How Close is Too Close?: Enhancing Tourists' Awareness of Iceland's Regional Hazards

An Interactive Qualifying Project Report
submitted to the Faculty of
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Ⅰ Abstract

This project addressed concerns over the safety of tourists in Iceland. Types of hazards were characterized and compared across Iceland's seven tourism regions. We assessed tourist reaction to current hazard mitigation methods, which include brochures, signs, websites, and SMS alerts. Interviews with tourist and tour professionals revealed disparities in perceptions of safety and responsibilities. Observation of tourists revealed a pattern of high-risk behavior despite warnings. A proposal is detailed for a combination of improved SMS alert system, infographic displays for hazard education, and suggested increased coordination and promotion of existing web-based Icelandic hazard education sites.

Ⅱ Executive Summary

The goal of this project was to survey safety communication strategies in Iceland's tourism industry. The team delivered recommendations on how to enhance tourists' awareness of Iceland's regional and seasonal hazards. The team proposed an SMS alert system along with region-specific multimedia infographics. In 2022, Iceland welcomed 1.7 million tourists, more than four times the total population of Iceland (Icelandic Tourist Board, 2023a). With the recent influx in tourism, there are growing concerns for tourists' safety (Bird, 2020).

Iceland has seven tourism regions with a variety of hazard types (Iceland.org, 2023). Volcano hazards include direct dangers such as lava flows and indirect dangers such as upper-respiratory diseases (Brown, 2017). Outdoor hazards include uneven hiking trails, waterfalls, sneaker waves, and glaciers (Visit Iceland, n.d.a). Transportation hazards include unsafe driving conditions, roaming livestock, and pedestrians (Gunnarsdottir, n.d.). These hazards are communicated by means of brochures, signs, websites, and, during emergencies, SMS alerts (Bird, 2020).

Fifty-five (55) survey interviews with tourists and eleven (11) expert interviews with tourism professionals were conducted. Additionally, twenty-five (25) tourist sites were ethnographically observed for individuals exhibiting three key behaviors. The key behaviors observed included ignoring verbal and/or posted warnings, violating boundaries, and other injurious behavior, which is other behaviors with the potential to cause serious injury or distress.

It was concluded that tourists feel entitled to structured supervision on tours while tourism professionals do not feel obligated to do so as guides. Tour guides expressed collective

concerns about tourists' limited application of critical thinking and situational assessment, particularly in high-risk settings with a pattern of unsafe behavior among tourists in Iceland, despite hazard signage and guidance from tourism professionals. Observation of tourism sites yielded high proportions of key behaviors relative to sample size. Furthermore, resources available from Icelandic tourism authorities do not reach the tourists they are intended to inform, with low proportions of surveyed tourists interacting with these hazard resources. According to surveyed tourists, there is demonstrated demand for region-specific multimedia infographics and for an improved, proactive SMS message system for hazard communications.

The team recommended that multimedia infographics and a regional hazard-alert SMS messaging system be implemented as methods of hazard education. These SMS messages should include information about current weather conditions, region-specific hazard information, and should be sent as people enter any of the seven regions. The SafeTravel.IS and The Icelandic MET Office websites should be better promoted, and provide links to the other website to increase hazard information available to tourists. Further investigation should be done into which governing body could most effectively sponsor the distribution of hazard education materials, and to determine the information tourists want included in these materials. Further inquiry should be conducted about where hazard education material can be most effectively displayed to reach the largest population of people.

Ⅲ Acknowledgements

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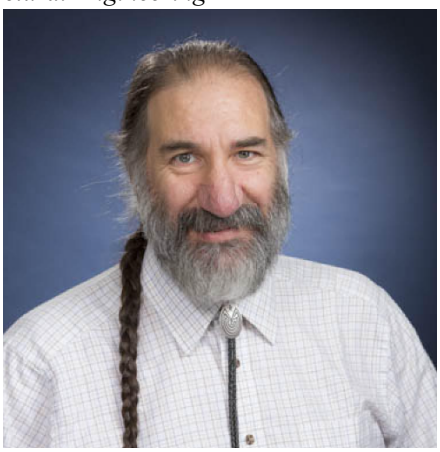

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1 Introduction

1.1 Economic Impact of Tourism in Iceland

Iceland's yearly total of international travelers has increased substantially from 302,900 visitors in 2000 to 2,343,800 in 2018, and with the decline of the COVID-19 pandemic, international tourism has resumed growing (Statista Search Department, 2023c). In 2019, tourism contributed 704.6 billion Icelandic króna (5.755 billion USD) to Iceland's 3.04 trillion króna (24.83 billion USD) gross domestic product (GDP) and accounted for 23.2% of Iceland's economy (Statista Search Department, 2022; Statista Search Department, 2023c). The observed growth has been met with mounting concerns for tourists' safety (Bird, 2020) as the dangers intrinsic to Iceland's tourism sites stand to threaten Iceland's tourist population without proper guidance (Bird, 2010a).

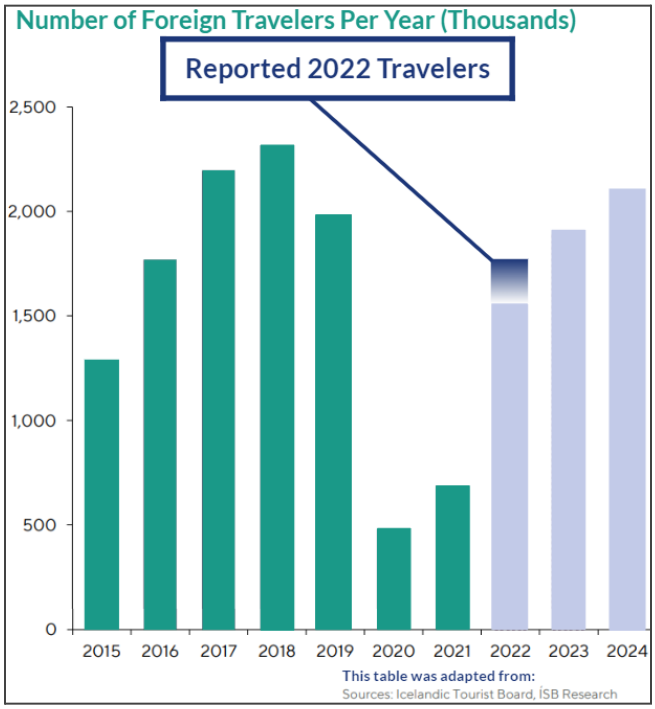

Figure 1 - *Graph of Increasing Yearly Tourist Projections*

1.2 Safety Concerns in Icelandic Tourism

Although outreach programs put forth by both the Icelandic Board of Tourism and private tourism companies exist, distinguished Icelandic volcanic risk expert Deanne K. Bird, PhD. concludes that these efforts have proven insufficient towards conveying the dangers posed by Icelands' terrain (Bird, 2010b). Interviewed tourists typically portrayed a lack of understanding of the hazards posed by these tourism sites or demonstrated knowledge of these dangers but consciously disregarded them in favor of enjoying their vacations (Matti, 2022). This disregard for the inherent risks of Iceland's tourism sites has led to avoidable, sometimes fatal, accidents involving international travelers.

1.3 Stakeholders in Icelandic Tourism

Given tourism's invaluable contributions to the Icelandic economy and the 43.4 thousand jobs in tourism in 2019 alone (Statista Search Department, 2023b), Icelanders hold a significant stake in maintaining Iceland's tourism industry and cultivating a reputation for its safety and care

(Langridge, 2023). Groups responsible for maintaining the tourism industry are called *stakeholders* and include governmental tourist authorities, tourism company personnel, and tourists themselves.

1.4 Existing Icelandic Educational Strategies

A current strategy used by Icelandic tourism professionals for educating tourists is pamphlets, however according to Bird's study these have been ineffective with tourists, citing reading difficulties or a lack of motivation to read such resources while on vacation (Bird, 2010b). Another safety strategy utilized is risk management training targeted at tourism employees designed to implement more conservative safety measures for tour groups. However, only 21% of employees received such training in 2010 (Bird, 2010a). More recently in 2018, the Icelandic government enacted legislation to amend risk procedures regarding tourism (Minister of Tourism, 2018). Throughout Iceland, signage and warning barriers have been used to communicate hazards, however the signage can be ignored or misunderstood by tourists (Matti, 2022). Other platforms for hazard communication include YouTube advertisements, and posters, however tourists can skip these or simply not look at them. The SafeTravel.IS website and smartphone application is the latest method of online communication by the Icelandic government which seeks to link tourists with up-to-date hazard information ranging from road and trail conditions to active eruption alerts (SafeTravel.IS, 2023).

1.5 Research Objectives

The goal of this project was to survey safety communication strategies in Iceland's tourism industry. The team delivered recommendations on how to enhance tourists' awareness of Iceland's regional and seasonal hazards. The team proposed an SMS alert system along with region-specific multimedia infographics. Furthermore, this project developed a proposal which outlines technical means by which Icelandic agencies might reach tourists to provide further education. To accomplish this, the team developed three distinct objectives:

1. Survey and interview tourism stakeholders and authorities responsible for conveying hazard education and communications to tourists in Iceland
2. Investigate and evaluate the current integration of SMS technology and communication media in Iceland used to convey hazards to tourism stakeholders

3. Formulate recommendations on how to better administer technology to reach tourism stakeholders concerning tourism risk

2 Background

2.1 Iceland's Tourism Regions

Iceland is composed of seven regions, listed in order by descending 2022 popularity:

1. Capital Region (*Höfuðborgarsvæðið*)
2. Southern Region (*Suðurland*)
3. Southern Peninsula (*Suðurnes*)
4. Western Region (*Vesturlands)*
5. Northern Region (*Norðurlands*)
6. Eastern Region (*Austurlands*)
7. Westfjords (*Vestfirðir*)

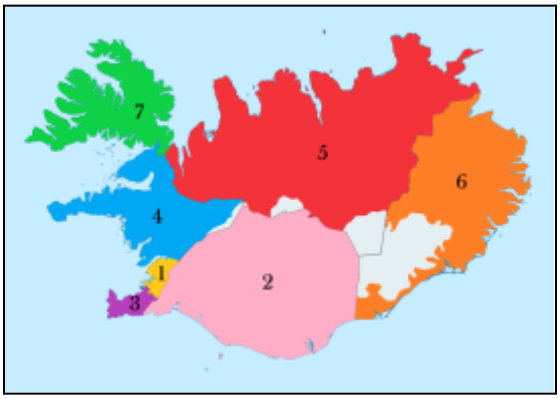

Figure 2 - *Map of Iceland's Tourism Regions*

These regions originated from parliamentary constituencies established to facilitate governance and tourism. The regional boundaries listed in Figure 2 follow some of Iceland's mountain ranges. Due to the isolation these mountains create, the hazards found in each region can differ widely (Iceland.org, 2023).

2.1.1 Capital Region & Reykjavík

Iceland's most popular region is the Capital Region. In 2022, the Capital Region welcomed 91% of Iceland's total tourism population with visitors spending on average 3.3 nights in the region (Iceland.org, 2022; Icelandic Tourist Board, 2022).

Mount *Esja* is a volcanic mountain range near the town of *Mosfellsbær*, and is located 10 kilometers away from Reykjavík. Esja is accessible by public transportation, which makes Esja the most visited recreation area in the region with 49,842 tourists during the 2022 season (Icelandic Tourist Board, 2023b). Other hiking opportunities include the fields of Krýsuvík, where steaming volcanic vents and boiling hot springs are located (Krýsuvík, n.d.). Another

natural wonder that people can explore is the Leiðarendi lava tube that was created by lava flowing under the earth post eruption (Leiðarendi Cave, n.d.).

Reykjavík is home to 17 geothermal swimming pools. The largest swimming pool is Laugardalslaug located in Laugardalur Valley (Visit Reykjavík, n.d.; Laugardalslaug, n.d.), Laugardalslaug includes swimming pools and seven hot tubs (Visit Reykjavík, n.d.). Another geothermal pool is Sky Lagoon, located seven kilometers away from downtown Reykjavík in Kársnes Harbour (Reykjavík Excursions, 2022).

2.1.2 South & Selfoss

The Southern Region is the second most popular among tourists and welcomed 79% of Iceland's 2022 tourists with 3.2 nights on average (Icelandic Tourist Board, 2022; Icelandic Tourist Board, 2023a). The South is known for *Þingvellir & Vatnajökull National Parks* (Iceland.org, 2022), black sand beaches, and glaciers. The most visited destination in this region, the Golden Circle, located in Þingvellir, welcomed more than 1 million tourists of the 1.7 million tourists in 2022 alone (Icelandic Tourist Board, 2023b; Icelandic Tourist Board, 2023a). In 2022, Þingvellir's *Geysir* received 1,117,054 visitors while Þingvellir's *Gulfoss* waterfall received 625,640 visitors (Icelandic Tourist Board, 2023b*)*. Located along the southern coast, Reynisfjara beach received 375,743 visitors (Icelandic Tourist Board, 2023b*)*. Comparably less trafficked are the *Svartifoss*, *Skógafoss*, *Seljalandsfoss* and *Gljúfrabúi* waterfalls in addition to the *Jökulsárlón* glacier lagoon (Iceland.org, 2022). The Southern Region is home to multiple active volcanoes such as *Katla*, *Hekla*, and *Eyjafjallajökull*. Year round, the Southern Region is accessible by car and by plane via Reykjavík domestic airport. During peak tourist season in the spring and summer, visitors can take tour buses to the South's most popular destinations (Iceland.org, 2022).

2.1.3 Southern Peninsula & Reykjanes

The attractions in the Southern Peninsula draw in 66% of the tourists that visit Iceland (Icelandic Tourist Board, 2023a). During the busy portions of the 2022 tourism season, more than 80% of hotel rooms in this region were occupied (Icelandic Tourist Board, 2023a). The Southern Peninsula of Iceland is home to many of Iceland's volcanoes, including the *Fagradsfjall* volcano that erupted in 2021 and July of 2023. The volcanic activity in this area created cliffs, black sand beaches, lava fields, geothermal baths, and lava-stone formations which are popular tourist attractions. Along with the international airport, the Southern Peninsula is

known for its hikes up *Borgarfjall* mountain and through the *Hrútádalur* valley which saw 110,090 and 92,964 visitors in 2022 respectively. ATV trails, and F-roads, as well as The Blue Lagoon and *Seltún* Hot Springs welcomed 209,381 of Iceland's 2022 visitors. The "Bridge between Two Continents" (*Brúin milli Heimsálfa)* welcomed 102,083 visitors in 2022 (Icelandic Tourist Board, 2023b).

2.1.4 West & Akranes

50% of Iceland's 2022 visitors visited the Western Region spending on average 1.9 nights (Icelandic Tourist Board, 2023a). Iceland's Western Region is home to *Snæfellsjökull* National Park. The park's namesake volcano is capped by the Snæfellsjökull glacier and serves as the origins of many Icelandic folktales (Environment Agency of Iceland, n.d.). A large proportion of the West is pristine wilderness, which appeals to hikers, birdwatchers, and backpackers. The *Hraunfossar* Waterfalls attracted 141,524 visitors in 2022 alone, while the *Saxhóll* Volcanic Crater welcomed 97,665 of the 2022 tourist population (Icelandic Tourist Board, 2023b). For tourists who are not drawn to this region by lava fields and Icelandic wilderness, there are miles of coastline which can be explored by kayak, or be appreciated from the beach (Visit Iceland, n.d.d.).

2.1.5 North, Akureyri, & Sauðárkrókur

The Northern Region welcomed 34% of the total tourists that traveled to Iceland in 2022 (Icelandic Tourist Board, 2023a) and is a 40 minute flight or a four to six hour drive from Reykjavík. Tourists are drawn to the North's mountains, geothermal lagoons, and waterfalls. The region's most trafficked monitored tourism site, the *Hvítserkur* Sea Spire, welcomed 73,498 visitors in 2022 (Icelandic Tourist Board, 2023b*)*. The Forest Lagoon in *Eyjafjarðarsveit*, overlooking the *Eyjafjorður* fjord, draws in tourists due to the view of the surrounding birch and pine trees, a rarity in the usually sparse Icelandic landscape (Akureyri Travel Guide, n.d.). A geothermal lagoon open year round is the hot tubs in Hauga which hosts the region's only accessible sandy beach (Akureyri Travel Guide, n.d.). The *Goðafoss* waterfall, located in the *Skjálfandafljót* river, can be readily accessed by car. (Goðafoss, n.d.) *Dettifoss*, known as the most powerful waterfall in Europe, is located north of the Ring Road, with two routes connecting the Ring Road to the falls (Dettifoss, n.d.). The less visited *Aldeyjarfoss* waterfall is off the main paths requiring a 41 kilometer drive to reach (Ragnarsdóttir, n.d.). The region has active volcano systems which are not monitored for tourism traffic, including Askja and Krafla.

2.1.6 East & Egilsstaðir

The Eastern Region of Iceland hosted 30% of Iceland's 2022 visitors (Icelandic Tourist Board, 2023a). The East is known for its fjords, sea cliffs, waterfalls, and its reindeer population of nearly 7000 individuals (Visit Egilsstadir, n.d.). The popular recreational activities in Iceland's Eastern Region are camping, backpacking, and hiking within the region's 22,721.9 square kilometers (Iceland.org, 2022; Visit Iceland, n.d.b). Further inland tourists can find hiking trails, *Snaefell* mountain, and paths to the southern coast's *Vatnajökull* mountain peaks (Iceland.org, 2022). This region is recognized for the *Stuðlagil* canyon which welcomed 139,185 visitors in 2022, the *Hengifoss* waterfall which had 73,081 visitors in 2022, and the *Hafnarhólmi* seabird cliffs which welcomed 39,367 visitors in 2022 (Visit Egilsstadir, n.d.; Icelandic Tourist Board, 2023b). Year round, the Eastern Region is accessible in three ways, driving, Reykjavík domestic-airline, and by car ferry from Denmark or from the Faroe Islands (Visit Egilsstadir, n.d.).

2.1.7 Westfjords & Ísafjörður

The Westfjords region sees the least amount of tourists compared to all other regions in Iceland, seeing only 13% of the total 2022 tourist population (Icelandic Tourist Board, 2023a). The landscape consists of volcanic mountains, sea cliffs, and Fjords. Recreational activities in the Westfjords include camping, backpacking, and hiking (Visit Iceland, n.d.c). On the southwest side of the region the sea cliff *Látrabjarg* is known as Europe's largest sea bird cliff with over a million seabirds nesting in the cliff as well as the largest razorbill colony in the world (Visit Iceland, n.d.c). This sea cliff attracted over 23,000 visitors in 2022 (Icelandic Tourist Board, 2023b). The 100 meter tall waterfall site known as *Dynjandi* is a popular tourist site in the Westfjords with over 45,000 visitors in 2022 (Icelandic Tourist Board, 2023b). During the summer months the Westfjords are accessible in three ways, driving, Reykjavík domestic-airline, and a ferry from Reykjavík. In the winter time access to the Westfjords becomes limited due to snow cover and lack of road maintenance (Visit Iceland, n.d.c).

