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Eco-innovation Types Adoption in Mexican Small and Medium Firms

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Abstract

The debate on eco-innovation is a relatively recent and emerging topic in the literature, and although it is gaining interest among cientific, academic, and enterprise community, and the analysis and discussion in the context of small and medium-sized enterprises is in an embryonic stage, especially in emerging economy countries, such as Mexico. In this sense, the objective of this research is to analyze the most important eco-innovation types that affect eco-innovation adoption in manufacturing SMEs. The results obtained follow that product eco-innovation, process eco-innovation and management eco-innovation are good eco-innovation types adoption of small and medium-sized companies in the automotive industry.

Keywords: eco-innovation, product eco-innovation, process eco-innovation, management eco-innovation, small firms

1. Introduction

Sustainable development and innovation are two themes that are constantly found in the agendas of society in general, in the scientific and academic environment and in business organizations (del Río et al., 2016; Levidow et al., 2016). However, the analysis and discussion of the environmental aspects began practically in the ECO-92 Conference of Rio de Janeiro, in which a series of commitments were established by the attending countries (Pacheco et al., 2017). In addition, the discussion of innovation has focused basically on economic aspects such as competitiveness, demand, and investment (Pacheco et al., 2017), but environment issue has incorporated the processes of technological innovation in its discussion (Triguero et al., 2013; Cueva et al., 2014; Simboli et al., 2014; Constantini et al., 2015; Przychodzen, 2015; Levidow et al., 2016). Also, there are published in innovation literature various studies of processes and technological innovation, as well as environmental sustainability, but there are relatively few studies that relate sustainability and innovation, and the actions that have been carried out to integrate these two concepts (Pacheco et al., 2018; Almeida & Wasim, 2023).

Likewise, the integration of sustainability and innovation is a single topic that is relatively new in the literature, particularly in small and medium-sized enterprises (SMEs) (Pacheco et al., 2018; Almeida & Wasim, 2023). del Río et al. (2016) identified several studies focused on the analysis of various topics of eco-innovation in SMEs in the Journal of Cleaner Production (e.g., Cai & Zhou, 2014; Klewitz & Hansen, 2014; Cueva et al., 2014), as well as in another journals (e.g., Hottenrott & Lopes-Bento, 2014; McGuirk et al., 2015; Lee et al., 2015), but there are few studies that have focused on specific types of eco-innovation in manufacturing SMEs (Almeida & Wasim, 2023). Thus, the topics that have generally been analyzed and discussed in the context of eco-innovation in SMEs are, for example, eco-innovation in services (Aykol & Leonidou, 2014), impact of the financial crisis (Lee et al., 2015), government funding to improve regional innovation (Doh & Kim, 2014), effects of improvement policies (del Río et al., 2010; Hottenrott & Lopes-Bento, 2014), capacity for innovation (Boly et al., 2014) and, recently, on eco-innovaation types (Almeida & Wasim, 2023).

Additionally, most of eco-innovation studies have oriented in developed countries (e.g., Díaz-García et al., 2015), and studies in emerging economies are relatively scarce (Pacheco et al., 2017). Therefore, literature suggest that this is an important gap that has to be discussed in studies future (e.g., Triguero et al., 2013; Cai & Zhou, 2014;

Díaz-García et al., 2015), particularly, because there are few studies that have integrated eco-innovation types in SMEs (Klewitz & Hansen, 2014; Sabadie, 2014; Borghesi et al., 2015). Also, eco-innovation types are relatively recent topic in literature, for which it is possible to conclude that given the immaturity of the discussion of this important topic, particularly in SMEs (Klewitz & Hansen, 2014; Rashid et al., 2015; del Río et al., 2016), and even more immature is the discussion of eco-innovation types in emerging economies, as is the case of Mexico. For this reason, Díaz-García et al. (2015) suggested that future research in emerging economies is necessary, while Kemp and Oltra (2011) recommended that eco-innovation studies have to be carried out by native researchers from these countries, because they have a greater level of knowledge of eco-innovation types.

