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Public attitudes toward secure AI enabled drone delivery for public services in the UAE

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Introduction: Secure artificial intelligence (AI)-enabled drone delivery systems are emerging as transformative solutions for public service delivery, particularly in smart governance contexts such as the United Arab Emirates (UAE). While promising, the adoption of these systems requires a nuanced understanding of factors influencing public acceptance, including AI-security assurances, perceived risks, costs, and social influence.

Methods: This study uses a survey of 410 UAE residents, analyzed through partial least squares structural equation modeling (PLS-SEM), to explore the drivers of public acceptance of AI-enabled drone systems. The study integrates these factors into a structural acceptance model, focusing on the roles of perceived benefits, risks, costs, and social influence.

Results: The findings demonstrate that both perceived benefits ($\beta = 0.386$, $p < 0.001$) and social influence ($\beta = 0.386$, $p < 0.001$) are strong and significant drivers of positive attitudes towards AI-enabled drone delivery systems. In contrast, perceived risks negatively impact acceptance ($\beta = -0.146$, $p = 0.002$). Interestingly, perceived cost does not significantly affect attitudes ($\beta = -0.057$, $p = 0.445$) but is positively associated with risk perceptions, indicating a layered barrier effect.

Discussion: The study contributes to technology acceptance models by revealing the interdependencies between barrier constructs. It suggests that in the UAE context, public engagement and security assurances are more crucial for fostering trust and adoption than cost-related incentives. Limitations of the study include nonrandom sampling, a cross-sectional design, and weaker loadings for certain indicators, which may limit generalizability but provide valuable exploratory insights.

KEYWORDS

drone delivery, AI acceptance, technology trust, UAE, structural equation modeling, smart governance

1 Introduction

The rapid advancement of technology has revolutionized various aspects of human life, with one of the most promising innovations being unmanned aerial vehicles (UAVs), commonly known as drones. Originally developed for military applications,

drones have evolved significantly and are now being integrated into commercial sectors, particularly in logistics and delivery services. The global drone delivery market, valued at US\$ 426.1 million in 2023, is projected to expand rapidly with a CAGR of over 30% by 2033, underscoring its transformative potential (Future Market Insights, 2023). In the UAE, Dubai's launch of the Middle East's first drone delivery network in 2024 marked a significant milestone toward smart governance and technology-enabled public service delivery (DAMAC Properties, 2024).

While global projections demonstrate the promise of drone delivery, much existing research remains descriptive, focusing on operational efficiency or cost comparisons across contexts (Hwang and Kim, 2021b; Kellermann et al., 2023b; Mathew et al., 2021; Xie et al., 2022). Few studies explicitly integrate AI-security assurances with perceived risks, cost sensitivity, and social influence in Middle Eastern settings, despite the UAE's rapid adoption initiatives (DAMAC Properties, 2024). This study addresses this gap by analyzing how these interrelated factors shape public acceptance of secure AI-enabled drone delivery in the UAE. Figure 1 summarizes the adoption framework for secure AI-enabled drone delivery in the UAE, showing how perceived benefits and social influence drive positive attitudes, perceived risks reduce acceptance, and perceived cost indirectly amplifies risk concerns, leading to implications for policy and future research.

This study investigates how secure AI considerations influence public acceptance of drone delivery services for UAE public sectors. Our specific objectives are to.

- Assess the impact of AI-security assurances (e.g., encrypted control channels, fail-safe algorithms) on attitudes.
- Examine how perceived AI-related risks (cyberattacks, privacy breaches, system failures) shape negative attitudes.
- Compare the relative weight of trust in the AI system *versus* utilitarian benefits when forming adoption intentions.
- Identify which security-focused messaging strategies (certifications, third-party audits, on-board transparency) most effectively reduce risk perceptions.
- Explore how social validation (expert endorsements, peer influence) interacts with security assurances to drive behavioral intention.

Accordingly, we pose five research questions.

1. RQ1: How do AI-security assurances affect public attitudes toward drone delivery?
2. RQ2: How do perceived AI-related risks influence negative attitudes?
3. RQ3: What is the relative importance of trust in the AI system *versus* perceived benefits?
4. RQ4: Which security-focused communication strategies most mitigate risk perceptions?
5. RQ5: How does social validation interact with security assurances to shape adoption intention?

By answering these questions, our work aligns with the special issue on Secure Artificial Intelligence, offering empirical insights and practical guidance for the safe deployment of AI-driven drone

services in public applications. Figure 2 illustrates the secure AI-driven ecosystem influencing public adoption of drone delivery services in the UAE, integrating technological, governmental, and social trust dimensions.

However, the adoption of drone delivery services is influenced by various factors that shape consumers' attitudes and behavioral intentions. Understanding these factors is crucial for the successful implementation and widespread acceptance of this technology. This study focuses on four key variables that influence attitudes toward using drone delivery services for public services in the UAE: perceived benefits, perceived risks, perceived cost, and social influence. Section 2 further reviews the global evidence on perceived benefits, risks, costs, and social influence, laying the foundation for our conceptual framework and hypotheses.

Social influence, the fourth variable in our conceptual framework, operates differently across cultural contexts but remains significant in all regions. In India, a country with a collectivist cultural orientation, social influence has been identified as a significant predictor of attitude and behavioral intention toward drone food delivery services (Mathew et al., 2023). Research from the UK has highlighted the importance of social trust and reputation, with positive experiences shared by trusted individuals having a significant impact on adoption intentions (Nunkoo et al., 2024). In the United States, studies focusing on Generation Z consumers have emphasized the role of peer opinions and social media in shaping perceptions of drone delivery services, with the "seeing is believing" moment being essential for adoption (Chen et al., 2023).

The interplay of these four factors—perceived benefits, perceived risks, perceived cost, and social influence—shapes consumers' attitudes toward using drone delivery services, which in turn influences their behavioral intentions. Understanding this relationship is crucial for stakeholders in the UAE's drone delivery ecosystem, including service providers, regulators, and policymakers. By identifying the factors that positively and negatively affect attitudes toward drone delivery services, this study aims to provide insights that can inform strategies to enhance adoption rates and improve service delivery.

This research is particularly relevant in the context of the UAE, where the government has been proactive in embracing technological innovations to enhance public services. The findings of this study will contribute to the growing body of literature on drone delivery services and provide practical implications for the implementation of this technology in the UAE and similar contexts. By examining the factors that influence attitudes toward drone delivery services, this research seeks to bridge the gap between technological capabilities and consumer acceptance, ultimately facilitating the successful integration of drones into the public service delivery ecosystem.

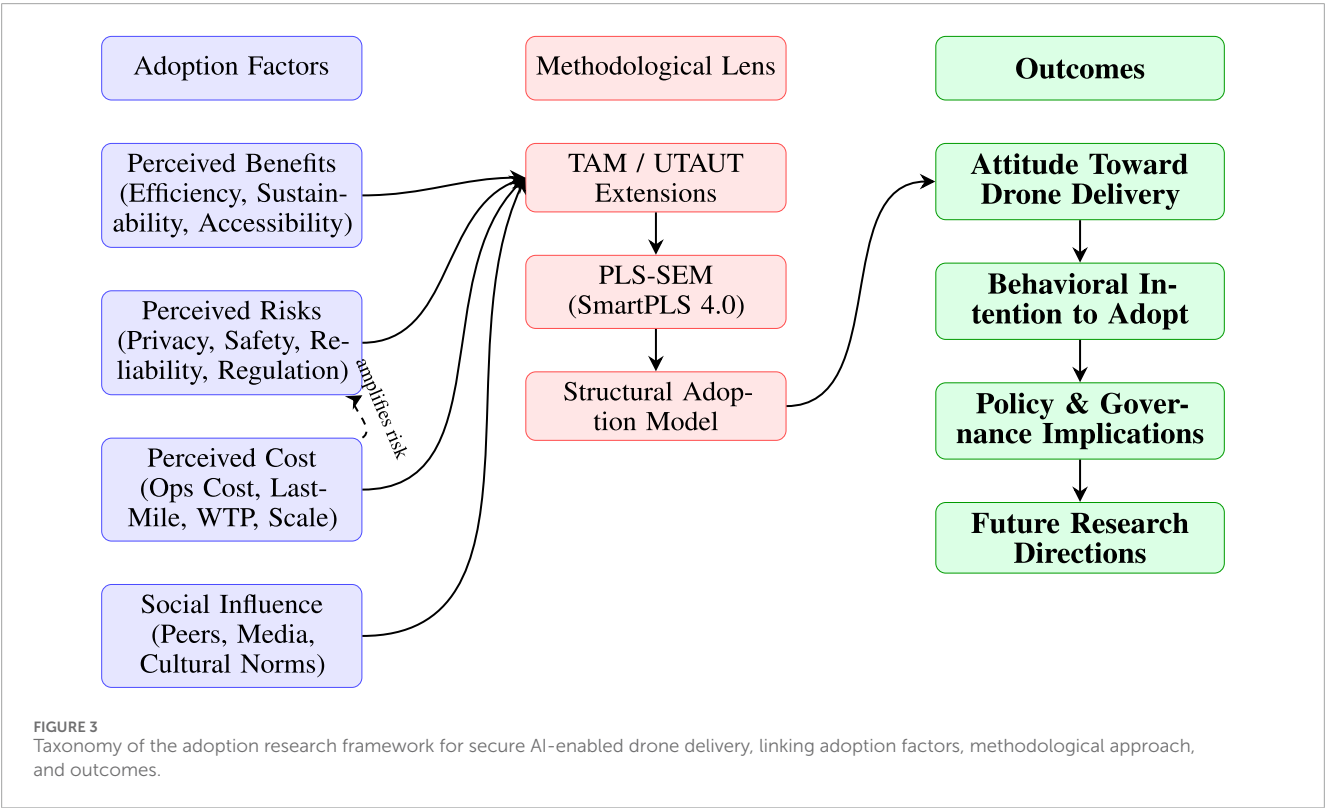
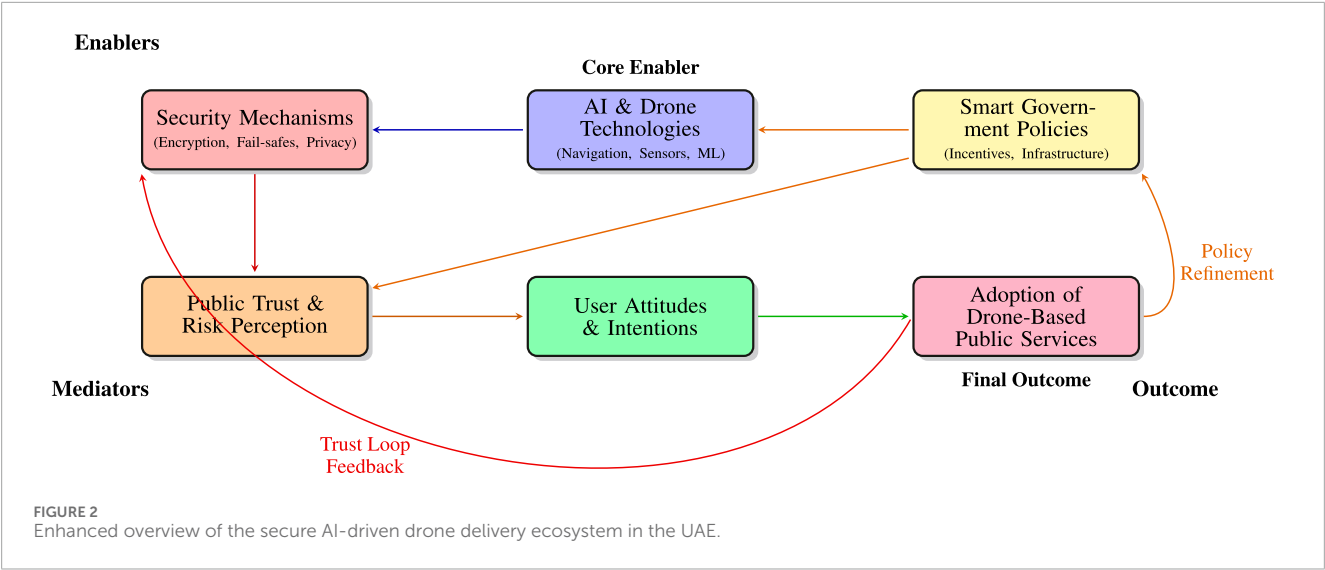
The remainder of this paper is structured as follows. Section 2 reviews the related literature on AI-enabled drone delivery and public service applications, highlighting current research trends and gaps. Section 4 presents the research methodology, including data collection, survey design, and analytical framework. Section 5 reports the results of the statistical analysis and hypothesis testing. Section 6 discusses the findings, linking them to theoretical and practical implications. Finally, Section 7 concludes the study by summarizing key contributions, outlining limitations, and suggesting directions for future research.