2.2 Iceland's Volcanic Hazards

Iceland has thirty-two (32) active volcanic systems varying in activity and danger levels, including *Askja*, *Kverkfjöll*, *Fagradalsfjall*, *Katla*, *Eyjafjallajökull*, *Vestmannaeyjar*, and *Hekla* (Sigmundsson, 2020; Gudmundsson, 2007), and the dangers these volcanic systems pose can be

categorized into direct hazards, stemming from eruptions and volcanic events, and indirect hazards, cascading consequences of eruptions or human activities within volcanic areas.

Table 1 - *Volcanic Hazards by Subtype*

Direct Hazards	Indirect Hazards
- Earthquakes	- Exposure
- *Jökulhlaup*	- Unsafe Driving and Hiking Conditions
- *Tephra Fallout*	- Upper-respiratory Diseases
- Pyroclastic Density Flows	- Evacuation-induced Risks
- Toxic Gas Emissions	- Crop and Livestock Loss
- Hot Landslides or Avalanches *(Lahars)*	- Steam Vents and boiling mud pots

Iceland's direct hazards include *Jökulhlaup* (sudden glacial meltwater bursts from eruptions) and *tephra fallout* (ash and pumice dispersion). Pyroclastic density flows, or currents of hot lava and toxic gas, threaten individuals in the vicinity due to their extreme speed, high temperature, and toxic gas emissions. The 1973 *Vestmannaeyjar* eruption prompted mass evacuations while the 1947 Hekla eruption decimated local areas (Gunnarsdottir, 2013; Lederer, 1989).

"It takes a special kind of stupid to get that close to the volcano and a lot of people have it." - 2023 Eruption Guide

Indirect hazards occur as a result of a volcanic eruption; indirect hazards include exposure (i.e., hypothermia, windburn, exhaustion), unsafe driving conditions, upper-respiratory diseases, and evacuation-induced risks (Brown, 2017). Fatalities and injuries have occurred in Askja's craters and the Kverkjokull Glacier often due to unstable conditions or poisonous gasses (Albert, 2017; Review, 2011). Incidents resulting from indirect hazards surpass direct hazard occurrences in Iceland over the last century (Bird, 2020).

2.3 Iceland's Outdoor Recreation Hazards

With roughly 43% of Iceland being designated as wilderness area, hiking serves as a means to explore Iceland's geography (Ólafsdóttir & Runnström, 2011). The easy access of the terrain contributes to the dangers of these remote areas (Heimisdóttir, Þ., Sæþórsdóttir, A. D., & Gísladóttir, G., 2019).

Table 2 - *Outdoor Recreation Hazards by Subtype*

Hiking	Waterfall	Wave	Glacier
- Exposure	- High & narrow canyons	- Sneaker waves	- Hidden crevasses
- Disorientation	- Unstable/slick paths	- Strong currents	- Exposure
- Rockslide/avalanches	- Hypothermia	- Icebergs	- Avalanches
- Fragile cliff edges	- Drowning	- Hypothermia	- Ice cliffs
			- Icy surfaces

Over the last two decades, sixteen (16) tourists have died due to hazards associated with hiking, including hypothermia from prolonged exposure, falling accidents, and encounters with avalanches (Fernandez-Fernandez, 2023). The catalyst for these accidents being either inadequate preparation or inadequate knowledge. Inadequate preparation, stemming from the aura of confidence, eagerness, ignorance, and awe (Heimisdóttir, Þ., Sæþórsdóttir, A. D., & Gísladóttir, G., 2019), may include inappropriate selection of footwear or attire, increasing the chance of slip, trip, and fall incidents or exposure.

Since 1974, sixty-nine (69) people have died due to avalanches and mudslides in Iceland (Icelandic Meteorological Office, n.d.). These slides can trap and submerge hikers, potentially leading to physical harm or suffocation. The lack of a *Personal Locator Beacon* (PLB), a small radio transmitter that when activated can transmit the user's location to potential rescuers and alert them to an emergency, can leave victims trapped without a means of contacting rescue (Iceland Association for Search and Rescue, n.d.). Irregular or unstable trails amplify the susceptibility to minor injuries. Hiking trails lack discernible markers that indicate the path, and lack of guidance increases the likelihood of disorientation, especially for less-acquainted tourists. Inaccurate online trail representations are prevalent, culminating in a misperception of the true length and difficulty of routes which increases the possibility of under-preparation. Iceland's proximity to the Arctic Circle means there are periods when the sun sets early, and very quickly. Early sunsets can create situations for unprepared hikers in which they are unprepared for the dark and can no longer navigate safely. The collective list of hazards associated with hiking in Iceland means that uninformed tourists may underestimate the breadth of Iceland's risks.

Iceland has over 10,000 waterfalls that have many inherent risks. The two-tiered *Gullfoss* waterfall is considered Iceland's most dangerous due to its high and narrow canyons (Iceland.org, 2022). During direct observation, waterfall areas frequently possessed unstable

walking conditions, with portions of paths crumbling towards the water's edge. Slick paths combined with short, rope-based guardrails to further contribute to the treacherous conditions.

Iceland's black sand beaches are a prominent feature along its shorelines, characterized by their hexagonal rock formations and black sand, and are readily accessible by car or tour bus. The strong ocean currents, combined with frigid water, occasional icebergs, and unpredictable rogue waves create a dangerous environment, particularly for uninformed visitors. Known as "Sneaker Beaches," they possess unexpected and forceful "sneaker waves" that strike the coastline with little warning, so-named because "one is in peril when one's sneakers are wet." While signs are posted with clear warnings of their potential harm to human life, tourists still flock to the famous beaches such as Reynisfjara Beach for photos on Iceland's "deadliest beaches." Between 2007 and 2023, there were five drownings reported at Reynisfjara (Kyzer, 2022), with a recent death occurring in June of 2022, and twelve emergency calls. (Dawson, 2022; Gottlieb, 2022). Rescue from these waves is unlikely, something conveyed explicitly by signs at the site and by the beach webpage banner: "WARNING: REYNISFJARA BEACH HAS CLAIMED THE LIVES OF VISITORS" (Visit Iceland, n.d.a).

Iceland's glaciers cover 10% of Iceland's total surface area. Glacial treks require proper fitness, hiking shoes, appropriate clothes, and ice spikes (Writer, 2022). Hidden crevasses can lead to severe injury or deadly outcomes, as unsuspecting tourists can fall into them (Byfleet, n.d.). Pockets of frigid meltwater can hide beneath layers of snow and measure hundreds of meters deep (Byfleet, n.d.). In a 2016 accident, a tourist fell more than twelve (12) meters down a frozen crevasse at the *Sólheimajökull* glacier, resulting in serious injuries.(Iceland Monitor, n.d.). The icy crevasses and treacherous conditions make rescue a difficult operation. In 2011, a fallen tourist died of hypothermia while awaiting rescue (Iceland Monitor, n.d.).

2.4 Iceland's Transportation Hazards

61% of Iceland's 2022 tourist population used rental cars as their main mode of transport (Icelandic Tourist Board, 2022). Driving in Iceland can be dangerous to drivers, passengers, and the vehicle itself, as the road's surface can shift from pavement to gravel or dirt, and excessive speed may damage tires or cause the vehicle to swerve due to driver overcorrection (Gunnarsdottir, n.d.; Driving Safely in Iceland, n.d.).

Table 3 - *Transportation Hazards by Subtype*

Driving	Scootering
- Driver distractions (fatigue, landscape) - Unfamiliar driving (manual transmission) - F-Roads - Wandering livestock - Speeding - High winds	- Uneven & slippery terrain - Pedestrian interference - Other motorized vehicles - Poor weather conditions - Hardware issues

Icelandic weather can make driving more hazardous for tourists unfamiliar with Iceland's swiftly changing road conditions. Adverse weather conditions may reduce driver visibility, raising the risk of drivers overlooking hazards ahead. Strong winds can potentially harm cars when a driver or passenger opens a door, leading to the door shearing off its hinges or flying into another vehicle; these winds can not only cause material damage but can also be dangerous to human life (Gunnarsdottir, n.d.).

Rental companies strongly recommend four-wheel drive (4x4) for rental cars to prevent vehicles from skidding off the road or becoming stranded in slippery conditions. Highland roads, known as F-Roads are dirt or gravel roads that weave up Iceland's steep terrain. The "F" in F-Road stands for *Fjall,* the Icelandic word for mountain, and a 4x4 vehicle is necessary to drive safely on these roads with the Icelandic government stating, "If you are not driving a 4x4 , you are not allowed to drive on mountain roads" (Driving safely in Iceland, n.d.). F-Roads are categorized by difficulty level, which includes easy, medium, and difficult. Easy F-Roads may include larger rocks, but are generally moderate gravel roads. Medium F-Roads include shallow river crossings and larger rocky sections which vary in intensity. Difficult F-Roads include fast flowing river crossings, and driving around and over boulders. Difficult F-Roads necessitate a high-clearance vehicle in order to access them properly. However the F-Road system is easily accessible from paved roadways, allowing reckless or unaware tourists to access them with vehicles ill-equipped for F-Road conditions, and the absence of published information on some F-Roads, according to rental car companies, leaves room for tourists to face unexpected challenges while driving (Bilquist, 2022).

Roaming livestock create potential hazards to drivers. While horses and cows are typically fenced, sheep and reindeer graze freely along Iceland's roads and wander onto the streets (Reinhardt, 2019). The Icelandic government warns drivers to be aware of livestock on and around roads, especially at night (Reinhardt, 2019), but collisions continue to occur

(Grandin, T., & Deesing, M. J. 2022). Frightened sheep often flee into roadways, and collisions can result in injured sheep and car damage, and the driver can be held responsible for covering all repair costs (Gunnarsdottir, n.d.). Furthermore in 2015, eight reindeer were struck by cars in the Eastern Region, which led to the death of five of the reindeer (Iceland Review, 2015).

In highly populated areas, the operation of electric scooters (e-scooters) poses hazards to tourists traveling around Iceland's urban areas. E-scooters are made specifically for Iceland's weather conditions, including rough terrain, wind, and rain storms which can cause traction loss and potential wipeouts. Sidewalks can have potholes, and some scooters possess a shock absorber intended to mitigate discomfort and prevent accidents (Hopp, n.d.).

2.5 Hazard Type versus Tourism Region

Table 4 - *Hazard Type and Subtype by Region*

	Volcanic Hazards		*Outdoor Recreation Hazards*				*Transportation Hazards*	
	Direct	**Indirect[1]**	**Hiking**	**Waterfall**	**Wave[2]**	**Glacier**	**Driving**	**Scootering**
Capital			X				X	X
South	X	X	X	X	X	X	X	
Southern Peninsula	X	X	X				X	X
West		X	X	X		X	X	
North	X	X	X	X			X	
East			X	X		X	X	
Westfjords		X	X	X		X	X	

[1] *Indirect Hazards form as a result of a volcanic eruption (i.e. dangerous road and hiking conditions due to new lava flow and mass evacuations as well as delayed upper respiratory problems).*

[2] *Wave Hazards are sneaker waves only and not other hazards associated with beaches.*

2.6 Hazard & Risk Communication in Iceland

Hazard and risk communication can be broken into two sections; one being hazard education and the other being hazard warnings. Hazard education serves to increase an individual's awareness of a certain hazard. On the other hand, hazard warnings are utilized to communicate imminent threats to an individual's livelihood (Bird, 2020).

The “Eruption Emergency Guidelines” brochure is one communication tactic used for volcanoes in Iceland. This brochure seeks to educate tourists and locals of the potential hazards of a specific volcano and what to do if an eruption takes place (Bird, 2010a). Along with hard copies distributed to mountain hut wardens, which are individuals responsible for maintaining Icelandic housing huts, the brochures are published in six (6) languages on the *Icelandic Department of Civil Protection and Emergency Management* website (Bird, 2010a). The pamphlets can be found in Iceland's free literature kiosks that distribute free literature to passerbyers on the street, in shops, in rental and tourism offices, and in other high foot-traffic areas where potential eruptions may take place.

In Iceland there are websites that provide hazard education to locals and tourists. One of these websites is the SafeTravel.is website. This provides detailed information and up to date alerts to inform travelers on how to travel safely in Iceland (Icelandic Association for Search and Rescue, 2023). SafeTravel.IS has an opt-in alert system that will send a text to an individual's smartphone warning of active hazards in the area including warnings on hiking, active volcanoes, driving, and avalanches. Integrated into SafeTravel.IS is an interactive map of Iceland that lists hazards found around the country, current road conditions, and live weather data. In her research, Bird found that 52% of tourists did not familiarize themselves with natural hazards and/or emergency management procedures before coming to Iceland, but a common website used by tourists is the *Icelandic Meteorological Office’s* (IMO) website (Bird, 2020). The IMO website provides vital information on active hazard events and weather in Iceland but does not display any permanent hazard information to possible tourist audiences.

Video media is utilized to communicate hazards about volcanoes to tourists. The visitor center at Skaftafell National Park displays a video of the *Gjálp* eruption from Vatnajökull Glacier and subsequent glacial burst flood in 1996. This video communicates hazards of subglacial eruptions and other hazards surrounding the eruption. In Bird’s survey, tourists that had seen this video described it very positively (Bird, 2010a). The positive reactions to the video do provide

evidence that hazard videos could be displayed elsewhere, such as airports and hotels, in order to reach a broader tourism audience (Bird, 2010a).

Another display of hazard education media is in the form of online video advertisements. These advertisements often display dangerous situations such as operating e-scooters while under the influence, or unsafe weather conditions affecting roads in order to inform people visiting Iceland of the more common recreational hazards they may experience day to day. Hazard advertisements, however, are only displayed after tourists arrive in Iceland and are surfing the web.

Another form of hazard warnings include the placement of warning signs in high traffic areas such as trailheads or parking lots before tourists encounter potential hazards. For example, the warning signage for sneaker waves at south Iceland beaches are bright yellow and read "DANGER" while depicting the dangerous waves on the sign. These signs display the most immediate hazard information for the given location. However, all of an area's hazards cannot always be conveyed on a single sign. This leads to tourists not reading or misunderstanding the magnitude and scale of hazards (Matti, 2022). One issue with the signs in the Katla volcanic area is that they read "Katla-Mýrdalsjökull" and not "BE AWARE" this misswording is one contributor to the fact that, in Bird's 2020 tourist study, 74% of people did not see or read the hazard warning sign (Bird, 2020). Visual appeal plays a key role in effectiveness of warning signs and hazard maps. For instance, some tourists in Bird's survey state that they only read about half of the sign but the map on the sign stuck with them (Bird, 2020). Bird's survey highlights the significance of visual appeal when it comes to communicating hazard information, and effective visuals like hazard maps should be implemented in all technological and non-technological hazard communications.

2.7 Hazard Communication via Short Message System

In the modern digital age, short messaging systems or SMS communication remains one of the quickest ways to reach a large population via a short form text message. An example of SMS as a form of hazard or emergency communication is the United States emergency alert system or EAS that is used by the *Federal Emergency Management Agency* (FEMA). FEMA collaborates with the National Weather Service, the National Center for Missing and Exploited Children and the President of the United States to provide American citizens, or people with a *System Identity Module* (SIM) card registered with an American cellular data provider,

government-issued emergency messages. These messages are able to override network congestion and delays to provide almost instant information about emergencies. Flash Flood Warnings disseminated by the U.S. National Weather Service and *America's Missing: Broadcast Emergency Response* (AMBER) Alerts for missing or abducted children issued by the National Center for Missing and Exploited Children (United States Department of Homeland Security, 2023), both utilize this method of instant hazard communication. EAS messages play a specific tone along with a unique pattern of vibrations to alert the phone user of the emergency. EAS alerts can be sent regionally, based on the cell tower that a cell phone user is pinging off of for regional emergencies such as a flash flood warning, or nation-wide threats. The warning message is sent by the government via radio to the appropriate cell towers that then distribute that alert in sms message form. These messages contain information about severe weather, immediate threats to life, or property and presidential alerts (United States Department of Homeland Security, 2023).

The Icelandic government uses an emergency alert program called Everbridge. Everbridge, similarly to FEMA, uses location-based SMS messaging, and recognizes user phone SIM cards when they ping off of cell towers; these alerts are received by cell phone users in their own language (Everbridge, 2022). This means the Icelandic government can reach users based on emergencies in the region they are in. When a user's cell phone pings off of a cell tower, the government can record the number of people in any given area, to better prepare for any rescue efforts that may be needed. Location-based alerts allow the Icelandic government to reach citizens with Icelandic SIM cards overseas, and warn them about foreign disasters. The Icelandic Meteorological Office notifies people using the Icelandic cellular data network when the weather forecast warrants a warning, when there is an aviation alert such as volcanic ash or extreme impending weather, and when research is being conducted concerning air, land or sea (The Icelandic Meteorological Office, 2020). A key difference between the Everbridge system and the standard American EAS system is that the EAS system relies solely on cell towers while the Everbridge system first utilizes cell towers, but if the cell towers become too encumbered by data or physically harmed the Everbridge system can utilize Wi-fi signals, emails, or even electronic billboards and road signs (Ailworth, 2013). The Everbridge system is not only utilized for government emergency applications but can be utilized for smaller scale local and business communication and alerts. The company allows anyone with a need to reach a large subset of

people to be able to utilize their platform, proving its usefulness in situations such as an opt-in based service. Opt-in based services, unlike emergency alerts, requires the user to confirm that they wish to receive or keep receiving messages but allows for longer form messages and notifications to be sent to the participants via the same location based sms networks that the emergency broadcasts utilize.

3 Methods

3.1 Objective 1: Survey and Interview Tourism Stakeholders

To corroborate its background research, the team interviewed eleven (11) local tourism experts and guides as well as surveyed fifty-five (55) tourists. Interviews and surveys were found to be effective in a similar Japanese study titled *Perceptions of Volcanic Hazard-related Information Relevant to Volcano Tourism Areas in Japan* in which they assessed how much, and how dangerous, both tourists and locals viewed volcanoes in the areas to be. The study found this research technique was effective in understanding public opinion on hazards, and provided sample interview and survey questions which were relevant to the design of the questions which the team asked (Kuri, 2018).

3.1.1 Interview Approaches

The team conducted in-person and virtual interviews with tourism professionals and tourists in Iceland. The surveys and interviews were conducted by approaching tourism professionals and visitors in both Rekjavík and identified tourist sites. Both individual interviews and survey interviews were used. The individual interviews followed a semi-structured format and utilized open-ended questions to pursue tangents brought up by the interviewee; this method allowed the opportunity for new questions to be added to the question set at a later date (Stuckey, 2013).

