Journal of Business Research 191 (2025) 115251

Contents lists available at ScienceDirect

Journal of Business Research

journal homepage: www.elsevier.com/locate/jbusres

Social, economic, and environmental implications of drones in marketing: A framework of safeguards for sustainable technology implementation

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ARTICLE INFO

Keywords:
Sustainability
Technology
Commercial drones
Unmanned aerial vehicle
UAV
Qualitative research

ABSTRACT

Emerging technologies in marketing can bring sustainability benefits but can also cause harms to the environment, the economy, and society. To better realize global sustainability goals, this empirically grounded study contributes a framework of safeguards for technologies in marketing. Focusing on the increasingly prevalent technology of commercial aerial drones, the authors employed inductive research involving a fully qualitative survey of 240 commercial drone experts, marketing professionals, and the general public to explore the sustainability implications of commercial drones. The findings reveal that commercial drones are linked to a range of benefits and harms, and that three groups of safeguards – technical safeguards, policy safeguards, and inclusive public safeguards – could create value by reducing the possible harms and bolstering the benefits of commercial drones in marketing.

1. Introduction

Marketing academics increasingly seek to create value not only for customers but also for society at large. As a result, sustainability is becoming a central focus in marketing, especially as it pertains to consumer behavior and company actions. Technology is known to play a key role in achieving sustainability outcomes, yet research on sustainability in marketing has largely overlooked the impact of technological developments (Lim, 2016). Researchers are therefore called upon to identify and understand the wider implications of new technologies (Hoffman et al., 2022), including negative ones (van Doorn et al., 2017; Grewal et al., 2020a; Hoyer et al., 2020) in order to create value for customers and society. Value, from a marketing perspective, is the perceived benefits versus the consequences (including costs and risks) associated with a product or service (Woodside et al., 2008). As Hoffman et al. (2022) recently asked: "How can we identify the public risks that new marketing technologies carry, and how should society manage those risks?" (p. 5). This is a key gap in marketing knowledge that we seek to fill.

One way forward is to identify safeguards (Foxman & Kilcoyne, 1993) – or actions to prevent unwanted outcomes while promoting desirable ones. A safeguard approach can enhance benefits for customers and society, reduce negative consequences, and drive marketing value. In this paper, we take a sustainability-centric approach to identifying safeguards that address the implications of technology and enhance value. The study answers the question: What sustainability safeguards can help create value in marketing by strengthening benefits of technologies while reducing potential drawbacks for customers and society? This research therefore contributes to the intersection of technology, sustainability, and marketing.

In answering this question, we focus on the under-theorized and under-researched technology of commercial drones. Drones, also referred to as unmanned aerial vehicles or service robots, are "system-based autonomous and adaptable interfaces that interact, communicate and deliver services" (Wirtz et al., 2018, p. 909). Marketing research on commercial drones is only just emerging while, at the same time, applied uses of commercial drones abound. Organizations are being encouraged to explore drone use (Raj et al., 2022) and many global organizations are already doing so: Walmart, Amazon, BBC, Alphabet, Meta, Uber, Intel and Disney all use drones (CB Insights, 2019) and the United Nations' World Food Programme (2024) uses drones to deliver humanitarian aid and to support disaster responses. The global commercial drone market was valued at over $6 billion in 2021, with estimates that it will grow to nearly $50 billion by 2029 (Fortune Business Insights, 2022).

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https://doi.org/10.1016/j.jbusres.2025.115251
Received 22 January 2024; Received in revised form 10 February 2025; Accepted 11 February 2025
Available online 22 February 2025

Given their versatile abilities, drones have tremendous potential to contribute to sustainable transportation and infrastructure, including the United Nation's Sustainable Development Goals (SDGs) (United Nations, 2024). The SDGs aim to foster a more sustainable future and specifically identify the need to create sustainable infrastructure by employing environmentally-sound technologies and realizing sustainable transportation (United Nations, 2024) – such as through the use of drones. Sustainable transport would provide for the safe and efficient movement of people and goods while also contributing to other goals, such as combatting climate change and reducing inequality, and thereby creating more value. Yet, current progress is insufficient, as accessibility, road safety, and carbon emissions remain major issues (United Nations, 2021).

Although business research lags behind practical uses of drones, the early research on drones identifies their potential importance with respect to sustainability, with calls to explore the sustainability of drones (Rejeb et al., 2023). Marketing scholarship also needs to explore and "explain why and how marketing contributes to bad societal outcomes" (Chandy et al. 2021, p. 4), towards enabling marketing actions that create value not only for customers, but also society. Beninger and Robson (2020) suggest drones can have far reaching implications for the triple bottom line of social, environmental, and economic factors, and note that drones in marketing bring a complex array of benefits and harms to society. Understanding the ways in which drones – and other technologies in marketing – contribute to, or detract from, value is needed.

To enrich marketing theory related to sustainability-centric implications of technology and to answer calls to explore the phenomena of commercial drones, we engaged in research employing fully qualitative surveys involving three groups: marketing professionals, experts from commercial drone companies, and the general public. Our inductive analysis of the qualitative data revealed emergent theory, specifically a theoretical framework of safeguards to mitigate potential harms while realizing benefits of drones, or other technologies, in marketing. The paper makes two contributions. First, it provides much needed and timely insights into the sustainability implications – both the harms and the benefits – of commercial drones. Second, this study builds on a seminal work in marketing focused on technology safeguards for privacy (Foxman & Kilcoyne, 1993) by providing an expanded and enriched novel theoretical framework of three sustainability safeguards related to modern technology in marketing.

2. Sustainability and safeguards of technology in marketing

A sustainable marketing strategy presupposes the use of technology to create value in marketing activities and sustain a competitive advantage while also contributing to sustainability in the world (Tollin & Christensen, 2019). Lim (2016) suggests technology should be included when considering the social, economic, and environmental dimensions of sustainability in marketing, and that wise use of technology is needed. Importantly, technology is a double-edged sword – for example, it can provide sustainable infrastructure, but it can also harm the natural environment – prompting the need to conduct research on these tradeoffs and the overall impact of technology on sustainability (Al-Emran & Griffy-Brown, 2023). As others have noted, marketing scholarship benefits from insights into how technologies impact customers and the world beyond (Plangger et al., 2022).

Research at the nexus of marketing and sustainability has focused on companies and customers, with suggestions that companies can implement technologies to become more sustainable (Kemper & Ballantine, 2019). As Ramirez (2013) notes, many firms are adopting a 'sustainability orientation' in which diverse perspectives are integrated as part of the firm's quest to conduct their business in a sustainable way. Indeed, organizations are increasingly focusing on sustainability as it is seen as a way to not only attract consumers, but also to extract innovation benefits (see Gil-Saura et al., 2023). Sustainability-oriented innovation (SOI) has recently been connected to marketing thought (Gil Saura et al., 2024; Ahmad et al., 2024); SOI "involves making intentional changes to an organization's philosophy and values, as well as to its products, processes or practices, to serve the specific purpose of creating and realizing social and environmental value in addition to economic returns" (Adams et al., 2016, p. 181).

In their systematic review of literature on SOI, Adams et al. (2016) identified three dimensions of SOIs – technical/people, stand-alone/integrated, and an insular/systemic dimension. To create sustainable businesses, there should be a movement towards taking a people, integrated, and systemic perspective. Regarding technical versus people, the dominant focus in literature is the technical aspect, in which innovation is focused on products and how they are used, with only recent works taking a people-oriented perspective (Adams et al., 2016). The stand-alone versus integrated dimension reflects whether SOI is a separate activity or is imbedded as a strategic firm behaviour, the latter being an increasing focus. The insular versus systemic dimension reflects whether innovations are focused internally on firms themselves, or on the wider socio-economic system. As Gil-Saura et al. (2023) articulate, there is a need for SOI research in marketing – which is in its infancy – to take such a systemic approach, rather than a more insular one. Recently, Little et al. (2023) proposed that SOI be defined as "the process of developing and diffusing (i.e., implanting) new or improved social or technological knowledge that transforms current systems of production and consumption, supporting the long-term well-being of all stakeholders and ecosystems" (p. 7). SOI can shift the focus from how firms and consumers use technology towards how technology can create value for the planet and people into the future, thus extending beyond existing firm- and technology-centric views (Little et al., 2023). Little et al. (2023) demonstrated this approach by uncovering social, economic, and environmental aspects in food production, with future research needed in SOI.

While there is an urgent need to understand the sustainability implications of technologies, research in marketing must also "provide more clarity with regard to when the outcomes might be augmented or mitigated, in ways both beneficial and potentially detrimental" (Grewal et al., 2020b, p. 7). Al-Emran and Griffy-Brown (2023) made similar conclusions from their bibliometric analysis of 1134 articles at the nexus of technology acceptance/adoption and sustainability by concluding that research is needed on the impact of technology on sustainability towards bolstering positive – and minimizing negative – impacts. In other words, marketing has a knowledge gap regarding implementing technologies in a sustainable way.

If we are to understand how SOI can be used to transform consumption and how marketing can use technology to create social, economic, and environmental value, we must identify comprehensive safeguards that can be used to maximize the benefits of technologies while minimizing their harms. Such guidance would offer both practical suggestions as well as conceptual insights with which to further explore the intersection of technology and sustainability in marketing and could be used to support the systemic integration of SOI into business activities. Despite its importance, we lack comprehensive sustainability safeguards for technology use in marketing to help bolster value by mitigating consequences. Past scholarship has provided insights into some concerns that may need safeguarding against, often focused on economic considerations in the company-customer dyad and, less frequently, on the social concern of customer privacy. Grewal et al. (2020b) conceptualized a technology-marketing framework that highlights two company benefits (big data access and improved customer experience) and two concerns (privacy and information security), yet lacked attention to potential safeguards. Regarding the former, seminal work has provided insights on how companies can adopt a technology strategy towards achieving economic goals (e.g., Capon & Glazer, 1987; John et al., 1999) but lacks attention on wider sustainability goals. Regarding the latter, a large body of work has focused on the implications of technology for consumers (e.g., Osburg, 2022; Mele & Russo-

Spena, 2022).

