Research article

E-commerce user's intention to switch toward drone delivery innovation: The role of environmental concern and customers' attitude

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Abstract: Environmental concern is a determinant in acquiring new green innovation. We aimed to investigate the relationship between environmental concern, consumer attitude, and behavioral intention to switch in the context of drone delivery. The motivation that comes from a green perspective is believed to create a behavior that is also keen on innovative green products. One of the examples is the implementation of drones in delivering parcels, which is believed to cut the carbon footprint. Our purpose was to analyze the direct impact of environmental concern on consumers' behavioral intentions regarding e-commerce drone delivery. Additionally, we aimed to examine the mediating role of consumers' attitudes toward innovation in the relationship between environmental concern and behavioral intention. We sought to provide insights into how environmental awareness and the adoption of innovative delivery technologies like drones can influence consumer behavior, contributing to more sustainable and eco-friendly e-commerce practices. Structured questionnaires were provided to e-commerce users, reliability and validity tests were confirmed, and structural equation modeling (SEM) was used to analyze the relationships among variables. The results of the SEM analysis proved that environmental concern and consumer attitudes have a positive impact on behavioral intention. Customer attitude mediates the relationship between environmental concern and behavioral intention. This research provides a deeper understanding of how environmental concerns influence consumer behavior towards drone delivery innovation within the e-commerce sector. The implications integrate environmental concerns with consumer behavior and innovation adoption, providing a comprehensive view that goes beyond traditional marketing and consumer research.

Keywords: Drones delivery; environmental concern; attitude; consumer innovativeness; innovation

1. Introduction

In recent years, Indonesia's e-commerce market has seen explosive growth [1], fueled by greater internet access, widespread smartphone use, and a rising middle class with increased spending power [2]. This has resulted in a dramatic surge in online orders, straining traditional delivery methods and creating a pressing need for more efficient and sustainable alternatives; the e-commerce business is highly linked with parcel delivery services [3,4]. Environmental issues are developing, as the last-mile delivery problem is regarded as the most polluting portion of the supply chain [5]. Last-mile delivery is a method of delivering goods from a hub or any facility to their final destinations [6]. The ubiquity of online customer shopping has exerted similar pressure on the e-commerce industry to embrace environmentally conscientious supply chain practices. To meet customer demands for environmentally friendly and sustainable products, firms must establish green-oriented management strategies that emphasize sustainability. Climate change, as a result of environmental degradation, becomes a global problem with drastic effects, including changing weather patterns, extreme weather, food shortages, and natural resource depletion. This has become a major challenge for humans [7]. Therefore, implementing measures for curbing climate change is imperative. The Paris Agreement was signed in 2015 as part of international efforts to curb climate disasters and global warming, demanding a commitment from countries to tackle this issue [8,9]. For that reason, global action is being taken in response to climate-related disasters and climate change. With increasing awareness about environmental problems, governments and companies are focusing on adopting eco-friendly production practices and incorporating sustainability into their central business activities [10,11]. Environmental challenges have also highlighted the importance of businesses, from big players to small and medium-sized enterprises. In the context of reducing the carbon footprint, in the e-commerce industry, in which many activities of logistics are aligned, must also take their place to offer greener solutions. Package delivery from e-commerce utilizes a method of delivery using a motorcycle or box truck. Drone delivery, a groundbreaking innovation with the potential to transform the logistics landscape, is promising [12,13]. While in its infancy, this technology promises faster, more cost-effective, and eco-friendly delivery, sparking excitement among businesses and consumers alike who see its potential to revolutionize how we receive goods.

The purchase of environmentally friendly products and services has become an emerging trend [14]. The rise of environmental concerns has sparked a new chapter in consumer behavior, where ecological consciousness intertwines with the pursuit of innovation. The consumption of green products is integral to sustainable business, nature preservation, and environmental hazard prevention in environmental protection. In the context of innovation in parcel delivery services, drones exist as a new greener option. Traditional delivery methods like cars and motorcycles contribute significantly to air pollution, especially in dense cities [15]. Drone delivery, on the other hand, offers a cleaner alternative by reducing environmental impact since it is operated by electricity. UAVs are considered a crucial tool for enhancing growth and maintaining a competitive edge [16], and if ecommerce and delivery service companies emphasize this eco-friendly aspect in their strategy, it could tap into consumers' desire for socially responsible innovation, making them more likely to adopt the technology. Environmental concern may contain several dimensions. Hence, we propose to examine the influence of environmental concern on consumer attitude toward innovation and behavioral intention in the context of e-commerce drone delivery. This highlights the growing importance of environmental consciousness in shaping consumer choices and the need for businesses to adapt to this evolving landscape. We aim to analyze the direct impact of environmental concerns towards behavioral intention as well as examine the mediating role of consumer attitude toward innovation in that relationship.