The team, in pairs of two (2), performed individual interviews of tourism professionals at local Rekjavík tourist offices, tourist sites, and the University of Iceland. The open-ended questions were given one at a time with time to discuss in between each question. All responses from tourism professionals were typed onto a shared document. An example of the questions asked are shown below. See Appendix B: Expert Interview Questions for a full bank of questions. An example question is as follows:

9. How do you choose to communicate hazards to tourists (verbal, pamphlets, videos, etc.)?

Figure 3 - *Question #6 Sampled from Appendix B: Expert Interview Questions*

The team surveyed tourists in the form of a short street interview to gather information on what hazard information is presented to the tourists. Survey participants were approached at tourism sites in Iceland by a pair of two team members and asked to participate in a research study. A team member conducted the survey interview while the remaining member recorded all participant responses. The survey interviews followed a sequence of preformed questions but were delivered in the form of a conversation with specific answer banks. See Appendix C for a full bank of questions. An example question is as follows:

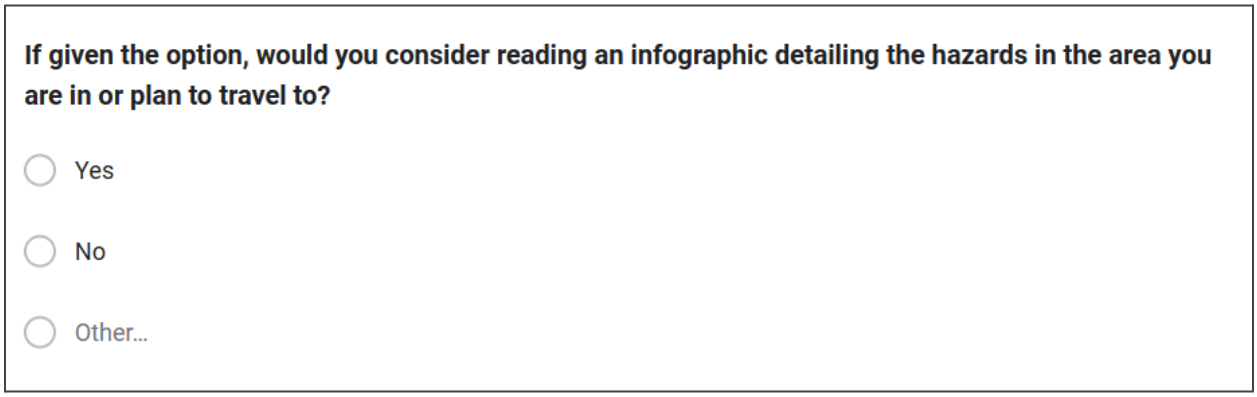

Figure 4 - *Question #49 Sampled from Appendix C: Survey Interview Questions & Responses*

All responses from participants were recorded in a *Google Form* and stored in a *Microsoft Excel Sheet*. This allowed the team to more directly compare responses and discern response trends. Responses to these interviews were collected and used to gauge the experiences of individual subjects and to understand subjects' opinions on infographics and SMS systems as hazard communication media.

3.1.2 Data Management and Analysis

All interviews and surveys conducted were documented with the consent of the interviewee. Each tour-guide interview and tourist survey was conducted by two team members. The first team member acted as the primary interviewer who asked the interviewee the questions, and the second team member acted as the secondary interviewer who recorded notes. During the

tour guide interviews the secondary interviewer recorded all questions asked and created a bulleted list of interviewee responses. During the survey interviews the secondary interviewer filled out the survey with the interviewee's responses. These transcripts were recorded in the secure team file-sharing application for analysis. This data was analyzed by comparing and contrasting different answers to the same questions across all interviewees to identify similarities, differences, and common threads.

3.2 Objective 2: Investigate SMS Technology and Communication Media

The team investigated the integration of SMS technology and hazard communication media from a tourist's perspective. The team evaluated the current implementations of the hazard media within the context of the team's background research. This investigative approach allowed the team to determine what information was needed in the team's final SMS alert proposal and regional hazard infographics.

Ethnographic observation was chosen for its capacity to gain insight on how individuals interact with the hazard alerts without any guidance. The information from these observations allowed the team to determine if any additional information was necessary to add to the SMS Alert message and the regional hazard infographics. Ethnographic observation allowed the team to observe individuals genuinely interacting with hazard communication media. A drawback of utilizing this style of ethnographic observations was that it precluded interviews or surveys from being conducted while subjects were being observed, however the interviews of Objective 1 covered this shortfall. From the observations, the team determined where changes could be made to pre-existing technology which would later be used to propose a system that suits the purpose of risk mitigation in tourist areas. The gathered data was used to design the final regional hazard infographics and SMS Alert proposal of the report, including necessary program behavior and alert message outlines for the SMS message outlines.

3.2.1 Observational Approach

The team conducted *ethnographic observations* to identify useful information in existing hazard media to incorporate in the reports final SMS proposal. Ethnographic observation is a process by which researchers study individual subjects' natural habits via detached observation.

The team engaged in two ethnographic observation environments: observation of Icelandic hazard media itself and observation of research subjects interacting with Icelandic hazard media.

Each team member interacted with Icelandic hazard media including the SafeTravel.IS website, hazard signage at tourism sites, verbal safety briefings delivered on tours, and advertisements from a tourists' perspective. The team analyzed each media piece's design, delivery method, and the content of hazard communications within the context of the team's research. These observations were recorded on a daily basis with the type and source of the media, the delivery method (e.g., physical pamphlets, posters, signage, digital advertisements, etc.), the intent (e.g., advertisement, safety missives, public service announcements, etc.), and any other additional comments on the piece of media.

The team observed individual subjects and their interactions with hazard media to gain more perspective on how tourists with less background knowledge approach and process hazard media. These occurred at twenty-five (25) different tourism locations spread across six of the seven tourism regions of Iceland. Each location was chosen for its popularity with surveyed tourists in Objective 1, its geographic location, and the feasibility of the team's members to reach it. These observations would last for fifteen (15) minutes or more per observation per area. Observers collected observational data on three (3) key behaviors:

1. Ignoring Verbal and/or Posted Warnings
2. Violating Boundaries
3. Other Injurious Behavior[1]

\

1- General category for behavior with the potential to cause serious injury or distress (i.e. **standing on a cliff's edge**, **roasting food near a lava flow, etc.**)

The total estimated number of observed individuals at each area as well as the number of instances of each key behavior were recorded. The discrete observational data was compiled into a table (see Table 5: Results from Ethnographic Observations), grouping each observational area's data by tourism region.

The team further observed whether tourists acknowledged hazard signage, or whether warnings were ignored or misunderstood as well as the behavior of subjects at tourism sites in

relation to hazards. These general observations followed a non-standard protocol, and no personally identifiable information was recorded.

3.2.2 Analysis of Observational Data

Notes on each observation were stored in a secure team file sharing application in a document folder that team members accessed. From these observations, the team identified common behaviors, significant occurrences (e.g., injuries, accidents, property damage, damage to nature, etc.), and general observations of tourist conduct to address with the recommendation report.

3.3 Objective 3: Formulate Recommendations

From the survey and interview outcomes of Objective 1 and the observational outcomes of Objective 2, the team formulated a recommendation summary of actionable items to address the identified areas in which Icelandic hazard communication media falls short. The implementation of these recommendations addressed:

1. The means by which Icelandic tourist media could be improved
2. The methods by which Icelandic tourists can be better reached
3. Potential paths for improvement including:
    - 3.1 Print and digital infographics
    - 3.2 SMS-based media
    - 3.3 Improvements to existing online resources

3.3.1 Creation of Infographics and SMS Proposal

The team utilized the digital application *Piktochart*, a creativity software which excels in graphic designs, to create each of the seven region-based hazard infographics. The team utilized document research to determine region-specific hazards. The team then used the results from tourist survey interviews to determine the tourist opinion on the preferred level of detail for hazard-prevention infographics.

The team utilized document research to learn about cellular data coverage in Iceland, to determine whether an SMS message would be an effective method of reaching tourists. Document research was used to investigate SMS as a method of hazard communication in other

countries. To validate the proposal for implementation of an SMS system the team utilized the tourists surveys to investigate tourists opinions on whether or not they would use an SMS system.

3.4 Project Obstacles and Limitations

3.4.1 Population Constraints and Sample Size

The team arrived in Iceland nearing the conclusion of the summer tourist season and no active eruptions occurred during the research period. This resulted in a limited population of interview subjects. Subjects aged eighteen (18) through thirty-five (35) were less common compared to subjects aged thirty-six (36) to fifty-plus (50+); this was reasoned due to the conclusion of summer vacation for college-aged adults and holiday for working adults, leaving a larger proportion of retirement-aged adults (50+) for survey. The smaller population size and skewed age distribution resulted in a smaller effective sample size than anticipated. The limited population of tourism experts on the topic of tourism safety as well as tourism professionals willing to participate in an individual interview remained an obstacle to research. The team could only conduct interviews with participants that understood and spoke English which resulted in a limited number of participants being interviewed at certain tourist sites.

3.4.2 Resource Limitations

Limited financial resources made visiting certain tourism sites, such as the Northern Region, less feasible for observation during the research study. Limited availability of tourism professionals during the final weeks of the Icelandic summer tourism season prevented interviews and surveys from being conducted which further limited the number of responses for interviews and surveys.

3.5 Ethical Considerations

All survey questions were reviewed by the Institutional Review Board to minimize possible ethical concerns. Ethical concerns taken into account by the team include questions regarding topics that can be construed as difficult to talk about for some interviewee and their inclusion in the interviews and surveys. The team asked interviewees about their experience in hazardous areas and responses potentially included reference to traumatic events and topics that are uncomfortable to discuss with strangers. The team did not survey children, prisoners or

otherwise compromised parties. The team did not record any personally identifiable information so interviewees would not be linked to the information that they provided.

4 Findings & Conclusions

4.1 Tourist Safety & Unsafe Behavior

Tourists feel entitled to structured supervision on tours while tourism professionals do not feel obligated to do so as guides.

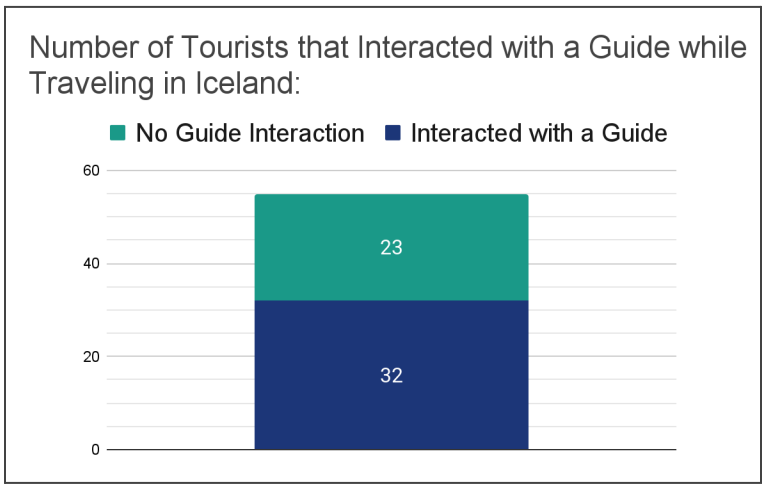

Figure 5 - *Number of Tourists that Interacted with a Guide*

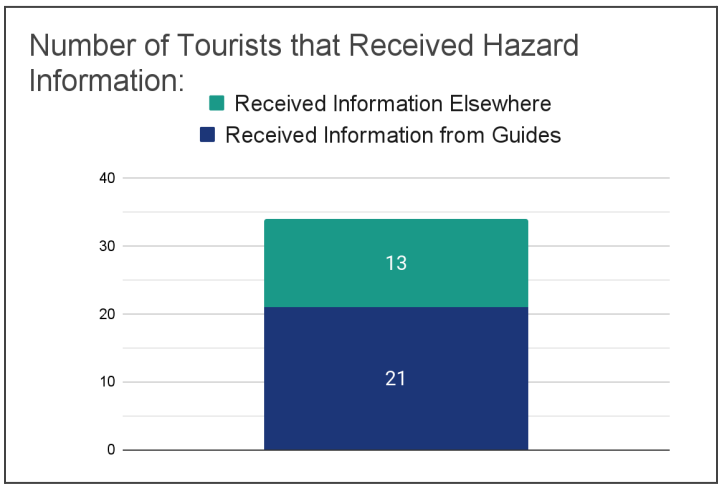

Figure 6 - *Number of Tourists that Received Hazard Information*

In the Icelandic tourism industry, tourists feel entitled as paying customers to a structured level of supervision on tours while tourism professionals do not feel obligated to do so as guides. The tourists' reliance on tour guides is represented in the survey interviews, see figure 3 and 4, where thirty-two (32) of fifty-five (55) tourists had interacted with a tour guide, and of thirty-four (34) tourists that had received safety information twenty-one (21) of those individuals received it from a tour guide.

"You are an adult, and you can choose to endanger your life and I can choose to not endanger mine for your sake." - Southern Area Guide

While tourists utilize tour guides to educate themselves on hazards they may face, the team discovered, through interviewing tour professionals, that the tour guides express collective concerns about tourists' limited application of critical thinking and situational assessment,

particularly in high-risk settings. A lava tube tour guide expressed their concern of having to "babysit" the tourists stating, "We tell them [the tourists] the risks. It is Iceland. [...] I should not have to treat them like little children. We tell them, and they listen but they do not hear sometimes." In a similar fashion a Golden Circle guide expressed their opinion on how tourists expect too much from guides by stating, "Old people will sign up for a four, five-kilometer-long hike and expect me to carry them. [...] But the tourists, they are just stupid. [...] They forget things, they forget to take their medicine [...] they forget to wear their good clothes." These interviews highlight the difference in responsibilities the tour guides feel they have, and the responsibilities tourists feel they are expected to cover.

There is a pattern of unsafe behavior among tourists in Iceland, despite hazard signage and guidance from tourism professionals.

A trend of risk-prone conduct is evident among tourists in Iceland. Survey Interviews highlighted a discrepancy between tourists' perceived safety and their actual behavior. Notably, respondents displayed a tendency to overlook explicit safety advisories in high-risk areas. Out of the fifty-five (55) survey respondents, thirty-four (34) reported receiving hazard communications in some form. Among the thirty-two (32) respondents who reported interacting with a guide, twenty-one (21) further reported receiving hazard communications from them.

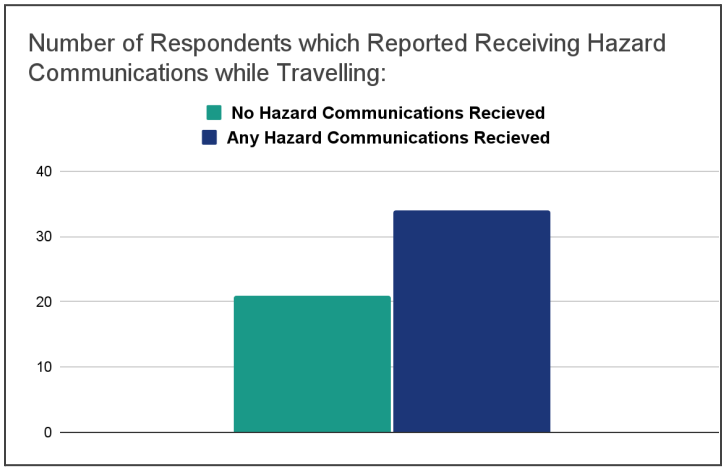

Figure 7 - *Number of Respondents which Received Hazard Communications*

The survey results demonstrate a consistent pattern of tourists disregarding hazard communications and guidance from professionals. This behavior poses a tangible risk to both individual safety and the preservation of Iceland's natural sites. It underscores the urgency of focusing on educating and empowering tourists to make responsible choices, rather than solely relying on the obligations of tourism professionals.

Expert Interviews consistently detailed unsafe tourist decision-making, often "for the photo," especially in environments with elevated risk factors.

“For a photo? People will never follow instructions, the signs. And I do not wish to shepherd cats” - Snæfellsjökull Area Guide

A tour guide in Iceland's Southern Region described this stating, "I will tell them 'Do not approach the cliff. There are ropes, there are signs. You will know.' And yet they will still shout for me to come, and I find them out on the cliffs, posing for a photo. And one will hand me the camera, step out to the edge, and take a jumping photograph. It is as if I did not speak at all." Guides maintain the perspective that they should not be required to provide constant supervision for tourists; a subset of tourists hold the expectation of oversight, and this subset encompasses the individuals who bear responsibility for irresponsible behavior observed at tourism sites.

“They are like little babies. Did your mother never tell you not to touch the stove?” - Eruption Area Guide

Ethnographic observation of visitors at one cliff mentioned by the guide, the Dyrhólaey Arch (see Table 5: Results from Ethnographic Observations), provided visual confirmation of tourists' risky behavior. During the 15-minute observation period, in excess of forty-five (45) individuals of the observed sixty-five (65) visitors crossed the guard fences near the cliff’s edge, corroborating the anonymous professionals’ claims of poor tourist conduct. This behavior aligns with observations of tourists' conduct, further underscoring the identified pattern of unsafe behavior.

The statistics and observations further illustrated that tourists' behavior often disregards safety guidelines. Observations at other tourism sites consistently offered more concrete instances of tourists engaging in risk-prone behavior contrary to explicit instruction and established safety guidelines. Given the notion that tourists expect supervision and the observed pattern of poor behavior, it is more feasible to address tourists’ behavior than to reorganize the obligations of Iceland’s tourism professionals, necessitating a better means of educating tourists.

4.2 Current Quality and Effectiveness of Hazard Education

Resources available from Icelandic tourism authorities (112, SafeTravel.IS, MET Office, etc.) do not reach the tourists they are intended to inform.

Existing digital hazard education methods do not reach the intended audience due to lack of promotion. Of the surveyed tourism population, seventeen (17) out of thirty-nine (39) tourists reported that they did not receive any hazard education before or during tourism experiences at volcanic sites with a further twenty-two (22) out of the thirty-nine (39) visitors failing to see any warning signs. In the free response section of the survey, eight (8) out of thirteen (13) respondents indicated hazard warning signs were most prominent at beaches while other outdoor locations did not have easily noticeable signs with twenty (20) out of fifty (50) tourists stating they did not see any signs whatsoever. Of twenty-one (21) tourists renting a vehicle or conducting self paced tours, eighteen (18) indicated they did not receive any warnings, and eleven (11) out of twenty (20) tourists did not see any hazard signs.

