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The Importance of Product Attributes in the Context of Self-Driving Food Delivery Services: Evidence from South Korea and Mongolia

Oyunnomin Bayanmunkh [1], Soyeon Jung [2], Junghoon (Jay) Lee [3] and Jinsoo Hwang [1,*]

[1] College of Hospitality and Tourism Management, Sejong University, Seoul 05006, Republic of Korea
[2] William F. Harrah College of Hospitality, University of Nevada, Las Vegas, NV 89557, USA
[3] School of Hospitality Leadership, College of Business, East Carolina University, Greenville, NC 27858, USA
* Correspondence: jhwang0328@gmail.com

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Abstract: The aim of this study is to investigate the importance of the product attributes of self-driving food delivery services in South Korea and Mongolia. The survey was conducted with 313 respondents from South Korea and 311 from Mongolia. First, the results for the exploratory factor analysis showed that the three concepts, which include perceived innovativeness, perceived risk, and word-of-mouth, have a high level of validity and reliability. Second, the measurement items for perceived innovativeness showed statistically significant differences in both South Korea and Mongolia, whereas two measurement items for perceived risk showed statistically significant differences. Finally, perceived innovativeness and perceived risk had a significant impact on word-of-mouth in both countries.

Keywords: self-driving food delivery services; perceived innovativeness; perceived risk; word-of-mouth; comparative study

1. Introduction

Robots are gradually replacing humans in various industries with the rapid development of related technologies by addressing numerous challenges that are faced by society. Intelligent food delivery robots have emerged as a significant innovation in the food industry. Traditional manually operated logistics vehicles face challenges, such as high costs, low efficiency, and safety risks, which require resolution [1]. Advancements in automation technology have paved the way for innovative business applications in last-mile logistics over the past decade [2].

Intelligent food delivery robots, such as autonomous delivery systems are increasingly being deployed in restaurants across many cities, which significantly enhance cost-efficiency and operational efficiency in the industry [3]. These robots utilize advanced technologies, such as sensors, cameras, and mapping systems in order to navigate sidewalks, roads, and other designated pathways safely, which streamline last-mile delivery operations for companies and logistics providers [4]. The first robotic package delivery was publicly conducted by the tech company Starship in the United States [5], and these robots operate today on more than a dozen college campuses, which offer contactless and convenient food delivery services that enhance everyday life [6]. They were initially met with curiosity, but they have quickly become integrated into urban environments, which marks a transformative shift in the food service industry. However, the widespread adoption of these technologies presents challenges, which include the need for regulatory frameworks, airspace restrictions, privacy concerns, and robust safety measures [7]. Self-driving food delivery systems are continuing to evolve, so businesses must understand key product attributes that shape consumer perceptions in regards to maintaining a competitive edge in this rapidly changing market. However, self-driving food delivery services have several limitations. One major concern is the

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potential risk of accidents involving autonomous vehicles, which may raise safety concerns among users and the general public. In addition, the lack of well-established legal and regulatory frameworks poses significant challenges, as it creates uncertainty regarding liability, insurance, and operational standards [8]. These issues may ultimately hinder the widespread adoption and commercialization of such services.

This research examines the existing research that is related to the importance of product attributes in regards to self-driving food delivery systems, which includes a particular focus on a cross-national study that encompasses South Korea and Mongolia. The previous studies explored the potential benefits of autonomous delivery systems by focusing on the technical characteristics and health beliefs. For instance, Chen et al. [2] investigated the adoption of self-serving delivery robots in last-mile logistics, which highlights their potential to save time by allowing robots to serve nearby customers while drivers handle other deliveries. Choi, Schonfeld, and Lee [9] also identified the cost-saving potential of third-party delivery services. However, a limited amount of research exists on consumer perspectives regarding self-driving delivery robots. The primary purpose of this study is therefore to examine the importance of product attributes, which include perceived innovativeness and perceived risk, in regards to shaping consumer perceptions and word-of-mouth behaviors toward self-driving food delivery systems due to this lack of research.

Another purpose of this study is to investigate the differences between South Korea and Mongolia, which focus on how product attributes influence consumer adoption of self-driving food delivery systems. South Korea is a global leader in technological innovation with a strong economy, which is driven by electronics and automotive industries, and it has emerged as a frontrunner in service robotics particularly in food delivery. The online food delivery market, which is projected to reach $59.14 billion by 2029, is propelled by economic growth, high disposable income, and mobile platforms. South Korean consumers prioritize speed, quality, and diverse options, and companies, such as Woowa Brothers and Neubility are able to integrate robotic systems with legislative changes that allow delivery robots to operate on sidewalks [10,11]. Mongolia's economy in contrast is traditionally reliant on agriculture, livestock herding, and mining. Despite significant infrastructure challenges, particularly in transportation, Mongolia is investing in sectors such as tourism, renewable energy, and technology, thereby creating opportunities for the adoption of autonomous driving systems. Although food delivery systems in Mongolia are still in their early stages, several local apps are gaining popularity, even though traffic congestion often results in long delivery times. Both South Korea and Mongolia show increasing interest in exploring the potential benefits of autonomous technologies, including self-driving food delivery systems, despite differences in economic development and population density.

Understanding the unique socio-economic and environmental factors of each country is crucial in order to evaluate the feasibility and implications of implementing these types of systems within their respective contexts. The previous studies identified various factors that focus on technical characteristics and health beliefs [12]. For example, Chen et al. [2] examined the adoption of self-service delivery robots in last-mile logistics. Their findings suggest that using delivery robots can result in significant time savings by allowing robots to serve nearby customers while drivers simultaneously attend to other deliveries. In addition, the past research highlights the potential of third-party delivery services in regards to reducing delivery costs [9].

This study in particular seeks to (1) identify the key product attributes, such as perceived innovativeness and perceived risk in both countries; (2) examine differences in product attribute preferences; and (3) analyze the impact of these attributes on consumer word-of-mouth behavior. This research will provide insights into how cultural norms, economic development, and technological infrastructure shape consumer perceptions and behaviors that in particular regard self-driving food delivery systems by comparing Korea and Mongolia.

2. Literature Review

2.1. Overview of South Korea and Mongolia's Economic Landscapes

South Korea has emerged as a global leader in technological innovation, which is driven by remarkable economic growth over the past several decades. South Korea has a GDP that exceeds $1.6 trillion [13] and a population of over 51 million, so it boasts one of the world's most dynamic economies. This growth has been fueled by key industries, such as electronics, automotive, and robotics, which is led by major conglomerates, such as Samsung, Hyundai, and LG. South Korean companies are also at the forefront of the global service robot industry, which set international standards [14].

