Universiteit Leiden
The Netherlands

Lifeguards in the sky: examining the public acceptance of beach-rescue drones

Real, C. del; Díaz-Fernández, A.M.

Citation
Real, C. del, & Díaz-Fernández, A. M. (2021). Lifeguards in the sky: examining the public acceptance of beach-rescue drones. *Technology In Society, 64*, 101502. doi:10.1016/j.techsoc.2020.101502

Version: Accepted Manuscript
License: Leiden University Non-exclusive license
Downloaded from: https://hdl.handle.net/1887/3485751

Note: To cite this publication please use the final published version (if applicable).

Lifeguards in the Sky: Examining the Public Acceptance of Beach-Rescue Drones

Cristina Del-Real[1]*, Antonio M. Díaz-Fernández[1]

[1]Department of International Public, Criminal and Procedural Law, Jerez de la Frontera, Cádiz, Spain

Correspondence: cristina.delreal@uca.es

Abstract: The use of rescue drones is expected to increase in forthcoming years. However, the success of their implementation through different applications will depend on public acceptance. Studies to date have analyzed public support for the use of drones with various applications. However, public acceptance of drones in specific contexts remains to be explored. In particular, the use of drones for beach rescues has proven beneficial in reducing response times, thus helping to save lives. In this study, we analyze the public acceptance of lifesaving drones and their influencing variables. Data collected from a survey of beach users (N = 3363) for this study are used to measure public acceptance of rescue drones. We found that public acceptance of rescue drones is moderate, with approximately half of all participants accepting their use. In terms of influencing variables, we found that the factors most associated with their use are 'perceived benefits' and 'perceived risks'. We also found that the participants from beaches without lifeguard services were more likely to accept the use of rescue drones. These results initiated a discussion on the variables that are associated with the public acceptance in the specific context of lifesaving. In addition, based on the results of this study, we propose implementation plans for rescue drones that might also include public information campaigns on their benefits for beach users.

Keywords: Lifeguarding; unmanned aerial vehicle; drones; perceived benefits; perceived risks; technology acceptance.

Citation: Del-Real, C., & Díaz-Fernández, A. M. (2021). Lifeguards in the sky: Examining the public acceptance of beach-rescue drones. *Technology in Society, 64*, 101502.

1. Introduction

The use of drones for safety and emergency applications is no longer a matter of whether, but when and where. Both questions, beyond the legal regulation of drones [1], [2], depend on whether the public would accept their use. Although drones have been used since the 20th century for military purposes [3], it was not until the early 21st century that their use increased, for which reason they can be defined as an 'emerging technology' [4]. According to Rotolo *et al.* [5], emerging technologies are characterized by their radical novelty, relatively fast growth, prominent impact, uncertainty, and ambiguity. Due to these characteristics, the public acceptance of emerging technologies –such as drones– is difficult to ascertain.

Understanding whether the use of drones would be accepted by the public is important for policymakers, safety and emergency agencies, and the industry. First, it is important for

policymakers who take their decisions based on public attitudes, especially towards public safety [6]. Second, without a careful analysis of public acceptance and the design of an implementation plan, the public might perceive that safety and emergency services are making unlawful use of drones, compromising public confidence in safety and emergency agencies [7]–[9]. Third, public rejection might result in negative publicity for the commercialization of drones, negatively affecting the market [10]. Accordingly, the successful implementation of a drone project will have to take account of public acceptance towards drones and other influencing variables.

Within the general field of safety and emergencies, the use of drones has been explored, particularly for search and rescue applications [11], [12], such as shark sightings from the shore [13], [14], distress in athletics competitions [15], beach usage [16], and crowd control [17]. In Spain, a highly tourist-dependent country, rescue drones can be implemented for surveillance, and search and rescue tasks along its 5978 km of coastline. According to the National Drowning Report of the Royal Spanish Lifesaving Federation, 440 people died in Spain from drowning in 2019, amounting to a total of 2,146 since 2015. Among these incidents, approximately 50% took place on beaches, and over 80% in situations without lifeguard services. In these cases, the lack of surveillance can be understood as one of the main causes of drowning. Since drowning typically occurs on isolated beaches, situated far from urban environments, the absence of lifeguard services is, in some cases, accompanied by the absence of other beachgoers who might otherwise be able to assist the person at risk of drowning.

Rescue drones offer rescue services with some advantages over human lifeguards. Firstly, rescue drones can control larger areas since they operate from the sky. Secondly, rescue drones are faster, thus reducing the response time to an off-shore emergency at sea. Thirdly, rescue drones can operate under conditions that might be too dangerous for human rescuers, thus preventing further loss of life in emergency situations. Finally, rescue drones can, through smart sensors, gather useful information for future interventions. However, despite their many advantages, rescue drones are not extensively used in practice [18].

A solid understanding of public acceptance of drones is important to ensure their successful implementation [19], [20]. Most public acceptance studies have analyzed the factors that determine whether an individual would adopt and use a specific technology. Among the technologies under analysis, studies can be found on the factors that determine the acceptance of mobile applications [21]–[24], Internet services [25], [26], and robots [27]–[32]. However, public acceptance of technologies used by such institutions as the police or the emergency services has been addressed in fewer studies. Studies on public acceptance of drones are among the exceptions. Empirical research conducted to date has explored a number of issues related to drone use, such as the best accepted definition of a drone [33], [34], the influence of knowledge, risk perception, and socio-demographic factors on acceptance [35], and the type of use that might receive the most public support [36].

So far, we are unaware of any study in Spain that has analyzed the public acceptance of the use of drones for rescue purposes. This study is the first empirical approach to the public acceptance of beach-rescue drones in the Spanish context. It is, to date and to the best of the authors' knowledge, the only study to have been focused on the specific field of lifeguards. The aim of this study is to understand whether beach users in Spain would accept the use of lifesaving drones, as well as the factors that may be associated with public

acceptance. In the background section, previous research on public acceptance of the use of drones will be summarized. We will then present the objectives and hypotheses for this study. In the methodology section, we will describe the variables, the sample and the procedure carried out to implement the questionnaire and to analyze the data. The results will then be presented and discussed in relation to previous research on the public acceptance of drones. Finally, the potential implications of the results obtained for future projects on the implementation of rescue drones will be discussed.

2. Literature review

Studies conducted on public acceptance of drones differ slightly from those conducted on other technologies such as mobile phones [22] or robots [28], [31]. Studies on the acceptance of drone use by third parties are addressed using two approaches. On the one hand, the comparative analysis of drone use by situations and, on the other, the risk perception, privacy concerns, and perceived benefits associated with drone use. Both approaches are discussed in the following paragraphs.

2.1. Usage context-dependent public acceptance

The research review by the authors suggests that the public acceptance of drones will depend on the usage context, with most acceptance for drones expressed in relation to security-related applications –such as crime detection and investigation, national security defense, and emergency search and rescue [36]–[38]. A survey conducted in the US found that 80% of respondents would support the use of drones for search and rescue missions, followed by other policing activities such as tracking criminals, giving speeding tickets, and controlling illegal immigration [39]. These results were later confirmed in another study [37], which revealed that 57% out of a sample of 2,119 participants supported the use of drones for all applications, search and rescue (88%), homeland security (67%), and fighting crime (63%); areas with greater support than, for example, commercial applications (61%). Thompson and Bracken-Roche [40] in Canada affirmed that 75.3% of participants would accept the use of drones for search and rescue operations.

However, public acceptance was lower when drones were used by private corporations, industry, or law enforcement agencies for routine policing activities –e.g., issuance of speeding tickets and routine patrols [41]–. In a later study on the acceptance of drones with five different policing applications, it was found that 94% of the sample population would accept the use of drones for search and rescue operations, and 76% for border patrol [42]. However, the acceptance levels decreased when drones were used for detection of criminal activity in open public spaces (57%) or for mass control (47%). In the same vein, in the study conducted by Lidynia *et al.* [43], participants reported the acceptance of a drone flying over their property only in rescue and emergency situations. These results were later confirmed in other studies, in which military and policing applications were seen as more acceptable when compared with others, such as hobby-related, commercial, delivery, and scientific applications [35], [36]. In particular, positive attitudes towards search and rescue, delivery of rescue floats, and emergency response applications were found among participants [35]. These results contrast with other studies that found low public support for drones with security functions [34], [44]. Similar results may be foreseen in the Spanish

context, and our initial expectation was that the sample population would express general acceptance towards the use of drones for beach-rescue applications.