2. Unmanned aerial vehicles (UAV)

Unmanned aerial vehicles (UAV), or drones, cover a wide range of utilizations, including agriculture [17,18], architecture, engineering, and construction [19], transportation and logistics [20,21], and food delivery [22]. Drones, or UAVs, show great potential for parcel delivery. In the context of drone delivery, Amazon, Alibaba, JD.com, and DHL have conducted pilot projects for UAVs [23]. Drone delivery offers a multitude of opportunities, notably the potential for near-instantaneous deliveries [4]. Their speed and adaptability make drones a powerful tool in overcoming the difficulties of last-mile delivery. Furthermore, drones are not limited to this role; they also show promise in providing critical supplies to remote or disaster-impacted areas [24]. Drone delivery presents as a green innovation [25] just like electric vehicles (EVs) [26]. Green innovation is described as a concept that encompasses technological breakthroughs designed to tackle environmental challenges, including pollution prevention, waste reduction, and energy conservation [27]. Drone delivery offers significant potential in reducing greenhouse gas emissions [28]. By using electric power, drones can significantly reduce carbon dioxide (CO_2) and other greenhouse gas emissions compared to conventional delivery vehicles that rely on fossil fuels. More than that, in a practical way, in dense urban areas, parcel deliveries that face problems such as traffic congestions can also be addressed with the use of drones. Drones do not require the same road space as conventional vehicles, thus helping alleviate traffic congestion. The operation of drone delivery through vehicle routing optimization supports the notion of cost-effective delivery and environmentally friendly delivery [25].

3. Environmental concern

Earlier investigations in environmental studies have delved into the connections between attitudes and behaviors, as well as the relationships between attitudes and the intention to act in a certain way. These studies can be found in the works of [29,30]. Environmental concern is defined as possessing a strong attitude towards environmental protection, reflected in a preference for selecting environmentally friendly products and/or services that generate minimal waste and utilize renewable energy sources [31–33]. Environmental concern is measured by several dimensions such as concern for nature, concern for waste, and concern for energy [31]. General attitudes, such as a concern for the environment, have a direct and significant influence on the behaviors that individuals choose to adopt [34]. The cognitive aspect of environmental concern is typically understood as an individual's beliefs and knowledge about the causes, nature, and potential solutions of environmental problems. We refer to Stafford [35] and Jeff et al. [31] to measure environmental concern based on the attitudes by individuals towards environments. Environmental concern is a wide-ranging idea that includes a variety of beliefs and behaviors focused on protecting the Earth. One key dimension of this concern revolves around the well-being of natural habitats and the diverse life forms they support. Individuals with a strong affinity for nature often prioritize the protection of these habitats and advocate for the conservation of wildlife. Their actions may include supporting environmental organizations, championing policies that safeguard natural environments, and making conscious choices to minimize their personal impact on ecosystems. Another significant dimension of environmental concern focuses on pollution and waste generation. Those who are deeply troubled by the detrimental effects of pollution actively strive to reduce their own contribution to the problem and may engage in practices such as recycling, composting, and minimizing the use of single-use plastics. Additionally, they may support businesses that prioritize sustainable waste management practices and advocate for stricter regulations on pollutants. A third dimension revolves around energy consumption and its environmental

consequences. Individuals concerned about energy recognize the link between energy use and climate change and actively seek to reduce their carbon footprint. This may involve adopting energy-efficient technologies, advocating for renewable energy sources, and supporting policies that promote sustainable energy practices. These three dimensions of environmental concern are interconnected, often influencing one another. For instance, concern for natural habitats may naturally lead to concerns about pollution and waste, as these factors can directly threaten ecosystems and biodiversity. Similarly, concern for energy consumption may be intertwined with worries about pollution and climate change, as fossil fuel use contributes significantly to both issues. Understanding these interconnected dimensions enables us to better grasp the diverse ways individuals relate to and care for the environment, fostering more effective and targeted environmental initiatives. Environmental concern is defined as having a strong attitude towards protecting the environment by referring to the attitude of selecting products and/or services that are environmentally friendly, low in waste products, and use of renewable energy sources.

4. Consumer attitude toward innovation

The concept of attitude is defined as the extent to which an individual holds a favorable or unfavorable evaluation of engaging in a behavior [36]. Attitude is explained as a comprehensive evaluation or individual tendency toward an innovation, starting from the level of good or bad and liked or disliked to whether it is useful or not useful. Schiffman and Kanuk [37] characterize attitudes as enduring evaluations that individuals hold towards things, people, or ideas. They are a mix of feelings and thoughts, leading us to act positively or negatively towards them [38]. These opinions are not easily changed and tend to guide our actions over time. Our feelings, like love or hate, and our thoughts, like beliefs or opinions, work together to shape our attitudes and influence how we behave and interact with the world. Consumer attitude offers interconnected dimensions of attitude: Cognitive, affective, and conative. These dimensions interplay and interact to shape an individual's opinions and behaviors. Hawkins and Mothersbaugh [39] also stated that attitude is composed of three elements: Cognitive, which is knowledge and belief,; affective, which is related to feeling; and behavioral, which is linked to action. Crosby, Gill. and Taylor found that attitude is an important predictor of behavior [40]. Eco-centric motivations are proven to have positive effects on consumers' product use behavior [41]. Consumer buying behavior are primarily shaped by their own internal psychological factors, including their motivation, attitude, and perception [42]. We refer to Schiffman and Kanuk [37] to measure consumer attitude. Attitudes are multifaceted constructs encompassing three major dimensions: Cognitive, affective, and conative components. The cognitive component involves an individual's beliefs and opinions about an attitude object, while the conative component pertains to their behavioral intentions or actions related to it. The affective component, however, refers to the emotional response an individual experiences towards the attitude object, whether it is positive (liking) or negative (disliking) [43]. In this research, consumer attitude toward innovation is described as a comprehensive evaluation or individual tendency toward an innovation, starting from the level of good or bad and liked or disliked, to whether it is useful or not. Researchers found that those who are concerned about the environment are more inclined to plan and implement multiple energy-efficient retrofits in behavior [44]. Thus, understanding the connection between attitude and behavior is important, as developers' environmental concerns could potentially influence their actions [45]. Researchers that have studied the motivation of consumers in adopting energy-sustainable innovation found that EC and its dimensions have more of an indirect than direct effect through perceived behavioral control for the intention to go green [46]. This research suggests that heightened

