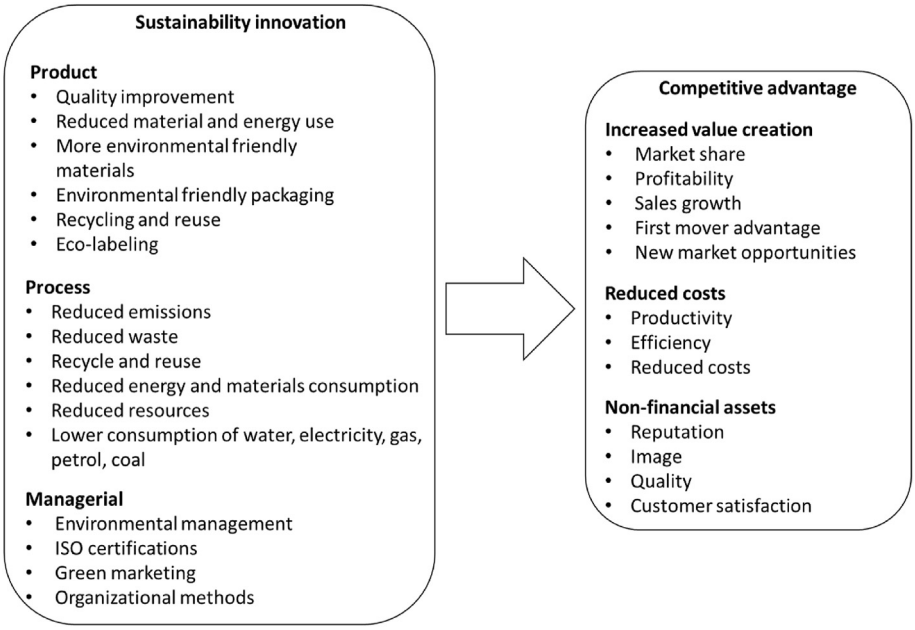

Fig. 3. Sustainability innovations and competitiveness variables.

Table 2
Methodology used in the selected articles.

Quantitative		Qualitative		Mixed methods
Survey	Secondary data	Single case	Multiple cases	2
73	17	2	6	

Table 3
Year of publication of the articles.

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Number of articles	1	1	0	1	1	2	5	3	12	7	7	10	10	11	25	4

and firm competitiveness; 29 reported mixed results that included positive, neutral, and/or negative effects; 5 studies reported inconclusive findings; and 2 studies reported negative effects.

Table 2 presents an overview of the research approaches used in the studies. The table shows that a large majority of the studies used quantitative methods (90 out of 100), whereas only 10 studies used qualitative methods. Hence, there seems to be an overload of articles using quantitative methods compared to qualitative in this research field. On one hand, this is not surprising as the topic being studied is the relationship between two factors and is a variance question in nature (Van de Ven, 2007). However, on the other hand, the high number studies using quantitative methods is still intriguing as the study of the competitive outcome of sustainability innovations is a rather recent subject in the academic literature, with 80% of the articles published in 2013 and after (see Table 3). As the underlying mechanisms still need to be studied in more depth (Tumelero et al., 2019), a case-study approach is in many ways more appropriate (Dionisio and de Vargas, 2020). Hence, we note that the sustainability innovation–competitiveness relationship is an understudied subject in qualitative method articles and propose this as a further research in section 5.3.

Table 3 shows that the number of studies in this domain is rapidly increasing, with the majority of studies published from 2013 onwards.

We also observed that while the studies came from a variety of industries, the manufacturing and high-tech industries were dominant (54% combined). Notably, the sample also includes 22 multi-industry studies (22% of the studies).

4.1.1. Sustainability innovation: terms

The reviewed studies use different terms to refer to sustainability innovations. Many of the studies (n = 38) use the term

Table 4
"Increased value creation" outcomes resulting from sustainability innovations.

Variable	Study	Result
Sales growth	Cortez and Cudia (2010)	Positive
	Forsman (2013)	Higher**
	Forsman (2013)	Higher*
	Cortez and Cudia (2011)	Positive (two)
Profitability	Cainelli et al. (2011)	Better*
Revenue	Antonioli et al. (2016)	Positive
	Lopes Santos et al. (2019)	Neutral (six)
	Tugores and García (2015)	Positive (two)
		Neutral (five)
Operating margin	Przychodzen et al. (2019)	Neutral (two)
	Ghisetti and Rennings (2014)	Positive (energy and resource-efficient innovations)***
		Negative (externality-reducing innovations)***
Profit margin	Rennings and Rammer (2009)	No differences*
	Rennings and Rammer (2011)	Neutral (product), negative (process)
Return on employed capital	Przychodzen et al. (2019)	Positive (green patents)
		Negative (green patents/total patents)
Market value/book value	Przychodzen et al. (2019)	Neutral (two)
EBITDA	Antonioli et al. (2016)	Mixed, both negative and neutral
	Cacciolatti et al. (2020)	Negative
Credit rating	Cacciolatti et al. (2020)	Neutral
Income	Cortez and Cudia (2011)	Neutral (two)
	Scarpellini et al. (2019)	Positive
	Aguado et al. (2013)	Positive
	Cortez and Cudia (2010)	Positive
Assets	Cortez and Cudia (2011)	Both positive and neutral
	Cortez and Cudia (2010)	Positive
Equity	Cortez and Cudia (2011)	Both positive and neutral
Earnings retention ratio (dividends to shareholders)	Przychodzen and Przychodzen (2015)	Negative (however, this means more resources available for further growth)
Operating earnings	Forsman (2013)	Higher**
	Forsman (2013)	Lower*
Equity ratio	Forsman (2013)	Higher**
	Forsman (2013)	Lower*
Return on total assets	Forsman (2013)	Higher**
Success of innovation	Rennings and Rammer (2009)	No differences*
Market share	Lin et al. (2014)	Positive (process and product)
Tobin's Q	Bermúdez-Edo et al. (2017)	Neutral
	García-Sánchez et al. (2019)	Positive
	Leyva-de la Hiz et al. (2019)	Positive
ROA	Sánchez-medina et al. (2015)	Positive
	Aguilera-Caracuel and Ortiz-de-Mandojana (2013)	Neutral*
	Aguilera-Caracuel and Oriz-de-Mandojana (2013) García-Sánchez et al. (2019)	Positive
		Negative
	Lopes Santos et al. (2019)	Neutral (six)
	Przychodzen and Przychodzen (2015)	Positive
	Xie et al. (2019)	Positive (two)
	Rezende et al. (2019)	Positive
	Przychodzen et al. (2019)	Neutral (two)
	Xie et al. (2016)	Positive (two)
ROE	Antonioli et al. (2016)	Neutral
	García-Sánchez et al. (2019)	Negative
	Przychodzen and Przychodzen (2015)	Neutral
ROS	Ghassim and Bogers (2019)	Positive
	Lopes Santos et al. (2019)	Mixed (five positive, one negative)
	Rexhäuser and Rammer (2014)	Positive: in general
		Positive: resource efficiency-innovations
		Negative: environmental impact-innovations
ROI	Courtney and Powell (2020)	Positive (two)
Firm performance constructs	Amores-Salvadó et al. (2014)	Neutral
	Lin et al. (2013)	Positive
	Hojnik and Ruzzier (2017)	Positive
	Hojnik et al. (2018)	Positive
	Juniati et al. (2019)	Positive
	Ma et al. (2018)	Positive
	Handayani et al. (2017)	Positive
	Tang et al. (2018)	Positive (two)
	Zhang et al. (2020)	Positive
Financial performance constructs	Tariq et al. (2019)	Positive
	Huang and Wu (2010)	Positive
	Cai and Li (2018)	Neutral
	Chan et al. (2016)	Positive
	Chu et al. (2019)	Positive
	Chu et al. (2018)	Positive