2.2. Perceived risks and benefits

Second, we also found a considerable amount of research that was aimed at measuring the perceived risks and privacy concerns regarding the use of drones. In general, these studies follow the general pattern described in a consistent manner in social science studies: people make their decisions based on their motivation to avoid loss or to prevent damage rather than to gain or to promote benefits [45], [46]. The concept used in the literature on public perception of drones is 'risk perception'. Risk perception is described by Renn and Benighaus [47] as the processing of 'physical signals and/or information about potential hazards and risks associated with a technology and the formation of a judgment about seriousness, likelihood, and acceptability of this technology'.

Studies have found that risk perception depends mainly on the applications of the drone rather than on its characteristics or conditions of use, such as who is piloting it. As such, Clothier *et al.* [33] found no significant differences in risk perception between autonomous and manned aircraft, and concluded that risk perception for both cases was low. Lidynia *et al.* [43] in their study in Germany found that respondents' knowledge that an accredited pilot was controlling the drone had no effect on their risk perception, and concluded that the most important barrier to the acceptance of drones was the anonymity of the pilot [43]. Consistently, Klauser and Pedrozo [36] found that between 28 and 36% of participants associated privacy issues with the use of military or police drones, an association that rose to 62% in the case of commercial and hobby drones. However, more recent studies have found that the perceived privacy risks of drone use were overwhelming [44] [4]. In particular, Nelson *et al.* [4] found a greater concern for privacy when drones are used by the government rather than, in comparison, private or commercial firms.

Finally, the influence of the perception of benefits has also been explored in the literature of public acceptance of drones, although less extensively than risk perception. In his study, Boucher [48] found that public acceptance of civil drones depended on the perception of social benefit, which in turn was related to the perceived legitimacy attributed to the pilot. The same result was reached by Thompson and Bracken-Roche [40] in Canada. The authors found that participants were more likely to accept the use of drones for those applications involving helping people at risk. Lastly, Russell [49] in his doctoral dissertation, evaluated the influence of perceived benefits among fire chiefs on the adoption of drones, and determined that perceived benefits to operations was a predictor of their adoption. Based on the research conducted to date, we expect to find low levels of risk perception and higher levels of perception of benefits towards the use of drones for rescue purposes. We also expect to find a positive association between public acceptance of rescue drones and the perception of benefits and a negative association with the perception of risks.

2.3. Attitudes

Together with perceived benefits and perceived risks, attitudes toward technology is the other factor that has been explored more than any other in the literature on the public acceptance of technologies [10]. Attitudes towards a technology have been defined as the

result of weighing up non-separate beliefs [50]. Likewise, the perception of benefits and the perception of risks have been studied as mediating factors within those attitudes [51], as well as factors that directly influence the public acceptance of technologies [10]. Research on drones has found that the general public express neutral or consenting attitudes, rather than negative attitudes toward drones [43]. Negative public attitudes toward the use of drones are related to concerns about drones flying overhead and privacy violations whenever a drone may be equipped with cameras [43], [52]. In the context of a dedicated beach-rescue drone equipped with cameras and other smart sensors, it will in all probability circulate over bathers, to monitor those at risk of drowning and, if necessary, to rescue an individual by dropping a lifejacket. People who express neutral or positive attitudes towards the fact that a drone is flying over them or filming them may be expected to show higher levels of acceptance of this technology when compared to those with negative attitudes towards the deployment of drones flying over a beach.

2.4. Individual differences

Individual factors have been also explored in the literature of public perceptions towards the use of drones [10]. In general, differences in perceptions according to age and gender are the two variables that have been explored most of all. Research has found that older people are more supportive of the use of drones compared to younger people, especially for rescue and emergency uses [42], [52]. With regard to gender, research has shown that women are less supportive of drone use and more concerned about privacy than men [35], [42], [53]. In contrast, educational levels of interviewees appear to have no effect on their public perceptions of drones [35], [42]. In addition to the above-mentioned socio-demographic characteristics – in the specific context of beach rescue –, it is expected that other personal variables may be associated with the rejection or acceptance of drones, such as the number of children under supervision at a beach, levels of self-confidence at swimming, drowning rescue training and first-aid skills when assisting a person at risk of drowning, and familiarity with the beach where the rescue drone may be deployed. However, little or no research that explores the association of those variables with public acceptance of rescue drones has been found. Thus, despite its relevance, the number of children under supervision has scarcely been considered as a variable that links supervision to child-injury risk on beaches and other aquatic environments [54]–[56]. Lack of appropriate supervision is a persistent risk factor in most drowning incidents on beaches that involve children and is always associated with a high risk of drowning when swimming. However, little is known about parent or child-carer supervisory practice and their perceptions of swimming safety at beaches [57]. We therefore expect to find that adults with children under their care will show higher levels of acceptance and will recognize the perceived benefits of the use of rescue drones on the beach.

Self-confidence has been explored, particularly in relation to child supervision and perceptions of risk in aquatic environments. Although there is still a major research gap, some research has shown that the self-confidence of parents reduces their perceptions of any need for supervision [58]. Specifically in open water environments –such as seaside beaches –, male parents were reported to be more likely to underestimate the risk, due to greater confidence in their own swimming fitness levels, estimated swimming competence, and the perception that they were safer in open water than others [59]. These results have

been corroborated in other studies with the general population, finding that personal self-confidence in swimming skills (swimming frequency, better self-reported swimming skills, and previous at-risk swimming behaviors) were all associated with lower perceptions of risk [60]. In concordance with these studies, we expect that perceived self-confidence and rescue capacity on the beach will be negatively related to public acceptance of rescue drones.

Finally, in a study on the acceptance of the use of drones for shark-bite mitigation, it was found to be more widely accepted among surfers, as they were the ones who frequented the beach more than any others [14]. In this study, we analyzed the frequency of beach use, to ascertain whether frequent beachgoers would show greater willingness to accept the use of drones as technological lifeguards.

In summary, research conducted to date has shown that public acceptance of drones is determined by usage context and perceptions of risk or benefit. However, we have found a lack of research on the factors influencing public acceptance of drones for specific uses, such as rescue and emergency. We consider further research focused on specific uses is required, as it would allow the exploration of additional variables associated with public acceptance, such as attitudes towards drones and socio-demographic characteristics. We believe that the association of these variables with the public acceptance of drones, despite having been included in other studies on public acceptance of technologies [10], should be further explored in specific user contexts. In this study we aim to deepen our understanding of the variables that influence public acceptance of drone use in the specific context of beach-rescue and off-shore sea emergencies.

3. The present study

Drones represent a technology of great potential for surveillance and rescue operations on beaches. However, there is still little empirical evidence on the nature of public opinion towards the use of drones in the context of rescue in Spain. Using a sample of 3363 respondents, the current study was designed to advance research into public opinions towards drones by pursuing three objectives: (1) to determine to what extent the public accepts the use of drones for search and rescue applications on beaches; (2) to determine whether public acceptance of rescue drones is associated with the perceived benefits, the perceived risks, the attitudes towards drones, the perception of self-confidence and the self-perceived rescue capacity; and, (3) to determine whether public acceptance of rescue drones differs across socio-demographic and context-dependent variables: specifically, the presence of human rescue services at the beach and the condition of having children under one's care.

4. Methodology

4.1. Questionnaire

An *ad hoc* questionnaire to assess public acceptance of the use of rescue drones on beaches and the associated factors was designed. The questionnaire was structured into eight sections containing 25 questions. Our dependent variable was the public acceptance of rescue drones, which we measured with two questions, one measuring the behavioral acceptance –question 3–, and the other measuring acceptance through judgement –question 4–. We used a 4-point

Likert scale to rate the responses (1 = 'strongly disagree', 2 = 'disagree', 3 = 'agree', and 4 = 'strongly agree').

The variables that determine the public acceptance of drones are scarcely explored. Research focused on specific applications of drones is even more limited. So, to define our independent variables we followed the few available studies on public acceptance of drones [8], [33], [43], which we complemented with previous research on public acceptance of other technologies [10], [28]. In the specific context of beach rescue, we expect the variables related to public acceptance of drones to be perceived risks, perceived benefits, attitudes towards drones, self-confidence at the beach, and perceived rescue self-efficacy. Along with the two items designed to measure our dependent variable – public acceptance – we developed 14 others to measure the independent variables – four for perceived benefits, three for perceived risks and self-confidence at the beach, and two for attitudes towards drones and self-perceived rescue capacity. The list of 16 items was examined through an exploratory factor analysis (EFA) to check its validity. The Kaiser-Meyer-Olkin measure of sampling adequacy was .79, above the commonly recommended value of .6, and Bartlett's test of sphericity was significant ($\chi 2$ (120) = 18826.1, $p < .001$). The communalities were all above .3 (see **Error! Reference source not found.**), further confirming that each item shared some common variance with other items. The factor loading matrix for the final solution is presented in **Error! Reference source not found.**. Composite scores were created for each of the six factors, based on the mean of the items which had their primary loadings on each factor.