environmental concern fosters a more favorable disposition towards adopting innovative, eco-friendly products or services. This positive attitude towards innovation, rooted in the belief that such innovations offer solutions to environmental challenges, subsequently increases the likelihood of individuals intending to switch their consumption patterns toward more sustainable alternatives. Thus, we posit that the influence of environmental concern on behavioral intention to switch is not direct but is channeled through the mediating factor of consumer attitude toward innovation. This suggests that a positive attitude toward innovation can act as a catalyst for individuals to adopt environmentally friendly practices. Pro-environmental behaviors and attitudes include operationalized behaviors, such as recycling, transport use, waste management, energy consumption, the purchase of green products, and using electrical appliances [47].

5. Behavioral intention

Behavioral intention is described as an individual's motivation and readiness or willingness to perform a behavior. The widely recognized relationship between attitude and behavior is illuminated not only in the Theory of Planned Behavior (TPB) framework but also in the Technology Acceptance Model (TAM), which suggests that understanding a consumer's beliefs and attitudes can effectively predict their behavior [36]. According to the frameworks, an individual's decision to engage in a specific action is shaped by their personal views on the action, what they believe others think about it, and how much control they feel they have over the situation. Furthermore, the theory proposes that successfully carrying out this action relies on the person's desire to do the specific intention and their perceived ability to actually do it.

Researchers have explored the complex interplay between beliefs, attitudes, and intentions in the context of consumer behavior. Researchers in India, utilizing a linkage perspective of beliefs, attitudes, and intentions, demonstrated a relationship between consumer beliefs and their intention to adopt EVs [48]. Similarly, a study conducted among Malaysian consumers showed a relationship between attitude and adoption behavior [26]. These studies highlight the importance of understanding the underlying beliefs and attitudes that drive consumer behavior, particularly in the context of new and emerging technologies.

Those who feel a strong responsibility toward the environment tend to be more worried about environmental problems and actively make eco-friendly choices in their daily lives. Research findings emphasize the importance of strategies that not only promote a sense of environmental duty but also tackle and reduce environmental worries, fostering a social context that supports sustainable actions [49].

Based on the literature, the following hypotheses are proposed:

H1: Environmental concern positively impacts consumers' attitudes toward innovation. This hypothesis posits a direct, positive relationship between an individual's level of environmental concern and their intention to adopt pro-environmental behaviors, such as switching to greener courier transport options such as drone delivery.

H2: Consumers' attitudes toward innovation positively impacts behavioral intention. This hypothesis suggests that a positive attitude towards innovation will lead to a greater intention to engage in pro-environmental behaviors, as individuals are more likely to embrace new, eco-friendly technologies and solutions in courier transport options such as drone delivery.

H3: Environmental concern positively impacts the behavioral intention. This hypothesis suggests that a direct, positive relationship between an individual's level of environmental concern and their intention to adopt pro-environmental behaviors, such as switching to greener courier transport options, including drone delivery.

H4: Consumers' attitudes toward innovation mediates the relationship between environmental concern and the behavioral intention. This hypothesis suggests that a consumer's positive or negative feelings toward innovation play a crucial role in determining whether their environmental concerns will translate into changes in behavioral intention.

6. Materials and methods

We employed a quantitative methodology, utilizing an online questionnaire survey to collect data from Indonesian e-commerce users. To ensure the relevance of the collected data, a screening process was implemented. Respondents were initially filtered based on their understanding of drones and their potential for parcel delivery only those demonstrating sufficient knowledge were included in the main survey. To focus the analysis on the target demographic's perceptions and opinions, this survey was administered only to participants already familiar with choosing and switching between different parcel delivery providers. This familiarity was deemed essential for providing informed responses.

Questionnaires were spread, especially those targeting e-commerce users in Java and Bali, through online surveys. E-commerce usage is high in Java and Bali, representing a significant portion of Indonesia's online shoppers [2,50]. The selection of e-commerce users in Java and Bali is a strategic decision aimed at maximizing the relevance and quality of the data collected while minimizing the costs and complexities of the research process. By focusing on this demographic, we could gather data that is more relevant to their research questions or objectives, likely related to e-commerce behavior or preferences. The survey questions utilized a 7-point Likert scale, where participants could indicate their level of agreement or disagreement with each statement, ranging from 1 (Strongly Disagree) to 7 (Strongly Agree). We obtained 202 responses from Indonesia e-commerce users and proceeded to data analysis [51]. The sample size of 202 is deemed sufficient for this research, aligning with the guidelines proposed by Bentler and Chou [52]. Their recommendation of a 10:1 ratio suggests that the sample size should be a minimum of ten times the number of parameters to be estimated within the model [53], ensuring the validity of the analysis.

