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An Exploratory Analysis of E-Commerce Adoption Determinants under Environmental Uncertainty in the Food Service Industry

Análisis exploratorio de los determinantes de la adopción del comercio electrónico en un entorno de incertidumbre en el sector de servicios alimentarios

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Resumen

La emergencia sanitaria por COVID-19 perturbó profundamente las operaciones del sector gastronómico, acelerando la adopción de soluciones de comercio electrónico como respuesta a las restricciones impuestas por la pandemia. Este estudio evalúa los determinantes de dicha adopción en empresas del sector durante ese período. Para ello, se emplearon el modelo de Interpretación Estructural (ISM) y el análisis Matrice d'Impacts Croisés Multiplication Appliquée à un Classement (MICMAC), herramientas que permiten examinar la jerarquía, causalidad y dependencia entre variables. Se identificaron 13 factores a partir de la literatura especializada y se recogieron los juicios de 9 restaurantes de la ciudad de Medellín frente a estos. Los hallazgos revelan que el teletrabajo obligatorio derivado de la pandemia y la reducción de la inversión operativa fueron los factores más determinantes para impulsar la transición hacia el comercio electrónico. Asimismo, se evidenció que dicha transición generó beneficios encadenados para las empresas, entre ellos el acceso a una base de consumidores más amplia, la penetración de nuevos segmentos de mercado y la reducción de tiempos en las operaciones cotidianas. El estudio aporta evidencia empírica sobre cómo condiciones de crisis extraordinaria reconfiguran las decisiones de adopción tecnológica en una industria que históricamente ha dependido de la presencialidad.

Palabras clave: Adopción tecnológica; Comercio electrónico; Pequeñas empresas; Servicio de comidas; Transformación digital.

Abstract

The COVID-19 health crisis profoundly disrupted operations in the restaurant industry, accelerating the adoption of e-commerce solutions in response to pandemic-related restrictions. This study evaluates the determinants of such adoption in companies within the sector during that period. To this end, the Interpretive Structural Modeling (ISM) and the Matrice d'Impacts Croisés Multiplication Appliquée à un Classement (MICMAC) analysis were employed, tools that allow

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for the examination of hierarchy, causality, and dependency among variables. Thirteen factors were identified from the specialized literature, and the opinions of nine restaurants in the city of Medellín regarding these factors were collected. The findings reveal that mandatory remote work resulting from the pandemic and reduced operational investment were the most decisive factors in driving the transition to e-commerce. Likewise, it was shown that this transition generated cascading benefits for businesses, including access to a broader consumer base, penetration of new market segments, and reduced time in daily operations. The study provides empirical evidence on how extraordinary crisis conditions reshape technology adoption decisions in an industry that has historically depended on in-person interactions.

Keywords: Technology adoption; Electronic commerce; Small business; Food services; Digital transformation.

Introduction

The restrictions imposed over pasts years have had different types of impact on economic activity. According to Moody's (2020), the leisure and entertainment industry had a higher level of exposure to the pandemic, especially the hospitality sector, due to its dependence on human mobility, which was hit hard at the beginning of the restrictions (Y. Yang et al., 2020). Some examples show the severity of the impact on the sector, where in some countries about 80% of the workforce was laid off as a cost-cutting measure, putting about 11 million jobs at risk (Dube et al., 2021).

In the case of the hospitality industry, some academic studies highlight the different impacts generated as well as possible mitigation strategies in times of crisis (Dube et al., 2021; Madeira et al., 2021; Nhamo et al., 2020; Y. Yang et al., 2020). Despite the great resilience of the sector to other shocks in the past (Israeli, 2007; Kim et al., 2020), it should be noted that the outlook for companies, especially SMEs (small and medium-sized enterprises) in the food and beverage sector, could become bleak and complex in the medium term, both because of possible new waves (Ben Hassen et al., 2021) and the impact generated by past outbreaks (Yilmaz & Şahin, 2021).

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The empirical literature presents diverse approaches to analyzing crises in the hospitality industry, including statistical simulations of pandemic impacts (Dube et al., 2021; Y. Yang et al., 2020), consumer behavior analysis (Wei et al., 2021; Luo & Xu, 2021), and digital transformation strategies (Fusté-Forné & Hussain, 2021; Sardar et al., 2022; X. Yang et al., 2020). While these studies provide valuable insights into crisis management, most focus on general impacts or supply chain perspectives, leaving a gap in understanding the structural relationships among factors driving digital adoption during emergencies.

The escalating digital transformation across industries, particularly in the food service sector during the COVID-19 pandemic, requires a focused examination of the factors that drive the adoption of e-commerce (Suali et al., 2024). This study addresses this need by empirically evaluating the determinants influencing the transition of food service businesses in Medellin to online platforms. Existing literature often examines the general impact of the pandemic on the hospitality industry or focuses on supply chain management within e-commerce (Venkatesh et al., 2015; X. Yang et al., 2020). From the above context, it is essential for the gastronomic sector to reinvent itself and promote alternatives to mitigate the effects of this crisis within the industry and take advantage of technology as a tool to facilitate the insertion in new forms of relationships (Ahachmi et al., 2025; Buhalis et al., 2019). In this sense, this study empirically evaluates the determining factors for the transition of SMEs in the gastronomic sector towards the use of digital channels to mitigate the crisis generated by the COVID-19 pandemic in the city of Medellin. For this purpose, an interpretative structural model (ISM) is used to weigh the strategic importance that these factors play in the transition to digital media.

Furthermore, studies of digital transformation in SMEs often use well-established theoretical frameworks, such as the Technology-Organization-Environment (TOE) model. As Ramdani et al. (2013) demonstrated, the TOE framework is a useful tool for categorizing determinants into technological, organizational, and environmental dimensions to explain the adoption of enterprise applications. However, this study uses Interpretive Structural Modeling (ISM) to complement these approaches by focusing on the systemic interrelationships and hierarchies between specific factors. While traditional adoption models effectively identify which variables influence a decision, they often treat these variables as independent or linear components. In the unique context of the pandemic, where e-commerce adoption was reactive rather than

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proactive, it is essential to identify the causal links and dependencies within the system. Thus, implementing ISM and MICMAC analysis alongside traditional adoption theories extends their utility by providing a structural decomposition that reveals the driving power and dependency of each factor within the specific business environment of Medellín's food service industry.