In this sense, the objective of this research is the analysis and discussion of the most important eco-innovation types that affect eco-innovation adoption in manufacturing SMEs, for which an empirical study was carried out in manufacturing SMEs in Mexican automotive industry, using a sample of 400 manufacturing SMEs. The analysis of the information obtained was carried out by using the statistical technique of structural equation models with the support of the EQS software (Bentler, 2005; Brown, 2006; Byrne, 2006). Furthermore, it is important to point out that SMEs are interesting, on one hand, because they represent 99.8% of the total existing firms in Mexico and employ the majority of workers in Mexico (INEGI, 2023) and, on other hand, because the relevance that SMEs have in the economy and society of Mexico since they contribute a little more than 50% of the Gross Domestic Product (INEGI, 2023). Additionally, manufacturing SMEs in the automotive industry are also interesting because it is commonly the industry most incompatible with sustainability (Scur et al., 2019), and because it is traditionally the industry that generates highest level of environmental pollution (Farkavcova et al., 2018).

In this context and given that eco-innovation activities in manufacturing SMEs is a global phenomenon, and that previous studies suggest the development of research aimed at analising and discussing the importance of different eco-innovation types in SMEs (Kesidou & Demirel, 2012; Cai & Zhou, 2014; Díaz-García et al., 2015), particularly in emerging economies (Kemp & Oltra, 2011; Horbach, 2014; Díaz-García et al., 2015), as in the case of Mexico, this study provides an initial overview, generalize significant inferences, and guide further and more detailed research. Thus, this paper contributes to the literature of eco-innovation with the generation of new knowledge, and developing an understanding of the contribution of eco-innovation types in manufacturing SMEs, particularly because previous studies developed by Marin-Vinuesa et al. (2020), and Maletic et al. (2021) lack a contextual focus on manufacturing SMEs. Additionally, we also contribute to the study of Thomas et al. (2021), and Hang et al. (2022), which despite focusing exclusively on SMEs.

2. Literature Review

Scientific and academic community has classified eco-innovation into several typologies (Almeida & Wasim, 2023), among which the one carried out by Rennings et al. (2006) stands out, who established that eco-innovation can be classified into two types: technical eco-innovations and organizational eco-innovations. Technical eco-innovations are those that establish the proposal of new products or processes that help SMEs to reduce negative impacts on the environment, while organizational eco-innovations are those that establish the redesign of organizational processes and structures that reduce the negative impact on the environment (Almeida & Wasim, 2023). Another of the most recognized classifications in the literature is the one carried out by Kemp and Pearson (2007), who included two new components in technical eco-innovations: technologies for the control and solution of environmental pollution problems and technologies for green innovation systems.

Additionally, Cheng et al. (2014) identified other types of classification of eco-innovation in the literature, such as one conducted by Kemp and Arundel (1998), who considered that eco-innovation can be classified as technical, organizational, and marketing types; or the classification proposed by Horbach (2008), and Triguero et al. (2013), who considered that eco-innovation can be classified as product eco-innovation (eco-products), processes eco-innovation (eco-processes), and management eco-innovation (eco-management). Cheng et al. (2014) classified eco-innovation into three essential types: products eco-innovation, processes eco-innovation, and management eco-innovation. Also, del Río et al. (2016) establishes that the analysis and discussion of eco-innovation in SMEs of different types (eco-innovation in products, processes and management), in future studies should be considered. For the purposes of this empirical study, we will focus on the analysis and discussion of these three eco-innovation types.

2.1 Products Eco-innovaion

Product eco-innovation refers practically to new products development or significant improvement of existing products in companies, which generally have better components and materials (Pujari, 2006), and are the result of eco-technological advances that significantly increase the life cycle of eco-products (Carrillo-Hermosilla et al., 2010). In addition, the environmental impact of eco-products is more in use than in their production process,

such is the case of CO_2 emissions made by cars or the disposal of car batteries. Therefore, the analysis of the life cycle of the eco-products (production, use, and disposal), generates positive environmental impacts (Christensen, 2011), such as the generation of energy through the wind, the reduction of the consumption of the electrical energy, and low environmental pollution impacts from eco-products (Aloise & Macke, 2017).

