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The Great Filter? A Preliminary Study on Metaverse and Sustainable Food Consumer

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Abstract: Collective virtual spaces are increasing attention from scholars and practitioners due to their potential to lead business growth while reducing environmental impacts. The Metaverse, with its immersive digital presence and virtual economies, serves as a prominent example, particularly in industries such as food. The existing literature on its adoption in the sector is still limited. Therefore, this study employs Mini Focus Groups with Italian Metaverse experts and a binary logistic regression model to identify the key factors influencing the adoption of the Metaverse in the food sector. It focuses on Italy due to its cultural-, economic-, and sector-specific dynamics in the sector, where the Metaverse could play a transformative role. Technological and regulatory uncertainties, as well as security risks, are the main obstacles which, according to experts, should deter consumers from embracing food purchases in the Metaverse. On the other hand, this study highlights several facilitating factors that can encourage adoption, also contributing to the achievement of SDG12: Responsible Consumption and Production. These include performance expectancy, effort expectancy, perceived behavior, hedonic motivation, and consumer innovativeness. These factors are likely to drive consumer engagement with Metaverse-based food platforms. The results provide interesting insights into which factors, according to experts, would influence people's willingness to purchase food products within the Metaverse, in view of the possible development of a new market for food products. This study provides a significant contribution to scholars and practitioners by shedding light on the main factors influencing consumer adoption of the Metaverse.

Keywords: metaverse; consumers behavior; mini focus groups; food consumers; SDG12; Italy

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1. Introduction

Technology development has become an integral part of modern lifestyles and people's consumption practices, driving a global transformation of the business environment [1–3]. Artificial Intelligence (AI) is driving significant transformations across various sectors of the economy, including its potential applications in the Metaverse [4,5]. Some scholars [4,5] have emphasized that the adoption of AI is prompting a rethinking of value creation, shifting it towards sustainability objectives. Specifically, their study outlines that a business model designed with this focus is characterized by sustainable practices, such as reduced waste, lower consumption, and a better balance between profit, environmental, and social concerns. Hence, technologies and sustainability are linked [6,7]. According to some scholars [8], people's digital propensity may positively drive their sustainable consumption.

In other words, these efforts by firms shape a digital business model that integrates digitalization into interactions with customers, partners, and internal operations [9]. Digital technologies include tools, devices, and systems that process, store, and display data. These encompass computing (e.g., software), connections (e.g., internet, Wi-Fi), algorithms, and digital systems for handling information (e.g., cloud computing). These technologies form interconnected spaces that mirror the real world, blurring the boundaries between the physical and digital area. Capurro et al. [10] assert that this integration of digital technologies often leads to the dissolution of boundaries separating the "physical (or traditional) world" from the "digital world". To better understand this phenomenon, Kaplan and Haenlein [11] referred to the "Fairyland of Second Life", introduced in Neal Stephenson's 1992 novel Snow Crash, in their article published in Business Horizons journal. Through this novel, the authors highlight the concept of the Metaverse, a three-dimensional virtual world in which Hiroaki Protagonist, the protagonist of the novel, lives, interacting with avatars and things in a digital space that allows him to perform any activity. Kaplan and Haenlein [11] state that the Metaverse has attracted large firms, creating new business opportunities. Although the Metaverse is still evolving, it has captured the attention of scholars [4,12–14]. However, there are varying interpretations of what the Metaverse is, as can be seen in the strategies of two major players in the field: Facebook's holding Meta Platforms concentrates on the development on virtual reality (VR) glasses and their own platform as part of the Metaverse. Apple's current focus, instead, is on augmented reality (AR), i.e., building a virtual layer on top of the real world, rather than recreating the real world virtually. Consequently, Apple has recently released the Vision Pro glasses, which are heralded by some as redefining the Metaverse, merging immersive digital experiences with the real world through next-level augmented reality [15,16].

As defined by Dwivedi et al. [17], the Metaverse is a virtual environment that offers immersive experiences, simulating real-world scenarios. It is often described as the next iteration of the internet after the fixed-line internet of the 1990s, the social net of the 2000s, and the mobile internet [18]. Therefore, it extends these technologies into a ubiquitous, persistent, and immersive digital layer that integrates with our physical world [18]. In other words, leveraging specialized virtual reality technology [19], it provides an experience that mimics the physical world. While the idea holds promise, it is crucial to emphasize that a fully functioning Metaverse has not yet come into existence [15], and its future trajectory remains uncertain [4]. However, its development could influence several SDGs, including SDG12 (Responsible Consumption and Production), by suggesting innovative ways to reduce waste, improve resource efficiency, and promote sustainable consumption in virtual environments. Moreover, it could impact SDG9 (Industry, Innovation, and Infrastructure) by driving digital infrastructure advancements, SDG10 (Reduced Inequalities) by providing more inclusive access to virtual experiences, and SDG4 (Quality Education) by enabling immersive learning environments. The integration of the Metaverse into these broader goals adds important questions about its potential to support or hinder sustainable practices and societal development. Hence, despite the Metaverse's potential to revolutionize customer experience is undeniable, it faces numerous challenges, including technical limitations, aesthetic shortcomings, ethical concerns, and potential health risks [20,21]. Consequently, the Metaverse is still largely a theoretical concept rather than a fully realized commercial reality [22]. Despite these challenges, this groundbreaking technology presents unique opportunities for marketing and brand promotion [4,23]. As a matter of fact, businesses are actively exploring ways to leverage the Metaverse to foster deeper brand engagement and service delivery [4,21,24].

