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# The Effects of Dynamic Absorptive Capacity on Innovation Strategy: Evidence from SMEs in a Technological Context

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**Abstract:** Absorptive capacity and innovation strategies are determining issues for the survival of organizations in current contexts. While organizations are immersed in the knowledge society, managers face great challenges to respond to market needs and performance in innovation ecosystems. This article aims to analyze the effects of absorptive capacity on the implementation of innovation strategy. A quantitative research study was conducted with a sample of 51 SMEs, and the construct model was analyzed using the SEM method. The results indicate that there is a high correlation between the level of absorptive capacity and innovation strategies. Even though firms in this specific sector work with advanced technologies, there is a basic level of development of absorptive capacity, generating some difficulties for the design and implementation of innovation strategies. Furthermore, by using the acquisition, assimilation, transformation, and exploitation of knowledge from the competitive landscape, firms improve their adaptability in the technological environment. The effects of absorptive capacity on innovation strategy contribute to the development of the extant literature on innovation management strategy and provide some managerial implications and future research areas.

**Keywords:** dynamic; absorptive capacity; strategy; technological; innovation; SMEs

**MSC:** 62J05



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## 1. Introduction

Absorptive capacity (ACAP) has been studied in the fields of strategic management, technology management, international business, innovation management, and innovation performance as one of the most important constructs that enhance the implementation of innovation in organizational activities through the exploitation of knowledge [1–6]. In the last years, studies in the field of innovation strategy have been identifying key elements indicating that resources and capabilities are key issues to foster the management of knowledge and value creation through the collaboration of many actors [7]. In this context, firms developing innovation capabilities can leverage external information more effectively through collaboration with communities to identify opportunities for product innovation in emergent markets [8]. For decades, scholars and experts have recognized that innovation is an important way for the success of the organization, especially in ecosystems from the perspective of ACAP [9]. Thus, firms have recognized a close relationship between ACAP and innovation as a source of value creation [10]. Hence, organizations face significant changes in technological environments and rely upon absorptive capacity before designing their innovation strategy [11], especially for the generation of sustainable competitive

advantages and economic growth in times of change, aggressive competition, and globalization in emerging economies. In this regard, innovation capabilities are significant sources for small and medium-sized enterprises (SMEs).

Although SMEs have faced major negative difficulties because of the economic crisis, they still have a low ability to adapt and lack the financial, human, and information resources, making them very vulnerable to adverse effects in times after the pandemic [12]. SMEs, throughout Colombia, contribute more than 65% of formal employment and 35% of gross value added. These enterprises have been considered a crucial source for employment generation and productivity, facing multiple needs. To overcome these challenges, processes must be planned with the goal of building strategies and resources to develop continuous innovation during and after the COVID-19 pandemic [13,14].

Recent research demonstrates that ACAP has a significant impact using external information sources for creating innovation performance on SMEs [15]. Then, the assimilation and transformation of external knowledge is a permanent need to achieve a competitive advantage for SMEs' success. However, the influence of ACAP on innovation strategy in emerging economies for the achievement of better business performance in SMEs has been underexplored in the extant literature.

Absorptive capacity (ACAP) in terms of the knowledge context was first defined, based on the research of Cohen and Levinthal [16], as the organization's ability to acquire valuable external knowledge and articulate it through transformation processes with existing knowledge and thus achieve its application for the creation and exploitation of new products and services. In the same way, studies on ACAP conducted by Zahra and George [17] argue that ACAP is composed in a dynamic way with two processes—potential absorptive capacity (PACAP) and realized absorptive capacity (RACAP)—each one made up of two dimensions, the first of acquisition and assimilation and the second of transformation and exploitation. Lanzolla, Pesce, and Tucci [18] consider that the transformation of knowledge based on ACAP comprises a set of values, norms, beliefs, knowledge, and the education of professionals who use knowledge within a role scheme.

Innovation has become an important factor in business strategy as a path that organizations have for aggressive competition in competitive environments, market changes, and the globalization of economies in the society of knowledge [19]. In the same current of research, Harris, Krenz, and Moat [20] highlight the strong relationship between innovation and absorptive capacity. However, recent studies have acknowledged that the high value of innovation capacity depends on the company's ability to promote ACAP and has a direct effect on strengthening organizational learning [21]. Hence, in turbulent technological environments, the ability of innovation managers to adapt to new customer needs and improve innovative skills helps to modify the business model, increases the portfolio of products and services, and improves organizational performance [22–24]. Thus, absorption capacity strengthens companies' ability to achieve better innovation outcomes when organizations have a clear intention to invest in knowledge creation [25].

This study examines the effects of ACAP on innovation strategy and business performance in SMEs by acquiring, assimilating, and exploiting external knowledge.

The theoretical construction of this work comes from two previous literature review works using the SCOPUS database. The purpose of this article is to analyze the level of development of ACAP and its effects on the innovation strategy of SMEs in the technology sector of the innovation ecosystem in Colombia. The general objective is addressed to answer the following research question: How does the level of development of ACAPs affect the implementation of the innovation strategy? Other secondary objectives of the current research through an online survey—to establish the main variables of each construct used by SMEs to adapt the innovation strategy, as well as the effects that limit their knowledge generation capabilities in order to compete in the city's technology and innovation ecosystem—are examined. Employing data from 51 Colombian SMEs, this research demonstrates that through the use of the four dimensions of ACAP (acquiring, assimilating, transforming, and exploiting knowledge), small and medium firms can enhance innovation

strategy. For SMEs, implementing innovation strategy means dealing with many difficulties such as scarce resources, a lack of better policies, and short-term thinking that affect value creation and adaptability in turbulent technological environments. However, the findings suggest the acquisition, assimilation, transformation, and exploitation of external knowledge have a positive effect on innovation strategy and business performance.