Internal consistency for each of the scales was then examined using Cronbach's alpha. For all the factors, an alpha greater than .70 –the alpha recommended for exploratory studies– was obtained [61]. Additionally, we collected socio-demographic characteristics – sex, age and education level–, and the numbers of children under supervision at the beach when the data collection took place, in order to test individual differences related to the public acceptance of drones[i]. We also expected that public acceptance would be influenced by the number of years participants had been visiting the same beach, and the number of days they would visit the beach during the month of the fieldwork (August). Finally, we established whether or not the beach had lifeguard services. The entire survey and the Cronbach's alpha values are provided in

Appendix *A*.

Table 1. Factor loadings and communalities based on Principal Component Analysis (PCA) with varimax rotation for 16 items (N = 3356).

	Components[i]						Communalities
	1	2	3	4	5	6	
Even if rescue drones were used, I would still visit this beach	.89						.83
Even if rescue drones were used, I would still like this beach	.85						.85
A rescue drone would be useful to me, in case something happened to me on this beach	.52	.60					.67
A rescue drone would be useful, in general, for people, in case something happened to them on this beach	.50	.56					.61

	Components[i]						Communalities
	1	2	3	4	5	6	
Rescue on this beach would be improved by the drones		.75					.64
The rescue drones would reduce the number of drownings on this beach		.80					.67
A rescue drone is a dangerous object			.75				.68
It's very likely that a rescue drone will harm a person			.81				.67
It's very likely that a rescue drone will scare a person			.76				.65
If a rescue drone filmed me, it might bother me						.91	.83
If a rescue drone flied over me, it might bother me						.90	.82
I am a great swimmer				.76			.64
I feel absolutely safe when I bathe at this beach				.81			.66
I can always reach the shore under any circumstances				.79			.63
In case a child is drowning, I am fully capable of saving him/her					.90		.85
In case an adult is drowning, I am fully capable of saving him/her					.90		.85

Note: Rotation converged on 6 iterations. Factor loadings < .4 are suppressed. [i] Percentage of variance explained by each factor: Factor 1 = 2.6.5%; Factor 2 = 15.5%; Factor 3 = 10.2%; Factor 4 = 7.4%; Factor 5 = 7.4%; Factor 6 = 5.4%. Total percentage of variance explained = 72.22%. KMO = .787.

4.2. Participants

A total of 3925 beach users were surveyed in Cádiz –South of Spain–. We identified 562 cases as incomplete, so we removed them from the data set. Our final sample included 3363 beach users. 1579 men (47.1%) and 1777 women (52.9%), ranging from 10 years to 87 years of age (M = 39.7, SD = 15.7), and mostly from Spain (n = 3284, 97.9%), resident in the province of Cádiz (n = 2320, 69.1%). Out of the 68 foreign participants, 65.3% were European, 26.4% were from a South American country, one from North America (1.4%), and one from Australia (1.4%). We found that 79.9% had spent their summers on the same beach for at least five years, with a mean number of 19.5 years (SD = 15.8) visiting the same beach. The survey was carried out at five beaches in Cádiz: La Cortadura (n = 1044; 31.1%), La Victoria (n = 1068; 31.1%), La Caleta (n = 286; 6.6%), Santa María del Mar (n = 299; 5.2%), and Valdelagrana (n = 573, 17.1%). La Cortadura has no lifeguard services, unlike the other beaches (66.3% of the sample). The distribution of the characteristics of the sample can be found in Table 2. The frequencies and percentages corresponding to each category are shown for the categorical variables, while the range, the mean (M), the standard deviation (SD), and the median (Md) are displayed for the quantitative variables.

Table 2. Descriptive statistics for the socio-demographic and contextual variables (N = 3356).

Variable	*n*	*%*	*Min.*	*M*	*SD*	*Md*	*Max.*

Sex							
Male	1579	47.1					
Female	1777	52.9					
Age							
< 18	228	6.8					
18-25	561	16.7					
26-40	949	28.3					
41-64	1345	40.1					
> 64	273	8.1					
Total			10	39.7	15.7	40	87
Education							
None	180	5.4					
Primary school	569	17					
Secondary school	862	25.7					
Higher vocational education	551	16.4					
University	1183	35.3					
Minors at care							
No	2204	65.7					
Yes	1152	34.3					
Total			0	0.34	0.47	0	6
Nationality							
Spanish	3284	97.9					
Non-Spanish	68	2					
Beach							
La Cortadura	1044	31.1					
La Caleta	286	8.5					
La Victoria	1068	31.1					
Santa María del Mar	299	8.9					
Valdelagrana	573	17.1					
Availability of rescue services							
Yes	2226	66.3					
No	1044	31.1					
Years visiting the same beach			0	19.5	15.8	15	75
Days will visit the same beach			1	12.5	8.6	10	31

4.3. Data collection and analysis

The questionnaire was administered in August and September 2017 on the beaches of La Cortadura, La Victoria, La Caleta, Santa María del Mar and Valdelagrana, all of them located in the province of Cádiz (Spain) (see Note: * The interviewer noted the beach where the participant was surveyed.

Appendix *B*). Six undergraduate research assistants visited the beaches every day throughout August to identify possible participants. Each beach was divided into geographical zones at a distance of 50 meters from the beach-sea line and each zone was numbered. Every day, three zones were randomly selected from each of the beaches and the researchers – identifiable by their cap, t-shirt and backpack from the University of Cádiz – were informed of the three zones where they would administer the survey to the beach users. First, the beach users were asked to consent to their participation in a study conducted by the University of Cádiz. Potential participants then listened to an explanation of what an autonomous beach-rescue drone is and how it operates. They were presented with a scenario in which a drone processes video images that are interpreted to be of a drowning person and it therefore approaches the scene to drop a life-jacket. We then asked if they had understood the scenario. If they answered affirmatively, the questions were asked and their answers were collected using the *1ka* survey application [62]. All questions addressed the specific use of rescue drones on beaches. When the respondents were children, verbal consent was requested from their parents or carers, informing them that no private data from the children would be collected. Participation in the study was voluntary and no incentives were given to participants.

5. Results

5.1. Public acceptance of rescue-drones

The results showed that public acceptance of rescue drones was moderate (Min. = 1, M = 2.9, SD = .8, Md = 2.5, Max. = 4). Analyzing by questions, we found that the participants scored slightly higher on the question of whether they would still visit the beach, if the drones were used (Min. = 1, M = 2.9, SD = .9, Md = 3, Max. = 4), than on whether they would still like the beach (Min. = 1, M = 2.9, SD = .8, Md = 3, Max. = 4). The responses to whether they would also visit the beach are mostly concentrated on the options 'disagree' and 'strongly agree', as can be seen in Table 3. The responses to whether they would also like the beach, however, are more or less equally scattered between the options 'disagree' (n = 1051, 3%), 'agree' (n = 1249, 37.2%), and 'strongly agree' (n = 1015, 30.2%). Based on the results, both variables were significantly correlated, $r(3354) = .8$, $p < .001$.

In the analysis of the percentage of respondents who would accept the use of rescue drones, we created two dichotomous variables by grouping the responses 'strongly disagree' and 'disagree' as 0 = 'no', and 'agree' and 'strongly agree' as 1 = 'yes' for both questions – would still visit the beach, and would still like the beach–. Specifically, we found that 49.1% of participants (n = 1648) reported that in cases where rescue drones were used, they would still visit and like the beach. These are considered as *public acceptance* of rescue drones. On the other hand, 29.5% (n = 990) of the sample reported that they would neither visit nor like the beach were drones ever used, which can be understood as *rejection* of rescue drones. Finally, 18.4% (n = 616) of participants reported they would still like the beach, but would not visit it, were drones used, and only 3% (n = 102) reported that they would still visit the beach even though they would not like it. Both options are considered rejection of rescue drones.

In summary, we observed from the results that participants scored moderately on both the behavioral item –frequency of visit the beach– and the cognitive item –liking the beach-, suggesting that public acceptance of rescue drones is not only due to the resignation of participants wishing to frequent the beach that they can, but also to a real acceptance of the technology.