(*continued on next page*)

Table 4 (*continued*)

Variable	Study	Result
	Li (2014)	Neutral
	Dey et al. (2019)	Positive
	Zailani et al. (2015)	Positive
	Zhu et al. (2017)	Positive
	Severo et al. (2017)	Positive
	Liao (2018)	Positive (three)
	Hojnik and Ruzzier (2016a)	Positive
	Long et al. (2017)	Positive (total)
		Positive (product design and production processes)
		Neutral (raw materials and waste treatment)
	Suat and San (2019)	Positive (product, process)
	Rotondo et al. (2019)	Positive
	Padgett and Moura-Leite (2012)	Negative
	Cavazos-Arroyo and Puente-Diaz (2019)	Neutral
Organizational performance constructs	Maletič et al. (2014)	Positive (two)
	Maletič et al. (2016)	Positive (two)
	Leal-Rodríguez et al. (2018)	Positive
	Wang et al. (2019)	Neutral
	Reyes-Santiago et al. (2019)	Negative
	Gupta (2017)	Positive (two)
	Huang and Li (2017)	Positive (product, process)
	El-Kassar and Singh (2019)	Positive (process) and neutral (product)
	Svensson et al. (2019)	Positive (two) and neutral (one)
Competitive advantage constructs	Chen et al. (2006)	Positive (two)
	Arenhardt et al. (2016)	Positive (two)
	Chen and Chang (2013)	Positive (two)****
	Gürlek and Tuna (2018)	Positive
	Chiou et al. (2011)	Positive (three)
	Dong et al. (2014)	Positive (four)
	Wong (2012)	Positive (process, product)
	Kamboj and Rahman (2017)	Positive (two)
	Qiu et al. (2019)	Positive
	Wang (2019)	Positive
	Ekawati et al. (2016)	Neutral
	Hojnik and Ruzzier (2017)	Positive
	Khaksar et al. (2016)	Positive
	Hojnik and Ruzzier (2016a)	Positive
	Chang (2018)	Positive (service, product)
	Chang (2011)	Positive (product)
		Neutral (process)
	Suat and San (2019)	Neutral (process)
		Positive (product)
	El-Kassar and Singh (2019)	Neutral (product, process)
	Herrera (2015)	Positive
Company growth construct	Hojnik and Ruzzier (2016a)	Positive
	Osei and Zhuang (2020)	Positive (two)
Business performance construct	Bacinello et al. (2019)	Positive
	Leenders and Chandra (2013)	Mixed (two positive, two neutral)
Economic sustainability	Javed et al. (2019)	Positive
Financial and intangible value	Spitzeck et al. (2013)	Positive
Shared value	Li et al. (2018)	Positive
International performance construct	de Menezes et al. (2013)	Inconclusive
New green product success construct	Wong (2013)	Positive (product, process)
Socio-economic construct	Tumelero et al. (2019)	Positive (product, organizational)
		Neutral (process)

*On comparing firms with green innovations with other firms **On comparing successful green innovations with non-successful green innovations *** Only for highly green innovations ****Non-linear relationship for highly green innovations *****Numbers in parentheses indicate the number of relationships with that particular result.

"green innovation," which is commonly defined as "a hardware or software innovation that is related to green products or processes, including the innovation in technologies that are involved in energy-saving, pollution-prevention, waste recycling, green product designs or corporate environmental management" (Chen et al., 2006, p. 332). Next, 23 of the studies use the term "environmental innovation," for which the common definition is "… new or modified processes, techniques, systems and products to avoid or reduce environmental harms" (Kemp and Arundel, 1998, p. 11). Further, 18 studies use the term "eco-innovation," which is defined as "new ideas, behaviors, products and processes that reduces the environmental impact" (Rennings, 2000, p. 322). A total of 11 of the studies use the term "social innovation," defined as "… new technologies, strategies, ideas and/or organizations to meet social needs or solve social problems" (European Commission, 2013, p. 15). Social innovations aim at addressing the challenges that society faces and "contribute to important public values (e.g., health, education, safety, and life quality)" (Piccarozzi, 2017, p. 6). Finally, 10 studies use the term "sustainability innovation," which is commonly defined as "a process where sustainability considerations (environmental, social and financial) are integrated into company systems from idea generations through to research and development (R&D) and commercialization. This applies to products, services and technologies, as well as new business and organization

Table 5
"Reduced costs" outcomes resulting from sustainability innovations.

