# Organisational agility, environmental knowledge and green product success

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# ORGANISATIONAL AGILITY, ENVIRONMENTAL KNOWLEDGE AND GREEN PRODUCT SUCCESS

**ABSTRACT**

*Purpose* – The aim of this study is to analyse the effect of organisational agility on environmental knowledge as an instrument for the successful development of eco-innovation in products.

*Design/Methodology/Approach* – The study used a cross-sectional design to collect data on the study variables from a sample of 184 Spanish manufacturing organisations. Structural equations with PLS were used to test the hypotheses.

*Findings* – Organisational agility is significantly linked to internal and external environmental knowledge. Our results highlight the effect of external knowledge on the success of eco-innovation. Internal environmental knowledge positively moderates the effect of external knowledge on the success of green products.

*Research implications* - Based on the Dynamic Capabilities approach, a theoretical model has been proposed in which organisational agility is configured as an effective capacity for the development of environmental knowledge. The results confirm this relationship and indicate that, although internal environmental knowledge is not decisive in developing new green products, it does enhance the effect of external knowledge on the success of eco-innovation.

*Practical implications* – Innovative companies must implement organisational agility practices that promote environmental knowledge for the success of new green products. They should also promote both external and internal knowledge.

*Originality/Value –.* Our study addresses the little explored area of the relationship between organisational agility and the successful development of new green products. The inherent particularities of eco-innovation prompt the need for further studies on the creation of specific knowledge for its promotion. Our study concludes that adopting agile practices enables key environmental knowledge for this type of innovation to be created. Additionally, it explores the tensions arising from the dichotomy between internal and external knowledge, with scarce resources allocated to the most effective source. Although both types of knowledge seem to be equally relevant, external knowledge plays a more significant role in the case of eco-innovation. A final contribution of the study is the finding that internal knowledge can further enhance the effect of external knowledge on the development of successful green products.

**Keywords –** Organisational agility, successful green products, environmental knowledge, internal knowledge, external knowledge, knowledge tensions

**Paper type** Research paper

## 1. INTRODUCTION

Climate change is an undeniable reality. Growing public awareness and the coordinated action of national governments are causing customers to demand ecological or less polluting and reusable products. Companies are adapting their production processes to new regulations to manufacture more sustainably and reduce the polluting emissions they release into the atmosphere. Businesses are also decreasing energy consumption in processing and transport as a response to customer demands (Huang, Hu, Liu, Yu, & Yu, 2016; Ben Arfi, Hikkerova, & Sahut, 2018; Li, Chi, Hao, & Yu, 2018; Wang, Zhao, & Hou, 2020). In order to put this strategies into practice, the creation of new knowledge and knowledge management are essential for companies (Moaniba, Lee, & Su, 2020).

Previous studies have highlighted the need to create new knowledge for business success (Abbas & Sağsan, 2019). Incorporating this knowledge helps companies explore new ways of doing things and exploit existing capabilities more effectively to gain competitive advantages through innovations (Andreeva & Kianto, 2011; Yaghoubi et al., 2011). Therefore, the literature concludes that companies should find the mechanisms necessary to acquire new knowledge and integrate it with existing knowledge to strengthen organisational skills and become more competitive (Tsai & Hsu, 2014; Y. Chen, Vanhaverbeke, & Du, 2016).

This context is even more relevant for innovative companies. The constant need to develop new products puts pressure on companies to increase and refurbish their knowledge, technology and skills to offer products with new specifications that renew the confidence of existing consumers or allow businesses to join other segments or markets. Previous literature has reported the effects of new knowledge on the success of innovation and the ambidextrous tensions between knowledge exploration and exploitation involved in integrating or replacing previous internal knowledge with new knowledge (Menon & Pfeffer, 2003; Rosell David, Lakemond, & Melander, 2017; Bresciani, Ferraris, & Del Giudice, 2018). Indeed, the difficulties resulting from an organisation's limited resources mean that firms have to decide whether to invest in one activity or another. Similar to the concept of ambidexterity suggested by March (1991) and applied to innovation (Jansen, Van Den Bosch, & Volberda, 2006), firms must also decide whether to devote their resources to generating knowledge internally or acquiring it externally. This tension extends to decision-making in situations where both types of knowledge are available.

The present research focusses on the study of eco-innovation. Nowadays, increasingly stringent environmental regulations and consumer group interest in environmental protection are prompting companies to develop green products (Y. S. Chen & Chang, 2013). The OECD defines eco-innovation as *the development of new products; including goods and services, procedures, marketing modes, organisational structures and institutional arrangements, that lead to environmental improvements over pre-existing alternatives* (OECD, 2010).

Studies have found that eco-innovation is somewhat different and more complex in terms of novelty, uncertainty and variety than non-green technologies, and is also influenced by different sets of drivers (Fernández, Torrecillas, & Labra, 2021). Introducing new products and processes that reduce environmental impact represents an increasingly important technological frontier that companies can only approach by incorporating new and different resources. In terms of internal innovation resources, the presence of a previous structure in research and development plays a more significant role in creating eco-innovations than in the development of other types of innovation (Cainelli, De Marchi, & Grandinetti, 2015). The existing literature seems to make this clear.

Additionally, and in contrast to other types of innovations, an open innovation approach is even more necessary with eco-innovations because of the need to capture specific and constantly evolving external knowledge flows, making it more difficult for companies to develop new green products without paying attention to the environment (Horbach, 2008; Marchi & Grandinetti, 2013;

Cuerva, Triguero-Cano, & Córcoles, 2014). Moreover, the development of new green products requires a culture of open-mindedness to new knowledge (J. G. Cegarra-Navarro, Papa, Garcia-Perez, & Fiano, 2019); in this case, of an environmental nature.

Although its relevance seems obvious, this aspect has not been dealt with in depth in previous studies, especially those concerning the success of new green products. Successfully developing these eco-innovations is a complex and costly task that involves a variety of factors and actors, and in which new ideas are essential (Cooper & Kleinschmidt, 2007; Oke, 2013). This type of environmental knowledge is especially specific and requires a more precise approach to its internal development or external acquisition (Cherifi, M'Bassègue, Gardoni, Houssin, & Renaud, 2019).