In this sense, the environmental impact of eco-products is closely related to life cycle indicators of eco-products, and it is possible to categorize them in the stages of extraction of raw materials, production of materials, production of products, use of the products, and the final stage of the life cycle of the products and their collection (Arena et al., 2013). Klewitz and Hansen (2014) concluded that before adopting practices of product eco-innovation in companies, particularly in SMEs, in the first instance a thorough evaluation would have to be carried out of the life cycle of existing products, even when the life cycle of the products of the organizations is standardized through ISO 14040 and 14044, which generally quantify the environmental impacts generated by the products in each of the stages of its life cycle (Jacquemin et al., 2012; Poudelet et al., 2012). Thus, considering the information previously presented, it is possible to establish the following research hypothesis.

H1: Products eco-innovation is a good type of eco-innovation adoption in SMEs

2.2 Processes Eco-innovation

Process eco-innovation refers essentially to the introduction of new elements in production systems for the development of eco-products, the modification of processes and the operation of production systems, which have as their main objective the reduction of the costs per unit of production, the production of products or the significant improvement of the existing products in the SMEs, in such a way that they generate a lower environmental impact (Negny et al., 2012). Also, according to Rennings (2000), eco-innovations are specifically oriented to significantly improve existing processes in production, or in the generation of new production processes that not only generate less environmental impact, but also develop new one's eco-products that have a positive impact on the environment and, above all, that generate a higher level of efficiency of eco-processes (eco-efficiency) (Carrillo-Hermosilla et al., 2010).

In this sense, Triguero et al. (2013) found too close a relationship between process eco-innovation and the use of clean technologies in the production processes of eco-products, since process eco-innovation is commonly characterized by the incorporation of components and controls that drastically reduce the negative impacts they generate on the environment, without the need for firms to replace all the processes that generally generate serious problems for the environment (Carrillo-Hermosilla et al., 2010). Thus, the adoption of eco-innovation practices will require responsible processes with the environment (eco-processes), in such a way that they support companies in the production of eco-innovation products (Triguero et al., 2013), or to significantly improve existing products in the organization, with the possibility of affecting as little as possible the supply chain of eco-products (Klewitz & Hansen, 2014). Therefore, considering the previously presented information, it is possible to propose the following hypothesis of investigation.

H2: Process eco-innovation is a good type of eco-innovation adoption in SMEs

2.3 Management Eco-innovation

Management eco-innovation is generally related to the significant improvement of the management processes of companies, including SMEs, through the development of eco-friendly practices and methods that facilitate a significant increase in business performance, changes in the supports, the administrative reduction and storage costs, as well as an improvement in the environmental impact (Cruz et al., 2006). In addition, it is clear that this type of practices will not directly reduce the negative impacts on the environment, but allow simplification and efficiency, both in the implementation of eco-processes and in the production of eco-products (Murphy & Gouldson, 2000). Also, the implementation of environmental programs such as personnel training, product development, the introduction of new techniques, the generation of environmental groups (Kemp & Arundel, 1998), as well as changes in administrative routines, procedures, devices and systems to produce eco-innovations, are part of the various actions generated by eco-innovation management (Cruz et al., 2006).

In this sense, management eco-innovation generally includes the development of new management methods, which are essentially focused on the significant reduction of negative impacts on the environment, as well as on improving working conditions and welfare of all personnel of the organization (Triguero et al., 2013; Klewitz & Hansen, 2014; Roscoe et al., 2016). Likewise, different initiatives generated by companies, including SMEs, may be the result of management eco-innovation (Vieira de Souza et al., 2018), being, for example, one of the most common training of employees in the sustainable and environmental development (Triguero et al., 2013), or the creation of programs of preference of purchases of raw materials and services to local suppliers, in such a

way that it allows organizations to significantly reduce the emission of pollutants related to transport and logistics of materials and raw materials (Klewitz & Hansen, 2014). Thus, considering the information previously presented, it is possible to propose the following research hypothesis.

H3: Management eco-innovation is a good type of eco-innovation adoption in SMEs

3. Methodology

To answer the three hypotheses, an empirical study was conducted in SMEs of the automotive industry of Mexico, analyzed in particular if product co-innovation, process eco-innovation and management eco-innovation are good types of eco-innovation adoption in SMEs. In the first phase of the study, qualitative research was applied through the application of in-depth interviews with 3 academics from innovation area and 5 entrepreneurs from the automotive industry and auto parts. The results obtained from this qualitative research allowed the design of an information collection instrument, which was reviewed by 4 expert researchers in eco-innovation area and 10 entrepreneurs from the automotive and autoparts industry, making minor writing adjustments, appearance and spelling. Pilot studies are essential to ensure validity when questionnaires are self-administered or contain self-developed scales (Bryman, 2016; Hair et al., 2016).