South Korea has recently ramped up investments in autonomous technologies, which include self-driving vehicles and this includes a focus on applications, such as autonomous food delivery systems in urban areas. South Korea's online food delivery market had been projected to reach a revenue of $44.42 billion, which includes an expected annual growth rate (CAGR 2024–2029) of 5.89% by increasing market volume to $59.14 billion by 2029 [10]. The

growth of this South Korean market is further fueled by the country's strong economy, high disposable income levels, and the rise of mobile food-delivery platforms that provide convenient ordering processes, diverse food options, and filters for high-quality restaurants.

South Korean consumers value convenience, speed, quality, and variety in regards to online food delivery drive the demand for services that offer quick delivery and diverse cuisine options. A significant trend is the surge in mobile ordering, which is supported by a smartphone penetration rate of over 95%. Mobile apps have become the most popular platform for food delivery, which lead to an increase in food delivery application usage [10]. 20.1 million Korean residents were using food delivery apps, such as Baemin and Yogiyo as of May 2023 [15].

The acceptance of service robots in South Korea depends on factors, such as technological readiness, societal receptiveness, and regulatory frameworks [14]. Legislative changes in November 2023 notably revised the Act on Development and Supply of Intelligent Robots, which allowed delivery robots to operate on sidewalks. These robots, which were previously classified as vehicles, were restricted from sidewalk use, but the robots that meet safety certifications can now navigate sidewalks, which enhances urban delivery logistics [11]. Leading this innovation are companies, such as Woowa Brothers, which are the creators of the Baemin food delivery service, and the robotics firm Neubility, which is conducting trials in order to refine the integration of robotic delivery systems [16].

Mongolia, which is situated between Russia and China, is home to approximately 3.3 million people, and it has a GDP that is around $17.1 billion [13]. Mongolia is endowed with an abundant number of natural resources, such as coal, copper, gold, and uranium, and these assets have been pivotal to Mongolia's economic development. However, the country faces significant challenges in regards to infrastructure development, particularly in transportation networks, due to its vast territory and harsh environmental conditions. For these reasons, expanding the transportation network is a key priority, and once this is achieved, the commercialization of self-driving delivery services will become more feasible.

The number of cars in Mongolia has been steadily increasing, which includes an average annual growth rate of 5% since 2015. Traffic congestion has become a persistent issue especially at key intersections in Ulaanbaatar, which is the capital and the most populous city of Mongolia. This congestion is driven by inadequate traffic infrastructure, which includes limited roadways and parking facilities, poor adherence to traffic rules by road users, and insufficient traffic management. Addressing these operational inefficiencies remains a critical area for improvement.

Mongolia has made strides in regards to economic growth and diversification despite these challenges, which includes increased investments in the tourism, renewable energy, and technology sectors [17]. These advancements offer opportunities in regards to adopting cutting-edge technologies, such as autonomous driving systems in order to alleviate transportation and logistics challenges in the country's evolving economic landscape. The food delivery systems in Mongolia are less advanced compared to the systems in South Korea, but local apps, such as Toktok, Songo.mn, and Ubeats are growing in popularity. Many restaurants also provide their own delivery services. However, lengthy wait times, which are often exacerbated by traffic congestion, remain a significant challenge, and customers frequently experience delays of 1–2 h.

As mentioned above, the significant economic and technological disparities between South Korea and Mongolia provide a strong foundation for cross-national comparative research. South Korea, with its highly developed economy, advanced technological infrastructure, and mature online food delivery market, offers an environment in which autonomous delivery systems can be rapidly introduced and scaled. In contrast, Mongolia, characterized by a smaller economy, less developed infrastructure, and an emerging food delivery market, faces distinct logistical and environmental challenges. Comparing these two countries enables an examination of how variations in economic development, technological readiness, and urban infrastructure influence the adoption, implementation, and perception of autonomous food delivery services. Such a comparison not only highlights context-specific challenges and opportunities but also provides insights into the broader applicability and potential limitations of autonomous delivery systems across diverse national contexts.

2.2. Cross-National Studies

Mongolian citizens continue to experience low-income levels despite the recent progress in regards to Mongolia's social and economic stability. According to Resolution No. 12, which was issued by the National Tripartite Committee on Labor and Social Consensus in October 2023, the minimum wage was set at $1.14 per hour or $191.40 per month starting in January 2024. South Korea's Minimum Wage Commission (MWC) held a plenary session in July 2023 and determined that the minimum wage for 2024 in contrast would be $7.50 per hour, which amounted to $1585.18 per month. These contrasting figures underscore the disparity in minimum wage

levels between Mongolia and South Korea, which highlight the ongoing challenges that are faced by Mongolian workers in regards to attaining a livable income.

Mongolia's traffic challenges arise from underdeveloped road infrastructure, the rising numbers of vehicle ownerships, and the resulting urban congestion. Traffic management systems are evolving, but the combination of traditional nomadic and modern driving behaviors further complicates the situation. Ulaanbaatar is on track to become one of Asia's most gridlocked cities with vehicle numbers continuing to surge. Studies predict rush-hour speeds will drop to just 5 km/h in 2025, which is a significant decline from the current 20–30 km/h [18]. Traffic congestion is already costing the city an economic loss equivalent to 9% of GDP, which is according to Ulaanbaatar's mayor's office. South Korea in contrast benefits from a well-developed road network, high numbers of vehicle ownerships particularly in urban areas, advanced traffic management systems, and a generally disciplined driving culture despite occasional aggressive driving. These factors result in a more organized and efficient traffic flow, which sharply contrasts with Mongolia's ongoing struggles with infrastructure development and traffic management.

Mongolia's digital transformation is progressing, even though it is still in its early stages. Only 23.8% of Mongolia's territory is currently covered by telecommunications services, which include high-speed internet access. 40% of the country is also sparsely populated by nomadic communities with no internet connectivity. However, significant strides have been made in recent times, such as notably with the launch of the ONDO Space Satellite via SpaceX and the initiation of Starlink services. These developments showcase Ulaanbaatar's commitment in regards to embracing modern digital technologies as well as also underscore how Mongolia's third-neighbor foreign policy, which is aimed at strengthening political, economic, and diplomatic ties with developed nations, such as the United States and South Korea, supports these types of transformative projects [19].