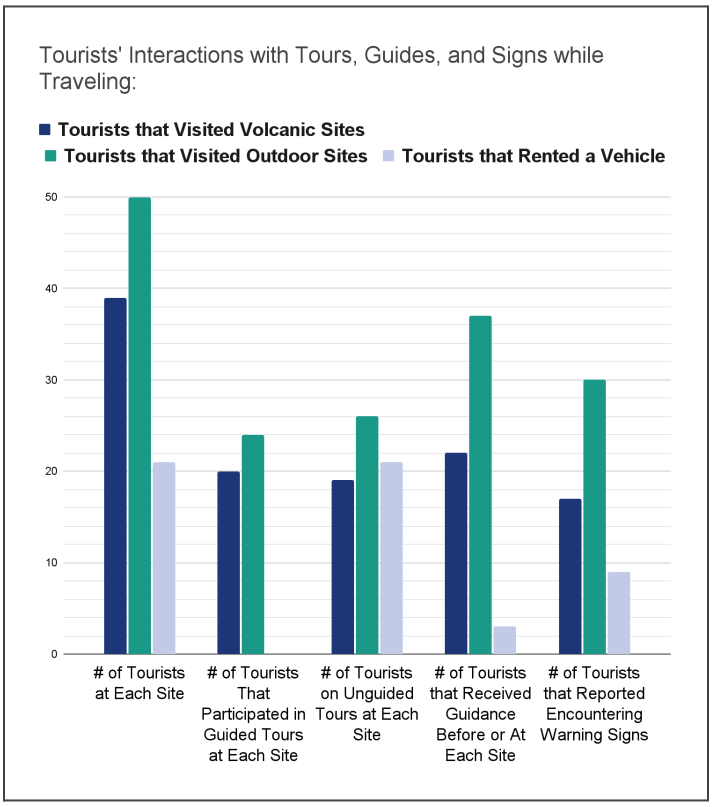

Figure 8 - *Number of Tourists' Interactions with Hazard Media Traveling to Tourism Sites*

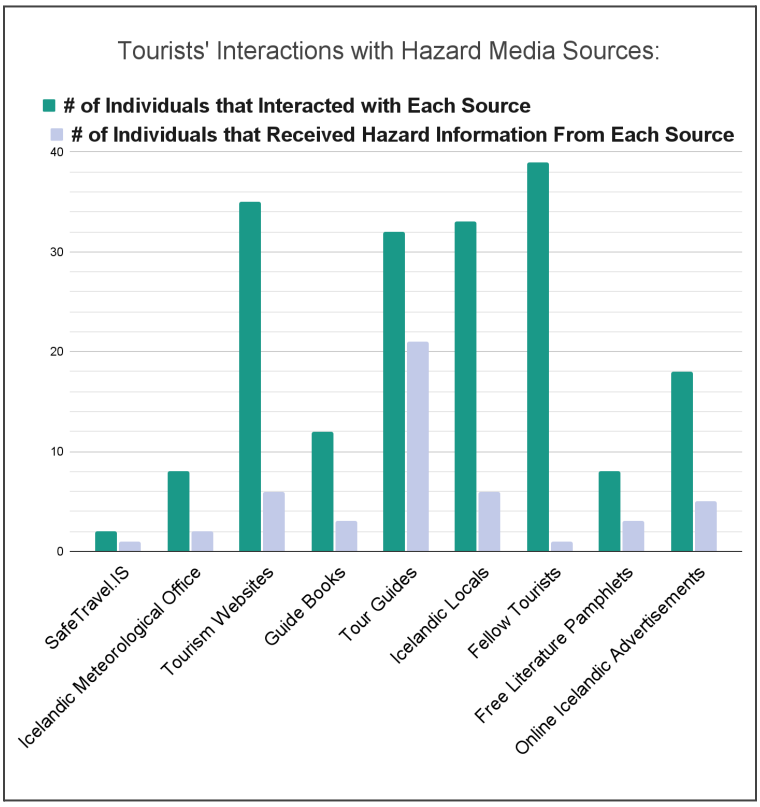

Figure 9 - *Number of Tourists' Interactions with Hazard Media Compared with the Number that Received Information*

Through surveys and ethnographic observation (see Appendix C; Table 5: Results from Ethnographic Observations), the team concluded that the hazard education materials did not reach the tourists at the observed tourism sites. While surveying tourists, the team noted two (2) out of fifty-five (55) tourists knew about SafeTravel.IS and eight (8) out of fifty-five (55) tourists knew about the Icelandic Meteorological Office, while thirty-nine (39) out of fifty-five (55) tourists interacted with fellow tourists. Other commonly used resources that tourists interacted with include tourism websites with thirty-five (35) out of fifty-five (55) tourists using various websites, and thirty-three (33) out of fifty-five (55) tourists interacted with Icelandic locals. When asked which platforms they used to receive hazard education, twenty-one (21) of fifty-five (55) tourists did not receive any hazard related communication. Out of the thirty-four (34) tourists that received hazard warnings, one (1) out of thirty-four (34) tourists stated that they used SafeTravel.IS, and two (2) out of thirty-four (34) tourists used the Icelandic Meteorological Office, while twenty-one (21) out of thirty-four (34) tourists relied on their tour guides to inform them of the hazards. Additionally, current hazard media (e.g., SafeTravel.IS, the MET Office, ICE-SAR, etc.) is advertised and administered as discrete outlets by the Icelandic federal ministries. There is an opportunity for cross-promotion of current hazard media to establish a more cohesive network for hazard education.

“We tell them, and some may listen but they do not always hear” - Þingvellir Area Guide

The team observed the SafeTravel.IS website did not respond to foreign phone numbers, as each member opted in to the alert messages using US (+1) phone numbers and Icelandic (+354) phone numbers, but did not receive any messages, although alerts were posted on the website.

There is demonstrated demand for region-specific multimedia infographics and for an improved, proactive SMS message system for hazard communications.

Given the observed pattern of unsafe conduct at tourist sites and the claim that tourism hazard media does not reach tourists, improvements in Icelandic hazard communications are necessary. According to fifty-five (55) respondents, there is a demand for both regional

multimedia hazard infographics and an SMS alert message system for hazard communications. The forms of hazard prevention media have the potential to reach more tourists seeing as fifty-four (54) out of fifty-five (55) owned cellular devices and forty-eight (48) of the fifty-four (54) have access to cellular data in Iceland. The demand for these forms of hazard prevention media was shown by of the fifty-five (55) surveyed tourists, forty-two (42) said they would look at a region-specific infographic detailing hazards in an area that they are visiting. An additional three (3) survey interview respondents indicated they would read an infographic depending on where they could find it. Within the surveyed population, fifty-one (51) of the fifty-five (55) respondents indicated preference for a free SMS message that detailed hazards in the area they were entering. The large proportion of surveyed tourists that indicated that they read multimedia infographics and SMS-based hazard communication media suggests demand for hazard education in these forms.

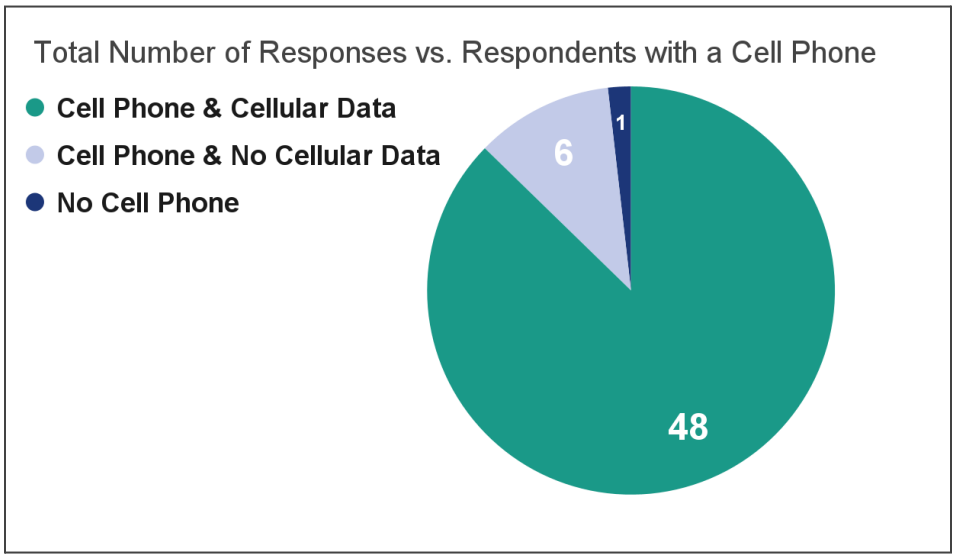

Figure 10 - *Number of Respondents which Owned a Cellular-capable Device while Traveling*

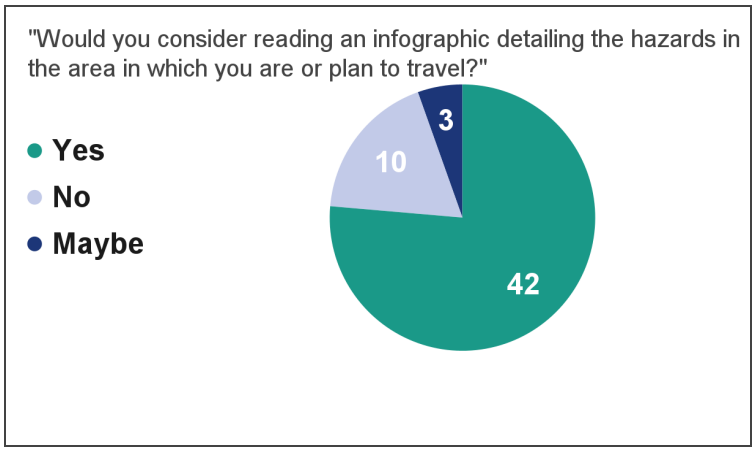

Figure 11 - *Number of Respondents' Opinions on Infographic Media as Potential Means for Hazard Communications*

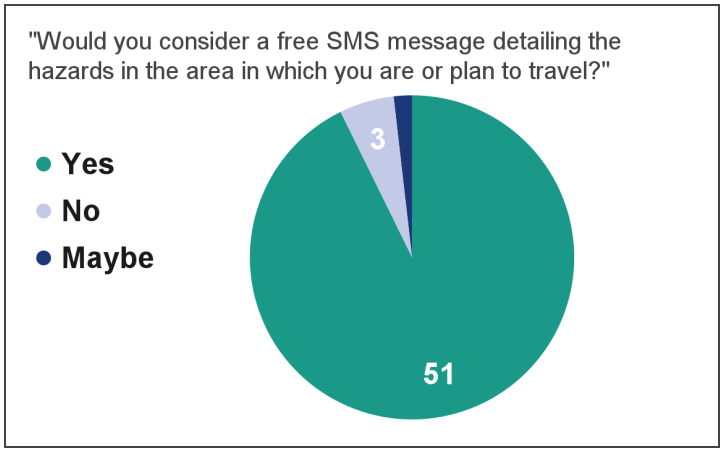

Figure 12 - *Number of Respondents' Opinions on SMS Messages as Potential Means for Hazard Communications*

Tourist interviewees were surveyed for the level of detail they wanted in both the SMS message and the infographic. When interviewees were asked what level of detail they preferred for an infographic, forty-one (41) of the fifty-five (55) responded that they preferred "light detail," and fourteen (14) responded that they preferred "medium detail." None of the surveyed tourists responded that they preferred "heavy detail." When asked about the SMS alert system, twenty-five (25) out of fifty-five (55) respondents said they preferred "light detail", 19 respondents preferred "medium detail" and 11 preferred "heavy detail" depending on the hazards in the area. This indicated that "light detail" hazard communication media had the highest demand, followed by medium and then heavy.

"Pictures, maps especially. They reach everyone. Anyone, young and old, Or someone who does not speak the language can understand"
- Westfjords Wilderness Guide

The demand for SMS alerts and multimedia infographics was further supported by an expert interview conducted with an expert of geospatial sciences for Palacký University, Professor Jinin Panek, PhD. Dr. Panek stated that the most important thing was that the team needed to "know their audience." Dr. Panek discussed tourists as a group of people who are often on their phones, and reaching them via an alert was "the best way to reach a large group of people […]." Dr. Panek stated that not all tourists would have access to cellular data, providing a gateway for another form of communication to be developed. This further supported the demand

for both SMS alert hazard communication media and multimedia infographics as methods that may reach more tourists.

5 Recommendation Summary

5.1 Action Items

To address the disconnect between tourism professionals and tourists as well as the pattern of risk-taking behavior among tourists, the following actions are recommended. To satisfy the surveyed demand for a proactive hazard-education system for tourists traveling to Iceland, a regional hazard-alert SMS system as well as regional hazard infographics should be created. To increase the reach of hazard education, a regional-alert SMS message should be made available to tourists as an opt-in system. SMS messages should be sent to cell phones in a given area as a method of reaching tourists before or when tourists enter a region. These messages should be managed by an Icelandic hazard authority or bureaucratic body. Messages should be sent over an EAS alert system managed by the Icelandic Government, styled similarly to that of the Everbridge System, complete with warning tones and vibrations produced by the mobile device. The content of these messages should be contingent on the region the user enters and be sent in measured intervals to avoid oversaturation or fatigue from the phone user. Information conveyed in these messages should include at least:

1. Weather conditions (temperature, precipitation/forecasted precipitation, wind speed)
2. Current hazards in the region
3. Active travel advisories (e.g., road closures, flood warnings, severe weather warnings, etc.)
4. Relevant links to hazard education material (SafeTravel.IS, Icelandic MET Office, etc.)

The regional infographics should be placed in high trafficked tourist areas such as rental-car pickup locations, the Keflavík and Rekjavík airports and cross-country bus stops. The importance of infographics being placed in high-traffic areas stems from the claim that these hazard-education resources must reach tourists as-intended. These infographics should be accessible on internet-capable devices and should be featured on the SafeTravel.IS and the Icelandic Meteorological Office websites. Each infographic should include a QR-Code to opt-in to the outlined SMS message system. Links to SafeTravel.IS and the Icelandic Meteorological Office should be included on the graphics. Based on the survey consensus in section three of

Appendix C, these infographics should contain medium to light detail pertaining to the hazards of a region. For example infographics see Appendix E.

Supported by the claim that hazard education resources do not reach tourists, the SafeTravel.IS and Icelandic Meteorological Office (IMO) websites should be promoted at frequently visited tourist locations and websites. This would allow for both infographics and the currently available Icelandic hazard education services like Safetravel.IS and the IMO office to be more widely accessible to tourists.

Based on SafeTravel.IS' currently available technology, the team recommends that the Icelandic Tourism board make improvements on the currently available SMS messaging system. The messaging system should be improved to reach both Icelandic and international phone numbers through cell tower based proximity alerts. To further connect the network of existing resources in Iceland, the SafeTravel.IS and the Icelandic Meteorological Office websites should reference the others' websites to directly increase exposure of the current hazard information accessible to tourists.

5.2 Future Research

A future research group should investigate the amount of information per hazard that tourists prefer in the SMS message and the infographics. Further research should investigate which Icelandic bureaucratic ministry or body of authorities (e.g., ICE-SAR, Ferðamálastofa, etc.) could effectively sponsor the infographics and the SMS hazard education systems. One of the surveyed individuals, when asked about how much information they would like to see on an hazard infographic, stated that "it would depend on what hazard you are talking about. I would like to know more about a volcano than some uneven path." From this information, the team determined that further inquiry into which hazards pose the most danger to tourists per region should be conducted to better shape the volume of content conveyed by the regional SMS message alerts and the region-specific infographic content.

A further investigation should be conducted with singular hazard infographics and whether or not these mediums would be effective. Icelandic tourism regions were used as a template to better organize hazard information, however infographics targeted at specific hazards found in Iceland (e.g., Sneaker Waves, Jökulhlaups, Highland Winds, etc.) could convey

information to tourists by outlining dangers they might encounter. Opposed to general hazard information contained within the previously recommended regional infographics.

An investigation into what specific locations in which infographics should be placed to reach the largest population of tourists should be conducted. This investigation should be conducted by the Icelandic tourism board and survey tourists at high-trafficked locations across the entire country in order to determine which locations tourists would prefer to see hazard education media displayed.

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Picture References

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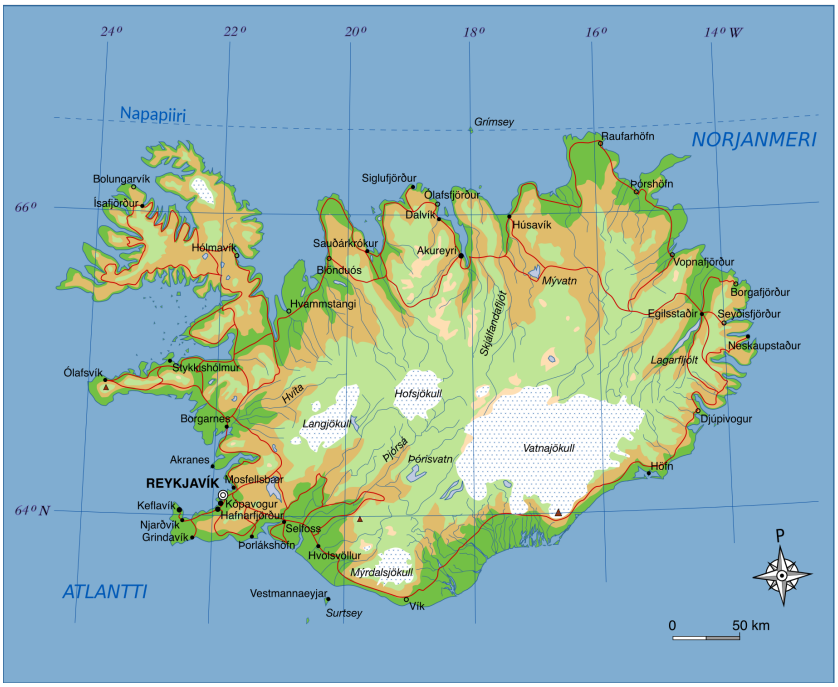

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Appendices

Appendix A: IRB Consent Script

Researchers

- Samantha LeBlanc
- Tanner Ross
- Edward Smith
- Isabel Sumner

Contact Information

The team (Team VSafe-A23) can be reached at the Outlook team email address: gr-vsafe-a23@wpi.edu.

Title of Research Study

Interviews with Individuals regarding Tourist Destinations and Behaviors in Iceland

Sponsor

Dr. Carrick Eggleston, WPI

Introduction

Hello, we are university students from Worcester Polytechnic Institute, an American college located on the United States' east coast. This is a request for your participation in a research study regarding Icelandic tourism. However, before you agree, you must be fully informed about the purpose of the study, the procedures to be followed, and any benefits, risks, or discomfort which you may experience as a result of your participation. This form presents information about the study so that you may make a fully-informed decision regarding your participation.

Purpose of the Study

In order to collect and analyze hazard communication in Iceland's tourism industry, our team will be recording and archiving information from individuals at tourist destinations in Iceland. We will conduct face-to-face interviews of individuals at specific Icelandic tourist destinations. The team is trying to learn about your experience with hazard communication about hazard safety in Iceland. The information obtained through these interviews will be used to create a recommendation to improve outreach and effectiveness of hazard communications.

Procedures to be Followed

Invited to participate in an interview that will take fifteen (15) to forty-five (45) minutes.

Risks to Study Participants

There are minimal risks for the participants involved. However, a foreseeable discomfort may arise should questions regarding safety evoke negative emotions or other potential negative memories. Interviews will consist of respectful, guided conversations with the two team members and an interview subject regarding their experiences. Should the line of inquiry cause discomfort, the participant may opt to conclude the interview or skip questions.

Benefits to Research Participants and Others

Benefits from your participation in this process includes the potential for you and other Icelandic tourists to receive more effective communications of hazards surrounding tourists destinations before and during your visit to Iceland.

Record Keeping and Confidentiality

Names of participants will be kept confidential. The team will request consent to record the audio of each interview.

Each participant's right to request for an unrecorded interview or to remain anonymous for any reason will also be considered and honored by the team.

Research gathered from this process, including participant responses, may be published within the team's final research proposal. Information expected to be reported includes any audio recordings, quotes, lines of discussion, or other such relevant information shared during the participant interview.

Records of your participation in this study will be held confidential so far as permitted by law. However, the study investigators, the sponsor or its designee and, under certain circumstances, the Worcester Polytechnic Institute Institutional Review Board (WPI IRB) will be able to inspect and have access to confidential data that identify you by name. Any publication or presentation of the data will not identify you.