Recent research [25] has highlighted the potential benefits of the Metaverse for the food industry. Some scholars [26] suggest that AI introduces a new approach to information

management within restructured business models, connecting innovation with sustainability. Innovation is key to business growth, as adopting new technologies helps firms to meet the UN 2030 Agenda. The scholars also highlighted that the linkage between human, technical, and natural systems is relevant for achieving the 17 Sustainable Development Goals (SDGs), concluding that ensuring sustainable food production for a growing population needs efficient and eco-friendly processes [26]. Recent studies [26–28] have highlighted that achieving SDGs needs innovation. In sectors such as water, energy, and food, AI can play a key role in achieving environmental SDGs, mainly those focused on climate action (SDG13), sustainable consumption, and responsible resource management (SDG12). Furthermore, when integrated thoughtfully into business models and sustainability strategies, AI can advance social SDGs by promoting equitable access (SDG4), improving livelihoods (SDG8 and SDG10), and fostering sustainable development in alignment with the UN 2030 Agenda in its full complexity.

Although the potential benefits of the Metaverse for the food industry have been highlighted [25], further investigation is needed to explore Metaverse's impact on consumer behavior within the agri-food sector. Indeed, practitioners are showing clear signs of interest, but this area is largely unexplored from a scientific research perspective [4,25]. Therefore, it is relevant to address a key question regarding the factors influencing Metaverse adoption. To tackle these issues, this exploratory study is grounded in Robin Hanson's Great Filter hypothesis, which suggests that even if life is abundant in our galaxy, civilizations eventually encounter a barrier that prevents their long-term survival [29]. Hanson argues that if life expands to fill every available niche, as we see on Earth, we should expect to find evidence of intelligent life in other star systems. However, the absence of such evidence suggests that a Great Filter might be at work, preventing civilizations from reaching a certain level of development or longevity [29]. On the other hand, Bailey [30], in addressing the Fermi Paradox, which questions the existence of extraterrestrial life due to the lack of confirmed encounters with humans, clarifies, through the Great Filter hypothesis, that the emergence of "intelligent life" is highly unlikely. According to the author, this leads to the phenomenon of cosmic silence. In this context, the rapid spread and adoption of new technologies, such as AI, on Earth may mark a pivotal moment in our technological evolution [30]. However, AI and the new technologies it drives could, in the long term, conceal dark or insidious aspects beneath the promises of an augmented and simulated reality.

This concern becomes even more pressing when considering the potential impact of technologies like the Metaverse, which, while offering the allure of immersive, augmented realities, also raises questions about their long-term implications for human behavior, societal values, and resource management. In light of the ongoing discourse surrounding the Metaverse, one might wonder whether it will catalyze significant societal improvement by advancing SDGs related to innovation and infrastructure (SDG9), SDG12, quality education (SDG4), and reduced inequalities (SDG10), or ultimately prove to be a futile investment of time and resources. There are several concerns about whether it will foster human progress or create obstacles that hinder development. This question becomes especially relevant when considering the potential impact of the Metaverse on production and consumption models, as outlined in the UN 2030 Agenda, particularly SDG12, which emphasizes the responsibility of these models for environmental and social sustainability. As the Metaverse continues to evolve as a powerful digital platform, its potential impact on sustainable business practices, especially in sectors such as food, are still limited. The existing literature has extensively discussed the role of AI in reshaping business models for sustainability; however, the adoption of the Metaverse in areas like food consumption and production still warrants deeper investigation. Considering that consumers have a pivotal role in influencing production models aligned with sustainability goals, exploratory analyses,

such as those conducted through focus groups, are fundamental for understanding the nuanced perceptions, behaviors, and expectations that shape their interactions with the Metaverse. Focus groups provide an important opportunity to uncover the motivations and concerns of consumers, providing rich qualitative insights that can guide the development of strategies for integrating sustainable practices within emerging digital environments like the Metaverse [29]. This approach enables researchers to capture the complexities of consumer attitudes and behaviors, facilitating the identification of potential barriers and opportunities for promoting sustainability in digital spaces. To address the existing knowledge gap, this exploratory study aims to investigate whether the adoption of the Metaverse in the agri-food sector can be interpreted as a Great Filter. Considering the broad scope of the topic and the limited scientific research available, the study employs Mini Focus Groups, a qualitative data collection method based on traditional focus groups, with both qualitative data collection and analysis. This study involved 60 experts in Metaverse adoption, divided into six groups of five participants each. Data were collected between June and July 2024. The Mini Focus Groups were designed to gather in-depth insights into the opinions, attitudes, perceptions, and experiences of these experts, specifically to identify the factors that influence consumers' willingness to purchase food products in virtual stores within the Metaverse. To steer the discussion, the experts were asked the following key question: "What factors influence consumer willingness to purchase food in the Metaverse?". The Mini-Focus Groups allowed us to develop a questionnaire for collecting the data, which were analyzed through the binary logistic regression model. Before conducting the factor analysis, the adequacy of the sample and correlation matrix was assessed. The Kaiser–Meyer–Olkin measure of sampling adequacy was found to be 0.87, indicating a suitable sample size. Bartlett's test of sphericity supports this study.