In this study, we analyse the effects of internal and external knowledge on the success of new green products and contribute to the prior understanding of how internal knowledge can serve as a stimulus to external knowledge, positively affecting the creation of new products. Moreover, in terms of new knowledge creation for the development of new green products, previous studies have highlighted the importance of promoting certain dynamic capabilities, such as organisational learning (Gema Albort-Morant, Leal-Millán, & Cepeda-Carrión, 2016), absorption capacity (Lane & Lubatkin, 1998; Hashim, Bock, & Cooper, 2015; G. Albort-Morant, Henseler, Cepeda-Carrión, & Leal-Rodríguez, 2018) or organisational agility (Hamad & Yozgat, 2017). Based on the Dynamic Capabilities approach, D. Teece, Peteratd, and Leih (2016) refer to agility as an organisation's ability to efficiently and effectively redeploy or redirect its resources towards activities that create, protect and capture value, as internal and external circumstances demand. Conforto, Amaral, da Silva, Di Felippo, and Kamikawachi (2016) define the agility construct as the ability to change rapidly in response to customers' or stakeholders' needs or market or technological demands to achieve better product performance in an innovative and dynamic environment. Although previous studies have explored the importance of this capacity for company innovation or competitiveness (Burchardt & Maisch, 2019), its effects on eco-innovation remain unexamined. To address this gap in the literature, we look more closely at this capacity by analysing the effects of organisational agility on the creation of both internal and external environmental knowledge. Our study seeks to build on the existing literature by examining how this dynamic capacity can serve as a basis for creating useful and environmentally friendly green knowledge.

Results reveal that organisational agility has a positive impact on both external and internal environmental knowledge. The findings also confirm that only external environmental knowledge favourably affects green product success. However, internal environmental knowledge plays a moderating role in the relationship between external environmental knowledge and green product success. Therefore, this study contributes to the literature on knowledge and innovation by detecting several research gaps that highlight the need to adopt agile approaches to building environmental knowledge in organisations. Undoubtedly, this research underlines the tensions that occur between internal and external knowledge in the creation of successful eco-innovations. This article provides new evidence arguing that while external knowledge is more valuable for the development of successful green products, the existence of internal knowledge can intensify this relationship. Our results corroborates the idea that organisations should not neglect the generation of internal knowledge as in Antonelli and Colombelli (2015); Doran, McCarthy, and O'Connor (2019). This is a relevant contribution to the existing literature on innovation and especially that dealing with the development of successful green products.

The remainder of this article is organised as follows. In the next section, we review the theoretical background and state the study hypotheses. We then show the methodology used in the study and present the results of the empirical analysis. Finally, the most relevant conclusions derived from the research are presented.

## 2. LITERATURE REVIEW AND HYPOTHESES

Eco-innovation implicitly involves reduced environmental impact. It goes beyond organisational boundaries to influence social contexts through changes in regulations, cultural values, behaviours and organisational structures (Pilat, 2009). Thus, such eco-innovations should represent a major step towards sustainable development by reducing the impact of production on the environment, increasing nature's resilience to environmental pressures or making more efficient and responsible use of natural resources (EU, 2019). Eco-innovation should reduce environmental risk, pollution or the negative impacts of resource use (Kemp & Pearson, 2008). As these initiatives are implemented, their application becomes increasingly complex, and industries need to adopt an approach that can integrate the different elements of knowledge to develop eco-innovation and maximise environmental benefits (OECD, 2010).

### 2.1. Organisational agility

The dynamic capability perspective recognises the role of specific organisational capabilities in shaping and reconfiguring resources to support a firm's alignment with its dynamic environment (D. J. Teece, Pisano, & Shuen, 1997), enabling the firm to introduce internal changes and remain competitive. Agility is widely regarded in the literature as a dynamic capability that allows organisations to react proactively, flexibly and quickly to the changes and demands of their environment and stakeholders, giving them a competitive advantage (Yaghoubi et al., 2011; Kuo, Lin, & Lu, 2017; C. J. Chen, Guo, Hsiao, & Chen, 2018; Gyemang & Emeagwali, 2020). Enterprise agility is considered a dynamic capability comprised of sensing capabilities, responsiveness and maintaining an appropriate balance between the two (Verma, Bharadwaj, & Nanda, 2017).

Many frameworks have been created to develop agility inside organisations (Gunasekaran, 1998; Trinh, Molla, & Peszynski, 2012; Harraf, Wanasika, Tate, & Talbott, 2015; Baškarada & Koronios, 2018).

Likewise, organisational agility has been defined in different ways in the literature. The concept of agility first appeared linked to manufacturing. It was introduced by Nagel and Dove (1991) from the Iacocca Institute. Agility was primarily associated with bringing out new products rapidly, producing on demand and offering a wide variety of products based on marketing projections. Agility has also been connected to building strategic relationships with clients, salespeople and consumers to obtain valuable information for product development. Dove (1999) explained agility as "the ability to manage and apply knowledge effectively." Agility is not possible if an organisation cannot recognise and assimilate change quickly, integrating new knowledge with existing information to take advantage of these changes before competitors do. Other authors support the idea that agility is the result of interaction among three capabilities: customer agility, partnering agility and operational agility (Sambamurthy, Bharadwaj, & Grover, 2003). Organisational agility is also defined as the ability to develop behaviours intentionally and efficiently in changing environments, to react quickly to change and to anticipate and find opportunities, especially through innovation and learning (Felipe, Roldán, & Leal-Rodríguez, 2016). The constitutive dimensions of organisational flexibility and agility, their most significant facilitators, practices and mechanisms of action and their effectiveness in the global success of firms are addressed in several studies (Bottani, 2010; Elkareem, Alzoubi, Al-otoum, Karim, & Albatainh, 2011; Lin, Su, & Higgins, 2016; Oliveira, 2017; Heilmann, 2018; Schuh, Dölle, Kantelberg, & Menges, 2018). Consequently, organisational agility could be viewed as the intentionally developed capacity to respond quickly, flexibly and efficiently to changes in the environment and the demands of clients and other people and organisations of interest. It also involves responding to internal demands, anticipating them through the construction of learning and innovative competencies.

