Is training a green innovation driver? The mediating role of knowledge acquisition

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Abstract:

Purpose – The purpose of this study is to contribute to empirical research on green innovation drivers. It examines the relationships between the training that companies give their workers, knowledge acquisition, green innovation and firm performance.

Design/methodology/approach – The analysis is carried out on a sample of 373 Spanish companies from a wide variety of sectors. This research has used the Partial Least Squares (PLS) model to test the hypotheses.

Findings – It is found that green innovation and knowledge acquisition improve firm performance, and that knowledge acquisition has a mediating effect between training and green innovation.

Originality/value – This paper analyzes two research areas that have received little attention: the role of human resource management in green innovation and the relationship between a given driver and green innovation. In the first, it analyzes whether training increases green innovation, and in the second, it considers the effect of training on knowledge acquisition and on green innovation, specifically, it studies whether knowledge acquisition mediates the relationship between training and green innovation.

Practical and social implications – The findings of this article indicate that green innovation allows the company to obtain benefits while reducing the negative environmental impact, then managers should bet on ecological innovation. This study also shows that there is an indirect effect of training on green innovation and, therefore, managers must invest in training as a mechanism to increase knowledge acquisition and thus green innovation.

Keywords - Training; Green innovation; Knowledge acquisition; Firm performance

Paper type - Research paper

1. Introduction

Currently, there is an increasing social concern for environmental issues and conservation of the environment should be one of the objectives of the companies' innovation strategy (Galbreath, 2019; Tariq *et al.,* 2019). The development of consumers' ecological awareness, the growth in environmental protection regulations and the increment of international conventions on these issues are changing competitive patterns in the industry and companies are pressured to reduce their negative environmental impact and to implement green innovations (Chang, 2011; Chen *et al.*, 2006; Leal-Rodríguez *et al.*, 2018; Song *et al.*, 2019; Wong, 2012). Green innovation or eco-innovation can be defined as the modification, improvement or development of new products, technologies, practices, systems or processes that have a favorable impact on the environment (Pham *et al.*, 2019).

According to Huang *et al.* (2019), the importance of green innovation is growing due to the tendency toward sustainable development. This has sparked interest in discovering what drives companies to engage in environmental sustainability. Even though the main engineering disciplines already devote significant research to sustainable solutions, the problem of how the need to protect the environment can influence a company's competitive advantage has not received much attention at the academic level until recently (Galbreath, 2019; Leonidou *et al.*, 2017). Further studies are necessary to understand whether green innovation influences firm performance (Bendell, 2017; Chen *et al.*, 2006; Tariq *et al.*, 2019) and what variables favor eco-innovation (Ben-Arfi *et al.*, 2018; Galbreath, 2019).

One relevant area that has received little attention is the role of human resource management (HRM) in green innovation. The pressure to which companies are subjected, derived from the need for sustainable resource management and the reduction of pollution, forces them to change continuously in order to offer the market green products that differentiate them from their competitors (Leal-Rodríguez *et al.*, 2018; Song *et al.*, 2019). In addition, given the rapid advances

of technology, rising costs and complex demand, companies have to innovate faster and faster (McNally *et al.*, 2011). The capacity of an organization to innovate is linked to the knowledge and skills of its workers (López-Cabrales *et al.*, 2009; Tan and Nasurdin, 2011). Therefore, HRM can be a determinant of innovation in a company because it influences employees' behavior and can play a key role in the creation and transference of knowledge among workers (Chen *et al.*, 2010; Shipton, *et al.*, 2005). Of all HRM practices, training allows a company to take advantage of its employees' potential by favoring the acquisition of knowledge and focusing it on the development of new products and processes (Bae and Lawler, 2000; Scarbrough, 2003; Tan y Nasurdin, 2010; Tharenou *et al.*, 2007). Therefore, it seems logical to assume that training will have a favorable influence on green innovation. However, it is necessary to empirically demonstrate this relationship so this paper analyzes whether training is a green innovation driver.

Another rather unexplored area of research is the role that knowledge management has in the development of green innovation (De Marchi and Grandinetti, 2013). The main contribution of this article is made in this area by analyzing the mediating role of knowledge acquisition between training and green innovation. According researchers, the acquisition of knowledge is a critical component of the company's ability to innovate (Cohen and Levinthal, 1990; Galbreath, 2019). Knowledge can come from internal units (internal knowledge acquisition) or outside of the firm (external knowledge acquisition). Both sources of knowledge are important for green innovation. On the one hand, firms need to absorb new knowledge from external sources to understand environmental problems and, on the other hand, the ability to evaluate and use outside knowledge depends on the level of internal knowledge (Albort-Moran *et al.*, 2018; Galbreath, 2019). Accordingly, training effect on development of products or processes aimed at improving the environment could be mediated by external and internal knowledge acquisition and this paper makes a very important contribution by empirically studying the possibility that the relationship training -green innovation is mediated by firms' knowledge acquisition.

The current paper contributes to the green innovation literature in three important ways. First, it studies whether green innovation has a positive effect on business performance from the natural resource-based view (NRBV) (Hart, 1995). Although some research shows a positive relationship between green innovation and business results and indicates that companies can further reduce their production costs and increase their economic efficiency through the application of environmental innovations (Chang, 2016; Chang and Chen, 2012; Chen *et al.*, 2006), green innovation performance literature is still scarce (Cheng, 2020) and most studies have focused on countries in Southeast Asia. Therefore, although it seems predictable that green innovation is going to have a positive effect on firm performance, it is necessary to deepen this relationship. In developed countries, as there is a more established environmental awareness, it could happen that green innovation is only a requirement for companies to maintain their competitive position but not an opportunity to obtain a sustainable advantage. This research raises the importance of recognizing the green innovation results in a developed economy and explores if some variables may improve them, which may ultimately contribute to better firm-level performance. Second, this investigation analyzes whether training, as an HRM practice that allows workers to acquire knowledge and skills, increases green innovation. Although there are studies that show that training favors innovation, very limited research effort has been done to study how training improves green innovation and this paper shows some light on the relationship between both variables. Third, based on the knowledge-based view (KBV) (Grant, 1996), this research suggests that the relationship between training and green innovation is mediated by knowledge acquisition. This is the most important contribution of our paper because little research has considered the role of knowledge in green innovation (De Marchi and Grandinetti, 2013; Marco-Lajara *et al.*, 2023). This paper advances the green innovation literature by showing how knowledge acquisition mediates the hypothesized link between training and green innovation and covers part of the gap about the background of green innovation (Chang, 2011; Galbreath, 2019).