The research design outlined in this section provides a foundation for understanding the motivations behind this exploratory study, which marks the initial phase of a larger research project. Specifically, this study identifies the factors that, according to the experts interviewed, influence consumers' willingness to purchase food products within the Metaverse. The second phase of our research, currently underway, focuses on Italian consumers' intentions to use the Metaverse for grocery shopping. As such, this study serves as a preliminary step in our broader research agenda, with future phases planned to explore consumer perspectives in greater depth. By examining the intersection of the Metaverse, consumer behavior, and food sustainability platforms, this study contributes to the ongoing discourse on how emerging digital technologies can support the achievement of SDG12, promoting sustainable ways.

This exploratory study contributes to promoting more sustainable consumption patterns. It allows for understanding of how new technologies, such as the Metaverse and its related factors (facilitators, social persuasion, and obstacles) can create sustainable and engaging consumer experiences, supporting the global goals of SDG12 and contributing to a more resilient food system. The results may provide effective insights for policymakers, firms, and stakeholders in the food industry to influence digital technologies in ways including to reduce food waste, improve transparency in food sourcing, and foster responsible consumption.

The roadmap of this study is organized as follows: Section 2 presents the literature review that forms the foundation of this research. Section 3 presents the methodology used for the analysis. Section 4 discusses the results, while Sections 5 and 6 provide the discussion and conclusions, respectively.

2. Literature Review

The body of research [14,31–35] provides a general framework outlining the facilitators, social influences, and barriers that shape consumer preferences when adopting new technologies. It served as a foundational guide for our study, which focuses on understanding the specific factors influencing the adoption of Metaverse in the agri-food sector.

2.1. Facilitators

According to Al-Adwan et al. [31], consumers' preference towards using new technologies, such as those in the Metaverse, is influenced by various psychological and behavioral factors. One critical factor is consumer innovativeness, which refers to an individual's tendency to embrace new and unfamiliar technologies. People with high levels of personal innovativeness are more likely to adopt cutting-edge technologies, such as the Metaverse, as they perceive them as accessible, manageable, and beneficial to their lives [36–38]. This propensity to explore new products and services ahead of others aligns with early adoption behaviors, a phenomenon where individuals proactively seek out and integrate new technologies before they become mainstream [39]. The Metaverse, with its immersive features and cutting-edge tools, is particularly attractive to these early adopters, who are excited about its potential to revolutionize digital experiences.

In addition to innovativeness, performance expectancy plays a crucial role in determining whether consumers will embrace technologies like the Metaverse. Performance expectancy reflects the belief that using a specific technology will enhance users' tasks or shopping experiences, making them more efficient and effective [31]. In the case of Metaverse commerce platforms, consumers may believe that these platforms offer novel opportunities for an enriched and seamless shopping experience [9,40,41]. Research by Venkatesh et al. [41] has indicated that when users expect positive outcomes from their interactions with a new platform, such as improved product discovery, efficient task completion, or enriched experiences, they are more likely to engage with it. As the Metaverse integrates more features designed to optimize the shopping journey, this positive belief about platform performance will be increasingly crucial in driving consumer preferences. Additionally, intuitive navigation and user-friendly interfaces are essential components in shaping these expectations [42,43]. When platforms are perceived as easy to navigate, particularly in the Metaverse, where users may interact with complex virtual environments, it directly influences their willingness to engage and interact with the platform [44,45]. For instance, intuitive design that enables users to perform actions with minimal effort or confusion fosters a sense of competence and ease. As highlighted in research by Davis [32], the simpler the interface and more intuitive the navigation, the higher the likelihood that users will adopt and stay engaged with the platform over time. In the context of the Metaverse, where both consumers and firms are still exploring its full potential, providing seamless user experiences is critical to overcoming early adoption challenges.

Hedonic motivation, another significant driver, is particularly relevant to the Metaverse. Hedonic motivation refers to the pleasure and enjoyment derived from using a technology or platform, which, in this case, is driven by the immersive experiences and entertainment opportunities offered by virtual environments [31,46]. This motivation often overlaps with the need for leisure, enjoyment, and excitement, and can play a key role in driving engagement, especially in virtual spaces where users seek pleasure beyond the act of purchasing [46,47]. In other words, hedonic motivations are often associated with leisure activities like shopping, where the process of browsing and exploring options is as important as the final purchase [48,49]. According to studies by Babin et al. [33] consumers are more likely to be attracted to platforms that provide enjoyable and engaging experiences, such as those found in virtual shopping and gaming environments. The pleasure