Variable	Study	Result
Productivity	Cainelli et al. (2011)	Higher[a]
	Doran and Ryan (2012)	Higher[a]
	Rennings and Rammer (2009)	Higher[a]
Cost reductions	Chan et al. (2016)	Positive
	Aguado et al. (2013)	Positive
	Rennings and Rammer (2009)	Higher[a]
	Triebswetter and Wackerbauer (2008)	Positive
	Grekova et al. (2013)	Positive (process)
	Burki et al. (2018)	Positive (managerial) and neutral (process)
	Liao (2016)	Positive (process) and neutral (product)
Cost competitive advantage	Wang et al. (2019)	Positive
Efficiency	Aguado et al. (2013)	Positive
	Hojnik et al. (2017)	Positive (three), neutral (three)
Turnover per employee	Doran and Ryan (2016)	Mixed (two positive, one negative, six neutral)
	Doran and Ryan (2012)	Positive
Value added per employee	Antonioli et al. (2016)	Neutral

[a] On comparing firms with green innovations with other firms **Numbers in parentheses indicate the number of relationships with that particular result.

Table 6
"Non-financial assets" outcomes resulting from sustainability innovations.

Variable	Study	Result
Quality	Rennings and Rammer (2009)	Higher[a]
	Lam et al. (2005)	Positive
Share of export	Rennings and Rammer (2009)	No differences[a]
New patents	Triebswetter and Wackerbauer (2008)	Positive
Increased skill levels	Triebswetter and Wackerbauer (2008)	Positive
Employment	Cainelli et al. (2011)	Higher[a]
	Horbach and Rennings (2013)	Positive (process) and neutral (product)
Reputation	Lam et al. (2005)	Positive
	Lin et al. (2014)	Positive (process) and negative (product)
Differentiation	Lam et al. (2005)	Positive
	Grekova et al. (2013)	Positive (product)
	Liao (2016)	Positive (product, process)
	Wang et al. (2019)	Positive
Brand value	Yao et al. (2019)	Positive (product, process)
Risk	Tariq et al. (2019)	Positive
Long-term debt	Cortez and Cudia (2011)	Positive and negative**
Access to new targets	Sanzo-Perez et al. (2015)	Positive (ten) and neutral (four)

[a] On comparing firms with green innovations with other firms **On comparing industries.

models" (Clark and Charter, 2007, p. 99). Hence, 79% of the studies use terms related to the environmental pillar of sustainability, while only 11% of the studies use the term social innovations, confirming the notion of Klewitz and Hansen (2014) that the literature to a large degree is skewed toward innovations reducing the impact on the environment.

4.1.2. Operationalization of sustainability innovations

Based on our review of the studies, it appears that there is also great heterogeneity with regard to how sustainability innovations are operationalized. As the majority of the studies include only the environmental pillar of sustainability, they use environmental-related measures. Studies seem to distinguish between sustainability-related products, processes, and managerial innovations. Sustainability-related product innovations are most often measured in terms of reduction in energy consumption, materials, and other input factors and the use of materials with a lower footprint and higher recyclability, reusability, and durability. Sustainability-related process innovations are frequently measured in terms of reduction in the use of materials, waste, water, soil, electricity, gas, coal, or oil/petrol; reduction in emissions and air and noise pollution; and the adoption of cleaner technologies. Finally, sustainability-related managerial innovations are measured in terms of redefining operation and production processes; redesigning and improving products or services; implementing environmental management systems, value chain management systems, and organizational methods; and implementing relevant international standards, such as ISO14001 (environment) or ISO9001 (quality).

The few studies including social innovation mainly measure the term by innovations that solve social problems, have social benefits, or address social needs.

4.1.3. Operationalization of firm competitiveness

As observed for sustainability innovations, the measures for firm competitiveness also differ between studies (see Tables 4–6), but they can be classified into increased value creation, reduced costs, and non-financial assets. Return on assets (ROA); growth in market share; growth in sales; growth in profits, income, or revenues; and improved productivity, efficiency, and quality are the most common operationalization measures.

Fig. 3 illustrates the most commonly used sustainability innovation and competitiveness variables, and the ways they can be related as sustainability innovations, such as product, process, or managerial, can result in competitive outcomes such as increased value creation, reduced costs, or non-financial assets.

Table 7
Moderators and mediators affecting the sustainability innovation–competitiveness relationship.

Moderators		Mediators
National	**Firm**	**Firm**
Stringency of environmental regulations (-)	*Sustainability performance*	*Sustainability performance*
Green subsidies (neutral for CT on FP, - EOP on FP)*	Green Image (+)	Environmental performance (+)
Green subsidies (neutral)	*Firm Characteristics*	Environmental performance (+)
Environmental normative levels (neutral)	Company size (+)	Social performance (+)
Market	Internationalization (neutral)	Sustainable consumption (+ for technical innovation, neutral for non-technical innovation)
Market resource intensity (+ for profitability, - for risk)	Environmental management system (+)	*Green innovation*
Market turbulence (+ for profitability, - for risk)	Channel structure management (+)	Competitive benefits (+)
Technological turbulence (+ for profitability, - for risk)	Low level of potential slack (+)	Green product competitive advantage (+)
Market uncertainty (+)	Resource commitment (+)	Cost competitive advantage (neutral)
Environmental dynamism (+ for both cost and profit)	Internal efficiency demand (+)	Differentiation competitive advantage (+)
Geographic scope of exploitation (+)	*Firm culture*	Green product innovation (+)
Geographic scope of knowledge sourcing (-)	Flexibility orientation (+)	*Firm capabilities*
Industry	Control orientation (-)	Resource integration capability (+)
Industry innovation speed (- for both process and product)	Managerial environmental concern (+ for process, neutral for product)	Resource reconfiguration capability (+)
Regulation intensity (+ for product, neutral for process)	Top management commitment (neutral)	Environmental insight capability (+)
Industry pollution intensity (+ for both process and product)	HR practices (neutral)	
Environmental dynamism/turbulent industry environment (- for product on cost, neutral for process on cost, - for product on differentiation, + for process on differentiation)	Training practices (+)	
	Customer relational governance: Relationship and trust (-)	
Industry munificence (+ for Tobin's Q, - for ROA, - for ROE)	Customer relational governance: Cooperation and reciprocity (+)	
	Firm capabilities	
	Absorptive capacity (+ for CT on FP, neutral for EOP on FP)*	

*CT (clean technologies), FP (financial performance), EOP (end-of-pipe technologies)

4.2. Empirical findings on the relationship between sustainability innovations and firm competitiveness

Tables 4–6 summarize the current literature on the direct relationship between sustainability innovations and firm competitiveness. The findings are presented according to the classification of firm competitiveness outcomes (shown in Fig. 3), namely, increased value creation, reduced cost, and non-financial assets. Even though there are some variations in the results, a significant majority of the studies conclude that there is a positive relationship between sustainability innovations and firm competitiveness, with the positive effects ranging from relatively weak to strong.