The present paper is structured as follows: First, the topic is briefly introduced by highlighting the importance of absorptive capacity based on the studies carried out by the main authors in the theoretical field. In the same way, as the research question arises, the theoretical background of absorptive capacity and the innovation strategy is then related, followed by the methodology approach detailing how we synthesized the collected data using a quantitative approach. Finally, the results, discussions, and conclusions are presented, which provide a set of insights based on the most significant aspects of the study and suggest some future lines of research.

## 2. Theoretical Background and Hypotheses

For the development of the research of ACAP in the technology SMEs of the innovation ecosystem in Colombia, the theoretical model proposed by Zahra and George [17] was chosen, and the conceptualization of the construct corresponds to the research questions and the general objective. Among other reasons, the ACAP model assumes capabilities as a set of organizational routines, which become a dynamic capacity that allows companies to reorganize resources and skills for a better adaptation to the environment. In addition, this model includes two components: potential absorptive capacity (PACAP) and realized absorptive capacity (RACAP), including four dimensions: acquisition, assimilation, transformation, and exploitation, which are present throughout the entire organization to align the organization's routines with business strategy and allow companies to reach innovation processes. Despite the progress made, there is still some confusion and diversity in the conceptualization of the definitions, background, and components. Some authors define ACAP as resources, others as dynamic capabilities, and still others as organizational capabilities or knowledge bases [16,17]. We define ACAP as a multidimensional construct: PACAP is conceptualized as a set of routines through which organizations acquire and understand prior and external knowledge to transfer value: RACAP is defined as the process through which acquired and assimilated information is incorporated into new knowledge, systems, and goods to create value.

### 2.1. Potential Absorptive Capacity

PACAP includes acquisition and assimilation activities. These capabilities act as a bridge between the organization and the environment [26]. Acquisition has been understood as an ability to identify and acquire new knowledge through external sources or, more recently, as the routines used to identify and acquire data considered critical for organizational operations [27]. Therefore, the capacity to integrate and reconfigure internal knowledge can be more efficient when the new knowledge is related to existing knowledge in the organization [16]. In other words, assimilation consists of the capacity of the organization to understand, adapt, and interpret the knowledge considering the routines of the organization [28,29].

According to Zahra and George [17], the intensity and speed of a company's efforts to identify and collect knowledge can determine the quality of its acquisition capabilities. The greater the organizational effort, the faster the required capabilities will be built [30]. Thus, feedback mechanisms with the environment are considered an organizational capacity to adjust and adapt to constant changes, and it is a valid model that guarantees better performance in the future [31].

In this context, assimilation capacity is framed in the monitoring, adaptation to the environment, and identification of the needs of the company, which require high levels of flexibility that must be developed by the management, so that the ideas and discoveries that go beyond the search zone are a limitation and are not overlooked because the company

cannot easily assimilate them [32,33]. Furthermore, externally acquired knowledge may incorporate a series of new procedures, which may differ significantly from the usual techniques used by the company, delaying the assimilation and understanding of knowledge [34]. Thus, external knowledge is also context-specific, which often prevents some people from understanding or replicating this knowledge [29].

### 2.2. Realized Absorptive Capacity

The other two dimensions that integrate ACAP, according to Zahra and George [17], are represented by RACAP, which includes a set of two dimensions: transformation and exploitation. The first is understood as the combination of the new knowledge with the existing knowledge [4,17,28,35,36]. This process requires changing the frames of reference and mental models according to which the knowledge base is being interpreted. Another way to achieve the transformation process of acquired knowledge is through socialization since socialization mechanisms can play a role in combining and integrating data-driven approaches with insight-based and experience-based approaches into the decision-making process. Todorova and Durisin [35] argue that firms need transformation as an alternative process to assimilate new information to fit existing knowledge and changes in markets. Therefore, transformation is the ability to link new knowledge through the construction of new cognitive schemes.

In this context, the transformation process allows the recognition of new opportunities and at the same time alters the way the organization sees itself and interprets its competitive environment. The recognition of the capacity for transformation as a component of RACAP allows us to delve into the black box that has dominated previous research on strategic change. Transformation requires two fundamental processes: the internalization and conversion of knowledge. An indicator of the degree of success of the transformation process can be the number of ideas or research projects focused on new products [17].

The second dimension is concerned with exploitation, which is based on the definition of absorptive capacity provided by [16]; this concept emphasizes the need to apply knowledge. Hence, exploitation means organizational capacity that allows the refining, extending, and leveraging of existing competencies creating new competencies that incorporate the knowledge acquired and transformed into their operations. The exploitation thread reflects the ability to collect and incorporate organizational knowledge in operations [37]. Moreover, the exploitation concept is considered as the ability of companies based on routines that allow perfecting, expanding, and taking advantage of existing and new skills [17]. Furthermore, this concept can be assumed as the ability of the company to use new external knowledge to achieve institutional goals [38].

Then, the results of the systematic exploitation of routines are the continuous creation of goods, services, processes, knowledge, or new organizational forms [39]. Therefore, the exploitation process requires the participation of innovative teams, by involving more members of the organization in validating and refining ideas [40]. Table 1 presents the characteristics of RACAP and PACAP and the main conceptualizations of the construct for the development of innovation capabilities because of empirical research in the context of a doctoral dissertation and two previous literature review works using the SCOPUS database.

**Table 1.** The absorptive capacity dimensions.

Dimension	Conceptualization	Authors
Acquisition	The capacity of the organization to locate, acquire, transfer, and share value through external knowledge or prior knowledge, from different sources to solve problems.	Szulanski [29]; Autio et al., [41]; Van Wijk et al., [42]; Zahra and George [17]; Mowery et al., [43]; Kim [30]; Lahti and Beyerlein [44]; Cohen, W. L. [16]; Jansen et al., [45]; Lane et al., [1]; Liao et al., [46]; Todorova and Durisin [35]; Lichtenthaler [47]; Flatten et al., [48]; Lane and Lubatkin [38]; Liao et al., [49]; Van den Bosch, and Volberda [42]; Veugelers [50]; Choi and Ko [51].