2 Literature review

The growing body of research on drone delivery and technology adoption highlights the interplay between technological capabilities, regulatory frameworks, and user perceptions. Prior studies have examined factors such as security, privacy, perceived benefits, and risks, often through technology acceptance and behavioral intention

models. While these works provide valuable insights, gaps remain in addressing trust, fairness, and governance dimensions, particularly in the context of AI-enabled public services. This section reviews key contributions in the domain and identifies limitations that motivate the present study. **Figure 3** illustrates how prior studies classify adoption of drone delivery into four factors—perceived benefits, risks, cost, and social influence—analyzed through TAM/UTAUT



and SEM approaches, leading to outcomes in attitudes, behavioral intentions, and policy implications.

Recent scholarly contributions have underscored the multifaceted factors shaping consumer attitudes toward drone delivery services, particularly in emerging economies like the UAE. Trust in artificial intelligence (AI) and the engineers behind such innovations is pivotal for public acceptance, as evidenced by (Ho and Cheung, 2024), who employed the UTAUT2 framework to show how media and professional credibility mediate trust

in autonomous drones. Similarly, (Gerlich, 2023) emphasized a multidimensional approach to AI acceptance, reinforcing the role of transparency and ethical alignment. (Abbasi et al., 2024) and (Chakraborty, 2025) explored how emotional trust, perceived convenience, and value-driven motives influence the adoption of drone delivery and AI-based platforms. These findings align with those of (Chen et al., 2022), who found that trust, risk perception, and perceived usefulness directly shape consumer intentions in last-mile delivery scenarios.

Research on contextual applications in the Middle East, including the UAE, highlights how AI has been harnessed in aviation and logistics projects to enhance operational efficiency and reliability (Alketbi et al., 2024). Studies like those of Lee et al. (2025) and Chi et al. (2023) demonstrate that consumer readiness for drone-based food and parcel delivery services varies significantly across countries and is shaped by local regulatory, infrastructural, and cultural dynamics. Foundational reviews by (Eskandaripour and Boldsai Khan, 2023), (Shuaibu et al., 2025), and (Garg et al., 2023b) detail the evolution and future direction of drone-based logistics, especially emphasizing sustainability, accessibility, and safety. Others like (Sham et al., 2023; Osakwe et al., 2022) investigated switching intentions and risk perceptions, showing that psychological and operational concerns must be addressed for large-scale adoption.

Technical advancements in drone routing, charging, and secure operation are also extensively studied. For instance, Raivi et al. (2023), Zhang et al. (2024), and Yin et al. (2023) have focused on algorithmic optimization and the cooperative dynamics between drones and trucks. Further engineering-oriented work includes studies by Alkouz et al. (2021), Thomas et al. (2024), and Moshref-Javadi et al. (2021), who highlight real-time scheduling, en-route coordination, and fleet management. Practical implementations—such as blood delivery via UAVs in Rwanda (Nisingizwe et al., 2022) and the use of battery-swapping drones in delivery networks (Cokyasar et al., 2021)—demonstrate that secure and efficient drone logistics are already in action globally. Models based on Ant Colony Optimization (Huang et al., 2022) and systematic reviews of scheduling (Pasha et al., 2022) and hybrid delivery systems (Madani and Ndiaye, 2022) provide a foundation for future research. The strategic integration of drones and autonomous ground vehicles (Lemardel  et al., 2021) showcases a vision where coordinated, secure, and intelligent delivery mechanisms can support smart city infrastructures, particularly relevant to the UAE's technological aspirations.

Table 1 provides a comprehensive summary of key scholarly contributions to the domain of drone delivery services. It highlights major themes, regional contexts, and technical or behavioral insights from recent literature, thereby offering a structured foundation for understanding the multidimensional factors influencing adoption. This synthesis reinforces the relevance of constructs such as trust, perceived usefulness, risk, and infrastructural readiness in shaping public acceptance across different global and cultural contexts.

2.1 Drone delivery services: a global perspective

Unmanned Aerial Vehicles (UAVs), commonly known as drones, have evolved from their military origins to become promising tools for commercial applications, particularly in logistics and delivery services. The global drone delivery market is projected to grow from US\$ 426.1 million in 2023 to US\$ 7,217.4 million by 2033, at a CAGR of 32.7% (Future Market Insights, 2023). This remarkable growth trajectory reflects the increasing recognition of drones as viable solutions to address challenges associated with traditional delivery methods across various global contexts.

Perceived benefits of drone delivery services have been extensively studied across different global contexts. In South Korea,

Hwang and Kim (2021a) identified speed and time efficiency as primary benefits, noting that drone deliveries could reduce delivery time to just 10 min for distances of 3 km. Similarly, research from Germany highlighted fast and time-flexible delivery as expected benefits, addressing the growing demand for ever-faster delivery options (Kellermann et al., 2023a). In the United States, studies have emphasized delivery speed, with Amazon's "30 min or less Prime Air" drone delivery services demonstrating significant time savings (Xie et al., 2022). Additionally, environmental sustainability has been recognized as a key benefit across multiple countries, with drone delivery perceived as a "green" transport option that contributes to reducing carbon emissions (Mathew et al., 2021). Despite these benefits, perceived risks remain significant barriers to adoption. Research from India has identified privacy risks as having a significant negative influence on consumer attitudes toward drone food delivery services (Mathew et al., 2021). Studies from Germany have highlighted social and spatial risks, including stress due to traffic in lower airspace and noise disturbances in urban environments (Kellermann et al., 2023a). In the United States, concerns about privacy invasion, safety, and security risks have been documented, including worries about damages to products and buildings during delivery (Xie et al., 2022). Research from the UK has also emphasized safety concerns and security risks, particularly regarding the potential misuse of drone technology (Nunkoo et al., 2024). The economic aspect of drone delivery services, represented by perceived cost, varies across different regions. In the United States, drone deliveries have been found to be more cost-effective than traditional express delivery methods, costing approximately \$1.23 per delivery compared to \$5.33 for a four-mile distance by electric van (Garg et al., 2023a). Canada, with its estimated CAGR of 35.9% in drone delivery services, is focusing on specialized drones with weather-resistance technology for efficient deliveries in remote areas, potentially reducing transportation costs for challenging terrain (Future Market Insights, 2023). China, with its rapidly growing e-commerce industry, is leveraging economies of scale to reduce per-delivery costs, with swarm technology applications offering potential for significant cost reductions through multi-drone coordinated deliveries (Future Market Insights, 2023).

Different regions worldwide have embraced drone delivery services at varying paces and with different emphases. In the United States, companies like Amazon, UPS, and DHL have invested heavily in drone delivery technology, with Amazon's Prime Air aiming to deliver packages within 30 min (Xie et al., 2022). By 2030, drone delivery services are predicted to save online merchants approximately 50 million U.S. dollars in delivery charges and increase e-commerce revenues by 25% (Chen et al., 2023). In China, the rapidly growing e-commerce sector has driven widespread adoption of drone delivery for last-mile deliveries, with companies implementing swarm technology for scalable and efficient product services (Future Market Insights, 2023). South Korea has leveraged its advanced 5G networks to enhance drone delivery capabilities, particularly in agriculture and rural deliveries (Future Market Insights, 2023).

Recent studies from the UAE provide complementary insights into technology adoption and digital transformation. Almuraqab et al. (2024) explored determinants influencing the usage intention of AI-based customer services in the

TABLE 1 Summary of key literature contributions on drone delivery services.