### 2.2. Organisational agility, environmental knowledge and eco-innovation

There is growing global awareness about the need for environmental preservation and the development of green policies in most countries. International treaties and a broader body of environmental legislation cover all areas of human activity (Horbach, 2016). At the same time, citizens are demanding that governments and companies take measures to reduce the polluting effects of industries and cities (Jansson, 2011; Horbach, Rammer, & Rennings, 2012). Companies are implementing social responsibility programmes to counteract the effects of the pollution they are causing and to produce in a cleaner and more efficient way (Costantini, Crespi, Marin, & Paglialunga, 2017; Cai & Li, 2018). Likewise, the products companies develop use more recyclable and/or biodegradable materials in response to growing consumer demand (Fernando, Chiappetta Jabbour, & Wah, 2019; Ch'ng, Cheah, & Amran, 2021). For these reasons, the creation of new environmental knowledge and eco-innovation is soaring. We can also see this in the literature, where research and published articles on the topic are growing (Díaz-García, González-Moreno, & Sáez-Martínez, 2015; Păcesilă & Ciocoiu, 2017; Jesus, Antunes, Santos, & Mendonça, 2018; Pacheco, Caten, Jung, Navas, & Cruz-Machado, 2018; Salim, Ab Rahman, & Abd Wahab, 2019).

Furthermore, the internal and external characteristics of firms and culture play a key role in understanding the development of environmental knowledge and eco-innovation (Albers et al., 2018; Michaelis, Aladin, & Pollack, 2018). Specifically, environmental knowledge is necessary for the successful development of green innovations. Environmental knowledge can be understood as the set of concepts, ideas, knowledge, skills and practices relating to environmental issues and the impact of these concepts, ideas, knowledge, skills and practices on society and the environment.

This knowledge may be obtained from both internal (internal R&D, collaboration among departments, etc.) and external (customers, suppliers, etc.) sources. A company's levels of intelligence and knowledge are a result of the interaction among employees who share their expertise (Laviolette, Redien-Collot, & Teglborg, 2016; Bogers, Foss, & Lyngsie, 2018; Schweisfurth & Raasch, 2018), the know-how and procedures accumulated over an organisation's lifetime and external awareness from multiple sources, intensified by the exponential growth of the internet.

Several authors have analysed how internal competition – cooperative competition – facilitates the development of new products or innovations in firms (Strese, Meuer, Flatten, & Brettel, 2016). Their findings support the idea that cooperation among company functions, such as R&D, marketing or production, helps to provide solutions that improve a company's products. This type of collaboration is especially important in eco-innovation (Carrillo-Hermosilla, del Río, & Könnölä, 2010).

The literature refers to the positive contribution of both internal and external knowledge to foster eco-innovation (Vega-Jurado, Gutiérrez-Gracia, & Fernández-de-Lucio, 2008; Shearmur & Doloreux, 2013). Likewise, learning and knowledge management are necessary to make enterprises more agile (Sherehiy, Karwowski, & Layer, 2007; Bahrami, Kiani, Montazeralfaraj, Zadeh, & Zadeh, 2016). Some authors suggest that balanced exploitation and exploration in innovation strategies permit companies to incorporate new knowledge through new products when efficiency criteria that consider the awareness available inside a company are implemented (Jimenéz-Jimenéz, Martínez-Costa, & Ahmed-Dine Rabeh, 2018).

As previously mentioned, agility implies responding quickly and effectively to changes in the environment, managing internal and external knowledge and resources (J.-G. Cegarra-Navarro, Soto-Acosta, & Wensley, 2016) through solid IT capability and a widely implemented IT system (Lu & Ramamurthy, 2011; Lee, Sambamurthy, Lim, & Wei, 2015; Ravichandran, 2018). Moreover, some studies show a strong, positive association between firms' IT capabilities and successful new product

development (Mauerhoefer, Strese, & Brettel, 2017). Thus, internal and external knowledge are necessary to build agile organisations (Tooranloo & Saghafi, 2019). Likewise, learning and knowledge management are crucial for enterprises to become more agile (Sherehiy et al., 2007; Bahrami et al., 2016).

Considering the relevance of the environmental demands that companies face and given the importance that knowledge has for organisations' ability to quickly react to market changes, it is logical to assume that organisational agility will help companies to increase their environmental knowledge base. Thus, we propose that:

*$H_1$.* *Greater organisational agility is associated with greater internal and external environmental knowledge*

### 2.2. Internal vs. external environmental knowledge and the success of green products

In a competitive environment, it is necessary to engage in new green product development projects that can be successful. A green product can be defined as one whose design, attributes, production or strategy uses recycled resources (renewable/toxic-free/biodegradable) and which improves environmental impact or reduces environmental damage throughout its life cycle (Durif, Boivin, & Julien, 2010; Sdrolia & Zarotiadis, 2018).

Typically, the success of a product has been measured against internal elements such as budget forecasts or company objectives, or against external elements such as similar competitive products. The success of new green products should be based on other aspects like compliance with environmental regulations, stakeholder requirements or market competitiveness (S. Wong & Tong, 2012). Therefore, companies need to look for efficient ways to develop new knowledge and apply it to the development of new green products.

As discussed above, both pre-existing organisational and external knowledge are needed to develop eco-innovations. Traditional literature has highlighted the importance of generating internal knowledge to develop any innovative project ((Linder & Sperber, 2019). In recent decades, the need for departments and functions of firms to cooperate in transferring and sharing knowledge useful for the development of new products has been highlighted (Brettel, Heinemann, Engelen, & Neubauer, 2011; Strese et al., 2016). Better solutions are achieved with individual or cross-functional cooperation among different company functions such as R&D, marketing or production. Eco-innovations also involve this type of collaboration. Companies need to understand how to implement solutions that do not harm the environment and provide an effective response to the challenges of product design, user behaviour, the relationship between products and service, the configuration of the value network or the innovation development process (Carrillo-Hermosilla et al., 2010).