Table 1. Cont.

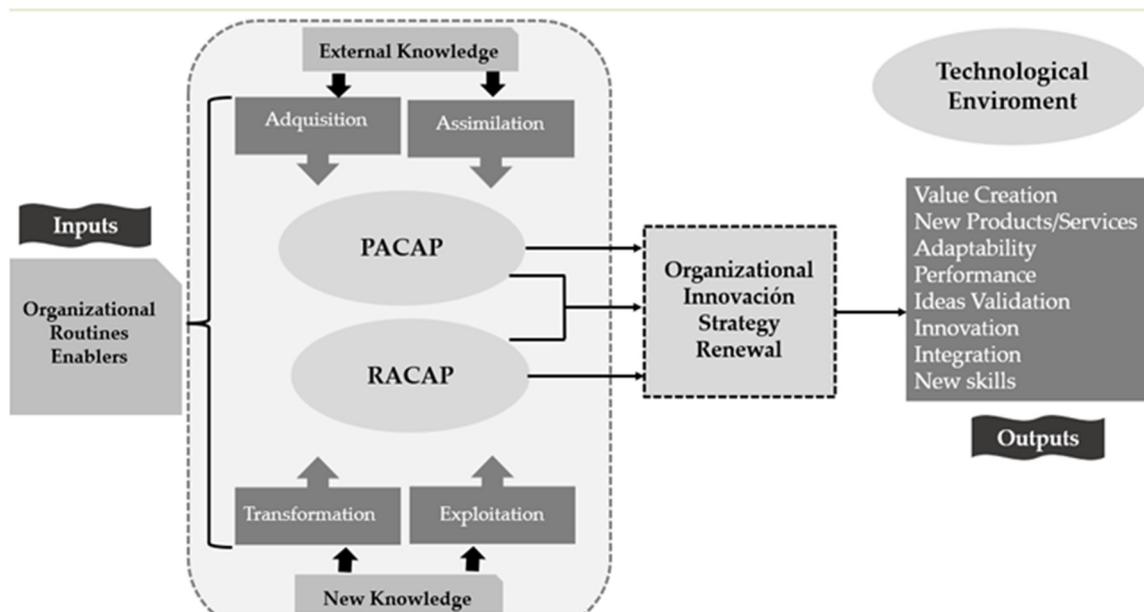
Dimension	Conceptualization	Authors
Assimilation	Understanding the acquired knowledge that is assimilated through routines and processes. Thus, the information is processed for interpretation, formalization, and understanding to create new knowledge.	Cohen, W. L. [16]; Dodgson [52]; Lane and Lubatkin [38]; Bontis et al., [53]; Jansen et al., [45]; Todorova and Durisin [35]; Lichtenthaler [47]; Szulanski [29]; Zahra and George [17]; Volberda et al., [4].
Transformation	Development and refinement of routines within the organization so that the previously acquired and assimilated information is used to create knowledge innovatively.	Szulanski [29]; Kim [30]; Gruenfeld et al., [54]; Collins and Smith [55]; Liao et al., [46]; Lichtenthaler [47]; Bontis et al., [53]; Jansen et al., [45]; Flatten et al., [48]; Grant [56]; Edmondson and Moingeon [57]; Kogut and Zander [58]; Van den Bosch et al., [37]; Zahra and George [17].
Exploitation	Routines allow the organization to incorporate all the knowledge acquired, assimilated, and transformed into operations to generate new goods, systems, and processes.	Cohen, W. L. [16]; Dodgson [52]; Lane and Lubatkin [38]; Autio et al., [41]; Lane et al., [1]; Szulanski [29]; Van den Bosch, Volberda, and de Boer [37]; Van Wijk, Van den Bosch, and Volberda [42]; Zahra and George [17]; Bierly and Daly [59]; Lawson and Samson [60]; Nonaka and Takeuchi [61]; Edmondson and Moingeon [57].

### 2.3. Innovation Strategy

The concept of strategy has captured a great field of interest over time through a wide range of meanings, interpretations, and views with its roots in the military field [62]. In the field of business administration, two important lines have historically been developed: research relating to the content of the strategy and research of the strategic process. The distinction between these two lines of research is based on the work carried out by Chandler [63] on the relationship between strategy and structure and the concept of corporate strategy, arising when the separation between the process and the strategy content was formally established [64–66]. In the line of strategy research, Fahey and Christensen [67] proposed a review of research trends concerning strategic content. Huff and Reger [68] made advances in the same direction of research related to the strategic process, with significant contributions to academics by introducing approaches based on decision making and the strategic direction [69–72].

On the other hand, Rumelt [73] argued that innovation strategy is a set of analyses, concepts, policies, arguments, and actions that respond to major challenges. Innovation strategies consider not only the internal development of R&D activities but also a set of actions associated with the external acquisition of knowledge through market transactions and cooperation with other agents [74].

Other scholars define innovation strategy as a set of decisions made by firms regarding innovation processes: central innovation activities (those related or not to R&D investment) and sources of information to be used externally or internally [75]. In the same current of research, Schilling [76] established a methodology for developing and implementing an innovation strategy in enterprises, breaking down the formulation and implementation of the innovation strategy in stages: a map of R&D projects, forms of collaboration, mechanisms of intellectual property, and technology law. In other words, innovation strategy is the way to change a company's business model and create new value for the customer in dynamic environments [77]. Figure 1 summarizes the development of the four dimensions built one on top of the other, which makes ACAP a coherent dynamic capacity to improve all innovation activities according to the need for continuous change and the evolution of the organization.



**Figure 1.** Conceptual framework of absorptive capacity linked to innovation strategy.

According to the ACAP literature review, through ACAP, companies achieve the potential capacity to acquire knowledge to make an evaluation of the usefulness of knowledge and transfer new capabilities. Therefore, because of the application of organizational routines based on PACAP and RACAP, the generation of new products and services is promoted, enabling the organization to react strategically, which allows the organization to react in a proactive form to the requirements of the industry [17,78].