Table 3. Descriptive statistics for the study variables (N = 3356)

Variable	Strongly disagree		Disagree		Agree		Strongly agree		*M*	*SD*
	n	%	n	%	n	%	n	%		
Public acceptance (PA)									2.97	.84
Even if rescue drones were used, I would still visit this beach	20	.6	1586	47.3	181	5.4	1569	46.8	2.98	.98
Even if case rescue drones were used, I would still like this beach	41	1.2	1051	31.3	1249	37.2	1015	30.2	2.96	.82
Perceived benefits (PB)									2.73	.70
A rescue drone would be useful to me, in case something happened to me on this beach	166	4.9	1710	51	584	17.4	896	26.7	2.66	.93
A rescue drone would be useful, in general, for people, in case something happened to them on this beach	130	3.9	1632	48.6	558	16.6	1036	30.9	2.74	.94
Rescue on this beach would be improved by rescue drones	60	1.8	1468	43.7	942	28.1	886	26.4	2.79	.85
Rescue drones would reduce the number of drownings on this beach	77	2.3	1668	49.7	722	21.5	889	26.5	2.72	.88
Perceived risk (PR)									1.79	.49
A rescue drone is a dangerous object	1003	29.9	2182	65	111	3.3	60	1.8	1.77	.59
It's very likely that a rescue drone will harm a person	1328	39.6	1805	53.8	209	6.2	14	0.4	1.67	.61
It's very likely that a rescue drone will scare a person	714	21.3	2235	66.6	347	10.3	60	1.8	1.93	.62
Attitudes towards drones (AT)									1.95	.71
If a rescue drone filmed me, it might bother me	876	26.1	1907	56.8	296	8.8	277	8.3	1.99	.82
If a rescue drone flew over me, it might bother me	970	28.9	1877	55.9	363	10.8	146	4.4	1.91	.75
Self-confidence at the beach (SC)									2.21	.60
I am a great swimmer	442	13.2	2174	64.8	596	17.8	144	4.3	2.13	.68
I feel absolutely safe when I bathe at this beach	271	8	2125	63.3	478	14.2	483	14.4	2.35	.82
I can always reach the shore under any circumstances	413	12.3	2233	66.5	412	12.3	298	8.9	2.18	.75
Self-perceived rescue capacity (RC)									1.94	.67
In case a child is drowning, I am fully capable of saving him/her	702	20.9	2135	63.6	409	12.2	110	3.3	1.98	.68
In case an adult is drowning, I am fully capable of saving him/her	1020	30.4	1727	51.5	481	14.3	128	3.8	1.92	.77

5.2. Factors associated with the public acceptance of rescue-drones

The correlations between the public acceptance of rescue-drones and all the dependent variables were examined using Pearson's correlation matrix that is summarized in Table *4*. Strong correlations were found between public acceptance and perceived benefits and between public acceptance and perceived risks. However, correlation scores can only indicate that variables are related, but cannot provide the direction of such influence. We therefore performed a OLS regression analysis to respond to our second objective (Durbin Watson = 1.8; VIF for all variables ranging from 1 to 1.5).

Table 4. Correlation matrix for study variables

	PA	PB	PR	AT	SC	RC	Children	Age	Years	Days
PA	-									
PB	.60**	-								
PR	-.39**	-.47**	-							
AT	-.07**	-.09**	.16**	-						
SC	.07**	.05**	-.04*	-.08**	-					
RC	.00	.00	.00	-.08**	.35**	-				
Children	.00	.00	.02	.02	.00	.05**	-			
Age	.01	.01	.09**	.13**	-.15**	-.12**	.13**	-		
Years	.02	.00	.04*	-.01	-.09**	-.05**	.06**	.44**	-	
Days	-.04*	-.08**	.10**	-.02	.01	-.01	.00	.13**	.36**	-

Note: significant correlations at levels $^{**}p<0.01$ and $^{*}p<0.05$.

The results of the OLS regression are summarized in Table 5. We found that the variable perceived benefits was associated with greater public acceptance of rescue drones. Conversely, the variable perceived risks was associated with lower public acceptance of rescue drones. We obtained these results regardless of whether the beach has human lifeguard services. We also observed that self-confidence in one's own swimming skills was slightly associated with greater public acceptance of human-rescue services on the beaches. In spite of having obtained significant associations between social acceptance and attitudes towards drones [X^2 (36, n = 3356) = 217.9, $p < .001$], self-perceived rescue capacity [X^2 (36, n = 3356) = 160.5, $p < .001$], and number of children under care [X^2 (36, n = 3356) = 58.4, $p < .05$] in the bivariate analyses, the results for the OLS regression were not significant for these variables. This model explains 37% of the variance in public attitudes towards rescue drones and their acceptance.

Table 5. OLS regression model for the public acceptance of rescue drones for the total sample and depending on the availability of human rescue services on the beach.

		Human rescue services at the beach	
	General	**Yes**	**No**

Variable	*B*	SE	*B*	SE	*B*	SE
Constant	1.59	.11	1.48	.13	1.71	.20
Perceptions towards drones						
Perceived benefits	.64***	.02	.66***	.02	.61***	.04
Perceived risks	-.25***	.03	-.25***	.04	-.30***	.05
Attitudes	.00	.02	.01	.02	-.00	.03
Individual characteristics						
Self-confidence	.05**	.02	.06**	.03	.03	.04
Perceived rescue capacity	-.01	.02	-.02	.02	.00	.03
Number of children in care	.00	.01	-.00	.01	.02	.03
Age	.00	.00	.00	.00	-.00	.00
Context						
Years visiting the beach	.01	.00	.00	.00	.00	.00
Days spend at the beach	.01	.00	.00	.00	.00	.00
RSE	.67		.66		.67	
R^2	.38		.38		.38	
Adjusted R^2	.37		.38		.37	
No. observations	3284		2187		1017	

Note: *B* = unstandardized coefficient, SE = standard error. ** $p < .05$, *** $p < .001$.

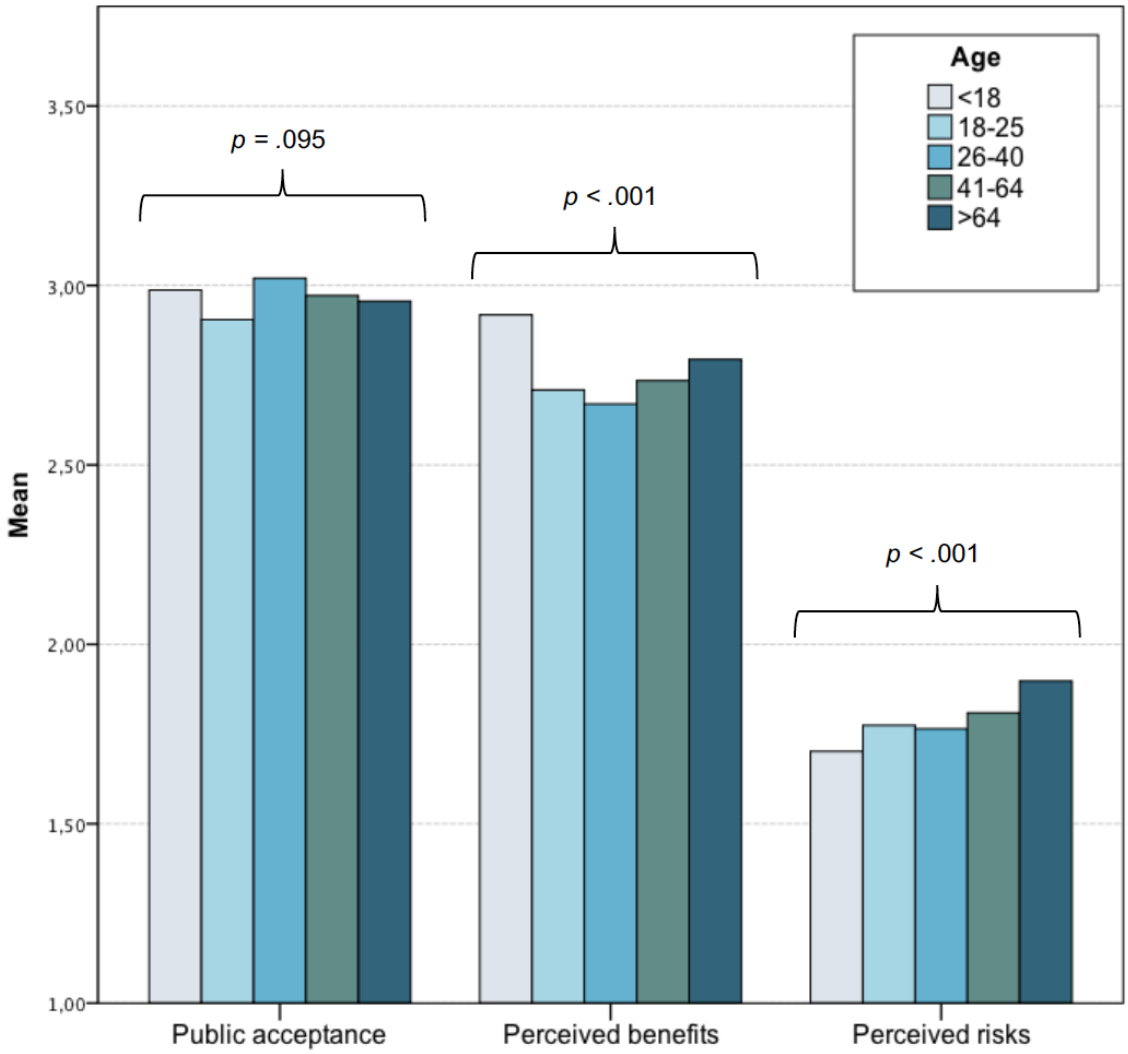
5.3. Socio-demographic and contextual differences

