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## Article

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## Article

# An Economic Perspective on the Implementation of Artificial Intelligence in the Restaurant Sector

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**Abstract:** Technology is evolving and being implemented across nearly every sector of society, including health, nutrition, and sustainability. Specifically, artificial intelligence (AI) has become an essential tool in gastronomy, not only facilitating chefs' work but also fostering business innovation through cost reduction. However, for a gastronomic business to be profitable, it is crucial to understand its strategic elements. In this study, three groups associated with gastronomy—chefs, entrepreneurs, and gastronomic experts—were surveyed to gather their opinions on the application of artificial intelligence in the restaurant sector in Spain. Additionally, the Business Model Canvas and Lean Model Canvas were developed, specifically adapted for the restaurant sector. These models, as novel approaches, allowed for the identification of key success factors based on the respondents' experiences, considering that the Business Model Canvas focuses on the market and the company, while the Lean Model Canvas prioritizes the market and the product. This distinction is essential for mitigating the high failure rate in the restaurant industry in Spain. The results from the Canvas models and SWOT analysis have allowed us to understand the participants' views. They largely see the use of AI in gastronomy as beneficial due to innovation in recipes and cost savings. However, concerns were raised about the potential loss of human touch in dish preparation and increased unemployment due to the automation of some cooking processes. These findings could be highly relevant for future restaurant entrepreneurs.



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## 1. Introduction

In recent decades, there has been a growing awareness among the populace regarding climate change and the need to ensure the sustainability of planet earth (Al-Delaimy et al. 2020). Active efforts are being made towards environmental conservation and protection, as neglecting these areas can lead to significant adverse consequences. These include increased air pollution, extreme weather events triggering floods in some regions, the spread of viral diseases, and droughts, which lead to decreased agricultural production, causing malnutrition due to food shortages.

In light of this scenario, the potential of Artificial Intelligence (AI) as a tool to address these challenges is becoming apparent (Pereira et al. 2021; Muthurajan et al. 2021; Mahroof et al. 2022). For instance, the use of 3D food printing could offer an innovative solution to the food shortages caused by climate change. Additionally, there is heightened concern regarding nutrition. Health-related research focuses on analyzing facets of life that enhance health (Rivera 2022), with increasing emphasis on quality nutrition, the creation of nutritious foods, and healthy consumption patterns. Food security is essential, as is personalized nutrition, among other aspects, while simultaneously avoiding food waste. According to Carvajal-Larenas (2016), the world would need about 1.8 planets earth to maintain itself.



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Food is a vital need for every human being and is satisfied through consumption. Food, food culture, and the way it is prepared, form the gastronomical idiosyncrasies of different people, such as the Mediterranean Diet typical of Mediterranean countries (Guasch-Ferré and Willett 2021).

Therefore, gastronomy is an ancient art that combines creativity, culture, and science. It is a discipline that encompasses diverse areas such as biology, chemistry, geography, anthropology, and psychology (Rojas-Rivas et al. 2020; Valverde-Roda et al. 2023; De Armas and Mandrell 2023; Ruiz and Guzman-Parra 2023). It is often confused with the term “cooking”, with the former being a broader concept, as gastronomy refers to the rules or norms regarding the combination of suitable foods, while cooking is the practice or act of cooking (Romeo-Arroyo et al. 2020), including the creation of dishes and food preparation methods.

We are faced with two concepts: gastronomy and cooking, where artificial intelligence (AI) has been rapidly advancing in recent decades. However, both concepts do not mean the same thing. While “gastronomy” comes from Greek, the term “cooking” comes from Latin. Originally, gastronomy referred to the rules or norms regarding the combination of suitable foods, while cooking was the practice or act of cooking. Over time, both terms have developed and evolved differently.

Gastronomy is concerned with the relationship between humans, their environment, and food. Humans eat based on their environment and the culinary traditions specific to each region. Therefore, gastronomy also focuses on studying food culture, the history of foods, and the processes of production and distribution. Gastronomy draws from various areas of knowledge. Biology, chemistry, and geography are fundamental sciences in the study of food, as they allow us to understand the properties of food and its relationship with the environment. Additionally, anthropology and psychology are important for understanding the relationship between culture and food, as well as the cognitive processes that influence food choices.

Gastronomy not only focuses on food preparation from a nutritional standpoint but also seeks innovation and creativity in dish preparation. Therefore, culinary art is an essential part of gastronomy, as it allows chefs to experiment with new flavors, textures, and presentations. As society evolves, so does the way food is prepared and consumed. Cooking has become an industry, involving not only cooking but also acquiring ingredients, planning menus, and managing businesses.

The emergence of technologies such as big data (Chakraborty et al. 2023; Kåle 2024), machine learning (Yaiprasert and Hidayanto 2023; Helm et al. 2020), and artificial intelligence is revolutionizing human relationships; these technologies are currently being used in various activities and sectors, including food-related areas such as agriculture, allowing for precision farming through crop monitoring (Prakash et al. 2023), predictive analysis, supply chain optimization, food processing, quality control, personalized nutrition, and food safety, thereby enhancing the efficiency of the agri-food sector, reducing waste, and improving food safety and quality, elements that impact the culinary field (Taneja et al. 2023).

We are facing a depletion of food resources, special nutritional needs, culinary innovations, etc., all affecting gastronomy, and AI could be a solution to this issue, as AI is a discipline focused on creating systems and programs capable of performing tasks that, when performed by humans, require intelligence. These systems may include capabilities such as machine learning, visual perception, speech recognition, decision-making, and problem-solving. AI seeks to simulate human cognitive processes to perform tasks autonomously or with computer assistance (Wang 2019; Dobrev 2005). When applied to gastronomy, AI could improve the world of restoration not only by simplifying repetitive processes, reducing costs, analyzing markets, and helping businesses adapt their offerings to customer demands, but also by facilitating innovations like robot waiters or food manufacturing printers to increase food production. However, it would also be necessary to analyze the ethical and safety consequences of the application of AI.

In this research, we will analyze how AI can be a key element in fine dining restaurants or culinary establishments. As [Türkoğlu and Yılmaz \(2022\)](#) indicate, companies must offer goods and services according to consumer desires and preferences. Therefore, AI, through the analysis of customer opinions, can be a useful tool to indicate what is in demand, how to produce it, and how to innovate in the creation of new dishes. However, there must first be awareness and information in the catering sector about the benefits and drawbacks that AI can bring, hence the importance of studies, which, as [Kaur et al. \(2023\)](#) indicate, are limited. AI will not replace human roles but will collaborate with human expertise, increasing capabilities and driving operational excellence.

To delve deeper into this topic, a study was conducted based on three groups in the catering world who know AI or have used it in their businesses or kitchens (chefs, entrepreneurs, and gastronomy experts) with the aim of understanding their opinions on the advantages and disadvantages that AI brings to the gastronomy sector, allowing us to perform a SWOT analysis. Canvas models have also been developed where gastronomy and AI are related in the business world, with the aim of showing how AI can help better manage a business related to gastronomy ([Pallathadka et al. 2023](#)).

In a world where innovation is the norm, AI has found fertile ground in cooking, unleashing a wave of changes that redefine how we create, cook, and enjoy food.

## 2. Artificial Intelligence as a Support for Gastronomy

Artificial Intelligence (AI) is revolutionizing many aspects of our lives, and gastronomy is no exception. In food preparation, AI is being used in several innovative ways:

Recipe creation is an inherently human process, where intuition and experience play key roles. However, AI has proven to be a formidable ally in this process. AI algorithms can analyze large databases of recipes to identify patterns and trends in cooking, as well as formulating ingredient combinations that spark new inspirations in cooks and chefs. Additionally, recipe generation algorithms can produce innovative combinations that challenge the boundaries of culinary tradition, combining ingredients in unexpected ways or suggesting variations on traditional dishes ([Jabeen et al. 2019](#)).