The model proposed in the conceptual framework is considered a reflective model since it is considered as a measurement model where the indicators of the latent variables of the three constructs are competitive with each other and represent manifestations of each latent variable. Following the aim of the research, the following working hypotheses were formulated in line with the theoretical framework and research question:

**H1:** *A high level of PACAP development has a positive effect on innovation strategy.*

PACAP is based on two capabilities that focus on the input of external knowledge through organizations to obtain and integrate new knowledge. Zahra and George [17] argued that innovation can be promoted by accumulating internal knowledge from external information and knowledge. Furthermore, a higher ability to acquire and use new external information and knowledge enables a higher ability to create innovations and expand the base of knowledge [79]. On the other hand, from the perspective of ACAP, assimilation entails routines and processes by understanding information obtained from outside and involves its incorporation into a new knowledge base within the organization [80]. Then, in this paper, we argue that by acquiring and assimilating useful external knowledge with the proper processes and procedures, SMEs can foster the implementation of innovation strategies and create value in the technological environment.

**H2:** *A high level of RACAP development has a positive effect on innovation strategy.*

The latter two dimensions, summarized as RACAP, focus on the output of external knowledge. Transformation is the ability to develop and refine the routines that facilitate the combination of the knowledge that the employees of the organization have and articulate it with the new knowledge that has already been acquired and assimilated [17]. Then, transformation can be realized by adding or removing knowledge or simply by interpreting the same knowledge differently, which provides new innovation capabilities to compete in

changing markets. On the other hand, exploitation enables companies with a fast response to customers' demands and contributes to the creation of continuous profits through innovation strategy [17]. Thus, the basis of the second hypothesis relies upon the ability of SMEs to strengthen the implementation of innovation strategies by providing new insights into commercialized new goods and products as a result of new knowledge.

**H3:** *The acquisition, assimilation, transformation, and exploitation of external knowledge have a positive effect on innovation strategy.*

In terms of commercializing new knowledge obtained, concerning new demands in the technological sector in SMEs, it is possible to argue that both PACAP and RACAP are closely linked but have different roles and both coexist and are necessary to determine the performance of the innovation strategy through the promotion of ideas of collaborators within the organization [17]. Furthermore, researchers have found that the development of new value helps meet customer demands, promotes the adaptability of innovation strategies, and generates new avenues for value creation [81,82]. Hence, this research suggests that a successful implementation of innovation strategy depends on a close understanding of routines and activities, as well as its incorporation into the new base of knowledge.

### 3. Materials and Methods

The research design is quantitative. For the interpretation of the data, factor analysis models and a structural equation model were used to unify the representations, relationships, and statistical validity raised in the assumptions of the working hypotheses and the research question. The scale to measure ACAP was established according to Zahra and George [17], such as the PACAP and RACAP, and adapted to the specific dynamics of the competitive environment of SMEs, following other scale contributions based on the research of recognized authors in the field of ACAP [48]. The questionnaire scale draws on survey data with 20 questions composed of a set of 10 variables to measure RACAP and 10 more in the case of PACAP in the specific case of SMEs in the technology sector. In the case of the innovation strategy, this research follows the conceptualization defined by Rumelt [73] with 10 more questions to measure the construct of the innovation strategy, with a total of 30 questions to operationalize the theoretical constructs (Appendix A, Table A1).

The empirical data were obtained through a survey with the different categories, which was completed online by top leaders involved in innovation and knowledge creation activities. We selected SMEs using the government database containing the information and profiles of companies that are part of the software industry cluster, that is, are sponsored by the science and technology budget in the technological ecosystem of the city of Medellín. There was a reply from 96 SMEs out of a total sample of 186 initially contacted. However, in the final sample, we only included 51 SMEs with an average of 10 years of experience in the business as an exclusion factor to enhance the generalization of the results (Appendix B, Table A2). The SMEs were categorized into small- and medium-sized according to the definition provided by the chamber of commerce: 23 were defined as small-sized (between 11 and 50 employees) and 28 as medium-sized (between 51 and 200 employees). The constructs were measured through a structured questionnaire using a Likert-type psychometric scale, with a rating range from 1 to 5, which presented a measurement scale as follows: Never (1); Seldom (2); Sometimes (3); Most of the time (4); and Always (5). The software package R was utilized to conduct the analysis of data following recommendations made by Shaffer et al. [83] as a very powerful analytical tool that can be used for different types of data analyses.

First, factor analysis and a structural equation model were carried out to unify the representations, relationships, and statistical validity raised in the assumptions of the working hypotheses and the research question. Next, exploratory and confirmatory factor

analysis was used to define how many factors of the constructs are related to each other and which items are related to each factor to assess the underlying factorial structure within a correlation matrix. A pilot test was performed with the survey questions and the sample size of the data represented by 25 enterprises in order to determine the validity and reliability of the instrument and make possible adjustments that could be considered significant to make sure that the resulting information meets the research objectives through a representativeness test. The results of this test indicated that the correlation matrix was not an identity matrix. Therefore, it was assumed that there was a relationship between the dimensions of the constructs and a positive relationship between the variables of the constructs. The sources of information for the results shown in all tables and figures to facilitate a high response rate were taken from the dataset of the city's chamber of commerce, which contains the formal database of the SMEs that belong to the information technology cluster of the innovation ecosystem.

### 3.1. Exploratory Factor Analysis

Based on the questionnaire and the data provided in the survey from the initial categorical data, an exploratory factorial analysis (EFA) was carried out corresponding to the constructs related to the conceptual framework: PACAP, RACAP, and the innovation strategy (IE). The validity of the EFA assumes that the variables are related in some way, so the variables indicate that there are several common factors [84]. This method is used to measure each quality of the variables and to determine the set of statistically significant factors. Due to the factorial analysis model, it was necessary to reduce the size of factors, which involved the measurement of KMO (Kaiser–Meyer–Olkin sample adequacy measure), which measures the suitability of the data for a factorial analysis when comparing the values of the observed correlation coefficients with the partial correlation coefficients.