Request to Record:

⬜ **Audio**

⬜ **Photo**

⬜ **Video**

Affirmation of Participation

For more information about this research or about the rights of research participants, or in case of research-related injury, contact: the Team (Email: gr-vsafe-a23@wpi.edu), the IRB Manager (Ruth McKeogh, Tel. 508 831- 6699, Email: irb@wpi.edu) and the Human Protection Administrator (Gabriel Johnson, Tel. 508-831-4989, Email: gjohnson@wpi.edu).

Your participation in this research is voluntary. Your refusal to participate will not result in any penalty to you or any loss of benefits to which you may otherwise be entitled. You may choose to skip questions at any time. You are allowed to ask any questions you may have before the start of the interview. You may decide to stop participating in the research at any time without penalty or loss of other benefits. Should you wish to withdraw from the study after it has begun, the following procedures should be followed: Please reach out to our team to communicate this decision. In this case, we will withdraw any previously gathered input from our deliverables such as our final proposal, any written or recorded documentation or footage, etc. The project investigators retain the right to cancel or postpone the experimental procedures at any time.

By signing below, you acknowledge that you have been informed about and consent to be a participant in the study described above. Make sure that your questions are answered to your satisfaction before signing. You are entitled to retain a copy of this consent agreement.

_____ _____

Study Participant Signature: Date:

_____

Study Participant Name: (Please print)

_____ _____

Researcher Signature: Date:

_____

Researcher Name: (Please print)

Appendix B: Expert Interview Questions

Your participation is voluntary; you can answer as many or as few questions as you'd like. Answers are anonymous; we do not record any identifiable information.

1. What kind of tour(s) do you guide?
2. What forms of transportation are used in your tour(s)?
3. What role do you play in ensuring tourists know the hazards they may experience while touring?
4. What are the specific hazards that you communicate to tourists on your tour(s)?
5. How did you personally learn about what hazards to communicate (i.e risk training, personal experience, mentors)?
6. Do you have a specified risk management procedure?
7. Do you think all tour guides receive adequate safety training from their employers?
8. Do you think there are any specific areas where tour guides would benefit from more training?
9. How do you choose to communicate hazards to tourists (verbal, pamphlets, videos, etc.)?
10. Which manner of communication have you found to be the most effective? Why?
11. Are there any challenges you face when communicating hazards to tourists?
12. How do you overcome those challenges?
13. In the event of hazardous behavior, how might you prevent a tourist from continuing going into a hazardous environment?
14. Any other comments or opinions you would like to share about your experiences or our project? All information is valuable even if you think it might not apply!

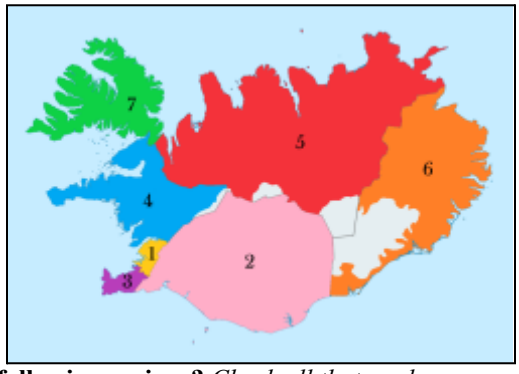
Appendix C: Survey Interview Questions & Responses

Section 1: Basic Subject Information

1.	**What is your age range?**	55 responses
	a. 18 - 25	19
	b. 26 - 35	9
	c. 36 - 49	6
	d. 50+	21
2.	**What is your nationality?** *Please write the country from which you come.*	55 responses
	a. Australia	2
	b. Canada	2
	c. China	1
	d. Columbia	1
	e. Germany	4
	f. United States	45
3.	**Where do you live?** *Please write the country from which you live.*	55 responses
	a. Australia	2
	b. Canada	2
	c. China	1
	d. Germany	4
	e. United States	46
4.	**Do you own a smartphone?**	55 responses
	a. Yes *Continue to Question 5*	54
	b. No *Skip to Question 6*	1
5.	**Do you have access to cellular data?**	54 responses
	a. Yes	48
	b. No	6

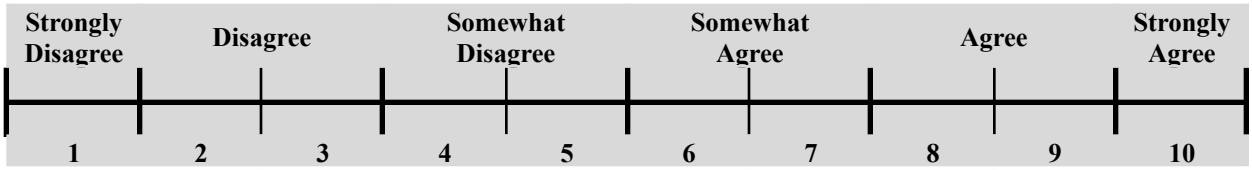
Section 2: Subject Travel Information

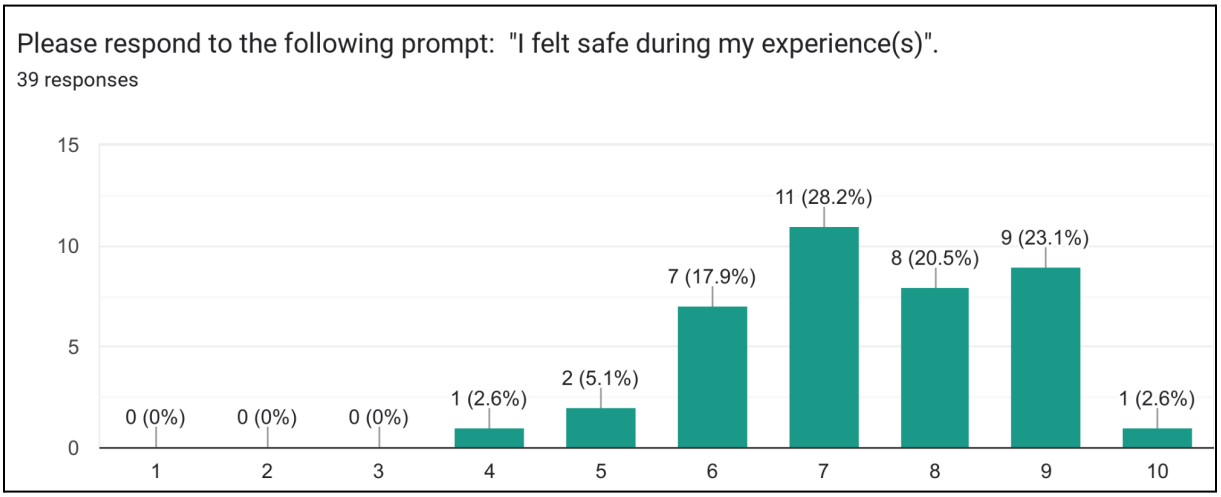
6.	**Have you participated in any tourism experiences in Iceland?**	55 responses
	a. Yes *Continue to Question 7*	53
	b. No *Skip to Question 46*	2
7.	**How many nights did you stay during your visit to Iceland?**	53 responses
	a. 1 - 3	4
	b. 4 - 6	20
	c. 7 - 9	11
	d. 10+	18



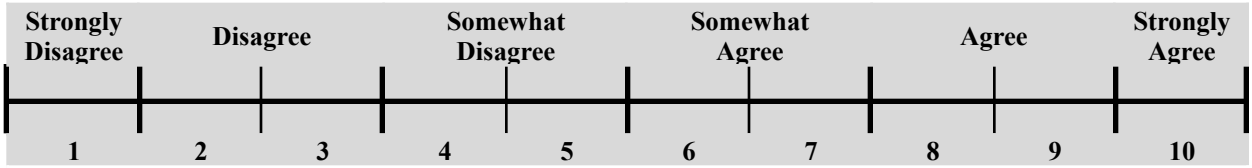
8. Did you visit any of the following regions? *Check all that apply.*	53 responses
□ 1. Capital Region	53 / 53
□ 2. Southern Region	47 / 53
□ 3. Southern Peninsula	51 / 53
□ 4. Western Region	27 / 53
□ 5. Northern Region	17 / 53
□ 6. Eastern Region	17 / 53
□ 7. Westfjords Region	7 / 53
9. Did you visit any of Iceland's volcanoes or volcanic areas?	53 responses
a. Yes *Continue to Question 10*	39
b. No *Skip to Question 18*	14
10. While at these volcanic sites, were you primarily with a tour or self-paced?	39 responses
a. Guided	20
b. Unguided	19
11. What best describes the types of volcanic features you encountered? *Check all that apply.*	39 responses
□ Volcano (active)	2 / 39
□ Volcano (inactive)	30 / 39
□ Geysir	25 / 39
□ Thermal Bath (i.e., Blue Lagoon, Sky Lagoon)	34 / 39
□ Hot Spring (i.e., Reykjadalur Hot River)	22 / 39
12. Did you receive any guidance <u>before</u> or <u>during</u> your visit to these sites?	39 responses
a. Yes	22
b. No	17
13. Did you encounter any signs which communicated local hazards?	39 responses
a. Yes	17
b. No	22
14. Do you have any thoughts about the hazards you encountered?	13 responses
"Common sense was sufficient"	5
"Different approach to risk compared to my country/expectations "	5
"I always felt safe"	2
"I never felt safe"	1

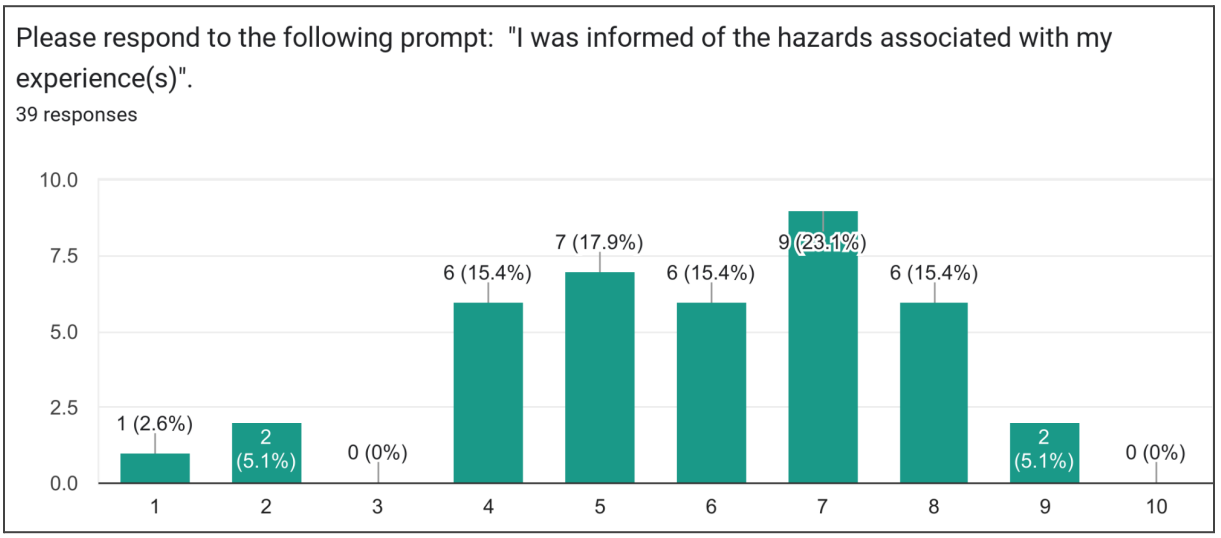
15. **Please respond to the following prompt: "I felt safe during my experience(s)".**





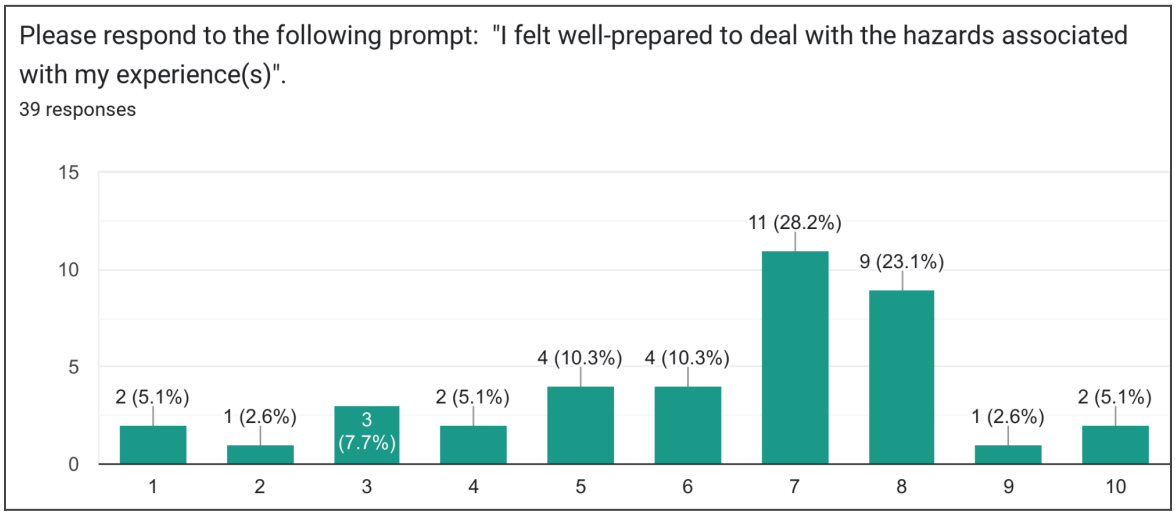
16. **Please respond to the following prompt: "I was informed of the hazards associated with my experience(s)".**





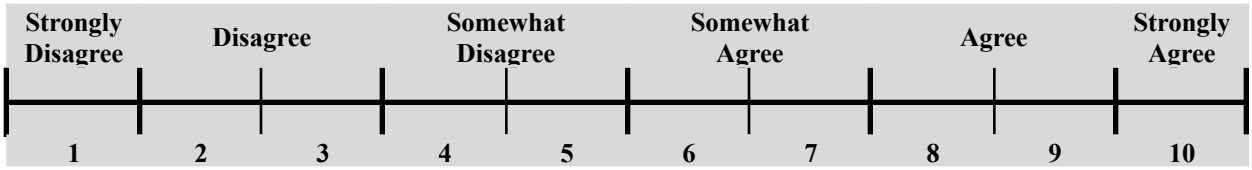
17. **Please respond to the following prompt: "I felt well-prepared to deal with the hazards associated with my experience(s)".**

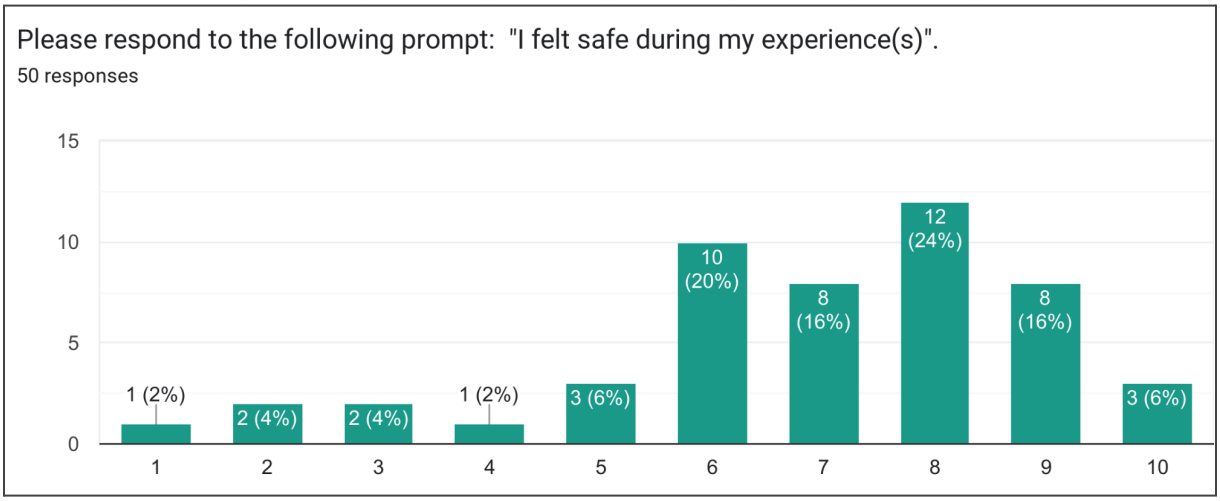
Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
1	2 3	4 5	6 7	8 9	10



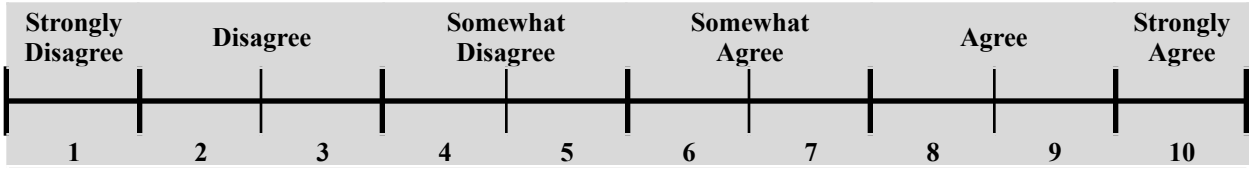
18. Did you visit any of Iceland's outdoor tourism sites or outdoor areas (e.g., waterfalls, beaches, glaciers, mountains, hiking trails, etc.)?	53 responses
a. Yes *Continue to Question 19*	50
b. No *Skip to Question 27*	3
19. While at these outdoor sites, were you primarily with a tour or self-paced?	50 responses
a. Guided	24
b. Unguided	26
20. What best describes the types of outdoor features you encountered? *Check all that apply.*	50 responses
□ Waterfall (e.g., Gullfoss, Seljalandsfoss, Skogafoss)	47 / 50
□ Beach (e.g., Reynisfjara, Sólheimasandur, Diamond Beach)	42 / 50
□ Glacier (e.g., Sólheimajökull)	30 / 50
□ Mountain (e.g., Helgafell)	25 / 50
□ Hiking Trail	41 / 50
21. Did you receive any guidance <u>before</u> or <u>during</u> your visit to these sites?	50 responses
a. Yes	37
b. No	13
22. Did you encounter any signs which communicated local hazards?	50 responses
a. Yes	30
b. No	20
23. Do you have any thoughts about the hazards you encountered?	13 responses
"Some signs you had to hunt for"	3
"The beach was full of signs"	8
"Trail conditions were borderline"	2

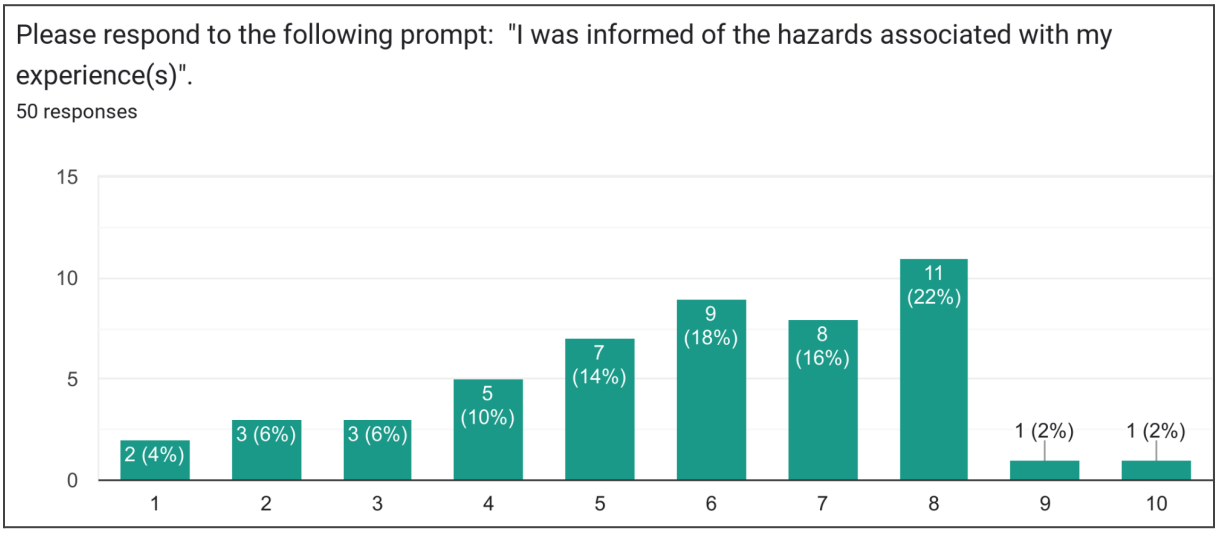
24. Please respond to the following prompt: "I felt safe during my experience(s)".