Authors	Focus area	Key contributions	Region/Context
Ho and Cheung (2024)	Trust and AI Acceptance	Media and professional credibility shape public trust in drones via UTAUT2 model	General
Gerlich (2023)	Ethical AI Acceptance	Emphasized transparency and ethics in drone adoption	General
Abbasi et al. (2024), Chakraborty (2025)	Emotional Trust and Value Perception	Emotional trust, perceived convenience, and value drive AI-based drone platform adoption	Asia
Chen et al. (2022)	Risk and Usefulness	Trust, risk, and usefulness predict drone delivery intention in last-mile logistics	United States of America
Lee et al. (2025), Chi et al. (2023)	Readiness across Cultures	Country-specific readiness depends on regulation and infrastructure	East Asia
Eskandaripour and Boldsaikhan (2023), Garg et al. (2023b)	Logistics Trends	Reviewed evolution, sustainability, and safety in drone logistics	Global
Sham et al. (2023), Osakwe et al. (2022)	Risk and Switching Intentions	Psychological and operational risks impede adoption; require mitigation	Global
Raivi et al. (2023), Zhang et al. (2024), Yin et al. (2023)	Routing and Optimization	Focus on routing efficiency, drone-truck coordination, optimization algorithms	Engineering
Alkouz et al. (2021), Thomas et al. (2024), Moshref-Javadi et al. (2021)	Scheduling and Fleet Mgmt	En-route scheduling, fleet optimization, and real-time coordination	Applied Engineering
Blood delivery (Rwanda) (Nisingizwe et al., 2022), Battery-swap drones (Cokyasar et al., 2021)	Real-World Applications	Demonstrated practical and secure use of UAVs in healthcare and logistics	Rwanda, China
ACO models (Huang et al., 2022), Hybrid systems (Madani and Ndiaye, 2022), Scheduling reviews (Pasha et al., 2022)	Optimization Methods	AI and heuristic-based models for secure and scalable delivery systems	Global
Drones + AGVs (Lemardelé et al., 2021)	Smart City Integration	Hybrid deployment of drones and ground vehicles for city logistics	Smart Cities

UAE, emphasizing the roles of perceived usefulness, trust, and facilitating conditions in shaping user acceptance. Similarly, Almuraqab (2021) discussed critical success factors for e-government adoption within emerging smart city frameworks, highlighting infrastructure readiness, governance mechanisms, and citizen awareness as key enablers. These findings align closely with the present study’s focus on behavioral, regulatory, and infrastructural factors influencing drone delivery service adoption.

In Europe, Germany has focused on developing drone delivery with sustainability as a priority, integrating drone services with urban air mobility plans (Future Market Insights, 2023). The United Kingdom has emphasised medical applications, using drones for transporting organ implants and other time-critical medical supplies (Future Market Insights, 2023). Canada has developed specialised drones with weather-resistance technology for efficient deliveries in remote areas, addressing the country’s unique geographical challenges (Future Market Insights, 2023). In the Middle East, the UAE has emerged as a pioneer in drone technology adoption. Dubai’s launch of the Middle East’s first drone delivery system

in December 2024 marked a significant milestone in the region’s technological advancement (DAMAC Properties, 2024). This initiative aligns with Dubai’s vision to become a smart city and demonstrates the UAE’s commitment to embracing innovative solutions for public services. The adoption of drone delivery services across these diverse global contexts is influenced by various factors that shape consumers’ attitudes and behavioural intentions. This study focuses on four key variables that influence attitudes toward using drone delivery services for public services in the UAE: perceived benefits, perceived risks, perceived cost, and social influence.

2.2 Perceived benefits of drone delivery services

Perceived benefits refer to the positive outcomes that consumers expect from adopting drone delivery services. Research across multiple countries has identified several common benefits that drive consumer acceptance of this technology.

2.2.1 Speed and time efficiency

Speed and time efficiency have been consistently identified as primary benefits of drone delivery services across different global contexts. In South Korea, [Hwang and Kim \(2021a\)](#) found that drone deliveries could reduce delivery time to just 10 min for distances of 3 km, representing a significant improvement over the traditional delivery methods. Similarly, research from Germany by [Kellermann et al. \(2023a\)](#) highlighted fast and time-flexible delivery as expected benefits, addressing the growing demand for ever-faster delivery options.

In the United States, studies have emphasised delivery speed as a key advantage, with Amazon's "30 min or less Prime Air" drone delivery services demonstrating significant time savings ([Xie et al., 2022](#)). DHL's drone delivery solution in urban areas of China reduced delivery time from 40 to 8 min, representing an 80% reduction in delivery time ([Xie et al., 2022](#)). This dramatic improvement in delivery speed is particularly valuable in congested urban environments where traditional delivery vehicles face significant delays due to traffic.

2.2.2 Environmental sustainability

Environmental sustainability has emerged as a significant perceived benefit of drone delivery services across multiple countries. Unlike conventional delivery methods that rely on fossil fuel-powered vehicles, drone delivery services typically operate on batteries and do not emit pollutants directly during operation ([Hwang and Kim, 2021a](#)). This environmental advantage is particularly relevant in countries facing severe air pollution challenges.

In India, [Mathew et al. \(2021\)](#) found that the green image of drone delivery services positively influenced consumer attitudes, especially in urban areas with significant air pollution concerns. The study noted that 21 of the world's 30 cities with the worst air quality are in India, making the environmental benefits of drone delivery particularly salient in this context. Similarly, research from Germany has positioned drone delivery as a "green" transport option that contributes to sustainability goals in urban logistics ([Kellermann et al., 2023a](#)).

Studies from China have also emphasized the environmental benefits of drone delivery, particularly in reducing carbon emissions compared to traditional truck deliveries in densely populated urban areas ([Future Market Insights, 2023](#)). This environmental advantage aligns with growing consumer awareness and concern about climate change and air pollution across global markets.

2.2.3 Accessibility and reach

Drone delivery services offer enhanced accessibility, particularly for remote or difficult-to-reach areas. This benefit has been highlighted in research from various countries with diverse geographical challenges. In Canada, drone delivery has been positioned as a solution for reaching remote communities that are otherwise difficult to access, especially during adverse weather conditions ([Future Market Insights, 2023](#)).

Research from South Korea has emphasized the ability of drones to transfer goods to rural and remote areas without the limitations faced by traditional delivery methods ([Future Market Insights, 2023](#)). Similarly, studies from the United States have highlighted the potential of drone delivery to overcome geographical and

infrastructure limitations, providing service to areas that might otherwise be underserved) ([Garg et al., 2023a](#)).

In the context of the UAE, with its diverse landscape including urban centres, suburban areas, and remote desert regions, the accessibility benefits of drone delivery could be particularly valuable for ensuring equitable access to public services across all communities.

2.2.4 Contactless delivery

The COVID-19 pandemic has accelerated interest in contactless delivery options, with drone delivery emerging as a promising solution. Research from South Korea has identified contactless delivery as a key benefit of drone services, particularly valuable during the pandemic when minimizing human contact was essential ([Hwang and Kim, 2021a](#)).

Studies from the United States have noted that companies like Amazon implemented drone delivery partly to decrease disease transmission during the COVID-19 pandemic ([Xie et al., 2022](#)). Similarly, research from China has highlighted the surge in demand for contactless delivery options during and after the pandemic, positioning drone delivery as an innovative solution to meet this need. While the immediate urgency of contactless delivery may have diminished as the pandemic has receded, this benefit continues to be valued by consumers who appreciate the convenience and safety aspects of reduced human interaction in the delivery process.

2.3 Perceived risks of drone delivery services

Despite the numerous benefits, the adoption of drone delivery services is hindered by various perceived risks. Research across different countries has identified several common risk factors that influence consumer attitudes toward this technology.

2.3.1 Privacy concerns

Privacy concerns have been consistently identified as significant barriers to drone delivery adoption across multiple countries. In India, [Mathew et al. \(2021\)](#) found that perceived privacy risk had a significant negative influence on consumer attitudes toward drone food delivery services. These concerns relate to surveillance and data collection during drone operations, as drones equipped with cameras and sensors could potentially infringe on personal privacy.

Research from the United States has highlighted similar privacy concerns, with [Xie et al. \(2022\)](#) noting worries about privacy invasion during drone operations. These concerns are particularly pronounced in residential areas where drones might capture images or data beyond what is necessary for delivery purposes.

Studies from the UK have emphasized the relationship between privacy concerns and regulatory frameworks, suggesting that clear privacy protections and transparent data practices are essential for addressing these concerns ([Nunkoo et al., 2024](#)). This highlights the importance of regulatory clarity in mitigating privacy risks associated with drone delivery services.

2.3.2 Safety and security risks

Safety and security risks represent significant concerns across various global contexts. Research from Germany has highlighted social and spatial risks, including stress due to traffic in lower airspace and potential accidents in urban environments (Kellermann et al., 2023a). These concerns relate to the physical safety of people and property in areas where drones operate.

Studies from the United States have documented worries about damages to products and buildings during delivery, as well as potential injuries from drone malfunctions (Xie et al., 2022). Similarly, research from Australia has explored the problematization of drones with a focus on safety, emphasizing the need for robust regulatory frameworks to address these concerns (Clarke and Moses, 2014).

In the UK, security risks have received particular attention, with reports highlighting concerns about drones being used for illegal activities (The Guardian, 2025). These security concerns extend beyond the intended use of delivery drones to encompass potential misuse of the technology.

2.3.3 Performance and reliability issues

Concerns about the performance and reliability of drone technology have been identified across various studies. Research from South Korea has noted time risks associated with potential delays or time wasted if drone deliveries fail (Hwang and Kim, 2021a). These concerns relate to the technological maturity and operational reliability of drone delivery systems.

Studies from India have examined performance risks related to the reliability and effectiveness of drone technology, including worries about drone malfunctions and technical failures (Mathew et al., 2021). Interestingly, some research has found that performance risks did not significantly influence consumer attitudes, suggesting growing confidence in drone technology capabilities as the technology matures.