But, AI is not limited to recipe generation. It has also become an invaluable tool for optimizing ingredients and processes. Algorithms can suggest ingredient combinations that maximize flavor, texture, and presentation of dishes, while also adapting to individual dietary preferences or restrictions. Furthermore, in commercial settings, AI is used to monitor and improve the quality of products, ensuring that each bite meets the highest standards ([Zoran et al. 2021](#)).

Personalization has also been an area of great advancement; AI allows for the efficient analysis of large amounts of data, facilitating the identification of patterns and relationships between diet and health at an individual level ([Agarwal et al. 2022](#)), thus enabling the recommendation of personalized diets tailored to the specific needs of each person, whether their diet is low-carb, gluten-free, or vegan. AI can help design a dietary plan that promotes health and well-being. Nutrigenomics, a field of study that analyzes the relationship between nutrition and the expression of our genes, has emerged as a revolutionary discipline that allows for the design of personalized dietary interventions using AI, optimizing health and preventing diseases ([Corella et al. 2018](#)), as not all individuals respond the same way to the same diet.

In the commercial sphere, AI is redefining the gastronomic experience. Restaurants can use algorithms to design menus that maximize customer satisfaction and business profitability, considering factors such as ingredient availability, dish popularity, and current gastronomic trends. Additionally, AI-driven cooking robots are beginning to make their way into commercial kitchens, automating tasks from ingredient cutting to the preparation of complete dishes, increasing efficiency and consistency in food production ([He et al. 2020](#)).

In summary, artificial intelligence is transforming the way food is created, prepared, and enjoyed, offering new opportunities for culinary innovation and the personalization of

the gastronomic experience. This will benefit food-related businesses, such as food factories that produce new foods or restaurants where dishes are increasingly prepared with more innovative recipes to be more attractive from a culinary standpoint and more profitable and competitive from an economic standpoint.

### 3. Materials and Methods

Spain is known for its excellent gastronomy and as a destination for gastronomic tourism (Jerez 2023), attracting more than 10 million people each year primarily due to its cuisine (Instituto Nacional de Estadística 2024). The top ten chefs in the world include representatives from seven countries: Sweden, Denmark, Slovenia, Brazil, Italy, France, and Spain. Spain stands out with four chefs ranked among the top: first place goes to Dabiz Muñoz, third to Joan Roca, fifth to Andoni Luis Aduriz, and seventh to Oriol Castro, Eduard Xatruch, and Mateu Casañas. Therefore, Spain boasts superb natural ingredients like olive oil, Iberian ham, and wine, along with a rich diet, the Mediterranean Diet (Medina 2018), which is recognized as an Intangible Cultural Heritage of Humanity, and skilled chefs capable of crafting exquisite dishes. Gastronomy is a sector that is increasingly thriving in this country, not only due to the rise in national clientele but also due to foreign tourists (Kovalenko et al. 2023).

To meet this growing demand, hundreds of restaurants open to the public each year, many of which fail (Instituto Nacional de Estadística 2024). According to The Restaurant Business School (2024), more than half of restaurants fail within their first year, and 8 out of 10 close before reaching five years. The reason for this is not due to poorly crafted menu items; on the contrary, the majority of these establishments offer a well-developed menu using quality, locally sourced products. The issue lies in the lack of adequate strategic planning (Revista de Hostelería 2022).

Key factors contributing to the failure of so many culinary establishments include:

1. **Poor Planning and Management:** The absence of solid strategic planning and proper management are critical factors in the failure of restaurants. Many owners underestimate operational costs, logistics, and the time required to manage a food service business. Inexperience in inventory management, hiring, and staff training, along with neglecting operational costs, can deplete financial resources and ultimately lead to business closure. AI can potentially aid in improving some of these tasks (Nesterchuk et al. 2022).
2. **Accelerated Competition and Fluctuating Demand:** The restaurant sector is highly competitive and continually evolving. The emergence of new establishments and existing competition make it challenging to stand out and attract a loyal clientele. Additionally, demand can fluctuate due to external factors such as economic shifts, consumer trends, and customer preferences. Restaurants that fail to quickly adapt to these changes may struggle to stay afloat (Bertan 2020). AI systems can analyze large volumes of online customer reviews and comments to identify trends, patterns, and areas for improvement in culinary destinations. This will assist restaurant owners in better understanding the needs and expectations of their patrons and help them make informed decisions on how to enhance their offerings. AI can detect reasons for business failure, such as a menu not aligning with consumer tastes, and assist by creating innovative recipes to attract new customers (Zoran et al. 2021) and differentiate from competitors.
3. **Financial Problems and Lack of Capital:** Restaurants are costly to establish and maintain. Many entrepreneurs underestimate the initial costs and lack sufficient capital to cover essential expenses like rent, equipment purchases, inventory, and marketing. Additionally, it is common for restaurants to face cash flow issues, especially in the initial months of operation when they have not yet secured a steady clientele. These financial challenges can lead to cumulative debt and, ultimately, the closure of the restaurant. AI can assist in developing a robust management plan.



4. **Poor Choice of Location and Concept:** The location and concept of a restaurant are fundamental to its success. A poorly chosen location, with little visibility or difficult access, can impact the ability to attract customers. AI could guide entrepreneurs, based on prior data, on where to establish their restaurant.

### 3.1. Research Objective

In this research (Table 1), our objective is to demonstrate how artificial intelligence can help create profitable businesses related to gastronomy through the proposed Canvas models. A panel of experts consisting of 210 individuals from various areas related to gastronomy was used: chefs (78 respondents) from those registered in section 5110 of the Spanish Social Security, restaurant sector entrepreneurs (80 respondents) selected from the population of restaurant entrepreneurs registered in the restaurant business associations and federations in Andalusia, and gastronomy experts (culinary critics and food science researchers, 52 respondents) selected from gastronomy magazines or researchers with publications in gastronomy from the Andalusian region. Once the three populations were chosen, the respective samples were selected through simple random sampling. The initial total sample consisted of 340 individuals from the three collectives who were initially interviewed to ask if they used AI in their kitchens (chefs) or restaurants (entrepreneurs) or wrote about AI in gastronomy (experts and researchers). A total of 130 respondents were excluded for not being familiar with artificial intelligence in gastronomy, as the research focus was to understand their opinions on the advantages and disadvantages of AI in the culinary world based on their professional experience, as well as to construct a SWOT matrix on the threats, strengths, weaknesses, and opportunities that AI can bring to the restaurant world, allowing us to analyze the key factors they considered important for the Canvas models, resulting in a final sample of 210 individuals.

**Table 1.** Technical aspects of the survey.

<b>Sample size</b>	210
<b>Margin of error</b>	±3.9%
<b>Confidence level</b>	95%; $p = q = 0.5$
<b>Date of fieldwork</b>	July 2023–March 2024

### 3.2. Sample Size Determination

The methods for calculating sample size can be based on various available formulas. In this research, the sample size was determined under the assumption of a finite population. According to [Kadam and Bhalerao \(2010\)](#), it can be challenging for researchers to decide which method to use. Additionally, these calculations are prone to errors, as small changes in the selected parameters can result in significant differences in sample size. As [Silva Ayçaguer and Alonso Galbán \(2013\)](#) indicate, the sample size selected for a study or investigation is often decided based on what is feasible or possible ([Senn 2021](#)). The most important factor is that the selected sample should be representative of the population being analyzed and should include a variety of perspectives to obtain a comprehensive and detailed analysis ([Falcón et al. 2023](#)).