Nevertheless, many authors claim that access to environmental knowledge, new technologies and less polluting raw materials come mainly from social and professional networks, suppliers, partners, customers and patents (Enkel, Gassmann, & Chesbrough, 2009; Husain, Dayan, & Di Benedetto, 2016). They highlight the importance that an open innovation approach, particularly external collaboration, has on eco-innovation for the creation of highly innovative products (Horbach, 2008; Valentina De Marchi, 2012; Cuerva et al., 2014; del Río, Peñasco, & Romero-Jordán, 2015). Especially significant is the case of collaboration with customers, partners and suppliers (Brettel & Cleven, 2011). Moreover, collaboration with organisational and individual networks facilitates radical innovations (Bahemia & Squire, 2010; Hemphälä & Magnusson, 2012; Venturini, Verbano, & Bron, 2013), as the diversity of ideas from multiple sources can lead to more innovative products. These products are often the ones that bring greater success to companies. Collaborative technological networks with suppliers, clients and research organisations are vital to increasing green product

originality (Nieto & Santamaría, 2007). Thus, developing radical innovations tests the limits of internal knowledge, changing the focus to external knowledge with advanced and original green products. Moreover, cooperation with suppliers ensures input or components with green characteristics that may not be readily available on the market. (Seuring & Müller, 2008; Albino, Balice, & Dangelico, 2009). Collaboration with universities often helps companies to develop more complex forms of eco-innovation, be it product, process or organisational (Wagner, 2007; Triguero, Moreno-Mondéjar, & Davia, 2013; Ardito, Ferraris, Messeni Petruzzelli, Bresciani, & Del Giudice, 2019). Customer participation makes it possible to identify aspects related to the life cycle, environmental impact and recyclability of products that can be included in the development of eco-innovations (Handfield, Walton, Seegers, & Melnyk, 1997; Thun & Müller, 2010). Consequently, cooperation among different knowledge brokers and functional groups is necessary to gain access to more diverse information and reach agreements (Hernández-Mogollon, Cepeda-Carrión, Cegarra-Navarro, & Leal-Millán, 2010), ensuring greater chances of success in the eco-innovation process.

The literature considers that to eco-innovate, companies need greater access to externally generated knowledge (Cainelli et al., 2015). Environmental knowledge, new technologies and less polluting raw materials come mainly from social and professional networks, suppliers, partners, customers and patents (Enkel et al., 2009, Husain et al., 2016). However, technological trajectories can provide a pathway for company innovation. (Thrane, Blaabjerg, & Møller, 2010). The literature on technological trajectories and path dependence (Nelson & Winter, 1982) establishes that firms may be constrained by their technologies. Previous studies suggest that companies reduce opportunities for choice over time and eventually reach dead ends that prevent them from reacting to changing environmental conditions (Bohnsack, Kurtz, & Hanelt, 2021). Tensions arise about whether to use internal knowledge that may lead to less innovative solutions or acquire external knowledge that is more distant from the company but may be more effective, especially in the case of eco-innovation, which is strongly influenced by external factors.

Some authors conclude that more successful eco-innovations require more external knowledge to generate proposals that are distinct from those previously implemented by companies (Chatterji & Fabrizio, 2014; Forés & Camisón, 2016). Thus, we suggest:

*$H_2$. External environmental knowledge is more closely associated with the success of new green products than internal environmental knowledge.*

### 2.3. Internal knowledge as a mediator between external knowledge and the success of new green products

From a global point of view, we can consider an enterprise as a learning environment (Senge, 1990; Lahtinen, 2007) where different elements interact, different instruments are available and different sources of information converge. Multiple, simultaneous processes take place, the results of which involve, among other things, the generation of knowledge, the evolution of the organisational structure and the creation of new products or services in response to the demands of the market, customers or stakeholders. The generation of knowledge and innovation are closely linked to different types of knowledge, such as tacit/explicit or internal/external, the preponderance of one or the other and the learning modes of an organisation's members. Research has linked strong learning capabilities to successful innovation (Damanpour, 1991; Zhou, Hu, & Shi, 2015).

One of the theories that can explain how organisations learn is the cognitive psychological theory of meaningful learning, which forms a part of constructivist thinking. Initially articulated by Ausubel in the 1960s, it has subsequently been reformulated and applied by other authors (Novak, 2002; Pande & Bharathi, 2020). This theory has been used to explain learning not only in educational

environments but also in other areas of activity (Urquidi-Martin & Aznar, 2017). According to this theory, learning occurs when new knowledge is related to pre-existing concepts acquired through various sources, such as experience, study, etc. When different types of knowledge are related, a new connection is established; this is called meaningful learning. Moreover, it is permanent, long-term and based on experience and previous awareness.

The literature suggests that learning is conditioned by several endogenous and exogenous factors (Alegre & Chiva, 2008; Ferreras-Méndez, Newell, Fernández-Mesa, & Alegre, 2015). The ability to leverage internal competences and absorb valuable external knowledge (absorptive capacity) is the cornerstone of strategic approaches to learning and innovating in the organisational context (Cohen & Levinthal, 1990; Zahra & George, 2002). Absorptive capacity is key to learning and innovation management (Lane & Lubatkin, 1998). This capacity can determine the inflow, harnessing, influence and use of knowledge, which have an impact on the innovation process and business outcomes (Kostopoulos, Papalexandris, Papachroni, & Ioannou, 2011; Ferreras-Méndez et al., 2015). For this reason, absorptive capacity and R&D activities are key determinants of innovation, and firms should continuously stimulate and promote such activities and any associated capabilities (Miroshnychenko, Strobl, Matzler, & De Massis, 2020). Therefore, increased absorptive capacity in a company will help it gain and use knowledge to develop eco-innovations (Hashim et al., 2015; Aboelmaged & Hashem, 2019). The ability to add new knowledge to existing knowledge is conditioned by internal environmental awareness and the level of learning maturity a company has (Flor, Cooper, & Oltra, 2018). New combinations of knowledge that lead to new successful green products are linked to previous knowledge.

Thus, in integration and rebuilding processes, prior knowledge will condition a firm's ability to capture and use external knowledge to develop environmentally sustainable innovation. Thus:

*$H_3$.* *Internal environmental knowledge positively moderates the relationship between external environmental knowledge and the success of new green products.*

INSERT FIGURE 1

## 3. METHODOLOGY

### 3.1. Research sample

The study population is made up of industrial companies located in Spain with more than 100 employees and at least five years of activity included in the SABI database (Bureau van Dijk). SABI represents the most complete database of financial analysis of Spanish and Portuguese companies with a twenty-five-year history of annual accounts. The choice of this type of population was made to guarantee a broad enough group to generalise the conclusions obtained. The database showed a total of 2,318 Spanish companies with these characteristics.