Considering the approaches addressed so far in recent literature, this study aims to evaluate the determinants of e-commerce adoption in companies in the gastronomic sector during the COVID-19 pandemic. This work will contribute new knowledge to the study of crisis management strategies applied to the case of the food sector, from the perspective of supply in the use of virtual channels but implementing methodological tools different from those used in this field of knowledge. It is important to note that although there are several works on online strategies for this industry, their focus has been more oriented to the issue of supply chain management (Reardon et al., 2021) and exploring the impact from a multicriteria perspective in the broad sense of tourism (Chang & Wu, 2021). Therefore, considering the literature consulted, this paper represents the first approach from a structural perspective (in terms of factor relationships) of the determinants of e-commerce versus the pandemic, specifically in the case of SMEs.

This context highlighted the critical need for businesses to adapt and explore alternative operational strategies, with e-commerce emerging as a vital avenue for survival and continuity. Understanding the specific factors that drove or hindered the adoption of e-commerce in this sector is crucial to inform future business strategies, guide policy interventions, and contribute to the broader academic discourse on digital transformation in times of crisis. While the acute phase of the pandemic has subsided, the study of e-commerce adoption in the hospitality sector during this period remains highly relevant. The rapid digital adaptations made by businesses under emergency conditions offer valuable insights into organizational resilience and the potential for accelerated technological integration (Browder et al., 2024). In addition, shifts in consumer behavior toward online platforms, initially driven by necessity, have in many cases persisted and evolved into new norms (Corvo et al., 2022; Fang, 2022). Understanding the factors that facilitated or impeded e-commerce adoption during the pandemic can therefore inform strategies for sustainable digital engagement and competitive advantage in the current context. Lessons learned from this period can also provide critical guidance for future crises or periods of significant market disruption,

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enabling companies and policymakers to make more informed decisions about digital transformation and operational adjustments.

The remainder of this paper is organized as follows: Section 2 presents a comprehensive literature review on the application of e-commerce in SMEs during the pandemic, the use of the ISM model in solving business problems, and recent studies on the impact of COVID-19 on the food service industry. Section 3 describes the methodology used, including the structuring of the factors, the sample selection process, the data collection tool, and the application of the ISM and MICMAC models. Section 4 presents the results obtained from the analysis, while Section 5 discusses these results in relation to the existing literature. Finally, Section 6 concludes the paper by summarizing the main findings, addressing the limitations of the study, and providing recommendations for future research.

E-Commerce adoption and covid-19 challenges in the gastronomic sector: a comprehensive review

The theoretical foundations of this research are rooted in the intersection of three primary conceptual currents. First, contingency theory provides a framework for understanding how external disruptions, such as the pandemic, necessitate alignment between organizational structure and environmental volatility (Lawrence & Lorsch, 1967). Recent scholarship confirms that digital transformation often functions as a contingency response, dictating the orientation of quality management and operational performance during periods of market instability (Bhatia & Kumar, 2023; Hentati et al., 2025; Ponsignon et al., 2026). Second, the Resource-Based View (RBV) posits that adopting e-commerce mobilizes internal IT capabilities to secure a competitive advantage (Barney, 1991; Lockett et al., 2009). From this perspective, digital transformation is driven by developing dynamic capabilities and technological resources that enhance innovation performance in SMEs (Abdurrahman, 2025; Civelek et al., 2023; Nwankpa & Roumani, 2016). Finally, systems theory provides the structural logic necessary to analyze the interrelationships within complex organizational systems (Luhmann, 2013). This multi-theoretical approach allows one to understand enterprise digitalization as an emergent phenomenon, where sustainability and survival depend on the interaction of multiple variables (Ou & Tian, 2025; Valentinov et al., 2023).

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Synthesizing these perspectives justifies using a structural methodology (ISM/MICMAC) to move beyond descriptive analysis and establish the causal hierarchy of factors in Medellín's food service industry.

The following literature review examines the impact of the pandemic on the restaurant industry and the adoption of e-commerce as a survival strategy for SMEs. It also provides an overview of recent studies that address the challenges faced by restaurants during the health crisis and examines the applications of the Interpretive Structural Modeling (ISM) approach to solving complex business problems.

Digital transformation and e-commerce adoption in SMEs during the pandemic

The pandemic has become a catalyst for trends that have been developing for several years. One of the most obvious examples is the exponential growth of e-commerce, which had been growing rapidly but has skyrocketed in the last two years (Barrios et al., 2021). Thus, the emergence of e-commerce and online shopping has initiated a new episode in human life and changed commercial patterns (Ngai & Wat, 2002). In this sense, online shopping provides access to a wider range of products and facilitates their delivery, which has increased demand (Adibfar et al., 2022; Rangaswamy et al., 2022). Guthrie et al. (2021) found that online consumers react, cope, and then adapt to stressful life events such as the COVID-19 pandemic, validating the usefulness of the react-cope-adapt framework of constrained consumer behavior in an online environment.

In parallel, the spread of COVID-19 has restricted the movement of consumers, workers, industries, and distribution centers to mitigate increased infection and spread of the virus (Reardon et al., 2021). However, such measures have had a direct impact on the reality and operation of businesses in all types of sectors such as transportation, tourism, manufacturing, and food (Kala'lembang, 2021). Various studies and reports indicate that SMEs have been the most affected by such restrictions, leading to total and temporary closures, significant staff reductions, and disinvestment of resources in businesses (Adan et al., 2022; Robayo-Botiva et al., 2022; Ruiz, 2021). In Colombia, micro, small, and medium-sized enterprises (MSMEs) represent more than 90% of the business fabric (Ministerio de Comercio, Industria y Turismo, 2023), further exacerbating the business crisis caused by the pandemic.