### 3.3. Exploratory Research Phase

Subsequently, an exploratory research phase was conducted using the initial version of the questionnaire. A pilot study was carried out among 15 respondents using face-to-face interview techniques. These participants evaluated the instrument in terms of its substantive adequacy and relevance, suggesting only marginal modifications to improve its clarity and comprehension.

### 3.4. Final Sample

The final sample consisted of 210 individuals surveyed from July 2023 to March 2024, with a 35-question survey. Some of these questions were qualitative, such as gender, educational level, and personal opinions on the weaknesses, threats, strengths, and opportunities that AI brings to gastronomy, with the aim of constructing a SWOT analysis. Other open-ended questions focused on relevant AI factors in gastronomy related to business, market, and product to build the Canvas models considered relevant to how AI interacts with these domains. Numerical questions such as age, income level, or scores were also included; the latter were used in the mean comparison test regarding the contribution of AI and the opinions and evaluations of its application in food preparation and business management related to gastronomy.

### 3.5. Types of Analysis

Two types of analysis were used:

1. **Qualitative Analysis:** The information provided by the respondents based on their experience with the use of AI in their daily work (kitchen, business, research) allowed the development of:
  - A SWOT matrix with the most relevant opinions of the 210 respondents. The main objective was to identify the Strengths, Opportunities, Weaknesses, and Threats of AI applied to gastronomy, especially in the restaurant sector, formulating strategies that maximize strengths and opportunities while minimizing weaknesses and threats, allowing for the planning of specific actions to improve weak areas and defend against threats.
  - Canvas and Lean Canvas models as strategic management tools that help to understand the key aspects of the restaurant business based on the factors that respondents consider key in the restaurant industry. The objective was to understand the vision that the main actors of this culinary art have regarding the effects, benefits, and disadvantages of AI implementation in gastronomy, to develop, from a Lean Canvas model, how AI can benefit gastronomy by innovating and creating gastronomic products based on algorithms that can favor the creation of businesses associated with gastronomy at any stage of their value chain, from the creation of new ingredients to the preparation of new dishes.
2. **Quantitative Analysis:** Comparing averages among the three analyzed groups (chefs, restaurant entrepreneurs, and gastronomy experts) regarding their assessment of AI applied to gastronomy to verify if the evaluations of AI are the same or different. The use of artificial intelligence (AI) in gastronomy is a topic that generates debate in various spheres. On the one hand, some authors argue that AI can be an invaluable tool for improving quality and efficiency in the gastronomic industry. On the other hand, there are concerns about how the introduction of AI could affect authenticity and creativity in the kitchen.

#### 3.5.1. Matrix SWOT

The techniques initially employed involved a qualitative analysis of the information provided by the respondents based on their experience to first develop a SWOT matrix (Benzaghta et al. 2021). The primary goal was to identify the Strengths, Opportunities, Weaknesses, and Threats of the restaurant sector concerning Artificial Intelligence, formulating strategies that maximize strengths and opportunities while minimizing weaknesses and threats, allowing for the planning of specific actions to improve weak areas and defend against threats.

These four aspects are broken down as follows:

**Strengths (S):** These are the positive internal aspects that AI can contribute to gastronomy, especially to restaurant businesses, providing them with a competitive advantage

or enabling them to achieve their objectives. This may include tangible resources such as advanced technology (AI), highly trained personnel (Michelin-starred chefs), or a strong brand reputation.

**Opportunities (O):** These are favorable external factors that the restaurant business can leverage using AI to improve its current situation or achieve its goals. These opportunities may arise from changes in the market, technological advancements, industry trends, or other external conditions.

**Weaknesses (W):** These are the unfavorable internal aspects that can hinder the performance of the restaurant business or limit its ability to achieve its objectives. This could include a lack of financial resources, inefficient processes, or a lack of experience in certain areas.

**Threats (T):** These are external factors that represent challenges or risks to the restaurant business that could hinder its success or even threaten its survival.

### 3.5.2. The Business Model Canvas (BMC) and Lean Canvas

Secondly, two Canvas models were conducted to analyze the most important factors that gastronomy-focused businesses must consider to be profitable using AI. This methodology is seldom used for restaurant businesses, but it allowed for the integration of food and AI. The Business Model Canvas (BMC) is used in various fields and businesses such as tourism and flamenco (Millán Vázquez de la Torre et al. 2016), or to design engineering entrepreneur enterprises (Flores-Aguilar 2019).

This study also utilized the Lean Canvas model based on the market and the product. For our purposes, it is first necessary to describe this canvas and its differences from the BMC.

The BMC was made available to entrepreneurs by Osterwalder (Osterwalder and Pigneur 2011) through his work “Business Model Generation”. This canvas allows a startup to diagram situational hypotheses, either to start a new business or develop new projects in ongoing enterprises. Some experts believe that when a company is started, there are certain critical aspects that the BMC does not address; however, it remains an important strategic management tool that helps businessowners understand the key aspects of their business, for example, how they relate and balance each other. It consists of nine blocks or sections that represent the key aspects of a business: customer segments, value proposition, channels, customer relationships, revenue streams, key resources, key activities, key partners, and cost structure.

Eric Ries (2011) provides the Lean Startup methodology, which aims to understand the situation as quickly as possible and has the capacity to seek solutions while minimizing reaction time. The Lean Startup methodology is based on the cycle Build—Measure—Learn or Action—Reaction—Adjustment. It is crucial to eliminate anything superfluous in the process to detect as soon as possible whether the started path is correct, and if not, to have the ability to correct it. In response to this need, Ash Maurya (Razabillah et al. 2023) offer the Lean Canvas tool.

In Figures 1 and 2, the similarities and differences between the two canvases can be observed.

The first and most important difference is that the BMC focuses on the market and the company, while the Lean Canvas focuses on the market and the product.

The common modules (represented by the lighter areas of Figures 1 and 2) are:

- Value proposition, where what is provided to the consumer is indicated.
- The customer, where the segment to which this value is targeted is defined.
- The channels that allow communication with the customer.
- The definition of revenue and cost structure.



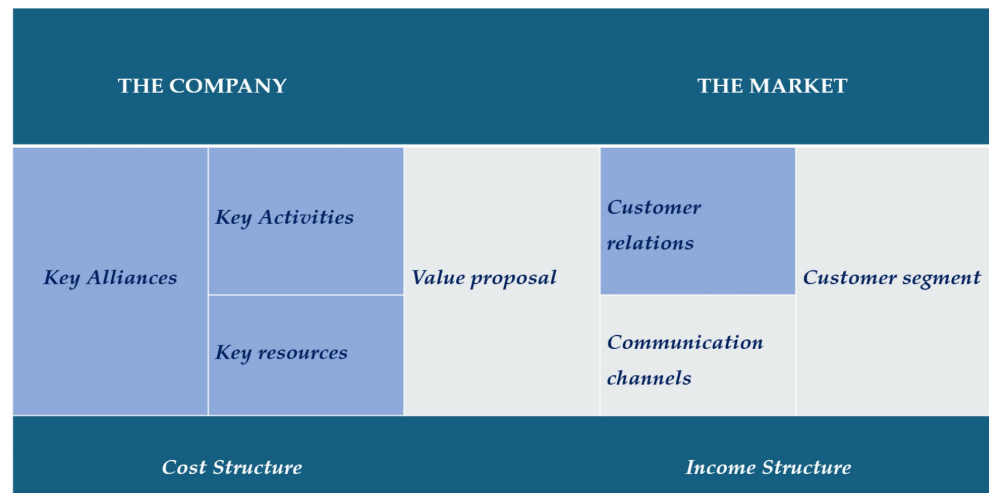


Figure 1. Business Model Canvas.