To achieve these goals, this paper is structured as follows. First, hypotheses proposed from developed theories and existing literature are provided. Second, the research methodology is presented. Third, the main results of the empirical study conducted on 373 Spanish companies are reported. Inferences from the findings are discussed regarding theoretical and managerial implications. Finally, limitations and future research are shown.

2. Theoretical background

2.1. Green innovation, knowledge acquisition and firm performance

The protection of the environment and its sustainability are issues that concern all companies today, both those working in ecological industries and those that are not. Although at the beginning, many organizations thought that corporate environmental management would be an unnecessary investment, or that it would even impede their development, companies are changing their attitude (Bendell, 2017). Some firms are being forced to do so by laws or by the pressure of consumers, others due to a sense of responsible social innovation (García-Piqueres and García-Ramos, 2021) and a third group believes that the adoption of environmental management strategies can generate superior competitive performance (Chang and Chen, 2013; Galbreath, 2019; Huang and Li, 2017; Sanni, 2018).

Based on the NRBV (Hart, 1995), this study proposes that green innovation enhances company performance. The NRBV arises as an extension of the resource-based view (RBV) and adds that strategy and competitive advantage of the firm are based on resources and capabilities that favor environmentally sustainable economic activity (Hart, 1995; Hart and Dowell, 2011). The RBV of the firm emphases the role of physical, human, and organizational resources and capabilities in achieving competitive advantage in the marketplace and superior performance. If these resources are valuable, rare, difficult to imitate, and no substitutable, the company could gain a sustainable competitive advantage (Barney, 1991). The RBV has been widely used in product

innovation research since the success of an innovation can be considered as the realization of a bundle of resources and capabilities that the company possesses (Andersén, 2021). The RBV could be used in relation to environmental issues, since green business strategies need to rely on heterogeneous resources and peculiar capabilities to improve firm performance (Cheng, 2020; Leodinou *et al*., 2017; Tariq *et al*., 2019). However, the RBV is limited to explaining the results at the company level and does not consider the environmental impact of the companies' activities, therefore our study relies on the NRBV (Hart, 1995; Hart and Dowell, 2011). The NRBV analyzes how resources can, at the same time, generate competitive advantage and positively influence the environment so that a successful innovation is simultaneously beneficial for the company and the environment (AlNuaimi *et al*., 2021; Andersén, 2021).

If companies carry out environmental management, they can improve their economic objectives, especially in the long term (Song *et al.*, 2019, Tariq *et al.,* 2019). In fact, globally successful companies have integrated environmental management into their strategic planning processes and have included ecological concepts in their normal activities, which has increased the idea that ecological management is important (Chang and Chen, 2013; Huang *et al.*, 2019). Therefore, organizations seek means to be more ecological, and one of the ways in which they are facing environmental problems is through innovations that can favorably influence the environment (Yarahmadi and Higgins, 2012). In an era of environmental protectionism, green innovation plays a critical role in creating competitive advantages (OECD, 2010; Przychodzen and Przychodzen, 2015; Wong, 2012) and is receiving greater attention at the academic and political level with the aim of reducing environmental damage (Ben Arfi *et al.*, 2018).

Organizations should not see environmental pressures as a threat, but as an opportunity since they can provide the motivation to develop ecological innovations, and, therefore obtain competitive advantages (Porter and van der Linde, 1995; Sanni, 2018). Companies can increase their productivity through green innovations that contribute to sustainable development since the

maximal use of natural resources is an important source of cost reduction. Furthermore, it minimizes environmental impact (Cai and Zhou, 2014; Chen *et al.*, 2006; Naveed and Iram, 2018). In addition, investing resources in environmental care can help avoid fines derived from the violation of laws on environmental protection (Chen, 2011).

If an organization develops green innovation, it can enjoy advantages, such as being able to request a higher price for green products, improving its corporate image or entering new markets (Chen *et al.*, 2006; Chang, 2011; Porter and van der Linde, 1995). Therefore, ecological management is not only a defence mechanism to preserve the legitimacy of a company, but it also becomes a key part in achieving sustainable development (El-Kassar and Singh, 2019; Huang *et al.*, 2019).

The innovation in ecological products and processes can reduce negative environmental impact and increase the economic and social benefits of the organization (Yarahmadi and Higgins, 2012). Indeed, innovation in green products can increase the competitive position of a firm in the market, strengthen its brand and attract new customers (Wong, 2012). Moreover, environmental innovation in processes can shorten production time and reduce costs and waste (Lambertini and Mantovani, 2009; Mu *et al.*, 2009).

Although numerous studies show a favorable relationship between green innovation and firm performance (Chen *et al*., 2006; Chen and Chang, 2013; Cheng *et al*., 2014; Huang and Li, 2017; Lin *et al*., 2013; Marco-Lajara, *et al.,* 2023; Suryanto *et al.,* 2018), others find no evidence (Aguilera-Caracuel and Ortiz-de-Mandojana, 2013; Chang, 2011; El-Kassar and Singh, 2019).