Mongolia holds complementary value for South Korea despite its small economy. South Korea finds Mongolia's abundant natural resources beneficial, because South Korea is an energy-importing nation with advanced technologies. Bilateral trade between the two countries reached $295 million in 2019 compared to just $900,000 in 1990. South Korea is now Mongolia's fourth-largest trade partner, and there are aspirations to increase its standing [20]. Furthermore, more than 50,000 Mongolian nationals were known to reside in South Korea in 2019, which formed the largest Mongolian diaspora in the world.

A comparison of the food delivery systems in Mongolia and South Korea would reveal notable differences shaped by economic development, technological infrastructure, cultural preferences, and consumer behaviors. The food delivery industry in South Korea is highly advanced with platforms, such as Baedal Minjok, which is also known as Baemin, and Yogiyo dominating the market. These platforms offer a broad range of cuisines and efficient delivery services to urban areas. The market is valued at $27.6 billion, and it is expected to grow at a compound annual growth rate (CAGR) of 4.2% and reach an estimated $35.7 billion by 2027.

Technological advancements, which include the rise of online food delivery and e-commerce platforms, are transforming the food market landscape [21]. The online food delivery market has surged in Mongolia particularly during the COVID-19 pandemic when stay-at-home measures increased reliance on online services. This trend is expected to continue as consumers increasingly value the convenience of ordering food online. The market is projected to generate $6.24 million in revenue by 2024, which includes a CAGR of 11.1% from 2024 to 2028 [22]. Mongolia's challenging climate and vast geographical landscape once limited access to diverse cuisines, but online delivery services have expanded culinary options, which include unique local dishes. This growth is further supported by the country's rising GDP, increased disposable income, and government efforts in regards to improving internet infrastructure and promoting e-commerce, which solidify the online food delivery sector as a key driver of Mongolia's food industry [22].

Robots are gradually becoming part of daily life in South Korea, and the recent legal changes allow robot deliveries and patrols on sidewalks. These robots, which were previously restricted, are now being tested by domestic companies, such as Woowa Brothers, which operates the Baemin food delivery service, and the startup Neubility. The global market for delivery robots is expected to grow from $273 million to $957 million by 2027 [22]. Mongolia's food delivery ecosystem is in contrast less developed, and it includes fewer delivery options, longer wait times, and limited technological integration due to infrastructure challenges and lower urbanization rates. Cultural preferences and dining habits, such as the preference for traditional over international cuisines may also further differentiate the food delivery landscapes in the two countries.

2.3. Product Attributes

The previous studies identified several product attributes that influence consumer perceptions and behaviors regarding autonomous food delivery systems. Lancaster [23] showed that consumers do exhibit preferences for

characteristics, which are also attributes, of products, which is the characteristic model, and attributes, such as delivery speed, accuracy, reliability, and convenience have been identified as the key determinants of consumer satisfaction and adoption intentions [24]. Factors, such as food quality, packaging, and environmental sustainability have also emerged as important considerations in regards to shaping consumer preferences in the market [25].

2.4. Perceived Innovativeness

Hospitality businesses must continuously improve their quality and service offerings in today's rapidly changing business environment. The characteristics of innovation play a key role in regards to how quickly new ideas, practices, or objects spread within a market. Innovation is defined by its objective novelty as well as by its perceived newness to potential adopters [26]. Strategic innovativeness has become essential for businesses to remain competitive [27]. Introducing innovation in market offerings serves as a strategic tool for both hospitality chains and independent enterprises to enhance their quality and reputation [28]. Innovation focuses on the outcomes of new elements or combinations in a firm's activities [29], so innovativeness refers to a firm's ability to embrace new ideas and services [30]. Service innovation in the restaurant industry can significantly impact customer satisfaction, but it will not be effective unless customers perceive the business as being innovative [31]. Measuring customer perceptions of innovativeness is essential, because creating methods in order to measure these types of perceptions forms the foundation for a scientific understanding of the phenomenon [32].

2.5. Perceived Risk

The concept of perceived risk, which was introduced by Bauer in 1960 to the American marketing community, pertains to the level of risk that consumers perceive when they make purchasing decisions, such as in particular in relation to service providers [33]. Perceived risk plays a significant role in consumer behavior, because it helps explain information-seeking behavior and purchase decision-making. It also helps marketers understand the consumer perspective [33].

Perceived risk is generally associated with two key dimensions, which include uncertainty and negative consequences [34]. It in essence refers to the uncertainty that surrounds the potential negative outcomes of purchasing decisions [35]. It is described as the assessment of uncertainties or the lack of knowledge regarding potential outcomes and the lack of control in regards to achieving those outcomes [36].

Perceived risk has been suggested as a significant factor in regards to explaining the behavior of consumers. These particular consumers are often more motivated to avoid mistakes than maximize utility during purchases. The way consumers perceive risk plays a crucial role in regards to their decision to engage in online food delivery services. Online food delivery providers are therefore best positioned if they understand the perceived risks of consumers and introduce features and services that mitigate and manage these concerns [37]. The previous research suggests that individuals are more likely to develop a negative image of products that rely on these types of technologies when they perceive that higher risks are associated with new technology. Perceived risk also significantly influences the willingness of consumers in regards to adopting new technologies.

2.6. Consumer Behavior

Consumer behavior encompasses a customer's decision to repurchase a product or recommend it to others based on prior experience [38]. The previous studies highlight the significant impact of product attributes on word-of-mouth behavior. Consumers often share opinions, experiences, and information with others by discussing vacations, movies, or restaurants. Word-of-mouth is defined as informal and interpersonal communications that are directed at other consumers regarding the ownership, usage, or characteristics of particular goods and services or their sellers [39]. According to Arndt [40], word-of-mouth refers to any oral and personal communication, which can be positive or negative, about a brand, product, service, or organization, regarding where the receiver perceives that the sender has a noncommercial intention.

Word-of-mouth significantly influences the purchase decisions and behaviors of consumers. Understanding the role of word-of-mouth is essential for businesses in the context of self-driving food delivery systems that are aiming to use consumer recommendations in order to drive adoption and market penetration. Goodman [41] suggests that negative word-of-mouth spreads more easily among customers and potential customers, which highlights its power when consumers are dissatisfied with their purchase experience. Other consumers may choose to purchase or avoid a product or brand based on both positive and negative information they receive from their environment. Poor service often leads to negative word-of-mouth.