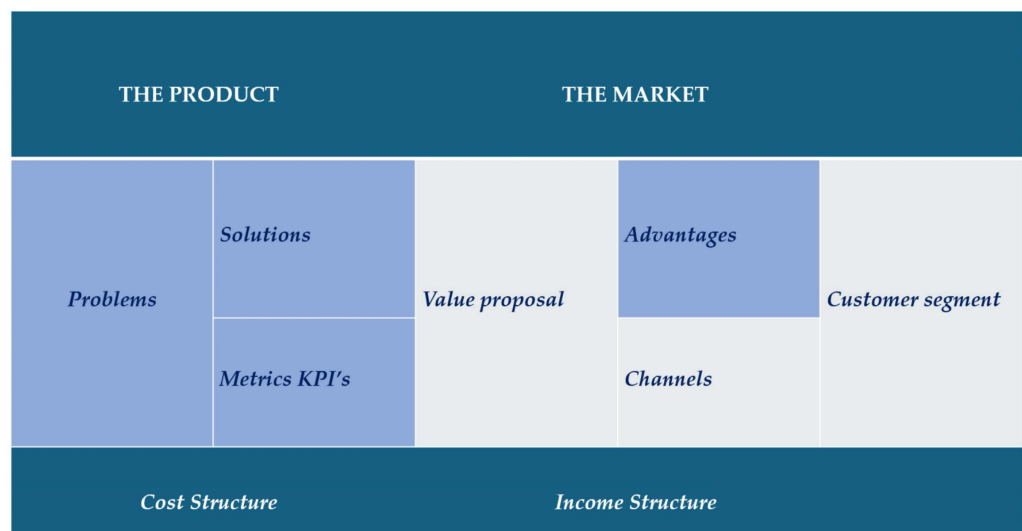


Figure 2. Lean Canvas.

The non-common modules in the Lean Canvas are (represented by the darker zones of Figures 1 and 2):

- In the market block, the channels and customer relationships are merged into one and a module is opened to define the advantages offered and how they differ from the competition.
- In the product block, the following modules are observed:
  - Problems that the customer presents, replacing the key partnerships section, which in most startups does not really exist.
  - The solutions offered to solve the problems, setting aside the key activities.
  - Metrics, which allow validating previously defined hypotheses. This module eliminates the definition of key resources.

To achieve the objective of minimizing the time it takes to perform the “build, measure, learn” cycle, it is possible to forgo the identification of key activities and resources, although there will come a time when it would be necessary to return to these tasks.

This study represents an initial approach to this reality. The aim is to understand the vision that the protagonists of this culinary art have regarding the effects, benefits, and disadvantages of the implementation of AI in gastronomy, so as to develop from a Lean Canvas model how AI can benefit gastronomy by innovating and creating gastronomic

products based on algorithms that may favor the creation of companies associated with gastronomy at any stage of its value chain, from the creation of new ingredients to the preparation of new dishes.

### 3.5.3. Mean Comparison Test

The third technique used in this research was based on a quantitative analysis comparing averages among the three analyzed groups (chefs, restaurant entrepreneurs, and gastronomy experts) concerning the valuation they give to artificial intelligence applied to gastronomy. A mean comparison test was used, where if it was determined that the means are different ( $H_1$ ), this meant that there was a statistically significant difference between the groups being compared. The hypotheses of the mean comparison test are:

- $H_0$ : The average scores regarding the evaluation of AI in gastronomy from the two analyzed groups are equal.
- $H_1$ : The average scores regarding the evaluation of AI in gastronomy from the two analyzed groups are different.

This can be useful for future research if the groups have different opinions, segmenting them and conducting studies on each independent collective.

#### Initial Hypothesis

- $H_0$ : The three collectives (chefs, restaurant entrepreneurs, and gastronomy experts) have similar opinions regarding the evaluation of AI applied to gastronomy. Therefore, the average assessments are the same regarding the application of AI in gastronomy.
- $H_1$ : The three collectives have different opinions on the evaluation of AI applied to gastronomy, their mean scores will be different.

To test this hypothesis, mean comparison tests were conducted taking the collectives two by two: chef–restaurant entrepreneurs, chef–gastronomy experts, restaurant entrepreneurs–gastronomy experts.

## 4. Results

The qualitative analysis of the information was based on the open-ended questions of the questionnaire, where the three groups of respondents (chefs, restaurant entrepreneurs, and gastronomy experts) provided their personal views on AI applied to gastronomy, allowing for the following results.

### 4.1. SWOT Analysis Results

Based on the responses provided by the respondents to the following questions: What opportunities do they see in this new technique of using AI to prepare recipes? What strengths can AI have in the field of food? What are the weaknesses that the new designs created by AI might have in the tradition of food preparation? And what strengths do the more efficient foods developed with AI bring within a globalized and sustainable world? How can AI contribute to the development of a culinary destination? etc. A SWOT analysis was conducted by selecting the responses that most closely aligned across the three groups (entrepreneurs, chefs, and gastronomy experts), ensuring the selection was representative of the analyzed sample. The results obtained are presented below and will help us better understand the context and perspectives of the addressed topic (Figure 3). However, it would be interesting in future research to develop a SWOT analysis for each group individually.



**Figure 3.** SWOT of AI applied to gastronomy.

#### 4.1.1. Weaknesses

**Data dependence:** AI in gastronomy largely depends on the availability and quality of data. If the data are not representative or are biased, the results can be inaccurate or unreliable (Ahnert 2013).

**Lack of human intuition:** although AI can generate innovative recipes and suggest combinations of ingredients, it often lacks the intuition and creativity that characterize human chefs (Banerjee and Preissner 2018).

**Cost and accessibility:** implementing AI systems in gastronomy can be costly, limiting its accessibility for small restaurants or independent chefs.

#### 4.1.2. Threats

**Labor displacement:** AI-driven automation in the kitchen could displace food sector workers, especially in preparatory and cooking roles.

**Privacy and data security:** the collection and analysis of data in gastronomy can raise concerns about the privacy and security of personal information of customers and employees.

#### 4.1.3. Strengths

**Efficiency and consistency:** AI can improve efficiency and consistency in food preparation, reducing human errors and optimizing cooking processes (Garg et al. 2018).

**Personalization:** AI allows for the personalization of diets and gastronomic experiences, adapting to individual preferences and specific dietary needs (Acosta 2023).

**Culinary innovation:** AI fosters culinary innovation by providing new ideas and ingredient combinations that can inspire chefs to experiment and create unique dishes.

#### 4.1.4. Opportunities

**Customer experience:** AI can enhance the customer experience in restaurants by optimizing menus, recommending dishes, and adapting to individual preferences (Abbar et al. 2015).

**Food waste reduction:** through data analysis, AI can help predict food demand and optimize quantities produced, reducing food waste in the gastronomy industry (Ahmed et al. 2011).

Research and development: AI can accelerate research and development in gastronomy by allowing for the exploration of new culinary techniques, ingredients, and flavor combinations (Shirai et al. 2021).

In summary, artificial intelligence presents a series of challenges and opportunities in the field of gastronomy. If addressed properly, these technologies have the potential to transform the way we create, cook, and enjoy food, offering benefits for both consumers and the industry as a whole.