The measurement model was validated, and the hypotheses were tested using the SEM method. SEM is used in this study to test the hypothesis and explore the relationships between the components describing the innovation nature and assessing its success regarding environmental concerns, consumer attitude toward innovation, and behavioral intention. We used the statistical software LISREL for factor analysis. LISREL was chosen for its robust capabilities in handling large datasets, its effectiveness in validating measurement models, and testing structural models.

To investigate the complex interplay between environmental concern, consumer attitudes towards innovation, and the behavioral intention to adopt drone delivery services, a research framework was developed (see Figure 1). This framework posits that environmental concern directly influences consumers' attitudes towards innovation and their behavioral intention to switch to drone delivery. Additionally, it proposes that consumer attitudes towards innovation mediate the relationship between environmental concern and behavioral intention. This suggests that individuals with higher environmental concern are more likely to hold positive attitudes towards innovative solutions like drone delivery, which in turn, increases their intention to adopt such services. The framework also considers the direct impact of environmental concern on behavioral intention, acknowledging that some individuals may adopt eco-friendly options regardless of their attitudes towards the specific innovation.
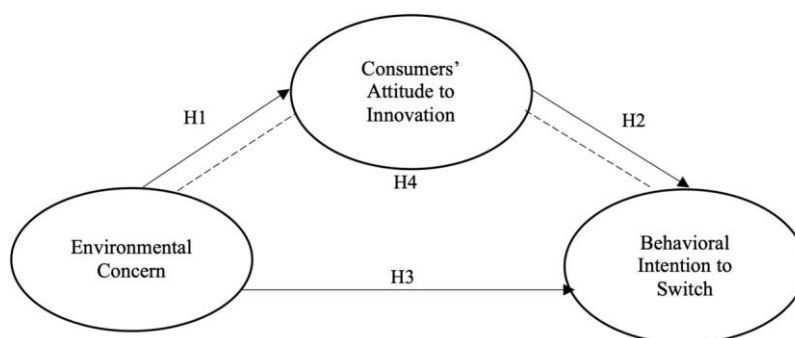
Figure 1. Research framework.

7. Results

7.1. Demographics data

The demographic characteristics of the participants who completed the main survey, as presented in Table 1, offer insights into the specific segment of e-commerce users who are likely to be early adopters of drone delivery services.

The demographics primarily consisted of young adults, predominantly women ($n=118$; 58.4%), while the rest ($n=84$; 41.6%) were male, which reflects the rising interest in drone delivery among tech-savvy younger generations who prioritize convenience and efficiency. The large number of students and professionals further emphasizes this trend, as this demographic is known for its adoption of innovative technology and openness to new shopping methods. Results showed that the largest age group was 17–26 years old ($n=121$; 59.9%), followed by 27–41 years old ($n =54$; 26.7%), and students comprised the largest occupational group (94; 46.5%), followed by private employees ($n=59$; 29.2%). Entrepreneurs, civil servants, homemakers, and other professionals each constituted 6.9% of the sample. There were minimal representations in the under 17 and over 62 age groups. The participants' high education levels also point towards a tech-literate consumer base ready for drone delivery. Unsurprisingly, most participants were concentrated in major urban areas like DKI Jakarta and West Java, as these regions are often early adopters of new e-commerce technology. However, our findings also suggest potential in smaller cities like Banten, DI Yogyakarta, and Central Java, where drone delivery could address logistical hurdles and enhance accessibility to goods. Overall, this demographic overview indicates a bright future for drone delivery in e-commerce, with a diverse and eager customer base ready to embrace this innovative technology.

The results revealed that when it comes to the frequency of their online shopping, a significant portion of respondent shop frequently, with 25.7% shopping at least once a week and 56.9% shopping at least once a month. This suggests that e-commerce is not just a sporadic activity but a regular part of their purchasing habits. In terms of spending habits, most respondents (55.0%) spend between IDR 100,000 and IDR 500,000 per month on online shopping. This middle range suggests a diverse consumer base with varying purchasing power. For preferred delivery services, 7.9% opt for "Instant Delivery", 15.3% choose "Same-day Delivery", 60.9% prefer a "Regular expedition courier", and 15.8% go for "Economics expedition courier". In terms of delivery time preference, 42.1% want next-day delivery, 37.6% want their purchases to arrive as soon as possible or on the same day, 19.8% are fine with a delivery within a few days, and 0.5% are okay with delivery taking more than 7 days. This highlights a strong demand for fast and efficient delivery services in the Indonesian e-commerce market. Overall, the data portrays that Indonesian e-commerce users are adept with technology,

regularly engaging in online shopping, and favoring swift delivery services. This presents a distinct opportunity for e-commerce platforms and logistics companies to align their offerings with these preferences, potentially exploring advancements such as drone delivery to meet evolving consumer expectations.