2.7. Hypothesis and Proposed Model

The following hypotheses are proposed, which are based on the discussions above.

H1: Perceptions of product attributes differ according to a country's development status.

H2: Perceived innovativeness positively influences word-of-mouth.

H3: Perceived risk negatively influences word-of-mouth.

This study also proposes a conceptual framework that guides the empirical investigation of how a country's development status influences the perception of product attributes and subsequently affects word-of-mouth, which is illustrated in Figure 1. The framework focuses on examining the differences and causal relationships between development status, perceived product innovativeness, perceived risk, and word-of-mouth, which are specifically in the context of self-driving food delivery services.

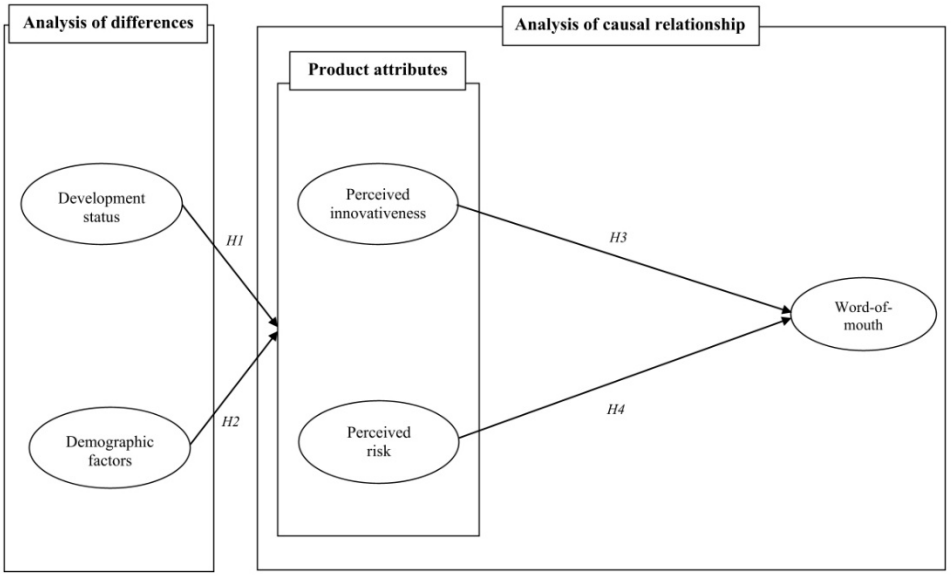

Figure 1. Proposed conceptual model.

3. Methodology

3.1. Measurement

The constructs in this study were measured using validated items from the previous research. First, three items, which were adapted from Hwang and Lee [42], were used to assess word-of-mouth, which were tailored in order to suit the context of this study. Perceived risk was measured using three items from Hwang and Choe [43]. Lastly, perceived innovativeness was evaluated using three items from Hwang et al. [38]. All measurement items were incorporated into the survey, and the participants responses were evaluated using a 7-point Likert's scale, which ranged from (1) *strongly disagree* to (7) *strongly agree.*

3.2. Data Collection

An online survey was conducted buy using a research company in order to examine the moderating role of a country's development status on consumer behavior. The study targeted participants from South Korea, which represented a developed country, and Mongolia, which represented a developing country. The survey questions were initially composed in English, and they were then translated into Korean and Mongolian. After that, they were subsequently back-translated into English in order to ensure accuracy. The participants watched a 3-min video that explained the concept of self-driving food delivery services prior to beginning the survey in order to establish a common understanding of the topic. A seven-point Likert's scale was used in order to measure the survey items.

320 survey responses were collected in South Korea, and seven responses were excluded, which resulted in 313 valid responses. The Mongolian dataset comprised of 320 responses, and nine responses were excluded, which resulted in 311 valid responses for the final analysis. The data analysis was conducted using SPSS software, and

a pilot test was conducted with a small group of participants prior to the main survey in order to validate the research approach, which ensured the survey's effectiveness as well as identify potential issues. The demographic characteristics of the participants were analyzed using a frequency analysis in SPSS. The reliability of the measurement scales was assessed by calculating Cronbach's alpha. A *t*-test was performed in order to identify and remove any unnecessary variables, which was followed by a regression analysis in AMOS in order to test the research hypotheses.

4. Results

4.1. Characteristics of the Respondents

The characteristics of the sample are displayed in Table 1. Males represented a slight majority at 52.1% (*n* = 163) for the South Korean respondents, whereas females accounted for 47.9% (*n* = 150). The age distribution showed a concentration in the younger demographics. Participants in their 20s accounted for 30.0% (*n* = 94), and the participants in their 30s totaled 31.3% (*n* = 98). The 40s age group was also well-represented at 21.7% (*n* = 68), and the participants aged 50 and above comprised of 16.9% (*n* = 53).

The majority of South Korean respondents, which totaled 54.0% (*n* = 169), in regards to educational attainment held a bachelor's degree, which was followed by 20.4% (*n* = 64) of the respondents having an associate's degree, 14.1% (*n* = 44) having high school diplomas, and 11.5% (*n* = 36) possessing graduate degrees. 53.0% (*n* = 166) of the respondents were single, 45.7% (*n* = 143) were married, and a small portion, which totaled 1.4% (*n* = 4), fell into other categories in regards to marital status. The average monthly income for this group was $2833.79.

On the other hand, the Mongolian sample exhibited a higher proportion of female respondents, which was 61.0% (*n* = 189), compared to having 39.2% (*n* = 122) male respondents. The age distribution was somewhat similar to the South Korean sample. The participants in their 20s represented 32.8% (*n* = 102), and the participants in their 30s represented 29.9% (n = 93). However, the Mongolian sample had a larger portion respondents in their 40s, which accounted for 28.6% (*n* = 89), and the respondents aged 50 and above accounted for 8.7% (*n* = 27).

The majority of the Mongolian participants, which totaled 62.7% (*n* = 195), held a bachelor's degree. A smaller proportion of participants, which included 9.6% (n = 30), had associate's degrees or graduate degrees, which totaled 1.9% (*n* = 6), and a notable 25.7% (*n* = 80) had only attained a high school diploma. The majority of the Mongolian participants, which included 66.6% (*n* = 207), were married, 21.9% (*n* = 68) of them were single, and others accounted for 11.6% (*n* = 36). The income levels were markedly lower, and the average monthly income for the Mongolian respondents was $471.95.

Table 1. Respondents' profiles (*n* = 624).