#### 4.2. Canvas Analysis Results

To develop the Business Model Canvas (BMC) and Lean Canvas models, open-ended questions were posed to the respondents. The BMC consists of nine blocks, where each segment is analyzed with the aim of helping gastronomy businesses identify the essential points for developing an economically viable business based on gastronomy with the assistance of AI. By addressing the questions in each segment (Figure 4), the respondents were asked about the nine key factors: customer segment, value proposition, distribution channels, customer relationship, revenue streams, key resources, key activities, key partners, and cost structure. Below are the main opinions provided by the respondents for each of these factors.

THE COMPANY THE MARKET				
<b>Key Alliances</b> *Food and beverage suppliers. *Delivery and logistics platforms. *AI technology developers. *Partnerships with other local businesses for joint promotions.	<b>Key Activities</b> *Development and continuous improvement of AI algorithms. *Design and preparation of personalized menus. *Online platform management and delivery logistics.	<b>Value proposal</b> *Creation of personalized menus using artificial intelligence algorithms. *Unique and personalized gastronomic experiences. *Use of AI to optimize kitchen processes and inventory management.	<b>Customer relations</b> *Personalized customer service. *Collecting feedback to improve the customer experience. *Loyalty programs based on artificial intelligence.	<b>Customer segment</b> *Restaurants and gastronomic establishments. *Catering companies. *End consumers interested in innovative gastronomic experiences.
	<b>Key resources</b> *Artificial intelligence development team. *Cooks and chefs with experience. *Robust and scalable technology platform		<b>Communication channels</b> *Suppliers of fresh and quality ingredients. *Home delivery platforms. *Technology companies for the integration of AI systems	
	<b>Cost Structure</b> *Development and maintenance of the technological platform. *Personnel costs (development, kitchen, customer service). *Marketing and brand promotion		<b>Income Structure</b> *Direct sales of personalized menus. *Commissions for orders placed through the online platform. *Artificial intelligence consulting services for gastronomic establishments	

Figure 4. Business Model Canvas applied to AI in gastronomy businesses.

- Customer Segments: who are your customers? What do they think? What do they see? What do they feel? What do they do?
  - Restaurants and gastronomic establishments: these are customers looking to differentiate themselves in a competitive market by offering personalized menus and operational efficiencies enhanced by AI.
  - Catering companies: these businesses seek AI solutions to manage large volumes of operations and personalize their services at events, improving customer satisfaction and optimizing resources.
  - End consumers interested in innovative gastronomic experiences: these customers value personalization and innovation in their culinary experience, seeking options that are traditionally not available in the mass market.
- Value Proposition: How compelling is your value proposition? Why do your customers consume your product? Why do they buy?

- Creation of personalized menus through artificial intelligence algorithms: offers clients a unique experience tailored to their dietary preferences and needs, which increases satisfaction and loyalty.
  - Unique and personalized gastronomic experiences: allows consumers to enjoy dishes that are innovative and specific to their tastes, using data to continually improve the offering.
  - Use of AI to optimize cooking processes and inventory management: enhances operational efficiency, reducing waste and costs, which translates into competitive pricing and more sustainable operations.
3. Distribution Channels: how are your products or services promoted, sold, and delivered? Why? Are they working?
    - Online platforms for orders and reservations: facilitate consumer access to the services offered, providing an easy-to-use interface for personalization and booking of gastronomic experiences ([Adhari 2020](#)).
    - Partnerships with restaurants and catering companies: establish distribution networks that can increase the reach of the offering and improve delivery capabilities.
    - Gastronomic events and fairs: serve as channels for promotion and direct sales, allowing customers to directly experience the gastronomic innovations.
  4. Customer Relationships: how do you interact with the customer through their journey?
    - Personalized customer service: ensures an exceptional user experience and helps solve specific problems or adapt services to individual needs.
    - Collection of feedback to improve customer experience: uses data collected to continuously improve products and services, adapting to changing consumer preferences.
    - Loyalty programs based on artificial intelligence: analyzes purchase patterns and preferences to offer personalized rewards and promotions that increase customer retention.
  5. Revenue Streams: how does your value proposition generate revenue?
    - Direct sales of personalized menus: generate revenue through the direct sale of tailor-made gastronomic experiences.
    - Commissions on orders made through the online platform: earns revenue from transactions facilitated through its technological platform.
    - Consulting services in artificial intelligence for gastronomic establishments: offers AI experts that enable businesses dedicated to gastronomy to optimize their operations.
  6. Key Resources: what unique strategic assets does your business have to compete?
    - Artificial intelligence development team: Essential for the creation and maintenance of AI solutions that enhance operations and the customer experience.
    - Experienced chefs and cooks: Fundamental to ensuring that AI recommendations translate into high-quality and creative dishes ([Alimohammadirokni et al. 2021](#)).
    - Robust and scalable technological platform: allows for the management of high volumes of transactions and data, ensuring a smooth and efficient user experience.
  7. Key Activities: what unique strategies does your business have to deliver its proposition to the customer?
    - Development and continuous improvement of AI algorithms: vital to maintaining the competitiveness and effectiveness of the solutions offered.
    - Design and preparation of personalized menus: core of the value proposition that differentiates the offering in the market.
    - Management of the online platform and delivery logistics: ensures that products and services are delivered efficiently and with high quality.
  8. Key Partners: what activities can your company stop doing to focus on its key actions?



- Suppliers of fresh and quality ingredients: essential for maintaining the quality standard of the dishes offered.
  - Home delivery platforms: expand the reach and delivery capabilities, making services accessible to a broader audience.
  - Technology companies for AI system integration: provide the infrastructure and technical support necessary for implementing advanced solutions.
9. Cost Structure: what are the main cost drivers of your business? How are they linked to revenue?
- Development and maintenance of the technological platform: represents a significant investment in technology and personnel.
  - Personnel costs (development, cooking, customer service): are recurring expenses that sustain the daily operation and quality of service.
  - Marketing and brand promotion: key to attracting and retaining customers, representing a significant part of the budget to achieve visibility in a competitive market.

The second model developed focuses on the product (developed in gastronomy) and the market (Figure 5) using artificial intelligence. The respondents identified 10 key points, which are elaborated below. The majority of the information in their responses was provided by entrepreneurs and some chefs who own their restaurants.

THE PRODUCT			THE MARKET	
<b>Problems</b> *Lack of customization in the gastronomic offer. *Inefficiencies in kitchen processes and inventory management.	<b>Solutions</b> *Use AI algorithms to create personalized menus. *Implement AI systems to optimize kitchen processes and inventory management.	<b>Value proposal</b> *Personalized and accurate recommendations based on individual customer preferences. *Improvement in the quality and consistency of gastronomic products and services.	<b>Advantages</b> *Personalized and unique gastronomic experiences. *Improved operational efficiency thanks to AI.	<b>Customer segment</b> *Local consumers interested in personalized gastronomic experiences. *Tourists and travelers looking to explore local gastronomy in an authentic way. *Companies and professionals that require catering services and food options for corporate events.
	<b>Metrics KPI's</b> *Percentage of customers who repeat orders. *Average order preparation time. *NPS (Net Promoter Score) of clients. <i>Key Performance Indicator</i>	*Reduction of operational costs and increase in efficiency through the use of advanced technology.	<b>Channels</b> *Physical store (restaurant, cafeteria) in integration of AI technology in the processes. *Online delivery platforms and mobile application for orders and reservations.	*Healthy food lovers looking for nutritious and balanced options adapted to their dietary preferences.
<b>Cost Structure</b> *Development and maintenance of the technological platform. *Personnel costs. *Marketing and promotion.			<b>Income Structure</b> *Direct sales of personalized menus. *Commissions for orders on the platform. *AI consulting services.	