Given these arguments, we observe that there is a need to provide more empirical evidence about this relationship. Therefore, the following research hypothesis is proposed:

H_1: Green innovation positively influences firm performance.

For its part, knowledge can also increase the competitive advantage of the company. The consideration of knowledge as a strategic firm resource gives rise to the KBV (Grant, 1996).

According to Grant (1996), transferability, capacity for aggregation and appropriability characterize knowledge. Transferability of knowledge within the firm determines its competitive advantage, capacity for aggregation influences the efficiency of knowledge transferability and appropriability refers to the ability of the knowledge owner to obtain benefits from it (Pereira and Bamel, 2021). The KBV suggests that the main function of the company is to integrate and use knowledge and that resources and capacities based on knowledge are the factors with the most influence on firm's performance (Duong *et al.*, 2022). Firm knowledge has more potential to create value and low depreciation rate, in addition it is more difficult for competitors to imitate knowledge-based resources, thus making knowledge a source of the firm's sustainable competitive advantage (Pereira and Bamel, 2021).

The KBV distinguishes between internally developed and externally acquired knowledge. Knowledge can be acquired both by investing in internal R&D and by integrating knowledge that is outside the limits of the company and that can be found, among others, in universities, public or private research institutions, customers, suppliers or competitors (Grant, 1996). In fact, to the traditional approach of knowledge acquisition through in-house R&D, more and more companies are adding the use of external knowledge sources (Delgado-Verde *et al.,* 2021). These external agents can provide market information, which allows the firm to differentiate its products and obtain new ways of satisfying customers (Duong *et al*., 2022). In addition, they can reduce technological uncertainty through new research methods (Ardito & Petruzzelli, 2017). Actually, many companies remain competitive despite having decreased their investments in internal R&D as they acquire knowledge from various external sources (Laursen and Salter, 2006). This does not mean that internal knowledge is not necessary, since in order for the company to benefit from external knowledge, it must have the ability to assimilate and apply new knowledge that comes from outside, and needs to have basic knowledge (Cohen and Levinthal, 1990). Some research shows that for the firm to remain competitive, it must not only develop internal knowledge, but it

must go beyond its limits and acquire new knowledge from external sources (Criscuolo *et al*., 2018: Delgado-Verde *et al*., 2021; Flor *et al*., 2018). Accordingly, the hypothesis can bestated as:

H_2: Knowledge acquisition positively influences firm performance.

2.2. Training and green innovation

The increased concern for the environment has amplified the importance of green innovation and has placed a focus on what the determinants or drivers of such innovation might be. However, scarce research has studied the relationship between innovation drivers and green innovation (El-Kassar and Singh, 2019).

The ability of an organization to innovate lies in the competencies and motivation of its employees because it is people who generate ideas, detect opportunities and develop new products or processes (Chen and Huang, 2009; Collins and Clark, 2003; Jiménez-Jiménez and Sanz-Valle, 2006; Wright *et al.*, 2001). Most of the knowledge and skills necessary to innovate resides in workers (Subramaniam and Youndt, 2005) and the innovation of a company is, above all, a human issue (Kianto *et al.*, 2017). Considering the human nature of innovation, it is supposed that HRM practices can growth a company's capacity for innovation (Ceylan, 2013; Scarbrough, 2003), and the literature points to HRM as one of its determinants (Beugelsdijk, 2008; López-Cabrales *et al.*, 2009; Tan and Nasurdin, 2011).

HRM practices can increase workers' knowledge, skills and attitudes (KSA), and this can lead to greater innovation. In addition, if HRM practices favor knowledge sharing while performing daily work, the likelihood of generating new ideas and solving more problems increases (Camelo-Ordaz *et al.*, 2011; García and Calantone, 2002). Therefore, HRM practices play a fundamental part in creating a work environment that encourages innovation (Ceylan, 2013; Collins and Clark, 2003; Dul *et al.*, 2011; Jiang *et al.*, 2012; Mazzei *et al.*, 2016). However, companies must place more emphasis on those HRM practices aimed at obtaining creative, flexible

and capable employees who are willing to take risks, since this will enhance innovation (Tan and Nasurdin, 2011).

According to NRBV, companies need rare, valuable, inimitable, and no substitutable new resources to remain competitive in the long term and at the same time be beneficial for the environment (Hart, 1995; Cheng, 2020). Green innovation meets these requirements and, therefore, firms are interested in implementing the necessary processes to promote this type of innovation. Among these processes is the training of workers. Therefore, NRBV supports the idea that training is one of the HRM practices that can help create innovative employees (Huang *et al.,* 2016).

Training can provide employees with new KSA that prepare them to discover new ways of performing their tasks (Jaw and Liu, 2003; Kraiger, 2003; Tharenou *et al.*, 2007). According to Kuratko *et al.* (2014), if employees acquire new KSA through training, they can increase their ability to innovate. Innovation-oriented training should offer new ideas so that workers question the way in which tasks are traditionally performed and look for alternative solutions (De Saá-Pérez and Díaz-Díaz, 2010). It should also stimulate the application of what they have acquired to the workplace, creating an environment of innovation (Argote *et al.*, 2003). According to Guisado-González *et al.* (2016), the most innovative companies carry out more training activities, and do so more continuously than less innovative ones.

In general, research demonstrates a favorable effect of training on product innovation (Zhou *et al.*, 2011; Zoghi *et al.*, 2010), process innovation (De Saá-Pérez and Díaz -Díaz, 2010), or administrative and technical innovation (Chen and Huang, 2009; Li *et al.*, 2006). However, green innovation is more complex than traditional innovation since it is characterized by higher levels of novelty and uncertainty and requires a greater quantity and variety of internal and external resources (Cainelli *et al*., 2015). Therefore, training is especially useful in green innovation and it serves both to improve competition and to motivate employees (Sarkis *et al.*, 2010), especially in

the case of small and medium-sized enterprises, where training can complement lower levels of other internal resources such as investment in R&D (Del Brío and Junquera, 2003).