derived from interacting with these technologies can significantly enhance self-satisfaction, as users experience gratification not only from the act of purchasing but also from the exploration process. In the Metaverse, this hedonic motivation is closely associated with leisure activities such as browsing digital products, interacting with other users, and engaging in virtual social interactions, all of which are as important, if not more so, than completing a transaction. This aligns with the work of Holbrook and Hirschman [34], who argue that consumers often view shopping as an enjoyable experience, with the process of exploring and discovering products being intrinsically rewarding. In fact, for many users of virtual platforms, the entertainment value derived from browsing, interacting with avatars, or experiencing digital worlds is a significant draw, even if no immediate purchase is made. The influence of hedonic motivation on the Metaverse extends to more immersive experiences, where consumers may engage in social, gaming, or entertainment activities that combine fun with commerce. As consumers spend time in these engaging environments, they may develop stronger emotional connections to both the technology and the brands present in these virtual spaces. This can be aligned with SDG12, which highlights responsible consumption by encouraging conscious and sustainable purchasing decisions [36,37,50]. New research on immersive technologies suggests that platforms offering pleasurable experiences are more likely to enhance consumer loyalty and increase the likelihood of repeat visits, particularly when users derive personal satisfaction from their interactions. This aligns with the growing interest in using immersive environments to promote sustainable consumer behaviors and mindful purchasing, leveraging emotional engagement to drive more responsible consumption patterns in the digital economy [38].

2.2. Social Persuasion

Consumer attitudes toward technology are shaped not only by their personal beliefs but also by significant social factors, such as the desire to conform to the norms and behaviors of reference groups, including family, friends, and social circles [51–53]. This social influence can have an important connection to SDG12, as the shift toward responsible consumption in the digital era depends on the choices made by individuals within their social environments. Specifically, the adoption of new technologies, such as the Metaverse, may be influenced by social norms that prioritize sustainable practices, responsible digital engagement, and reducing environmental footprints through virtual interactions. Building on existing research [31,54], this study distinguishes between two types of social influence: perceived herd behavior and subjective norms. Perceived herd behavior occurs when individuals adopt a technology or behavior based on their observations and perceptions of others' actions [31]. This behavior is heavily influenced by the human instinct to conform to group behaviors or follow trends, especially in a social context where individuals are unsure about the benefits or value of adopting a technology on their own. The adoption of cutting-edge technologies, like virtual worlds and platforms (e.g., the Metaverse), can align with SDG12 when consumers adopt these tools as sustainable alternatives to physical consumption, thereby reducing the environmental impact of traditional activities. Additionally, herd behavior accelerates adoption, as users are motivated to join digital spaces when others in their social networks do so [55]. This phenomenon of social contagion, where behaviors and attitudes spread like a "virus" within social groups, can reinforce adoption, making it easier for consumers to embrace the virtual world in place of resource-intensive alternatives. In contrast, subjective norms (SNs) refer to individuals' perceptions of social expectations and pressures to adopt a technology [31]. These norms reflect the influence of significant others, such as family members, close friends, or colleagues, who communicate implicit or explicit approval or disapproval regarding the use of technology. SNs capture the social pressures that individuals feel, either consciously or unconsciously, to behave in

a way that aligns with social expectations. In the context of new technologies, especially the Metaverse, individuals may feel the need to adopt such platforms not only for personal benefit but also to avoid being excluded from conversations, group dynamics, or social interactions that occur within those platforms [55]. By integrating social influences and pressures, this aligns with SDG12, which emphasizes shifting consumer behavior toward more sustainable, inclusive, and resource-efficient consumption patterns. Consumers may be more likely to adopt technologies like the Metaverse as a way to meet social expectations related to digital engagement, sustainability, and collective responsibility, thus making the Metaverse an increasingly viable alternative to more traditional, physical consumption practices. This is evident in cases where technologies have become highly visible within a social group, such as when social influencers or celebrities publicly embrace a new platform. When these figures adopt sustainable digital spaces, they not only encourage others to follow but also influence perceptions about responsible consumption practices. In simpler terms, perceived herd behavior is the tendency to mimic the actions, styles, or beliefs of others, often because of a perceived social consensus about technology's worth [55]. For instance, when consumers observe a surge in popularity or adoption of specific technology, they may feel compelled to follow suit to be part of the crowd, especially when they perceive benefits from others' experiences. This tendency to improve the Metaverse can contribute to SDG12 by providing a low-impact, socially driven alternative to traditional consumption, hence supporting the goal of reducing waste and resource use. On the other hand, SNs reflect individuals' perceptions of the approval or disapproval of significant others regarding technology use [55]. These norms influence technology adoption on a more personal and relational level, where the desire to meet the expectations of others guides decision-making. For instance, individuals may feel pressured to adopt virtual environments like the Metaverse if they perceive that friends or family members expect them to engage in these digital spaces or if social or professional networks are integrating such technologies into daily life and business practices. The pressure to conform to digital engagement may foster more sustainable practices, especially if the social context surrounding the Metaverse encourages responsible digital interactions. This aligns with the broader objectives of SDG12 by promoting sustainable consumer behaviors in virtual environments, supporting a shift toward environmentally conscious digital consumption [39]. The influence of social factors on technology adoption has been extended in recent research, particularly in digital platforms and online environments, where social approval and conformity are key motivators. For instance, Cialdini and Goldstein [40] examined the psychological principles behind social influence and conformity, suggesting that individuals' technology adoption behaviors are shaped by perceived social pressures, including social proof, which is the tendency to follow the behavior of others in uncertain situations. Similarly, Venkatesh et al. [41] in their Unified Theory of Acceptance and Use of Technology (UTAUT) highlight that social influence, including subjective norms, is a central factor in shaping an individual's decision to adopt technology, as the approval of important others can greatly impact the perceived utility of a platform.