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Despite the uncertain outlook, the restrictions of the health crisis have forced SMEs to explore alternative strategies, such as the implementation of e-commerce, to overcome the adversities (Palomino et al., 2020). In this sense, Robayo-Botiva et al. (2022) state that the use of e-commerce has been a vital factor for the survival of service firms in Colombia, as it allows contact with their consumers and the development of new service modalities, such as home delivery. The implementation of this type of tools in SMEs has brought significant improvements to businesses, such as: i) greater reach of potential customers; ii) improvements in customer service and communication; iii) savings in operating costs; iv) better coordination between areas; and v) agility in payment systems (Alfonso et al., 2021; Kala'lembang, 2021; Tran, 2021).

In parallel with these advantages, it is also important to note that the adoption of e-commerce requires companies to invest in technological infrastructure, training, and digital marketing (Robayo-Botiva et al., 2022) and to be aware of the legislation governing e-commerce in the country (Tapia et al., 2021). In this sense, Tapasco and Garcia (2020) identify that the underlying barriers to the acceptance of telework in Colombia are: lack of knowledge, resistance to change, problems of teleworker control, fear of uncertainty and information security. Similarly, Flores-Cueto et al. (2020) highlight access to and use of technology as a constraint to the advancement of teleworking, given its critical role in its development. In addition, the adoption of technological tools must be compatible both with the legislation in the case of teleworking and with the operational functions and specific objectives of the company, effectively mitigating the recently emerging problems (Hoang et al., 2021; Tran, 2021).

Based on the above arguments, it can be stated that the covid-19 pandemic has created an indirect opportunity for SMEs to explore the usefulness and benefits of adopting e-commerce, but this brings with it multiple challenges for the transition (Rodríguez et al., 2020). Thus, companies that adapt their work teams to the new conditions imposed and identify new market consumption habits will have a better chance of coping with the internal and external demands of the pandemic (Hashem, 2020; Mandasari & Pratama, 2020; Veeragandham et al., 2020).

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E-commerce in the food service industry

Prior to the pandemic, e-marketing had already been implemented in SMEs and demonstrated benefits in terms of application and operational costs. Qashou and Saleh (2018) found that relative advantage, customer pressure, and market scope significantly influenced e-marketing acceptance and implementation in small and medium restaurants in Palestine. They also found a positive and significant relationship between e-marketing acceptance and implementation and marketing performance. The health restrictions caused by the pandemic have affected the functioning and stability of organizations in all industries. However, the negative effects have been particularly accentuated in sectors related to tourism and entertainment, with restaurants and food service establishments being one of the hardest hits and most affected segments (Guo et al., 2021; Lai et al., 2020; Zeb et al., 2021). This adverse situation has led to the development of several studies related to restaurants and their response to the impact of the health crisis. Studies on the impact underlying changes in consumer preferences during the pandemic stand out, noting the preference for home delivery, private dining, and other modalities that provide safety to consumers (Kim & Lee, 2020). Other determinants of consumer intentions include the influence of aspects such as excitement about sharing, trust in official reports of declining cases, familiarity with restaurants, or simply a sense of solidarity with the food industry during the crisis (Byrd et al., 2021; Hakim et al., 2021). Ferriera Rodrigues et al. (2021) found that Brazilian consumers are prioritizing homemade preparations and fresh food, reducing their trips to markets and using delivery services and shopping platforms.

On the other hand, there are studies developed around the strategies, innovations and changes in the business model implemented by restaurants in the face of the aforementioned challenges. Here, studies mention the implementation of safety protocols, new menus, and social distancing as strategies reported during the first months of confinement (Kim et al., 2021; Zeb et al., 2021). Nevertheless, the mere implementation of safety protocols and care processes has shown little effectiveness in generating sustainability during the crisis (Nhamo et al., 2020). Against this backdrop, a greater number of studies stand out that recommend the implementation of much more drastic changes for restaurants and their operations, involving the adoption of new innovation models, the generation of resources through government aid and preferential loans, new payment

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systems, and digital attention to orders (Bai et al., 2021; Gavilan et al., 2021; Harms et al., 2021). Likewise, the objectives and priority factors also tend to mutate given the demands of the context, paying greater attention to generating perceptions of innovation and creativity in services, solidarity in language with consumers, creating unique customer experiences to increase reputation, and expanding the offer of activities or services to obtain the highest possible profitability on each visit (Lai et al., 2020; Brizek et al., 2021). Based on these new priorities and strategies, managers at the head of restaurants and catering companies are moving towards the use of new approaches to the operation of restaurants and the focus of their marketing and sales budgets to migrate towards the use of digital media and the establishment of partnerships with intermediary companies (apps, platforms, carriers) that allow them to be sustainable in these uncertain times (Dirsehan & Cankat, 2021; Reardon et al., 2021; Yost et al., 2021).

In summary, the reviewed literature suggests that the determinants of e-commerce adoption in the food service industry can be grouped into three theoretical dimensions: i) Operational efficiency, which includes cost reduction and resource optimization (Tran, 2021; Qashou & Saleh, 2018); ii) Market positioning, which is related to reaching new market segments and consumers (Rangaswamy et al., 2022); and iii) External drivers, which include health policies and technological trends triggered by the pandemic (Reardon et al., 2021). These categories provide the theoretical foundation for the thirteen specific factors evaluated in this study, ensuring that the measurement instrument is deeply rooted in the sector's current empirical reality.

Applications of the ISM model to business problems

Given the importance of decision making and its impact on the proper functioning of organizations, tools that improve this type of process have become particularly important for businesspeople and researchers in this field (Chica-Salgado, 2013). In this sense, multicriteria analysis (MCDM) models are characterized by their ability to support the solution of different problems where uncertainty prevails and multiple alternatives and evaluation criteria are involved, as is the case in business environments and problems present in organizations (Zavadskas & Turskis, 2011). In particular, in the last decade, one of the most popular methodological tools among researchers corresponds to the ISM, which is a method developed by Warfield (1974) that

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allows identifying the order and interaction of the variables that make up a given problem or complex system, through its hierarchical decomposition based on the level of influence or dependence that the variables have on each other.