If training focuses on ecological activities aimed at specific objectives, such as training in methodologies and techniques of green design, recycling of materials, the use of cleaner or renewable technologies, etc., can change the traditional view that workers have of the environment and can help them improve their environmental learning skills, which is expected to lead to improvements in green innovation (Huang *et al.*, 2016; Neto *et al.*, 2014). Regarding the relationship between non-green training and green innovation, although studies are scarce they show a positive impact between both variables (Barth and Melin, 2018; Cainelli *et al.*, 2015).

In view of the arguments presented, and taking into account that the objective of this study is to analyze the relationship between training (by studying a set of characteristics that will allow it to be more effective) and green innovation, the following research hypothesis is proposed:

H_3: Training positively influences green innovation.

2.3. Knowledge acquisition as a mediator between training and green innovation

The workers' prior KSA are necessary to develop new knowledge in the company and promote the creation of new products (Foss, 2007; Galbreath, 2019; López-Cabrales *et al.*, 2009). Meanwhile, the more creative the workers are and the more knowledge they possess, the more likely they will be to have new ideas or to rethink the ways in which activities are traditionally done. Therefore, these employees can act as agents of change, favoring innovation (Kianto *et al.*, 2017). This knowledge becomes a differentiating and inimitable resource for firms and plays an essential role in their capacity to innovate (Ben Arfi *et al.*, 2018; Foss, 2007). Therefore, the ability to acquire and apply new knowledge is critical to innovation (Cheng, 2020; Cohen and Levinthal, 1990).

Since researchers have realized that knowledge is an essential element for fostering innovation, the capability to innovate has been related primarily to firm's ability to acquire knowledge and maximize its value (Duong *et al*., 2022; Kong *et al.,* 2020). An organization can acquire tacit or explicit knowledge and can acquire it within the company (internal knowledge acquisition) or outside of the company (external knowledge acquisition) (Grant, 1996). In either case, it is necessary for workers to be willing to share their knowledge through relationships with colleagues, partners, professionals or technicians outside the company, or with other institutions or organizations (Lundvall and Nielsen, 2007). Knowledge combination brings employees new perspectives and gives them the opportunity to reorganize their previous knowledge, consequently, firm creates new knowledge (Kong *et al.*, 2020; Nonaka and Takeuchi, 1995) which lets to innovate. Therefore, the use of sources of knowledge, both internal and external, allows acquiring novel environmental knowledge inputs which enable to generate greater green innovation (Cheng, 2020). The companies that have the necessary prior knowledge understand new technologies better and can create new products and processes more easily (Albort-Morant *et al.*, 2018; Wang *et al*., 2020).

However, green innovation is usually more complex for companies than traditional innovation, since technological uncertainties in the environmental area are greater and there are no standardized solutions to deal with ecological problems (De Marchi and Grandinetti, 2013). Given the complicated nature of green innovation, knowledge acquisition is even more important in this type of innovation than in non-green innovation (Kong *et al*., 2020). Therefore, both the internal R&D activity of the company and the skills from external partners are essential for the creation of ecological innovations. In fact, green innovation requires a high cooperative effort and a wide variety of specialized knowledge possessed by different external agents (customers, suppliers, universities, …) (De Marchi, 2012; De Marchi and Grandinetti, 2013). So the more

knowledge the company acquires, the less uncertainty it feels about green innovation and the more predisposed it will be to adopt it (Ben Arfi *et al.*, 2018).

Literature shows that knowledge acquisition lead toward ecological innovation (Chen *et al*., 2015; Lin and Chen, 2017; Pham *et al.*, 2019; Shahzad *et al.,* 2020) and that the success of the environmental innovation process depends on access to internal and external sources of knowledge (Ben Arfi *et al.*, 2018; Rabal-Conesa *et al.,* 2022). However, this line of research is still recent and more studies are needed to delve into the effect of knowledge management process on green innovation (Ben Arfi *et al.,* 2018).

When an organization understands that knowledge is useful and necessary for innovation, it is concerned with having adequate mechanisms to ensure that knowledge is constantly available (Cohen and Levinthal, 1990). Firms need knowledge to help them properly manage the environment and must implement processes that allow them to achieve this ecological knowledge (Albort-Morant *et al.*, 2018). Training can be one of these processes. According to De Saá-Pérez *et al.* (2012), training is of great importance in the creation, exchange and use of organizational knowledge since it prevents obsolescence. Training gives access to new KSA and allows employees to devise new ways of carrying out their tasks, which empowers them to innovate (Jaw and Liu, 2003), develops workers' knowledge and makes them an inexhaustible source of ideas for future innovation (Mumford, 2000).

Studies suggest that training is an essential tool for improving organizational knowledge (Bollinger and Smith, 2001; Jerez Gomez *et al.*, 2004; Nonaka and Takeuchi, 1995). However, most researchers analyze the relationship between training and organizational knowledge by studying training together with other HRM practices instead of in isolation (Chen and Huang, 2009; Perez Lopez *et al.*, 2006). Our research analyzes whether training as an individual HRM practice and with specific characteristics (adapted to the needs of the company, long-term oriented,

promoting polyvalence and empowerment, among other characteristics) influences knowledge acquisition.