### 3.2. Confirmatory Factor Analysis

The second stage used the confirmatory factor analysis (CFA) technique to develop the model of structural equations, which were validated by the KMO and SBT. Both the EFA and the AFC were used following the classic recommendation suggested by Matsunaga [85] which allows the assessment of the factorial structure underlying a correlation matrix to test the structure of the hypothetical model.

Next, to verify the statistical validity, the structural equation model (SEM) was adopted to integrate and statistically contrast the proposed relationships of the variables based on the hypothetical model. According to Cupani [86], researchers have been using structural equation modeling, given its ability to estimate and evaluate the relationship between unobservable constructs, generally referred to as latent variables. Finally, the correlation between the variables of the constructs was determined through partial least-squares structural equation modeling (PLS-SEM), a useful method applied by many scholars and researchers in the last decade in the field of strategic management research [87].

## 4. Results

A data analysis was performed to evaluate the reliability of the scale using the EFA and CFA correlation technique with all constructs according to the conceptual framework. For this purpose, correlation matrices were determined for each of the dimensions of the PACAP, RACAP, and IS. The measurement model involved a systematic process for assessing reliability and validity.

In this sense, the outer loadings of all indicators should be higher than 0.7 [88]. The internal construct reliability was tested for PLS-SEM by using composite reliability (CR) as recommended by Nunnally and Bernstein [89]. For CR, all reflective constructs present are greater than 0.7, which indicates that reliability was also achieved. For the validation of internal consistency, the values of Cronbach's alpha coefficient were determined, and reliability was carried out over each coefficient's value; as a result, a set of correlations with a positive result was obtained by all constructs according to the observed data. Cronbach's

alpha analysis indicates that all variables associated with each dimension present a positive response according to the sample obtained, with an overall of 0.867, much higher than a minimum of 0.5. As illustrated below in Table 2, the reliability in terms of factor loadings was suitable.

**Table 2.** Measurement model of the statistical analysis: loadings and construct reliability.

Construct/Dimensions	Cronbach's Alpha	Average Variance Extracted (AVE)	Composite Reliability (CR)	Loading	t-Value
Absorptive Dynamic Capabilities	0.867	0.853	0.896		
PACAP Acquisition (aq5)	0.884	0.622	0.826		
P_aqs1				0.765	12.520
P_aqs2				0.721	15.550
P_aqs3				0.896	27.540
P_aqs4				0.746	12.269
P_aqs5				0.852	21.709
PACAP Assimilation (asm)	0.890	0.548	0.863		
P_asm1				0.703	18.226
P_asm2				0.802	29.154
P_asm3				0.726	18.326
P_asm4				0.816	31.230
P_asm5				0.791	20.741
PACAP Transformation (trf)	0.878	0.632	0.846		
R_trf 1				0.711	18.995
R_trf 2				0.752	26.293
R_trf 3				0.703	20.320
R_trf 4				0.803	24.452
R_trf 5				0.724	17.845
PACAP Exploitation (ept)	0.805	0.742	0.852		
R_ept 1				0.752	33.290
R_ept 2				0.768	25.260
R_ept 3				0.675	18.654
R_ept 4				0.776	19.348
R_ept 5				0.852	21.526
Business Innovation Strategy					
Innovation Strategy (is)	0.867	0.621	0.851		
BIS_is1				0.785	23.764
BIS_is2				0.728	20.254
BIS_is3				0.742	19.251
BIS_is4				0.755	24.228
BIS_is5				0.841	20.030
BIS_is6				0.753	20.097
BIS_is7				0.748	18.547
BIS_is8				0.712	18.500
BIS_is9				0.725	23.650
BIS_is10				0.778	19.072

Convergent validity for the latent variables was examined using the average variance extracted (AVE), following the initial set of 0.5, which was achieved with all constructs over the minimum reference point [90]. Furthermore, discriminant validity was applied with all constructs fulfilled through the heterotrait–monotrait (HTMT) criteria. The results evaluated the average of the heterotrait–heteromethod correlations following the recommendations of Henseler, Ringle, and Sarstedt [91], as a better method that provides the best reliability in variance-based analyses, when PLS-SEM is used. Consequently, all variables present discriminant validity according to the HTMT criterion with a threshold

of a 0.85 ratio, as suggested by Voorhees, Brady, Calantone, and Ramirez [92], in all the constructs, as illustrated in Table 3.

**Table 3.** Measurement model with discriminant validity.

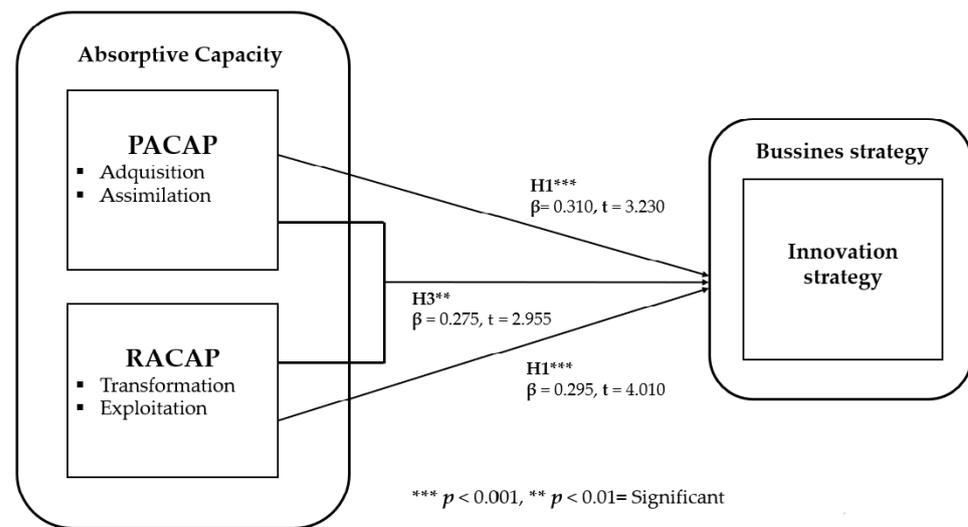
Heterotrait–Monotrait Ratio (HTMT)					
	aqm	asm	trf	ept	is
aqm					
asm	0.852				
trf	0.862	0.801			
ept	0.932	0.832	0.812		
is	0.811	0.930	0.803	0.845	