Research from Canada has highlighted concerns about the impact of adverse weather conditions on drone performance, particularly in a country known for its challenging climate (Future Market Insights, 2023). These performance concerns are context-specific and reflect the unique operational challenges faced in different geographical and climatic environments.

2.3.4 Regulatory uncertainty

Regulatory uncertainty has emerged as a significant concern across multiple countries. Studies from the United States have highlighted concerns about evolving regulations and their impact on service reliability, as well as questions about liability in case of accidents or failures (Xie et al., 2022). These regulatory concerns create uncertainty for both service providers and consumers.

Research from China has emphasized the importance of clear regulatory frameworks for drone operations, particularly in densely populated urban areas where safety and privacy concerns are heightened (Future Market Insights, 2023). Similarly, studies from the UK have highlighted the need for comprehensive regulatory approaches that address safety, privacy, and security concerns while enabling innovation (Nunkoo et al., 2024).

In the context of the UAE, regulatory clarity will be essential for addressing perceived risks and facilitating the adoption of drone

delivery services for public services. The UAE's proactive approach to drone regulation, exemplified by initiatives like the Drone Rules 2021 in neighboring India, could serve as a model for creating an enabling regulatory environment.

2.4 Perceived cost of drone delivery services

The economic aspects of drone delivery services, represented by perceived cost, play a crucial role in shaping consumer attitudes and adoption intentions. Research across different countries has examined various cost-related factors that influence the acceptance of this technology.

2.4.1 Operational cost efficiency

Operational cost efficiency has been identified as a key advantage of drone delivery services across multiple studies. Research from the United States has found that drone deliveries are more cost-effective than traditional express delivery methods, costing approximately \$1.23 per delivery compared to \$5.33 for a four-mile distance by electric van (Garg et al., 2023a). This represents a significant cost saving of approximately 77% for short-distance deliveries.

Studies from China have highlighted the potential for significant cost reductions through economies of scale and technological innovations such as swarm technology for multi-drone coordinated deliveries (Future Market Insights, 2023). Similarly, research from South Korea has emphasised cost savings compared to traditional delivery methods, particularly for specialised applications such as agricultural uses (Future Market Insights, 2023).

These operational cost efficiencies translate to potential savings for both service providers and consumers, making drone delivery an economically attractive option for certain types of deliveries.

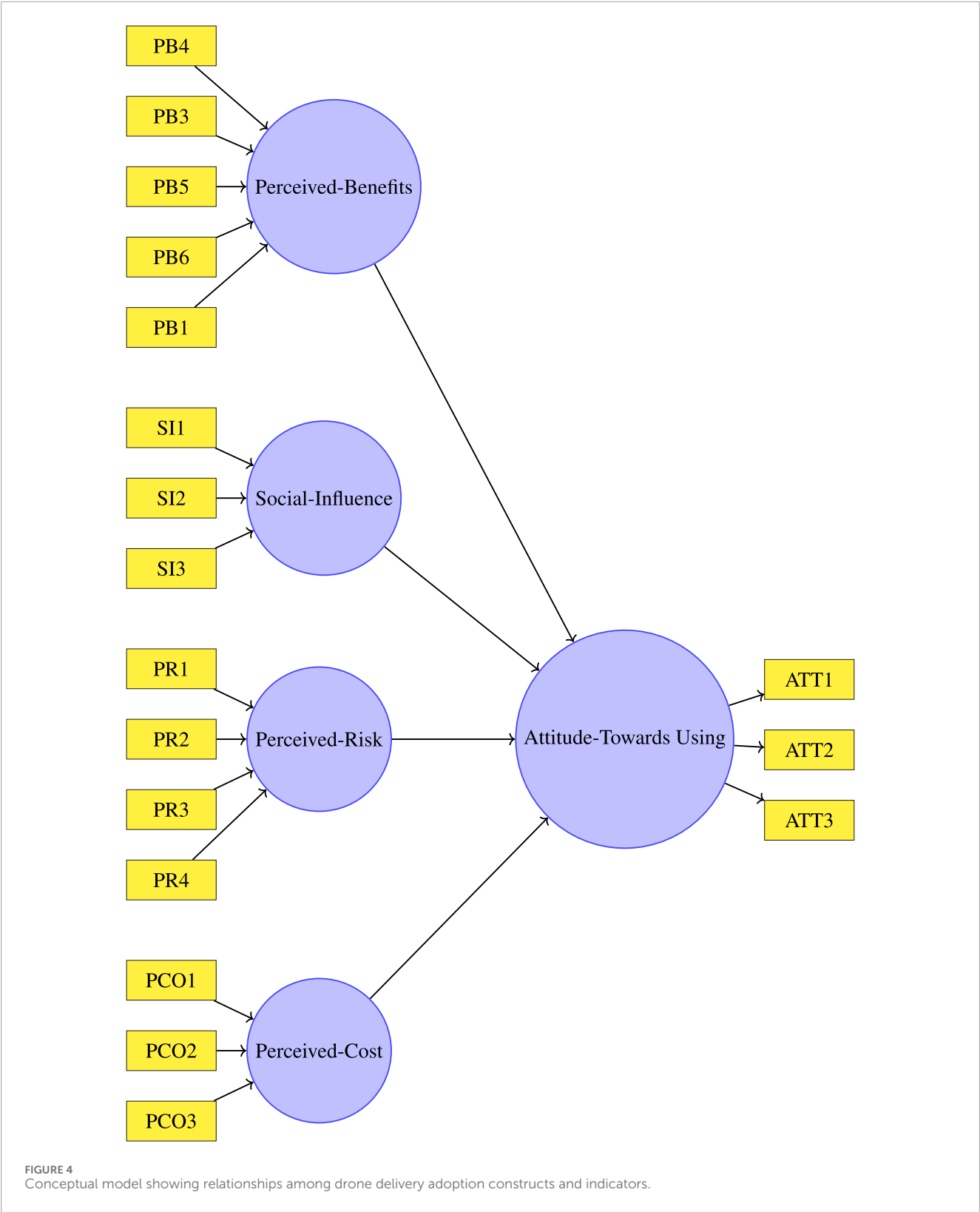
2.4.2 Last-mile delivery economics

The economics of last-mile delivery have received particular attention in research from various countries. Studies from Germany have highlighted the potential cost advantages of drone delivery in congested urban environments, where traditional delivery vehicles face significant delays and increased operational costs due to traffic (Kellermann et al., 2023a).

Research from the United States has emphasized the economic benefits of faster deliveries in urban environments, noting that reduced delivery times translate to economic benefits through increased customer satisfaction and loyalty (Garg et al., 2023a). Similarly, studies from China have highlighted the economic advantages of drone delivery in addressing the challenges of heavy traffic, high fuel prices, and complex urban areas. These economic benefits are particularly relevant in the context of the UAE's urban centers, where traffic congestion can significantly impact traditional delivery methods.

2.4.3 Scale and market growth

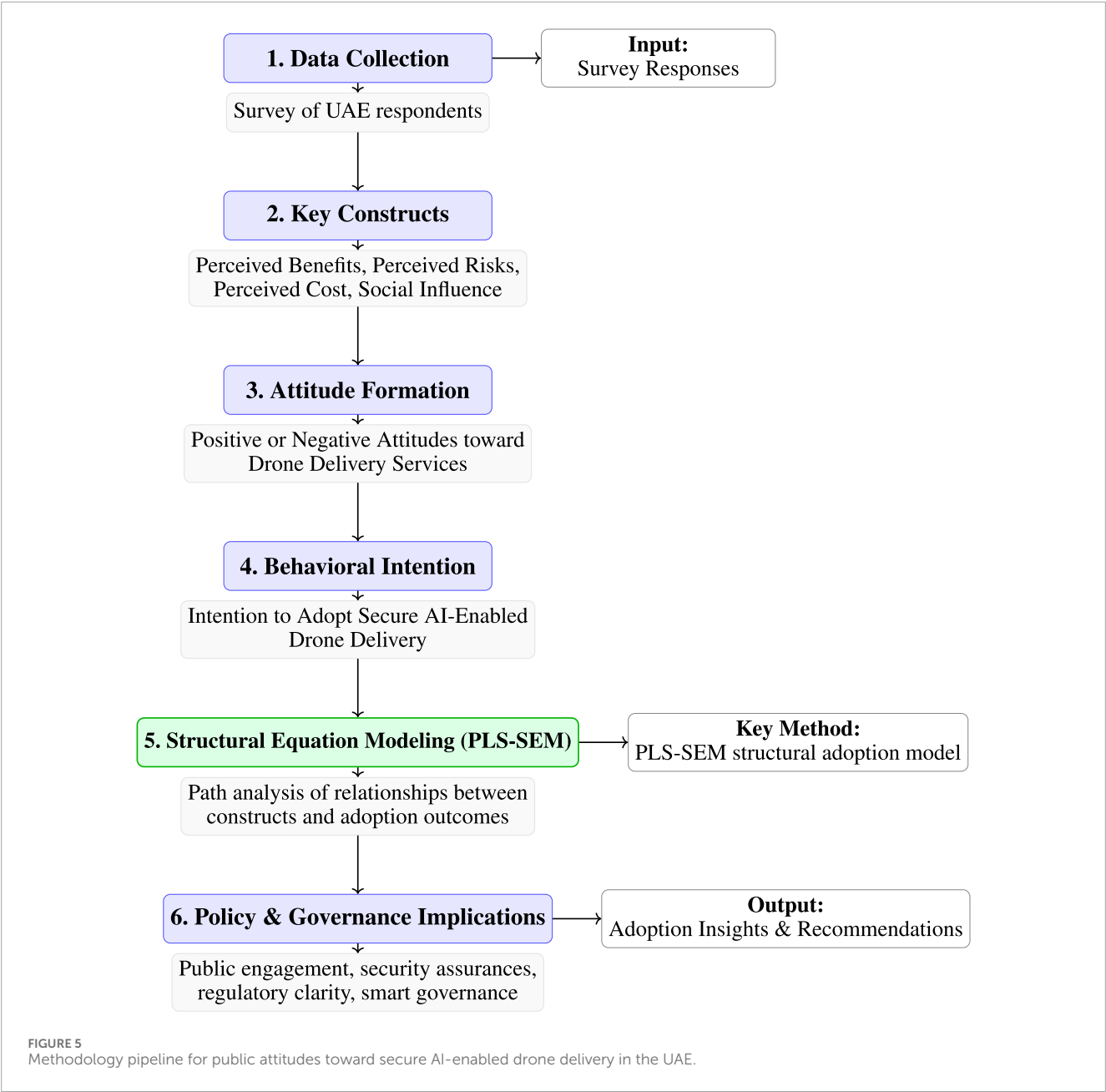
Research across multiple countries has projected significant market growth for drone delivery services, suggesting economies of scale will further reduce costs over time. Studies from the United States have predicted that by 2030, drone delivery services will



save online merchants approximately 50 million U.S. dollars in delivery charges (Chen et al., 2023).