4.2.1. Increased value creation

Overall, the majority of the published studies examines whether sustainability innovations contribute to increased value creation. The studies investigated a total of 188 unique relations between sustainability innovations and increased value creation: 120 relations were found to be positive (64%), 54 were found to be neutral or inconclusive (29%), and 14 were found to be negative (7%). We also observed that the relationship was studied by means of a broad range of statistical methods and variables for competitiveness and that there was no obvious pattern indicating that the methodology used influenced the negative and positive findings. Hence, it seems reasonable to assume that the conclusion of a positive relationship is robust regardless of the statistical methods used and the operationalization of variables.

4.2.2. Reduced costs

There are fewer studies on the effect of sustainability innovations on reducing costs. Nonetheless, this review identified 15 studies that investigated a total of 31 different relationships. Of these reported relationships, 18 were positive (58%), 12 were neutral (39%), and 1 was negative (3%). As with the previous outcome, a broad range of statistical methods and operationalizations are used in the different studies, and hence, one can assume that the findings are robust.

4.2.3. Non-financial assets

With regard to the last category, non-financial assets, this study also found predominantly positive conclusions. The 13 relevant studies investigated 35 relationships: 27 were positive (77%), 6 were neutral (17%), and 2 were negative (6%). Hence, the findings appear to be robust for this category, too, as the studies find similar results regardless of the methodologies and operationalizations used.

4.3. Moderating and mediating effects

The section above answers the first part of the research question. The second part, which focuses on the circumstances under which sustainability innovations positively influence firm competitiveness, revolves around the question of which context-related factors mediate or moderate this relationship. An analysis of the included studies indicates that based on the context, these factors can be categorized as national-, market-, industry-, and firm-level factors.

4.3.1. National context

Three studies investigated the moderating influence of the national context. The earliest study found that national environmental regulations have a negative moderating effect on the relationship between green innovation and firm performance, whereas environmental normative levels have no moderating effect (Aguilera-Caracuel and Ortiz-de-Mandojana, 2013). Quite surprisingly, another study observed that green subsidies have a negative effect on end-of-pipe technologies and financial performance and a neutral effect on clean technologies and financial performance (Xie et al., 2016). This neutral effect of green subsidies was also reported in another study (Xie et al., 2019). Based on these findings, or rather, due to a lack of sufficient studies, it appears that

the effect of national-level factors is understudied and the findings are inconclusive.

4.3.2. Market context

Several studies have explored the moderating effects of market context. One study found that market uncertainty has a positive moderating effect on the green innovation–competitiveness relationship (Chu et al., 2018). Similarly, Chan et al. (2016) found that environmental dynamism, which implies high variations in customer preferences, demand, supply, and technology innovations, positively moderates the effect of green product innovations on cost efficiency and profitability. Another study investigated the moderating effects of market resource intensity, market turbulence, and technological turbulence and found that all three market-level factors amplify the effect of green innovation on financial performance (Tariq et al., 2019). Apart from these studies, which predominantly focus on various types of market turbulence, a recent study found that munificent environments positively moderate the effect of eco-innovations on market value; additionally, the negative effect of eco-innovations on profitability was found to be increased in munificent surroundings (García-Sánchez et al., 2019). Bermúdez-Edo et al. (2017) found that a low geographic scope of innovation knowledge sourcing positively moderates the relationship between environmental innovation and firm performance. Further, they found that a broad international scope of innovation exploitation positively moderates the effect of sustainability innovations on firm performance (Bermúdez-Edo et al., 2017). In conclusion, there is little research on how market factors influence sustainability innovations' effect on competitiveness; however, the existing studies indicate that turbulent markets with high uncertainty positively affect the relationship.

4.3.3. Industry context

Not only market-level factors but also industry-level factors are found to moderate the relationship between sustainability innovation and competitiveness. For example, Yao et al. (2019) found that high regulation intensity and pollution intensity in the industry positively moderate the effect of green innovation on brand value. However, with regard to industry innovation speed, it was found that a high industry innovation speed negatively affects this relationship (Yao et al., 2019). Further, another study on the moderating effect of environmental dynamism, referring to a turbulent industry environment, found that this positively moderates the effect of environmental process innovation on differentiation advantage (Liao, 2016). When it comes to environmental product innovation, however, a negative moderating effect is found. In addition, environmental dynamism has neutral and negative moderating effects of environmental process and product innovation on low-cost advantage, respectively (Liao, 2016).

Thus far, several market- and industry-level factors that moderate a firm's ability to benefit from sustainability innovations have been identified. However, in these areas, research is far from able to deliver a comprehensive framework of the industry and market factors that influence the sustainability innovation–firm competitiveness relationship.

4.3.4. Firm context

Firm-level factors are the most studied moderators and mediators in the literature to date. Relevant firm-level factors can be divided into the following five categories: sustainability performance, firm characteristics, firm culture, firm capabilities, and green innovation. Amores-Salvadó et al. (2015) studied the moderating effect of environmental management systems on the relationship between environmental product innovation and firm market performance and found it to be positive. Another study found that the absorptive capacities of the firm strengthens the relationship between green process innovation and financial performance (Xie et al., 2016). Similarly, Chu et al. (2019) show that organizational culture influences the effect of sustainability innovations on firm performance—that is, a flexibility-orientation enhances the relationship, whereas a control-orientation weakens it. Further, Leyva-de la Hiz et al. (2019) examined the slack of resources in firms, i.e. the amount of resources exceeding what is needed to produce the minimum levels of output, and found that low levels of slack positively affect the environmental innovation–firm performance relationship. Another study examined the moderating effect of managerial environmental concern and found that this positively moderates the effect green process innovations have on firm performance (Tang et al., 2018), whereas another study found that top management commitment had no such moderating effect (El-Kassar and Singh, 2019). Table 7 summarizes the moderating and mediating factors that have been identified at the national, market, industry, and firm levels. The effects are indicated in parentheses.