In general, the ISM model works by creating a structural diagram that describes the complex relationships that exist between the variables of a system, allowing the hierarchical structure through which a given problem operates to be identified in a simplified manner (Venkatesh et al., 2015). Thus, given its usefulness in the identification of variables for decision making, this method allows the solution of complex problems in various business issues. It has been used in the analysis of barriers to knowledge management (Singh & Kant, 2008). In other cases, it has been used to identify barriers to IT implementation (Agrawal et al., 2019). This tool is also useful for analyzing employee perceptions of human resources department practices (Das et al., 2020). More recent studies relate to solving digitization and finance issues in supply chain management (Marak & Pillai, 2021). Finally, it has been of great use in various problems in the service, gastronomy and restaurant sectors, such as those studied by Kala (2020), who determined the factors of memorable food and restaurant experience and modeled the interrelationships among them using ISM in the mountainous destination. Abdollahzadeh (2021) used ISM and MICMAC analysis to identify the factors affecting the sustainable development of food services and provide action plans for improvement in the city. Chacko et al. (2022) used ISM to identify the most challenging factor that poses a significant threat to the food franchise. Nevertheless, no applications of the ISM model have been identified specifically focused on the relationship of the explanatory variables of the transition to e-commerce as a response to the COVID-19 pandemic, which is a topic of interest for research and preparation of companies in this segment of the service sector.

Methodology

The methodology is divided into four sections. The first section details the structuring of the set of variables to be studied, based on various references in the field. The second section describes the sampling process in the selected companies. Subsequently, the composition of the primary data collection instrument is mentioned. In the fourth section, the proposed model is

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described in detail to decompose the problem posed in a hierarchical structure of influence and dependence. As a final step, the fifth section describes how the variables are distributed in quadrants according to their degree of power or dependence within the set.

Structuring factors for the use of e-commerce

According to the literature and general business dynamics, there are many reasons for current businesses to migrate their operations from traditional commerce to e-commerce. With this in mind, we sought to structure and measure a set of benefits that would cover both internal and external motivators that exist in foodservice SMEs when considering e-commerce as a business alternative. The 13 factors presented in Table 1 represent an adaptation and expansion of the e-commerce benefits framework initially proposed by Dinesh and MuniRaju (2021), who identified scalability factors for e-commerce during the pandemic. Building upon their work and incorporating insights from complementary literature on digital transformation in SMEs (Bai et al., 2021; Hoang et al., 2021; Tran, 2021; Rangaswamy et al., 2022; X. Yang et al., 2020), we structured these factors into three theoretical categories: (i) operational efficiency factors (F1-Cost reduction, F6-Reduction in operational investment, F9-Time reduction in all company activities), which address resource optimization and process improvement; (ii) market expansion factors (F2-Reaching new market segments, F3-Service excellence, F8-Access to unlimited consumers), which relate to market positioning and customer reach; and (iii) technological enablement factors (F4-Availability of specialized software, F5-Mandatory teleworking policies, F7-Availability to make and receive payments, F10-Possibility of extended opening hours, F11-Constant communication with customers and suppliers, F12-Ensuring quality control, F13-Fulfill company functions), which encompass the tools, policies, and capabilities required for digital operations. This categorization ensures that the measurement instrument is theoretically grounded while capturing the specific realities of food service SMEs during the health crisis.

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Table 1

Determining factors for the use of e-commerce

Factor	Category	Operational definition	Literature support
F1: Cost reduction	Operational Efficiency	Decrease in operational expenses through digital channels	Qashou & Saleh (2018); Bai et al. (2021)
F2: Reaching new market segments	Market Expansion	Ability to access previously unreachable customer groups	Qashou & Saleh (2018); Rangaswamy et al. (2022)
F3: Service excellence	Market Expansion	Enhanced service quality through digital tools	Tran (2021)
F4: Specialized software availability	Technological Enablement	Access to industry-specific digital solutions	Hoang et al. (2021)
F5: Mandatory teleworking policies	Technological Enablement	Government-imposed remote work requirements	Tapasco & García (2020)
F6: Reduction in operational investment	Operational Efficiency	Lower capital requirements for digital vs. physical operations	Bai et al. (2021)
F7: Payment availability	Technological Enablement	Digital payment processing capabilities	Hashem (2020)
F8: Access to unlimited consumers	Market Expansion	Global reach potential of e-commerce	Rangaswamy et al. (2022)
F9: Time reduction	Operational Efficiency	Process acceleration through automation	Qashou & Saleh (2018)
F10: Extended opening hours	Technological Enablement	24/7 availability of digital platforms	Tran (2021)
F11: Constant communication	Technological Enablement	Continuous customer-business interaction	X. Yang et al. (2020); Tran (2021).
F12: Quality control assurance	Operational Efficiency	Monitoring and quality management capabilities	Qashou & Saleh (2018)
F13: Fulfill company functions	Operational Efficiency	Maintaining core business operations digitally	Qashou & Saleh (2018)

Note. Own elaboration.

Sample selection process

After clarifying the factors to be analyzed, these variables were evaluated from the specific perception of experienced entrepreneurs involved in the gastronomic sector, who could identify the determining factors in their transition to digital channels. Using local tourism search engines, a total of 190 small and medium-sized restaurants in the city of Medellin were identified. From these, a sample of nine restaurants was obtained through non-probabilistic convenience sampling, dictated primarily by accessibility constraints during the pandemic (Otzen & Manterola, 2017). Given the severe operational restrictions imposed during 2020, most restaurants were either temporarily closed or operating under strict capacity limitations, which significantly restricted

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researcher access to potential participants. The sampling approach was therefore opportunistic rather than criterion-based, selecting those establishments whose managers were both available and willing to participate during the data collection period. While this approach limits the sample's representativeness, it was the only feasible method under the circumstances and aligns with the ISM methodology's emphasis on expert judgment rather than statistical generalization (Gardas et al., 2017). Despite these constraints, the final sample achieved diversity in restaurant type (fast-food, casual dining, fine dining, themed restaurants, and buffet) and managerial experience (ranging from 0.7 to 15 years in the sector), as detailed in Table 2.