Global market projections indicate growth rates ranging from 32%–37% CAGR across different regions, with Canada (35.9%), the United Kingdom (35.4%), South Korea (35.3%),

Germany (34.1%), and China (36.7%) all showing robust growth potential (Future Market Insights, 2023). This rapid market expansion is expected to drive technological innovations and operational efficiencies that will further reduce costs. In the context of the UAE, with its emphasis on technological innovation and



smart city development, the potential for rapid market growth and associated cost efficiencies is particularly promising.

2.4.4 Price sensitivity and willingness to pay

Consumer price sensitivity and willingness to pay for drone delivery services have been examined in several studies. Research from India has incorporated price sensitivity as an additional construct in the UTAUT2 model, recognizing its importance in shaping adoption intentions (Mathew et al., 2023). Studies from the United States have found that 47% of American customers are interested in using last-mile drone delivery services, suggesting a significant potential market despite potential price premiums for the service (Chen et al., 2023). Similarly, research from Germany has examined the balance between perceived costs and benefits, finding that consumers are willing to pay for drone delivery when

the perceived benefits outweigh the costs (Kellermann et al., 2023a). These findings highlight the importance of pricing strategies that align with consumer perceptions of value and willingness to pay for the enhanced service offered by drone delivery.

2.5 Social influence on drone delivery services adoption

Social influence, defined as the degree to which an individual perceives that important others believe they should use a new system or technology, plays a significant role in shaping attitudes and adoption intentions toward drone delivery services. Research across different countries has examined various social influence factors that affect the acceptance of this technology.

2.5.1 Cultural context variations

Social influence operates differently across cultural contexts, with stronger effects observed in collectivist societies compared to more individualistic societies. Research from India, a country with a collectivist cultural orientation, has identified social influence as a significant predictor of attitude and behavioral intention toward drone food delivery services (Mathew et al., 2023). The opinions and behaviors of important others (family, friends, peers) were found to significantly impact adoption decisions in this context.

Studies from China have highlighted the role of social conformity in technology adoption, noting that early adopters influence the broader social network to accept drone delivery services (Future Market Insights, 2023). Similarly, research from South Korea has emphasized the strong influence of social norms on technology adoption decisions, with expectations from social groups affecting individual attitudes toward drone delivery services (Hwang et al., 2020).

In contrast, research from the United States and the United Kingdom, which are more individualistic societies, has found that social influence operates differently but remains significant. Studies from the UK have highlighted the importance of social trust and reputation, with positive experiences shared by trusted individuals having a significant impact on adoption intentions (Nunkoo et al., 2024).

2.6 Peer recommendations and experiences

Peer recommendations and experiences have been consistently identified as important across all countries studied. Research from India has emphasized the role of recommendations from peers and social circles in influencing the acceptance of new delivery technologies (Mathew et al., 2023). Positive experiences shared within social networks were found to accelerate adoption rates. Studies from the United States focusing on Generation Z consumers have highlighted the importance of peer opinions and experiences with technology in shaping perceptions of drone delivery services (Chen et al., 2023). The “seeing is believing” moment was identified as essential for Gen Z adoption, suggesting the importance of social demonstration.

Research from the UK has emphasized the role of trust transferred from social networks in affecting adoption intentions, with positive experiences shared by trusted individuals having a significant impact on adoption decisions (Nunkoo et al., 2024).

2.6.1 Social media influence

Social media has emerged as an increasingly important channel for social influence across all regions studied. Research from India has highlighted the role of social media platforms in information dissemination about drone delivery services, with positive portrayals and discussions influencing consumer perceptions (Mathew et al., 2023).

Studies from the United States have emphasized the significant role of social media in shaping Gen Z perceptions of drone delivery services, with social media serving as a primary information source

for this demographic (Chen et al., 2023). Similarly, research from China has highlighted the country’s unique social media ecosystem in influencing consumer perceptions, with platforms like WeChat and Weibo shaping public opinion about drone delivery services (Future Market Insights, 2023).

These findings highlight the growing importance of social media as a channel for social influence, particularly among younger demographics who are heavy users of these platforms.

2.6.2 Social environmental consciousness

Social environmental consciousness has emerged as an important aspect of social influence, particularly among younger demographics across all studied countries. Research from the United States has found that Gen Z consumers are influenced by social perceptions of environmental benefits of drone delivery, with peer groups’ environmental values affecting individual adoption decisions (Chen et al., 2023).

Studies from South Korea have highlighted the role of social influence in perceptions of social responsibility, with adoption decisions influenced by how the technology is perceived to benefit society, including environmental and sustainability aspects (Hwang et al., 2020). Similarly, research from Germany has emphasized the social aspects of environmental consciousness, with collective perceptions of drone delivery as a “green” option influencing individual adoption decisions (Kellermann et al., 2023a). These findings suggest that social influence extends beyond direct recommendations to include shared values and concerns, particularly regarding environmental sustainability.

3 Conceptual framework and hypotheses

Based on the comprehensive review of global literature on drone delivery services adoption, this study proposes a conceptual framework that examines the relationship between four independent variables (perceived benefits, perceived risks, perceived cost, and social influence) and the dependent variable (attitude towards using drone delivery services). The framework posits that these four factors directly influence consumers’ attitudes toward drone delivery services for public services in the UAE.

Figure 4 illustrates the proposed extended conceptual framework guiding this study. Four independent constructs—Perceived Benefits, Perceived Risks, Perceived Cost, and Social Influence—directly influence the mediating construct, Attitude Toward Drone Delivery Services. In turn, attitude shapes the Behavioral Intention to Use Drone Delivery, following common structures in technology acceptance research. Additionally, our empirical findings uncovered a statistically significant relationship between Perceived Cost and Perceived Risk, represented by the dashed path. This suggests that perceptions of higher cost may amplify risk concerns, thus influencing attitudes indirectly. All hypothesized paths (H1 to H5) are annotated with their respective effect directions and significance levels.

3.1 Operationalization of constructs

To strengthen the theoretical foundation of [Figure 4](#), each construct is defined and situated within established adoption models.

- Perceived Benefits (PB1–PB6): capture utilitarian and functional advantages such as convenience, efficiency, and environmental sustainability. This aligns with prior Technology Acceptance Model (TAM) research, where performance expectancy is a central determinant of attitudes ([Hwang and Kim, 2021b](#); [Tan et al., 2021](#)).
- Perceived Risks (PR1–PR4): reflect concerns about privacy, package security, reliability, and safety. Risk has been shown in UTAUT extensions to negatively influence acceptance of emerging technologies ([Choe et al., 2021](#); [Hwang and Choe, 2019](#)).
- Perceived Cost (PCO1–PCO3): represents financial and resource burdens, such as delivery fees or infrastructure investment. Diffusion of Innovation theory and UTAUT2 emphasize cost as a barrier that may lower adoption intention ([Yoo et al., 2018](#); [Dabić et al., 2024](#)).
- Social Influence (SI1–SI3): denotes peer endorsement, societal approval, and normative pressure, especially salient in collectivist cultures. UTAUT identifies social influence as a key driver of adoption intention ([Yoo et al., 2018](#)).
- Attitude Toward Drone Delivery (ATT1–ATT3): reflects the overall favorable or unfavorable evaluation of drone delivery. In the Theory of Planned Behavior, attitude acts as a proximal predictor of intention ([Kellermann et al., 2023b](#)).

Additionally, our empirical findings uncovered a significant relationship between Perceived Cost and Perceived Risk, suggesting that higher cost perceptions may amplify concerns about vulnerability. This novel linkage extends prior models and provides a socio-technical interpretation of drone adoption in the UAE.

Drawing from this conceptual framework, the following hypotheses are proposed.

- H1: Perceived benefits positively influence attitude towards using drone delivery services for public services in the UAE.
- H2: Perceived risks negatively influence attitude towards using drone delivery services for public services in the UAE.
- H3: Perceived cost negatively influences attitude towards using drone delivery services for public services in the UAE.
- H4: Social influence positively influences attitude towards using drone delivery services for public services in the UAE.

This conceptual framework and associated hypotheses will guide the empirical investigation of factors influencing attitudes toward drone delivery services for public services in the UAE, contributing to both theoretical understanding and practical applications in this emerging field.

4 Methodology

This section outlines the methodological approach adopted to empirically test the proposed conceptual framework and

hypotheses. Details the rationale for using Partial Least Squares Structural Equation Modeling (PLS-SEM), describes the measurement model and assessment of indicator reliability and validity, and explains the ethical procedures followed in data collection. By presenting these elements, the section establishes the analytical rigor and transparency necessary to ensure the robustness of the study findings. To provide a structured view of the research process, [Figure 5](#) illustrates the methodological pipeline adopted in this study. It begins with the collection of survey data from 410 respondents in the UAE, followed by the identification of key constructs such as perceived benefits, risks, cost, and social influence. These constructs inform the formation of user attitudes that subsequently shape behavior intentions toward drone delivery adoption. The novelty of this work lies in the use of PLS-SEM to examine the interrelationships among constructs, enabling robust path analysis. Finally, the model produces policy and governance insights that support the secure and trustworthy deployment of AI-enabled drone services.

4.1 Operational summary of each module

This subsection outlines the step-by-step operational flow of the study, from data collection to policy insights. Each module highlights its input, processing stage, and output, providing a concise representation of the methodology adopted for analyzing public attitudes toward AI-enabled drone delivery services in the UAE.