In a rare focus on safeguards, Foxman and Kilcoyne (1993) theorized safeguards specifically related to consumer privacy when using information technology in marketing. The safeguards described government-mandated safeguards (U.S.A. federal and state legal protections), marketer-originated safeguards (specific industry guidelines and company policies), consumer strategies (specific behaviors consumers could take to avoid privacy infringements), and also briefly noted that technologies (caller identification and blocking) could be used to protect privacy. To build on this, safeguards beyond those related to privacy should be identified and developed; such an endeavor must encompass a broader sustainability perspective regarding modern technology in marketing. We suggest that approaching technology use and safeguards in marketing with a sustainability-centric perspective is needed and timely, and that commercial aerial drones are extremely well suited to provide the basis for developing such a framework.

Drones are uniquely poised to assist in conceptualizing safeguards related to technology in marketing for two main reasons. First, literature reveals that drones are extremely versatile in their use (Hwang et al., 2019). Across a wide range of industries, they are used in internal operations (e.g., in warehouses and stores to carry products and monitor inventory), in business-to-business services (e.g., surveying, media production, and security) and in business-to-consumer services (e.g., product delivery, window washing, and photography). One outcome of their versatility is that they impact a large number of stakeholders, including customers and society at large, and have wide-ranging sustainability impacts (Beninger & Robson, 2021). Another outcome of their versatility is that drones increasingly influence experiences outside of organizational contexts because they cross into personal and private spheres (van Doorn et al., 2017) and leave typical consumption settings (e.g., stores). This is evident in how drones can fly over forests, public parks, private homes, and buildings. Such varied uses and use contexts can provide a range of benefits but could also pose potential harms to social (e.g., private homes) and environmental (e.g. forests) sustainability, which could impact value for customers and society at large. Overall, the versatility of drones makes them well suited to informing our understanding of a broad set of sustainability implications and related comprehensive safeguards.

Second, drones have overlapping capabilities (and therefore implications) with other technologies, such as artificial intelligence (AI) (Buchelt et al., 2024) and unmanned ground vehicles (Asadi et al., 2020), among others. Issues faced by drones – such as privacy concerns, regulatory issues, and environmental impact – could be related to the other integrated technologies. By examining drones, we could take a step towards identifying common challenges that may hold for other technologies, leading to potentially transferrable safeguards for a wide range of technologies used to create value in marketing.

Ultimately, we suggest that research on aerial drones can reveal implications for the environment, people, and organizations, including those related to benefits and harms (Beninger & Robson, 2020; Sham et al., 2023; Khan et al., 2019) and support the identification of sustainability safeguards. By unpacking these sustainability implications, we can provide insights to support SOI and contribute to realizing the United Nation's SDGs to create value.

3. Methodology

Diverse research methodologies are called for when exploring new technologies in marketing (Hoffman et al., 2022). We adopted an inductive approach; a key benefit of this approach is the ability to gain rich and detailed data from multiple perspectives without being constrained by preconceived theory, which is appropriate when exploring an understudied phenomenon. To do so, we conducted a fully qualitative survey. Fully qualitative surveys, and the open-ended questions they are populated with, are increasingly employed in the social sciences (Braun et al., 2021). Such surveys allow the gathering of complex and rich accounts from geographically dispersed populations (Braun et al., 2021), which is appropriate for areas lacking previous empirical work (Braun et al., 2017), such as sustainability implications of technology, including drones, in marketing. The open-ended survey questions that are part of fully qualitative surveys avoid presupposing knowledge, as participants respond by typing instead of selecting pre-determined options (Braun et al., 2021). Academic researchers are rediscovering the value of open-ended questions, as they can provide crucial information that would not emerge from closed-ended questions (Neuert et al., 2020).

Traditionally, efforts to understand the implications of emerging technologies in marketing have focused primarily on the economic view and, relatedly, on the consumer-company dyad – an understandable lens given that that customers and companies are crucial actors in marketing. This trend is thus far true for drones, as emerging research in marketing has largely explored implications for consumers (e.g., Choe et al., 2021; Khan et al., 2019). Yet, research at the nexus of technology and marketing should draw on knowledge from different groups (Grewal et al., 2020b) beyond the customer-company dyad (Yadav & Pavlou, 2020). Our research question sought to uncover wide implications of drone use; thus, a wide perspective was needed in order to understand broader societal implications. Our study focused on three groups: marketing professionals, commercial drone experts, and the general public.

Marketing professionals were included within our sample as we expect them to have deep knowledge of consumer- and public-facing activities, as well as of business-to-business contexts. Their perspective is important, as current commercial drone applications focus both on both B2B and B2C contexts. The decision to include marketing professionals also aligns with the recommendation by Berthon et al. (2019) to include marketers in research on technology that is used in marketing activities. Drone experts were included within our sample as we expect them to have expertise into the technological possibilities and limitations. The general public was also included in our sample. The input of members of the general public offers a perspective that may be overlooked or interpreted differently than by experts and is valuable is supplementing expert perspectives regarding the societal impact of emerging technologies (Dijkstra & Schuijff, 2016). Like other scholars, we argue that marketing exchanges should be assessed as a system of different groups, and that such an approach is strategic in achieving a sustainable competitive advantage (e.g., Kull, Mena, & Korschun, 2016) and sustainability. Furthermore, the general public can provide insights into drones' broader impact: drones can and do cross from service contexts into private realms. We thus sought to capture a comprehensive range of viewpoints that include both expert opinions and general public sentiments. Policymakers in this area were not contacted for this study, owing to challenges with identifying and accessing such policymakers.

To capture insights into this missing perspective, and as is standard in qualitative research, information was sought out through secondary data in addition to our primary data. Drawing on multiple data sources is a practice used to strengthen research findings by providing collaborating evidence (Jack & Raturi, 2006). To this end, both authors read widely on various drones. Our primary data was thus complemented by secondary data, including news articles, company reports, and policy documents (identifiable through in-text citations in our Findings).

For our primary data collection, the fully qualitative survey was hosted on the online survey platform Qualtrics. The surveys were anonymous, did not collect any personally identifying information, and were conducted under consent protocols. Our data set included 240 participants: 102 marketers, 36 drone experts, and 102 members of the general public. Fully qualitative surveys involving over 100 participants are the upper end of sample size for this approach (Braun et al. 2020). Most surveys were completed in English, aside from three surveys from marketing participants who responded in Spanish (transcripts M6 and M20) and Polish (transcripts M40), which were translated into English. We piloted the survey with four people before a final version was distributed. The surveys took an average of 14 min for the general public

participants to complete, 12 min for the marketing expert participants, and 10 min for the drone experts.

The surveys included open-ended questions on the uses, implications, and potential solutions regarding commercial drones (see Table 1), as well as general demographic questions (Table 2). As can be seen in Tables 1 and 2, the questions were largely the same between all three participant groups. The reason for using uniform questions was to maintain consistency in data collection to provide all participants equal opportunity to express their viewpoints. As was the focus of our study, these questions were aimed at understanding the wider implications of drones, including their benefits and harms, and how they can be addressed. Participants responded to the questions about obstacles and if they had additional comments with additional benefits, harms, and possible solutions, which were coded appropriately. Analysis of all questions provided deep insights that led to the identification of three safeguards to handle the range of social, environmental, and economic benefits and harms. Additional screening questions were added to the marketing experts and general public to ask if they knew what drones were and if they knew drones were used commercially, as well as asking them to describe drones. While twelve general public participants and seven marketing participants stated originally that they were not aware that drones were used in a commercial manner, all these participants then detailed ways in which they knew drones are being used commercially.

The four demographic questions (age, gender, industry of work, and country of residency) offered fixed options for the participants to select, as well as an option to 'prefer not to say', and "other (please specify here)" option for industry. Participants came from diverse industries and from five global regions: Africa, Australasia and Asia, Europe, North America, and South America. The sample reflects our goal to include a diversity of perspectives and reflects the approximate global market share of commercial drones, which is 29 % in North America, 24 % in Europe, 41 % in Asia, and a combined 6 % in South America, Australia, and Africa (as derived from McNabb, 2020).

Table 1
Open-Ended survey questions.

Open-ended Questions	Marketers	General Public	Drone Experts
Do you, or have you ever, worked in or with a company or industry that is involved in the commercial use of drones?			X
Do your decision-making responsibilities at work include marketing, sales, and advertising?	X		
Do you know what drones (also known as unmanned aerial vehicles) are? (Yes/No answer); Please describe what drones (also known as unmanned aerial vehicles) are in a few sentences.	X	X	
Are you aware that drones are being used in a commercial manner by companies to provide products or services? (Yes/No answer); In your experience, how are drones currently being used commercially? Please provide as much detail as possible.	X	X	X
What are some benefits of using drones commercially and who do you think benefits?	X	X	X
What are some harms that the commercial use of drones can cause and to whom?	X	X	X
What can companies do to prevent such harms as you noted above?	X	X	X
In your opinion, what are the biggest obstacles to the commercial use of drones?	X	X	X
Is there anything else you would like to share with us about the commercial use of drones?	X	X	X

Note: X denotes that these questions appeared in the survey to that particular group.