Table 2

Profile of the experts surveyed

Restaurant ID	Type	Position	Academic level of manager	Experience in the gastronomic sector (years)
R1	Fast-food	Owner	Undergraduate student	15
R2	Fast-food	Manager	Diploma	7
R3	Casual dining	Manager	Diploma	5
R4	Casual dining	Manager	Diploma	5
R5	Themed restaurant	Manager	Diploma	4
R6	Fine dining	Manager	Diploma	2
R7	Fast-food	Manager	Bachelor's Degree	2
R8	Themed restaurant	Manager	Bachelor's Degree	1,5
R9	Buffet	Manager	Bachelor's Degree	0,7

Note. Own elaboration.

Data collection tool

The information-gathering tool used in the selected restaurants sought to understand how business owners viewed the factors affecting their establishments during the pandemic, based on their individual experiences and the specific circumstances of their businesses. Likewise, the questionnaire was accompanied by informed consent, previously approved by the ethical committee of the project to which this study belongs, regarding anonymous participation and the exclusive academic use of their contributions. The questionnaire was divided into two sections: the first section collected details about the experts, including their job titles, educational qualifications, and length of experience in the restaurant industry. The subsequent section used a

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paired matrix to assess the relationships or interactions between the identified factors, as shown in Table 3. Experts assigned one of four ratings (*V, A, X, or O*) to reflect the perceived relationships: *V* indicated that factor *i* influenced factor *j*, *A* indicated that factor *j* influenced factor *i*, *X* represented a reciprocal influence between factors *i* and *j*, and *O* indicated no connection between the two factors.

Data collection was conducted between August and October 2020. Restaurant managers were initially contacted by telephone to explain the study objectives and request participation. Upon agreement, self-administered questionnaires were completed in-person at each establishment following strict biosafety protocols, with researchers available to clarify the 13 factors and guide participants through the paired comparison matrix. All questionnaires were administered by the same two researchers to ensure methodological consistency.

Table 3

Model of questionnaire

Factor *i*	**Factor *j***												
	13	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
1. Cost reduction													
2. Reach new market segments													
3. Efficient use of resources													
4. Widespread increase in the use of electronic devices													
5. Mandatory teleworking policies due to the COVID-19 pandemic													
6. Reduction in operational investment													
7. Availability to make and receive payments													
8. Access to unlimited consumers													
9. Time reduction in all company activities													
10. Possibility of extended opening hours													
11. Constant communication with customers and suppliers													
12. Responsiveness in customer service													
13. Fulfillment of the company's functions													

Note. Prepared by the authors.

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Interpretive Structural Modelling

The ISM approach is designed to make sense of unclear mental concepts by transforming them into well-defined structures that reveal how a problem or system operates (Sage, 1977). This method relies on recognizing both direct and indirect links between variables and organizing them into levels based on their degree of influence or dependence on other variables within the problem (Gardas et al., 2017; Janes, 1988; Malone, 1975). As outlined by Warfield (1974), the application of the ISM model involves the following steps: i) identifying the variables to be studied; ii) establishing their contextual relationships through expert insights; iii) creating a self-interaction matrix for the variables; iv) forming an accessibility matrix; v) dividing the matrix into levels according to influence and dependence; and vi) constructing a hierarchical diagram of the variables.

Matrice d'Impacts Croisés Multiplication Appliquée à un Classement (MICMAC) Analysis

MICMAC analysis, first introduced by Duperrin and Godet in 1973, is a technique that focuses on exploring the interactions among variables in a complicated problem by evaluating their direct and indirect links. It visually illustrates the levels of autonomy, influence, linkage, and dependence among the components under analysis (Sharma & Gupta, 1995). Because of its compatibility with the goals of the ISM model, MICMAC is often used alongside it in various studies, helping to uncover relationships and classifications that may not be apparent using ISM alone (Jadhav et al., 2015; Hughes et al., 2020).

Extending this, the MICMAC analysis uses the totals from the rows and columns of the full set of factors to plot and divide the variables into four quadrants. These quadrants classify the variables as: 1) autonomous variables, which have little influence or dependence on others, resulting in limited impact; 2) driving variables, which have strong influence on other elements, making them highly significant to the problem; 3) linking variables, which have both high dependence and influence, acting as connectors between the elements of the other quadrants; and 4) dependent variables, which are largely shaped and influenced by the rest of the set's components.

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Results

First, regarding the ISM model results, the individual judgments provided by business owners on the relationships among the proposed factors were converted into binary values, where scores X and V were coded as 1, and scores A and O as 0. We then attempted to synthesize the ratings into a single overall perspective. For this purpose, the data were grouped using the geometric mean, as recommended in recent ISM applications (Prakash & Ambekar, 2026) and as shown in Table 4. The sum of the rows corresponds to the power of influence that a given factor has on the others in the set, while the sum of the columns refers to the degree of dependence that a given factor has on the rest of the factors. Finally, the factors are ranked (from I to VI) according to their level of influence and total dependence.

Table 4

Accessibility matrix

Factor *i*	Factor *j*													Driving power	Ranking
	1	2	3	4	5	6	7	8	9	10	11	12	13		
1. Cost reduction	1	0	1	0	0	0	0	0	0	0	0	0	0	2	VI
2. Reach new market segments	0	1	1	0	0	0	0	0	0	0	0	0	0	2	VI
3. Efficient use of resources	1	1	1	1	0	1	0	0	0	0	0	0	1	6	III
4. Widespread increase in the use of electronic devices	0	1	0	1	0	0	1	1	0	0	0	0	0	4	IV
5. Mandatory teleworking policies due to the COVID-19 pandemic	0	0	0	0	1	0	0	0	1	0	0	1	0	3	V
6. Reduction in operational investment	0	0	0	0	0	1	0	0	0	0	0	0	0	1	VII
7. Availability to make and receive payments	0	0	0	1	0	0	1	0	0	0	0	0	1	3	V
8. Access to unlimited consumers	0	1	0	0	0	0	0	1	1	1	1	0	1	6	III
9. Time reduction in all company activities	0	0	0	0	1	0	0	1	1	1	1	1	1	7	II
10. Possibility of extended opening hours	0	0	0	0	0	0	0	1	1	1	0	0	0	3	V
11. Constant communication with customers and suppliers	0	1	0	0	0	0	0	1	1	0	1	0	0	4	IV
12. Responsiveness in customer service	0	1	0	1	0	0	0	0	1	0	0	1	0	4	IV
13. Fulfillment of the company's functions	1	1	1	0	0	0	1	1	1	0	0	1	1	8	I
Dependence power	3	7	4	4	2	2	3	6	7	3	3	4	5		
Ranking	V	I	IV	IV	VI	VI	V	II	I	V	V	IV	III		

Note. Own elaboration.