From the reviewed studies, we observe three interesting issues. First, moderating effects are far more studied than mediating effects (see Table 7). Secondly, the moderating variables that are studied include both external factors (i.e., national, market, and industry) and internal factors (i.e., firm context), whereas the mediating variables include only internal factors (i.e., firm context). Thirdly, seen as a whole, the moderating and mediating variables mostly study internal factors, whereas external factors are in comparison understudied.

5. Discussion

This review study sought to examine the currently available research findings on the relationship between sustainability innovation and competitiveness as well as the factors that influence this relationship. The findings of this systematic review of the direct effect of sustainability innovations on firm competitiveness strongly indicate that the relationship is generally positive in the sense that sustainability innovations, in general, increase a firm's value creation and its ability to attract non-financial assets and also reduce costs. This finding supports the revisionist view that new business opportunities accompanying the sustainability shift more than compensate for the associated liabilities. Consequently, these findings also indicate that the traditionalist view, which considers sustainability innovations as a financial burden for firms, lacks explanatory power.

If, as per the findings of most studies, the traditionalist view lacks explanatory power and sustainability innovations contribute to firm competitiveness, why are more firms not investing more in such innovations? The reason may lay lie in the somewhat complex and ambiguous relationship between sustainability innovations and competitiveness, which several of the studies in this review have illustrated. As Rosca et al. (2018) point out, "… sustainable development is a holistic, complex process which encompasses various dimensions and links between key stakeholder groups and issues" (p. 152). This complexity, in addition to the diversity associated with sustainability-related issues, which range from climate change to human rights, may be the reason why many firms lack sustainability strategies (Engert et al., 2016). Additionally, a common trait of sustainability innovations is the uncertainty of the outcome (Hojnik and Ruzzier, 2016a). Hence, strategic decisions related to sustainability innovations are associated with both complexity and uncertainty in regard to outcomes (Engert et al., 2016), and this reduces the attractiveness of these kinds of investments.

Even though the general positive nature of the relationship has been established in this review, there is still significant

heterogeneity in the findings across studies. Below, we will discuss two important sources of this heterogeneity, namely, the methods and contextual factors (that is, the mediation and moderation effects of these factors).

5.1. Method-related heterogeneity

One obvious reason for heterogeneity in the findings is the methodological approach and choice of method in each study. First, this study shows that the variables used to operationalize sustainability innovations and firm competitiveness vary extensively across studies (see Fig. 3 and Table 4–6). Not only are the conceptualizations of sustainability and firm competitiveness different, but they are also measured differently. For example, some studies use single-question variables, while others use more robust indexes of multiple variables. In fact, some researchers argue that the variations in the outcomes of studies is caused by the variance in measurement (Hussain et al., 2018). However, there are also other ways of interpreting these findings. One can argue that the heterogeneity of the methods is a strength of the field of research because it means that the findings are robust in the face of variance in measurement. Alternatively, one can argue that as we compare different variables and operationalizations, it is hard to really compare the results from the studies and accumulate knowledge.

Another reason for the heterogeneity in outcomes might be that different types of sustainability innovations influence competitiveness differently (Rexhäuser and Rammer, 2014). Different types of innovations, such as product, process, radical, and incremental, influence business activities differently with varying levels of impact on efficiency and risk and, hence, result in different outcomes (Forsman, 2013) and also influence the strength of the relationship differently (Dong et al., 2014). Further, some sustainability innovations simply aim to reduce unwanted externalities, such as pollution or emissions, and do not necessarily result in any payoff in monetary terms (Antonioli et al., 2016; Ghisetti and Rennings, 2014). Another example is research finding that environmental product and process innovations had a different impact on firm competitiveness, namely, differentiation advantage and cost efficiency advantage, respectively (Grekova et al., 2013). Schiederig et al. (2012) argue that the challenge in measuring and comparing the environmental benefits resulting from different innovations makes it difficult to accumulate knowledge in this research area. In summary, the heterogeneous findings on the relationship between sustainability innovation and competitiveness can partly be explained by the great variety of methodological approaches and operationalizations, underscoring the call for more typology studies in researching this relationship (Dong et al., 2014).

An additional methodological challenge is related to time lags and time of censoring. As with all innovations, there is a time lag between their implementation and their economic results (Hojnik and Ruzzier, 2016a; Rezende et al., 2019; Wong, 2012). Investment costs and temporary higher operational costs during the implementation and learning phases may lead to negative effects on firm profitability in the short term (Antonioli et al., 2016), and it might take years before positive economic effects are visible on the accounts (Hojnik and Ruzzier, 2016a). Consequently, the results of studies might vary according to the time span between the adoption of an innovation and the measurement of firm performance (Antonioli et al., 2016) and also according to whether the study uses cross-sectional or longitudinal data.

Another recurring issue regarding research methods is related to the directionality of the sustainability innovations–competitiveness relationship. In other words, do sustainability innovations provide increased competitiveness, or are highly competitive firms more likely to adopt sustainability innovations? Cross-sectional studies are unable to establish the directionality (Pätäri et al., 2012), and in the literature, cross-sectional studies are quite common. Some argue that competitive advantages from sustainability innovations are a result of a cumulative process that starts prior to the development of the innovation because highly competitive firms already have both innovative capacity and competitiveness (Forsman, 2013; Forsman et al., 2013). For example, Forsman (2013) finds that in the period preceding the innovation process, successful green innovators show higher return on total assets than unsuccessful green innovators. In addition, during the development period, successful green innovators have higher market and financial advantages. In other words, a firm's competitive advantage as a result of green innovations may be influenced by the prior advantages they possess in terms of, for example, capabilities, financial resources or risk, and reputation among customers. In line with this, Martínez-Ferrero and Frías-Aceituno (2015) identified a positive two-sided relationship between sustainability initiatives and financial performance among firms. They argue that this is a virtuous circle, as good economy gives firms the opportunity to invest in sustainability activities, which in turn leads to positive firm outcomes that make it possible to invest new resources into sustainability activities. One can argue whether this means that financially stronger firms take more sustainability initiatives than other firms, or whether sustainability initiatives result in financially stronger firms, which in turn becomes a reinforcing factor. Hence, like many other researchers (Y. C. Huang and Wu, 2010; W. L. Lin et al., 2019), we see a strong need to investigate the sustainability innovation–competitiveness relationship based on longitudinal data in order to settle the debate on directionality.