Table 2
Age, gender, and region of participants.

	Marketers (102 participants)	General Public (102 participants)	Drone Experts (36 participants)
What is your age?	18–29 (45 %) 30–45 (38 %) Over 46 (17 %)	18–29 (59 %) 30–45 (25 %) Over 46 (16 %)	18–29 (12 %) 30–45 (42 %) Over 46 (46 %)
How would you describe your gender?	50 % female	57 % female	22 % female
In which country do you currently reside?	Africa (12 %) Austral(Asia) (21 %) Europe (31 %) North America (23 %) South America (13 %)	Africa (26 %) Austral(Asia) (25 %) Europe (22 %) North America (25 %) South America (2 %)	Africa (14 %) Austral(Asia) (19 %) Europe (42 %) North America (25 %) South America (0 %)

Regarding sampling, for the general public participants and marketing expert participants, we used Prolific, a platform that offers an online research subject pool and integrates with Qualtrics. This platform offers a more internationally diverse subject pool than other similar platforms (Peer et al., 2017). As we sought to take a global perspective on the use of drones, the use of this platform was appropriate. For the general public participations, we used a standard sample that was distributed to available participants. For the marketing participants, we utilized a demographic screener to target individuals with professional decision-making responsibilities in marketing, sales, or advertising. The marketers also asked an additional screening question to confirm that their professional responsibilities involved marketing.

For the drone experts, the first author and a research assistant identified and contacted 377 commercial drone companies across 45 countries through Google searches on respective national Google websites, using terms such as "drones", "unmanned aerial vehicle", and "UAVs". The websites of the organizations were checked to ensure that the companies focused at least partially on commercial drones (rather than only on private or military drones) and if they offered English language information. In this process, 31 national and regional associations related to commercial drones were also identified. 377 companies and 31 associations were emailed, or contacted via their website contact boxes if no emails were posted, asking them to partake in the study. Reminder emails were sent. Further, three LinkedIn groups focused on commercial drone use were identified and invitations posted in these groups. In total, 36 complete surveys of drone experts were gathered. The response rate is perhaps not surprising: the commercial drone industry is known to be highly competitive, with actors often unwilling to share information (de Miguel Molina & Segarra Oña, 2018). Nonetheless, employing an anonymous survey likely provided more access than would be gathered otherwise from this relatively secretive group, as it allowed participation without revealing company-specific data.

As the data was collected, inductive coding was undertaken following a grounded approach. We treated the data as a cohesive dataset, analyzing across the dataset (Braun et al., 2020). The lead author engaged in line-by-line manual coding of the data supported by the qualitative data analysis software Atlas.ti. This coding process followed an iterative process of constant comparison moving between data and theory (Corbin & Strauss, 2008). For example, harms identified by the participants were compared to an existing social harm framework comprised of four categories of social harm (physical harm, financial and economic harm, cultural safety harm, and emotional and psychological harm) (Hillyard & Tombs, 2004), noting instances that fell outside those categories. The emerging codes were organized into

themes, and, finally, into higher order categories, and were refined. For example, solutions suggested to mitigate harms were descriptively coded, such as 'better technology & design', and 'maintenance & checks by organizations', and these preliminary codes gave rise to interpretative codes (e.g., 'technical safeguards'), which eventually gave rise to the safeguards framework. After engaging in the inductive coding which led to our theoretical model, a research assistant re-coded the entire dataset, line by line, using our theoretical categories. This process provided quantitative information as to the frequency with which each participant group mentioned specific themes.

4. Findings

The findings revealed insights into the implications of commercial drones and three safeguards to handle the implications. To understand the nature of the safeguards, the implications – specifically benefits and harms – are first presented in the findings. These findings emerged in the three central categories of sustainability – social (Table 3), economic (Table 4), and environmental (Table 5). In each table, we also identify the proportion of each participant group that brought up a specific theme to showcase the variance in perspectives on drones across these groups. The findings then turn towards the three safeguards (technical safeguards, policy safeguards, and inclusive public safeguards). In the following findings, verbatim participant quotes are used throughout to give voice to the participants. The letters 'E', 'P', and "M' are used to denote drone experts, the general public, and marketers, respectively, with numbers specifying the unique response.

Table 3
Social impacts of commercial drones.

Theme	Illustrative Quotes
Social Benefits	
Accessibility	"…access locations…" (E9)
Experts: 17 %	"Also, drones can be used to access more areas and, because they are aerial vehicles, be accessible to more customers." (M50)
Marketers: 19 %	"…to go places humans can not [sic] go…" (P97)
Public: 27 %	
Safety	"Being able to do things remotely, vs having to travel through difficult terrain, have to use expensive equipment and put human lives in danger, is cheaper and safer." (E2)
Experts: 44 %	"Benefits include human safety for dangerous jobs like mining." (M75)
Marketers: 10 %	"For companies using it for delivery, it's a precise and safer way to deliver product…" (P4)
Public: 7 %	
Social Harms	
Physical Danger	"…a drone can cause an accident equivalent to the harm caused by a civil aircraft, adding the fact that here there is no pilot that can execute safety maneuvers and take decisions." (E33)
Experts: 31 %	"Drones may fall out of the sky and hurt people on the ground" (M54)
Marketers: 29 %	"There is a huge safety concern with drones. Any malfunction can hurt or kill people on the ground as they can fall on them." (P80)
Public: 38 %	
Privacy Concerns	"privacy which is very relevant for urban drone operations, in densely populated areas" (E34)
Experts: 25 %	"… privacy concerns for people being recorded without their agreement or knowledge" (M22)
Marketers: 35 %	'lack of privacy as drones could have cameras and get everywhere" (P56)
Public: 39 %	
Nuisance	"noise pollution…" (E14)
Experts: 8 %	"…the noise that drone propellers can cause" (M38)
Marketers: 8 %	"Drones also tend to be noisy, so they may create some noise pollution." (C73)
Public: 10 %	

Table 4
Economic impacts of commercial drones.

Theme	Illustrative Quotes
Economic Benefits	
Cost Effectiveness	"Lower cost. There is a 97 % reduction in cost compared to traditional spraying methods." (E6)
Experts: 61 %	"Benefits of using drones – cut costs on fuel and labour. Unless the savings are passed onto the end customer, it will be the company who benefits, not the worker." (M72)
Marketers: 41 %	"[companies] don't need to pay a human's wages, worry about them taking time off…" (P71)
Public: 41 %	
Productivity	"Reduced cost, save time, faster response time" (E26)
Experts: 69 %	"Faster work process." (M19)
Marketers: 39 %	"I think, drones like any kind of new technology just making things faster and easier in general, which benefits all humanity to some exten[t]." (P11)
Public: 30 %	
Differentiation	"…more comprehensive data…" (E4)
Experts: 14 %	"They are something uncommon to see so people are usually very amused by them. The usage of drones may attract potential customers to the brand that uses them…" (M39)
Marketers: 31 %	"It's very convenient and gives pretty good footage. Those who benefit from it can be both producers and users." (P54)
Public: 35 %	
Economic Harms	
Livelihood Threats	"…loss of employment…" (E21)
Experts: 11 %	"the more drones we have, the more people will get replaced thus leading into a different kind of crisis" (M15)
Marketers: 14 %	"Harm to employees who can be replaced and will lose jobs" (P56)
Public: 19 %	
Property Threats	"Abuse of use can cause damage and failure to infrastructure equipment." (E3)
Experts: 25 %	"They can damage property, wildlife and even people if not used correctly." (M11)
Marketers: 20 %	"…high potential collision of drones into people, animals, cars, and buildings." (P4)
Public: 20 %	

Table 5
Environmental impacts of commercial drones.

Theme	Illustrative Quotes
Environmental Benefits	
Reduced Resource Use	"Massive reduction in the Use of Chemicals (30 to 50 % reduction) as well as Water (up to 90 % reduction) can only show good results." (E28)
Experts: 3 %	"fuel efficient due to this just-the-right-size scalability" (M68)
Marketers: 2 %	"More environmentally friendly than say using a car to deliver packages." (P101)
Public: 2 %	
Reduced Carbon Emissions	"Also – 8 times more CO2 efficient" (E7)
Experts: 8 %	"The main benefit of commercial use of drones is less carbon footprint – flying a more compact vehicle rather than a full-size aircraft has less emissions" (M74)
Marketers: 8 %	"don't have a big carbon footprint" (P26)
Public: 11 %	
Environmental Harms	
Wildlife Stress	"Harm… for birds during birds nesting time" (E17)
Experts: 8 %	"…damage to local flora and fauna and humans… local habitat and inhabitants" (M19)
Marketers: 14 %	"Birds (scares them and can cause injury)." (P60)
Public: 25 %	
Nature Destruction	"they must always be handled with care (possible short circuits and consequent fires)" (M10)
Experts: 3 %	"They could also get stuck in trees" (P78)
Marketers: 9 %	
Public: 3 %	

4.1. Social implications of commercial drones

4.1.1. Social benefits: accessibility and safety

Accessibility refers to the ways in which technology provides communities with access to resources that they would otherwise not have. Accessibility was noted by 27 % of the general public participants and only 17 % and 19 % of the experts and marketers, respectively. Drones allow delivery "to inaccessible areas" (P15) and can therefore improve access to critical products and services, "especially in hard-to-reach areas, the benefits include providing services to the most rural areas, like delivering medication to rural areas fast" (P47), which the organization Zipline currently does for tens of millions of Africans. Beyond deliveries, drones can also produce electricity when outfitted with wind-powered turbines, generators, and tethers (Zillman, 2016) and can provide internet and mobile phone access. Companies including Alphabet, Airbus, and Meta have indicated their interest in this drone-provided connectivity, underscoring the benefits of accessibility.