Table 1. Sample demographics.

Criteria	n	%
Sex		
Female	118	58.4%
Male	84	41.6%
Age		
< 17 years of age	2	1.0%
17–26 years of age	121	59.9%
27–41 years of age	54	26.7%
42–61 years of age	24	11.9%
62–77 years of age	1	0.5%
Occupation		
Private Employees	59	29.2%
Students	94	46.5%
Entrepreneurs	14	6.9%
Civil Servants	14	6.9%
Housewives	7	3.5%
Others/Professional	14	6.9%
Education		
Secondary education, high school/or equivalent	47	23.3%
Diploma	67	33.2%
Bachelor's Degree	60	29.7%
Master's Degree	25	12.4%
Doctoral's Degree	3	1.5%
Job Titles		
Manager	10	5.0%
Supervisor	106	52.5%
Business Owners	14	6.9%
General Manager/Senior Manager	2	1.0%
Staff	47	23.3%
Others	23	11.4%
Domicile		
Banten	24	11.9%
DI Yogyakarta	8	4.0%
DKI Jakarta	96	47.5%
Bali	4	2.0%
East Java	7	3.5%
Central Java	11	5.4%
West Java	52	25.7%

7.2. *Measurement model assessment*

The results in Table 2 suggest that the model demonstrates a good fit for the data. This means that the model is a good representation of the relationships between variables, and we can have confidence in the model's validity for further analysis or prediction. The results reveal strong statistical support for the convergent and discriminant validity of the proposed model, with average variance extracted (AVE) exceeding 0.50 and composite reliability scores surpassing 0.7, indicating high internal consistency within the data. A factor loading value of item >0.5 is generally considered acceptable (Sekaran & Bougie, 2016), showing that the indicator explains at least 25% of the variance in the latent construct. Reliability testing is also conducted to determine the consistency and accuracy of a measurement instrument. This is done by examining the internal consistency of valid items to ensure that the instrument produces stable results over time and across measurement occasions.

Based on Table 3, all indicators have path coefficient values greater than 0.5 and an average variance extracted (AVE) value greater than 0.5 (specifically 0.514), showing that all indicators are valid. The Construct Reliability (CR) value is greater than 0.7 (specifically 0.863), suggesting that the construct is reliable.

Table 2. Goodness of fit (GoF).

GoF indices	Cut-off value	Result	Decision
Chi-Square			
Chi -Square	< Chi table (df=132; Chi-square table=159.814)	138.11	Good fit
Significance Probability	> 0.05	0.34	Good fit
Absolut Fit Measure			
GFI	≥ 0.90	0.93	Good fit
RMSEA	<=0.08	0.015	Good fit
Incremental Fit Indices			
NFI	≥ 0.90	0.95	Good fit
NNFI	≥ 0.90	1.00	Good fit
CFI	≥ 0.90	1.00	Good fit
RFI	≥ 0.90	0.95	Good fit
Parsimony Fit Indices			
AGFI	0–1	0.91	Good fit
PGFI	0–1	0.72	Good fit

Table 3. Construct and scale items.

Construct and Scale Items	Item	Standard Loading λ	λ²	e	Construct Reliability	AVE
Environmental Concern						
Drone delivery innovation products can reduce the effects of climate change	ECN.1	0.68	0.462	0.538	0.861	0.509
Seeking information about environmentally friendly innovations such as drone delivery is important to help preserve the environment and nature.	ECN.2	0.72	0.518	0.482		
Choosing drone delivery for delivering goods can reduce carbon footprints and exhaust gas emissions.	ECW.1	0.68	0.462	0.538		
The less we rely on conventional goods delivery, the lower the pollution levels will be.	ECW.2	0.81	0.656	0.344		
Choosing drone delivery for delivering goods reduces non-renewable fuel consumption.	ECE.1	0.69	0.476	0.524		
I choose products that promote principles that minimize the effects of climate change.	ECE.2	0.69	0.476	0.524		
Consumers Attitude						
Positive Attitude Towards Innovative Product Service such as drone delivery	cgCAI.1	0.83	0.689	0.311	0.86	0.509
Wise Feeling Attitude from Using Innovative Products such as drone delivery	cgCAI.2	0.76	0.578	0.422		
Attitude of Desire for Innovative Products such as drone delivery	afCAI.1	0.56	0.314	0.686		
Attitude of Enjoyment in Using Innovation such as drone delivery	afCAI.2	0.66	0.436	0.564		
Attitude of Perceived Usefulness in Innovation such as drone delivery	cnCAI.1	0.68	0.462	0.538		
Attitude Towards Positive Value from Drones Delivery Innovation	cnCAI.2	0.76	0.578	0.422		
Behavioral Intention						
Positive View of Using Innovative Products like Delivery Drones	BI_1	0.75	0.563	0.438	0.863	0.514
Providing Positive Feedback on Drone Delivery	BI_2	0.72	0.518	0.482		
Positive Feedback on Drone Delivery	BI_3	0.81	0.656	0.344		
Decision to Switch to Innovative Delivery Methods like Drone Delivery	BI_4	0.68	0.462	0.538		
Determination to Use Drone Delivery on E-commerce Platforms	BI_5	0.63	0.397	0.603		
Plan to Use New Innovative Products like Drone Delivery on E-commerce Platforms	BI_6	0.70	0.490	0.510		