2.3. Obstacles

Some scholars [31] have identified perceived cyber risks, regulatory uncertainty, and technological uncertainty as significant barriers to the adoption of Metaverse commerce. These challenges are due to the rapidly evolving nature of the Metaverse, which is characterized by frequent technological advancements [31]. Hence, this dynamic environment can lead to uncertainty regarding both technological tools and regulatory frameworks [17,56,57]. These uncertainties can hinder the adoption of sustainable practices in digital environments,

which is a crucial consideration for achieving the broader targets of SDG12, specifically in fostering responsible production and consumption.

Some authors [42] highlighted that the Metaverse presents potential benefits for sustainable digital engagement; however, its uncertain regulatory and technological landscape can impede efforts to ensure environmentally responsible behaviors. For instance, a lack of clear guidelines or standardization around data privacy, cybersecurity, and digital transactions could lead to inefficiencies or even increase carbon footprints associated with digital infrastructures. Furthermore, rapid technological changes in the Metaverse may result in inefficient resource consumption or increased electronic waste, conflicting with SDG 12's focus on promoting sustainable consumption and production patterns. Addressing these barriers is essential for aligning the Metaverse with sustainability goals, enabling consumers and businesses to engage in digital spaces responsibly. As such, a balance needs to be struck between technological innovation and sustainable practices to ensure that the Metaverse does not exacerbate existing environmental challenges. This involves developing regulatory frameworks that encourage sustainable design and consumption practices, as well as fostering technological advancements that prioritize energy efficiency and reduce resource consumption [43].

3. Materials and Methods

3.1. Survey and Sample

This study is based on a general framework derived from existing literature on technology adoption [44–46]. We conducted Mini Focus Groups with experts from the agri-food sector, who are either directly or indirectly involved in the adoption of the Metaverse in the firms in the industry. The knowledge and insights provided by these experts helped us identify and understand the factors influencing consumers' willingness to purchase food products in the Metaverse. Furthermore, they played a key role in testing our pilot questionnaire, which will be administered in the second phase of this research, providing guidance to help us refine and finalize its items. According to some authors [48,49], Mini Focus Groups are useful when the groups are made up of individuals with a high level of expertise [51]. Mini Focus Groups were used in this study, considering the participants' characteristics. Participants were experts in the Metaverse field, including academics, computer scientists, engineers, experts in food science, cybersecurity, law, and psychology, and business professionals. To be eligible for the Mini Focus Groups, they had to be Italian residents, Metaverse experts, and familiar with family food expenditure. These criteria were selected to account for the exploratory nature of this study.

A total of 60 participants were recruited, with 5 participants for each Mini Focus Group [45]. This focus group size aligns with the current literature [48,51], balancing the need for diverse perspectives with manageable group dynamics [48,51]. Hence, Mini Focus Groups were conducted between June and July 2024, lasting approximately one hour each [49]. Based on the existing literature on Metaverse adoption [31–33] we developed a semi-structured questionnaire. Mini Focus Groups with experts were conducted via the Zoom platform, guided by the semi-structured questionnaire. Participants were asked to respond to questions designed to measure various factors, including their innovativeness, PE, effort expectancy, hedonic motivation, perceived herd behavior, subjective norms, perceived cyber risks, technological uncertainty, regulatory uncertainty, and their willingness to use Metaverse platforms for grocery shopping. Mini Focus Groups are particularly useful in exploratory studies, especially in emerging technologies like the Metaverse, because they allow for in-depth, qualitative insights that uncover the underlying attitudes, beliefs, and social influences driving user behavior. These groups, typically comprising 4–8 participants, create a dynamic environment where participants can engage in open discussion,

providing rich, nuanced data about their perceptions of the Metaverse's potential, its risks, and its benefits. Krueger and Casey [51] discuss how focus groups help uncover deeper insights into participant attitudes, beliefs, and motivations, which can then inform survey design and further research. By facilitating interaction among participants, Mini Focus Groups provide a significant method for capturing diverse perspectives and exploring complex topics, such as the factors influencing Metaverse adoption in specific sectors like grocery shopping. Morgan [52] highlights how Mini Focus Groups can support analysis in exploratory studies, especially in contexts where the subject matter is novel or rapidly evolving, such as with Metaverse adoption. Moreover, these groups help identify issues that may not be immediately apparent through surveys alone, such as the influence of social norms or the perceived risks of virtual environments. Therefore, the use of Mini Focus Groups complements quantitative approaches by adding depth and context to the understanding of consumer attitudes and behaviors. Demographic information was also collected. A 10-point Likert scale was used to assess each item group, ranging from totally disagreement to totally agreement [8].