Safety refers to the ways in which technology reduces or removes danger. Drones allow admission to dangerous locations in a way that does not risk human lives. In this way, drones improve the "safety of people who otherwise would have to perform the work physically" (M76). This theme is supported by secondary data; a study suggested that deliveries by drones in Finland could avoid up to 38 road accidents per year (Gaia Consulting Oy, 2021). Interestingly, participant comments on the theme of safety differed substantially in their frequency between the groups, with 44 % of drone expert participants mentioning this and only 10 % and 7 % of marketing professionals and general public participants, respectively, mentioning this theme.

4.1.2. Social harms: Privacy concerns, physical danger, and nuisance

The largest concern related to drones was related to privacy. This concern was the most frequently noted concern by both marketing professionals (29 % of whom noted this concern) and members of the general public (39 % of whom noted this concern). Commercial drones can "collect data and images without drawing attention" (M58) and "can be hard to detect and track with the naked eye" (M43), or even with radar or radiofrequency. For example, a United States company called AdNear trialed the use of drones to collect data from unwitting individuals using public Wi-Fi to push targeted advertisements (Bi, 2015). Drones can also be perceived as being "used for surveillance and spying on individuals" (M36), related to the "fear of being monitored by authorities" (P30). Further complicating the matter is that people are not always aware that their data is being collected, which could occur "without their agreement or knowledge" (M22). Recent academic suggestions that companies could share the view of the 'real-time delivery journey' from a delivery drone's camera with the waiting customers (Choe et al., 2021), prompting further questions about privacy regarding drones. Drones can therefore arguably harm "the general public, since drones [can] collect personal data" (M41).

Another major concern with commercial drones was that of physical danger, including the range of possible injuries that technologies pose to humans. This concern was raised by 38 % of the general public participants, 31 % of drone experts, and 29 % of the marketing professionals. All three groups were concerned with "malfunctioning" (M2) or "defective" (P94) drones. Reasons given for such drone failure included maintenance lapses or battery concerns. Even if not causing physical injury, drones may cause "anxiety" (M68) and "fear" (M18). These fears are not unfounded. Medical practitioners are concerned about the rising number of drone-related injuries (Chung et al., 2017), such as marketing drones crashing into a bystander at a sports event (BBC, 2014) and into a patron inside a restaurant (Allen, 2014), among others. The most probable type of human injury from a drone is a laceration, while the most likely cause of death is blunt force trauma, such as from spinning blades (Arterburn et al., 2017). Drones can also impact other airspace users, prompting concerns about both "safety on the ground and in the air" (E23). Drones could "run into each other mid air" (M15), including crashing into the "rising number of uncontrolled [private] hobby drones flying without the appropriate permissions or safety means" (E33). This concern is significant, as "a drone can cause an accident equivalent to the harm caused by a civil aircraft…there is no pilot [in a drone] that can execute safety maneuvers and take decision[s]" (E33). Drones have indeed interfered with airplanes and caused delayed flights, partially because drones can be hard to identify in general – but especially from airplane cockpits (Kiernan, 2019).

A variety of factors exacerbate the potential for physical harm from drones. Operators, wildlife, electrical lines, inclement weather, and even kites can cause drones to fly erratically or crash. Even when relying on pre-set programming or AI, drones do not necessarily arrive safely due to nefarious actors. Commercial drones are "a good and easy target for hijacking" (M36) with "vulnerability to digital hacks" (P5). Such concerns are warranted: A graduate researcher in the Netherlands was able to hack into and take control of a government-grade drone, one used by police and firefighters, through weaknesses in the drone's radio connection (Greenberg, 2016), while drones involved in a public light show in China in 2021 crashed, with unverified reports that a rival company had used transmitters to overwhelm the commercial drones' navigation (Tangermann, 2021). Drone theft could perhaps become the shoplifting of the future, while dropped or otherwise lost products could also increase costs.

Nuisance concerns encompass the ways in which the technology is simply annoying. In addition to drones being "a bit of an eye sore" (P76), a major concern was that of "noise pollution" (E14), specifically the "[a]nnoying loud buzzing sounds from the helicopter style drones" (P91). Drones, especially larger commercial drones with more propellers, are as loud as a gas-powered leaf blower or lawn mower, where even "a single drone can make an area 8 to 12 times louder than it is now" (Paine 2019, n.p.). People also reportedly prefer the noise from drones less compared to those from road vehicles and airplanes, which could lead to annoyance (Torija et al., 2020). These nuisance concerns were raised by 8–10 % of each participant group. In sum, while drones can provide accessibility and increase safety in some contexts, commercial drones can be a nuisance, pose privacy concerns, and cause bodily harm.

4.2. Economic implications of commercial drones

4.2.1. Economic benefits: Cost effectiveness, productivity, and differentiation

All three groups of participants frequently noted that drones can save money and be more productive. Cost effectiveness refers to the ways in which technology can lower operating costs. In short, "drones save money" (M4) through their use, but also can help drive down costs, as drones have a "long productive lifespan, low maintenance cost, and its parts are easy to replace" (E6). Productivity refers to the ways that technology can streamline or improve processes, including being more efficient and "always operational" (M36) because they "do not sleep or take breaks" (P27). Drones are also faster. They can, for example, offer "fast acquisition of information from the field" (E4) or save "time needed for traditional and manual inspections" (E8). In addition to being faster, some noted that drones improve service quality. For example, an expert revealed that drones, equipped offer "possibility to get other/better data than we could get from a human" (E9). In short, they can offer increased productivity. Drone experts were the group who most frequently pointed out the productivity benefits of drones (69 %) compared to only 35 % and 30 % of marketers and members of the general public, respectfully.

Differentiation benefits refer to the ways in which technology allows organizations to strategically stand out from competitors by creating more value than competitors. Marketing participants in particular stressed how drones bring "benefits [to] the brands" (M26) to, for example, "lead or complement… marketing campaigns" (M17), including to "promote a brand" (M11), create "original" advertising (M7), and provide "publicity" (M9). Wider strategic benefits mentioned also included "a new perspective, better decision-making opportunities

with better data". Another way that drones provide a means of differentiation is through improved convenience. For example, when used to show images of tourist destinations or real estate, drones allow buyers to gain insights "from the comfort of their home" (P6). Differentiation benefits were more frequently noted by marketing professionals (31 %) than by members of the general public (25 %) or drone experts (14 %).

4.2.2. Economic harm: Livelihood threats and property threats

Livelihood threats refer to the ways that technology may reduce options for community members to secure the necessities of life. Many drone experts caution that drones pose a threat due to "loss of jobs" (E30), which is prevalent in certain areas, such as delivering needed supplies (Leone et al., 2021), or surveying. Many participants feared drones would "encroach on the jobs that we need" (P85), leading to "increasing unemployment" (M16). In short, drones are "hard on those jobs that used to do the work the drone has replaced" (E2). This potential harm was noted by 11 % of experts, 14 % of marketers, and 19 % of the general public participants.

Property threats refer to the ways that technology can destroy or damage infrastructure, possessions, or the goods being transported by drone. Concerns of this nature were prevalent. A drone has a "risk of dropping fragile items" (M15) resulting in "damaged goods" (E14), harming the company and, by extension, customers. More troubling for the wider public, drone experts reported a potential of harm related to "drones hitting things" (P34), such as buildings, objects, or "[p]ets, property and everything in their path" (P27), including infrastructure (E4), such as electric lines, resulting in economic harm to the impacted community. Taken together, drones can increase cost effectiveness, productivity, and differentiation, but also pose livelihood and property threats. This potential harm was noted by between 20–25 % of each participant group.

4.3. Environmental implications of commercial drones

4.3.1. Environmental Benefits: Reduced resource use and reduced carbon emissions

Reduced resource use refers to the ways in which technology lowers the need for resources, sometimes in unique ways, such as being a "sustainable and a better alternative to fireworks" (E5). In other examples, a drone expert (E6) shared that, when using drones to spray pesticides, the pollution of soil and water was markedly reduced, while allowing for less water and pesticide use. Environmental benefits also stem from not only reduced "fuel consumption" (M3) and "amount of diesel" (E28) needed for certain tasks, but also the use of "alternative power sources [that] are already on the market" (E3) as drones are increasingly battery powered. Taken together, reduced resource use is a noted benefit for 2–3 % of each participant group.

Lower carbon emissions was another type of environmental benefit noted by participants, although less mentioned. As argued by a marketer (M74), reduced emissions is among one of the main benefits of commercial drone use. Research in the United States found that even small drone deliveries reduced the use of energy compared to truck deliveries and can reduce over 50 % of the greenhouse gas emissions of traditional delivery approaches – even if drones are powered by non-renewable sources and even when accounting for the need for more warehousing locations; larger drones are even more environmentally efficient (Stolaroff et al., 2018). A Finnish study had similar conclusions, finding that replacing 6 % of deliveries with drones would eliminate 2000 tons of CO_2 emissions yearly (Gaia Consulting Oy, 2021). Reduced carbon emissions were mentioned between 8–11 % of the time across the three participant groups.

4.3.2. Environmental harm: Wildlife stress and nature destruction

Wildlife stress refers to the ways in which technology can cause harm to animals in a community, a concern brought up by all three groups, although less often than other concerns. Participants primarily raised concerns that drones may "frighten" (P16), "distract" (M8), "hurt" (M39), or "kill" (P19) birds, with "concerns that drones can frighten humans and animals alike" (P33). Biologists found that birds do show physiological responses to drones, although the research still emerging (Rebolo-Ifrán et al., 2019). Beyond birds, drones have separated bighorn sheep calves from families (Baltrus, 2014), scared livestock (O'Donovan, 2022), and impacted heart rates of bears, prompting concerns about whether increasing drones could negatively impact wildlife (Ditmer et al., 2015), with Wildlife threats were more frequently mentioned by the general public (25 %) than by experts (8 %) or marketers (14 %).