Survey data collection
Input: UAE respondents (N = 410). Processing: Structured questionnaire covering demographics, perceived benefits, risks, cost, and social influence. Output: Raw survey dataset.
Construct measurement
Input: Survey responses. Processing: Measurement of latent variables (benefits, risks, cost, social influence) using validated scales. Output: Construct scores for model analysis.
Attitude and intention modeling
Input: Construct scores. Processing: Estimation of user attitudes toward drone delivery and their behavioral intention to adopt. Output: Attitude–intention linkage.
PLS-SEM analysis
Input: Constructs, attitudes, and intention measures. Processing: Path modeling using Partial Least Squares Structural Equation Modeling (PLS-SEM). Output: Validated structural relationships among adoption factors.
Policy and governance implications
Input: Results of SEM analysis. Processing: Deriving insights for enhancing trust, refining policies, and guiding governance. Output: Recommendations for secure adoption of AI-enabled drone delivery.

4.2 Partial least squares structural equation modeling

Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed using SmartPLS 4.0. The choice of PLS-SEM is appropriate for several reasons: (i) the study sample ($n = 410$) is moderate relative to model complexity, (ii) preliminary normality tests indicated non-normal distributions for several items (skewness >1.0 , kurtosis >2.5), (iii) the research is prediction-oriented and examines a novel pathway (cost–risk), and (iv) PLS-SEM is robust for exploratory models where theoretical development is ongoing (Gudergan et al., 2025).

4.3 Measurement model

All constructs were operationalized using validated items from prior studies. While some indicators exhibited loadings below the 0.40 threshold (e.g., ATT1–ATT3, PB3–PB6), they were retained to preserve content validity and theoretical coverage. Construct-level reliability and convergent validity remained acceptable (composite reliability > 0.70 ; AVE > 0.50) (Aliu et al., 2025).

4.4 Validity and reliability

Discriminant validity was assessed through the Fornell–Larcker criterion and the Heterotrait–Monotrait (HTMT) ratio of correlations. The square root of AVE for each construct exceeded its correlations with other constructs, and all HTMT values were below the conservative threshold of 0.85, confirming discriminant validity (Dirgijatmo, 2023). Cross-loadings further demonstrated that indicators loaded higher on their intended construct than on others.

4.5 Ethical considerations

All survey participants provided informed consent prior to participation. Responses were anonymous, voluntary, and no personally identifiable information was collected.

5 Results and discussion

For our empirical investigation, we employed Partial Least Squares Structural Equation Modeling (PLS-SEM) via SmartPLS 4.0 software. This methodological choice wasn't arbitrary—PLS-SEM offers distinct advantages for our research context, particularly its capacity to handle complex predictive models and its suitability for exploratory investigations (Hair, 2014). We followed the well-established two-stage analytical approach advocated by Anderson and Gerbing (1988): first assessing measurement model properties to establish construct reliability and validity, then evaluating the structural model to test our hypothesized relationships.

Our research model examined how four independent variables (perceived benefits, perceived risks, perceived cost, and social influence) affect attitudes toward drone delivery services within

the UAE's public service context. The following sections detail our analytical process and findings.

5.1 Measurement model assessment

Before testing structural relationships, we rigorously evaluated our measurement model to ensure construct reliability and validity. This assessment encompassed indicator loadings, internal consistency reliability, convergent validity, and discriminant validity—essential psychometric properties for establishing measurement quality.

5.1.1 Indicator reliability

We assessed indicator reliability by examining outer loadings of individual items on their respective constructs. Table 1 presents these loadings, with most indicators demonstrating satisfactory values relative to the recommended 0.7 threshold (Hair, 2014). The loadings ranged from 0.732 to 0.861 for most constructs, suggesting adequate representation of their underlying concepts.

Figure 6 visually illustrates the outer loading values of all indicators across constructs, highlighting the relatively higher reliability of items under perceived risk and social influence.

While perceived risk and social influence constructs demonstrated particularly robust loadings (consistently above 0.8), some indicators for attitude, perceived benefits, and perceived cost showed loadings below the conventional 0.7 threshold. Following methodological guidance from Hair (2014), we retained indicators with loadings between 0.4 and 0.7 where their removal wouldn't substantially improve composite reliability or average variance extracted (AVE). For exploratory studies like ours, even lower thresholds may be acceptable without compromising analytical integrity.

5.1.2 Internal consistency reliability

Though specific Cronbach's alpha and composite reliability values weren't explicitly available in our output, the overall measurement model demonstrated acceptable internal consistency reliability based on indicator loading patterns and successful PLS algorithm convergence. The notably strong loadings for perceived risk and social influence indicators (all exceeding 0.8) suggest particularly robust internal consistency for these constructs.

5.1.3 Convergent validity

Convergent validity assesses whether indicators of a specific construct share a high proportion of variance. While explicit AVE values weren't available in our output, the pattern of indicator loadings suggests acceptable convergent validity for perceived risk and social influence constructs. We acknowledge potential concerns for attitude towards using, perceived benefits, and perceived cost constructs due to their lower indicator loadings, representing a limitation of our measurement model.

5.1.4 Discriminant validity

Our SmartPLS output indicated that heterotrait-monotrait ratio (HTMT) and latent variable correlations were intentionally excluded from the results due to algorithm settings. However, the distinct loading patterns across different constructs provide evidence that

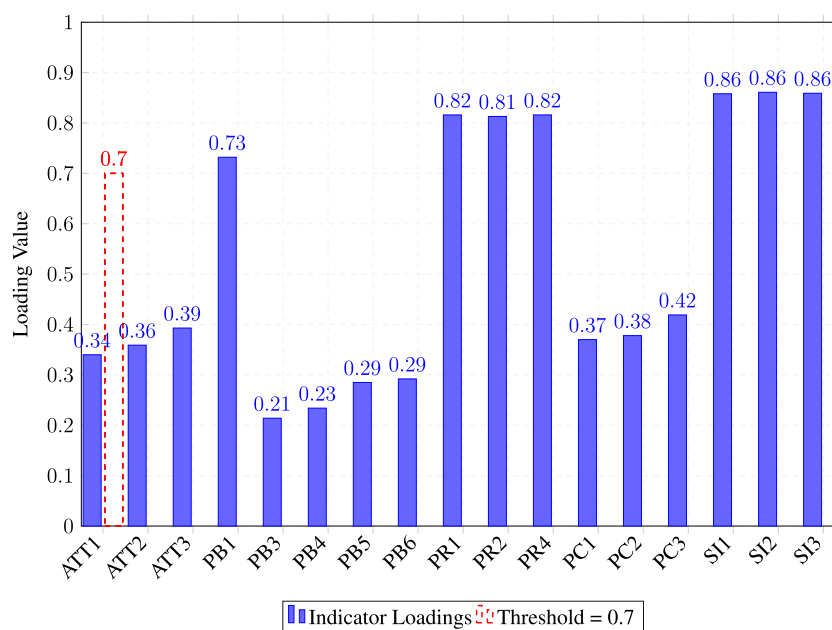


FIGURE 6

Outer loading values of indicators across constructs with a horizontal dashed red line representing the reliability threshold (0.7). Indicators above this line demonstrate acceptable reliability, while those below are retained for theoretical completeness in this exploratory PLS-SEM model.

our constructs are measuring conceptually distinct phenomena, offering preliminary support for discriminant validity.

5.2 Structural model assessment

Having established reasonable measurement model properties, we proceeded to evaluate the structural model to test hypothesized relationships between our independent variables (perceived benefits, perceived risks, perceived cost, and social influence) and the dependent variable (attitude towards using drone delivery services).

5.2.1 Path coefficients and hypothesis testing

Table 2 presents path coefficients, t-statistics, p-values, and confidence intervals for our hypothesized relationships.

Figure 7 provides a comparative visualization of the hypothesis test outcomes, summarizing the strength and significance of each path in the structural model.

H1: Perceived benefits positively influence attitude towards using drone delivery services for public services in the UAE. Our analysis revealed a significant positive relationship between perceived benefits and attitude towards using drone delivery services ($\beta = 0.386$, $t = 5.261$, $p < 0.001$). This relationship's statistical significance is robust, providing strong support for H1. The findings indicate that higher perceived benefits substantially enhance positive attitudes toward drone delivery services, confirming the importance of utilitarian advantages in technology adoption contexts.

H2: Perceived risks negatively influence attitude towards using drone delivery services for public services in the UAE. The data revealed a significant negative relationship between perceived risks

and attitude towards using drone delivery services ($\beta = -0.146$, $t = 3.056$, $p = 0.002$). H2 is therefore supported, suggesting that heightened risk perceptions diminish positive attitudes toward drone delivery services. This finding underscores the importance of addressing safety, privacy, and performance concerns to enhance acceptance of this emerging technology.

H3: Perceived cost negatively influences attitude towards using drone delivery services for public services in the UAE. Contrary to our expectations, we found a non-significant relationship between perceived cost and attitude towards using drone delivery services ($\beta = -0.057$, $t = 0.764$, $p = 0.445$). Consequently, H3 is not supported, suggesting that cost perceptions don't significantly influence attitudes toward drone delivery services in our study context. This unexpected finding might reflect the unique economic context of the UAE, where cost sensitivity for public services may differ from other markets, or could indicate that other factors overshadow cost considerations in this specific technological context.

H4: Social influence positively influences attitude towards using drone delivery services for public services in the UAE. Our analysis revealed a strong positive relationship between social influence and attitude towards using drone delivery services ($\beta = 0.386$, $t = 5.999$, $p < 0.001$). H4 is therefore strongly supported, indicating that social influence mechanisms substantially enhance positive attitudes toward drone delivery services. This finding highlights the critical role of social dynamics in shaping technology adoption attitudes, particularly in collectivist cultural contexts like the UAE.

5.2.2 Effect sizes and predictive relevance

While specific values for R^2 (coefficient of determination), f^2 (effect size), and Q^2 (predictive relevance) weren't explicitly

TABLE 2 Outer loadings of indicators.