**Figure 5.** Canvas of AI in gastronomy applied to the market.

1. Problem: Identifying the customer's problems that our product can solve. If there is no problem to resolve or need to fulfill, the product serves no utility. Many businesses start by creating a product which, once in the market, finds that the demand was not as expected, and this often marks the beginning and end of the business. Why offer a gastronomic offering if no one needs it?
  - Lack of customization in the gastronomic offering: modern consumers seek experiences that cater to their unique tastes and specific dietary needs, a demand that traditional methods may not fully satisfy.
  - Inefficiencies in kitchen processes and inventory management: many gastronomic establishments face issues with inventory management and resource optimization, which can lead to significant losses and reduced operational efficiency.
2. Solution:

- Use of AI algorithms to create personalized menus: implement artificial intelligence technology that analyzes consumption preferences and behaviors to offer recommendations and menus tailored to each customer.
  - Implement AI systems to optimize kitchen processes and inventory management: use automated systems that help forecast demand, manage stock efficiently, and minimize waste.
3. Key Metrics: These indicate whether we are developing our business model correctly and measure to what extent the consumer is attracted to the manufactured foods and is willing to pay for their consumption. They can be obtained through:
- Percentage of customers who repeat orders: indicates customer satisfaction and loyalty, reflecting the effectiveness of personalization and service quality.
  - Average time for order preparation: reflects the operational efficiency introduced by AI solutions in kitchen processes.
  - NPS (Net Promoter Score) of customers: measures customer satisfaction and the likelihood that customers would recommend the service, a crucial indicator of success in today's market.

Based on the above, [Mejía \(2022\)](#) identifies 10 fundamental metrics that could apply both to private projects and public projects, including those estimated at a macroeconomic level to gauge the overall impact on a country's economy. These metrics, adapted to the research analyzed, are as follows:

- Acquisition by source identifies the origin of potential consumers.
  - Activation measures the ratio between the number of consumers who have shown interest in the gastronomic foods or dishes through a website that makes an offer and the number of consumers who have ultimately registered on said page.
  - Retention/ENGAGEMENT quantifies how many times a gastronomic consumer demands a gastronomic product.
  - CHURN (measure the percentage of consumers who, having shown interest in a gastronomic offering, ultimately did not consume it and clients lost/initial clients)  $\times 100$
  - Conversion measures the percentage of potential consumers interested in the gastronomic product (ACQUISITION) who finally ended up buying (MONETIZATION).
  - Customer Acquisition Cost (CAC) is the ratio between the investment in acquisition, which includes all costs associated with making the product known and reaching the customer, and the number of consumers who have purchased the offer.
  - Customer Lifetime Value (CLTV) is the gross margin obtained from each gastronomic consumer over the time they are consuming the offered product.
  - The profitability ratio acquisition is  $CLTV \text{ (customer lifetime)} / CAC \text{ (Cost acquisition)}$ .
  - Cash burn rate (CBR) refers to the fixed monthly costs.
  - Reference measures the ratio between the number of gastronomic consumers attracted by other gastronomic consumers and the number of new consumers of those gastronomic products.
4. Unique Advantage:
- Personalized and unique gastronomic experiences: offer a clear differentiation in a saturated market where consumers seek experiences tailored specifically to their personal preferences.
  - Improved operational efficiency thanks to AI: the ability to reduce costs and improve profitability through process optimization is a significant competitive advantage.
5. Channels:
- Online platform: allows customers easy access to the services offered, allows them to place orders, and lets them personalize their menus from anywhere.

- Partnerships with restaurants and catering companies: extend the reach and availability of the service, using existing infrastructure to deliver the personalized experience.
  - Participation in gastronomic events: provides a platform for showcasing the technology and services in a dynamic and engaging environment attractive to potential new customers.
6. Cost Structure:
    - Development and maintenance of the technological platform: represents an ongoing investment in technology to maintain and improve the service offering.
    - Personnel costs: include not only cooks and chefs but also developers, data scientists, and support staff.
    - Marketing and promotion: fundamental to attract new customers and retain existing ones, especially in such a competitive industry.
  7. Revenues:
    - Direct sales of personalized menus: the main source of revenue, where customers pay for menus designed specifically for them.
    - Commissions for orders through online platforms or mobile applications: a secondary source of income derived from transactions facilitated through technology.
    - Monthly or annual subscriptions for access to platforms for diet customization and gastronomic recommendations: generate a recurring revenue stream.
    - Consulting services in AI for other gastronomic businesses: expand the offering by monetizing technological expertise.
  8. Customer Acquisition Costs:
    - Digital marketing strategies: include SEO, social media advertising, and other online tactics designed to attract users to the platform.
    - Initial discounts and promotions: strategies to encourage first purchases and attract customers to try the service.
  9. Key Resources:
    - AI development team and data scientists: essential for the creation and refinement of the algorithms that drive personalization and operational efficiency.
    - Cooks and chefs: provide the culinary knowledge necessary to ensure that AI recommendations are feasible and appealing.
    - Technological platform: acts as the core of the offering, enabling interaction, personalization, and efficient management of orders and services.
    - Database of recipes and gastronomic preferences: a crucial tool for analysis and personalization.
  10. Pricing Strategy:
    - Competitive prices for personalized menus: ensure accessibility while reflecting the added value of personalization.
    - Subscription fees for additional services: offer a stable and predictable revenue model.
    - Commission models for orders placed on the platform: facilitate a scalable business model aligned with the volume of transactions.

This expanded analysis of the Lean Canvas provides a detailed view of how a company that integrates AI in gastronomy can structure and develop its business model to maximize its impact and success in the market and provide a framework for understanding how artificial intelligence can be applied in the gastronomic industry, from recipe generation to the customization of the customer experience, highlighting key areas for success and sustainability of the business

#### 4.3. Results of the Comparison of Means Test

The three surveyed groups—chefs, restaurant entrepreneurs, and gastronomy experts—were analyzed, revealing that the youngest percentage is found among chefs (36.7%), aged between 30 and 39 years, compared to entrepreneurs who are between 50 and 59 years old (35.8%). Every day, chefs are becoming younger and more inclined to use new kitchen technologies like AI. The world of fine dining is predominantly occupied by men; among the surveyed chefs, the majority were men (64.3%), while women were primarily kitchen assistants, with only 35.7% attaining the title of chef or kitchen managers. The rest assist in dish preparation as helpers. This can be corroborated by the ranking of the top 10 chefs in the world, where nine are men and only one woman, Slovakian Ana Roš, is listed. It can be affirmed that there exists a glass ceiling in the restaurant sector, both internationally and in Spain, which needs to be overcome.

Regarding the group of gastronomy sector entrepreneurs, the majority are men at 69.3%, compared to 30.7% women. Additionally, a higher level of education is observed among younger groups in both entrepreneurs and chefs or gastronomy experts. They are increasingly concerned about taking courses and staying up to date with new food techniques. However, the older demographic is more reluctant (Table 2).

