



Original paper

Investigating Public Perceptions Concerning the Acceptability and Effectiveness of Nudges for Disaster Risk Reduction Efforts in Japan

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Abstract In Japan, local governments have attempted to prepare citizens for and protect them from potential natural disasters by organizing activities such as evacuation drills and enacting rules and regulations such as building standards. A complementary approach to disaster risk reduction (DRR) efforts is to use “nudges.” In this paper, we investigate nudges as a means to improve current DRR efforts. Through a survey, we analyze the views of Japanese people regarding the acceptability of nudges and their effectiveness in influencing people’s behavior. We conclude that the most favorable nudges in terms of effectiveness and acceptability are those used in an emergency scenario (when a disaster is imminent) that also convey useful information.

Keywords: Behavioral Economics, Nudge, Disaster Risk Reduction

1. INTRODUCTION

Before starting this article, it is important for us to define “nudge.” In the context of behavioral economics, a nudge is any mechanism implemented to influence people’s decisions without introducing mandatory actions or restricting choices and without making major changes to economic incentives (Thaler and Sunstein 2008). Some of the most well-known nudges are the use of default options (people tend to abide by defaults because of psychological inertia), changing the order of objects (such as food in a cafeteria), and disclosing population statistics (people tend to follow what the majority of people in their society are doing). There

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are many examples of how beneficial nudges have been in helping people in a wide range of areas, including saving money for the future (Thaler and Benartzi 2004), paying taxes (Kettle *et al.* 2016), and protecting the environment (*e.g.*, the “Don’t Mess With Texas” campaign explained in Nagatsu [2015]). Another example that can be considered a nudge is that of “agency assignment” ; for example, a study from McGlone *et al.* (2013) concluded that people’s threat perception of human papillomavirus (HPV) was higher when assigning agency to HPV (*e.g.*, “HPV preys on millions of people”) than when assigning agency to people (*e.g.*, “Millions of people contract HPV”).

Conceptually, nudges differ from persuasion or some methods in the risk communication field in that they are not an appeal to people’s reasoning or logical thinking, instead, nudges influence people’s behavior by triggering shallow cognitive processes (Saghai, 2013). Also, nudges are not limited to verbal communication, they can be delivered through changes in visual design, by use of colored lights, sounds, introduction of visual illusions, etc. Modifying messages to obtain a predictable result is only one of many ways to apply nudges; Of course, there are intersections between nudge theory and risk communication studies, when, for example, risk communication studies involve transforming messages in order to trigger shallow cognitive processes then those changes in the messages can be considered nudges. The same intersections also exist when it comes to nudges and techniques of persuasion.

Despite finding only a few examples of nudges specifically in DRR research through our review of the literature, examples of nudge research can be found in the field of disaster risk communication, including work from Ohtake, Sakata, and Matsuo (2020). By using messages that express social norms and communicate the potential for loss if evacuating late in a disaster, they showed that more people could be nudged to evacuate early compared with those who received only evacuation advisory messages.

One problem in researching nudges in DRR is that some theories can be tested only during the occurrence of an actual disaster (and would require a camera recording people’s reactions). On that matter, Fujimi and Fujimura (2020) used virtual reality (VR) to test the effects of leading evacuees and using a trapezoidal river design (both of which are nudges that appeal to human herd-behavior instinct and visual cues) to encourage people to evacuate from a flood, concluding that the groups that received the nudges evacuated earlier than groups that did not.

It is important to note that nudges also happen naturally and help people to prepare and save their lives. One such example is “lead evacuators.” Research by Katada (2016) on the 2011 Great East Japan Earthquake provides evidence that if some people evacuate at the earliest sign of an incoming tsunami, this act will



Figure 1. Red sea level warning sign in Okinawa, Japan (taken by author)

influence other people to evacuate as well. Given how lead evacuators can predictably influence other people's decision to evacuate, the concept of "lead evacuators" can be considered a nudge even though the term "nudge" was never used by Katada (2016) to describe the concept. Sometimes nudges are also coupled with other approaches, for example, making tsunami signs that are green, yellow, or red can provide an intuitive notion that some places are safer (green) than others (see Ongkrutraksa, 2015), possibly encouraging people to act faster or to memorize where they should go in the event of a disaster (see Figure 1). Nudges can also help people understand DRR information better (through simplification) and allow the information to have a greater impact on people through the method and timing of information disclosure.

Nevertheless, as we will see later in this article, not all nudges are considered acceptable by the majority of respondents who answered our questionnaire survey. On top of that, sometimes private companies or governments will use nudges in a way that does not align with people's best interests. For example, a company trying to sell magazines might offer a 3-month free trial to attract clients, but to cancel the subscription, people have to take actions such as calling a customer service agent or submitting a form. Because of inertia, many people will let the subscription continue after the first 3 months and continue paying for a product they do not actually want. In behavioral economics, taking advantage of people's flaws to steer them to do things that are not in their best interest is known as "sludges" (Thaler 2018).