3.2. Factor Analysis

To reduce the dimensionality of the data, a factor analysis with orthogonal rotation (varimax) was conducted [53], and these data were included in the binary logistic regression model. Before conducting the factor analysis, the adequacy of the sample and correlation matrix was assessed. The Kaiser–Meyer–Olkin measure of sampling adequacy was found to be 0.87 [54], indicating a suitable sample size. Additionally, Bartlett's test of sphericity was significant (χ^2: 10,139, df: 139, $p < 0.001$) [55], suggesting that the correlation matrix was appropriate for such an analysis. Later, to determine the optimal number of factors, Kaiser's criterion was applied [56]. Thus, nine factors with eigenvalues greater than 1 were retained, explaining 76% of the total variance. Moreover, the reliability of each factor was assessed using Cronbach's alpha. Table S1 in the Supplementary Materials shows the nine factors and their corresponding Cronbach's alpha coefficients. All factors demonstrated acceptable reliability, with Cronbach's alpha values ranging from 0.88 to 0.93. Furthermore, the factor analysis yielded a simple structure, with each item loading strongly on a single factor. Later, summated scales were created for each factor and used as independent variables in a binary logistic regression model [56]. The goodness-of-fit of the factor analysis model was evaluated using the Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA) [57,58]. Additionally, convergent and discriminant validity were assessed by examining the correlation between items and their respective factors [59].

3.3. The Binary Logistic Regression Model

A binary logistic regression model [60] was applied to identify the factors influencing respondents' willingness to use the Metaverse for grocery shopping. The binary dependent variable y_i takes the values "Yes" or "No" and the probability of success P(Y = Yes | x) is the probability that an individual is willing to use Metaverse commerce for grocery shopping conditioned by variables of the questionnaire. Initially, all explanatory variables were included in the model.

The initial model was:

$$P(Y = \text{Yes} \mid x) = \beta_0 + \beta_1 \text{Gender} + \beta_2 \text{Age} + \beta_3 \text{Edu} + \beta_4 \text{CI} + \beta_5 \text{PE} + \beta_6 \text{EE} + \beta_7 \text{HM} + \beta_8 \text{PH} + \beta_9 \text{SN} + \beta_{10} \text{PC} + \beta_{11} \text{PT} + \beta_{12} \text{PR} \quad (1)$$

Later, the variables with not significant coefficients were excluded from the final model. The final model parameterization was selected based on the Akaike Information Criterion (AIC; Akaike, 1973), using a mixed "backward" and "forward" stepwise selection strategy.

In formula, the final model is:

$$P(Y = Yes \mid x) = \beta_0 + \beta_4 CI + \beta_5 PE + \beta_6 EE + \beta_7 HM + \beta_8 PH + \beta_9 SN + \beta_{10} PC + \beta_{11} PT + \beta_{12} PR \quad (2)$$

The β values and the significance of each variable have been looked. Marginal effects were used to interpret variables, revealing how changes in each factor influence the likelihood of using Metaverse platforms for grocery shopping. All analyses were performed using R Studio (version 2024.09.0) a software environment for statistical computing and graphics [61].

4. Results

4.1. The Analysis

The analysis with nine factors provided a good fit (CFI = 0.96; TLI = 0.92; RMSEA = 0.07). Therefore, to have a good fit analysis, values approaching 0.90 or greater are desirable for the CFI and TLI indexes [58], while RMSEA values between 0.06 and 0.08 indicate an acceptable fit model [57]. In addition, following some academics [59], the convergent and discriminant validity of construct was confirmed. In fact, items belonging to the same factor were correlated highly with the factor considered, while items belonging to different factors did not correlate highly with the factor analyzed (Table S2 in the Supplementary Materials).

4.2. Participants' Characteristics

The focus group participants ranged in age from 18 to 65 years old. The largest demographic was individuals aged 31 to 40, comprising 51% of the sample (Table 1). In terms of gender and education, the majority of participants were female, accounting for 69% of the total, and 55% of the sample reported a high level of education. Furthermore, 90% of the respondents stated a high willingness to use Metaverse for buying food.

Table 1. Participants' characteristics.

Sociodemographic Information		**%**
Sex	Female	69.0
	Male	31.0
Total		100.0
Age	18–20 years	19.0
	20–30 years	20.0
	31–40 years	51.0
	>41 years	10.0
Total		100.0
Education	High-Level	55.0
	Low-Level	45.0
Total		100.0
Willingness to use Metaverse for grocery shopping	Yes	90.0
	No	20.0
Total		100.0

4.3. Proposed Model

The results of the binary logistic regression model are showed Figure 1 and in Table 2; the goodness of fit, as measured by McFadden's pseudo-R^2, was 0.89, and multi-collinearity was not a major issue in the model as it was tested through Variance Inflation Factors (VIFs) (the highest value is equal to 1.25).

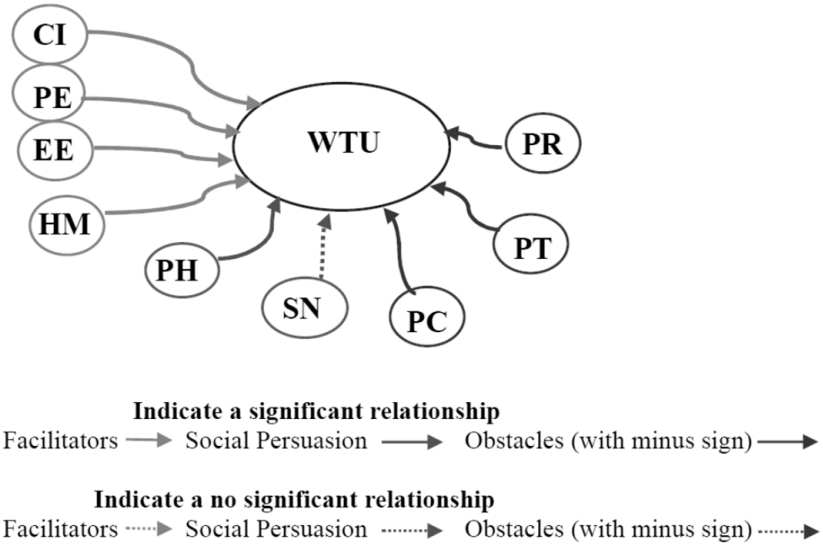

Figure 1. Results.