5.2. Context-related heterogeneity

Given that the business environment is characterized by complexity and uncertainty, the relationship between managerial actions and their consequences is not necessarily straightforward (Chen and Chang, 2013). Sustainability innovations' effect on firm competitiveness is influenced by a variety of factors (Ben Arfi et al., 2018). As shown in the results section, contextual factors influence the relationship between sustainability innovations and competitiveness in a variety of ways. It is important to understand and take into account these contextual factors in order to gain a more precise understanding of this relationship (Bermúdez-Edo et al., 2017). As we see from the results section, national regulations, incentives, society's awareness of sustainability issues, market uncertainty, industry norms and regulations, type of industry, and firm factors all have an influence on the effect of sustainability innovations on competitiveness. Hence, Fig. 4 below extends our initial research framework to include these factors. This deduction is in alignment with earlier research findings that the effectiveness of green innovations depends on certain contextual and conditional factors (Chu et al., 2018). However, we have also contributed to the knowledge by specifying the most pertinent mediating and moderating factors identified in the literature so far. These factors are discussed in more detail below.

First, the national context seems to play an important role in the ability of firms to turn sustainability innovations into competitiveness (Aguilera-Caracuel and Ortiz-de-Mandojana, 2013; Horváthová, 2010). Regulations, industrial agreements, and incentives from the government all influence the degree to which firms engage in green innovations (Doran and Ryan, 2012). Moreover, institutional contexts and corporate governance systems are found to moderate the relationship between sustainability initiatives and financial performance (Martínez-Ferrero and Frías-Aceituno, 2015). Findings in published studies also indicate that green innovative firms are more common in countries with stronger environmental regulations (Aguilera-Caracuel and Ortiz-de-

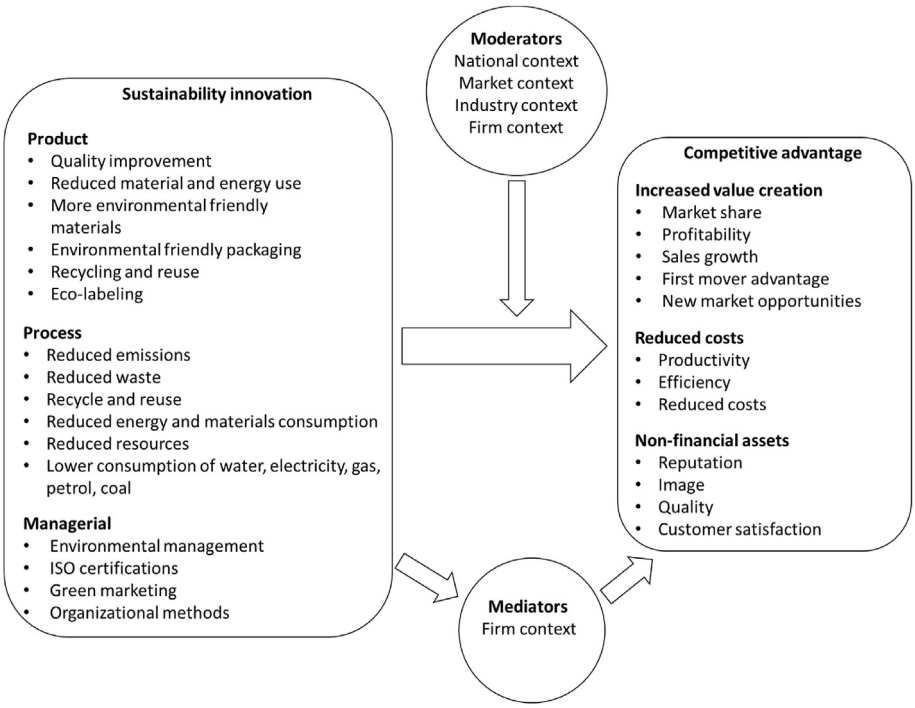

Fig. 4. Extended model depicting the relationship between sustainability innovation and competitiveness.

Mandojana, 2013). This is in agreement with the argument of Porter and van der Linde (1995) that environmental regulations drive innovation in firms. Additionally, compared to non-green innovative firms, green innovate firms are located in environments where the normative levels are higher (Aguilera-Caracuel and Ortiz-de-Mandojana, 2013). This means that businesses situated in countries with high environmental consciousness and values will strive to improve environmental outputs and create awareness around their activities (Aguilera-Caracuel and Ortiz-de-Mandojana, 2013). Similarly, Rezende et al. (2019) found that firms located in Europe benefit more from green innovations than firms located in North America and Asia, both in the short and long term, for the same reasons. Thus, societies with high awareness of environmental issues are more likely to foster more innovative green firms. This notion is in alignment with the meta-analysis conducted by Bitencourt et al. (2020), in which it was found that countries with high scores on the global sustainable competitiveness index, measured by, for example, natural capital, intellectual capital, and governance efficiency, have a stronger relationship between eco-innovations and firm performance.

With regard to the second context, market-related factors are also found to affect the relationship between sustainability innovations and competitiveness. More specifically, findings show that high environmental dynamism, which refers to high variations in customer preferences, demand, supply, and technology innovations, positively affects the relationship (Chan et al., 2016). In dynamic environments, existing products and services become quickly outdated in the face of new and improved offerings (Chan et al., 2016). Hence, there is more "room" for new sustainability innovations to succeed in the market. Chu et al. (2018) explain the positive moderating effect of uncertain markets as follows: in an uncertain business environment, few companies dare to take the risk associated with green innovations; however, those who do will gain more. Hence, a turbulent technological and market context enhances the effect of sustainability innovations on firm competitiveness (Tariq et al., 2019).