Summarising the previous arguments, the following research hypothesis is proposed:

H_4: Knowledge acquisition mediates the relationship between training and green innovation

H_{4a}: Training positively influences knowledge acquisition

H_{4b}: Knowledge acquisition positively influences green innovation

Figure 1 shows the proposed conceptual model:

Insert Figure 1 about here

3. Research methodology

3.1. Population

The data used in this study were obtained from a sample of Spanish companies from a wide variety of sectors. To achieve the objectives of the project, it was considered appropriate to use the most heterogeneous population possible, taking into account the characteristics of the companies in the Region of Murcia, a region in the southeast of Spain. The inclusion of several sectors in the study allowed us to generalise our conclusions to a greater extent and it is a contribution of our paper since most of the existing studies are focused on the manufacturing sector (Tariq *et al.,* 2017). The population selected for the hypothesis test consists of firms from the Region of Murcia that meet two requirements. The first requirement is that companies have 20 or more employees according to the SABI database (Iberian Balance Analysis System). This size was selected since it is supposed that smaller companies have poorly developed HRM. In addition, smaller firms find it more difficult to resort to external sources of knowledge (Cruz-González *et al.*, 2015; Flor *et al.*, 2018). The second requirement is that companies have been operating a minimum of 5 years, to

avoid the variation derived from the creation of a new business. Taking the above into account, the total population of the study consists of 1,622 companies.

3.2. Sample and data collection

The collection of information has been carried out through personal interviews with the CEOs of the firms of the population, using a previously structured questionnaire with closed questions. The unit of analysis is the company (as well as other research such as Damanpour's, 1996), since the objective of the study is to discover the characteristics that promote green innovation in companies and its effect on performance.

With the objective of increasing the participation of CEOs, the following phases were carried out: a) a structured questionnaire was prepared with closed questions that could be easily understood; b) the interviewers were trained and given a manual with the main recommendations and rules of action during the interview with the CEO; c) two presentation letters about the project were prepared. One was sent by mail before conducting the interviews, and the other was attached to the questionnaire and was presented when conducting the personal interview; and d) the firm was guaranteed the confidentiality of the information given, being assured that this information would only be used for the purposes of the study.

Finally, 373 valid questionnaires were obtained, representing 23% of the total population. Of these responses, 202 correspond to industrial companies (54.2%) and 171 to service firms (45.8%). To check whether the sample data are representative of the population in terms of sector distribution of enterprises, the variable about the number of firms in the population has been correlated with the variable that collects the number of companies in the sample. The resulting Pearson correlation is 0.932 and significant at 1%, indicating that the sample is representative of the population in terms of distribution of firms by sector. In addition, Chi-square distribution analysis revealed no significant differences in terms of size, sales or company performance between the sample and the population, suggesting no response bias.

3.3. Measures

In this research the variables were acquired from an extensive review of the literature on the subjects analyzed. The main variables are measured on five-point Likert scales. The measurements of the constructs were obtained from previous studies. All of the constructs were measured with multiple-scale items.

Training was measured using six items drawn from previous studies by Chen y Huang (2009) and Jerez Gomez *et al.* (2004). The items measured the company's usage of comprehensive training policies; formal and long-term training, group-based training, multi-skill training, training based on job rotation programmes and the degree to which firms allow employees to make decisions about training.

Knowledge acquisition was measured using seven items based on Pérez López *et al.* (2007). Four items inquired about external knowledge acquisition: the firm encourages cooperation agreements with other companies, universities, technology centres, etc., the company is related to professional and technical experts, the organization supports the membership of its employees to formal or informal networks composed of people outside the organization, and employees usually attend fairs and exhibitions. The remaining three items regarding internal knowledge acquisition were: there is a consolidated R&D policy that is well endowed with resources, new ideas and approaches are continually present in the work environment, and organizational systems and procedures support innovation.

Green innovation was measured with five items related to the actions that the company carries out to prevent pollution: the development of new production processes, the modification of production processes, the development of new products, the improvement of existing products, and the use of recycling and recovery criteria. Traditionally, green innovation has been measured through the development of products or processes aimed at improving the environment (Cheng *et al.*, 2014; El-Kassar and Singh, 2019; Kawai *et al.*, 2018).

Firm performance was assessed using six items based on Quinn and Rohrbaugh (1983). The respondents were asked about the evolution during the last three years of the performance of their organization related to product quality; customer satisfaction, company image, market share, profitability and productivity.

Finally, we have included two control variables with one indicator per variable to explain the three endogenous variables of the model. These variables are broadly used for explaining our endogenous variables. They are *Antiquity of the company*, based on the number of years since its creation; and *Size*, measured by the number of employees.

The nature of the measurements for the variables in this study are modelled as composites since they are design constructs or artefacts that are the result of theoretical thinking (Henseler, 2017), such as innovation or training (Henseler *et al.*, 2016b). Specifically, we have used Mode A for acquisition and Eco innovation, but Mode B for training because of its formative structure.

3.4. Data analysis

The Partial Least Squares (PLS) model used to test the hypotheses is a structural equation modelling (SEM) technique based on variance (Henseler *et al.*, 2016a). PLS-SEM allows the construction of a research model that represents a certain theory simply by converting theoretical concepts into unobservable variables (latent) and empirical concepts into indicators, which are linked by a series of hypotheses (Cepeda Carrión *et al.*, 2016). We have used SmartPLS 3 software (Ringle *et al.*, 2015) to evaluate the measurement model and to estimate the structural model.

4. Results

Before studying the structural model, the suitability of the measurement model has been verified.

4.1. Measurement model

Several tests have been developed to confirm the measurement model (Henseler *et al.*, 2016a). Specifically, these analyzes (saturated model) provided standardised root mean square residual (SRMR = 0.064), unweighted least squares discrepancy (dULS = 1.226) and geodesic discrepancy (dG = 0.410) values.