The structural model allowed concluding that the principal components of each dimension variable were statistically significant according to the hypothetical relationships. Tables 2 and 3 provide an overview of the three hypotheses tested, which are described in detail as follows. First, hypothesis H1 proposes that a high level of PACAP development has a positive effect on innovation strategy. The empirical results indicate a positive effect of PACAP on innovation strategy ( $\beta = 0.310, t = 3.230, p < 0.001$ ). Based on this result, H1 is accepted. Therefore, the hypothetical model indicates that, for SMEs, there has been a positive contribution in the sense that companies acquire learning through the company’s communication with research laboratories, universities, technology consultants, public sector agents, clients, competitors, and suppliers. Moreover, companies are able to assimilate knowledge coming from outside the organization through a rapid flow of communication, which allows the agile exchange of information between units.

Next, hypothesis H2 proposes that a high level of RACAP development has a positive effect on innovation strategy, for which the empirical data indicate a positive effect of RACAP on innovation strategy ( $\beta = 0.295, t = 4.010, p < 0.001$ ). Hence, H2 is also accepted. In this sense, it means that the SMEs positively take advantage of the organization’s capacity, specifically at the level of managers and employees, to integrate the technology created in their company with one that comes from outside and manage to reconfigure the organization based on the knowledge obtained from the environment. Therefore, results indicate that there is an adaptation of strategic decisions based on the knowledge obtained from the competitive environment.

Finally, hypothesis H3 states that the acquisition, assimilation, transformation, and exploitation of external knowledge have a positive effect on innovation strategy. In the same way, the empirical results indicate a positive effect of the acquisition, assimilation, transformation, and exploitation of external knowledge on innovation strategy ( $\beta = 0.275, t = 2.955, p < 0.01$ ). Thus, H3 is supported, and its relationship with ACAP is significant. Furthermore, SMEs use the knowledge obtained from the environment in favor of new products or services of the company to develop new products or services by using the innovations or ideas developed elsewhere. Consequently, companies have the ability to modify existing products or services by using the innovations or ideas developed for the exploitation of new products or services as a result of the innovations developed.

Based on the results of the correlation matrix, it is established that there is a high correlation between the dimensions of PACAP and RACAP and the innovation strategy. Furthermore, the goodness-of-fit measure of the hypothetical model is 0.727 and belongs to the interval  $<0.50\text{--}0.75>$ , which indicates an acceptable value. Thus, in concordance with the results in Table 3, concerning discriminant validity, the heterotrait–monotrait criterion is in line with the results, as shown in Figure 2, which provides better reliability in variance-based PLS-SEM, as it is an established method to validate the significance and direction of the hypothesized model.



**Figure 2.** Results of the PLS-SEM analysis.

Consequently, hypotheses H1, H2, and H3 of the proposed theoretical model were corroborated empirically. Therefore, the analysis of principal components and common factors revealed that 76% of the total variation of constructs and survey items is explained by all the other variables. In the same way, the oblique orthogonal rotation method used allowed us to increase the interpretability of the data and conclude that there was a positive correlation between the three constructs according to the theoretical model.

## 5. Discussion

This study analyzes how PACAP and RACAP are directly related to the innovation strategy in SMEs from the technology sector in the innovation ecosystem of Medellin, Colombia. Structural equation modeling (SEM) was conducted for the analysis of the information extracted from the surveys applied in 51 different companies in the technology sector into a multiple-case study as strategy research. The methodology aimed to find the best linear combination between the variables that compose each of the constructs based on the survey and the categorical data to measure each quality of the variables and determine the set of statistically significant factors in each of the four ACAP dimensions based on the hypothesis model.

The results were intended to answer the research question according to the size and characteristics of the companies that compete in the technological environment with products and services in the software industry. The paper indicates that, for SMEs, there is a wide range in the levels of development of PACAP and RACAP that has a significant impact on the implementation of the innovation strategy. In this sense, the assimilation capacity in the organizations has allowed them to identify and understand the innovations developed by other companies, and in this way, companies have been able to assimilate knowledge coming from outside the organization, in coherence with the proposals developed by Zahra and George [17].

Additionally, this research provided empirical evidence that the effect of PACAP and RACAP has a positive impact on developing an innovation strategy in an emerging context, according to the findings described by Algarni, M. A., Ali, M., Leal-Rodríguez, A. L., and Albort-Morant, G. [93]. They argued that the effect of PACAP and RACAP on the innovation strategy may well be greater in an emerging economy than a mature economy. Thus, ACAP contributes to the implementation of innovation strategy through the assimilation of external resources and fostering innovation performance through integration with their internal knowledge [15].

However, implementing ACAP in SMEs results in a challenging situation for the leaders, due to a lack, in some instances, of the required resources and capabilities to foster the innovation strategy. Therefore, the implementation of organizational capabilities to achieve adaptability and value creation requires a series of routines that strengthen the skills to innovate in technological environments. Furthermore, research and development processes in firms become more flexible and adaptable when it is possible to use resources external to the organization [94]. Consequently, responses to the organizational environment tend to vary depending on the perception and interpretation of the managers in the turbulent environments in which they compete [95].