The information was collected using an online survey located on the university's corporate website and based on a pre-tested, structured questionnaire. The information was gathered by an external marketing research company. This company has been working with our university research team for several years, so we are confident of its methods in carrying out the surveying process. After familiarisation with the questionnaire and a series of pre-tests (analysis of the questions, identification of errors or understanding of content) with trusted companies, the information was collected. To do this, companies were sent a letter to present the project (where extensive information about it and its connection to the research team were explained) and were provided with access to the website. Companies that did not respond in the first instance were sent a reminder, inviting them again to

participate in the survey. Similarly, errors detected in the contact addresses of some enterprises were corrected. The option of conducting the survey by telephone was also given, with the information being collected directly by the marketing research company. Contact with the companies on the list was random. If a company could not be contacted or the interviewee refused to participate in the study, the next company was phoned.

The study was directed to the head of innovation or, alternatively, the person who managed organisational knowledge in the company. The average respondent is male (87%), with an average length of time in the job of 9 years and with 16 years' average experience in the company. The collection process lasted three months, and information from 184 companies was collected. A power analysis with G*Power was run with a power of 0.8 and an alpha of 0.05 and given a medium effect size this sample surpasses the minimum requirement of sample size (Faul, Erdfelder, Buchner, & Lang, 2009). Except in three cases, the companies deal in international import and/or export and, on average, the sample is made up of companies with more than 39 years of seniority. The average share capital is €17,886,943.69, operating income €310,839,969.30 and results €18,433,258.18. The average economic profitability is 8.36%, the financial return 21.19% and the size of the company is more than 520 employees.

### 3.2. Measurement and scales

The measurement of the constructs used in our study was carried out with 7-point Likert scales. Specifically, Mode A composites have been used to operationalise these measures.

*Organisational agility* is understood as the capacity to detect changes in the market and make decisions. Using Liu, Chan, Yang, and Niu (2018) study, we calculate it as a second-order construct from three first-order constructs that comprise the measures of operational agility (4 items), partnering agility (6 items) and customer agility (5 items). These constructs have been measured reflectively.

*Environmental knowledge* refers to the knowledge created from internal sources (training, internal R&D, collaboration among departments, etc.) or external sources (customers, suppliers, competitors, consultants, etc.) that provide new solutions to environmental problems, less polluting products or green programmes. From the studies by Pedersen, Soo, and Devinney Timothy (2011) and Martínez-Martínez, Cegarra-Navarro, and García-Pérez (2015), two reflective scales of 5 items each have been proposed to measure internal and external environmental knowledge.

We also measure *green product success* as an indicator of the performance of eco-innovation. Using S. K. S. Wong (2012) study, we include five measures related to compliance with green directives, stakeholder requirements, revenue, profitability and success.

Finally, we have included four control variables with one indicator per variable to explain the three endogenous variables of the model. The variables used were: *Antiquity* of the company, based on the number of years since its creation; *Size,* measured by the number of employees; *Activity,* with a variable that includes industrial sub-sectors; and the existence of an *environmental management system* in the company.

### 3.3. Statistical analysis

The partial least squares (PLS) path model was used to test the model. This is a variance-based structural equation modelling (SEM) methodology that allows different latent (unobserved) variables derived from the hypotheses to be measured (Cepeda-Carrion, Cegarra-Navarro, & Cillo, 2019). These variables are measured using several indicators collected in the sample (Cepeda-Carrión, Henseler, Ringle, & Roldán, 2016). According to Rigdon (2016), PLS-SEM is adequate when the data are not necessarily normal, when making an exploratory study of relationships not been strongly consolidated in the literature and when reflective variables are used to measure concepts they can explain and that can be explained by other variables. Moreover, PLS can be used in a confirmatory way (Henseler, 2018).

SmartPLS 3.3.3. software (Ringle, Wende, & Becker, 2015) was used to assess the measurement model and to estimate the structural model.

## 4. RESULTS

The application of the PLS-SEM methodology generally involves a global analysis of the model. It checks the reliability and validity of the measurements and analyses the relationships established in the structural model (Jörg, Geoffrey, & Ash, 2016). We will now analyse the measurement and structural models.

### 4.1. Measurement model

First, to confirm the measurement model, several tests have been developed (Henseler, Hubona, & Ray, 2016). Specifically, these analyses (saturated model) provided standardized root mean squared residual (SRMR =0.065), unweighted minimum squares discrepancy (dULS =0.726) and geodetic discrepancy (dG =0.544) values within acceptable limits (values less than the percentile levels based on 95% bootstrapping). This implies that the model has an acceptable adjustment in PLS-SEM (G. Albort-Morant et al., 2018).

Various tests have been applied to check the reliability and validity of the reflective composite scales (Mode A). In the first place, the individual reliability of the indicators (Table I) that adopt values higher than 0.7 (Chin, 1998) has been verified. Cronbach's alpha (α) and the composite reliability index (CR) have been used to verify the reliability of internal consistency, observing that their values are higher than 0.7 (Bagozzi & Yi, 1998). The average extracted variance index (AVE), with values greater than 0.5 (Bagozzi & Yi, 1998), shows the existence of convergent validity (Fornell & Larcker, 1981).

INSERT TABLE I

The discriminant validity has been verified with two tests. The first one is the more traditional test of the mean extracted variance and the correlations of the latent variables (Fornell & Larcker, 1981). Table II shows that the square root of each AVE value is higher than the correlations of the variables. Table II also shows the results of the second test, where the values of the heterotrait-monotrait ratio (HTMT) are lower than 0.85 (Henseler, Ringle, & Sarstedt, 2015). Both results confirm the discriminant validity.

INSERT TABLE II

We also analyse the possibility of Common Method Biases (CMV) (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003; Chin, Thatcher, Wright, & Steel, 2013). 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, Saraf, Hu, & Xue, 2007). The results suggest that CMV is not a serious issue in the study (Chang, van Witteloostuijn, & Eden, 2010).

Finally, we have checked for the existence of the endogeneity problem following the recommendations by Hult et al. (2018). The results of the Gaussian copula analysis do not show significant indications of this problem. In any case, we have used four control variables to mitigate the existence of omitted variables as the main source of endogeneity (Hult et al., 2018).

### 4.2. Structural model

The results of this study have been obtained with the SmartPLS 3.3.3 software package. Figure 2 shows the structural model derived from the PLS-SEM analysis. The significance of the parameters

that analyse the relationship between each construct has been obtained with bootstrapping using 5,000 resamples for one tail of the t-student. Figure 2 demonstrates how most of the paths are significant, and the $R^2$ of each construct is explained. Organisational agility was modelled as a second order factor that is significantly reflected in three first-order constructs. Furthermore, the moderating effect (external * internal environmental knowledge) was calculated using this software with the two-stage calculation method and as the standardised product of the terms.