7.3. Hypothetical testing

We further examine the relationship using the SEM. Figure 2 illustrates the relationships between Environmental Concern, Consumers' Attitudes toward Innovation, and Behavioral Intention.
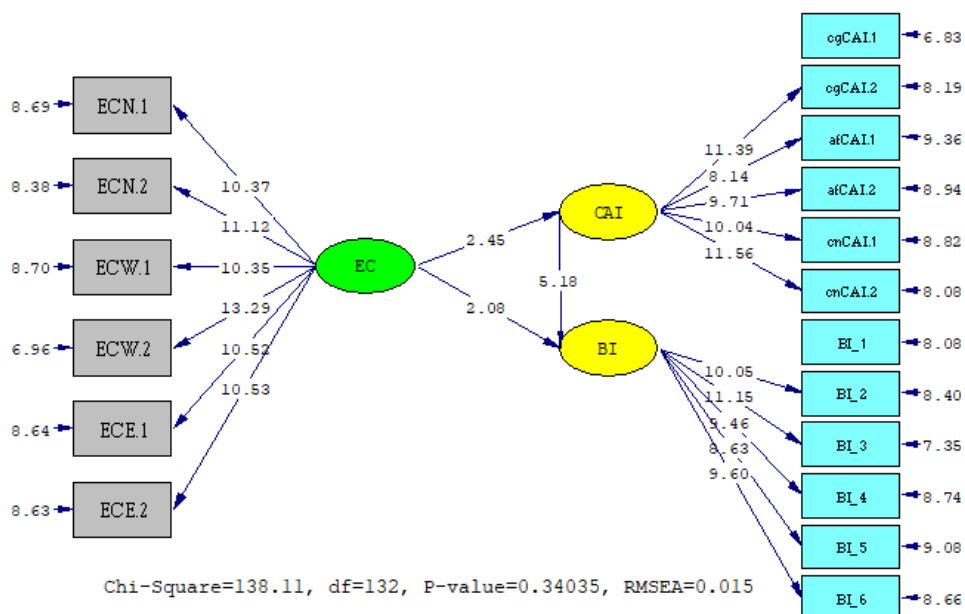

Figure 2. Estimated t-values.

Based on the overall model fit, the chi-square value is 138.11 with 132 degrees of freedom. While the p-value (0.34035) suggests that the model fits the data adequately, the chi-square test is sensitive to sample size, so other fit indices should be considered. The RMSEA (Root Mean Square Error of Approximation) value is 0.015, which is well below the commonly accepted cutoff of 0.08, indicating a good model fit. The t-value of 2.08 suggests a significant positive relationship between EC and BI. This means that individuals with higher environmental concerns are more likely to have stronger intentions to engage in pro-environmental behaviors. The t-values for the paths connecting CAI to EC (2.45) indicate a significant positive relationship. This suggests that cognitive beliefs about environmental issues significantly influence overall environmental concern.

The results of the SEM analysis are presented in Figure 3, visually depicting the relationships between the key variables in the study.
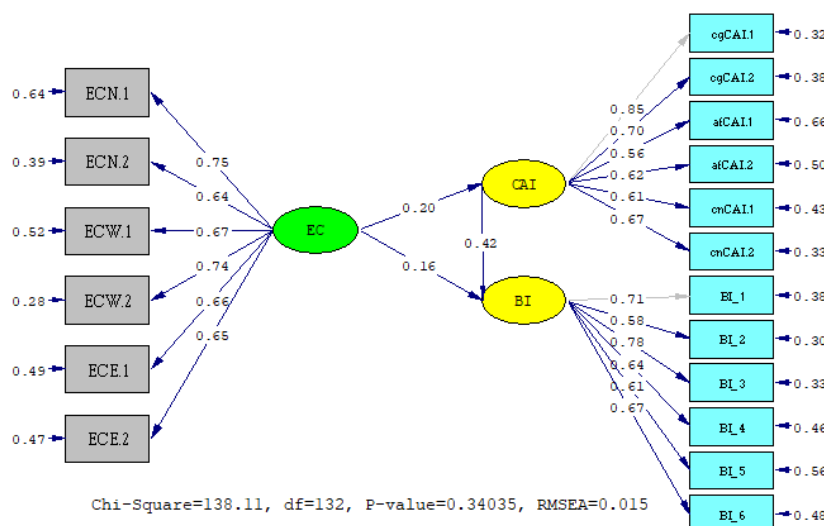
Figure 3. Standardized results.