Variable	Korean (*n* = 313)	Mongolian (*n* = 311)
Gender		
Male	163 (52.1%)	122 (39.2%)
Female	150 (47.9%)	189 (60.8%)
Age		
20s	94 (30.0%)	102 (32.8%)
30s	98 (31.3%)	93 (29.9%)
40s	68 (21.7%)	89 (28.6%)
50s and older	53 (16.9%)	27 (8.7%)
Education level		
Less than High school diploma	44 (14.1%)	80 (25.7%)
Associate's degree	64 (20.4%)	30 (9.6%)
Bachelor's degree	169 (54.0%)	195 (62.7%)
Graduate degree	36 (11.5%)	6 (1.9%)
Marital status		
Single	166 (53.0%)	68 (21.9%)
Married	143 (45.7%)	207 (66.6%)
Others	4 (1.3%)	36 (11.6%)
Monthly income level		
Mean (US$)	2833.79	471.95

4.2. Principal Component Analysis

Table 2 presents the results of a principal component analysis (PCA) that was conducted on the data from South Korea and Mongolia. The PCA was performed in order to extract the key constructs, which included perceived risks, perceived innovativeness, and word-of-mouth. The results of the PCA showed that factors with eigenvalues greater than 1.0 were extracted, which was suggested by the existing theoretical background. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.804 for the South Korean data, and it was 0.817 for the Mongolian data, which indicated the validity of the factor model. The analysis revealed that perceived risk accounted for 44.640% of the variance, which included a high Cronbach's alpha of 0.954. Word-of-mouth, which reflects the likelihood of recommending and promoting the services, explained 30.110% of the variance, which also exhibited strong reliability with an alpha of 0.956. Perceived innovativeness accounted for 27.904% of the variance, with a reliability score of 0.911. The factor model explained 88.934% of the variance in the South Korean data and 88.550% of the variance in the Mongolian data. The factor loadings for all items exceeded 0.842, and the Cronbach's alpha values were all higher than 0.70, which suggested a high level of reliability across the constructs.

Table 2. Principal component analysis for Korean and Mongolian data.

Variables (Mean and Standard Deviation)	Factor Loading	Eigen Value	Explained Variance	Cronbach's *a*
Perceived risk (3.88/3.64 and 1.50/1.58)		4.144/4.489	46.040/49.873	0.954/0.946
Using self-driving food delivery services makes me feel nervous.	0.964/0.960			
The usage of self-driving food delivery services would lead me to a psychological loss.	0.953/0.936			
Using self-driving food delivery services makes me feel anxiety.	0.947/0.940			
Word-of-mouth (4.77/5.43 and 1.17/1.02)		2.710/1.006	30.110/11.173	0.936/0.923
I would recommend self-driving food delivery services to others.	0.925/0.892			
I am likely to encourage others to use self-driving food delivery services.	0.911/0.853			
I am likely to say positive things about self-driving food delivery services to others.	0.859/0.884			
Perceived innovativeness (5.31/5.72 and 1.05/0.88)		1.151/2.475	12.785/27.504	0.915/0.931
Self-driving food delivery services are likely to be creative.	0.902/0.913			
Self-driving food delivery services seem to be an original idea for better services.	0.889/0.898			
Self-driving food delivery services seem to be an advanced, forward-looking service.	0.864/0.842			

Notes 1: The unmarked values are for Korean data, whereas the underlined values are for Mongolian data. Notes 2: Korean data: Total explained variance = 88.934%, KMO measure of sampling adequacy = 0.804, and Bartlett's test of sphericity ($p < 0.001$). Notes 3: Mongolian data: Total explained variance = 88.550%, KMO measure of sampling adequacy = 0.817, and Bartlett's test of sphericity ($p < 0.001$).

4.3. Result of the t-Test for Perceived Innovativeness and Perceived Risk

Table 3 presents the results of the *t*-test, which was conducted in order to examine differences in the product attributes based on the development status of the country. A *p*-value less than 0.1 was considered significant for this study. The variables PI1, PI2, and PI3 measure different dimensions of perceived innovativeness.

The mean score for South Korea is 5.19 for PI1, whereas it is 5.82 for Mongolia, which includes a *t*-value of 7.609 and a highly significant *p*-value that is less than 0.001. This result suggests that Mongolian consumers perceive a higher level of innovativeness than their Korean counterparts. The mean scores for P12 are 5.20 in Korea and 5.62 in Mongolia, which include a *t*-value of 5.054 and a *p*-value of 0.000, and these further support the conclusion that Mongolian consumers perceive greater innovativeness. The scores are 5.53 in Korea and 5.79 in Mongolia for P13, which include a *t*-value of 2.949 and a *p*-value of 0.003, and these indicate another statistically significant higher perception of innovativeness in Mongolia.

The PR1 and PR2 variables measure the different aspects of this construct in regards to perceived risk. PR1 shows a mean score of 3.87 in Korea and 3.61 in Mongolia, which include a *t*-value of 1.937 and a *p*-value of 0.053, and these suggests a marginally higher perception of risk among Korean consumers, which is significant at the 10% level. The mean scores are 3.74 in Korea and 3.47 in Mongolia for PR2, which include a *t*-value of 1.948 and a *p*-value of 0.052, and these indicate a slightly higher perceived risk in Korea, which is again significant at the 10% level. A third risk variable, which is PR3, showed no significant difference between Korea (4.03) and Mongolia (3.84), which included a *t*-value of 1.437 and a *p*-value of 0.151.

The risk perceptions do not differ significantly across all measures, which indicates a nuanced view of perceived risk, and there are varying concerns across the two countries. However, significant differences were

found in the perceived innovativeness and perceived risk based on development status. This result indicates that Koreans had lower perceived innovativeness compared to Mongolians, so Hypothesis 1 is therefore supported.

Table 3. Results of *t*-tests: Effects of development status on product attributes.

		Korean	Mongolian	*t*-Value	*p*-Value
Perceived innovativeness	Self-driving food delivery services are likely to be creative.	5.19	5.82	7.609	0.000 ***
	Self-driving food delivery services seem to be an original idea for better services.	5.20	5.62	5.054	0.000 ***
	Self-driving food delivery services seem to be an advanced, forward-looking service.	5.53	5.79	2.949	0.003 ***
Perceived risk	Using self-driving food delivery services makes me feel nervous.	3.87	3.61	1.937	0.053 *
	The usage of self-driving food delivery services would lead me to a psychological loss.	3.74	3.47	1.948	0.052 *
	Using self-driving food delivery services makes me feel anxiety.	4.03	3.84	1.437	0.151

* $p < 0.1$ and *** $p < 0.001$.