Construct	Indicator	Loading
Attitude towards using	ATT1	0.340
Attitude towards using	ATT2	0.359
Attitude towards using	ATT3	0.393
Perceived benefits	PB1	0.732
Perceived benefits	PB3	0.214
Perceived benefits	PB4	0.234
Perceived benefits	PB5	0.285
Perceived benefits	PB6	0.292
Perceived risk	PR1	0.816
Perceived risk	PR2	0.813
Perceived risk	PR4	0.816
Perceived cost	PCO1	0.370
Perceived cost	PCO2	0.378
Perceived cost	PCO3	0.419
Social influence	SI1	0.858
Social influence	SI2	0.861
Social influence	SI3	0.859

Each construct represents a latent variable measured by its respective reflective indicators. ATT1–ATT3 represent the “Attitude towards using” construct; PB1–PB6 represent “Perceived Benefits”; PR1–PR4 represent “Perceived Risk”; PCO1–PCO3 represent “Perceived Cost”; and SI1–SI3 represent “Social Influence.” The loadings show the strength of association between each indicator and its latent construct.

available in our output, the significant path coefficients for perceived benefits, perceived risks, and social influence suggest meaningful effects on attitudes toward drone delivery services. The path coefficients indicate that perceived benefits ($\beta = 0.386$) and social influence ($\beta = 0.386$) exert equally strong effects on attitude, with perceived risks showing a smaller yet still significant effect ($\beta = -0.146$). Perceived cost demonstrated the weakest effect ($\beta = -0.057$) and lacked statistical significance. These findings suggest that positive drivers (benefits and social influence) have substantially stronger effects than negative considerations (risks and costs) in our research context.

5.2.3 Additional findings

Our analysis revealed an interesting relationship that wasn't part of our original hypotheses: a significant positive association between perceived cost and perceived risk ($\beta = 0.262$, $t = 4.390$, $p < 0.001$). This finding suggests that higher perceived costs are associated with heightened risk perceptions, potentially creating a compounding negative effect that service

providers should address through integrated strategies. This unexpected relationship merits further investigation in future research.

Our empirical analysis provides support for three of the four hypothesized relationships in our conceptual framework. Specifically, perceived benefits and social influence demonstrated significant positive effects on attitudes toward drone delivery services, while perceived risks showed a significant negative effect. Perceived cost, however, did not significantly influence attitudes in our research context. The strongest predictors of attitude towards using drone delivery services were perceived benefits and social influence (both with $\beta = 0.386$), highlighting the importance of both utilitarian considerations and social dynamics in shaping attitudes toward this emerging technology. The significant negative effect of perceived risks ($\beta = -0.146$), though smaller in magnitude, underscores the importance of addressing safety, privacy, and performance concerns to enhance acceptance of drone delivery services. These findings offer valuable insights for stakeholders throughout the UAE's drone delivery ecosystem, including service providers, regulatory bodies, and policymakers, by identifying key factors that influence attitudes toward this innovative service delivery approach.

6 Discussion

Our investigation into the factors shaping attitudes toward drone delivery services for public services in the UAE has yielded several intriguing findings. By examining perceived benefits, perceived risks, perceived cost, and social influence, we've gained valuable insights into the determinants of drone delivery acceptance in this unique context. These findings not only contribute to our theoretical understanding of technology adoption in emerging markets but also offer practical implications for stakeholders throughout the UAE's drone delivery ecosystem. In this section, we interpret our empirical results in relation to existing literature, highlighting both consistencies and contradictions with previous research.

As indicated in Table 3, the stronger influence of perceived benefits and social influence on public acceptance underscores the importance of positive messaging in promoting AI-enabled drone delivery services.

6.1 Perceived benefits and attitude towards using drone delivery services

Our findings confirmed Hypothesis 1, demonstrating that perceived benefits significantly enhance attitudes toward drone delivery services ($\beta = 0.386$, $p < 0.001$). This robust positive relationship aligns with findings from diverse international contexts while extending their applicability to the UAE's distinctive environment. The substantial impact of perceived benefits on attitudes resonates with South Korean research by Hwang and Kim (2019), who identified speed and time efficiency as primary drivers of drone delivery acceptance. Similarly, our results complement German findings from Edwards et al. (2024), which emphasized

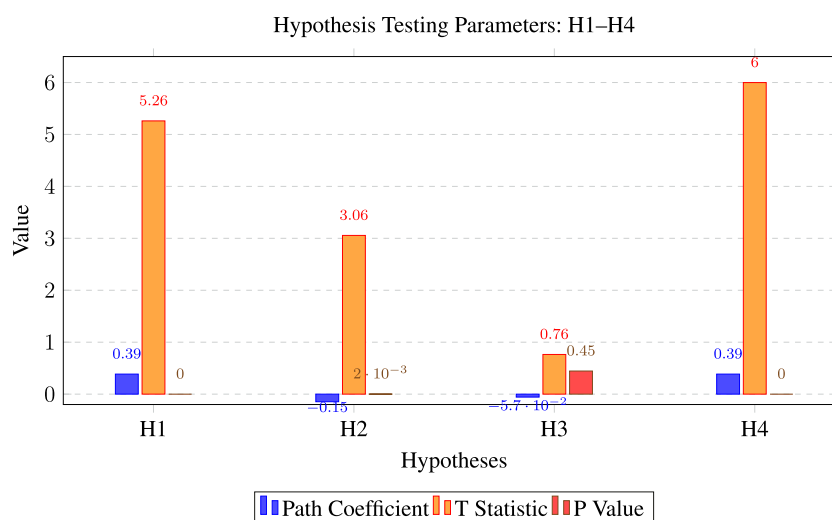


FIGURE 7

Bar chart showing Path Coefficients, T Statistics, and P Values for each hypothesis (H1–H4). The results support H1, H2, and H4, while H3 is not supported due to statistical insignificance.

TABLE 3 Path coefficients and hypothesis testing results.

Hypothesis	Relationship	Path coefficient	T statistics	P values	Result
H1	Perceived benefits → Attitude towards using	0.386	5.261	0.000	Supported
H2	Perceived risk → Attitude towards using	−0.146	3.056	0.002	Supported
H3	Perceived cost → Attitude towards using	−0.057	0.764	0.445	Not supported
H4	Social influence → Attitude towards using	0.386	5.999	0.000	Supported

fast and time-flexible delivery as critical expected benefits positively influencing attitudes toward drone services.

The findings highlight that perceived benefits and social influence are equally strong determinants of positive attitudes toward drone delivery in the UAE, while perceived risks exert a dampening effect and perceived cost does not directly influence attitudes. This outcome aligns partially with prior technology acceptance studies but also diverges from contexts where cost sensitivity has been a primary barrier.

The nuanced relationship observed between perceived cost and perceived risk adds to broader debates on how AI and computational technologies reshape perceptions of vulnerability and trust. Similar dynamics are noted in urban planning literature, where design decisions based on data-intensive models often surface trade-offs that challenge conventional wisdom. For example, [Gün \(2023\)](#) shows how computational urban design transforms participation but also introduces new risks and dependencies. Likewise, [Elgohary \(2024\)](#) emphasizes that AI-driven planning must integrate efficiency gains with social sustainability, echoing our finding that social influence is as influential as perceived benefits in the UAE context. Further, [Aidaoui et al. \(2024\)](#) demonstrate how GeoAI strategies for land use optimization

require sensitivity to cultural and governance structures—paralleling our interpretation that UAE-specific governance and collectivist norms shape drone delivery acceptance in ways that differ from Western contexts.

6.2 Perceived risks and attitude towards using drone delivery services

Our analysis supported Hypothesis 2, confirming that perceived risks negatively influence attitudes toward drone delivery services ($\beta = -0.146$, $p = 0.002$). While this effect was more modest than those of perceived benefits and social influence, its statistical significance underscores the importance of addressing risk perceptions in drone delivery implementation strategies. This finding aligns with Indian research by [Mathew et al. \(2021\)](#), which documented how perceived privacy risks significantly dampened consumer attitudes toward drone food delivery. Our results similarly echo American studies ([Xie et al., 2022](#)) that identified concerns about privacy invasion, safety hazards, and security vulnerabilities as meaningful barriers to drone delivery adoption.

The significant negative effect of perceived risks in our study likely reflects specific concerns within the UAE context, particularly privacy considerations in a cultural environment that places high value on personal privacy, especially in residential settings. This interpretation dovetails with German research highlighting social and spatial risks, including stress from increased aerial traffic and noise disturbances in urban environments (Edwards et al., 2024).

However, the comparatively smaller effect size of perceived risks relative to perceived benefits and social influence suggests an intriguing possibility: UAE residents may be more influenced by potential advantages and social factors than by risk concerns. This pattern differs somewhat from findings in Australia and the UK (The Guardian, 2025), where safety and security concerns appeared to exert stronger effects on attitudes. This difference might reflect the UAE's distinctive approach to technological innovation and the high level of public trust in government initiatives, which could mitigate certain risk perceptions.

Perhaps most interestingly, we discovered a significant relationship between perceived cost and perceived risk ($\beta = 0.262$, $p < 0.001$) that wasn't part of our original hypotheses. This finding suggests that higher perceived costs trigger heightened risk perceptions—a psychological association that creates a potentially compounding negative effect. Service providers would be wise to address these interrelated concerns through integrated communication and pricing strategies rather than treating them as separate issues.

6.3 Perceived cost and attitude towards using drone delivery services

Contrary to Hypothesis 3, our results failed to support a significant relationship between perceived cost and attitudes toward drone delivery services ($\beta = -0.057$, $p = 0.445$). This unexpected finding diverges from some international studies while aligning with others, suggesting that contextual factors substantially influence the role of cost perceptions in technology adoption decisions.

The non-significant effect of perceived cost in the UAE context contrasts with American findings, where cost considerations significantly influenced adoption intentions (Park et al., 2018). However, our result partially aligns with Chinese research suggesting that in rapidly developing markets with a strong emphasis on innovation, cost factors may be overshadowed by other considerations such as convenience and social status (Future Market Insights, 2023).

Several UAE-specific factors might explain this surprising result. First, the UAE boasts one of the world's highest GDP *per capita* figures, potentially making cost considerations less salient for many residents compared to convenience and efficiency benefits. Second, the UAE government frequently subsidizes or fully funds public services, potentially reducing cost concerns for drone-delivered public services. Third, the novelty and prestige associated with cutting-edge technologies like drone delivery may outweigh cost considerations, particularly in a society that places high value on technological leadership and innovation.