Third, we observe that industry characteristics can moderate the sustainability innovation–competitiveness relationship especially in terms of industrial institutional environments (Yao et al., 2019). For example, Rezende et al. (2019) found that manufacturing firms gain more from green innovations that non-manufacturing firms do. Their rationale is that the manufacturing sector includes more pollution and emissions, and hence, it is easier to identify business opportunities than, for example, in the service and information sectors. In another study, a comparison of the automotive and electronics industries showed that environmental innovations positively affect all performance measures (sales, income, assets, long-term debt, and equity) in the automotive industry, while in the electronics industry, it affects only sales (Cortez and Cudia, 2011). Similarly, Chen et al. (2006) found significant differences between industries with regard to the effects of green process and product innovations. Furthermore, the pressure for environmental practices varies between industries as there are different levels of self-regulation initiatives and codes of practice (Lenox and Nash, 2003). In industries with high energy use and emissions, the adoption of sustainability innovations is high and common (Cainelli et al., 2011). Hence, what drives sustainability innovations is industry specific, and the extent to which industries react to environmental challenges varies (Chu et al., 2018). For example, some process industries with high levels of pollution are found to face higher pressure and, hence, are more liable to develop sustainability innovations (Amores-Salvadó et al., 2015). Moreover, the specific industry a firm belongs to also predicts the ability to respond as industry factors influence the effect of resources, capabilities, and behaviors of the firm (Liao, 2016). Hence, type of industry can be a good predictor of a firm's incentives for adopting environmental innovations both in terms of drivers, such as governmental regulations and market pressure, and goals, such as reduction in energy and material consumption or emissions (Cainelli et al., 2011). In addition, the specific industry plays an important role in the effects of sustainability innovations.

The national, market, and industry factors are central in institutional theory, which discusses how institutions such as governments, consumers, and competitors exert pressure and drive development and the adoption of sustainability innovations in firms (Tariq et al., 2017). Firms create social legitimacy among stakeholders by adjusting to the customers' values and social norms and incorporating the standards proposed by governmental institutions and industry regulatory bodies (Chu et al., 2019; Sarkis et al., 2010). Fulfilment of these criteria increases legitimacy and the likelihood of competitive survival (Tariq et al., 2017). Thus, institutional theory explains how external norms, values, and traditions can account for the actions of firms (Chu et al., 2018). In addition to institutional theory, stakeholder theory is commonly used to explain the development and adoption of sustainability innovations. This is because primary and secondary stakeholders are found to influence strategic decisions regarding sustainability innovations that, in turn, attract new customers and shareholders (Tariq et al., 2017). Hence, institutional and stakeholder theories are central in the research on how external factors influence firms and their tendency to develop and adopt sustainability innovations for competitive purposes. These factors can work as drivers, but they also help us explain under what circumstances sustainability innovations have a positive effect on competitiveness.

Fourth, this study has identified several firm-level factors that influence the sustainability innovation–competitiveness relationship. The complexity of sustainability innovation stipulates that firms need experience and skills exceeding the traditional industry experiences (Ben Arfi et al., 2018). It is argued that in order to create value from sustainability innovations, resources and capabilities must be used in a way that differentiates the firm from other companies (Forsman, 2013). As different sustainability innovations are found to have different competitive outcomes, managers' knowledge of the firm's competitive capabilities and the integration of sustainability innovations with the overall strategy becomes important (Wong, 2012). The moderating and mediating effects of different firm-level factors are also reported in the literature review by Tariq et al. (2017). They discuss the relationship in light of the resource-based theory and argue that resource commitment and the uniqueness of the firm's resource bundle contribute to the firm's ability to respond to external stakeholder demands and achieve results from green innovations. In addition, they argue that dynamic capabilities are understudied but constitute an important perspective as firms in a dynamic environment must constantly create, deploy, and protect their competitiveness.

5.3. Further research

Several gaps have been uncovered in the review, and hence we have numerous propositions for further research. With regard to the first part of our research question, we discover that the majority of the included studies finds that sustainability innovations have a positive effect on firm competitiveness. However, there are still studies that find neutral and negative effects. We therefore see this inconsistency in findings as proof that this still needs to be studied in greater depth in future research. We also observe that as many as 80% of the studies have researched the environmental part of sustainability in terms of environmental-, green-, or eco-innovation. Hence, the social part of sustainability is far understudied, which we see as an issue as social matters and environmental issues are interrelated and must be solved simultaneously to achieve sustainability (Engert et al., 2016). We hence propose further research to include social innovations when conducting these types of studies to obtain a more holistic understanding of sustainability.

With regard to the second part of the research question, this study concludes that current research has yet to provide a comprehensive answer to the question as to what factors positively moderate and mediate the relationship between sustainability innovations and firm competitiveness. Even though several factors have been identified, there are many factors that remain understudied and have yet to be identified. Hence, we see a strong need for future research to focus on the mediating and moderating variables affecting the sustainability innovation–competitiveness relationship. We propose that a reason for the variation in regard to sustainability innovations' effect is because of different national, market, industry, and firm factors. One can debate whether these factors can be generalized across studies as each firm has its own characteristics and operates in idiosyncratic contexts. We therefore propose to both study the already-investigated moderating and mediating effects presented in this study but also to investigate new factors that may influence this relationship. Specifically, we observe that mediating variables and variables concerning external factors (e.g., in the national, market, and industry contexts) are understudied.

In relation to moderating and mediating effects, we find the institutional and stakeholder theories, and strategic management theories, such as the resource-based and dynamic capabilities theories, to provide valuable insight into this subject. Therefore, we call for more research that employs and extends these theories to provide a fuller understanding of factors that influence the relationship between sustainability innovation and competitiveness.

Further, as noted earlier in the article, the manufacturing industry is the most studied industry on this research topic (Chu et al., 2018). This is not surprising as the manufacturing industry has several sustainability challenges. However, to obtain an enhanced understanding, we propose that future studies include other industries as well in order to observe the differences between different industries (G. Li et al., 2019) regarding sustainability innovations, moderators, mediators, and competitiveness outcomes.