Based on the levels previously established in the accessibility matrix, the factors are decomposed according to their relationship with the others, as shown in Table 5. The individual effects of the factors are distributed among the Reachability Set (factors that were influenced), the

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Antecedent Set (factors that influence them) and the Intersection Set, for factors with reciprocal effects. The purpose of this decomposition is to identify the variables with the greatest influence on the transition to e-commerce in companies in the catering sector and to create successive levels according to this level of relationship.

Table 5

Level of interaction of the factors

Barrier number	Reachability Set	Antecedent Set	Intersection	Level
1	1,3	1,3,13	1,3	V
2	2,3	2,3,4,8,11,12,13	2,3	I
3	1,2,3,4,6,13	1,2,3,13	1,2,3,13	IV
4	2,4,7,8	3,4,7,12	4,7	IV
5	5,9,12	5,9	5,9	VI
6	6	3,6	6	VI
7	4,7,13	4,7,13	4,7,13	V
8	2,8,9,10,11,13	4,8,9,10,11,13	8,9,10,11,13	II
9	5,8,9,10,11,12,13	5,8,9,10,11,12,13	8,9,10,11,12,13	I
10	8,9,10	8,9,10	8,9,10	V
11	2,8,9,11	8,9,11	8,9,11	V
12	2,4,9,12	5,9,12,13	9,12	IV
13	1,2,3,8,9,12,13	3,7,8,9	8,9	III

Note. Own elaboration.

As a final result of the ISM model, based on the classification levels identified, a hierarchical scheme was developed to represent the mental map of the variables perceived in the reality of the entrepreneurs of the gastronomic sector, as shown in Figure 1. This scheme made it possible to identify the direct and indirect relationships around the subject of study, explicitly indicating the incidence of different aspects in the decision making of entrepreneurs in uncertain and turbulent times, such as the pandemic. The final interaction structure determined that factors 6-reduction in operational investments and 7-mandatory teleworking policies due to the health policy restrictions were the most influential aspects among the variables for the adoption of e-commerce within restaurant operations. Next, the influence of other factors related to the benefits of using digital channels was also highlighted, such as 11-constant communication with customers and suppliers, 10-possibility of extended opening hours, 7-availability to make and receive payments, and 1-cost reduction. Meanwhile, the factors that presented greater dependence within the system were associated with the strategic benefits of marketing through digital media in

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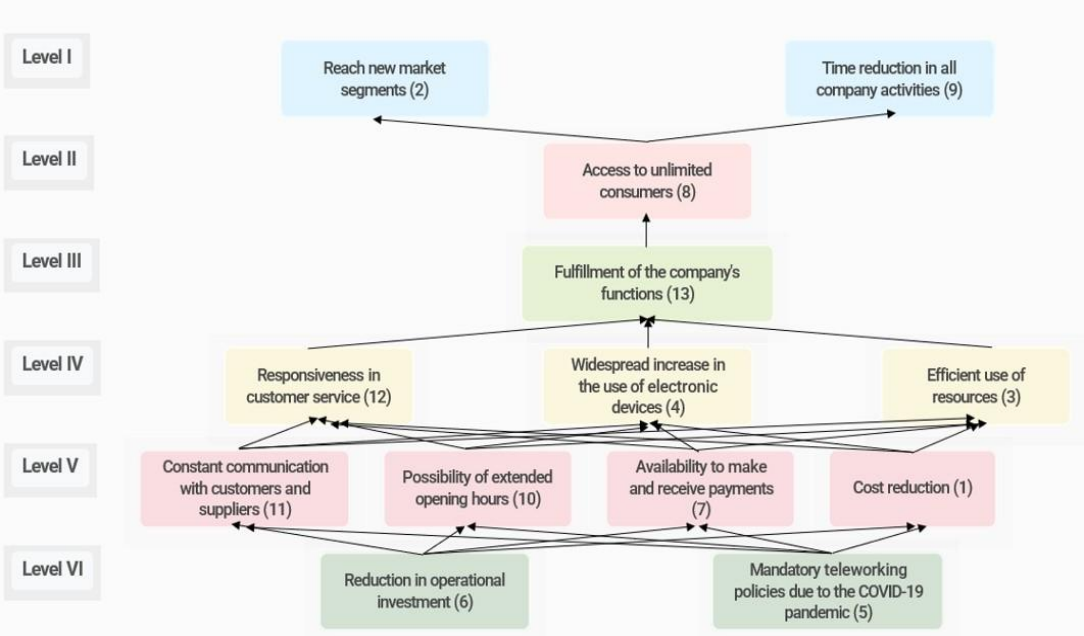
business, such as 2-Reaching new market segments, 9-Time reduction in all business activities, and 8-Access to unlimited consumers.

Figure 1

Interaction model of factors in the digitalization of the gastronomy sector



Note. Own elaboration using Genspark.

To complement the previous results, although the hierarchical structure proposed by the ISM model highlighted notable influences among the variables studied, when performing the MICMAC analysis, the results showed that most of the elements were located in the quadrant of autonomous variables, indicating that although there was an impact with other variables, the relationships were not strong enough to be interpreted as highly influential or dependent within the problem, as shown in Figure 2. "Constant communication with customers and suppliers" (F11) emerges as an independent factor, uniquely positioned to drive change with minimal dependency, making it a strategic priority. The linkage quadrant, rich with factors such as "Fulfill company functions" (F13) and "Reduce time in all company activities" (F9), serves as the core of the system, where high influence and interdependence require balanced interventions. "Reaching new market segments" (F2), in the dependent quadrant, reflects the end goal of adoption efforts, which is