4.4. Result of Difference Tests of Demographic Factors

This study examined whether perceived innovativeness and psychological risk differed according to gender, age, education level, and marital status in the Korean and Mongolian samples (Table 4). First, in terms of gender, independent samples *t*-tests indicated that gender did not produce significant differences in either perceived innovativeness or psychological risk in both countries. In the Korean sample, no significant gender differences were found for perceived innovativeness ($t = 0.709$, $p = 0.479$) or psychological risk ($t = -0.896$, $p = 0.371$). Similarly, in the Mongolian sample, neither perceived innovativeness ($t = 1.048$, $p = 0.295$) nor psychological risk ($t = 0.555$, $p = 0.580$) differed significantly by gender.

Regarding age, one-way ANOVA results revealed no significant differences across age groups for either perceived innovativeness or psychological risk in both samples. In Korea, perceived innovativeness ($F = 0.535$, $p = 0.659$) and psychological risk ($F = 0.263$, $p = 0.852$) did not significantly differ across age groups. Likewise, in Mongolia, no significant age differences were observed for perceived innovativeness ($F = 0.697$, $p = 0.554$) or psychological risk ($F = 1.364$, $p = 0.254$). These findings suggest that age was not a determining factor for either construct in either country.

In the case of education, the results for education level showed some cross-national differences. In the Korean sample, education level showed a marginally significant effect on perceived innovativeness ($F = 2.518$, $p = 0.058$, $p < 0.10$), while no significant difference was found for psychological risk ($F = 1.847$, $p = 0.139$). This suggests that education may partially influence perceived innovativeness among Korean respondents. In contrast, in the Mongolian sample, education level did not significantly affect perceived innovativeness ($F = 0.494$, $p = 0.687$), but it significantly influenced psychological risk ($F = 6.770$, $p < 0.001$). Post-hoc comparisons using the Bonferroni test revealed that respondents with a high school education perceived significantly higher psychological risk than those with a bachelor's degree ($p < 0.001$). No other pairwise differences were statistically significant.

Lastly, regarding marital Status, ANOVA results showed no significant differences in perceived innovativeness or psychological risk according to marital status in either country. In Korea, marital status did not significantly influence perceived innovativeness ($F = 1.591$, $p = 0.205$) or psychological risk ($F = 0.344$, $p = 0.709$). Similarly, in Mongolia, neither perceived innovativeness ($F = 0.403$, $p = 0.668$) nor psychological risk ($F = 0.730$, $p = 0.483$) differed significantly across marital status groups.

4.5. Results of the Regression

Table 5 presents the results of the regression analysis that was conducted in order to examine the influence of perceived innovativeness and perceived risk on word-of-mouth behavior by testing Hypothesis 2 and Hypothesis 3. The detailed results are shown in Table 5. The analysis indicates that perceived innovativeness has a significantly positive relationship with word-of-mouth ($\beta = 0.549$, $t = 11.697$, and $p < 0.05$), which provides support for Hypothesis 2. This suggests that consumers are more likely to engage in positive word-of-mouth behavior as they perceive higher levels of innovativeness. Perceived risk was conversely found to have a significantly negative impact on word-of-mouth ($\beta = 0.301$, $t = 4.681$ and, $p < 0.05$), which supports Hypothesis 3. This result indicates that likelihood of engaging in word-of-mouth behavior decreases as they as perceive higher levels of risk being associated with a product or service.

Table 4. Results of difference tests of demographic factors.

Factor	Variable	Korean			Mongolian		
		Mean (SD)	*t*/*F*	*p*	Mean (SD)	*t*/*F*	*p*
Gender	Perceived innovativeness	Male: 5.35 (SD: 1.05)	$t = 0.709$	0.479	Male: 5.66 (SD: 0.93)	$t = 1.048$	0.295
	Psychological risk	Female: 5.27 (SD: 1.07)			Female: 5.77 (SD: 0.85)		
	Perceived innovativeness	Male: 3.81 (SD: 1.61)	$t = -0.896$	0.371	Male: 3.71 (SD: 1.68)	$t = 0.555$	0.580
	Psychological risk	Female: 3.96 (SD: 1.38)			Female: 3.60 (SD: 1.70)		
Age	Perceived innovativeness	20s: 5.28 (SD: 0.97)	$F = 0.535$	0.659	20s: 5.75 (SD: 0.84)	$F = 0.697$	0.554
		30s: 5.23 (SD: 1.21)			30s: 5.65 (SD: 1.00)		
		40s: 5.42 (SD: 0.89)			40s: 5.72 (SD: 0.82)		
		50s+: 5.39 (SD: 1.10)			50s+: 5.91 (SD: 0.83)		
	Psychological risk	20s: 3.98 (SD: 1.53)	$F = 0.263$	0.852	20s: 3.74 (SD: 1.72)	$F = 1.364$	0.254
		30s: 3.86 (SD: 1.64)			30s: 3.85 (SD: 1.57)		
		40s: 3.89 (SD: 1.33)			40s: 3.40 (SD: 1.75)		
		50s+: 3.75 (SD: 1.42)			50s+: 3.40 (SD: 1.75)		
Education	Perceived innovativeness	HS: 5.56 (SD: 0.94)	$F = 2.518$	0.058 *	HS: 5.76 (SD: 0.79)	$F = 0.494$	0.687
		Associate: 5.52 (SD: 1.00)			Associate: 5.80 (SD: 0.94)		
		Bachelor: 5.20 (SD: 1.08)			Bachelor: 5.69 (SD: 0.92)		
		Graduate: 5.19 (SD: 1.12)			Graduate: 6.06 (SD: 0.90)		
	Psychological risk	HS: 4.02 (SD: 1.47)	F =1.847	0.139	HS: 4.33 (SD: 1.71)	$F = 6.770$	<0.001 ***
		Associate: 4.11 (SD: 1.49)			Associate: 3.64 (SD: 1.73)		
		Bachelor: 3.86 (SD: 1.47)			Bachelor: 3.39 (SD: 1.60)		
		Graduate: 3.41 (SD: 1.66)			Graduate: 2.67 (SD: 1.52)		
Marital status	Perceived innovativeness	Single: 5.22 (SD: 1.12)	$F = 1.591$	0.205	Single: 5.77 (SD: 0.87)	$F = 0.403$	0.668
		Married: 5.43 (SD: 0.97)			Married: 5.70 (SD: 0.88)		
		Others: 5.17 (SD: 1.11)			Others: 5.81 (SD: 0.94)		
	Psychological risk	Single: 3.94 (SD: 1.54)	$F = 0.344$	0.709	Single: 3.85 (SD: 1.78)	$F = 0.730$	0.483
		Married: 3.83 (SD: 1.47)			Married: 3.60 (SD: 1.69)		
		Others: 3.50 (SD: 0.96)			Others: 3.49 (SD: 1.49)		

Note: *** $p < 0.001$.