The process that was followed in this study to obtain the frame of reference consisted essentially of obtaining the business directory as up-to-date as possible of the companies that make up the automotive industry in Mexico, for which the Association's support was requested by the Asociación Mexicana de la Industria Automotriz [Mexican Association of the Automotive Industry] (AMIA), obtaining a business directory composed of 909 companies producing cars and auto parts, as of November 30, 2018. It should also be noted that the companies associated with the AMIA belong to various organizations and local, regional and national business chambers, so the empirical study did not focus on a particular business group or association.

In addition, the information collection instrument was designed exclusively to collect information relevant to the activities of products eco-innovation, processes eco-innovation, and management eco-innovation, applying to a sample of 400 SMEs selected through a simple random sampling, with a maximum error of ±4% and a level of reliability of 95%, representing this sample 50.6% of the total business population, and applied during the months of January to March 2019. It should also be noted that all managers interviewed are directly responsible for implementation of eco-innovation practices in their respective companies, and they have been working in the automotive industry for several years, which allowed the interviewees to provide very valuable and interesting information, due to the deep knowledge and experience they have in the automotive industry. Table 1 presents the characteristics of the sample used in this empirical study.

Table 1. Sample chararcteristics

Variable	*Frequency*	*Percentage*
Firm's Age		
Young Companies (< 10 years)	129	32.3%
Mature Companies (> 10 years)	271	67.7%
Total	400	100.0%
Manager Gender		
Male	352	88.0%
Female	48	12.0%
Total	460	100.0%
Manager Age		
Young People (20–35 years)	47	11.8%
Adults (36–60 years)	320	80.0%
Older Adults (> 60 years)	33	8.2%
Total	400	100.0%

3.1 Development of Measures

As a preliminary step to the analysis of reliability and validity of the measurement scales used in this empirical study, the scales of measurement of the three variables used were determined. Thus, for the measurement of product eco-innovation, process eco-innovation and management eco-innovation, an adaptation was made to the scales proposed by Hojnik et al. (2014) and Segarra-Oña et al. (2014), being measured the first of them through 4 items, the second through 4 items and the third through 6 items. A five-point Likert-type scale was chosen to strike a balance between complexity for respondents and accuracy for analysis (Forza, 2016; Hair et al., 2016).

The items of the scales used are presented in the Appendix A.

3.2 Reliability and Validity of the Measurement Scales

The evaluation of the reliability and validity of the scales of product eco-innovation, process eco-innovation and management eco-innovation was carried out through the Confirmatory Factor Analysis (CFA), using the maximum likelihood method with the EQS 6.2 software (Bentler, 2005; Brown, 2006; Byrne, 2006). Therefore, the Cronbach's alpha coefficient and the Composite Reliability Index (CRI) were used for reliability measurement (Bagozzi & Yi, 1988). Also, according to the results obtained, all the values of the scales of product eco-innovation, processes eco-innovation and management eco-innovation are greater than 0.7 for both indices, which provides evidence of the existence of the reliability of the scales used and justifies its internal reliability (Nunally & Bernstein, 1994; Hair et al., 2014). Additionally, given that it is assumed that the normality of the data is present, the estimation methods of Chou et al. (1991) and Hu et al. (1992) for the correction of statistics, therefore, robust statistics will also be used to obtain better evidence of statistical adjustments (Satorra & Bentler, 1988).

In addition, as evidence of convergent validity, the results obtained from the CFA and that are presented in Table 2, indicate that all the items of the related factors are significant ($p < 0.001$), the size of all the standardized factorial loads are greater than 0.6 (Bagozzi & Yi, 1988), and the average standardized factor loads of each factor exceed the value of 0.7 (Hair et al., 2014). Also, these results suggest that the measurement model provides a good fit of the data ($SB\text{-}X^2 = 347.513$, $df = 74$, $p = 0.000$, $NFIT = 0.893$, $NNFIT = 0.894$, $CFI = 0.914$, $RMSEA = 0.076$), and the Index of Extracted Variance (EVI) was calculated for each pair of constructs, obtaining EVI values higher than 0.5 in all cases, which demonstrates the validity of the scales used. In Table 1 these results can be better appreciated.