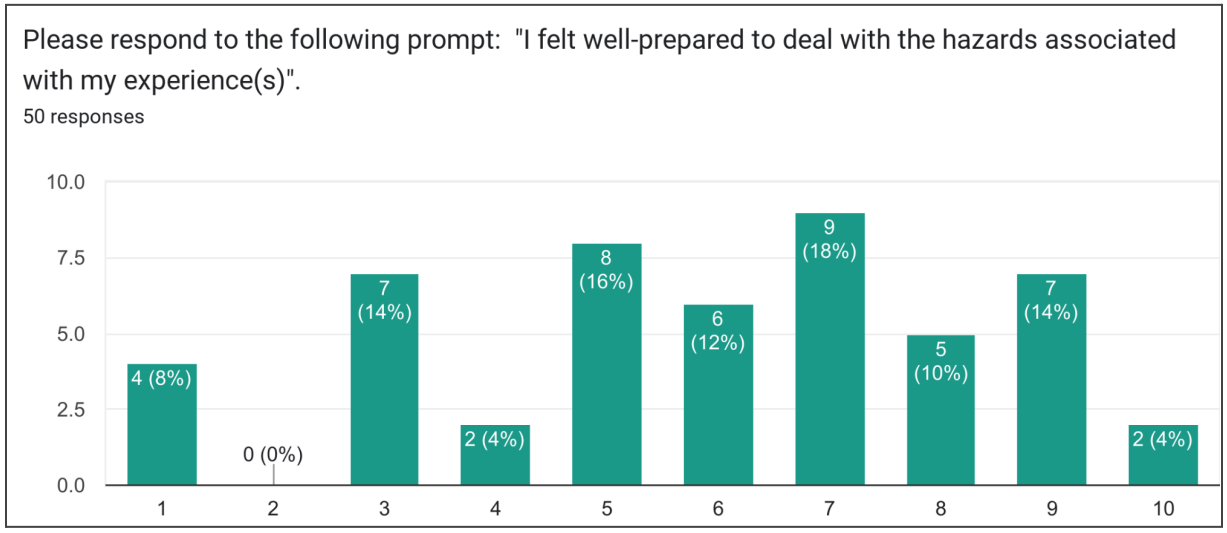
25. Please respond to the following prompt: "I was informed of the hazards associated with my experience(s)".





26. Please respond to the following prompt: "I felt well-prepared to deal with the hazards associated with my experience(s)". *Mark only one oval*

Strongly Disagree		Disagree		Somewhat Disagree		Somewhat Agree		Agree		Strongly Agree
1	2	3	4	5	6	7	8	9	10	



27. Did you drive in Iceland or conduct any self-paced tours?	53 responses
a. Yes *Continue to Question 28*	21
b. No *Skip to Question 38*	32
28. Did you rent a vehicle (e.g., rental car, camper van, ATV)?	21 responses
a. Yes	21
b. No	0
29. Were you primarily with a tour or self-paced?	21 responses
a. Guided	0
b. Unguided	21
30. What best describes the types of outdoor features you encountered? *Check all that apply.*	21 responses
□ F-Road	16 / 21
□ The Ring Road	14 / 21
□ Wilderness Area	14 / 21
□ National Park (e.g., "Golden Circle", Þingvellir, Vatnajökull, Snæfellsjökull)	20 / 21
□ Museum	19 / 21
31. While traveling, did you encounter any wildlife (e.g., sheep, goats, horses, reindeer)?	21 responses
a. Yes	18
b. No	3
32. Did you receive any guidance <u>before</u> or <u>during</u> your visit to these sites?	21 responses
a. Yes	3
b. No	18
33. Did you encounter any signs which communicated local hazards?	21 responses
a. Yes	10
b. No	11

34. Do you have any thoughts about the hazards you encountered?

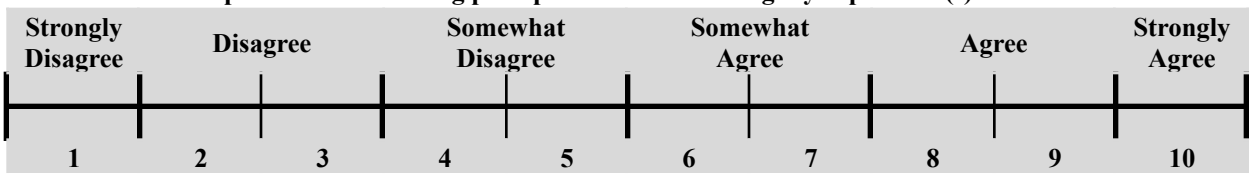
5 responses
1
2
2

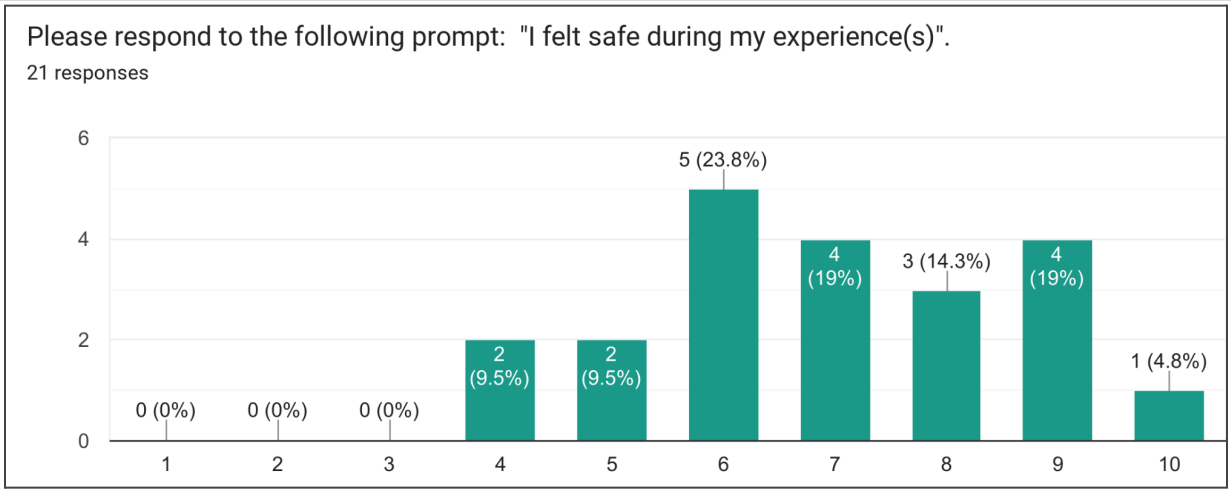
"F-road signs were not sufficient"

"I drove through a blizzard without knowing it was a blizzard"

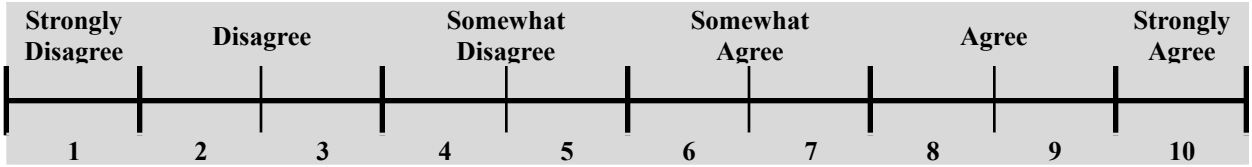
"Road signs were sufficient"

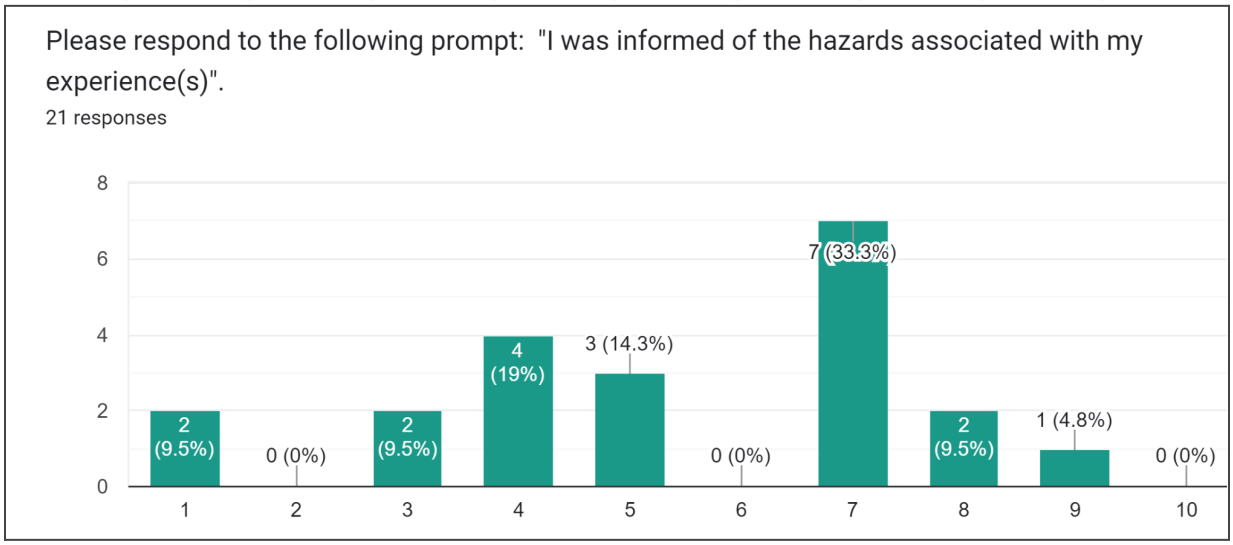
35. Please respond to the following prompt: "I felt safe during my experience(s)".





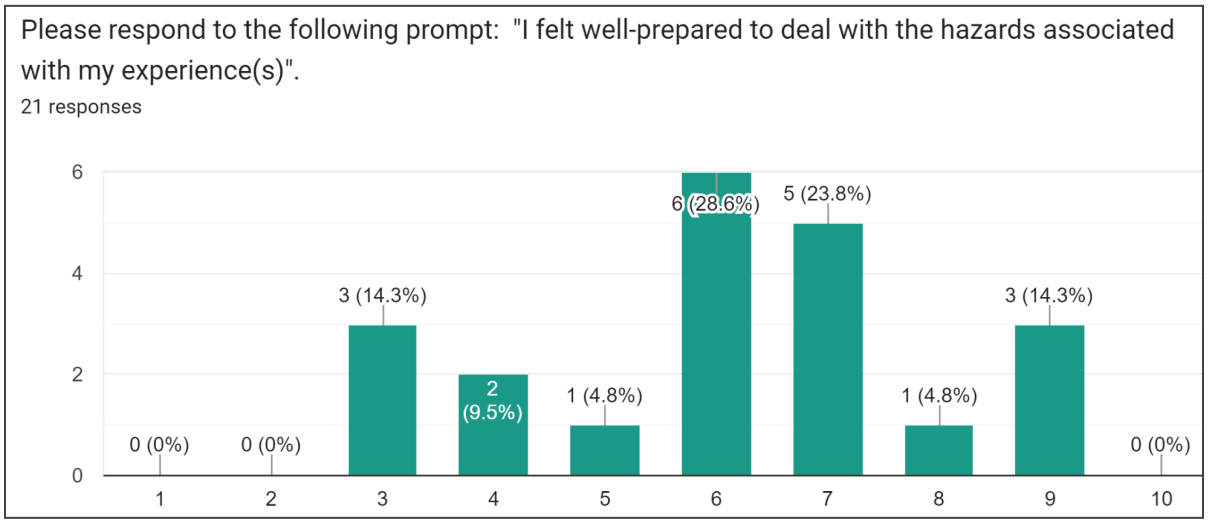
36. Please respond to the following prompt: "I was informed of the hazards associated with my experience(s)".





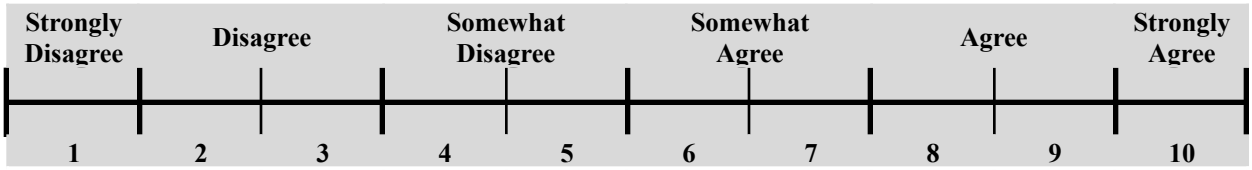
37. **Please respond to the following prompt: "I felt well-prepared to deal with the hazards associated with my experience(s)".** *Mark only one oval*

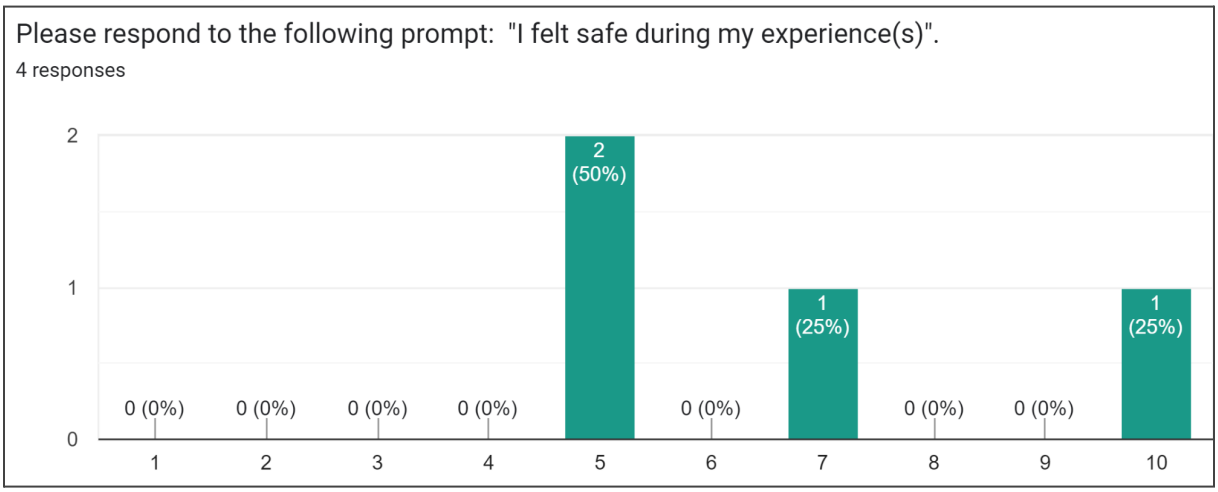
Strongly Disagree		Disagree		Somewhat Disagree		Somewhat Agree		Agree		Strongly Agree
1	2	3	4	5	6	7	8	9	10	



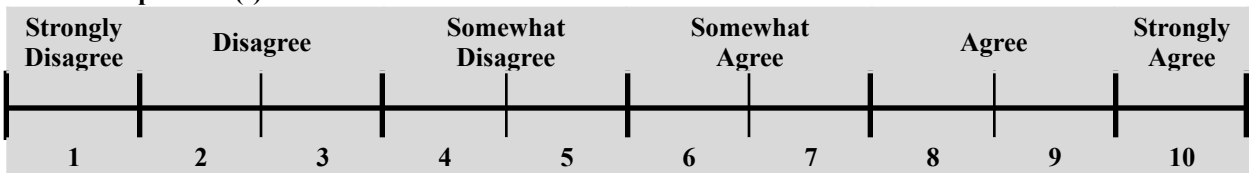
38. Did you participate in any other experiences or tours not yet mentioned?	53 responses
a. Yes *Continue to Question 39*	4
b. No *Skip to Question 47*	49
39. Please briefly describe your experience.	4 responses
"Northern Lights Tour"	1
"RekjavíkBus Tour"	1
"Snowmobile on a mountain glacier"	1
"Whale-watching Cruise Tour"	1
40. Were you primarily with a tour or self-paced?	4 responses
a. Guided	4
b. Unguided	0
41. Did you encounter any signs which communicated local hazards?	4 responses
a. Yes	1
b. No	3
42. Do you have any thoughts about the hazards you encountered?	4 responses
"The hazards were not dire."	3
"The hazards were well-explained"	1

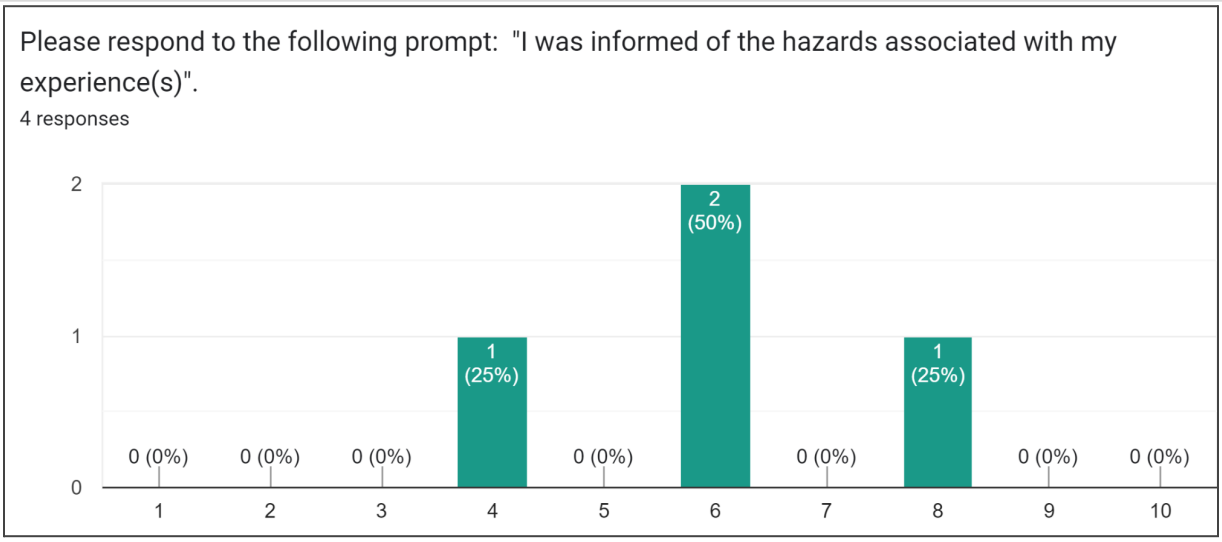
43. **Please respond to the following prompt: "I felt safe during my experience(s)".**