The reliability and validity of the compounds in Mode A have been checked (Table 1). The reliability values of the individual indicators were higher than the recommended minimum level of 0.7, as suggested by Chin (1998). The reliability of internal consistency was measured using the composite reliability index of Bagozzi and Yi (1998). All composite reliability values were greater than the recommended minimum of 0.7 (Table 1). Cronbach's alpha values also exceeded the recommended minimum of 0.7 (Roldán and Sánchez-Franco, 2012). Convergent validity was evaluated using the Fornell and Larcker (1981) average variance extracted index (AVE). The AVE values for the constructs were greater than the recommended minimum threshold of 0.5 (Bagozzi and Yi, 1998).

Insert Table 1 about here

Discriminant validity of the measures was observed with two procedures. First, as suggested by Fornell and Larcker (1981), the average variance extracted for each construct is greater than the corresponding correlations (see Table 1). Second, we have confirmed that all the values above the diagonal in Table 1 are lower than the suggested 0.85 with the heterotrait-monotrait (HTMT) criterion (Henseler *et al.*, 2015). Consequently, all the variables exhibited suitable discriminant validity. In short, the model has good convergent validity, reliability and discriminant validity.

For the formative construct, we have checked that the value of the variance inflation factor (VIF) for each indicator of training is lower than the limits suggested by literature, which means that there was no collinearity problem with this construct.

Finally, we also analyze the possibility of Common Method Biases (CMV) (Chin, *et al.,* 2013; Podsakoff *et al.,* 2003). Harman's Single-Factor Test is the most common test performed by researchers to examine CMV. We look at the effects of considering a single common factor that includes all the model indicators (Liang *et al.,* 2007). The results suggest that CMV is not a serious issue in the study (Chang *et al.,* 2010).

4.2. Structural model

The results of the structural model of the PLS-SEM analysis are presented in Table 2, including the standardised path coefficients (β) and p values. A one-tailed test is used (Ned, 2015), assuming that the coefficient of the hypothesis predicted by the association has a positive sign (Kock, 2015). Bootstrapping resampling with 5,000 subsamples is used to analyze the significance of the effects of interaction (Chin, 1998).

Insert Table 2 about here

As can be seen in Table 2, the results offer empirical evidence to sustain hypothesis 1 ($\beta = 0.106$, $p < 0.05$) and hypothesis 2 ($\beta = 0.389$, $p < 0.001$). The hypothesis 1 shows a positive and significant relationship between green innovation and firm performance and the hypothesis 2 indicates a favorable effect of knowledge acquisition on firm performance. With respect to hypothesis 3, training does not have a significant positive impact on green innovation ($\beta = -0.018$, $p > 0.05$). Therefore, hypothesis 3 is not accepted. Hypothesis 4 proposes that knowledge acquisition mediates the relationship between training and green innovation. To obtain empirical evidence of this mediating effect, it has first been verified that training has a positive and significant effect on knowledge acquisition ($\beta = 0.472$, $p < 0.001$). Thus, hypothesis 4a is supported. Secondly, it is observed that there is also a positive and significant relationship between knowledge acquisition and green innovation ($\beta = 0.218$, $p < 0.001$). Therefore, hypothesis 4b is also supported. Hence, empirical evidence is obtained to support hypothesis 4.

These results reinforce the idea that training could have an indirect effect on green innovation through knowledge acquisition. The results shown in Table 2 indicate this indirect effect ($\beta = 0.103$, $p < 0.001$) between training and green innovation, which suggests that knowledge acquisition plays a total mediating role in this relationship.

5. Discussion and implications

This paper sights to develop and empirically test a conceptual model linking training to green innovation, knowledge acquisition and firm performance. Specifically, the main contribution of our research is the analysis of the mediating role of knowledge acquisition between training and green innovation. However, although the other proposed relationships may be more predictable, it is necessary to examine them more carefully since, at the moment, the literature is scarce. Several relevant findings emerge from our research.

First, our results show that green innovation improves business performance even in an advanced country, such as Spain, where environmental awareness is more ingrained. According to the third climate survey (2020-2021) conducted by the European Investment Bank (EIB), 82% of Spanish respondents affirm that climate change is the greatest challenge facing society in the 21st century and 81% are in favor of stricter government measures that force changes in the behavior of citizens and firms. A majority social awareness about the importance of the environment could lead to the development of new products and more ecological processes being an obligation of the company (such as paying fair wages) without impact on its results. However, the findings of this paper show that green innovation improves firm performance, becoming a source of competitive advantage. Second, our results indicate that knowledge acquisition has a positive effect on firm performance. Third, it has been proven that the effect of training on green innovation is indirect. Finally, in this paper we have found that knowledge acquisition acts as a mediating variable between training and green innovation. Training has a favorable impact on

knowledge acquisition, and knowledge acquisition positively influences green innovation. The theoretical and practical implications of these results are discussed below.

5.1. Theoretical contributions

This research contributes to existing green innovation and knowledge management literature in the following ways. First, our results expand the knowledge about the effect that green innovation has on firm performance and have implications for the NRBV. This theory states that if the company has resources with certain characteristics, they can be a source of competitive advantage and at the same time benefit the environment. The NRBV does not consider the environment as a setback on firm's attempts to create sustainable advantages but rather recognizes it as an opportunity (Hart, 1995). This paper provides evidence to this line of reasoning by showing that green innovation positively affects firm performance. In addition, the current study complements the green innovation research (Chen and Chang, 2013; Cheng *et al*., 2014; Huang and Li, 2017) using a sample from Spanish companies to provide empirical evidence that green innovation has a favorable influence on organizational performance in a different context than most previous investigations. This finding supports the NRBV by demonstrating that adequate environmental management can be a source of competitive advantage, as it serves as an innovation mechanism that allows firms to obtain some benefits, such as higher product quality, increased customer satisfaction or the improvement of a company's image products. Green innovation helps to gain competitive advantages while reducing the negative impacts of a company's activity on the environment (Cai and Zhou, 2014).