INSERT FIGURE 2

The first hypothesis ($H_1$) indicated a positive relationship between organisational agility and environmental knowledge. The results show that the path coefficients of the relationship between agility and external ($\beta = 0.561$, $p<0.001$) and internal ($\beta = 0.514$, $p<0.001$) environmental knowledge are positive and significant, which supports our first hypothesis. This means that a company's awareness of external changes together with its ability to make internal adjustments to respond to them are very useful ways to create knowledge on environmental matters. In other words, the generation of this knowledge depends largely on regulations, social demands and technological advances. Therefore, those companies that detect these changes and respond to them will be more agile in acquiring new specific knowledge directly from external sources, or they will be able to create that knowledge internally from changes in the environment.

INSERT TABLE III

In the second hypothesis ($H_2$), it was proposed that given the external nature of environmental knowledge, external environmental knowledge would have a greater effect on the success of new products than internal environmental knowledge. The results support these arguments by identifying a significant relationship only between external knowledge and the success of green products ($\beta=0.568$, $p<0.001$). The absence of a significant association with internal knowledge can be explained by the fact that this type of knowledge often leads to less innovative products. New ideas are necessary to launch products not previously produced. Furthermore, we have verified the mediating importance of this type of environmental knowledge in the relationship between organisational agility and the success of green products. Table III shows there is an indirect effect only for external knowledge ($\beta=0.319$, $p<0.001$), which indicates that this type of knowledge could play a mediating role in this relationship.

However, this does not mean that internal knowledge is unimportant since, as proposed in the third hypothesis ($H_3$), internal knowledge can help to make better use of external knowledge in innovation processes. The results show that internal knowledge positively moderates the relationship between external knowledge and the success of green products ($\beta=0.093$, $p<0.05$). This also suggests that internally developed knowledge helps companies take advantage of external knowledge. New external knowledge, even if it has great value, will not be properly exploited if there is no previous experience and basic knowledge to recognize and apply what has been acquired externally.

Finally, we have identified some relevant information from the introduction of the four control variables. Although there seems to be no significant influence between the age or industrial activity of the firm on internal or external environmental knowledge or on the success of green products, our results do show that the existence of an environmental management system facilitates the capture and creation of external environmental knowledge ($\beta=0.178$, $p<0.01$). This result supports the need to implement such management systems in companies to promote eco-innovations. A relationship between size and green product success has also been identified ($\beta=0.076$, $p<0.05$). This could indicate that larger firms have greater resources to acquire external knowledge and develop the internal innovation activities necessary for green product success.

## 5. DISCUSSION

This study focusses on understanding how agile organisations can create conditions that enhance eco-innovation processes. Drawing on the Dynamic Capabilities Theory (D. Teece & Pisano, 1994), it explores how organisational agility becomes a dynamic element in environmental knowledge creation processes to develop new green products. Indeed, many of the findings derive from the ability of firms to understand external changes and react to them quickly by creating new green products.

The results from a sample of Spanish industrial companies seem to support our assumptions in a context where various internal and external sources compete for scarce resources. As in the field of organisational ambidexterity, the combination of external and internal knowledge is not always feasible, and tensions arise from the use of both types of knowledge sources. First, we have found that organisational agility has an effect on creating new internal environmental knowledge. A company's ability to identify changes, trends or opportunities will lead to the incorporation of new external knowledge (Ben Arfi et al., 2018). Determinants of eco-innovation and aspects such as new materials, technological improvements, legal changes or external collaboration networks with different agents allow new sources of environmental knowledge to be identified. This knowledge can be useful in eco-innovation processes (Păcesilă & Ciocoiu, 2017; Pacheco et al., 2018). Most of this developed knowledge must be incorporated into the company. However, this is only possible if a company is agile enough to detect it, introduce it and use it. Moreover, organisational agility encourages the creation of knowledge that must be developed internally. In companies with R&D departments accustomed to internally developing their knowledge, rapidly detecting changes in the market can guide these learning processes and help to develop knowledge oriented towards these environmental trends. For this reason, organisational agility is a powerful tool in the processes of creating new environmental knowledge.

Second, it has become clear that external knowledge is more relevant to the successful development of green products. Reliance on this type of knowledge is appropriate because green products must incorporate knowledge about regulations, trends and technological developments to be successful. Organisational path dependency resulting from a focus on internal knowledge can reduce the possibilities of creating novel eco-innovations that are tailored to external requirements. This result is in line with those obtained in other studies, which emphasise the predominant importance of external sources of knowledge for eco-innovative enterprises (Valentina De Marchi, 2012; V. de Marchi & Grandinetti, 2013; Chatterji & Fabrizio, 2014; Forés & Camisón, 2016). Therefore, organisational agility indirectly contributes to success since it allows companies to identify this new knowledge and apply it in the development of successful eco-innovations.

However, our results also highlight the importance of developed internal knowledge. This type of prior knowledge makes it easier for companies to understand and apply external knowledge. With prior knowledge, companies can produce new products more efficiently than if they start from scratch. Our study shows that internal knowledge positively moderates the effect of external knowledge on the success of new products. This suggests that an internal orientation towards producing innovative products might not be efficient compared to an open innovation perspective, but companies with high internal knowledge development will better apply new external knowledge. These results are consistent with other studies that show R&D activity and internal knowledge to be more important for the development of eco-innovations than for non-ecological innovations (Horbach, 2008; Pihlajamaa, Kaipia, Säilä, & Tanskanen, 2017; Aboelmaged & Hashem, 2019).

Interesting ideas for academics and practices emerge from this research. First, this research contributes to the line that highlights the advantages of organisational agility. In this case, our study provides evidence in the area of environmental knowledge, which is a fundamental element in the development of organisational agility. This dynamic capacity therefore becomes strategic for the

development of internal and external environmental knowledge. Second, this study helps to understand the tensions between internal and external knowledge. The literature has attempted to clarify the advantages of both types of knowledge for the development of innovations (Menon & Pfeffer, 2003; Monteiro, Mol, & Birkinshaw, 2011). In our study, we focus on the special case of the knowledge necessary to develop eco-innovations that, due to its characteristics, has a greater external orientation. Although internal knowledge could lead to path dependency (D. J. Teece et al., 1997) or organisational resistance to environmental changes (Leonard-Barton, 1992) and limit the creation of new products, this internal knowledge facilitates the applicability of external knowledge. We contribute to the literature by pointing out the different roles that both types of knowledge play. The tensions between the use of internal and external knowledge are evident since, although the latter is more effective for the development of green products, the former acts as a catalyst for external knowledge.