Nature destruction refers to the ways technology can damage wider ecosystems. Drones can crash and "get stuck in trees… which could be very dangerous" (P78), especially if causing fires. In the United States, a drone sparked a 1.36 km^2 wildfire in 2018, which took 30 firefighters to extinguish (Gab, 2018), while, in 2022, a research drone reportedly caused a wildfire resulting in 300 people being evacuated (Singh, 2022) and an Amazon-related drone crash reportedly caused a brush fire (Jaupi, 2022). Such drone-caused fires could ultimately harm nature, property, and people. Nature destruction was most frequently raised by marketing professionals (9 %), with only 3 % of both experts and general public raising this concern. In sum, while drones can reduce resource use and emissions, they can also cause nature destruction and wildlife stress.

4.4. Safeguards for harm mitigation and bolstering benefits

The preceding sections described the social, economic, and environmental implications of drones, both the potential benefits and harms. Participants suggested ways in which these implications could be handled. Three multifaceted safeguards, which we define as measures taken to provide protecting against harms and bolstering benefits, emerged from the analysis: technical safeguards, policy safeguards, and inclusive public safeguards (Table 6).

4.4.1. Technical safeguards

This safeguard refers to technical improvements that prevent harms. Many felt "[b]etter drone technology" (P81) is needed. While a few mentioned solutions to limit harm to the environment, such as using "more sustainable fuel/batteries for drones" (M74) including solar

Table 6
Safeguards for commercial drones in marketing.

Theme	Illustrative Quotes
Technical safeguards	"…a very important aspect of risk mitigation in aviation is the redundancy……." (E34) "Make them lighter and less susceptible to errors that could take them out of action or out of control" (M2) "Ensure that each drone has diagnostic equipment with warning systems and are easy to stop or override if something goes wrong…" (P98)
Policy safeguards	"Follow rules and guidelines, adhere to best practices and code of conducts" (E10) "Adhere to (and strive for a greater degree of) all requisite safety regulations involved in the operation of drones for commercial purposes – ensure pilots (if used) are qualified or the automatic guidance technology utilised reliable enough for incident-free commercial service." (M78) "rules and regulations about the locations of use, time of use, operator licensing" (P82)
Inclusive public safeguards	"Be proactive with public before flights, increase awareness of drone use and objectives." (E18) "Ensure good and clear communications with third parties in any area where potential filming will take place, ensuring they are aware that there are cameras above. Gaining written permission when 'intruding' on private spaces (and being open and transparent about this)." (M71) "Obtaining the written consent of the people in the area or at the very least a written notice that the drone would be in the area, for how long and for what reason so that everyone around is aware of it" (P46)

power (P60), most focus was on avoiding crashes and limiting their risk of harm if they do crash. These recommendations focused around two key areas: avoidance and mitigation. Regarding avoidance, participants suggested 'sense and avoid' systems that identify other aircraft and weather systems, although such systems are still viewed as relatively unreliable (E33).

Mitigation was two-fold, namely, to mitigate the chance of crashes and to mitigate harm when a crash occurs. Regarding the former, a technical safeguard suggested was drone detection and removal systems, such as jammers that shoots disrupting signals or lasers that blind or disable drones to protect privacy and prevent crashes. In one example, DroneShield, used by airports and stadiums, uses AI-based sensors to listen for and identify drones, monitor their movements, and ground drones or return them to their operator. Mitigation systems can also provide "delimited areas" (M28) such as through geofencing, or virtual 'fences in the sky'. These are digital systems which program maximum heights or coordinates off no-fly areas, although they can be disabled (Kiernan 2019), requiring complementary strong policies to manage commercial drones. Some participants noted that drones can also "be shot" (P14) with guns, where citizens have shot at drones (Bilton, 2016) or threatened to do so (O'Donovan, 2022) for privacy reasons, prompting public safety concerns, including that this could cause a crash.

In the event of a crash, suggestions of technical safeguards also included making drones safer, such as without "rigid parts" and instead with "padded surfaces" (P100) and protective "foam" (M24) or "parachutes to drones to prevent and avoid accidents" (E27), which companies such as Matternet already do. Drones can also be designed to disintegrate slowly as they lose altitude, where the smaller jettisoned components may pose less of a risk than an entire drone (see Jaramillo et al. 2019). However, experts caution that such technical solutions are not complete, because equipping "drones with protective measures (parachutes)… minimizes risk and does not eliminate it" (E4). Further, as an expert pointed out, people "want all available sensors, technologies, and safety precautions to be integrated onto a drone which increases weight which in turn reduces flight time performance" (E3), which could limit drone benefits.

Technology was also suggested to reduce noise. A drone expert encouraged companies to "continue to invest in noise reduction technology in blade design" (E13). Propeller shape refinements can change the pitch, but companies will likely only invest if its demanded (Paine, 2019). Noise reduction might also not solely rely on technical improvements. As Torija et al. (2020) found, drones would cause relatively less noise pollution and annoyance if they were used in loud traffic areas, pointing to the need to align this with policy safeguards.

4.4.2. Policy safeguards

Policy safeguards refer to rules and processes – by operating individual, organizations, industries, and governmental frameworks – aimed at preventing harm. By far, this safeguard was the most frequently suggested solution. At the individual operator level, ensuring qualified operators through "proper training" (E12) of both the "technical" and "mental" aspects (M64) was a frequent comment. In addition to training, suggestions were made that the operators need to remain "vigilant of [there] surroundings" (E36) and "practice caution when flying" (E87) to ensure they are "using them effectively and carefully" (M47). These comments suggest that some see the operator as a large concern.

At the organizational level, safeguards focused on the need for companies to engage in three distinct activities: planning, monitoring, and adhering to rules. Planning was focused on "make a detailed plan about its purpose, demands, costs and benefits" (M32). Such planning could include creating "robust security measures" (M75) and involving "[g]ood preparation and a good plan to operate the drone" (E5) to help "maintain a good safety record" (E7). Planning could also involve doing "extensive research into the people, flora and fauna" (P6) and impact on employees. Suggestions on employees focused on the need for companies to "leave some jobs for humans" (M37) by only using, for example, "drones for those jobs too dangerous or almost impossible to humans" (M95). Alternatively, companies could dedicate resources to retraining or upskilling (even for the industry itself, towards addressing industry labor shortages mentioned by experts). For example, Zipline hired locals to fly its drones and manage its distribution center (Landhuis, 2017). The suggestion of monitoring was focused on flights, such as "prevent(ing) such harm by having more overview and supervision over the drones and their path" (M50), but also ensuring "regular maintenance and checks" (P76) and "servicing" (M63). Many responses pointed towards the need to act "in accordance with the law" (E25), linking to national rules.

Beyond the organizational level, participants suggested the need for industry efforts, such as through engaging in creating "professional standards" (E19) and "workshops and training sessions with Industry Associations to work together to build standards… for their member companies" (E18). As E34 argued, "it's the entire industry that must collaborate to create a system that doesn't fail or result into incidents. It is not only for a single company to change a piece, but all actors of an eco-system must make sure it is all working properly.".

Finally, many responses pointed towards the need for robust and clear governmental rules. As a drone expert reasoned, "like any commercial hardware products, laws and regulatory agencies create safety guidelines and define criminal uses and define severe punishment for those who willfully abuse and misuse drones" (E3) towards creating "specific regulations, with teeth" (M92). The findings focused on two key areas: providing permissions and approving actors. Regarding permissions, suggestions focused on sanctioning certain flights while limiting locations, such as creating "drone free areas" (P86) and avoiding "large crowds" (P3), "residential areas" (P62), near "nesting areas" (E17), or near sensitive cultural or military areas (Lichtman & Nair, 2015), instead only flying in "acceptable" areas (P5). The recommendations for licensing individuals involved calls to certify pilots, but also hold them accountable for their actions. However, as experts pointed out, "regulations are 4–6 years behind the technology" (E31), and the "industry is evolving much faster than the regulations" (E33).

While many pointed towards regulation as ways to minimize harms, paradoxically, regulation was also stressed as a key aspect holding back the development of the commercial drone industry, with experts and marketers citing an array of "red tape" (E2), "regulatory hurdles" (E10), and "various permits" (M10). A major concern was the rule that, in many jurisdictions, operators must keep drones with eyesight. The limitation on beyond-visual-line-of-sight (BVLOS) activities is seen as the "biggest restriction" (E23) by some. Further, with drone "legislation varying in each country" (E24), and with legislation being "often changed quickly" (E31), the lack of cohesive inter-country rules is problematic as drones can easily cross borders.

4.4.3. Inclusive public safeguards

Inclusive public safeguards refers to efforts undertaken to improve understanding of the technology to "normalize drones" (M12). These efforts would be two-fold, namely creating awareness around use and educating about their implications. Regarding the former, generating awareness around drone activities would involve people being notified of [drone use] in advance" (P30). Efforts could involve "public announcements" (M68) and "warning signs" (M77) to "inform people" (M29), especially in private areas. Informed consent could be secured, such as by having community members to get "written consent of the people in the area or at the very least a written notice that the drone would be in the area, for how long and for what reason so that everyone around is aware of it" (P46). In this way, awareness of use can be cultivated.