Second, as pointed out by Ben-Arfi *et al*. (2018), Galbreath, (2019) or Huang *et al.* (2019), it is necessary to identify what factors favor green innovation and understand how they work, and our research contributes to increasing the knowledge on this subject. Although our findings do not show that employee training has a direct effect on green innovation and this is not consistent with other studies, such as those by Barth and Melin (2018), Cainelli *et al*. (2015) or Neto *et al*. (2014),

which indicate that training positively influences the introduction of innovations with less impact on the environment, we must bear in mind that in our study, a relationship between training and knowledge acquisition has been raised that is significantly positive, and it has been proven that the effect of training on green innovation is indirect. This may be because we did not look at the specific content of the training provided but rather measured six indicators that assess a consistent set of training characteristics aimed at promoting knowledge management and innovation. In this way, a complete training design will help to acquire new knowledge and create more green innovation.

The theoretical implication of our results is very important because it provides evidence that the way in which training is managed influences the knowledge acquisition and the development of green innovation. This shows that training (regardless of its content) can have an impact on ecological innovation, which reinforces the value of the investments that the company makes in practices or processes not exclusively oriented to promoting environmental innovations. This does not diminish, in any way, the importance of green training, but it goes beyond the most foreseeable and obvious relationship that can exist between green training and green innovation. Our findings demonstrate training helps to develop the employees' capabilities to promote green innovation in the company, acting as an indirect green innovation driver. This represents greater theoretical knowledge about which variables serve as drivers of ecological innovation.

Third, our study reinforces the theoretical approaches of the KBV. On the one hand, our results indicate that knowledge acquisition improves firm performance and, on the other hand, show that knowledge acquisition acts as a mediating variable since training has a favorable impact on knowledge acquisition, and knowledge acquisition positively influences green innovation. At a theoretical level, we point out that both internal and external knowledge acquisition are important for developing green products and processes, so the company must pay attention to both types, carrying out actions that promote the search for knowledge both within like outside the firm. The

mediating effect of knowledge acquisition is of great interest as it provides evidence on the effectiveness of training (a subject under continuous debate) by showing that employee training contributes to generate innovation even though it does not have a direct effect on the company's performance. If it is not possible to demonstrate the usefulness of an investment, the company tends to reduce it, but our research concludes that investments in training are useful since they favor the acquisition of organizational knowledge, which has a positive impact on the obtaining of green innovations and thus increases the organization's wealth.

Our research serves to support the ideas defended by the KBV by demonstrating that knowledge acquisition helps to obtain better business results through its impact on green innovation, allowing the company to achieve sustainable competitive advantages, and make a contribution in the field of green innovations drivers where studies are scarce. This study fills this gap and provides evidence to understand which variables influence green innovation. Specifically, it shows that training could boost company's performance through the mediating mechanism of knowledge acquisition on green innovation.

5.2. Practice contributions

Once the theoretical implications of our paper have been exposed, the practical contributions are discussed. First, managers must promote green innovation in their companies for two reasons: the possible economic benefit it can bring and the opportunity it represents to strengthen ethical behavior that reaffirms their companies' social work and respect for the environment (Chang, 2011). Likewise, if a company carries out proactive green innovation taking into accounts the objectives of its stakeholders, it is preparing to face new environmental risks and to offer improvements that can lead to sustainable development. Therefore, we recommend managers to bet on green innovation because there are numerous reasons that justify it. Firstly, at the legal level, the regulation on environmental pollution that currently affects companies requires that they reduce their polluting emissions and waste if they want to continue operating. Secondly,

the demands derived from market trends and the desire of consumers for organic products are growing. These products compete with non-organic products at the margin, since they incorporate higher prices paid by consumers willing to pay for products at a higher cost but with the desired characteristics. And, thirdly, green innovation generates more efficient production processes in which materials are reused and consumption is reduced, which leads to a reduction in the cost of the products developed and, therefore, to an increase in the benefits of the company.

Managers must also be informed of what factors act as drivers of green innovation. Then they will be able to put them into practice in their companies. The results of our research indicate that training has an indirect influence on green innovation and that knowledge acquisition has a direct impact, playing a mediating role between training and green innovation. Managers must know this mediating effect in order to invest in training. If they are aware that training has an important organizational impact through the acquisition of knowledge, they will give it more value and decide to invest in this HRM practice. Our study also shows that, although the content of the training is important, and some research shows that the training aimed at developing environmental knowledge and skills will foreseeably foster green innovations (Huang *et al.,* 2016; Neto *et al,* 2014), managers should pay attention to other features of training as enablers, albeit indirectly, of ecological innovations. Hence, second, managers must design training in such a way that it is as effective as possible to generate new knowledge and obtain more innovation. For this, and according to our investigation, managers should implement training programs designed to meet the future needs of the firm through a formal process, oriented to the long term and teamwork, providing broad skills (through mechanisms such as job rotation) that favor polyvalence and that encourage employee autonomy and participation in the company.

Third, considering the positive impact of knowledge acquisition on results, managers must promote knowledge acquisition, both internal and external, to improve firm performance and green innovation. Internally, among other actions, managers must invest in R&D and encourage the

creativity of their employees. Meanwhile, in the external field, managers must establish relationships and cooperate with suppliers, competitors, technical experts, universities, etc. These relationships are of great value because if workers come into contact with new knowledge, they can positively influence the development of ecological innovations (Ben Arfi *et al*., 2018; Chen *et al.,* 2015). In fact, access to external resources and cooperation is more relevant and more effective for green innovation than for other types of innovation (Cainelli *et al.,* 2015; De Marchi, 2012), so managers must be more selective when choosing partners.

6. Limitations and future research directions

Despite the important theoretical and practical contributions of this paper, it has several limitations that must be taken into account when interpreting the findings. These limitations provide opportunities for improvement to advance this research topic.