We carried out T-student and ANOVA tests to explore the different levels of public acceptance of drones according to socio-demographic and contextual variables. We found that the levels of public acceptance towards rescue drones reported by both male and female participants hardly differed, $t(3354) = -.014$, $p = .99$. Neither educational level [$F(3, 3340) = 1.09$, $p = .36$] nor children under supervision [$t(3354) = -1.23$, $p = .22$] were associated with significantly different levels of drone acceptance. However, we did find statistically significant differences according to the nationality, and the presence of rescue services at the beach. Specifically, we found that Spanish beachgoers would accept the implementation of rescue drones ($M = 2.9$; $SD = .8$) to a greater extent than non-Spanish beachgoers ($M = 2.7$; $SD = .9$); $t(3350) = -2.4$, $p < .05$; $d = -.3$. Regarding the presence of rescue services at the beach, participants from beaches with lifeguard services reported lower levels of public acceptance ($M = 2.9$; $SD = .8$), than those surveyed on beaches without rescue services ($M = 3.04$; $SD = .8$); $t(3269) = 2.5$, $p < .05$; $d = .1$. Assuming a significance level of $\alpha = .05$, Levene's test indicated unequal variances for the age ($F = 2.6$, $p = .03$), so we conducted the non-parametric Kruskal-Wallis test. We found no significant differences for drone acceptance across age groups ($X^2 = 7.9$, $p = .095$) (see Figure 1).

The regression analysis showed that the variables associated with the public acceptance of rescue drones are perceived benefits and perceived risks, so we also investigated the significance of socio-demographic differences within the sample in relation to both variables. To do so, independent T-test and ANOVA tests were performed. The differences in perceived benefits were the first to be examined. The results showed that those participants surveyed at beaches without human rescue services perceived more benefits for the use of rescue drones ($M = 3.04$; $SD = .85$) than those at beaches with human rescue

services (M = 2.96; SD = .84), $t(3268) = 9.45$, $p < .001$; d = .4. Besides, the group reporting higher levels of perceived benefits was formed of participants under 18 years old (M = 2.92; SD = .69), followed by those over 64 years old (M = 2.79; SD = .75). The group who reported lower levels of perceived benefits was formed of middle-aged participants (26 to 40 years old) (M = 2.67; SD = .69), $F(4, 3351) = 6.61$, $p < .001$; $\eta^2 = .01$ (see Figure 1). No significant differences were found between male and female participants [$t(3354) = -.624$; $p = .539$], nor by educational level [$F(4, 3340) = 1.27$, $p = .281$], nor by nationality [$t(3350) = -1.32$, $p = .186$].

Figure 1. Differences in the mean for public acceptance, perceived benefits, and perceived risks of the use of beach-rescue drones across age intervals.



Finally, we found statistically significant differences in risk perception according to the age [$F(4, 3351) = 6.49$, $p < .001$; $\eta^2 = .01$] and the educational levels of the participants [$X^2 = 21.89$, $p < .001$], as well as according to the presence of human rescue services at the beach [$U = 1018545.5$, $p < .001$]. Specifically, we found that participants older than 64 years reported higher levels of risk perception (M = 1.89, SD = .54), than younger participants

(see Figure 1). By educational level, we found that those with no studies perceived greater risks that they associated with the use of drones (M = 2, SD = .63), than the rest of the sample. Finally, participants surveyed on beaches with human lifeguard services perceived higher risks (M = 1.82, SD = .47) than those surveyed on beaches without lifeguard services (M = 1.72, SD = .52). No significant differences were found between male and female participants [U = 1388610.5, p = .595], nor by nationality [t(3350) = -.51, p = .608].

6. Discussion

As citizens become more risk-adverse and susceptible to expect prompt responses, drones can make an important contribution to safety and emergency management. Complementing the service provided by humans, the incorporation into lifesaving tasks of the drone will be one of the major growth areas in the deployment of this technology. At present, technological barriers to the addition of new safety and emergency services are hardly present and any legal barriers are gradually being removed. Therefore, the decision over which emergency areas should benefit from their implementation is now firmly on the agenda of policy makers, as is a careful analysis of the process of public acceptance of this technology and the information campaigns of city councils and rescue and emergency agencies. The general objective of this study was to advance and to deepen in the understanding of public acceptance of drones, specifically in the context of beach lifesaving. To address this goal, the public acceptance of drones on the beaches of Cádiz is, in this study, examined, in relation to a set of associated variables.

With regard to public acceptance, we found that 52.3% of respondents would continue to visit the beach even if rescue drones were used, while 47.8% said that they would not visit it. On the other hand, 67.5% said they would still like the beach, although 18.4% would not visit it. These results allow us to draw several conclusions. We understand that the participants who would accept the rescue drones are those who would continue to visit the beach and would still like it (i.e., 49.1%). The attitudes reported by some participants, who would still visit the same beach, even though they would not like it if rescue drones were used, can be also considered as public acceptance. Beyond the reasons for which they would continue to go to the same beach (e.g., resignation, impossibility of changing beaches, etc.), the behavior of these participants would imply acceptance of the presence of the drones, regardless of whether they support it. In other words, those are the individuals who, despite not supporting a policy, would be willing to accept it [63]. However, those people who would still like the beach, but would not visit it, cannot be considered as cases of public acceptance. They might after all still like the beach for some other reasons (e.g., because the beach is well located), unaffected by the installation and use of rescue drones.

Understanding that only those participants who answered positively to the two items would be those who would accept the implementation of rescue drones, the conclusion is that public acceptance is lower than in those investigations conducted on non-specific usage contexts. Hence, 49.1% of participants who would accept the use of lifesaving drones on beaches is far from the high levels of support obtained in other research papers [35]–[37], [39], [40], [42], [43]. From our results, two possible explanations come to mind. First, following the discussion by Sakiyama *et al.* [42], we have argued that this result may simply reflect the greater clarity or the lesser ambiguity in relation to people's perceptions of this

specific public safety objective. The public are accustomed to perceive reactive responses from the emergency services: often called to the scene of an incident only when a member of the public needs help, the emergency services hardly interfere in the life and the routines of citizens. Consistently, those technologies used for reactive actions -including the use of drones- would be better accepted than those of a proactive nature. In addition to this explanation, search and rescue operations often take place in remote areas. When people are asked –in general terms– to think of a search and rescue operation, their stereotypical image may refer to a mountainous area or to open spaces with few inhabitants. Re-entering the discussion by Sakiyama *et al.* [42], the public's concern about being watched in these open and unoccupied spaces are less likely to be expressed. However, our study examined the acceptance of drones in the context of beach rescues located in densely populated urban spaces. In these places, where the presence of drones would be more visible than in remote contexts, we found less acceptance for their implementation.

Another possible explanation for the lower level of public acceptance of drones that the results reflect when compared to similar studies is that we chose to measure public acceptance in an indirect way. Most studies measure public support for drone implementation with dichotomous measures (support vs. opposition) [37], [39], [42], or with scales of strong opposition to strong direct support [34], [35]; that is, they directly ask whether they would support or oppose drone implementation for a list of applications. We were not as interested in whether or not they would support the technology, but in whether their behavior would change, were the technology implemented. Given that the Spanish and particularly Cádiz's economy depends largely on tourists from abroad, often generated around offshore tourism activity, our interest in this study was largely focused on whether the implementation of lifesaving drones would not change the behavior of beach users.