Towards changing this reaction to the "relatively new concept" (M22) of drones, an expert argued that there is a need to "increase awareness of drone use and objectives" (E18), where a "lack of people know… what is a drone and that it can be used to benefit them" (M13).

Such efforts to "educate consumers" (E23) could include "pilot projects and technology demonstration projects" (E18), as well as sharing of information. In one example, UNICEF encouraged community members to discuss, view, and touch drones used in their projects towards soliciting feedback, understanding needs, and allaying fears related to drones (Fraser, 2017). An issue not mentioned by the experts but brought up by the general public and marketing participants was the perceived lack of human oversight. Drones have "limited capabilities they cannot think or communicate like humans" (P5) with "no reasoning capacity like human [s]" (P7). To many, "the human factor is still important because drones don't have eyes really so a lot could go wrong" (P49). Human involvement could be addressed through awareness campaigns.

5. Discussion

5.1. Theoretical implications

While Little et al. (2023) identified tensions that exist when considering social, economic, and environmental aspects related to SOI, our study uncovers tensions that exist *within* social, economic, and environmental aspects themselves (see Fig. 1). As with all technologies, drones provide benefits across all three sustainability dimensions but also pose harm. As this research reveals, tensions and tradeoffs abound, as the technology can both provide and threaten safety in the social realm, improve and derail economic outcomes, and help and harm the natural environment. By answering calls to explore the wider implications commercial drones in marketing (Sham et al., 2023; Beninger & Robson, 2020; Khan et al., 2019) beyond crashes, noise (e.g., Jaramillo et al., 2019), and privacy (e.g., Khan et al., 2019), our findings provide a comprehensive view into the range and depth of potential sustainability implications.

Emerging from our data, we offer an Integrated Safeguards Framework which identifies three interconnected safeguards towards improving the benefits of this emerging technology while minimizing harms (see Fig. 2). These safeguards include technical safeguards, policy safeguards, and inclusive public safeguards. This novel Integrated Safeguards Framework builds upon past theoretical efforts of Foxman and Kilcoyne (1993) by broadening not only the range of risks that the safeguards seek to address and benefits that can be bolstered, but also identifying three categories of safeguards and their overlapping nature. In doing so, we answer Quach et al.'s (2022) recent call to understand regulatory aspects in marketing and technologies. By going beyond a limited focus only on government policies (e.g., Jaramillo et al., 2019), we found that guidance is needed not only at the government-level, but also from companies, the wider industry, and operators. We also identified inclusive public safeguards that go beyond the consumer-company dyad, as many technologies do, thus building on past limited work in marketing looking primarily at consumers (e.g., Choe et al., 2021), by stressing the need not only for education about the technology in general

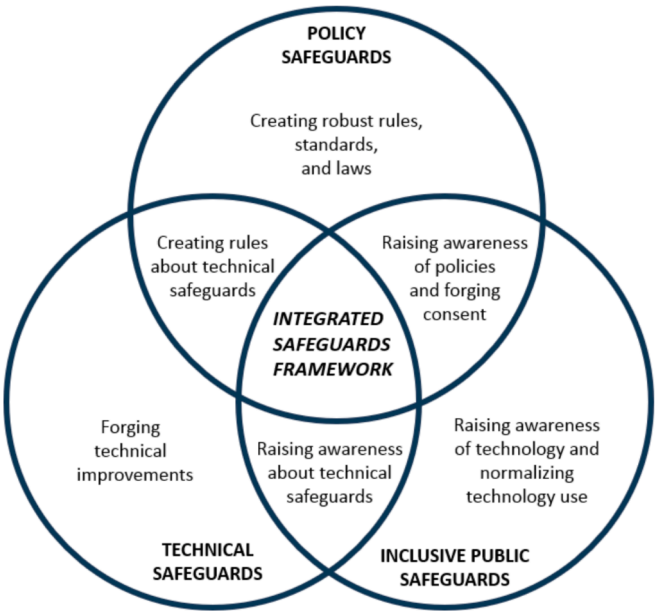

Fig. 2. Integrated safeguards framework.

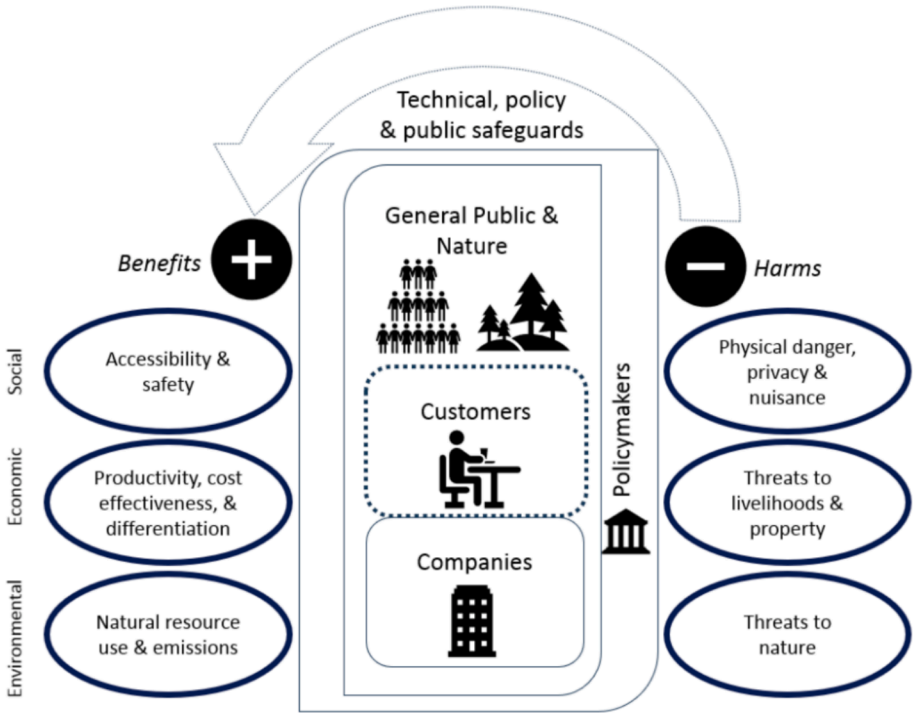

Fig. 1. Community-centric framework of benefits and harms.

but also awareness about when it is in use.

As with other inductive qualitative research, the findings have the potential of transferability to theoretically similar situations (Shenton, 2004), such as other emerging technologies. The framework would likely be useful when considering technologies in marketing that have physical forms and involve movement, such as autonomous road-based vehicles, in-store moveable robots, and augmented reality. For example, reflecting on Fig. 1, in-store robots and autonomous road-based vehicles would likely provide differentiation benefits and may positive implications for productivity and costs. However, even when doing difficult or tedious work, these technologies and may also represent a threat to people's physical safety (given their embodied and autonomous nature) and privacy (given their range of sensors). While such robots could likely provide some environmental benefits, such as by managing inventory levels and waste, their use and disposal could have environmental implications, all areas which could benefit from research. We suggest this reveals the potential for the Integrated Safeguards Framework to apply beyond drones. Emerging work in marketing has conceptually explored the implications for customers of in-store service robots, which have the ability to move around stores, although such research is also in its infancy (Grewal et al., 2020a), as it is for drones.

5.2. Practical implications

Marketers are increasingly called upon to understand the implications of new technologies (Hoffman et al., 2022). For marketers and others who seek to engage in SOI, they can utilize the Integrated Safeguards Framework to understand and manage the benefits and harms of technology. Importantly, for similar other technologies, the technical, policy, and inclusive public safeguards could apply, such as the need for creating robust standards and laws, ensuring technical improvements, and raising awareness.

Regarding drones in particular, the general public and marketers appear concerned about the perceived lack of human involvement in drone use. Companies could employ the public inclusive safeguard to stress how human oversight is involved. Humans can supervise the drones or take control of piloting, especially in more risky contexts (Osburg et al., 2022), such as during inclement weather or over heavily populated areas. Our findings therefore bring nuance to Hwang et al.'s (2019a) recommendation to promote the innovative nature of drone delivery, as our findings suggest that caution is needed regarding the innovative aspects of the pilot. Given that people may react differently to autonomous versus human controlled technologies (e.g., Osburg et al., 2022; Hoyer et al., 2020), marketers (and academics) can seek to assess whether including more human intervention, even if not technologically necessary, could help increase appeal and therefore allow the more sustainability benefits of drones to be realized.

While the drone experts were primarily focused on the human benefits, many paid less attention to ecological issues. In comparison, the general public and marketing participants were seemingly more aware of the environmental aspects. As marketers use drones in their services, stressing their environmental aspects, such as reduced carbon emissions, could bolster the inclusive public safeguards. Companies can, for example, promote the environmental differences between drones and their alternatives (Choe et al., 2021). Research suggests that exposure to positive information increases the willingness of consumers to ride in autonomous road-based vehicles (Anania et al., 2018), and a similar approach could be explored for drones.

5.3. Policy implications

Drone experts, marketers, and the general public shared many concerns about drones, yet their perspectives also differ, which results in varying pressures on policymakers. The different perspectives may also necessitate differing communication to each group. While drone experts see the clear productivity and safety benefits, the general public noted these much less often. Stressing these potential benefits could help increase perceived value and general acceptance of drones. On the other hand, the general public was more concerned about a lack of safety (i.e., physical danger), privacy, and threats to wildlife. Towards addressing these concerns, policymakers can mandate the research and use of technology improvements, such as sustainable fuel, crash avoidance and mitigation, and geofencing. Further, policymakers can also create policies related to (mis)use of drones, such as determining off-limit areas and licensing, and ensure they enforce such rules. Drones can easily cross borders and jurisdictions and a multinational approach is needed, such as by establishing international conventions regarding drone use, which could potentially be developed and monitored by a supranational body such as the United Nations. The United Nations discusses and reflects on the ramifications of drones, although their focus has primarily been on military actions (see United Nations, 2015). Their focus could potentially be extended to commercial use to provide broadly accepted guidelines.