Table 2. Internal consistency and convergent validity of the theoretical model

Variable	*Indicator*	*Factorial Loading*	*Robust t-Value*	*Cronbach's Alpha*	*CRI*	*EVI*
Products Eco-innovation	PEI1	0.736***	1.000[a]	0.887	0.888	0.667
	PEI2	0.783***	9.820			
	PEI3	0.897***	9.306			
	PEI4	0.840***	8.508			
Processes Eco-innovation	PRE1	0.865***	1.000[a]	0.914	0.915	0.729
	PRE2	0.888***	29.301			
	PRE3	0.863***	24.341			
	PRE4	0.796***	18.035			
Management Eco-innovation	MEI1	0.752***	1.000[a]	0.932	0.933	0.699
	MEI2	0.725***	14.789			
	MEI3	0.842***	18.932			
	MEI4	0.886***	17.651			
	MEI5	0.907***	18.792			
	MEI6	0.887***	18.444			
$S\text{-}BX^2$ (df = 74) = 347.513; p < 0.000; NFI = 0.893; NNFI = 0.894; CFI = 0.914; RMSEA = 0.076						

Note. [a] = Constrained parameters to such value in the identification process; *** = $p < 0.01$.

Likewise, the discriminant validity of the theoretical model of product eco-innovation, process eco-innovation and management eco-innovation, was measured through two types of tests. First, *the confidence interval test* is presented (Anderson & Gerbing, 1988), which establishes that with a confidence interval of 95%, none of the individual elements of the latent factors of the correlation matrix has the value of 1. Secondly, the *extracted variance test* is presented (Fornell & Larcker, 1981), which states that the variance extracted from each pair of constructs is lower than its corresponding EVI. Therefore, according to the results obtained from the application of both tests, it is possible to conclude that both tests show sufficient evidence of the existence of discriminant validity. Table 3 shows these results better.

Table 3. Discriminant validity of the theoretical model

Variables	Products Eco-innovation	Processes Eco-innovation	Management Eco-innovation
Products Eco-innovation	0**.667**	0.048	0.085
Processes Eco-innovation	0.144–0.296	**0.729**	0.220
Management Eco-innovation	0.208–0.376	0.347–0.591	0**.699**

The diagonal represents the Extracted Variance Index (EVI), whereas above the diagonal the variance is presented (squared correlation). Below diagonal, the estimated correlation of factors is presented with 95% confidence interval.

4. Results

To answer the three research hypotheses presented in this paper, a structural equation modelling (SEM) was applied with the EQS 6.2 software (Bentler, 2005; Byrne, 2006; Brown, 2006), through which the nomological validity was analyzed of the theoretical model of product eco-innovation, process eco-innovation and management eco-innovation through the Chi-square test, by means of which the results obtained between the theoretical model and the measurement model were compared, obtaining non-significant results which allows to establish an explanation of the relations observed between the latent constructs (Anderson & Gerbing, 1988; Hatcher, 1994). Table 4 shows in greater detail the results obtained from the SEM application.

Table 4. Results of the SEM

Hypothesis	Structural Relationship	Standardized Coefficient	Robust t-Value
H_1: Products eco-innovation is a good type of eco-innovation adoption.	Product → Eco-innovation	0.475***	23.959
H_2: Processes eco-innovation is a good type of eco-innovation adoption.	Process → Eco-innovation	0.669***	33.689
H_3: Management eco-innovation is a good type of eco-innovation adoption.	Management → Eco-innovation	0.931***	43.398
$S\text{-}BX^2$ (df = 70) = 213.224; p < 0.000; NFI = 0.935; NNFI = 0.941; CFI = 0.955; RMSEA = 0.072			

Note. *** = P < 0.01.