The results reinforce the existing findings in the literature described by Gao et al. [96], who demonstrated that, through ACAP, organizations strengthen their ability to exploit valuable knowledge. Hence, it could be verified that companies in the technology sector belonging to the innovation ecosystem must make permanent adjustments in acquiring technology, implement innovation processes, and design business models to take advantage of new knowledge, especially firms with scarce resources. Then, it is necessary for SMEs to keep establishing knowledge through long-term strategic alliances along with many external companies to foster innovation strategy and synergies for extending new products and services to the markets [97].

The results also show that most of the companies in the sample effectively invest in or allocate resources to R&D activities and additionally dedicate a percentage of the annual budget to innovation activities. Although firms use these resources with internal knowledge and capabilities acquired to exploit new products or services resulting from the innovations developed, as was argued by Zhu et al. [98], they state that the absorptive capacity of firms in a cluster depends on the capabilities of the innovators and the use of external sources of knowledge through integration and collaboration actions. Hence, ACAP has a significant impact on the company innovation process strategy, but the combination of PACAP and RACAP requires companies to establish cooperation policies with other public or private companies to promote R&D activities, hence providing a more compressive landscape of environmental changes and the consolidation of innovation ecosystems for knowledge generation that improves and extends the comprehension of the technological environment in turbulent contexts. Nevertheless, SMEs' managers in an emerging economy context must encourage innovation capabilities, since SMEs tend to have a closed perspective and a short-term strategy, and they need to exploit different types of external information sources and keep searching for government support to acquire scarce resources to improve innovation strategy. This agrees with the findings of Jiao, M., Du, D., Shi, W., Hou, C., and Gui, Q. [99] and Aboelimged, M., and Hashem, G. [100] and confirms the importance of the roles and promotion of innovation performance in cities for elevating ACAP through collaborative alliances with various stakeholders for the developing of new products and services.

Therefore, it is possible to demonstrate that a high level of ACAP development enforces the implementation of innovation strategies. Due to the practice of ACAP, routines become more precise in the assessment of tangible and intangible assets that can be used for the development of new improved products or processes and to take advantage of the new knowledge of the environment, improving sustainable performance to develop new products or services as a result of the innovations. Thus, the present empirical research agrees with the hypothetical model (H1-H2-H3) and prior studies conducted by Gao et al. [96] and Valentim et al. [101], who found that ACAP substantially influenced the innovation process, but it depends on the ability of companies to have strategies that enable the constant monitoring of innovation activities with their partners for a new entry of goods or services into the markets, which requires leveraged efforts in research and advertising [102,103].

This study suggests some insights with managerial implications, consequently, the managers and practitioners of the innovation processes should encourage the development of innovation strategies based on PACAP and RACAP continuously, which supports the formulation and implementation of successful strategies. The incorporation of these

routines plays a vital role in addressing innovation activities for the renewal of organizations and value creation in a proactive way, which requires the continuous involvement of leaders and working teams, in collaboration with other firms and stakeholders in the technological ecosystem. These managerial implications include a framework for firms to develop continuous and sustained innovation policies that serve as facilitating mechanisms in the decision-making process to adopt best practices proactively. Then, managers and organizational leaders must promote and transfer innovation capabilities with an internal and external knowledge base and promote the appropriation of innovation strategies to maximize outcomes. The present findings encourage leaders, practitioners, and business owners to cultivate open communication channels, training programs, and an innovation culture to align their routines and practices with technological turbulence and customers' preferences to have a permanent competitive advantage in emerging economies.

## 6. Conclusions

This paper integrates extant literature elements used by researchers of ACAP and the innovation strategy based on solid theoretical grounds and a framework enriching the current knowledge and literature. The data analysis revealed that knowledge ACAP plays a crucial role in the implementation of innovation strategies. Hence, scholars and practitioners should pay special attention to PACAP and RACAP as the key determinants of innovation strategies and business performance [93,104]. The research objective was to explore how ACAP routines strengthen the implementation of innovation strategies. Additionally, this multiple-case study provides interesting insights about relationships between the two disciplines for the development of innovation capabilities, specifically through the results of this empirical study applied to SMEs in the innovation ecosystem of Medellín, Colombia. In this regard, new key variables that help strengthen the existing literature were examined, especially when combined with resources, capabilities, and relationships with stakeholders, and can help to successfully adopt ACAPs in a turbulent context. Moreover, ACAP becomes important in business performance, especially when proactivity is involved in routines and the innovation process, and their relationship is a current topic in the field of knowledge creation [25]. However, the road to success is not easy, as the implementation of an innovation strategy demands firms to respond to or manage risks, government policies, and external conditions that might affect firm performance. Managers may realize that in an environment of aggressive and constantly changing competition, there is a need to find a perfect balance between core competencies and capabilities assessment to leverage potential knowledge generation activities, innovation culture, and collaborative actions with other firms. Then, it would help to make better strategic decisions effectively in the technological context with the vision of the top management.

The managerial implications of this study demonstrate a high development of the acquisition, assimilation, transformation, and exploitation dimensions of knowledge in SMEs, and consequently, better results can be achieved in innovation strategies that enable improvements in the product and service portfolio.

It was evident that there exists a strong correlation between PACAPs and RACAPs and innovation strategies, especially in the technology sector of SMEs in Medellín's innovation ecosystem. Nevertheless, the successful exploitation of capabilities in organizations demands a clear innovation policy, budgets, and a long-term culture. These results are consistent with the contribution of Sancho-Zamora, Rafael, et al. [21], who stated that firms need to improve their capacity to acquire, assimilate, and transform external knowledge in order to improve innovation. Thus, better use of valuable knowledge can gradually be incorporated into the routines of employees to reduce error costs in innovation activities. Practitioners need to understand and encourage the competitive environment and develop communication channels with other companies to enhance knowledge outside the boundaries of the organization. Keeping the innovation strategy updated helps identify new opportunities and reshape the business model toward value creation.