In this study we found that the perceived benefits and the perceived risks are the two factors most strongly associated with public acceptance. In particular, we found that perceived benefit is the variable with the greatest effect on public acceptance of drones ($\eta 2 = 0.28$), in line with other studies that have measured public acceptance of drones [40], [48], [49], as well as studies on other technologies [64]. In terms of risk perception, our results were more in line with studies that found low-risk perceptions for the use of drones [33], [36], in contrast with studies that associated a very high risk with their use [4], [44].

In our study, we introduced the analysis of the presence of lifeguard services on beaches in relation to public acceptance of drones. The results showed that the presence of human lifeguard services was associated with lower perceived benefit, higher perceived risk and, consequently, lower public acceptance of lifesaving drones. These results are consistent, as drones are more likely to be perceived by the participants as unnecessary in the presence of human rescue services. In contrast, the fact that public acceptance of drones is higher on isolated beaches, without lifeguard services, suggests that participants might understand the use of drones as an alternative to human lifeguards. Future analysis could examine other options that would be preferred by bathers and beachgoers with no lifeguard services.

This study also has implications for the literature. First, it advances our knowledge of the variables related to public acceptance of drones by introducing two main innovations: (1) the fieldwork was carried out for the first time in Spain; and, (2) the study focused on a specific application of drones rather than on a comparison between different applications. Further studies are therefore essential with other applications, to test the reproducibility of

these data-collection techniques. This study should be understood in the general framework of studies on public acceptance of drones, and can be considered as an example of focusing on a specific area of application: beach-rescue drones. And second, the results support the association of perceived risks and perceived benefits with the public attitudes towards acceptance of rescue drones. Future studies may use these results as a basis for adding variables to the study to complement their model in various ways, such as the mediating roles of the physical characteristics of drones, privacy concerns, and trust in human emergency services, among others.

This study also has implications for practice. Implementation programs for rescue drones should include public information campaigns providing detailed information on the benefits of their use. In particular, they should address (1) their effectiveness in reducing response times; and, (2) their advantages in areas without human rescue services. In addition, explaining to the population that drones are low risk should also be included as part of the implementation strategies. In particular, beaches that make use of rescue drones are recommended to warn bathers of their presence. In this way, the probability of the drone scaring them off when maneuvering overhead would be reduced.

Finally, this study has some limitations that should be taken into account when interpreting the results. First, although the sample size is large (3363 participants), it was only collected within the province of Cádiz. Therefore, the results cannot be generalized to beach users from other parts of the world, because the impact of cultural differences is not present. Second, the study includes a reduced number of associated variables. Future studies should include more variables in the analysis. Third, we have not taken into account the characteristics of the drone or the terminology used to name it, which may bias the results. Thus, we cannot point to a type of rescue drone that might be acceptable to beach users or the best way of referring to it in the surveys. In future studies we will explore acceptance according to the drone design. Fourth, this study is based on a questionnaire with hypothetical questions – in case of drone use –. The reality of implementing rescue drones may differ greatly. As a technology associated with surveillance, participants who initially reported public acceptance may change their minds having experienced their presence. Conversely, people who reported low acceptance might, having experienced drones and observed their performance, eventually accept them. Future research could therefore include experimental studies on public acceptance of rescue drones when used in real time.

7. Conclusion

The objective of this paper has been to determine public acceptance of beach-rescue drones and the associated variables, because understanding public acceptance is important for designing implementation programs. To achieve this goal, we have conducted an extensive literature review of research on public acceptance of drones. The set of variables has been defined that might, in our opinion and based on the literature review, affect public acceptance of drones. These variables have been complemented with others from the specific context of beach lifeguards – e.g., self-confidence at the beach, self-perception of efficacy, and presence of human lifesaving services – which had not previously been considered in the literature on the public acceptance of drones. In addition, the focus of the analysis on the particular context of drones was considered an important contribution since, up until now,

studies have compared applications – e.g., hobby, rescue, or commercial applications – rather than looking in depth at one of them. Given the complexity of the interaction between humans and technology, studies should focus more on applications for specific drone-related services. In general, our results have shown how public acceptance of rescue drones is moderate. We have also found that perceived benefit and perceived risk are the key variables in explaining public acceptance of rescue drones, as well as the presence of human rescue services on the beach. This study may therefore be of service to the subsequent development of a comprehensive model that might help explain public acceptance of drones.

References

[1] M. L. Smith, 'Regulating Law Enforcement's Use of Drone: The Need for State Legislation', *SSRN Electron. J.*, 2014, doi: 10.2139/ssrn.2492374.

[2] J. Straub, 'Unmanned aerial systems: Consideration of the use of force for law enforcement applications', *Technol. Soc.*, vol. 39, pp. 100–109, Nov. 2014, doi: 10.1016/j.techsoc.2013.12.004.

[3] P. J. Springer, *Military robots and drones: a reference handbook*. Santa Barbara, Calif: ABC-CLIO, 2013.

[4] J. R. Nelson, T. H. Grubesic, D. Wallace, and A. W. Chamberlain, 'The View from Above: A Survey of the Public's Perception of Unmanned Aerial Vehicles and Privacy', *J. Urban Technol.*, vol. 26, no. 1, pp. 83–105, Jan. 2019, doi: 10.1080/10630732.2018.1551106.

[5] D. Rotolo, D. Hicks, and B. R. Martin, 'What is an emerging technology?', *Res. Policy*, vol. 44, no. 10, pp. 1827–1843, Dec. 2015, doi: 10.1016/j.respol.2015.06.006.

[6] O. R. Holsti, *Public opinion and American foreign policy*, Revised edition. Ann Arbor: The University of Michigan Press, 2004.

[7] B. Bradford, 'Public support for police surveillance techniques: the case of live facial recognition', presented at the 19th Annual Conference of the European Society of Criminology, Ghent, Belgium, 2019.

[8] A. Saulnier and S. N. Thompson, 'Police UAV use: institutional realities and public perceptions', *Polic. Int. J. Police Strateg. Manag.*, vol. 39, no. 4, pp. 680–693, Nov. 2016, doi: 10.1108/PIJPSM-11-2015-0136.

[9] J. Sunshine and T. R. Tyler, 'The Role of Procedural Justice and Legitimacy in Shaping Public Support for Policing', *Law Soc. Rev.*, vol. 37, no. 3, pp. 513–548, Sep. 2003, doi: 10.1111/1540-5893.3703002.

[10] N. Gupta, A. R. H. Fischer, and L. J. Frewer, 'Socio-psychological determinants of public acceptance of technologies: A review', *Public Underst. Sci.*, vol. 21, no. 7, pp. 782–795, Oct. 2012, doi: 10.1177/0963662510392485.

[11] A. Birk, B. Wiggerich, H. Bülow, M. Pfingsthorn, and S. Schwertfeger, 'Safety, Security, and Rescue Missions with an Unmanned Aerial Vehicle (UAV): Aerial Mosaicking and Autonomous Flight at the 2009 European Land Robots Trials (ELROB) and the 2010 Response Robot Evaluation Exercises (RREE)', *J. Intell. Robot. Syst.*, vol. 64, no. 1, pp. 57–76, Oct. 2011, doi: 10.1007/s10846-011-9546-8.

[12] D. Camara, 'Cavalry to the rescue: Drones fleet to help rescuers operations over disasters scenarios', in *2014 IEEE Conference on Antenna Measurements & Applications (CAMA)*, Antibes Juan-les-Pins, France, Nov. 2014, pp. 1–4, doi: 10.1109/CAMA.2014.7003421.

[13] P. A. Butcher *et al.*, 'Beach safety: can drones provide a platform for sighting sharks?', *Wildl. Res.*, vol. 46, no. 8, p. 701, 2019, doi: 10.1071/WR18119.

[14] D. Stokes, K. Apps, P. A. Butcher, B. Weiler, H. Luke, and A. P. Colefax, 'Beach-user perceptions and attitudes towards drone surveillance as a shark-bite mitigation tool', *Mar. Policy*, vol. 120, p. 104127, Oct. 2020, doi: 10.1016/j.marpol.2020.104127.