Furthermore, currently most of the research concerning the effect of sustainability innovations uses cross-sectional data. Many researchers argue that it takes time to see the effect of sustainability innovations (Hojnik and Ruzzier, 2016a). Because of this, we see a strong need for longitudinal studies. Only by using longitudinal studies can the real effects of sustainability implementation be observed (Chu et al., 2019; Tariq et al., 2017).

It is also clear from the literature review that sustainability innovations can take many forms, such as process, product, or managerial. However, many of the studies do not differentiate between the different types of innovations. Researchers argue that different innovations have different effects on competitiveness (Horváthová, 2010; Rexhäuser and Rammer, 2014). This has also been observed in this review. We see this issue as an important area of further research as this has critical influence on what kind of innovations firms should invest in and what the innovation success criteria are. In the same manner, we observe from the articles a broad variety of measurements of competitiveness. We purport that a standard measurement scale for competitiveness in the research field is necessary to measure and compare the sustainability outcomes in the same way (Dong et al., 2014).

Lastly, our findings reveal that the majority of studies (90%) used quantitative methods and that qualitative studies, including case studies, are not as commonly used. We propose, in line with, for example, El-Kassar and Singh (2019), that further research concerning sustainability innovations should conduct more case studies. As we now have uncovered that the majority of studies find a positive relationship between sustainability innovations and competitiveness, we see the need for more research taking a more practical approach in how firms should implement competitive

sustainability innovations considering the difference in national, market, industry, and firm factors. We also see a need for understanding more in depth how the moderating and mediating factors affect the relationship. For example, we find conflicting results on whether government subsidies have positive or negative effects on the sustainability innovations–competitiveness relationship (Xie et al., 2016, 2019). Further research can thus help in explaining what kinds of regulatory schemes, including subsidies, are effective in motivating industries to become more sustainable. This has great importance for future regulations. In this, we support prior researchers in the notion that the question is not whether firms should implement sustainability but rather *how* (Engert et al., 2016; Grekova et al., 2013).

6. Conclusion

Due to pressure from shareholders and tough competition in international markets, many firms focus on short-term profits (Leal-Rodríguez et al., 2018). In many cases, a short-term focus is not compatible with the necessary patience and risk associated with sustainability. Hence, there is often a conflict between economic results and sustainable development (Sjafjell, 2018). However, we argue that this conflict can be solved by sustainability innovations in which firms meet the increasing competition in changing markets while contributing to sustainability (Klewitz and Hansen, 2014).

In this literature review, 100 articles were reviewed with the goal of mapping the current state of the research on the relationship between sustainability innovation and competitiveness and identifying the factors that influence this relationship. By reviewing the literature, several contributions are made. First, the findings from this review show that a large majority of the reviewed studies has concluded that sustainability innovations have a positive effect on firm competitiveness and that only a small fraction of the studies found a negative relationship between the two. We find that the outcomes resulting from sustainability innovations can be divided into increased value creation, reduced costs, and non-financial assets. Hence, we show that the conflict between sustainability and economic results can be eased via sustainability innovations as they contribute both to the sustainability shift and competitive advantage. These findings support the revisionist view that the sustainability shift comes with a set of business opportunities that are so large and so many that they outweigh the costs. Thus, these findings also indicate that the traditionalist view of sustainability innovations predominantly driving costs lacks explanatory power.

Secondly, we contribute to the research field by including social innovation in our literature search. Corporate social innovation is an understudied topic and provides unexploited business opportunities (Dionisio and de Vargas, 2020). As the sustainability research is often reduced to the environmental pillar (Klewitz and Hansen, 2014), a more holistic perspective on sustainability is needed by researchers (Engert et al., 2016). Only by understanding that the pillars of sustainability must be addressed simultaneously can we sufficiently address the societal challenges.

Third, we contribute to the literature by investigating and presenting the extensive operationalization of terms and variables used to measure sustainability innovations and competitiveness in a systematic manner. The current review shows that there exists great heterogeneity in the terms and variables used. This makes it difficult to make direct comparisons across studies and accumulate knowledge and may be a reason for the inconsistent results concerning the relationship. The variation in conceptualizations and operationalization is a limitation often mentioned in the literature (Tariq et al., 2017). However, we argue that the heterogeneity is also a strength because it shows that the sustainability innovation–competitiveness relationship is robust regardless of the method or operationalization of variables.

Fourth, this study contributes to the field by examining and listing the moderating and mediating factors that affect the sustainability innovation–competitiveness relationship. We have discovered that these factors can be classified according to context into national-, market-, industrial-, and firm-level factors. This makes important contributions to the field, both theoretically and practically, as this knowledge about the effects of moderators and mediators may shine light on which strategies are effective and which are not (Tariq et al., 2017). Understanding the factors influencing the relationship is also vital to manage the technological challenges associated with sustainability innovations (El-Kassar and Singh, 2019).

Finally, the review contributes with important suggestions for further research. In particular, we argue that the question is not whether firms should adopt sustainability innovations but *how* to do it successfully (Eiadat et al., 2008). Hence, we suggest that future research look into how firms should implement sustainability innovations that create win-win situations. By this, the sustainability innovation–competitiveness relationship can be disentangled from the conflict of traditionalist vs. revisionist views to the focus on *how and under what conditions* sustainability innovations become successful. These kinds of studies will have great implications for firms and governing bodies. In addition, there is a need for more studies on the moderating and mediating effects, which are still underdeveloped in the literature. We see these kinds of studies as utterly important for an increased understanding of the complexity of sustainability innovations.

6.1. Limitations of study

While this review makes important contributions to the literature concerning the effect of sustainability innovations, it has a number of limitations. Firstly, the choice of databases could have affected the number of relevant articles. Using other or additional databases could have increased the number of articles relevant to the research question. Secondly, because of the large variation in terms and definitions within the sustainability innovation topic (Engert et al., 2016; Klewitz and Hansen, 2014), it is possible that relevant studies using terms other than the keywords used were not found in the literature search. Thirdly, the inclusion criteria of keywords in abstracts could also have excluded relevant papers. Finally, the literature review approach, despite the use of inclusion and exclusion criteria, still entails making individual decisions on what is relevant versus irrelevant literature. This may be another limitation of conducting this type of study (Engert et al., 2016).

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.

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