Table 2. Binary logistic regression model.

Variable	β	Standard Error	t-Value	*p*-Value	Marginal Effects
Intercept	0.579	0.076	6.98	0.00	6.87
CI	0.210	0.055	4.93	0.00	8.20
PE	0.114	0.065	2.35	0.01	5.39
EE	0.110	0.002	6.63	0.00	4.50
HM	0.213	0.003	2.80	0.001	3.39
PH	0.215	0.001	1.91	0.00	4.44
SN	0.170	0.003	4.70	0.10	-
PC	−0.219	0.006	2.35	0.00	−3.74
PT	−0.173	0.003	6.01	0.00	−2.37
PR	−0.163	0.002	2.40	0.001	−3.11

Note: Dependent variable: Respondent's willingness to use Metaverse for grocery shopping (WTU).

According to experts interviewed, consumer innovativeness (CI) is a strong predictor of Metaverse adoption. Those interviewed with higher levels of CI were 8.20 times more likely to use Metaverse platforms for grocery shopping (WTU). Similarly, individuals who believed that using a Metaverse platform would enhance their shopping experience (performance expectancy—PE) were 5.39 times more likely to adopt the technology. Additionally, positive perceptions of effort expectancy (EE) were associated with a 4.50 times higher likelihood of using Metaverse platforms. Furthermore, hedonic motivation (HM) and perceived herd behavior (PH) were found to positively influence experts' willingness, as those with higher levels of HM, seeking pleasure and enjoyment from technology use, were 3.39 times more likely to adopt the Metaverse. Interestingly, SNs did not have a significant direct impact on adoption intent, despite prior assumptions in related studies. However, as anticipated, perceived cyber risks (PC), technological uncertainty (PT), and regulatory uncertainty (PR) emerged as significant barriers to adoption. Hence, people who perceived higher levels of these risks were 3.74, 2.37, and 3.11 times less likely to use Metaverse platforms for grocery shopping, respectively. These results highlight the importance of fostering consumer engagement with the Metaverse in ways that promote responsible and sustainable consumption practices, as outlined in SDG12. By addressing barriers such as perceived risks and uncertainties, companies can enhance the adoption of Metaverse technologies while ensuring that consumer behaviors align with sustainable production and consumption patterns. The results highlight the need for a balanced approach, integrating innovation and sustainability in the adoption of digital platforms like the Metaverse, which could potentially revolutionize the way consumers engage with sectors like grocery shopping.

5. Discussion

The Metaverse is reshaping marketing strategies and creating new opportunities for brand engagement and consumer interaction [4]. However, the application of Metaverse technology within the agri-food sector remains largely unexplored [25]. Consequently, to fill this knowledge gap, this study conducted by Mini Focus Groups with experts in the Metaverse field identifying the factors that, according to the experts interviewed, would influence people's willingness to purchase food products within the Metaverse. This study represents the first step in our broader research initiative, which aims to define questionnaire items, test their clarity, and identify key drivers of consumer behavior in the Metaverse. Further research, currently underway, focuses on Italian consumers' intentions to use the Metaverse for grocery shopping, marking the second phase of this research.

In line with SDG 12, which encourages responsible consumption and production, the results of this study highlight the significance of consumer innovation (CI) as a predictor of Metaverse adoption for food purchases, aligning with previous research [46]. Innovative individuals are more likely to embrace new technologies, particularly those offering novel experiences [31]. In other words, they view Metaverse commerce as an opportunity to explore new ways of shopping and are willing to adapt their behavior accordingly [31]. Moreover, our results highlight that performance expectancy (PE) and effort expectancy (EE) significantly influence consumer intent. Moreover, hedonic motivation (HM) was found to positively impact consumer willingness to purchase food via Metaverse technology. As noted earlier, HM refers to the pleasure derived from using new technology [46]. This result aligns with research on technology adoption [31]. Therefore, the immersive and interactive nature of Metaverse commerce can provide enjoyable and engaging shopping experiences, satisfying consumers' hedonic needs [31]. By fostering these key factors, Metaverse could promote more sustainable consumption patterns, particularly in the context of food, in alignment with SDG12 for ensuring sustainable consumption and production. Among the persuasion factors that were analyzed in this exploratory study, perceived herd behavior (PH) emerged as a significant social influence on consumer willingness to adopt Metaverse commerce, consistent with previous research [46]. Positive experiences and recommendations from others can enhance the credibility and trustworthiness of a technology, sparking curiosity and interest among potential users [8,46]. This curiosity can drive individuals to explore and adopt technology, even in the face of uncertainty [46]. In our study, the results emphasized the critical role of herd behavior as the primary social influence, especially given the absence of subjective norm influence within close social circles. Therefore, according to our respondents, perceived herd behavior (PH) has a stronger influence than SN, suggesting respondents rely more on external information sources to shape their intentions. This aligns with some authors [9] who found that external information sources can significantly impact consumer behavior. Moreover, the absence of subjective norm influence within close social circles is due to the recent nature of Metaverse commerce, which is a relatively new and unfamiliar concept [22]. In fact, people may have limited opportunities to discuss it with their close social circles [31]. Consequently, they may turn to other sources, such as online reviews or social media, for information and recommendations [31].