[15] V. Homier, F. de Champlain, M. Nolan, and R. Fleet, 'Identification of Swimmers in Distress Using Unmanned Aerial Vehicles: Experience at the Mont-Tremblant IRONMAN Triathlon', *Prehosp. Emerg. Care*, vol. 24, no. 3, pp. 451–458, May 2020, doi: 10.1080/10903127.2019.1657211.

[16] E. J. Provost, P. A. Butcher, A. P. Colefax, M. A. Coleman, B. G. Curley, and B. P. Kelaher, 'Using drones to quantify beach users across a range of environmental conditions', *J. Coast. Conserv.*, vol. 23, no. 3, pp. 633–642, Jun. 2019, doi: 10.1007/s11852-019-00694-y.

[17] D. Morgan, 'Counting Beach Visitors: Tools, Methods and Management Applications', in *Beach Management Tools - Concepts, Methodologies and Case Studies*, vol. 24, C. M. Botero, O. Cervantes, and C. W. Finkl, Eds. Cham: Springer International Publishing, 2018, pp. 561–577.

[18] Ministry of Development of Spain, 'Plan Estratégico para el desarrollo del sector civil de los drones en España 2018-2021', Ministry of Development. Government of Spain, 2018. Accessed: Apr. 13, 2020. [Online]. Available: https://www.fomento.gob.es/NR/rdonlyres/7B974E30-2BD2-46E5-BEE5-26E00851A455/148411/PlanEstrategicoDrones.pdf.

[19] F. D. Davis, 'A technology acceptance model for empirically testing new end-user information systems: Theory and results.', Massachusetts Institute of Technology, Boston, MA, 1985.

[20] J. Stilgoe, R. Owen, and P. Macnaghten, 'Developing a framework for responsible innovation', *Res. Policy*, vol. 42, no. 9, pp. 1568–1580, Nov. 2013, doi: 10.1016/j.respol.2013.05.008.

[21] L. da Chen, 'A model of consumer acceptance of mobile payment', *Int. J. Mob. Commun.*, vol. 6, no. 1, p. 32, 2008, doi: 10.1504/IJMC.2008.015997.

[22] H. Chen, W. Rong, X. Ma, Y. Qu, and Z. Xiong, 'An Extended Technology Acceptance Model for Mobile Social Gaming Service Popularity Analysis', *Mob. Inf. Syst.*, vol. 2017, pp. 1–12, 2017, doi: 10.1155/2017/3906953.

[23] F. Forest and L. Arhippainen, 'Social acceptance of proactive mobile services: observing and anticipating cultural aspects by a sociology of user experience method', in *Proceedings of the 2005 joint conference on Smart objects and ambient intelligence innovative context-aware services: usages and technologies - sOc-EUSAI '05*, Grenoble, France, 2005, p. 117, doi: 10.1145/1107548.1107582.

[24] C. S. Montero, J. Alexander, M. T. Marshall, and S. Subramanian, 'Would you do that?: understanding social acceptance of gestural interfaces', in *Proceedings of the 12th international conference on Human computer interaction with mobile devices and services - MobileHCI '10*, Lisbon, Portugal, 2010, p. 275, doi: 10.1145/1851600.1851647.

[25] L. Gao and X. Bai, 'A unified perspective on the factors influencing consumer acceptance of internet of things technology', *Asia Pac. J. Mark. Logist.*, vol. 26, no. 2, pp. 211–231, Apr. 2014, doi: 10.1108/APJML-06-2013-0061.

[26] C.-L. Hsu and J. C.-C. Lin, 'Acceptance of blog usage: The roles of technology

acceptance, social influence and knowledge sharing motivation', *Inf. Manage.*, vol. 45, no. 1, pp. 65–74, Jan. 2008, doi: 10.1016/j.im.2007.11.001.

[27] M. M. A. de Graaf, S. Ben Allouch, and J. A. G. M. van Dijk, 'Why Would I Use This in My Home? A Model of Domestic Social Robot Acceptance', *Human–Computer Interact.*, vol. 34, no. 2, pp. 115–173, Mar. 2019, doi: 10.1080/07370024.2017.1312406.

[28] M. M. A. de Graaf and S. Ben Allouch, 'Exploring influencing variables for the acceptance of social robots', *Robot. Auton. Syst.*, vol. 61, no. 12, pp. 1476–1486, Dec. 2013, doi: 10.1016/j.robot.2013.07.007.

[29] I. Gaudiello, E. Zibetti, S. Lefort, M. Chetouani, and S. Ivaldi, 'Trust as indicator of robot functional and social acceptance. An experimental study on user conformation to iCub answers', *Comput. Hum. Behav.*, vol. 61, pp. 633–655, Aug. 2016, doi: 10.1016/j.chb.2016.03.057.

[30] P. Salvini, C. Laschi, and P. Dario, 'Design for Acceptability: Improving Robots' Coexistence in Human Society', *Int. J. Soc. Robot.*, vol. 2, no. 4, pp. 451–460, Dec. 2010, doi: 10.1007/s12369-010-0079-2.

[31] N. Savela, T. Turja, and A. Oksanen, 'Social Acceptance of Robots in Different Occupational Fields: A Systematic Literature Review', *Int. J. Soc. Robot.*, vol. 10, no. 4, pp. 493–502, Sep. 2018, doi: 10.1007/s12369-017-0452-5.

[32] A. Weiss, R. Bernhaupt, M. Tscheligi, D. Wollherr, K. Kuhnlenz, and M. Buss, 'A methodological variation for acceptance evaluation of Human-Robot Interaction in public places', in *RO-MAN 2008 - The 17th IEEE International Symposium on Robot and Human Interactive Communication*, Munich, Germany, Aug. 2008, pp. 713–718, doi: 10.1109/ROMAN.2008.4600751.

[33] R. A. Clothier, D. A. Greer, D. G. Greer, and A. M. Mehta, 'Risk Perception and the Public Acceptance of Drones', *Risk Anal.*, vol. 35, no. 6, pp. 1167–1183, Jun. 2015, doi: 10.1111/risa.12330.

[34] L. M. PytlikZillig, B. Duncan, S. Elbaum, and C. Detweiler, 'A Drone by Any Other Name: Purposes, End-User Trustworthiness, and Framing, but Not Terminology, Affect Public Support for Drones', *IEEE Technol. Soc. Mag.*, vol. 37, no. 1, pp. 80–91, Mar. 2018, doi: 10.1109/MTS.2018.2795121.

[35] B. Aydin, 'Public acceptance of drones: Knowledge, attitudes, and practice', *Technol. Soc.*, vol. 59, p. 101180, Nov. 2019, doi: 10.1016/j.techsoc.2019.101180.

[36] F. Klauser and S. Pedrozo, 'Big data from the sky: popular perceptions of private drones in Switzerland', *Geogr. Helvetica*, vol. 72, no. 2, pp. 231–239, Jun. 2017, doi: 10.5194/gh-72-231-2017.

[37] J. Eyerman *et al.*, 'Unmanned Aircraft and the Human Element: Public Perceptions and First Responder Concerns', Institute for Homeland Security Solutions, North Carolina, Post-project report, 2013. Accessed: Feb. 02, 2020. [Online].

[38] K. G. Herron, H. C. J. Smith, and C. L. Silva, 'US Public Perspectives on Privacy, Security, and Unmanned Aircraft Systems', Center for Risk and Crisis Management, Norman, Oklahoma, Research report, 2014. Accessed: Feb. 02, 2020. [Online].

[39] P. Murray, 'U.S. supports some domestic drone use, but public registers concern about own privacy', Monmouth University, West Long Branch, NJ, Jun. 2012. Accessed: Feb. 02, 2020. [Online]. Available: https://www.monmouth.edu/polling-institute/documents/monmouthpoll_us_061212.pdf/.

[40] S. Thompson and C. Bracken-Roche, 'Understanding public opinion of UAVs in Canada: A 2014 analysis of survey data and its policy implications', *J. Unmanned Veh. Syst.*, vol. 3, no. 4, pp. 156–175, Dec. 2015, doi: 10.1139/juvs-2015-0025.

[41] M. SJ. Heen, J. D. Lieberman, and T. D. Miethe, 'The thin blue line meets the big blue sky: perceptions of police legitimacy and public attitudes towards aerial drones', *Crim. Justice Stud.*, vol. 31, no. 1, pp. 18–37, Jan. 2018, doi: 10.1080/1478601X.2017.1404463.