**Table 2.** Profile of the respondents.

Block	Factor	Classification	Chefs (%)	Restaurant Entrepreneurs (%)	Gastronomy Experts (%)
Personal characteristics of chefs, restaurant entrepreneurs, and gastronomy experts	Age	18–29 years old	14.2	0.6	3.4
		30–39 years old	37.1	8.4	23.8
		40–49 years old	28.2	27.9	28.6
		50–59 years old	13.2	35.9	23.1
		More than 60 years old	7.3	27.2	21.1
	Education level	No studies completed	0.2	0.4	0.1
		Primary studies	14.6	9.4	6.3
		Secondary studies	69.3	74.1	70.2
		Higher studies	15.9	16.1	23.4
	Gender	Male	67.2	69.3	58.9
		Female	32.8	30.7	41.1

In addition to the univariate descriptive analysis of the personal characteristics of the three surveyed groups, a test of means comparison was conducted to determine if all groups evaluated artificial intelligence applied to gastronomy equally. They scored from 1 to 10, with 10 indicating that AI is very important in the gastronomy sector. The chef group rated the results of AI applied to gastronomy with an average score of 7.6 points and a standard deviation of 1.2 points. The group of gastronomy sector entrepreneurs gave an average rating of 6.1 with a standard deviation of 1.3, while the gastronomy experts rated AI applied to gastronomy with an average score of 6 points and a standard deviation of 1.6 points.

From Table 3, it can be observed that the group of chefs assigns a higher score to AI applied to gastronomy. Among the explanations provided for this rating, they mentioned that AI facilitates the creation of new recipes and the exploration of new flavors and textures. It is noted that younger chefs are the ones who use this technology more extensively for innovation, as evidenced by their mean scores, which differ from those of the other groups. Conversely, the mean scores of the group of entrepreneurs and gastronomy experts do not differ, which is consistent with the null hypothesis ( $H_0$ ). Both groups gave lower scores to AI applied to the culinary field. Experts believe that AI diminishes the value of tradition

and the personal innovation of each chef (He et al. 2020), while entrepreneurs are concerned about the costs associated with implementing AI in their businesses. Therefore, based on the mean comparison test, we can conclude that there are no significant differences between the evaluations of the group of entrepreneurs and gastronomy experts regarding the scores given to the application of AI in gastronomy. However, there are significant differences between the collective of entrepreneurs and chefs, and between chefs and gastronomy experts. Thus, we can conclude that the initial hypothesis  $H_1$  is met: “The collectives have different opinions on the evaluation of AI applied to gastronomy; their mean scores will be different”, since of the three collectives analyzed in pairs, two of them have differing mean scores.

**Table 3.** Mean comparison test among the surveyed groups, chefs, entrepreneurs, and gastronomy experts.

Mean comparison (groups)	Variance test $H_0: \sigma_1^2 = \sigma_2^2$ $H_1: \sigma_1^2 \neq \sigma_2^2$ $2Pr(F < f) > \alpha$ $H_0$ is accepted $2Pr(F < f) < \alpha$ $H_0$ is rejected	Mean comparison test $H_0: \mu_1 = \mu_2$ $H_1: \mu_1 \neq \mu_2$ $2Pr( T  >  t ) > \alpha$ $H_0$ is accepted $2Pr( T  >  t ) < \alpha$ $H_0$ is rejected
Chefs (1)—entrepreneurs (2)	$f = 0.8521$ $2Pr(F > f) = 0.4820$ The null hypothesis ( $H_0$ ) is accepted: the variances of the mean scores are equal across both groups	$t = 7.5314$ $2Pr( T  >  t ) = 0.0000$ The null hypothesis ( $H_0$ ) is rejected. The mean scores are different across both groups
Chefs (1)—gastronomy experts (2)	$f = 0.5642$ $2Pr(F < f) = 0.0220$ The null hypothesis ( $H_0$ ) is rejected. The variances of the mean scores are different across both groups	$t = 6.1496$ $2Pr( T  >  t ) = 0.0000$ The null hypothesis ( $H_0$ ) is rejected. The mean scores are different across both groups
Entrepreneurs (1)—gastronomy experts (2)	$f = 0.66023906$ $2Pr(F < f) = 0.0958$ The null hypothesis ( $H_0$ ) is accepted. The variances of the mean scores are equal across both groups	$t = 0.3939$ $2Pr( T  >  t ) = 0.6943$ The null hypothesis ( $H_0$ ) is accepted: the mean scores are equal across both groups

## 5. Discussion

The use of artificial intelligence (AI) in gastronomy is a topic that sparks debate in various spheres. On one hand, some authors argue that AI can be an invaluable tool for improving quality and efficiency in the restaurant industry (Larson 2022). On the other hand, there are concerns about how the introduction of AI could affect authenticity and creativity in cooking.

One of the main arguments in favor of using AI in gastronomy, as highlighted by the respondents, is its ability to optimize processes and improve precision in food preparation (a point indicated in the strengths of the obtained SWOT analysis). This aligns with the research of Lin et al. (2021). AI systems can analyze large amounts of data to identify trends in tastes and preferences, helping chefs develop new dishes that better suit public tastes, facilitating innovation and creativity based on extensive recipe databases, and combining ingredients in novel ways (opportunities in the obtained SWOT). This could lead to the creation of new dishes and flavors previously not considered (Mahroof et al. 2022), enhancing fusion cuisine (Şirin and Gençer 2024; Peters and Broersma 2019). Therefore, it is crucial to offer customers unique and exclusive sensations while considering culinary trends. It is important to note that the customer experience begins before visiting the restaurant. Consumers often turn to the internet to explore restaurant websites, view product offerings, and read reviews. From the open responses provided by the interviewees, we can indicate that AI can analyze information and propose innovative suggestions for both products and services based on customer reviews. Secondly, it can recommend specific restaurants or dishes tailored to individual tastes (Shaik 2023). The respondents indicate that the convergence of AI with the culinary world represents a dynamic and evolving



intersection, offering innovative solutions to enhance various aspects of gastronomy, similar to the opinions found in studies by [Thakur and Sharma \(2024\)](#).

Additionally, according to the opinions of the surveyed experts, AI can assist in inventory management and supply chain optimization, leading to cost reduction and increased efficiency in restaurant and culinary establishment operations. In environments such as restaurant kitchens and large-scale food production, AI can help automate repetitive processes and optimize resource utilization, thus increasing efficiency and reducing waste. These aspects are highly valued by the group of entrepreneurs in the gastronomic sector, aligning with studies conducted in the healthcare sector, where AI has reduced costs ([Ilan 2021](#)).

AI can also be used to personalize menus according to customers' personal preferences or dietary restrictions. For example, it could suggest modifications to dishes that meet the specific nutritional needs of each individual.

In the realm of food service, AI can help maintain consistency in dish preparation, ensuring that each customer receives a high-quality product consistently, regardless of when or where it is ordered. Additionally, AI could assist through Canvas models in identifying key factors for restaurant businesses, with the aim of making them profitable and sustainable over time.

However, some surveyed gastronomy experts and chefs are against applying AI in gastronomy because it implies a loss of the human elements (indicated as a threat in the obtained SWOT). Cooking is considered an art involving creativity, passion, and a personal touch, elements that may be lost when automation is introduced through AI. This depersonalization of the culinary experience could reduce cooking to a formula, and some critics argue that the excessive use of AI in gastronomy could lead to a loss of creativity and originality in cooking. They fear that reliance on algorithms and data could limit chefs' ability to innovate and create unique dishes. Moreover, there is a concern that AI-driven standardization could homogenize culinary offerings, eliminating the diversity and individuality of establishments.

As [Parga \(2023\)](#) points out, AI should be a tool serving humanity and should only be used as such; otherwise, it could become an uncontrollable resource. Therefore, there is an urgent need for responsible use of AI that protects humanism and fundamental rights, reflecting that human beings are, and must remain, at the center of creation.