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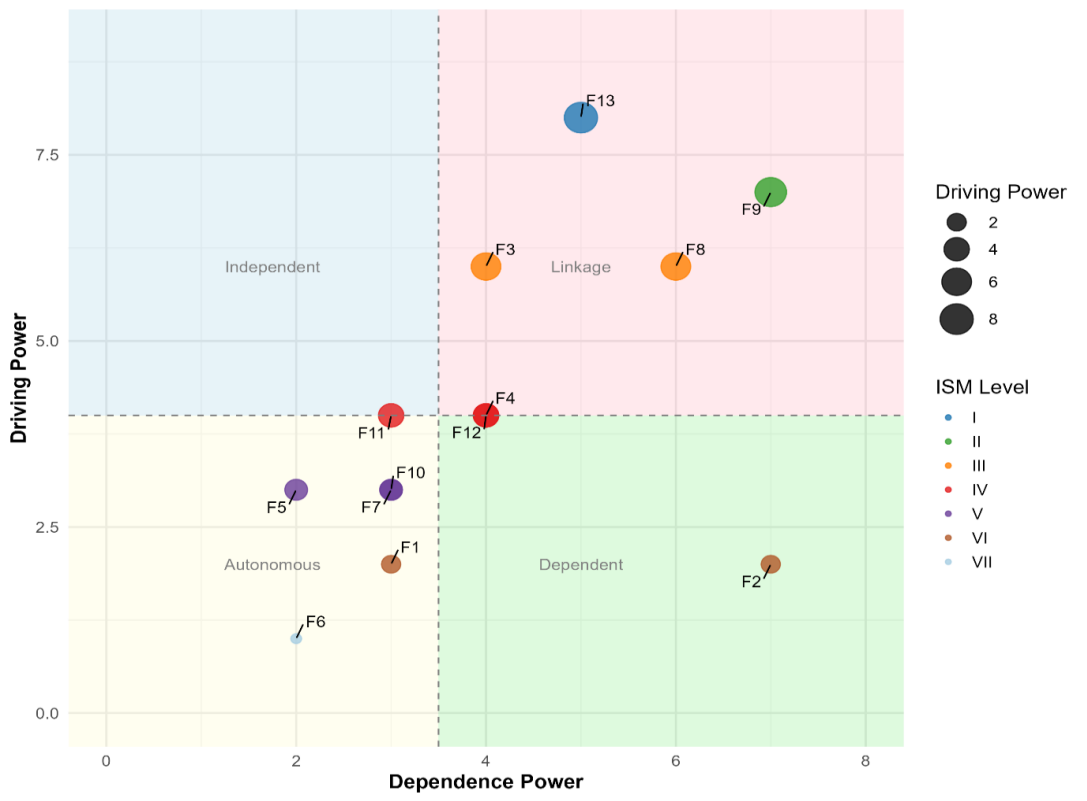
shaped by other factors. Autonomous factors, such as "cost reduction" (F1), remain peripheral with limited systemic impact. Strategies should therefore prioritize improving communication (F11), optimizing linkage factors, and pursuing market expansion (F2).

Figure 2

Results of the MICMAC graphical analysis



Note. Own elaboration using Grok and R software.

These structural findings reveal notable tensions within the food service sector's digital transformation process. The positioning of mandatory teleworking policies (F5) and reduced operational investment (F6) as foundational drivers suggests that the adoption was predominantly reactive rather than strategic, driven by external necessity rather than competitive advantage seeking. This reactive nature is further evidenced by the high dependence of strategic benefits (F2-market expansion, F9-time reduction) on the stabilization of operational functions, indicating that restaurants prioritized survival over growth during the crisis. Furthermore, the divergent

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positioning of factors between the ISM hierarchy and MICMAC quadrants—particularly the autonomous classification of several operational factors—suggests that while these elements influenced each other within the sample studied, their broader systemic impact may be context-dependent and tied specifically to the emergency conditions of 2020. This contextual specificity raises questions about the persistence of these structural relationships in post-pandemic scenarios and highlights the need for longitudinal research to assess whether the forced digital adoption has led to permanent strategic reorientation or merely temporary operational adjustments in the gastronomic sector.

Discussion

The results obtained from the ISM and MICMAC models align with existing literature on e-commerce adoption during crisis periods. Consistent with current empirical evidence, mandatory teleworking (Factor 5) emerged as one of the most determinant factors. This is understandable, since national restrictions have led restaurants to seek new alternatives, such as digitalization, in order to prevail in the face of the health crisis and to cope with the new consumption habits of the population, as has already been observed in numerous cases (Ferreira Rodrigues et al., 2021; Guthrie et al., 2021). Similarly, the reduction in investment, with reference to factors 6-reduction in operational investment and 1-cost reduction, has also played a fundamental role in the decision making of entrepreneurs regarding the use of e-commerce. According to Bai et al. (2021), its implementation has a relatively low cost and with the redesign of operations under the use of new technologies, it is also possible to reduce operating costs and improve the overall efficiency of companies.

Several of the intermediate factors (from level II to V) within the structure proposed by the ISM model also had a high influence on the use of e-commerce strategies in other studies, with 11, 7, and 13 being the most recurring factors. Regarding Factor 11-Continuous Communication with Customers and Suppliers, references such as Y. Yang et al. (2020) and Tran (2021) emphasize that through e-commerce platforms, it is possible to improve communication with consumers, create bonds of trust with the brand, and maintain a continuous customer-seller relationship during the health crisis. Similarly, the usefulness of Factor 7-Availability to make and receive payments

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stands out, given that consumers in the current situation seek to have as little contact as possible, leading restaurants and other companies in the food sector to offer the possibility of making electronic payments through digital platforms and other alternative means (Hashem, 2020). With regard to factor 13-Fulfilling the company's functions, authors such as Qashou and Saleh (2018) emphasized that the use of e-commerce improves the company's operational functions, as it enhances the monitoring of various processes, improves responsiveness to market needs, and allows for direct feedback from consumers. However, in order to achieve these benefits, restaurants need to overcome many challenges in adapting and changing their traditional operational structures.