[42] M. Sakiyama, T. D. Miethe, J. D. Lieberman, M. S. J. Heen, and O. Tuttle, 'Big hover or big brother? Public attitudes about drone usage in domestic policing activities', *Secur. J.*, vol. 30, no. 4, pp. 1027–1044, Oct. 2017, doi: 10.1057/sj.2016.3.

[43] C. Lidynia, R. Philipsen, and M. Ziefle, 'Droning on About Drones—Acceptance of and Perceived Barriers to Drones in Civil Usage Contexts', in *Advances in Human Factors in Robots and Unmanned Systems*, vol. 499, P. Savage-Knepshield and J. Chen, Eds. Cham: Springer International Publishing, 2017, pp. 317–329.

[44] E. C. Anania *et al.*, 'Public support for police drone missions depends on political affiliation and neighborhood demographics', *Technol. Soc.*, vol. 57, pp. 95–103, May 2019, doi: 10.1016/j.techsoc.2018.12.007.

[45] E. T. Higgins, 'Promotion and Prevention: Regulatory Focus as A Motivational Principle', *Adv. Exp. Soc. Psychol.*, vol. 30, pp. 1–46, 1998, doi: 10.1016/S0065-2601(08)60381-0.

[46] A. Tversky and D. Kahneman, 'The framing of decisions and the psychology of choice', *Science*, vol. 211, no. 4481, pp. 453–458, Jan. 1981, doi: 10.1126/science.7455683.

[47] O. Renn and C. Benighaus, 'Perception of technological risk: insights from research and lessons for risk communication and management', *J. Risk Res.*, vol. 16, no. 3–4, pp. 293–313, Apr. 2013, doi: 10.1080/13669877.2012.729522.

[48] P. Boucher, '"You Wouldn't have Your Granny Using Them": Drawing Boundaries Between Acceptable and Unacceptable Applications of Civil Drones', *Sci. Eng. Ethics*, vol. 22, no. 5, pp. 1391–1418, Oct. 2016, doi: 10.1007/s11948-015-9720-7.

[49] M. T. Russell, 'Fire chief perception of unmanned aircraft systems: A diffusion study', Doctoral Dissertation, New Jersey City University, New jersey, 2016.

[50] I. Ajzen and M. Fishbein, 'The prediction of behavioral intentions in a choice situation', *J. Exp. Soc. Psychol.*, vol. 5, no. 4, pp. 400–416, Oct. 1969, doi: 10.1016/0022-1031(69)90033-X.

[51] J. Chamata and J. Winterton, 'A Conceptual Framework for the Acceptance of Drones', *Int. Technol. Manag. Rev.*, vol. 7, no. 1, pp. 34–46, 2018.

[52] T. D. Miethe, J. D. Lieberman, M. Sakiyama, and E. I. Troshynski, 'Public Attitudes about Aerial Drone Activities: Results of a National Survey', Center for Crime and Justice Policy, Las Vegas, NV, Research in Brief 02, 2014.

[53] S. Rice *et al.*, 'Public perception of UAS privacy concerns: a gender comparison', *J. Unmanned Veh. Syst.*, vol. 6, no. 2, pp. 83–99, Jun. 2018, doi: 10.1139/juvs-2017-0011.

[54] N. Spitzer, T. Mangione, W. Chow, L. Quan, and E. Bennett, 'Parental Choices of Flotation Devices for Children and Teen Swimmers and Waders: A Survey at Beaches in Washington State', *Int. J. Aquat. Res. Educ.*, vol. 12, no. 1, 2019, doi: 10.25035/ijare.12.01.02.

[55] N. H. Khan, 'Exploring Drones to Assist Firefighters During Emergencies', presented at the 1st International Workshop on Human-Drone Interaction, Glasgow, UK, May 2019, [Online]. Available: https://hal.archives-ouvertes.fr/hal-02128386.

[56] B. A. Morrongiello, 'Caregiver Supervision and Child-Injury Risk: I. Issues in Defining and Measuring Supervision; II. Findings and Directions for Future Research', *J. Pediatr. Psychol.*, vol. 30, no. 7, pp. 536–552, Oct. 2005, doi: 10.1093/jpepsy/jsi041.

[57] K. Moran, 'Parent/caregiver perceptions and practice of child water safety at the beach', *Int. J. Inj. Contr. Saf. Promot.*, vol. 16, no. 4, pp. 215–221, Dec. 2009, doi: 10.1080/17457300903307045.

[58] B. A. Morrongiello, M. Sandomierski, D. C. Schwebel, and B. Hagel, 'Are parents just treading water? The impact of participation in swim lessons on parents' judgments of children's drowning risk, swimming ability, and supervision needs', *Accid. Anal. Prev.*, vol. 50, pp. 1169–1175, Jan. 2013, doi: 10.1016/j.aap.2012.09.008.

[59] K. Moran, 'Will They Sink or Swim? New Zealand Youth Water Safety Knowledge and Skills', *Int. J. Aquat. Res. Educ.*, vol. 2, no. 2, May 2008, doi: 10.25035/ijare.02.02.04.

[60] J. P. McCool, K. Moran, S. Ameratunga, and E. Robinson, 'New Zealand beachgoers' swimming behaviours, swimming abilities, and perception of drowning risk', *Int. J. Aquat. Res. Educ.*, vol. 2, no. 1, Feb. 2008, doi: 10.25035/ijare.02.01.02.

[61] J. C. Nunnally, *Psychometric theory*, 2d ed. New York: McGraw-Hill, 1978.

[62] M. Callegaro, K. Lozar Manfreda, and V. Vehovar, *Web survey methodology*. Los Angeles: SAGE, 2015.

[63] C. Dermont, K. Ingold, L. Kammermann, and I. Stadelmann-Steffen, 'Bringing the policy making perspective in: A political science approach to social acceptance', *Energy Policy*, vol. 108, pp. 359–368, Sep. 2017, doi: 10.1016/j.enpol.2017.05.062.

[64] M. Siegrist, 'The Influence of Trust and Perceptions of Risks and Benefits on the Acceptance of Gene Technology', *Risk Anal.*, vol. 20, no. 2, pp. 195–204, Apr. 2000, doi: 10.1111/0272-4332.202020.

Appendices

Appendix A. Questionnaire.

	Question	Measurement and code	Alpha
Public acceptance			.86
1	Even if rescue drones were used, I would still visit this beach		
2	Even if rescue drones were used, I would still like this beach		
Self-confidence at the beach			.71
3	I am a great swimmer		
4	I feel absolutely safe when I bathe at this beach		
5	I can always reach the shore under any circumstances		
Self-perceived rescue capacity			.83
6	In case a child is drowning, I am fully capable of saving him/her		
7	In case an adult is drowning, I am fully capable of saving him/her	1 = 'Strongly disagree'	
Perceived benefits		2 = 'Disagree'	.78
8	A rescue drone would be useful to me in case something happened to me on this beach	3 = 'Agree' 4 = 'Strongly agree'	
9	A rescue drone would be useful, in general, for people, in case something happened to them on this beach		
10	Rescue on this beach would be improved by rescue drones		
11	Rescue drones would reduce the number of drownings on this beach		
Perceived risk			.73
12	A rescue drone is a dangerous object		
13	It's very likely that a rescue drone will harm a person		
14	It's very likely that a rescue drone will scare a person		
Attitudes			.79
15	If a rescue drone filmed me, it might bother me		
16	If a rescue drone flew over me, it might bother me		
Individual factors			
17	What is your sex?	1 = 'Male' 2 = 'Female'	
18	What is your nationality?	0 = 'Foreign' 1 = 'Spanish'	
19	(*If 18 is "Spanish"*) What Province in Spain are you from?	Name of the Province	
20	What year were you born?	Number of years	
21	What is the highest level of education you have completed?	1 = 'None' 2 = 'Primary school' 3 = 'Secondary school' 4 = 'Higher vocational education'	

	Question	Measurement and code	Alpha
		5 = University	
22	How many children are you supervising on the beach right now?	Number of children	
23	How many years have you visited this beach?	Number of years	
24	How many days do you expect to visit this beach in the month of August?	Number of days	
*Situational factor**			
25	Beach	1 = La Cortadura 2 = La Caleta 3 = La Victoria 4 = Santa María del Mar 5 = Valdelagrana	

Note: * The interviewer noted the beach where the participant was surveyed.

Appendix B. Map of beaches in the Province of Cádiz where the interviews were held.

[i] The beaches of the province of Cadiz are very familiar; that is, the users of the beaches are usually families who come with several children. This variable does not measure the number of children in the household, but rather the number of children that the interviewee was supervising on the beach at the time of the survey.