5.4. Future research and limitations

Future research should further investigate the proposed safeguard framework, both with drones and with other technologies, especially as the technology progresses. Such efforts would overcome a limitation of this study – namely that the qualitative surveys were administered in one year (2022) in a fast-changing industry. Importantly, drones also increasingly execute their own maintenance, adjust their payload, work in teams through the 'Internet-of-drones' (Boccadoro et al., 2021), and even carry people. Other methods, such as quantitative studies, are needed to determine if benefits and harm evolve over time. Drones, like other technologies, and our proposed safeguards has implications well beyond the marketing perspective, with implications for supply chain, human resource management, and finance, for example. Future research could explore the technology and the safeguards from these perspectives.

While our research collected data from diverse regions, the study did not provide insights into differences that may exist between such countries, which future research could explore. Future research could also explore the sustainability implications of drones in different usages. For example, a drone used to deliver a product in front of someone's house or in a public park (which is being done by Google's Wing in Finland) likely elicits very different implications than an aerial drones used in a restaurant or stores. Further, people in or near conflict areas require special considerations. In these contexts, individuals may be accustomed to seeing drones engaging in military acts and may have adverse reactions to seeing the technology used in other ways, such as humanitarian relief (Lichtman & Nair, 2015) or product delivery.

This study only included the perspectives of drone experts, marketers, and the general public. The differing implications across roles and with roles changing over time are also worthy of study. For example, a person who has something brought by drone (in the role of consumer) may feel differently about the benefits and risks than when the drone is delivering to someone else, such as a neighbor. Future research could also include others, such as policymakers, workers from diverse industries (including environmental and humanitarian organizations), as well as frontline workers involved in drone services. Past research in marketing has focused on the 'service triad' of grounded service robots, human frontline workers, and customers in restaurants (Odekerken-Schröder et al., 2021), and future research potentially consider a 'service tetrad' of robot, human workers, customers, and wider public given the unbounded nature of aerial drones and thus contribute to a systems approach for SOI (e.g., Little et al., 2023). Certain groups might experience a higher magnitude of both harms and benefits, such as underserved communities in poverty, which is also an area in need of research (Beninger & Robson, 2020).

Further, rapid advances in AI have potential to drastically change the abilities of existing robot technology. Our study indicates that

stakeholders are concerned about AI-driven drones, potentially preferring human intervention. We therefore echo calls to better understand the role of human interaction in commercial drone use (Sham et al., 2023) and the implications of autonomously managed technologies in marketing (Yadav & Pavlou, 2020). A future study which applies the sustainability safeguards framework in this paper to AI specifically would be timely. Additionally, when considering drones, Huang and Rust (2021) theorized that 'mechanical AI', or AI seeking to maximizing efficiency is particularly useful for delivery tasks undertaken by drones, rather than that of 'feeling AI' (an AI that learns to create personalized relationships) most applicable to service tasks. We surmise that drones could also employ 'feeling AI' to interact with consumers in a more personalized way, such as when dropping samples into shopping carts or delivering products to homes. AI in drones could, for example, assess whether consumers are potentially scared of the drone and offer empathetic reassurances about its safety. Such interactions would also likely increase concerns around privacy, requiring further research into the benefits and harms of aerial drones.

6. Conclusion

As drones are poised to transform both marketing and our skies, our findings provide a timely assessment of the benefits and harms of this technology and underscores the need for three-pronged comprehensive safeguards that span technical, policy, and inclusive public aspects. As we look to the future, more research is needed to understand the range of implications that commercial aerial drones – and other SOIs – bring to companies, consumers, and society at large.

CRediT authorship contribution statement

Stefanie Beninger: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Karen Robson:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This research was supported by internal grants and funding from two of the authors' affiliated institutions, IE University, Spain and the University of Windsor, Canada.

References

Adams, R., Jeanrenaud, S., Bessant, J., Denyer, D., & Overy, P. (2016). Sustainability-oriented innovation: A systematic review. *International Journal of Management Reviews, 18*(2), 180–205.

Ahmad, W., Saeed, S., Janovská, K., Rizomyliotis, I., & Ahmed, S. (2024). Radical product sustainability oriented innovation (SOI) and triple-bottom-line (3BL) performance: Findings from Malaysian and Singaporean B2B firms. *Industrial Marketing Management, 117*, 457–466.

Al-Emran, M., & Griffy-Brown, C. (2023). The role of technology adoption in sustainable development: Overview, opportunities, challenges, and future research agendas. *Technology in Society, 73*(May), 1–6.

Allen, K. (2014, December 10). TGIFridays drone delivers Bloody 'Mistletoe Mischief'. CNBC. Retrieved from https://www.cnbc.com/2014/12/08/tgi-fridays-mistletoe-drone-chips-tip-off-customers-nosej.html.

Arterburn, D., Ewing, M., Prabhu, R., Zhu, F., & Francis, D. (2017). FAA UAS Center of Excellence Task A4: UAS ground collision severity evaluation. United States Federal Aviation Administration.

Asadi, K., Suresh, A., Ender, A., Gotad, S., Maniyar, S., Anand, S., & Wu, T. (2020). An integrated UGV-UAV system for construction site data collection. *Automation in Construction, 112*, Article 103068.

Baltrus, A. (2014, May 5). Drone harasses Bighorn Sheep at Zion National Park. National Park Service. Retrieved from https://www.nps.gov/zion/learn/news/droneharassesbhs.htm.

Beninger, S., & Robson, K. (2020). The disruptive potential of drones. *Marketing Letters, 31*(4), 315–319.

Berthon, P., Pitt, L., & Campbell, C. (2019). Addictive de-vices: A public policy analysis of sources and solutions to digital addiction. *Journal of Public Policy & Marketing, 38*(4), 451–468.

Bi, F. (2015, February 23). Drones are intercepting cell phone signals in L.A. Forbes. Retrieved from https://www.forbes.com/sites/frankbi/2015/02/23/drones-are-already-intercepting-cell-phone-signals-in-l-a/#4f87dd56db26.

Bilton, N. (2016). *January 27)*. The New York Times: When your neighbor's drone pays an unwelcome visit. Retrieved from https://www.nytimes.com/2016/01/28/style/neighbors-drones-invade-privacy.html?r=0.

Boccadoro, P., Striccoli, D., & Grieco, L. A. (2021). An extensive survey on the Internet of Drones. *Ad Hoc Networks, 122*(Nov), Article 102600.

Braun, V., Clarke, V., & Gray, D. (2017). Innovations in qualitative methods. In V. Braun, V. Clarke, D. Gray, & C. Bourne (Eds.), *The Palgrave handbook of critical social psychology* (pp. 243–266). Palgrave Macmillan.

Braun, V., Clarke, V., Boulton, E., Davey, L., & McEvoy, C. (2021). The online survey as a qualitative research tool. *International Journal of Social Research Methodology, 24*(6), 641–654.

Buchelt, A., Adrowitzer, A., Kieseberg, P., Gollob, C., Nothdurft, A., Eresheim, S., & Holzinger, A. (2024). Exploring artificial intelligence for applications of drones in forest ecology and management. *Forest Ecology and Management, 551*(1), Article 121530.

Capon, N., & Glazer, R. (1987). Marketing and technology: A strategic coalignment. *Journal of Marketing, 51*(3), 1–14.

CB Insights. (2019). From retailers to insurance providers, here are 21 corps using drone tech today. Retrieved from https://www.cbinsights.com/research/report/corporations-drone-technology/#intel.

Chandy, R., Johar, G., Moorman, C., & Roberts, J. (2021). Better marketing for a better world. *Journal of Marketing, 85*(3), 1–9.

Choe, J. Y., Kim, J. J., & Hwang, J. (2021). Innovative marketing strategies for the successful construction of drone food delivery services: Merging TAM with TPB. *Journal of Travel & Tourism Marketing, 38*(1), 16–30.

Chung, L. K., Cheung, Y., Lagman, C., Au Yong, N., McBride, D. Q., & Yang, I. (2017). Skull fracture with effacement of the superior sagittal sinus following drone impact: A case report. *Child's Nervous System, 33*, 1609–1611.

Corbin, J., & Strauss, A. (2008). *Basics of qualitative research: Grounded theory procedures and techniques* (3rd ed.). Sage.

de Miguel Molina, B., & Segarra Oña, M. (2018). The drone sector in Europe. In B. de Miguel Molina, & M. Segarra Oña (Eds.), *Ethics and civil drones: European policies and proposals for the industry* (pp. 7–33). Springer.

Dijkstra, A., & Schuijff, M. (2016). Public opinions about human enhancement can enhance the expert-only debate: A review study. *Public understanding of science, 25*(5), 588–602.

Ditmer, M., Vincent, J., Werden, L., Tanner, J., Laske, T., Iaizzo, P., & Fieberg, J. (2015). Bears show a physiological but limited behavioral response to unmanned aerial vehicles. *Current Biology, 25*(17), 2278–2283.

Fortune Business Insights. (2022, May 4). Commercial drone market worth USD 47.38 billion by 2029. Globe Newswire. Retrieved from https://www.globenewswire.com/news-release/2022/05/24/2448921/0/en/Commercial-Drone-Market-Worth-USD-47-38-Billion-by-2029-Increasing-Demand-for-Small-Drones-in-Commercial-Applications-to-Propel-Market-Growth-Fortune-Business-Insights.html.