Table 5. Results of regression analysis.

Paths			Beta Value	*t*-Value	Hypothesis
H2 Perceived innovativeness	→	Word-of-mouth	0.549/0.<u>615</u>	11.697 */<u>13.836 *</u>	Supported
H3 Perceived risk	→		−0.110/<u>−0.097</u>	−2.344 */ <u>−2.192 *</u>	Supported
Korean data: $F = 72.295$, $p < 0.001$, and $R^2 = 0.318$; Mongolian data: $F = 105.400$, $p < 0.001$, and $R^2 = 0.406$					

Notes 1: The unmarked values are for Korean data, whereas the underlined values are for Mongolian data. Notes 2: * $p < 0.05$.

5. Discussions and Implications

The purpose of the current study is to investigate the importance of product attributes in the context of self-driving food delivery systems. Three hypotheses were specifically tested in order to identify the key product attributes that were perceived by consumers in South Korea and Mongolia by exploring the differences in product

attribute preferences between the two nations as well as analyze the influence of perceived innovativeness and perceived risk on consumer word-of-mouth behavior. The data was collected from 313 respondents in South Korea and 311 respondents in Mongolia.

The results from the data analysis reveal that perceived risk is the most dominant factor in both countries, which significantly affected the attitudes of consumers toward self-driving food delivery services. Perceived innovativeness also plays a crucial role. Word-of-mouth has lesser explanatory power despite being reliable, which suggests that positive recommendations are present, but they may not be as influential as the direct perceptions of risk and innovativeness. These findings highlight the importance of managing perceived risk and promoting innovative features to enhance consumer attitudes and encourage positive word-of-mouth across different cultural contexts. This study provides valuable insights into how various product attributes influence consumer acceptance and advocacy for self-driving food delivery systems in South Korea and Mongolia.

The findings suggest that Mongolian consumers generally perceive a higher degree of innovativeness in regards to self-driving food delivery systems compared to South Korean consumers. This difference may be attributed to variations in market maturity or the level of exposure to technology in each country. On the other hand, South Korean consumers exhibit a marginally higher perception of risk being associated with these services, which likely reflects greater familiarity with the potential downsides or limitations of this type of technology. However, the differences in risk perceptions across all measures are not statistically significant, which indicates that risk perceptions may vary based on specific concerns or types of risks.

These results are crucial in regards to understanding how product attributes, such as innovativeness and risk are perceived differently in countries with varying levels of economic development and technological adoption. The findings provide implications for marketers and policymakers who are looking to promote new technologies in diverse cultural and economic contexts. Consideration of these perceptions can lead to strategies that are tailored to address specific concerns and leverage opportunities for innovation in each market.

The results of the regression analysis confirm that perceived innovativeness significantly enhances word-of-mouth, which is a key factor for the adoption and spread of new like self-driving food delivery systems. Perceived risk in contrast has a negative impact on word-of-mouth, even though the effect size is smaller. These findings underscore the importance of effectively managing the consumer perceptions of both the benefits and risks of new technologies in order to encourage positive word-of-mouth and promote adoption.

The contrast between the two countries is striking: the explanatory power of the models is substantially higher in Mongolia, suggesting that consumer behavior is more strongly influenced by perceived product attributes than in South Korea. This difference underscores the need for marketers and businesses to adopt context-specific strategies that address distinct consumer perceptions in each country.

5.1. Theoretical Implications

This study explored the significance of product attributes in regards to self-driving food delivery systems, which highlights the impact of perceived innovativeness and perceived risk on consumer word-of-mouth behavior. This study shifts the focus to consumer perceptions, which is an area that remains underexamined in the existing literature, and this is in contrast to the previous research, such as Chen et al. [2] and Yuen et al. [12], which primarily examined the technical aspects of autonomous technologies. This research bridges the gap in the existing literature by considering the influence of socio-economic and cultural factors in regards to the adoption of emerging technologies, which is a perspective that is often overlooked in single-nation or developed-market studies, by analyzing data from both South Korea and Mongolia. These findings offer valuable insights for global companies that are seeking to effectively implement self-driving food delivery services across diverse markets.

The result of the principal component analysis showed that the factor loadings for each item indicate strong correlations with their respective constructs, which confirmed the appropriateness of the items. The eigenvalues that are associated with each factor suggest that perceived risk is the most dominant factor, and it explained the largest portion of variance, which was followed by word-of-mouth and perceived innovativeness. This finding aligns with the findings from Al-Emran, Elsherif, and Shaalan [44], which emphasize the critical role of user attitudes in regards to the acceptance of new technology. The study further underscores the importance of promoting innovative features in order to foster positive consumer perceptions and mitigate potential concerns that are related to perceived risks.

Theoretical implications extend traditional technology acceptance models by incorporating unique product attributes, such as perceived innovativeness and perceived risk, thereby providing a more comprehensive understanding of consumer behavior across diverse cultural and economic contexts. Importantly, the findings reveal clear differences in technology adoption patterns between South Korea and Mongolia, underscoring that

consumer perceptions vary significantly across national contexts. These results suggest that global marketers and developers should tailor their strategies to account for country-specific differences when introducing self-driving food delivery systems. The study offers valuable insights for companies seeking to implement such services, emphasizing the importance of culturally nuanced approaches to promote both acceptance and advocacy across markets.

Overall, demographic variables such as gender, age, and marital status did not significantly influence perceived innovativeness or psychological risk in either country. This suggests that managers may not need to rely heavily on basic demographic segmentation when promoting innovative services. However, education level played a role in Mongolia, where less-educated consumers perceived higher levels of psychological risk. Therefore, managers in Mongolia should provide clearer information and stronger reassurance to reduce perceived risk among these groups. In South Korea, the marginal effect of education on perceived innovativeness suggests that innovation-related messages may need to be slightly tailored according to education level.