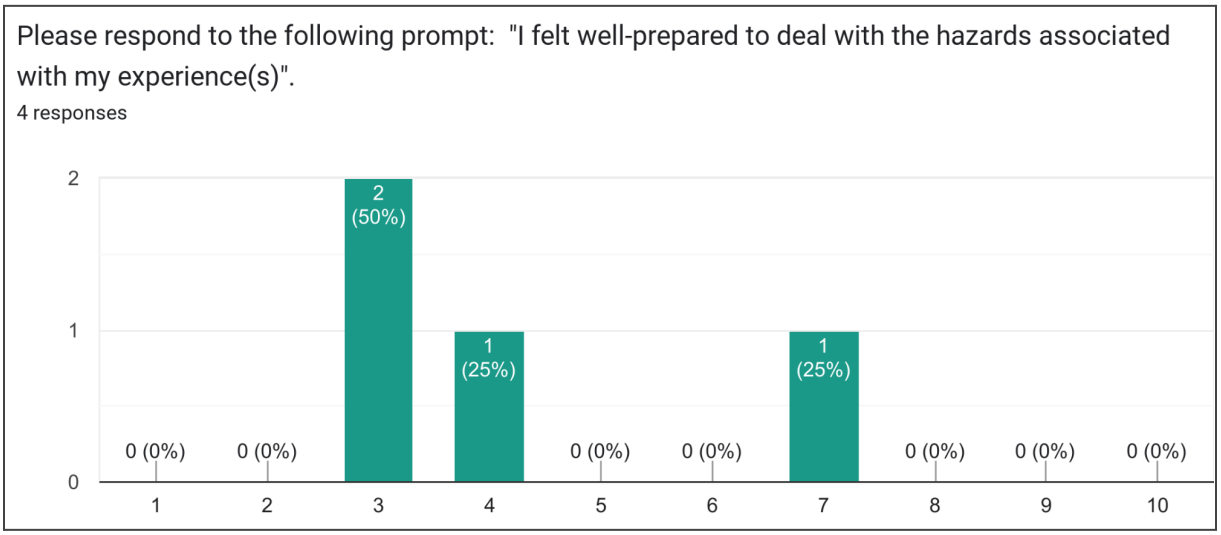
44. **Please respond to the following prompt: "I was informed of the hazards associated with my experience(s)".**



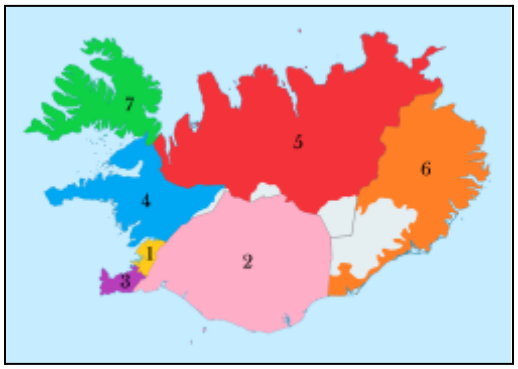


45. **Please respond to the following prompt: "I felt well-prepared to deal with the hazards associated with my experience(s)".**

Strongly Disagree		Disagree		Somewhat Disagree		Somewhat Agree		Agree		Strongly Agree
1	2	3	4	5	6	7	8	9	10	



Skip to Question 47



46. **Do you intend to visit any of the following regions in Iceland?** *Check all that apply.*

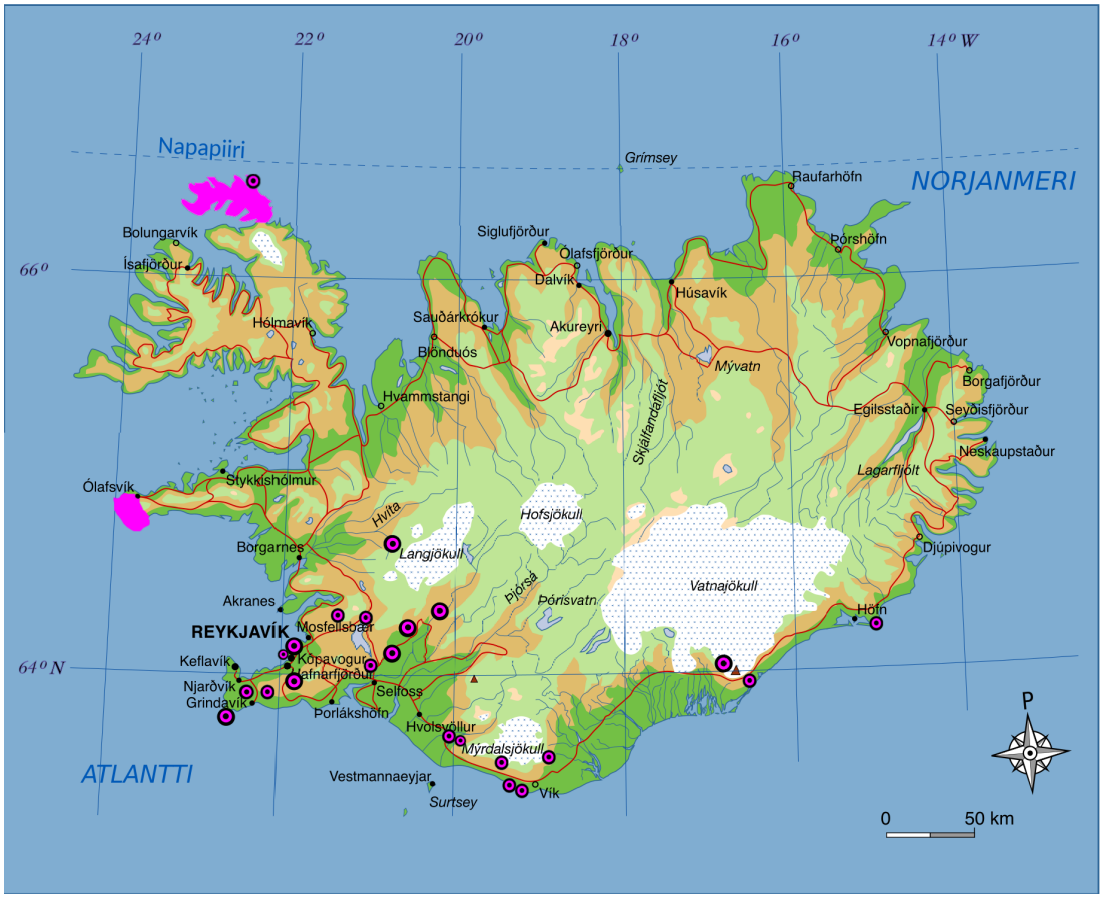
	2 responses
□ 1. Capital Region	2 / 2
□ 2. Southern Peninsula	2 / 2
□ 3. Southern Region	2 / 2
□ 4. Western Region	1 / 2
□ 5. Northern Region	1 / 2
□ 6. Eastern Region	2 / 2
□ 7. Westfjords Region	0 / 2

Section 3: Subject Experience with Hazard Media

47. Have you interacted with any of the following from Iceland? *Check all that apply.*	55 responses
□ SafeTravel.IS	2 / 55
□ Icelandic Meteorological Office	8 / 55
□ Tourism Websites	35 / 55
□ Guide Books	12 / 55
□ Tour Guides	32 / 55
□ Icelandic Locals	33 / 55
□ Fellow Tourists	39 / 55
□ Free Literature Pamphlets (e.g., travel brochures, tourism site advertisements)	8 / 55
□ Online Icelandic advertisements (e.g., YouTube ads, online website pop-ups)	18 / 55
48. Have you received any hazard-related information or communications from any of the following from Iceland? *Check all that apply.*	34 responses
□ SafeTravel.IS	1 / 34
□ Icelandic Meteorological Office	2 / 34
□ Tourism Websites	7 / 34
□ Guide Books	3 / 34
□ Tour Guides	21 / 34
□ Icelandic Locals	6 / 34
□ Fellow Tourists	11 / 34
□ Free Literature Pamphlets (e.g., travel brochures, tourism site advertisements)	4 / 34
□ Online Icelandic advertisements (e.g., YouTube ads, online website pop-ups)	5 / 34
49. If given the option, would you consider reading an infographic detailing the hazard in the area you are in or the area to which you plan to travel?	55 responses
a. Yes	42
b. No	10
c. Maybe	3
50. Please indicate which infographic style you most prefer.	55 responses
a. The Heavy Detail Infographic	0
b. The Medium Detail Infographic	14
c. The Light Detail Infographic	41
51. What do you prefer about your indicated choice? Why?	8 responses
"It is nice to have information about where I am going"	1
"Quality of detail/information should depend on hazard type"	3
"Quick, easy, simple-to-read"	4
52. Please indicate which infographic style you least prefer.	55 responses
a. The Heavy Detail Infographic	53
b. The Medium Detail Infographic	1
c. The Light Detail Infographic	1
53. What do you dislike about your indicated choice? Why?	8 responses
"Too much information to digest / too time consuming"	8
54. If given the option, would you consider receiving a free SMS message detailing the hazards in the area you are in or plan to travel to? This would be similar to the U.S. AMBER Alert System or the EU-Alert System?	55 responses
a. Yes	51
b. No	3
c. Maybe	1

55. Please indicate which message style you most prefer.	55 responses
a. The Heavy Detail Message	11
b. The Medium Detail Message	19
c. The Light Detail Message	25
56. What do you prefer about your indicated choice? Why?	10 responses
"A text should be a quick read"	2
"Free information at my convenience would be nice"	5
"It should be dependent on the hazard"	3
57. Please indicate which message style you least prefer.	55 responses
a. The Heavy Detail Message	39
b. The Medium Detail Message	1
c. The Light Detail Message	15
58. What do you dislike about your indicated choice? Why?	8 responses
"Some information sounds need-to-know"	3
"Too little information"	2
"Too much information"	3

Appendix D: Ethnographic Observations



	Region			
	Capital	South	Southern Peninsula	West
Tourism Site	1. Greater Reykjavík Area 2. Mount Esja 3. Sky Lagoon	4. Dyrhólaey Arch 5. Katla Ice Cave 6. Reykjadalur Hot Spring 7. Reynisfjara Beach 8. Silfra Fissure 9. Skogafoss 10. Sólheimajökull Glacier 11. Kerid Crater 12. Gullfoss 13. Geysir 14. Seljalandsfoss	15. Blue Lagoon 16. Gunnuhver Hot Spring 17. Litli Hrútur 18. Þríhnúkagígur Volcano	19. Snæfellsjökull National Park 20. Víðgelmir Lava Tube
	North	East	Westfjords	
	-	21. Blue Ice Cave 22. Diamond Beach 23. Vestrahorn	24. Hornbjarg Sea Cliff 25. Hornstrandir Nature Reserve	

Table 5 - *Results from Ethnographic Observations*

Region									
Capital					South				
Site	Key Behavior			Estimated Total of Observed Individuals	Site	Key Behavior			Estimated Total of Observed Individuals
	Ignoring Posted/Verbal Warnings	*Violating Boundaries*	*Other Injurious Behavior*			*Ignoring Posted/Verbal Warnings*	*Violating Boundaries*	*Other Injurious Behavior*	
1	108	32	335	**850**	**4**	-	45	49	**65**
2	4	-	13	**50**	**5**	9	17	0	**125**
3	45	0	4	**250**	**6**	20	-	45	**225**
	157	**32**	**352**	**1,150**	**7**	24	51	105	**375**
					8	1	0	3	**20**
					9	0	24	0	**125**
					10	26	-	40	**200**
					11	22	58	35	**195**
					12	47	200	175	**435**
					13	7	16	51	**300**
					14	19	32	14	**250**
						175	**443**	**517**	**2,315**

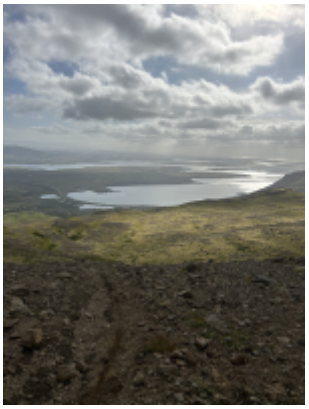
Region									
Southern Peninsula					West				
Site	Key Behavior			Estimated Total of Observed Individuals	Site	Key Behavior			Estimated Total of Observed Individuals
	Ignoring Posted/Verbal Warnings	*Violating Boundaries*	*Other Injurious Behavior*			*Ignoring Posted/Verbal Warnings*	*Violating Boundaries*	*Other Injurious Behavior*	
15	7	0	25	**300**	**19**	-	-	31	**235**
16	-	11	27	**120**	**20**	3	1	4	**65**
17	0	0	3	**35**		**3**	**1**	**35**	**300**
18	33	21	17	**125**					
	40	**32**	**72**	**580**					

Region									
East					Westfjords				
Site	Key Behavior			Estimated Total of Observed Individuals	Site	Key Behavior			Estimated Total of Observed Individuals
	Ignoring Posted/Verbal Warnings	*Violating Boundaries*	*Other Injurious Behavior*			*Ignoring Posted/Verbal Warnings*	*Violating Boundaries*	*Other Injurious Behavior*	
21	7	31	11	**75**	**24**	4	-	10	**15**
22	47	-	23	**205**	**25**	3	8	4	**65**
23	34	33	41	**85**		**7**	**8**	**14**	**80**
	88	**64**	**75**	**365**					

Table 6 - *Locations of Ethnographic Observations*

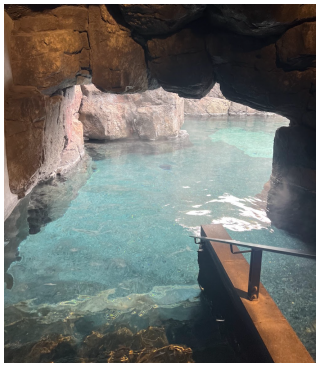
1. Greater Reykjavík Area

This area has driving and outdoor recreation hazards. It is known for the Hallgrimskirkja Church, Laugavegur , and Hopp electric scooters.



2. Mount Esja

Mount Esja is a popular hiking location for tourists, and has driving and outdoor recreation hazards.



3. Sky Lagoon

Sky Lagoon has recreational hazards including slippery surfaces and injurious behavior in the form of drunk and disorderly conduct.

4. Dyrhólaey Arch

Across from Reynisfjara beach the Dyrhólaey Arch has panoramic views of the surrounding landscape. It has outdoor recreational hazards in the form of cliffs and unstable terrain.

5. Katla Ice Cave

The Katla Ice Cave has recreational hazards associated with glaciers including slippery and unstable footing, crevasses, and high winds.

6. Reykjadalur Hot Spring

The Reykjadalur Hot spring is a popular hike for tourists and has outdoor recreation hazards.

7. Reynisfjara Beach

Reynisfjara Beach is famous for its beautiful black sand and basalt columns, however it has dangerous sneaker waves that can pull visitors out to sea.

8. Silfra Fissure

The Silfra Fissure, located in Þingvellier national park and has outdoor recreational hazards associated with it due to its low temperature water and its meandering current.

9. Skogafoss

Skogafoss has outdoor recreation hazards associated with it due to unstable terrain and slippery paths.

10. Sólheimajökull Glacier

Sólheimajökull Glacier is dangerous due to the slippery ground and deep hidden crevasses. The hazards associated with it are outdoor recreation hazards.

11. Kerid Crater

The Kerid Crater has outdoor recreation hazards which may lead to slips, trips, and falls down the crater walls.

12. Gullfoss

Gullfoss is a popular attraction in the Golden Circle, however the uneven paths create recreational hazards.

13. Geysir

The Geysir is a popular attraction in the Golden Circle, however uneven gravel paths cause recreational hazards.

14. Seljalandsfoss

Seljalandsfoss has outdoor hazards due to slippery surfaces and sharp rocks lining the sides of the waterfall.

15. Blue Lagoon

Blue Lagoon has recreational hazards including slippery surfaces and injurious behavior in the form of drunk and disorderly conduct.

16. Gunnuhver Hot Spring

The Gunnuhver Hot Springs has recreational hazards including boiling mud pits.


17. Litli Hrútur

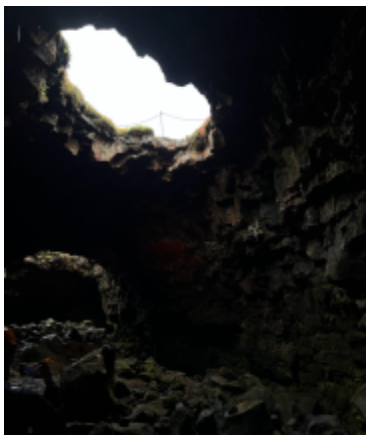
The most recently erupting volcano in Iceland, this attraction has both outdoor recreational hazards and volcanic hazards associated with it.


18. Þríhnúkagígur Volcano

The hazards associated with this tourist attraction are both outdoor recreation hazards and volcanic hazards.

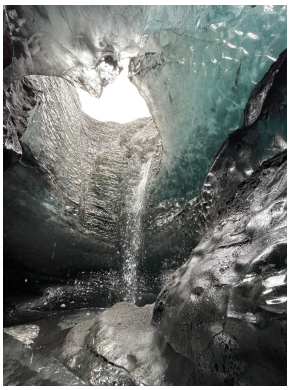

19. Snæfellsjökull National Park

The hazards associated with this tourist attraction include outdoor recreation hazards and volcanic hazards.




20. Víðgelmir Lava Tube

The hazards associated with this tourist attraction include outdoor recreation hazards and volcanic hazards.



21. Blue Ice Cave

A popular tourist attraction, the blue ice cave has outdoor recreation hazards in the form of slippery and unstable footing, and a high potential of overexposure.

22. Diamond Beach

Diamond Beach (*Breiðamerkursandur*) is a popular attraction for tourists to photograph icebergs, however recreational hazards including tipping icebergs and freezing water are present.