Foxman, E., & Kilcoyne, P. (1993). Information technology, marketing practice, and consumer privacy: Ethical issues. *Journal of Public Policy and Marketing, 12*(1), 106–119.

Fraser, A. (2017, September 14). 'The whites have brought planes': Perceptions of drones in Malawi. Impakter. Retrieved from https://impakter.com/whites-brought-planes-perceptions-drones-malawi/.

Gaia Consulting Oy. (2021). *The potential benefits of drone delivery in Helsinki*. Finland: Research report.

Greenberg, A. (2016, March 2). Hacker says he can hijack a $35k police drone a mile away. Wired. Retrieved from https://www.wired.com/2016/03/hacker-says-can-hijack-35k-police-drone-mile-away.

Grewal, D., Noble, S. M., Roggeveen, A. L., & Nordfalt, J. (2020a). The future of in-store technology. *Journal of the Academy of Marketing Science, 48*, 96–113.

Grewal, D., Hulland, J., Kopalle, K., & Karahanna, E. (2020b). The Future of Technology and Marketing: A Multidisciplinary Perspective. *Journal of the Academy of Marketing Science, 48*, 1–8.

Hillyard, P., & Tombs, S. (2004). Beyond criminology. In P. Hillyard, C. Pantazis, S. Tombs, & D. Gordon (Eds.), *Beyond criminology: Taking harm seriously* (pp. 10–29). Pluto Press.

Hoffman, D., Moreau, C. P., Stremersch, S., & Wedel, M. (2022). The rise of new technologies in marketing: A framework and outlook. *Journal of Marketing, 86*(1), 1–6.

Hoyer, W., Kroschke, M., Schmitt, B., Kraume, K., & Shankar, V. (2020). Transforming the customer experience through new technologies. *Journal of Interactive Marketing, 51*(1), 57–71.

Huang, M.-H., & Rust, R. (2021). Engaged to a robot? The role of AI in service. *Journal of Service Research, 24*(1), 30–41.

Hwang, J., Lee, J.-S., & Kim, H. (2019). Perceived innovativeness of drone food delivery services and its impacts on attitude and behavioral intentions: The moderating role of gender and age. *International Journal of Hospitality Management, 81*, 94–103.

Jack, E., & Raturi, A. (2006). Lessons learned from methodological triangulation in management research. *Management Research News, 29*(6), 345–357.
Jaupi, J. (2022, April 13). Amazon '30 minute flying deliveries' delayed after drone shot down. Newsweek. Retrieved from https://www.newsweek.com/amazon-delivery-drone-shot-down-alabama-tornadoes-amazons-drone-launch-delayed-1687753.
Jaramillo, F., Shih, K., & Cheng, C. (2019). Can drones deliver food? What the food delivery industry needs to know. *International Journal of Performance Measurement, 9*(2), 41–62.
John, G., Weiss, A., & Dutta, S. (1999). Marketing in technology-intensive markets: Toward a conceptual framework. *Journal of Marketing, 63*, 78–91.
Kemper, J. A., & Ballantine, P. W. (2019). What do we mean by sustainability marketing? *Journal of Marketing Management, 35*(3–4), 277–309.
Khan, R., Tausif, S., & Malik, A. (2019). Consumer acceptance of delivery drones in urban areas. *International Journal of Consumer Studies, 43*(1), 87–101.
Kiernan, K. (2019, February 21). How much of a threat do drones pose to air travel? Here's what you should know. *Forbes*.
Kull, A. J., Mena, J. A., & Korschun, D. (2016). A resource-based view of stakeholder marketing. *Journal of Business Research, 69*(12), 5553–5560.
Leone, D., Schiavone, F., Appio, F. P., & Chiao, B. (2021). How does artificial intelligence enable and enhance value co-creation in industrial markets? An exploratory case study in the healthcare ecosystem. *Journal of Business Research, 129*, 849–859.
Lim, W. (2016). A blueprint for sustainability marketing: Defining its conceptual boundaries for progress. *Marketing Theory, 16*(2), 232–249.
Little, V. J., Holmlund, M., Polsa, P., & Naidu, M. (2023). Towards more resilient food production systems: Implementing sustainability-oriented innovation. *Journal of Cleaner Production, 385*, Article 135708.
McNabb, M. (2020, June 23). DRONEII: The drone market from 2020-2025, five key takeaways. *Dronelife*. Retrieved from https://dronelife.com/2020/06/23/droneii-the-drone-market-from-2020-2025-five-key-takeaways/.
Mele, C., & Russo-Spena, T. (2022). The architecture of the physical customer journey: A dynamic interplay between systems of insights and systems of engagement. *European Journal of Marketing, 56*(1), 72–91.
Odekerken-Schröder, G., Mennens, K., Steins, M., & Mahr, D. (2021). The service triad: An empirical study of service robots, customers and frontline employees. *Journal of Service Management, 33*(2), 246–292.
O'Donovan, C. (2022). June 20). Amazon drones are coming to town. Some locals want to shoot them. Retrieved from *The Washington Post.* https://www.washingtonpost.com.
Osburg, V.-S., Yoganathan, V., Kunz, W. H., & Tarba, S. (2022). Can (A) I give you a ride? Development and validation of the CRUISE framework for autonomous vehicle services. *Journal of Service Research, 25*(4), 630–648.
Paine, G. (2019, May 4). Drones to deliver incessant buzzing noise, and packages. The Conversation. Retrieved from https://theconversation.com/drones-to-deliver-incessant-buzzing-noise-and-packages-116257.
Peer, E., Brandimarte, L., Samat, S., & Acquisti, A. (2017). Beyond the Turk: Alternative platforms for crowdsourcing behavioral research. *Journal of Experimental Social Psychology, 70*, 153–163.
Plangger, K., Grewal, D., de Ruyter, K., & Tuck, C. (2022). The future of digital technologies in marketing: A conceptual framework and an overview. *Journal of the Academy of Marketing Science*, 1–10.
Quach, S., Thaichon, P., Martin, K., Weaven, S., & Palmatier, R. (2022). Digital technologies: Tensions in privacy and data. *Journal of the Academy of Marketing Science, 50*(6), 1299–1323.
Raj, A., Mukherjee, A., de Sousa Jabbour, A., & Srivastava, S. (2022). Supply chain management during and post-COVID-19 pandemic: Mitigation strategies and practical lessons learned. *Journal of Business Research, 142*, 1125–1139.
Ramirez, E. (2013). Consumer-defined sustainably-oriented firms and factors influencing adoption. *Journal of Business Research, 66*(11), 2202–2209.
Rebolo-Ifrán, N., Grana Grilli, M., & Lambertucci, S. A. (2019). Drones as a threat to wildlife: YouTube complements science in providing evidence about their effect. *Environmental Conservation, 46*(3), 205–210.
Rejeb, A., Rejeb, K., Simske, S. J., & Treiblmaier, H. (2023). Drones for supply chain management and logistics: A review and research agenda. *International Journal of Logistics Research and Applications, 26*(6), 708–731.
Shenton, A. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information, 22*(2), 63–75.
Singh, I. (2022, May 4). No criminal charges in drone crash that caused 52-acre Colorado fire. DroneDJ. Retrieved from https://dronedj.com/2022/05/04/drone-crash-colorado-fire/.
Sham, R., Chong, H., Aw, E., Thangal, T., & Abdamia, N. (2023). Switching up the delivery game: Understanding switching intention to retail drone delivery services. *Journal of Retailing and Consumer Services, 75*.
Stolaroff, J., Samaras, C., O'Neill, E., Lubers, A., Mitchell, A., & Ceperley, D. (2018). Energy use and life cycle greenhouse gas emissions of drones for commercial package delivery. *Nature Communications, 9*(1), 409.
Tangermann, V. (2021). Light show goes wrong when drones start plummeting out of the sky. Retrieved from *The Byte.* https://futurism.com/the-byte/light-show-dr ones-plummeting-sky.
Tollin, K., & Christensen, L. (2019). Sustainability marketing commitment: Empirical insights about its drivers at the corporate and functional level of marketing. *Journal of Business Ethics, 156*, 1165–1185.
Torija, A., Li, Z., & Self, R. (2020). Effects of a hovering unmanned aerial vehicle on urban soundscapes perception. *Transportation Research Part D: Transport and Environment, 78*, Article 102195.
United Nations. (2021). Sustainable transport, sustainable development. Interagency report for second Global Sustainable Transport Conference. Retrieved from https://sdgs.un.org/sites/default/files/2021-10/Transportation%20Report%202021_FullReport_Digital.pdf.
United Nations. (2024). The 17 goals. Retrieved May 14, 2024, from https://sdgs.un.org/.
van Doorn, J., Mende, M., Noble, S., Hulland, J., Ostrom, A., Grewal, D., & Petersen, J. (2017). Domo arigato Mr. Roboto: Emergence of automated social presence in organizational frontlines and customers' service experiences. *Journal of Service Research, 20*(1), 43–58.
Woodside, A. G., Golfetto, F., & Gibbert, M. (2008). *Customer value: Theory, research, and practice. In Creating and managing superior customer value* (pp. 3–25). Emerald Group Publishing Limited.
World Food Programme. (2024). Using drones to deliver critical humanitarian aid. Retrieved from https://drones.wfp.org/updates/using-drones-deliver-critical-humanitarian-aid.
Yadav, M., & Pavlou, P. (2020). Technology-enabled interactions in digital environments: A conceptual foundation for current and future research. *Journal of the Academy of Marketing Science, 48*, 132–136.

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