Among the obstacles examined in this study, perceived cyber risk (PC) emerged as a significant barrier to Metaverse adoption, consistent with existing research [46]. Concerns about security and privacy may deter users from engaging with Metaverse platforms, as they may doubt the ability of these platforms to protect their personal information and financial transactions [46]. This lack of trust can significantly hinder consumers' willingness to purchase food through Metaverse technology. Additionally, perceived technological uncertainty (PT) also negatively impacted adoption intent. Hence, interoperability issues, high costs, and rapid technological advancements can contribute to uncertainty among

users [31]. Users may worry about investing in a platform that may become obsolete or incompatible with future developments. Finally, according to the experts interviewed, perceived regulatory uncertainty (PR) is another significant barrier. Regulatory ambiguity can raise concerns about data security and privacy, leading to hesitation among users to share sensitive information or engage in transactions on Metaverse platforms [31].

To sum up, the results highlight that the integration of factors such as consumer innovativeness (CI) and performance expectancy (PE) with adoption barriers like perceived technological uncertainty (PT) is a strength of the study, as it provides a skeleton for understanding the drivers and inhibitors of Metaverse adoption in the food sector. This is especially important as these barriers could serve as a Great Filter for the Metaverse's long-term success, suggesting that unless these challenges are addressed, the technology may fail to reach its full potential. Just as in the Great Filter hypothesis, where certain existential barriers must be overcome for civilization or technology to advance, these adoption barriers must be surmounted for the Metaverse to become a sustainable and transformative force in sectors like food. This study highlights the importance of consumer engagement and addresses the need for usability and perceived benefits, which are practical considerations for Metaverse platform developers, highlighting the ongoing challenges in overcoming these significant adoption barriers.

6. Conclusions

This study employs a Mini Focus Group to analyze insights from 60 experts in the Metaverse's adoption within the agri-food sector. Results show that consumers' intention to purchase food in the Metaverse is influenced by key obstacles, such as perceived technological uncertainty (PT), concerns about the reliability of emerging technologies; perceived regulatory uncertainty (PR), stemming from the lack of clear policies for virtual transactions; and perceived cyber risks (PC), driven by fears of data breaches and fraud. Conversely, facilitators identified include performance expectancy, effort expectancy, perceived herd behavior, hedonic motivation, and consumer innovativeness. These factors, if addressed, suggest that the Metaverse could increasingly become a viable platform for food transactions. In alignment with SDG12, which promotes responsible consumption and production, addressing these obstacles and leveraging the facilitators could enable more sustainable and efficient food transactions in the Metaverse. However, social norms (SNs) had a minimal impact on consumers' willingness to engage with Metaverse food platforms. Unlike traditional online shopping, where social influence plays a significant role, consumer decisions in virtual spaces appear more influenced by individual motivations, ease of use, and perceived benefits. The immersive nature of the Metaverse may reduce social pressures, placing greater emphasis on personal experiences.

This exploratory study suggests precious insights into the factors influencing consumers' willingness to purchase food in the Metaverse. Although the research is in its early stages, it highlights the importance of usability and perceived benefits for Metaverse platform developers. Therefore, this study also contributes to understanding the relationship between the Metaverse and sustainability, especially regarding food waste. Addressing food waste is critical as it impacts waste management systems, exacerbates food insecurity, and contributes to pollution, climate change, and biodiversity loss. Incorporating sustainability in the Metaverse design can mitigate these effects by prioritizing resource efficiency, waste reduction, and environmental impact.

This study has limitations. The sample consisted of Metaverse experts, and while their insights are valuable, they may not fully represent broader consumer perspectives. The next phase of research involves surveying Italian consumers to expand upon these findings. Additionally, future research could explore the gap between consumer intention and

actual behavior, using metrics such as purchase data and usage patterns. Given the rapid development of the Metaverse, long-term tracking studies are necessary to monitor changes in consumer attitudes. Lastly, the study's Italian context may limit the generalizability of the results, and future studies should include diverse cultural perspectives to gain a deeper understanding of how context shapes Metaverse adoption.

However, this study raises key questions about the Metaverse's potential to catalyze societal progress. Will the Metaverse lead to meaningful societal improvements, or will it become a waste of resources? Could it support human progress, or hinder it? The results do not provide a definitive answer, indicating the need for further research to explore consumer behavior and adoption factors in the evolving Metaverse space. As technology progresses, consumer perceptions and behaviors will continue to change, and long-term studies are crucial to understanding these shifts. This study serves as a significant milestone in research on the Metaverse and SDG12, offering crucial insights for future investigations. It may help determine whether the Metaverse strengthens or challenges the Great Filter Hypothesis, shedding light on whether technological progress will improve or hinder human development in the long term.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su17052069/s1, Supplementary Materials with Table S1. Factor analysis with varimax rotation; Table S2. Convergent and discriminate validity of the construct.

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