Second, companies with more dynamic capabilities will have an easier time fostering the organisational agility needed to deal with environments of great uncertainty and change (D. Teece et al., 2016). Agility and knowledge acquisition have a cost. For this reason, managers must prepare their firms to sense, search, seize, shift and shape (Baškarada & Koronios, 2018), choosing the most suitable strategy to make their organisations agile. Likewise, the conclusions are evident for those innovative companies involved in projects that are sensitive to the environment. They need to promote open innovation orientations to acquire environmental knowledge from external sources (Lopes, Scavarda, Hofmeister, Thomé, & Vaccaro, 2017). This means that they must be agile and dynamic organisations. They must be aware of the environment and establish collaborative relationships with external agents to quickly introduce this new knowledge, apply it to the development processes of new products and not rely exclusively on internally generated knowledge.

This study is not without limitations. First, a cross-sectional sample is used, which makes it impossible to indicate causality in the relationships studied. Additional research with longitudinal studies would resolve this issue. The sample used in our study is drawn from the Spanish industrial sector. It would be interesting to replicate the survey in other sectors and countries to check whether the results obtained could be extrapolated. It is also important to consider that only one key informant has been used, although this person was well-informed about the issues relevant to the research. The study would be stronger if the information had been obtained from various company sources, and data from other objective sources to measure the relevant constructs had been incorporated. Also, additional variables in the questionnaire could strengthen common method variance analyses with a latent marker variable approach (Chin et al., 2013). Moreover, the effects on some variables are difficult to assess in the short term, especially in the success of new green products. Finally, the methodology used shows only the linear effects between the variables studied.

An interesting future line would be to continue delving deeper into the tensions that occur between internal and external environmental knowledge. The incorporation of curvilinear effects and the decision about what type and amount of knowledge to promote when faced with limited resources could help to clarify how environmental knowledge contributes to the success of eco-innovations. In this case, further progress could be made on the possible synergistic effects of using both types of knowledge sources beyond the direct and moderating effects described in this study.

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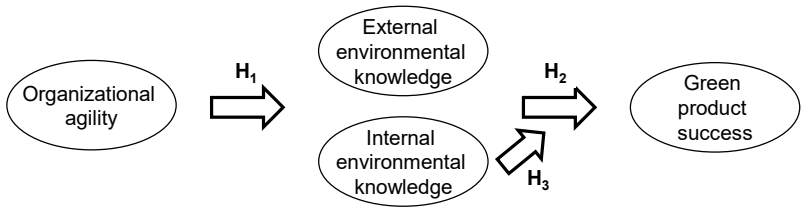
**Figure 1** Model and hypothesis

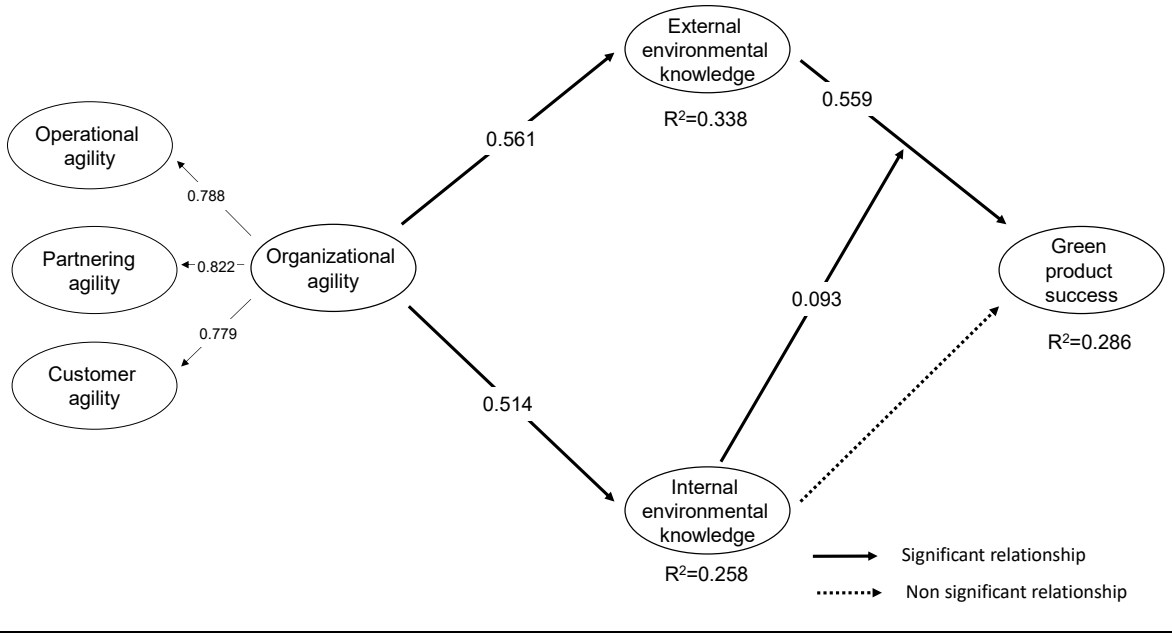



*$H_1$ Greater organisational agility is associated with greater internal and external environmental knowledge*

*$H_2$ External environmental knowledge is more closely associated with the success of new green products than internal environmental knowledge*

*$H_3$ Internal environmental knowledge positively moderates the relationship between external environmental knowledge and the success of new green products*