Additionally, AI could potentially lead to unemployment in the gastronomic sector, as implementing AI technologies in kitchens could automate many tasks, reducing the need for cooks and other workers in the sector, as seen in other sectors according to studies by [Mutascu \(2021\)](#), [Ford \(2013\)](#), and [Bordot \(2022\)](#). Restaurant entrepreneurs surveyed argue about the high costs and accessibility issues (weaknesses obtained from the SWOT matrix), as implementing AI systems in gastronomy can be expensive and not feasible for small restaurants or emerging businesses, potentially widening the gap between large chains and independent businesses ([Dauvergne 2022](#); [Mun et al. 2020](#); [Hjalager 2022](#)).

There is also a risk of excessive reliance on technology, as an over-reliance on technology could lead to a lack of traditional culinary skills among new chefs, who might depend excessively on technology for dish creation.

In summary, the use of AI in gastronomy has both positive and negative aspects. If used appropriately and in conjunction with human creativity, AI can be a powerful tool to improve quality and efficiency in the gastronomic industry. However, it is important to find a balance to ensure that the introduction of AI does not compromise authenticity and diversity in cooking.

## 6. Conclusions

This study on the application of artificial intelligence (AI) in the field of gastronomy has revealed a series of significant findings through qualitative analysis of responses to open-ended questions in a survey directed at three groups of respondents: chefs, restaurant entrepreneurs, and gastronomy experts.

From the obtained results, we can conclude the following.

Firstly, the use of artificial intelligence has not yet become widespread in the restaurant sector, with younger chefs being the most supportive of using AI to innovate in the creation of new recipes.

Secondly, the SWOT analysis indicates that the strengths of applying AI in gastronomy would be based on efficiency and consistency in food preparation, personalization of diets, and culinary innovation. As opportunities, respondents indicated that it would reduce food waste and improve the customer experience in restaurants by optimizing and recommending menus. On the contrary, weaknesses include the lack of a large amount of data in gastronomy that AI needs to be effective and provide reliable results, the lack of human intuition in creating recipes, and the cost of implementing AI in restaurant businesses. Threats include the employment consequences of AI-driven automation in the kitchen, which could displace food sector workers, especially in preparation and cooking roles, and concerns about privacy and security of personal information of customers and employees.

Thirdly, regarding the valuation of artificial intelligence in the gastronomy sector and according to the means comparison test, there are significant differences in the valuation of the importance of AI in gastronomy based on the scores among the three surveyed groups (chefs, restaurant entrepreneurs, and gastronomy experts). Chefs assigned a higher average score (7.6) to AI applied to gastronomy, highlighting its ability to facilitate the creation of new recipes and explore new flavors and textures, while entrepreneurs and gastronomy experts gave lower average scores (6.1 and 6, respectively), expressing concerns about the costs of implementing AI in their restaurants and the impact on the tradition and personal innovation of each chef. Additionally, there is concern that AI-driven innovation may not be well received by customers, especially the replacement of human labor by robots in customer service (Tung and Au 2018; Tuomi et al. 2019; Ivanov and Webster 2019; Liu et al. 2022).

Fourthly, the development of the Business Model Canvas (BMC) and Lean Canvas proposed in this research provides a detailed framework for gastronomy businesses to identify essential points for developing an economically profitable business with the support of AI. This analysis highlighted several key aspects that every entrepreneur should consider when setting up a restaurant business to avoid becoming part of the list of failed companies, including customer segments, with key segments being restaurants and gastronomic establishments seeking to differentiate themselves in a competitive market, catering companies looking to manage large volumes of operations, and final consumers interested in innovative gastronomic experiences (Sestino and De Mauro 2022). Value propositions, based on the creation of personalized menus through AI algorithms and offering unique and personalized gastronomic experiences, stand out as core values that attract and retain customers. Customer relationships and distribution channels include an online platform for orders and reservations, along with partnerships with restaurants and catering companies, are essential for promoting, selling, and delivering services. Revenue streams and key resources include revenue that is generated through direct sales of personalized menus, commissions for orders placed through the online platform, and AI consulting services for gastronomic establishments. Key resources include AI development teams, experienced chefs, and a robust technological platform.

The Lean Canvas proposed in this research on gastronomy using AI has led us to several important conclusions:

- It identifies specific problems within the restaurant sector that could be addressed with AI, such as inventory management, menu personalization, or process optimization in the kitchen, helping entrepreneurs strengthen their business weaknesses and identify key factors, saving costs and improving their investment.
- It validates the feasibility of AI based solutions to address these identified problems. The results highlight the need to include personalized food recommendation systems,

autonomous kitchen robots, or data analysis tools to enhance operational efficiency in restaurants.

- It validates the feasibility of AI-based solutions to address these identified problems. The results highlight the need to include personalized food recommendation systems, autonomous kitchen robots, or data analysis tools to improve operational efficiency (Berezina et al. 2019).
- It analyzes the added value that AI can offer to restaurant businesses, such as improving customer experience, reducing operational costs, or optimizing food quality.
- It facilitates continuous iteration and improvement of the business model as more information is gathered and different AI solutions are tested. This allows for quick adaptation to changing market needs and customer preferences, reducing losses.
- The developed Lean Canvas promotes consideration of the scalability and sustainability of AI solutions in the gastronomic context. This implies evaluating how the solutions can grow with the business and remain relevant in the long term. It also encourages collaboration between gastronomy experts and AI professionals to develop effective solutions that combine culinary knowledge with advanced technological capabilities (Camaréna 2021).
- Following the Lean Canvas modules and influenced by expert opinions, it can be concluded that it is important to segment the gastronomic consumer to tailor the offer to their needs, and that communication through online channels is essential to attract potential gastronomic consumers to our product (Nurcahyo et al. 2022; Kassem et al. 2021).

From the research conducted, we can conclude that the application of AI in the restaurant sector, from an economic perspective, contributes to the following: 1. Cost Reduction: AI can automate routine tasks, optimize inventory management, and improve operational efficiency, which can lead to significant cost savings. 2. Price and Menu Optimization: by using data on customer preferences and consumption patterns, AI can help restaurants adjust their menus and prices to maximize revenue. 3. Improvement in Planning and Management: AI algorithms can forecast demand and optimize the supply chain, helping to avoid excessive waste and improve resource management.

From a sustainable perspective, AI can 1. reduce food waste. AI can help predict the exact quantity of ingredients needed, thereby reducing food waste. 2. AI can optimize energy use in kitchens, reducing consumption and promoting more sustainable practices. 3. AI can select suppliers offering sustainable products and optimize transportation routes to reduce the carbon footprint, achieving sustainability in the supply chain.

In this research on “An Economic Perspective on the Implementation of Artificial Intelligence in the Restaurant Industry”, we address how AI can be used to make Spanish restaurants more efficient, profitable, and sustainable by integrating innovative practices that benefit both the business and the environment. This research is particularly relevant for future restaurant entrepreneurs, as the Lean Canvas model helps them identify the critical factors for setting up a restaurant business and avoiding failure.

In conclusion, the effectiveness or acceptance of AI in gastronomy could largely depend on the specific context and how the technology is implemented. It is a topic that will undoubtedly continue to evolve and generate debate as technology advances and becomes more integrated into our daily lives.

The limitations of this research include the challenge of finding a large sample of restaurant entrepreneurs who use AI in their businesses or chefs who incorporate it into their recipe development.

As future lines of research, it would be interesting to segment the application of AI in the restaurant industry, distinguishing by categories of restaurants and by regions of Spain. Additionally, these results could be extrapolated to Mediterranean Basin countries, which share the Mediterranean Diet highly valued by restaurant customers, to see if there are similarities or differences and to analyze the success or failure rates of restaurants based on the degree of AI utilization in their businesses.

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