The path coefficient of the variable EC on consumers' attitudes toward innovation (CAI) is 0.20. Its positive direction indicates that an increase of 1 unit in EC results in a 0.20 unit increase in CAI, and vice versa. The R-squared value obtained for Eq 1 is 0.039. This signifies that the variable EC contributes to CAI by 3.9%. Following that, the variable CAI demonstrates a path coefficient of 0.42, indicating that a one-unit increase in CAI results in a 0.42 unit increase in BI, and vice versa. Similarly, the variable EC shows a path coefficient of 0.16, signifying that a one-unit increase in EC leads to a 0.16 unit increase in BI and vice versa. The R-squared value of 0.23 indicates that collectively, the variables CAI and EC explain 23.0% of the variance in BI. This suggests a substantial influence of CAI and EC on BI within the analyzed model. The model suggests that EC has a direct and positive effect on both consumers' attitudes toward innovation and behavioral intention. It is also shown that consumers' attitudes toward innovation has a partial mediation role in the relationship between EC and behavioral intention, as compiled in Table 4.

Table 4. Structural model results.

Path Testing	Hypotheses	Standardized Estimate	t-Value[1]	Decision
EC → CAI	H1	0.20	2.45	Supported
CAI → BI	H2	0.42	5.18	Supported
EC → BI	H3	0.16	2.08	Supported
EC → CAI → BI	H4	0.08	2.25	Supported

H1: Environmental concerns positively impact consumers' attitudes toward innovation.

In the relationship between EC and CAI, the path coefficient value is 0.20 with a positive direction (0.20 > 0) and a t-value of 2.45. Since the t-value (2.45) is greater than 1.96, and the path coefficient is 2.45, H1 is accepted, meaning that EC has a significant positive influence on CAI. This reveals a compelling connection between ECs and CAI. Our hypothesis (H1) posited that heightened environmental concerns would foster a more positive attitude toward innovative products or services, especially those that are able to address environmental challenges, such as drone delivery, which is perceived as a way to reduce the ecological footprint of traditional logistics.

Consumers' interest in drone delivery technology is fueled by the belief that this innovation can alleviate the environmental burden of traditional logistics, offering a tangible way to reduce their carbon footprint and contribute to a greener world. Consumers also experience a thirst for knowledge regarding environmentally friendly alternatives, which propels consumers to research and engage with innovations like drone delivery. This active information-seeking behavior reinforces the link between environmental concerns and openness to change. For many consumers, the appeal of drone delivery lies in its tangible potential to reduce carbon emissions and mitigate pollution. This indicates a shift from abstract environmental concerns to concrete actions, where adopting sustainable technologies becomes a means of personal contribution to a greener future. The findings also highlight the importance of resource conservation and ethical consumption in shaping consumer attitudes towards drone delivery. Consumers are increasingly drawn to products and services that align with their values and support companies prioritizing environmental responsibility.

H2: CAI positively impacts behavioral intention.

In the relationship between CAI and BI, the path coefficient value is 0.42 with a positive direction (0.42 > 0) and a t-value of 5.18. Since the t-value (5.18) is greater than 1.96, H2 is accepted, meaning that CAI has a significant positive influence on BI. Our second hypothesis (H2) examined the relationship between a positive consumer attitude towards innovation (CAI) and the resulting behavioral intention (BI) to adopt drone delivery. This hypothesis explored whether favorable perceptions of innovation translate into a willingness to utilize innovative services.

This finding resonates with the broader understanding of consumer psychology, suggesting that attitudes are a powerful predictor of behavior. When individuals hold positive beliefs and feelings towards innovation, they are more inclined to engage with it, whether it be through researching, purchasing, or recommending innovative offerings. A positive attitude associated with innovations like drone delivery is strengthened when consumers perceive it as a premium, wise, and intelligent choice. Consumers also highlighting the desire for and enjoyment of drone delivery amplify the positive sentiment, further solidifying the intention to use it. Consumers who are environmentally conscious are more likely to view drone delivery favorably. This positive attitude, reinforced by the perception of environmental benefits acts as a catalyst, propelling consumers along the path from initial interest to adoption. Moreover, this positive relationship between CAI and BI offers valuable insights for the ecommerce industry as well as courier, express, and parcel businesses. It emphasizes the importance of cultivating a positive image of innovation among consumers. By showcasing the benefits, convenience, and overall value of innovative products, companies can enhance consumer attitudes and, consequently, stimulate greater intention in adoption.

H3: Environmental concerns positively impact behavioral intention.

In the relationship between EC and BI, the path coefficient value is 0.16 with a positive direction (0.16 > 0) and a t-value of 2.08. Since the t-value (2.08) is greater than 1.96, H3 is accepted, meaning that EC has a significant positive influence on BI. The third hypothesis (H3) introduces a direct link between environmental concerns (EC) and behavioral intention (BI). This relationship suggests that environmental concerns can be a powerful motivator for consumers, even before a positive attitude toward specific innovations is fully formed. Consumers with high ECs may be more likely to actively seek out sustainable products and services or to avoid those perceived as environmentally harmful.

This direct effect could be particularly pronounced when environmental issues are highly salient, and consumers feel a strong sense of urgency to take action. This reveals that EC can function as a primary motivator, bypassing the need for an intermediary step of developing a positive attitude towards innovation. This could be particularly relevant in cases where consumers are already highly

motivated by environmental concerns.

H4: Consumer attitude mediates the relationship between environmental concern and behavioral intention.