Table 4 shows the results obtained from the application of the SEM and, with respect to the hypothesis H1, it can be seen that the results $\beta = 0.475\ p < 0.001$, indicate that product eco-innovation is a good type of eco-innovation adoption by SMEs in the automotive industry. Regarding hypotheses H2, the results obtained $\beta = 0.669\ p < 0.001$, indicate that process eco-innovation is also a good type of eco-innovation adoption by companies in the automotive industry. Finally, considering hypothesis H3, the results found $\beta = 0.931\ p < 0.001$, indicate that management eco-innovation is a good type of eco-innovation adoption by companies in the automotive industry. In conclusion, it can be corroborated that the three eco-innovation types (eco-innovation of products, processes and management), are excellent types of eco-innovation adoption in SMEs.

5. Discussion

The results obtained have different conclusions, among which, first, that the model of eco-innovation types adoption has a strong internal consistency by generating a strong correlation between the three types of eco-innovation (product eco-innovation, process eco-innovation and management eco-innovation), which allows accepting the three hypotheses. In the second instance, the model of eco-innovation types also offers a general vision in which eco-innovation in products, process and management are the three types of eco-innovation most cited in the literature, particularly in the few studies oriented in SMEs. In the third instance, the discussion of studies focused on eco-innovation in SMEs has received little attention from researchers, academics and professionals in innovation, compared to studies conducted in large companies (Pacheco et al., 2017, 2018).

Also, this study presents a model that simultaneously analyzes product eco-innovation, process eco-innovation and management eco-innovation as determinant eco-innovation types adoption in SMEs in the automotive industry; which contributes both to the discussion and to generation of new knowledge regarding eco-innovation in SMEs. Therefore, it is possible to conclude that, according to the results obtained, management eco-innovation is the type of eco-innovation that has not only a greater emphasis on SMEs in the automotive industry, it is also the practice of eco-innovation that has been most developed in SMEs, followed by process eco-innovation and, finally, product eco-innovation, these results being similar to those obtained by Theyel

(2000), Chen (2008) and Bonzanini et al. (2016), which argue that the adoption of environmental management practices induces companies to continue improving.

Additionally, the results obtained also allow us to conclude that management eco-innovation type, will significantly condition eco-innovation adoption in SMEs in the automotive industry, since this is the main factor that will impede or facilitate the development of eco-innovation practices in SMEs. Likewise, process eco-innovation and product eco-innovation will also have a significant effect, although to a lesser extent than management eco-innovation, in eco-innovation adoption by increasing the capacity of eco-innovation in the SMEs Thus, recent studies such as those of Triguero et al. (2013), Klewitz and Hansel (2014), Cai and Zhou (2014), and del Río et al. (2016) consider the need to guide new research on eco-innovation practices, to provide a differentiation according to the different types of SME industry, for which our paper contributes to the discussion of eco-innovation in a context specific to manufacturing SMEs.

The results obtained in this study have different implications that are important to establish. On one hand, the data obtained through an information collection instrument allowed the execution of a general analysis of eco-innovation types adoption in SMEs in a specific sector of the industry (SMEs in the automotive industry), as recommended by Triguero et al. (2013), Klewitz and Hansel (2014), Cai and Zhou (2014), and del Río et al. (2016). Likewise, this study, incorporating a theoretical model that contemplates the discussion of the three most recurrent eco-innovation types in the literature (product eco-innovation, process eco-innovation and management eco-innovation), provides a point of a more holistic view that better explains the product eco-innovation, process eco-innovation and management eco-innovation adoption by SMEs in the automotive industry (Lozano, 2013; Hallstedt et al., 2013; Cheng et al., 2014).

On other hand, the results obtained in the literature reveal that SMEs are increasingly willing to adopt sustainable practices that allow them to increase their innovation activities beyond simple environmental monitoring (Oxborrow & Brindley, 2013), which contradicts the results obtained by Tilley (1999b) who considered that SMEs have restrictions in their economic activities and environmental performance. However, the results obtained in this paper show that SMEs in the automotive industry are more open not only to adopting eco-innovation practices, but are also focused on developing eco-innovation types in the automotive industry, management eco-innovation is a greater type, followed by the activities of eco-innovation in processes and eco-innovation in products, these results being consistent with those obtained by Oxborrow and Brindley (2013).