Similarly, it is worth highlighting that both the ISM model and the MICMAC tool considered factor 2 - reaching new market segments - as the variable with the highest degree of dependence on the union and functioning of the rest of the factors, according to the perspective of the entrepreneurs surveyed. These results are in line with the study postulated by Qashou and Saleh (2018), who state that entrepreneurs in the gastronomic sector would not adopt the use of digital platforms if it did not represent a real benefit or a clear opportunity to reach new markets and business opportunities. Therefore, the achievement of new markets is a primary factor for restaurants to explore e-commerce platforms and adopt them in their operations. At this point, it is worth mentioning that at the time of interviewing the entrepreneurs, several of the respondents indicated that with the increased use of digital platforms, they were able to increase their sales even more than in a face-to-face situation. This indicates that, although the use of e-commerce platforms has acted as a reactive strategy for the gastronomy sector, which has been severely affected by the pandemic, its correct adoption within the operation of restaurants can lead to reaching new markets and opportunities not previously considered by companies in this sector.

The divergence between our MICMAC results and previous literature warrants critical examination. While MICMAC positioned F13 (fulfilling company functions) as a linkage variable with moderate influence, studies in non-crisis contexts suggest this factor plays a more dominant role in technology adoption decisions (Qashou & Saleh, 2018). This discrepancy may reflect a fundamental difference in adoption logic between crisis-driven and opportunity-driven digitalization. In emergency conditions, the imperative to maintain basic operations may paradoxically reduce the strategic weight of operational optimization, as survival—not

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efficiency—becomes the primary objective. Furthermore, our findings show that F2 (reaching new markets) has high dependence despite being cited in literature as a primary motivator (Qashou & Saleh, 2018). This inversion challenges the assumption that market expansion drives digital adoption in SMEs. Instead, our results suggest that in resource-constrained crisis scenarios, market opportunities may be viewed as aspirational outcomes rather than immediate drivers, emerging only after foundational operational challenges are addressed. These contradictions highlight the context-sensitivity of digital transformation models and question the universal applicability of frameworks developed in stable economic environments. The crisis context appears to have fundamentally reorganized the causal structure of adoption determinants, suggesting that theories of technology adoption may require contingent modifications to account for environmental volatility and organizational emergency states.

Finally, while the application of ISM and MICMAC analysis has elucidated the structural relationships as perceived by the surveyed experts, the interpretation and potential generalization of these findings require careful consideration of the study's methodological parameters. In particular, the reliance on expert judgment based on the subjective perceptions of a limited group (nine restaurants) means that the derived hierarchical structure and MICMAC quadrant positions reflect the collective view of this specific sample rather than statistically validated causal relationships across the industry. Furthermore, the purposive sampling strategy, while practical under pandemic constraints, prevents statistical generalization of results to the broader population of gastronomic SMEs in Medellin or other geographic regions. The exclusive focus on restaurants may also overlook unique factors or dynamics present in other food service segments, potentially limiting the applicability of the model beyond the context studied. The volatile nature of the crisis and the evolving business environment suggest that the perceived influence and dependence of these factors may have changed over time, making the findings more of a snapshot of a particular moment in time than a representation of enduring relationships. Consequently, while this study provides an initial structural understanding of the determinants of e-commerce adoption based on expert perceptions during a critical period, the findings should be considered exploratory and contextual, and further research using different methodologies and broader samples is needed to increase external validity and robustness.

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Given these limitations, the theoretical grounding of the 13 factors becomes critical. As detailed in the methodology, each factor is supported by literature on SME digital transformation (Bai et al., 2021; Hoang et al., 2021; Tran, 2021) and organized within established frameworks, ensuring that while structural relationships are exploratory, the factors represent validated constructs, enhancing instrument validity despite sample constraints.

Conclusions

ISM and MICMAC analyses establish a hierarchy among the determinants of e-commerce adoption in Medellín's food service sector. The results show that mandatory teleworking (Factor 5) and reduced operational investment (Factor 6) are at the bottom of the structure (Level VI), driving the digital shift. These findings confirm that the transition was fundamentally reactive, triggered by external regulatory pressures and financial necessity. Furthermore, the analysis identifies the fulfillment of company functions (factor 13) as a highly influential element. Meanwhile, reaching new market segments (factor 2) and time reduction (factor 9) emerge as the most dependent variables (level I). This hierarchy shows that the strategic benefits of digitalization in this industry depend on successfully stabilizing core operational tasks in new technological formats.

From a theoretical perspective, this study contributes to the literature on digital transformation by providing a structural decomposition of factor interrelationships during a crisis. While established models often treat adoption determinants as independent categories, this research proves that, in the context of SMEs, environmental pressures act as foundational causes that dictate the trajectory of all subsequent operational benefits. This adds a structural dimension to the study of organizational resilience, suggesting that external constraints are the primary catalyst for accelerated technological integration in sectors that traditionally rely on a face-to-face presence.

In practical terms, the results provide managers in the gastronomic industry with a roadmap. The high dependency on "reaching new market segments" suggests that achieving this objective requires consolidating “linkage” factors, such as customer responsiveness and efficient payment systems, first. Therefore, business strategies should focus on stabilizing digital internal

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functions before attempting to maximize consumer reach. For policymakers, these findings suggest that support programs should reduce the barriers associated with foundational drivers, such as the cost of technological investment, to ensure that the forced digitalization initiated during the pandemic evolves into a sustainable competitive advantage for the sector.

In general, this study makes it possible to identify the most influential factors in the decision-making process of entrepreneurs in the Colombian gastronomy sector regarding the adoption of e-commerce within their activities, highlighting how they interact with each other, which act as main causes, and which have a greater degree of dependence in the implementation of e-commerce. Likewise, this study allows us to glimpse that, beyond the conjunctural situation caused by COVID-19 and the reactive strategies of the companies, there are different factors or benefits that make e-commerce an attractive bet for the future dynamics of restaurants and catering companies, being much more than a temporary strategy induced by external causes.

Among the main limitations, we can mention the size of the sample used in this study, due to the difficulty in collecting data due to the health situation, as well as the fact that it was only possible to measure restaurants, leaving aside other companies in the gastronomic sector, such as buffets, gastronomic bazaars, etc. In future studies, it is expected to contrast these results with those obtained in other cities in Colombia and to increase the number of measurement factors for a more comprehensive analysis of the determinants of the implementation of e-commerce in this sector.

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