**Figure 2** Empirical model results



| **Table I** | Reliability and validity | | | | |
|---|---|---|---|---|---|
| ***Construct*** | ***Items*** | ***Coef.*** | ***Std*** | ***t-st*** | ***Reliability & validity*** |
| **Operational agility** | We are able to quickly respond to changes in our customers' products or service needs. | 0.829 | 0.037 | 22.611 | α: 0.964<br>CR: 0.907<br>AVE: 0.710 |
| | We fulfill demands that require a rapid response and include special requests of our customers whenever such demands arise; our customers are confident in our ability. | 0.793 | 0.039 | 20.357 | |
| | We can quickly scale our production/service levels up or down to support fluctuations in market demand. | 0.855 | 0.028 | 30.400 | |
| | When a disruption occurs in our production or service, we can quickly make necessary alternative arrangements and internal adjustments. | 0.890 | 0.021 | 42.760 | |
| **Partnering agility** | Employees learn more soft skills that are required to manage customer encounters. | 0.735 | 0.039 | 18.924 | α: 0.886<br>CR: 0.914<br>AVE: 0.640 |
| | We are able to quickly implement new governance structures. | 0.847 | 0.027 | 31.665 | |
| | We can combine, recombine, and create new business processes with little notice. | 0.874 | 0.020 | 44.488 | |
| | Through online, rapid, and up-to-date communications among partners, we are able to reduce information discrepancies. | 0.702 | 0.050 | 13.973 | |
| | It allows us to innovate our service offerings technologically. | 0.770 | 0.058 | 13.343 | |
| | It brings us about new ways of managing organizational structures and partnerships. | 0.857 | 0.023 | 37.815 | |
| **Customer agility** | We can quickly make and implement appropriate decisions in the face of market/ customer changes. | 0.776 | 0.044 | 17.652 | α: 0.888<br>CR: 0.923<br>AVE: 0.751 |
| | We can quickly respond to changes in our customers' products or service needs. | 0.913 | 0.019 | 47.181 | |
| | Co-opting with customer gives us greater contextual ability to explore opportunities and options. | 0.871 | 0.033 | 26.139 | |
| | Partnering with customer makes the customer service experience more memorable. | 0.901 | 0.020 | 44.708 | |
| **External environmental knowledge** | New solutions to environmental problems. | 0.880 | 0.025 | 35.363 | α: 0.939<br>CR: 0.953<br>AVE: 0.803 |
| | New less polluting product/service. | 0.916 | 0.021 | 42.845 | |
| | New less polluting processes. | 0.899 | 0.018 | 50.630 | |
| | A green program (waste management, control of effluents, inventory of pollution sources). | 0.892 | 0.020 | 44.696 | |
| | A drafting of environmental emergency plans and measures | 0.893 | 0.018 | 50.090 | |
| **Internal environmental knowledge** | New solutions to environmental problems. | 0.872 | 0.033 | 26.354 | α: 0.933<br>CR: 0.949<br>AVE: 0.789 |
| | New less polluting product/service. | 0.888 | 0.029 | 31.052 | |
| | New less polluting processes. | 0.905 | 0.016 | 56.955 | |
| | A green program (waste management, control of effluents, inventory of pollution sources). | 0.884 | 0.022 | 40.736 | |
| | A drafting of environmental emergency plans and measures | 0.892 | 0.022 | 41.139 | |
| **Green product success** | They are in compliance with green directives. | 0.846 | 0.028 | 29.698 | α: 0.900<br>CR: 0.926<br>AVE: 0.713 |
| | They meet the green requirements set by stakeholders. | 0.869 | 0.032 | 27.263 | |
| | They bring in more revenue than competing products. | 0.867 | 0.030 | 29.275 | |
| | They are more profitable than the competing products. | 0.818 | 0.043 | 19.201 | |
| | They are successful. | 0.822 | 0.036 | 22.769 | |
| **Notes:** Bootstrapping with 5000 resamples; Coef= Path coefficient; Std= Standard deviation; t-st =Student's t value; α= Cronbach alpha; CR= composite reliability; AVE= average variance extracted | | | | | |

| Table II | Correlations and discriminant validity | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| *1 Operational Agility* | **0.843** | 0.561 | 0.558 | 0.440 | 0.407 | 0.249 |
| *2 Partnering Agility* | 0.492 | **0.800** | 0.577 | 0.561 | 0.518 | 0.366 |
| *3 Customer Agility* | 0.492 | 0.508 | **0.867** | 0.481 | 0.417 | 0.386 |
| *4 External Environmental Knowledge* | 0.398 | 0.516 | 0.440 | **0.896** | 0.736 | 0.568 |
| *5 Internal Environmental Knowledge* | 0.367 | 0.477 | 0.380 | 0.689 | **0.888** | 0.406 |
| *6 Green Product Success* | 0.225 | 0.333 | 0.350 | 0.531 | 0.380 | **0.845** |

**Notes:** Diagonal elements (bold figures) are the square root of the variance shared between the constructs and their measures. Below diagonal elements are the correlations between constructs. Above diagonal elements are the Heterotrait-Monotrait Ratio (HTMT) values.

| **Table III** | Structural model results | | | | |
|---|---|---|---|---|---|
| | **Coef** | **Std** | **t-st** | **LL** | **UL** |
| **Direct effects** | | | | | |
| *Organizational Agility → External Environmental Knowledge* | 0.561*** | 0.059 | 9.542 | 0.462 | 0.655 |
| *Organizational Agility → Internal Environmental Knowledge* | 0.514*** | 0.056 | 9.149 | 0.422 | 0.607 |
| *External Environmental Knowledge → Green Product Success* | 0.568*** | 0.091 | 6.211 | 0.419 | 0.718 |
| *Internal Environmental Knowledge → Green Product Success* | 0.022 | 0.099 | 0.226 | -0.131 | 0.192 |
| *EEK * IEK → Green Product Success* | 0.093* | 0.048 | 1.962 | 0.015 | 0.172 |
| **Indirect effects** | | | | | |
| *Organizational agility → External Environmental Knowledge → Green Product Success* | 0.319*** | 0.062 | 5.151 | 0.222 | 0.425 |
| *Organizational agility → Internal Environmental Knowledge → Green Product Success* | 0.011 | 0.052 | 0.221 | -0.067 | 0.103 |
| **Significant control variable effects** | | | | | |
| *Envir. management system → External Environmental Knowledge* | 0.178** | 0.058 | 3.051 | 0.087 | 0.280 |
| *Size → Green Product Success* | 0.076* | 0.037 | 2.052 | 0.026 | 0.147 |

**Notes:** Coef= Path coefficient; Std= Standard deviation; t-st =Student's t value; *p<0.05; **p<0.01; ***p<0.001; t(0.05;4999)=1.6451; t(0.01;4999)=2.327; t(0.001;4999)=3.091; LL=Lower 95% percentile confidence interval; UL= Upper 95% percentile confidence interval; EEK * IEK= interaction effect of External and Internal Environmental Knowledge