23. Vestrahorn

Vestrahorn is a rocky outcrop with recreational hazards due to rain which can cause rockslides

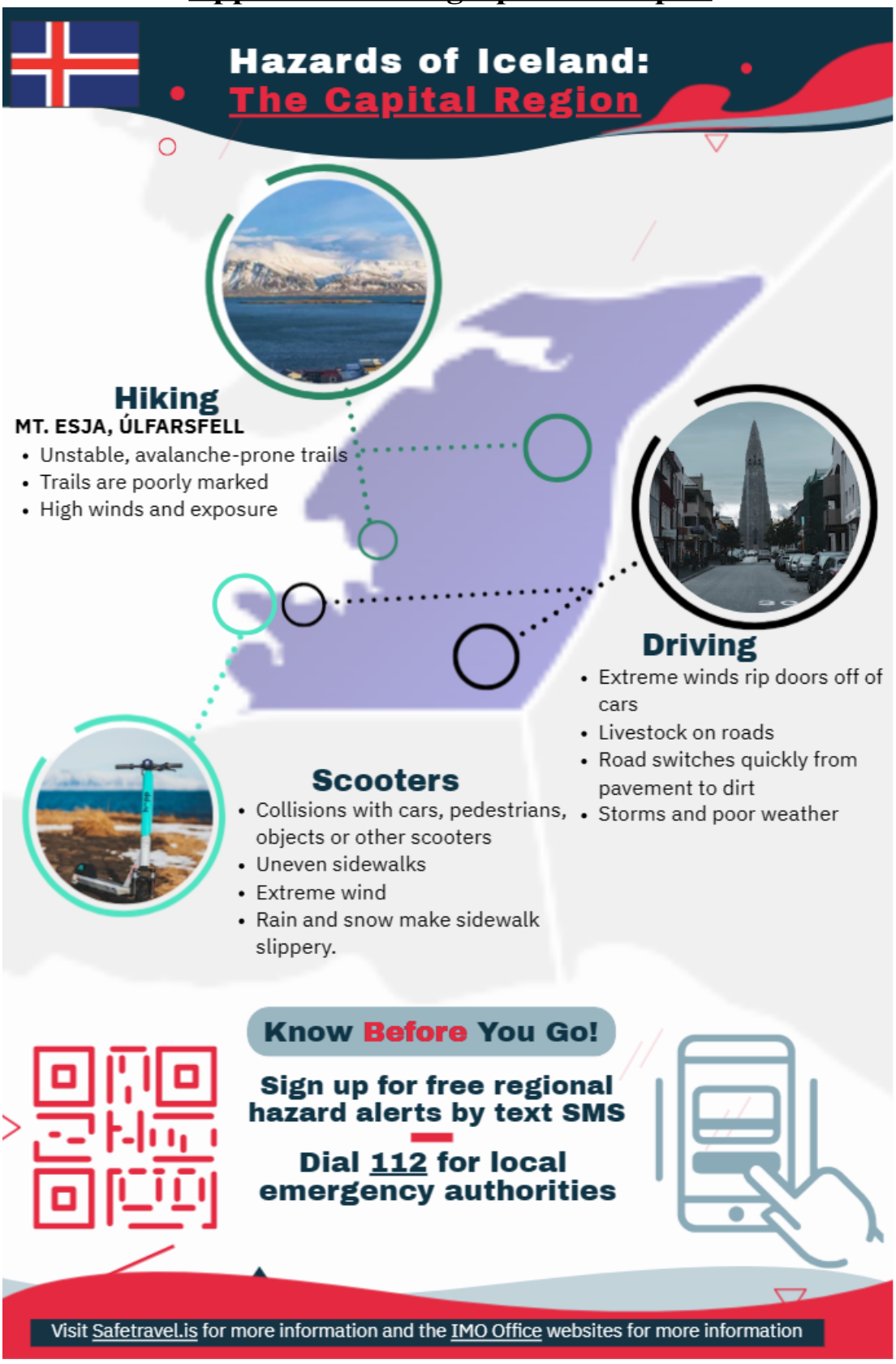
24. Hornbjarg Sea Cliff

The Hornbjarg sea cliff has recreational hazards including rock slides, with no barriers to keep individuals on the designated paths.

25. Hornstrandir Nature Reserve

Hornstrandir nature reserve is a popular backpacking area with outdoor recreation hazards in the form of hiking hazards.

Appendix E: Infographic Examples



HAZARDS OF ICELAND

THE SOUTH

Volcanoes and Parks

Katla, Eyjafjallajökull, Hekla, Þingvellir

- Lava, ash, toxic gas, avalanches, floods
- Large crevasses
- Uneven and sharp surfaces
- Physically demanding hikes
- Dangerous F-roads and rivers
- Hypothermia and exposure risks

Glaciers

Vatnajökull, Torfajökull, Mýrdalsjökull, Tindfjallajökull

- Extreme wind and hypothermia
- Dangerous ice cliff edges
- Deep crevasses
- Slippery and uneven surfaces

Waterfalls and Geothermal Areas

Gulfoss, Svartifoss, Skógafoss

- Deep canyons and crevasses
- Scalding water in Geysers and springs
- Dangerous cliff edges
- Slippery and uneven surfaces

Black Sand Beaches

Reynisfjara and Kirkjufara

- Sneaker waves are huge coastal waves that can suddenly appear
- Sneaker waves sweep people away
- Slippery basalt columns/rocks

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HAZARDS OF ICELAND
SOUTHERN PENINSULA

Outdoor Recreation

- Lava tubes are hard to see, and hikers who step off marked trails could fall into them.
- The terrain is uneven in this region. Visitors who choose to hike in this area need good footwear to protect against slips and falls.
- Weather in this region changes quickly and hikers should be prepared with warm clothes and waterproof gear.

Transportation

- High wind speeds can rip off open car doors drivers can avoid this by not opening car doors into the wind.
- Electric scoters can be rented and operated on sidewalks. Follow all bike laws.
- Volcanic ash in the area can make visibility difficult. Avoid driving through areas that have large amounts of volcanic ash.

Volcanoes

FAGRADSFJALL AND LITLI-HRUTER

- Lava fields can have very thin crust over molten lava beneath creating "hot spots" that cause burns for visitors that get too close.
- Toxic gas and ash collects in valleys or depressions causing fainting and upper-respiratory disease.
- Volcanic terrain can be very uneven. Good footwear is a must to prevent slipping and falling.

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HAZARDS OF ICELAND
THE WEST

Hiking
KIRKJUFELL & VATNSHELLIR CAVE
- Hidden lava tubes
- Poor weather and exposure
- Terrain is steep and unstable

Hot Springs
DEILDARTUNGUHVER & KRAUMA
- Scalding water
- Steam and water can cause wooden boardwalks to be slick
- Terrain can be uneven and unstable
- Drowning risk

Parks and Glaciers
SNÆFELLSJÖKULL NATIONAL PARK & GLACIER
- Hidden icy crevasses
- Extreme wind and hypothermia
- Fragile cliff edges
- Hidden Laval Tubes
- Treacherous and Unstable ground

Driving
ROUTE 1 & F-Roads
- Livestock in roadways
- High winds rip off open car doors
- Rivers run extremely high after storms
- Erosion makes F-roads unstable

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HAZARDS OF ICELAND

THE NORTH

Waterfalls and Geothermal Areas

Forrest Lagoon, Goðafoss, *Dettifoss*

- Boiling water in lagoons and springs
- Slippery and uneven surfaces
- Dangerous cliff edges
- Deep canyons and crevasses
- Physically demanding hikes

Road conditions

- Extreme winds (rip car doors off)
- Dangerous F-roads and river crossings
- Extreme weather
- Coastal road cliffs
- Impassible roads in winter
- Wild life crossings

Volcanoes

Askja, Krafla, Hofsjökull

- Eruption dangers (Lava, ash, toxic gas, avalanches, floods)
- Uneven and sharp surfaces
- Large crevasses
- Physically demanding hikes
- Hypothermia and exposure risks

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HAZARDS OF ICELAND

THE EAST

Glaciers

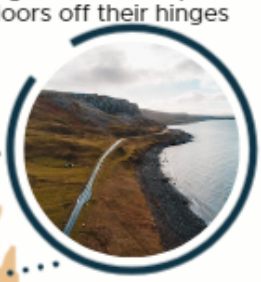
Tungnafellsjökull

- Deep and icy crevasses
- High winds and low temperatures can cause over exposure
- Crampons and an ice axe are needed to prevent hikers from sliding off ice faces

Driving

ICELAND ROUTE 1

- Livestock on roads can cause car damage, injuries, or fatalities
- Poor weather can make roads very slippery or icy
- High winds can rip car doors off their hinges



Hiking and Waterfalls

KLIFBREKKUFOSSAR, PRESTAGIL

- Waterfalls make hiking trails slick along cliffs
- Avalanches are common and bury hikers who are not cautious
- Trails are very remote and the wait for emergency services is long
- Warm, waterproof gear is needed for quickly changing weather conditions

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HAZARDS OF ICELAND

WESTFJORDS

Waterfalls

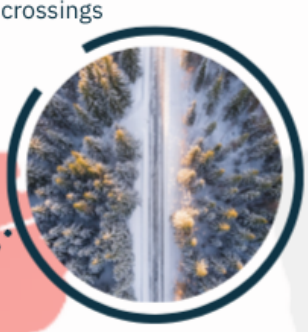
Dynjandi, Svuntufoss, Valagil

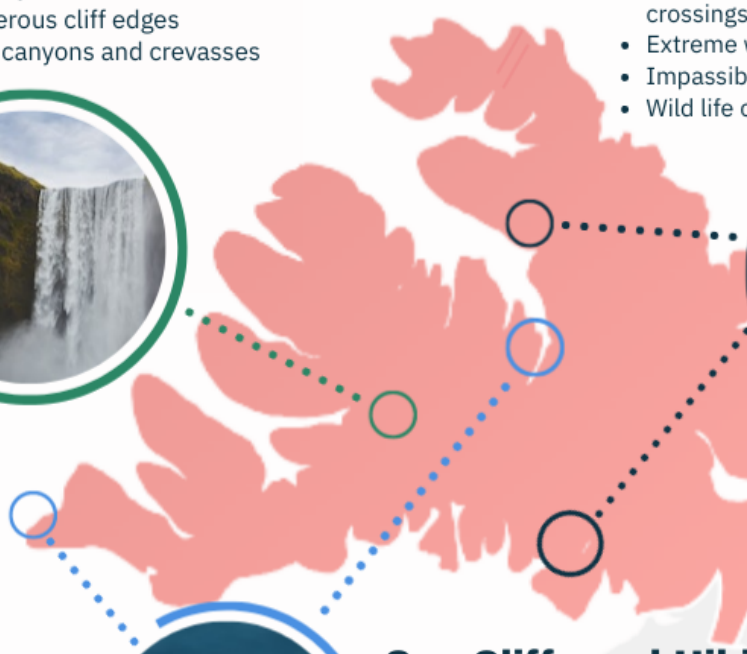
- Slippery and uneven surfaces
- Dangerous cliff edges
- Deep canyons and crevasses

Road conditions

Westfjords Region

- Extreme winds (rip car doors off)
- Dangerous F-roads and river crossings
- Extreme weather
- Impassible roads in winter
- Wild life crossings





Sea Cliffs and Hiking

Látrabjarga and Hornstrandir

- Avalanches, mudslides, rock falls
- Hypothermia risks
- Unstable fragile sea cliffs
- Treacherous terrain
- Extreme weather and exposure risks

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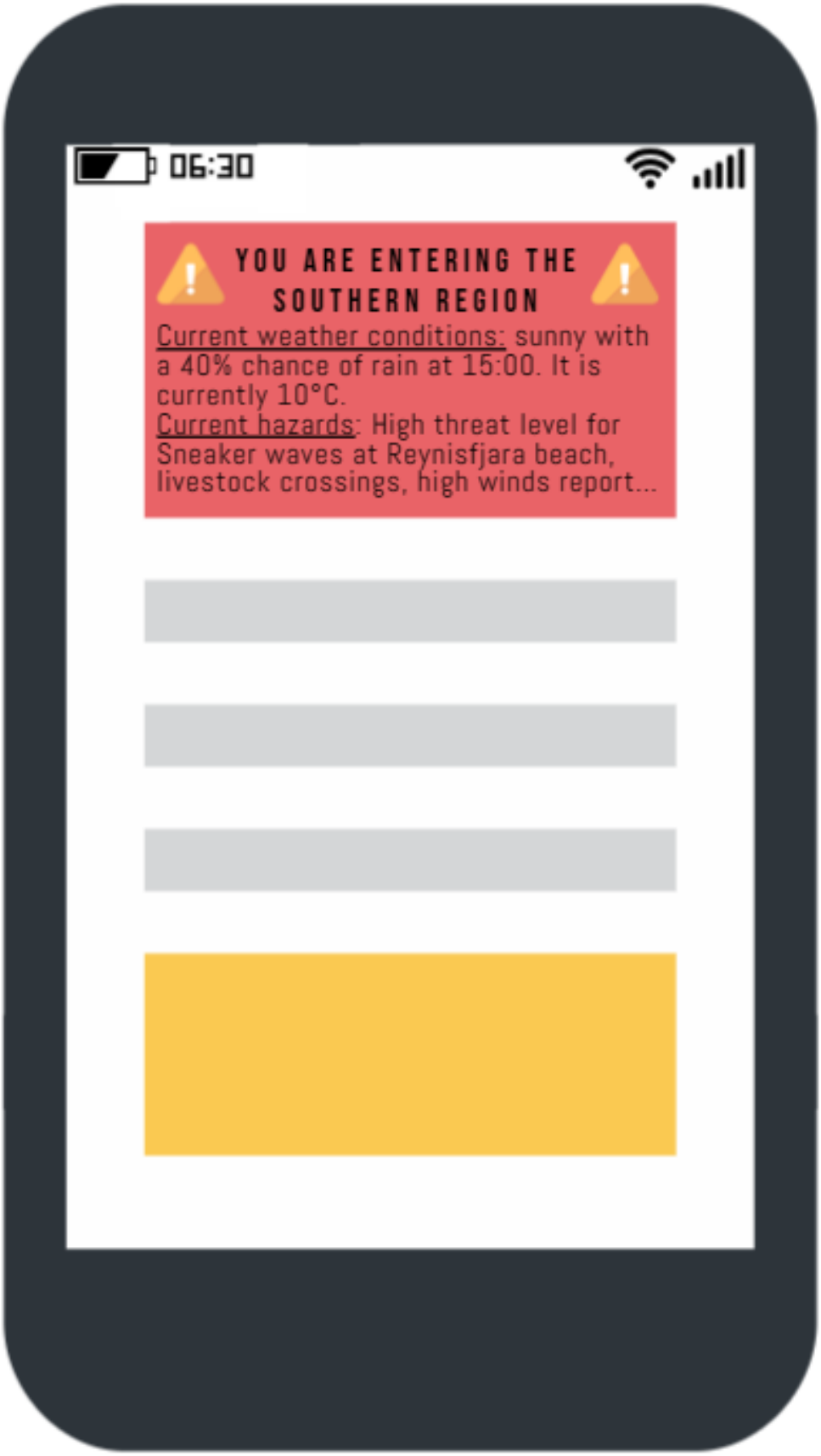
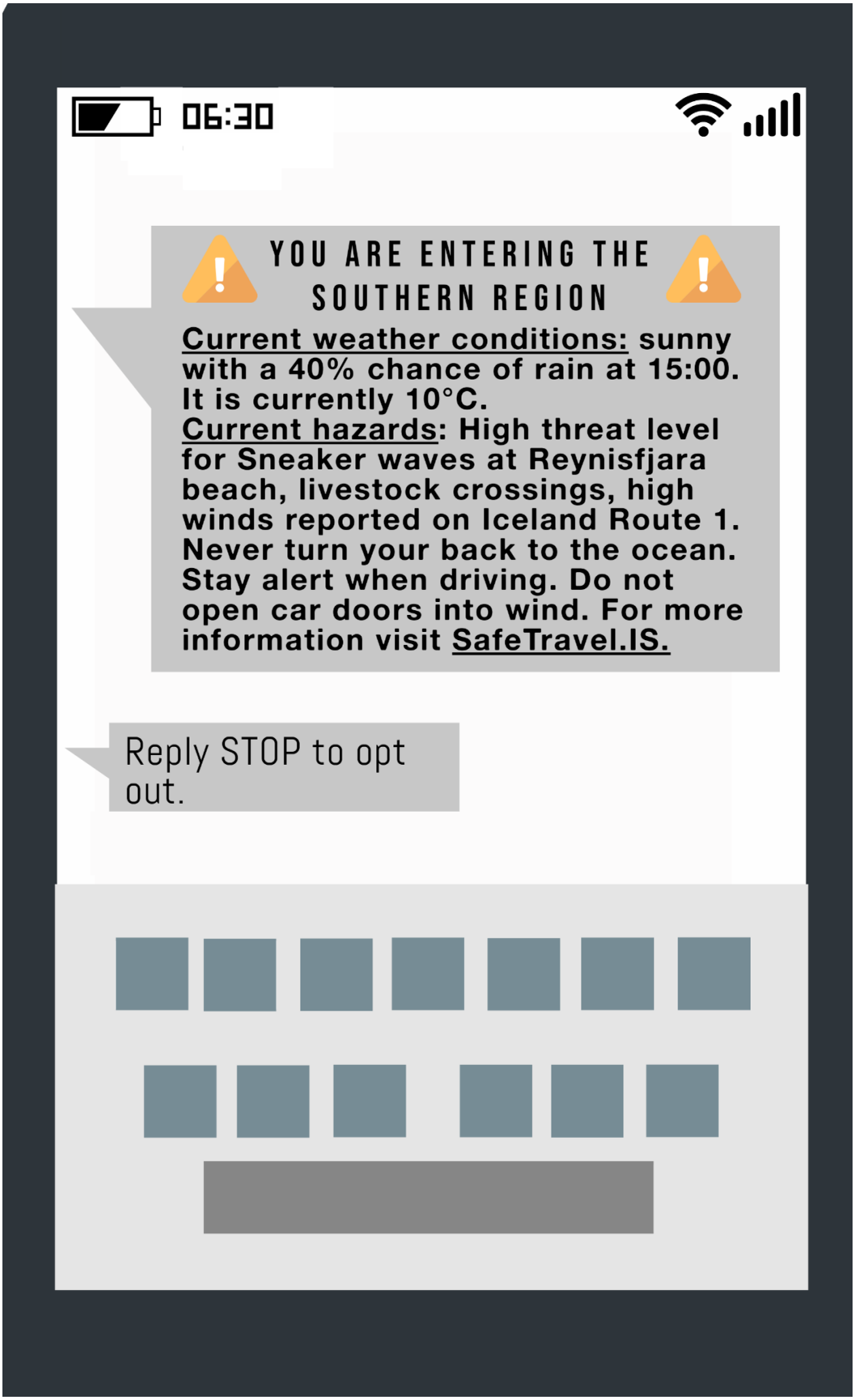

06:30
YOU ARE ENTERING THE SOUTHERN REGION
Current weather conditions: sunny with a 40% chance of rain at 15:00. It is currently 10°C.
Current hazards: High threat level for Sneaker waves at Reynisfjara beach, livestock crossings, high winds report...


06:30
YOU ARE ENTERING THE SOUTHERN REGION
Current weather conditions: sunny with a 40% chance of rain at 15:00. It is currently 10°C.
Current hazards: High threat level for Sneaker waves at Reynisfjara beach, livestock crossings, high winds reported on Iceland Route 1. Never turn your back to the ocean. Stay alert when driving. Do not open car doors into wind. For more information visit SafeTravel.IS.
Reply STOP to opt out.