Although this study analyzed the effects of PACAP and RACAP on innovation management strategies in SMEs, the findings identify some important limitations. First, it must be recognized that the conceptual framework presented in this study is not generalizable since the strategic vision, resources, and capabilities are specific to the sample in this study, which was directed to the technological sector. Secondly, the present study included data from 51 companies in a specific restricted internal technological context, and thus quantitative generalization is not possible since SMEs compete in a particular emerging economy. Third, this research analyzes PACAP, RACAP, and innovation strategy and focuses on SMEs with a minimum of ten years of experience in the technological environment as an exclusion factor in the final sample to enhance the data interpretation. However, the final sample did not include companies that, regardless of their years of experience, could have provided more valuable information to understand how they respond to the imminent changes from an ACAP perspective and their influence on innovation strategy.

Finally, to get a better understanding of the effects of ACAP on innovation management, future research may explore the incorporation of new variables; culture, organizational structure, and government policies are possible variables to analyze, as well as other growing sectors such as the human health, textile, and automotive sectors. Further, a comparative cross-country study of industries in emerging economies and innovation ecosystems in different regions is recommended.

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## Appendix A

**Table A1.** Constructs and survey items.

Construct/Dimensions	Question	Item Code
Absorptive Dynamic Capabilities		
Pacap Acquisition	Acquire learning through the company’s communication with universities, public sector institutions, customers, competitors, and suppliers.	P_aqs1
	Systematically search for external information relevant to your business.	P_aqs2
	Invest in R&D activities by allocating a percentage of the company’s annual budget.	P_aqs3
	Conduct training processes for employees to work on innovation projects.	P_aqs4
	Promote knowledge management among employees, in particular regarding the search for relevant external information.	P_aqs5
Pacap Assimilation	The business identifies innovations developed by others	P_asm1
	The business understands innovations developed by others.	P_asm2
	The business adopts innovations developed by others.	P_asm3
	The business assimilates knowledge that comes from outside the organization	P_asm4
	The business maintains a rapid flow of communication, allowing agile exchange of information between units.	P_asm5

Table A1. Cont.

Construct/Dimensions	Question	Item Code
Racap Transformation	Linking the company's knowledge with market innovations.	R_ trf 1
	Integrate the technology created in your company with innovations that comes from outside.	R_ trf 2
	Reconfigure the organization based on the knowledge obtained from the environment.	R_ trf 3
	Adapt strategic decisions based on the knowledge obtained from the environment.	R_ trf 4
	Apply new knowledge in projects portfolio.	R_ trf 5
Racap Exploitation	Use the knowledge obtained from the environment in favor of new products or services of the company.	R_ ept 1
	Adjust the company's technology, processes, or methodologies, by taking advantage of new knowledge from the environment.	R_ ept 2
	Develop new products or services by using innovations or ideas developed elsewhere.	R_ ept 3
	Modify existing products or services by using innovations or ideas developed elsewhere.	R_ ept 4
	Exploiting new products or services resulting from innovations developed.	R_ ept 5
Business Innovation Strategy	The level of commitment of the company's management and support provided for innovation activities.	BIS_ is1
	Your organization has defined a formal strategic plan with the objectives and actions of innovation activities.	BIS_ is2
	How often the organization carries out research and development activities to create new knowledge.	BIS_ is3
	How often the organization the company has offered training specifically for the development and introduction of products/services.	BIS_ is4
	Has the company conducted or contracted feasibility, analysis and industrial engineering studies oriented to the generation of new products or services.	BIS_ is5
	Evaluate the amount of advanced machinery, equipment, and software the company has acquired for new or significantly improved products or processes.	BIS_ is6
	Evaluate the quantity and quality of know-how acquired from other companies for the development of new or significantly improved products.	BIS_ is7
	Evaluate the number and quality of activities that were contracted to introduce new or improved goods or services to the market	BIS_ is8
	Evaluate the quantity and quality of new products or services designed and developed based on actual market needs.	BIS_ is9
	Evaluate the quantity and quality of the contracting that the company has made with other public or private organizations to carry out R&D activities.	BIS_ is10

## Appendix B

Table A2. Sociodemographic characteristics of the companies in the sample.

Enterprise Services	Number of Employees	Year in Business	Position over Total Sample
Telecommunications	41	31	1
Educational	30	28	2
Outsourcing	15	24	3
Security	22	22	4
Software solutions	15	22	5
SMEs software	60	21	6
Government	71	21	7

Table A2. Cont.

Enterprise Services	Number of Employees	Year in Business	Position over Total Sample
Technological support	21	20	8
Data analytics	16	20	9
Data analytics	24	19	10
Software—Hardware solutions	32	18	11
Data analytics	15	18	12
Security	40	18	13
Software development	32	17	14
Human resources	23	17	15
Information security	90	16	16
Data analytics	41	16	17
Data analytics	22	16	18
Management solutions	18	15	19
Cloud computing	63	15	20
IT software	45	15	21
Automatization	50	15	22
Outsourcing	36	15	23
Data analytics	45	15	24
Information security	62	15	25
Outsourcing	85	15	26
Information systems consulting	11	14	27
Security	14	14	28
Mobile applications	29	14	29
Management solutions	27	13	30
Custom-made solutions	42	13	31
Technological support	62	13	32
Software solutions	38	13	33
Manufacturing	35	13	34
Management solutions	71	12	35
Software—Hardware solutions	11	12	36
SMEs Software	94	12	37
Management solutions	112	12	38
Financial	23	12	39
Government	57	12	40
Information systems consulting	30	12	41
TI Global	41	11	42
Management solutions	81	11	43
CRM software development	18	11	44
Human resources	49	11	45
Engineering and T	61	11	46
ERP provider	85	10	47
Technological support	28	10	48
Mobile applications	62	10	49
Information security	18	10	50
Mobile application	38	10	51

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