The first limitation is theoretical. Our study tries to find green innovation drivers. However, although in the literature it is assumed that HRM practices can increase the innovative capacity of the company, we have only focused on non-green training and the mediating role of knowledge acquisition. Future studies may investigate how other HRM practices influence green innovation. As other possible antecedents of ecological innovation, the impact of the type of employee recruitment, employee performance appraisal or the relationship between remuneration and green innovation could be analyzed.

The second limitation is related to the context in which this study is carried out. It has focused on a sample of companies from the Region of Murcia (Spain). Although they belong to a wide range of sectors, the generalization of the results could be limited to companies from similar contexts, so the extrapolation of the results of this research to other geographical regions should be done with caution. Future research should replicate and extent the results to other Spanish regions, as well as to other countries to provide additional insights into the external validity of the

conceptual model. Comparative studies of green innovation drivers across developing and developed countries could also be conducted. This could provide interesting results because the findings could vary from one context to another.

Finally, we can point out two methodological limitations. On the one hand, the use of cross-sectional data since the data has been collected at one point in time. Cross-sectional data cannot fully report the cause-effect relationship in the model and cannot show changes in ecological innovation over time (Tariq *et al.,* 2017). To solve this limitation, it is proposed that future studies use longitudinal data, this will allow analysing the dynamics of green innovation. Longitudinal data will let causal conclusions to be drawn about the effect of antecedents on green innovation as well as to observe the changes produced by the passage of time, which will represent an advance for research in this area. On the other hand, the use of a quantitative approach to test hypotheses makes it difficult to learn more about the "how" the relationships between the study variables are produced. Therefore, we propose that future research address the relationships from a qualitative perspective, taking into account the structural and situational contexts. This qualitative approach could help to better understand, especially, the indirect relationship between training and green innovation that our study has revealed. At the methodological level, one last recommendation can be made. In our study, all the measurements were obtained from the same participants and, although our analyzes rule out the existence of CMV, future research could incorporate objective financial data to complement the subjective responses.

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Is training a green innovation driver?

The mediating role of knowledge acquisition

Figure 1. The conceptual model

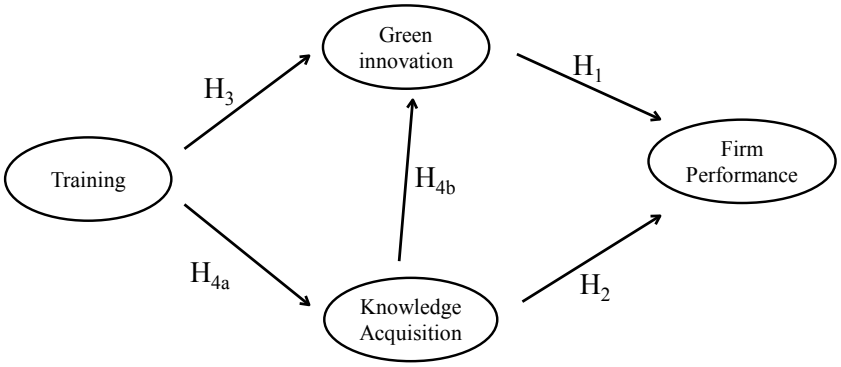

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Table 1. Correlation matrix, mean values, standard deviations and reliability

	Training	*Knowledge acquisition*	*Green innovation*	*Firm performance*
Training	**a**	a	a	a
Knowledge acquistion	0.473	**0.719**	0.228	0.463
Green innovation	0.084	0.219	**0.866**	0.191
Firm Performance	0.321	0.406	0.185	**0.735**
Notes: a= formative construct. The diagonal elements of the correlation matrix (in bold) are the square root of the variance shared between the constructs and their measurements. Below the diagonal elements are the correlations between constructs. Above, the diagonal elements are the values of the Heterotrait-monotrait (HTMT) criterion.				
Mean value	3.073	3.233	3.014	3.967
Standard deviation	0.820	0.778	1.180	0.504
Cronbach's Alpha (α)	a	0.844	0.917	0.826
Composite reliability	a	0.881	0.937	0.876
Average variance extracted	a	0.516	0.750	0.541

Table 2. Structural model results

Paths	*Standardised Coefficient*	*Standard deviation*	*Confidence interval*	
			LL	*LS*
Hypothesis				
H_1. Green innovation→ Firm performance	0.106*	0.053	0.017	0.190
H_2. Kwoledge acquisition → Firm performance	0.389***	0.045	0.467	0.303
H_3. Training→ Green innovation	-0.018	0.080	-0.162	0.103
H_{4a}. Training → Knowledge acquisition	0.472***	0.049	0.369	0.537
H_{4b}. Kwoledge acquisition → Green innovation	0.218***	0.062	0.110	0.314
Control variables				
Age→ Knowledge acquisition	-0.020	0.046	-0.096	0.054
Age→ Green innovation	0.003	0.057	-0.091	0.097
Age→ Firm performance	0.048	0.051	-0.036	0.134
Size→ Knowledge acquisition	0.021	0.030	-0.020	0.073
Size → Green innovation	-0.014	0.033	-0.070	0.035
Size → Firm performance	-0.024	0.029	-0.071	0.023
Indirect effect				
Training→ Green innovation	0.103***	0.032	0.054	0.161

Note: ***p<0.001 **p<0.01 *p<0.05 based on a Student's t(4999) distribution with one tail [t(0.05, 4999) = 1.645, t(0.01, 4999) = 2.327, t(0.001, 4999) = 3.092)]. Bootstrapping based on n = 5.000 subsamples; LL=Lower bias corrected bootstrap 95% confidence interval; UL= Upper bias corrected bootstrap 95% confidence interval.