This study builds on the previous research, which mostly emphasizes technical efficiency and health beliefs in autonomous delivery systems by integrating perceived risk and innovativeness into a more comprehensive framework in order to analyze consumer decision-making. This approach enriches the theoretical understanding as well as also contributes to discussions on global consumer dynamics in an increasingly digital world. The findings offer a holistic perspective on consumer behavior, which enhance the existing theoretical frameworks that are used to study technology acceptance, by addressing the interplay between perceived risk and innovativeness.

5.2. Practical Implications

Bridging the gap between a theoretical understanding and actionable strategies is essential for the successful market implementation of self-driving food delivery systems in diverse contexts, such as in particular in South Korea and Mongolia. This study highlights practical strategies that are to these regions, which emphasize the need for companies to showcase innovative features as well as educate consumers about safety and operational efficiency in order to mitigate perceived risks. Marketing approaches should be adapted to specific market needs, which emphasize advanced technological features in emerging markets, such as Mongolia in order to generate enthusiasm as well as focus on safety measures in technologically advanced markets, such as South Korea in order to address consumer concerns and foster acceptance.

This research also has significant policy implications, which emphasizes the need for adaptive regulatory frameworks that balance technological innovation with consumer protection. Understanding how perceived risks and benefits shape consumer attitudes is vital for policymakers in order to create regulations that address apprehensions as well as foster innovation This study highlights the importance of tailoring regulatory measures to specific socio-economic and cultural contexts given the cultural variability in regards to consumer perceptions. This research provides a roadmap for further inquiry into global consumer dynamics during the digital transformation era by advocating for policies that are both consumer-centric and innovation-driven.

Developing policies that maximize the benefits of service robots as well as minimizing the potential drawbacks is equally important. Risk management efforts, such as improvements in cybersecurity and physical safety features are critical in regards to building consumer trust. Policymakers should establish supportive regulatory frameworks that ensure the safe operation of autonomous delivery services as well as promote industry growth. Companies can effectively manage consumer perceptions and encourage broader adoption of these technologies in regards to addressing these aspects. Integrating self-driving food delivery systems into restaurant operations can also enable more sustainable delivery practices and pave the way for innovative business models.

Companies should capitalize on the country's advanced technological infrastructure and high consumer receptivity to innovation in order to successfully implement self-driving robot delivery services in South Korea. Marketing campaigns should emphasize the convenience, speed, and safety of robotic delivery services by appealing to South Korea's tech-savvy population [45]. Highlighting the use of smart technology in regards to enhancing daily life can resonate strongly with consumers, which fosters trust and excitement about the services.

Companies might consider offering customizable delivery options, such as scheduled deliveries, secure storage solutions for delivered items, and integration with smart home ecosystems to enhance convenience and efficiency in order cater to the preferences of South Korean consumers. These features address the demand for personalization and technological integration, which makes the service more attractive. Simultaneously promoting the environmental benefits of robotic delivery services, such as reduced carbon emissions and decreased traffic congestion aligns with South Korea's increasing focus on sustainability and green technology. This dual approach meets consumer expectations as well as also supports national environmental objectives by combining personalization and sustainability. These types of strategies are particularly compelling for urban and densely populated areas, which is where innovation and eco-conscious solutions are highly valued.

Leveraging digital marketing strategies and social media can accelerate the adoption and normalization of robotic delivery services in Mongolia, which is where a significant portion of the population is young and increasingly tech-savvy. Targeted campaigns that emphasize innovation and convenience will resonate with this demographic, which fosters interest and acceptance.

Ulaanbaatar, which is facing severe traffic congestion due to rapid and uncontrolled increase in vehicle growth, is on the verge of becoming one of Asia's most gridlocked cities [18]. Studies by Kunze [46] and Mangiaracina, Perego, Seghezzi, and Tumino [47] highlight the potential of automated delivery systems to mitigate driver shortages and reduce traffic volumes. Robotic delivery services can therefore alleviate congestion by utilizing less trafficked routes and minimize the reliance on traditional delivery vehicles by providing a viable solution to the city's transportation challenges in urban areas, such as Ulaanbaatar. It is essential given Mongolia's diverse geographical landscape, which includes urban centers and remote regions with rugged terrains, in order to develop delivery robots that are capable of navigating varying environmental conditions. Investments should prioritize enhancing the durability and adaptability of these robots in order to ensure reliable performances across all settings.

Implementing educational programs that are focused on operating self-driving robots is also crucial in order to cultivate a skilled workforce and instill confidence in the technology. Addressing safety concerns is equally important. Potential risks must be rigorously identified and mitigated via comprehensive risk and safety analyses during the development stages. Collaborating with researchers in regards to conducting testing at various phases will help ensure that the technology meets safety standards before deployment, which builds consumer trust and fosters broader acceptance.

6. Limitations and Future Research

This research offers valuable theoretical contributions and insights into the consumer adoption of technology in both developed and developing countries. However, several limitations must be acknowledged. First, the data was exclusively collected from two Asian countries, which included South Korea and Mongolia, so the findings may have limited generalizability due to the geographic and cultural diversity within and beyond these regions. The future research should expand the scope in order to include other parts of the world, which enables a broader evaluation of the constructs and enhances the study's applicability.

Second, the study focuses solely on the food delivery sector, which may not fully capture the broader implications of self-driving technologies across other service domains. Investigating the adoption of these types of technologies in industries, such as healthcare, logistics, or retail could provide a more comprehensive understanding of their impact. In addition, the study emphasizes perceived risks and innovativeness, but other possible factors, such as cost, usability, and actual service quality were not examined. Including these variables in the future research could provide a more holistic view of the factors that influence technology adoption.

Finally, incorporating qualitative methods, such as interviews or focus groups could offer deeper insights into the underlying reasons behind consumer perceptions, which in particular concern perceived risk and innovativeness. This approach would enable a richer exploration of the psychological and social factors that shape consumer behavior in this rapidly evolving technological landscape. Qualitative research can complement quantitative findings by capturing diverse consumer perspectives, which provide a more holistic understanding of the adoption barriers and drivers.

Author Contributions

O.B.: Conceptualization, methodology, data curation, writing—original draft preparation. S.J.: Methodology, validation, writing—reviewing and editing. J.L.: Investigation, visualization, writing—reviewing and editing. J.H.: Conceptualization, supervision, methodology, writing—reviewing and editing. All authors have read and agreed to the published version of the manuscript.

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