Likewise, the results obtained in this study are in line with the results found by van Hemel and Cramer (2002), and Erkko et al. (2005), who considered that a combination of environmental care with commercial activities is the most effective way that SMEs seek, beyond the mere compliance with environmental initiatives. In addition, Vernon et al. (2003) suggested that lack of awareness, or what Tilley (1999a) called eco-literacy, is generally a factor that can inhibit eco-innovation adoption in SMEs, therefore, our results suggest that SMEs are willing to further develop eco-innovation adoption in management (e.g., making changes or improvements in management systems, compliance with some environmental standards), which allow them to meet certain requirements of automotive firm who are its suppliers, rather than the development of eco-innovation adoption in processes and eco-innovation in products.

Additionally, these results are also closely related to those obtained in the literature, specifically on the importance of product eco-innovation, or also called green products, since according to Fercoq et al. (2016), a combination of clean production with product eco-innovation can minimize the negative impacts to the environment in manufacturing companies, including SMEs. In this same direction, Johansson and Sundin (2014) considered that a solid orientation in the creation of value for consumers is what the adoption of eco-innovation types in companies have to focus on. In this sense, our results establish that the SMEs of the automotive industry do constant eco-innovation adoption in products, which are combined with the development of eco-innovation adoption in processes, which allows a cleaner production of products.

Finally, the results obtained in this study corroborate that the discussion of eco-innovation types adoption, particularly in manufacturing SMEs, is in an incipient stage of development, which is why the lack of empirical studies oriented in this important construct combined with the lack of analyzes categorized by country, maturity of eco-innovation culture, type of manufactured product, sector or business strategy, make the discussion on this topic difficult. Therefore, in accordance with Pacheco et al. (2017, 2018) in future studies, published studies of eco-innovation types adoption in SMEs should be increased, trying to categorize studies as best as possible, since this represents an important opportunity for researchers and academics to advance in the academic perspectives and practices that entails eco-innovation types adoption in SMEs, especially by targeting them in specific sectors and in emerging market countries.

This paper has different limitations that are essential to consider in the light of the interpretation of the results obtained, being one of them the reference with the scales of measurement of eco-innovation types adoption in products, eco-innovation in processes and eco-innovation in management, since these three types were measured with subjective indicators obtained through surveys (subjective data). Therefore, in future studies it will be pertinent to incorporate objective data of the SMEs of the automotive industry (e.g., percentage of use of clean energies, percentage of use of treated water, percentage of clean production), in order to verify whether the results obtained are similar to those obtained in this research study.

A second limitation is that the existing relationship between the three eco-innovation types and eco-innovation adoption in SMEs (product eco-innovation, process eco-innovation, and management eco-innovation), possibly generate better results if they are related to the main drivers of the eco-innovation (e.g., clean technology, tax incentives, competitiveness). Therefore, future studies will require the use of some variables that are directly related to eco-innovation types, in order to corroborate whether the results obtained are similar to those obtained in this study. A third limitation is that in this paper only the three most recurrent types of eco-innovation were considered in the literature (eco-innovation in products, processes and management), so in future studies it will be pertinent to consider other types of eco-innovation (e.g., marketing, technology, systems), in order to corroborate whether the results obtained differ or not from those obtained in this study. A final limitation is the possibility of the existence of respondent bias, since a survey was administered to SMEs managers and the information obtained may not be solid.

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Appendix A

Indicators	Constructs
Product Eco-innovation	
PEI1	It constantly improves its product life cycle standards and conducts product life cycle studies
PEI2	It uses or develops new energy sources with a tendency to reduce CO_2 emissions
PEI3	It uses the eco-label system required by each destination country for its products
PEI4	It uses and elaborates eco-innovative components and materials that are made from recycled raw materials
Process Eco-innovation	
PRE1	Treat your wastewater
PRE2	It uses sterilization methods for its components or technological devices
PRE3	Produces or uses fabric components that use fabric sanitization technologies
PRE4	It uses ecological or recyclable paper in its processes
Management Eco-innovation	
MEI1	Has a management system that reuses obsolete components and equipment
MEI2	Has an ISO 14001 Certification or similar
MEI3	It has constant audits of energy saving and ecology by the state and/or municipal authorities of its location
MEI4	Constantly conducts seminars or training courses for staff related to eco-innovation
MEI5	It has well-defined policies that encourage and support eco-innovation activities throughout the organization
MEI6	It has a monitoring and control system for wastewater generated by the company