In the relationship between EC mediated by CAI on BI, the path coefficient is 0.08 with a positive direction (0.08 > 0). The calculated t-value is 2.25. Since the calculated t-value (2.25) is greater than 1.96, hypothesis (H4) is supported. The output indicates that CAI mediates the relationship between EC and BI. The indirect effect of 0.08 is statistically significant and signifies that a portion of the total effect of EC on BI is explained by the mediating role of CAI. Thus, consumer attitude plays a partial mediation role in a relationship between environmental concerns and behavioral intention. This means that individuals with higher environmental concerns are more likely to develop a positive attitude towards drone delivery, which increases their intention to switch.

People who care about the environment are more predisposed to consider drone delivery due to its potential environmental benefits. However, it is not just about ECs. A person's attitude toward innovation in general also plays a significant role. If they see drone delivery as a positive innovation, they are even more likely to switch. This suggests that environmental concerns not only spark interest in innovation but also set off a domino effect, leading to the adoption of eco-friendly products and services. Overall, our results suggest that environmental concerns have a positive impact on CAI and behavioral intention, both directly as well as indirectly through CAI.

8. Discussion

Our findings offer valuable insights for e-commerce businesses seeking to optimize their last-mile delivery operations using drones. Focusing on e-commerce users, we found a significant positive relationship between environmental concern, consumer attitude, and behavioral intention toward drone delivery adoption. The demographic composition of our sample, primarily comprising students and young professionals, underscores the potential of this market segment and are known for their tech-savviness and openness to innovative solutions. These findings suggest that e-commerce companies can leverage eco-conscious messaging and highlight the environmental benefits of drone delivery to positively influence consumer attitudes and purchase intentions. The confirmation of H1, revealing a strong link between environmental concerns and a positive consumers' attitudes toward innovation, offers valuable insights for businesses aiming to thrive in an increasingly eco-conscious market. Companies can capitalize on the growing environmental consciousness among consumers by strategically promoting innovative solutions, like drone delivery, that directly address environmental challenges. As consumers gravitate toward technologies perceived as eco-friendly, positioning such solutions as tangible contributions to sustainability can significantly boost consumer engagement and market penetration. Additionally, educational campaigns highlighting the environmental benefits of these innovations can further solidify consumer interest and support. The findings from H2 and H3 demonstrate that favorable perceptions of new technologies, like drone delivery, can lead to consumer adoption of these technologies. This underscores the importance of cultivating a positive image of innovation in the e-commerce and logistics sectors. Businesses can strategically enhance consumer attitudes by emphasizing the practical benefits and positive impacts of their innovative solutions, such as convenience, speed, and efficiency, particularly for tech-savvy demographics, to further stimulate adoption. By strategically integrating these insights, e-commerce and logistics businesses can effectively target their marketing and service offerings, enhance customer satisfaction, and position their businesses at the forefront of sustainable and innovative last-mile delivery solutions. Moreover, while environmental concerns directly influence consumer behavior, their impact is bolstered when

accompanied by a positive attitude toward innovative solutions, as proven in H4. Companies can strategically position themselves by promoting both the environmental benefits and innovative features of their offerings. By creating a supportive environment that fosters positive attitudes towards eco-friendly innovations like drone delivery, businesses can effectively shape consumer decision-making and adoption. Hence, these findings suggest that businesses in the e-commerce and logistics sectors can enhance consumer engagement and adoption of innovative services, such as drone delivery, by aligning their offerings with environmental values, promoting positive attitudes toward innovation, and highlighting the practical benefits of their solutions. Furthermore, fostering a sense of environmental responsibility among consumers can create a market for sustainable innovations. This approach not only meets consumer demand for sustainable practices but also positions companies as leaders in driving positive environmental impact through technological innovation.

9. Conclusions

This study illuminates the critical role of EC as a motive in generating intention. It also proposes a nuanced understanding of consumer attitudes towards innovation (CAI) and how these attitudes drive the intention to adopt such technologies. It suggests that heightened environmental consciousness, coupled with positive attitudes towards innovation, can potentially lead to more sustainable consumer behavior through embracing innovative solutions like drone delivery. Our results confirm the hypothesized positive relationship between ECs, CAI, and BI. The results suggest that environmentally conscious individuals are more likely to embrace innovative products or services that align with their values, leading to a greater intention to adopt them. While this research offers valuable contributions, it is important to acknowledge its limitations. We focused on a specific context and sample, potentially limiting the generalizability of the findings. Researchers could explore the influence of other factors, such as perceived risk, social norms, and economic considerations, on consumer adoption of drone delivery. Longitudinal studies could provide deeper insights into the long-term impact of ECs on consumer behavior. Additionally, cost, energy, and gas emission reductions associated with drone delivery for last-mile supply chain optimization have been primarily demonstrated for small packages. Researchers should investigate the feasibility and environmental impact of drone delivery for a wider range of package sizes and delivery distances. In conclusion, this research underscores the importance of environmental concern in shaping consumer behavior and highlights the potential of innovation to drive sustainable consumption. Researchers should build on these findings to further explore the complex interplay between environmental values, innovation, and consumer choice.

Author contributions

Use of AI tools declaration

Acknowledgments

Conflict of interest

The authors declare no conflict of interest.

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