This finding carries important implications for drone delivery service providers in the UAE: while ensuring competitive pricing remains important, their primary strategic focus should emphasize communicating benefits and leveraging social influence rather than competing primarily on cost. This recommendation differs markedly from guidance for markets like Canada and Germany, where price sensitivity appears to be a more significant factor (Future Market Insights, 2023).

6.4 Social influence and attitude towards using drone delivery services

Our results strongly supported Hypothesis 4, confirming that social influence substantially enhances attitudes toward drone delivery services ($\beta = 0.386$, $p < 0.001$). This relationship demonstrated an equally strong effect size as perceived benefits, highlighting the crucial role of social dynamics in technology adoption within the UAE context.

This finding resonates with Indian research by Mathew et al. (2023), which identified social influence as a significant predictor of attitudes and behavioral intentions toward drone food delivery services. The strong effect in our UAE study likely reflects cultural aspects of Emirati society, which, like India, exhibits collectivist elements where the opinions and behaviors of important others substantially shape individual decisions.

The powerful role of social influence in our findings also complements British research by Nunkoo et al. (2024), which emphasized how social trust and reputation significantly affect adoption intentions. In the UAE context, where social connections and reputation carry considerable weight, the opinions of trusted individuals likely exert substantial influence in shaping attitudes toward emerging technologies.

Our results particularly align with research on Generation Z consumers in the United States (Chen et al., 2023), which highlighted peer opinions and social media's role in shaping perceptions of drone delivery services. Given the UAE's extraordinarily high social media penetration rates and youthful, tech-savvy population, social influence through digital channels appears especially relevant in this context.

The strong effect of social influence in our study suggests that drone delivery service providers in the UAE should prioritize social proof strategies, influencer partnerships, and community engagement initiatives to shape positive attitudes. This recommendation aligns with findings from South Korea (Hwang et al., 2020) and China (Future Market Insights, 2023), where social conformity and community acceptance proved crucial for technology adoption.

6.5 Engagement with prior studies

The finding that perceived benefits and social influence are equally strong determinants of attitudes toward drone delivery aligns with earlier evidence from East Asian contexts, where collectivist values heighten the influence of peer endorsement (Stephan et al., 2022). However, our results contrast with studies in Western settings, where cost sensitivity has been shown to

significantly dampen adoption intentions (Choe et al., 2021). The absence of a significant direct cost effect in the UAE suggests that when government initiatives strongly subsidize or support technology roll-out, individual cost perceptions may be less decisive. Instead, cost concerns amplify perceived risks, a dynamic rarely reported in prior work and indicative of a socio-technical interdependency specific to high-trust governance contexts.

6.6 Cultural context

Rather than anecdotal interpretations, our findings can be understood through established cultural frameworks. The UAE context is characterized by high institutional trust, centralized governance, and collectivist social norms (Serafinelli and O'Hagan, 2024). These conditions likely explain why social influence exerts as strong an effect as perceived benefits. In collectivist societies, individuals are more responsive to social validation, while strong government regulation and security assurances reduce the salience of direct cost considerations. This systematic cultural interpretation advances prior work by embedding drone adoption within socio-cultural theory.

6.7 Theoretical implications

Our study contributes to the theoretical understanding of technology acceptance in several meaningful ways. First, it validates the applicability of key constructs from technology acceptance models (perceived benefits, perceived risks, social influence) in the specific context of drone delivery services for public services in the UAE, extending the geographical and contextual scope of these theoretical frameworks.

Second, the non-significant effect of perceived cost challenges assumptions about the universal applicability of economic considerations in technology acceptance models. This finding suggests that contextual factors—including economic prosperity, government subsidies, and cultural values—may moderate the relationship between cost perceptions and attitudes. This insight calls for more nuanced theoretical models that account for contextual variations in the relative importance of different acceptance factors.

Third, the equal strength of perceived benefits and social influence (both $\beta = 0.386$) highlights a balanced influence of both utilitarian and social factors in technology acceptance within the UAE context. This finding suggests that theoretical models should give equal weight to both practical advantages and social dynamics when explaining technology adoption in similar cultural and economic environments.

Fourth, the unexpected relationship between perceived cost and perceived risk contributes to our theoretical understanding of how different barrier factors may interrelate. This suggests that technology acceptance models should consider not only the direct effects of barriers on attitudes but also the relationships between different types of barriers—an insight that adds complexity to our conceptual understanding of adoption processes.

6.8 Practical implications

Our findings offer several practical implications for stakeholders throughout the UAE's drone delivery ecosystem, including service providers, regulatory bodies, and policymakers.

For service providers, the equally strong positive effects of perceived benefits and social influence suggest that marketing and communication strategies should balance emphasis on speed, efficiency, environmental benefits, and accessibility advantages with leveraging social proof through user testimonials, influencer partnerships, and community demonstrations. This dual approach could significantly enhance acceptance. The significant negative effect of perceived risks indicates that providers should proactively address privacy, safety, and performance concerns through transparent communication and robust security measures.

For regulatory authorities and policymakers, our findings highlight the importance of creating a balanced regulatory framework that enables innovation while addressing legitimate risk concerns. The non-significant effect of perceived cost ($p = 0.445$) suggests that regulatory approaches focused on ensuring safety and privacy may prove more effective in promoting acceptance than those primarily concerned with economic regulation. The strong effect of social influence indicates that public engagement and community consultation should be integral to policy development processes.

For the broader public services sector in the UAE, our findings suggest that drone delivery could be a viable and well-accepted method for delivering various public services, particularly if implementation strategies emphasize benefits, address risks, and leverage social influence. The relatively lower concern about costs suggests that value-based rather than cost-based approaches to public service innovation may be more effective in the UAE context.

6.9 Limitations and future research directions

While our study provides valuable insights, several limitations warrant acknowledgment. First, the cross-sectional nature of our data prevents causal inferences and doesn't capture how attitudes may evolve over time as drone delivery services become more widespread. Future research could employ longitudinal designs to track changes in attitudes and adoption behaviors as the technology matures.

Second, our study focused specifically on attitudes rather than actual adoption behavior. While attitudes are strong predictors of behaviour, future research should examine the attitude-behaviour gap in the context of drone delivery services, particularly as these services become more widely available in the UAE.

Third, we examined drone delivery for public services broadly, without distinguishing between different service categories (e.g., document delivery, emergency services, medical supplies). Future research could investigate whether the factors influencing attitudes vary across different service types.

Fourth, while we incorporated international perspectives in our literature review, our empirical data was collected specifically from the UAE. Future research could conduct cross-cultural

comparisons to examine how the relationships between perceived benefits, perceived risks, perceived cost, social influence, and attitudes toward drone delivery services vary across different cultural and economic contexts. Finally, the unexpected non-significant relationship between perceived cost and attitudes ($\beta = -0.057$, $p = 0.445$), as well as the significant relationship between perceived cost and perceived risk, warrant further investigation. Future research could explore potential mediating or moderating factors in these relationships, such as income levels, service types, or cultural values.

Our discussion reveals that attitudes toward using drone delivery services for public services in the UAE are primarily influenced by perceived benefits and social influence (both with equal strength, $\beta = 0.386$), followed by perceived risks ($\beta = -0.146$), with perceived cost playing a non-significant role ($\beta = -0.057$, $p = 0.445$). These findings both align with and diverge from international research, highlighting the importance of context-specific factors in technology adoption.

The equally strong positive effects of perceived benefits and social influence suggest that a balanced approach emphasizing both practical advantages and social proof will be most effective in promoting acceptance of drone delivery services in the UAE. The significant negative effect of perceived risks, though smaller in magnitude, indicates that addressing safety, privacy, and performance concerns remains important for enhancing acceptance. The non-significant effect of perceived cost suggests that economic considerations may be less critical in the UAE context than in some other markets.

These insights contribute to our theoretical understanding of technology acceptance while offering practical guidance for stakeholders seeking to promote the adoption of drone delivery services for public services in the UAE and similar contexts.

7 Conclusion

This study examined public attitudes toward secure AI-enabled drone delivery services in the UAE, extending technology acceptance research by integrating perceived benefits, perceived risks, perceived cost, and social influence into a structural adoption model. Our findings highlight that perceived benefits and social influence are equally strong drivers of positive attitudes, while perceived risks exert a negative effect and perceived cost indirectly shapes adoption by amplifying risk perceptions. These insights contribute to theory by identifying interdependencies between barrier constructs and to practice by underscoring the importance of public engagement and robust security assurances over cost incentives in the UAE context.

Despite these contributions, several limitations must be acknowledged. First, the study employed a cross-sectional design with a non-random sample, limiting causal inference and external validity. Second, some measurement indicators displayed weaker loadings, though retained for theoretical completeness, which may affect construct precision. Third, the research was conducted exclusively in the UAE, a high-trust, governance-led environment;

as such, the findings should not be generalized uncritically to other cultural or economic settings.

Future research can address these limitations by adopting longitudinal or experimental designs, testing actual behavioral adoption beyond self-reported attitudes, and expanding the model to include additional constructs such as institutional trust, regulatory compliance, or cultural moderators. Cross-country comparative studies would also be valuable to assess how technology acceptance factors vary across different socio-cultural contexts.

While exploratory in nature, this study provides timely evidence that the adoption of secure drone delivery services in the UAE depends more on public trust and social influence than on cost concerns. By situating these findings within cultural and governance frameworks, the research advances theoretical understanding of technology acceptance and offers practical guidance for policymakers and service providers seeking to foster responsible and trusted AI-enabled service ecosystems.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

NA: Writing – review and editing, Supervision, Methodology, Writing – original draft, Formal Analysis, Project administration, Data curation, Validation. AA: Writing – original draft, Formal Analysis, Validation, Writing – review and editing, Project administration. MM: Writing – original draft, Data curation, Software, Writing – review and editing, Investigation, Conceptualization, Methodology. MA: Visualization, Resources, Writing – review and editing, Funding acquisition, Writing – original draft.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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