In DRR, the goal is for the largest number of people to survive a natural disaster, so it is easy to see that any method used to steer people into harm's way would be a sludge. But the question is how do we know when a nudge is actually a sludge? What if nudges that the government intended to help people actually lead them to harm? Unfortunately, this is a difficult question, but it is not unique to nudges—the same question can be asked about efforts in education and law enforcement. The best we as researchers can do is to either study past real-world examples or to test nudges in as realistic a scenario as possible.

Our goal with this paper was to create a classification of nudges in the field of DRR, to understand their acceptability and the limits on their effectiveness, and to consider directions for future work. This research shows that there are differences regarding the acceptability of nudges by Japanese people, therefore they should not all be banned from practice in Japan and at the same time they should not all be utilized since some nudges might be unacceptable for the majority of the population. We hope this study will help guide decision makers in Japan in order to improve their DRR methods and that nudges will be used as a complement to educational methods. Moreover, we hope the results of our survey can be used by scientists in order to make comparisons with surveys done on nudges in different fields or applied in different societies in order to better understand the nuances of nudge acceptability. Finally, we hope our classification of nudge, judge and oblige (NJO) presented in section 2 can be used in future comparative studies between different methods of DRR.

In the first part of this paper, we present a classification of nudges and compare these nudges with other DRR approaches. In the second part, we present a questionnaire survey intended to help us understand Japanese people's opinions about nudges in terms of acceptability and effectiveness in comparison with other DRR methods. Finally, in the third part, we present our conclusions and outline our future work.

2. CLASSIFYING NUDGES USED IN DRR

To clarify and compare different methods of changing people's behavior in DRR and shape this study, the authors defined the three following concepts: "nudge," "judge," and "oblige" (hereinafter referred to collectively as "NJOs"). A nudge is as defined previously in this paper: a method to influence people in a predictable way, that preserves freedom of choice, that is easy and cheap to avoid, and that does not significantly change the economic incentives (Thaler and Sunstein, 2008). Judges are methods that involve educating or informing people and appeal to their logic, reasoning, memory, and knowledge. Examples of judges are education provided in schools explaining how disasters happen and what the signs of imminent disasters are; this includes textbooks about natural disasters and the like. Obliges are methods that involve restricting freedom of choice and are usually achieved through legislation and law enforcement. Oblige methods appeal to people's desire to avoid punishment or sanctions as well as their desire to do the right thing for society. For example, laws about how houses have to be constructed to withstand disasters are obliges. Please see Table 1 for a quick summary of nudges, judges, and obliges.

As seen in Table 1, judges are applied through education (*e.g.*, in schools, via the media, at events), obliges are applied through legislation and law enforcement, and nudges are applied through what is called "choice architecture." Choice architecture is a term coined by Thaler and Sunstein (2008) and refers to the practice of influencing people's choices by organizing the environment or context in which people make decisions. For example, a government official that prepares a pamphlet to be distributed in their town with the aim of influencing people to prepare an evacuation bag is a "choice architect." Many features of the pamphlet, including the images, words, and choice of information to be shared, can contribute to people's decision to prepare an evacuation bag; in the worst case, they simply ignore the pamphlet's message and do not prepare an evacuation bag.

In his book *Thinking, Fast and Slow* (2011), Daniel Kahneman presents the theory that humans have two systems of thinking: one that is automatic, fast, and unconscious, and another that is slow, logical, and conscious. Thaler and Sunstein also refer to these two systems of thinking as the "automatic system" and the "reflective system." Considering the two different systems of thinking, we classified NJOs according to which system of thinking they appeal to (see the second row of Table 1). Accordingly, it follows that if there is a behavior change, nudges encourage mostly unconscious behavior changes, whereas judges mostly encourage

conscious behavior changes. This is because people generally do not realize they are being nudged, and thus the change is not conscious. At the same time, judges work through education and depend on people's conscious, logical thinking and memory in order to have an effect. Obliges work because people consciously follow rules and regulations; however, the behavior change is often forced and therefore might not continue in the long term if the rules and regulations are ever changed or rescinded.

Another nuance of the differences between NJOs is what kind of liberty they preserve. We classified NJOs based on Hayman's (1992) classical conception of liberty. Therefore, nudges protect people's negative liberty because no obstacles, barriers, or constraints are introduced when a nudge is used. In other words, with nudges, people can choose whether or not to do a certain thing. In contrast, judges protect people's positive liberty, giving them the power to act according to their own reason and free will. Finally, obliges protect people's civil liberties because people have liberty as long as they act within the boundaries of human laws.

Table 1. Table summarizing the differences between nudges, judges, and obliges

	Nudge	Judge	Oblige
<i>Applied through:</i>	Choice architecture	Education	Legislation and law enforcement
<i>Works due to:</i>	People's automatic system of thinking	People's reflective system of thinking	People's reflective system of thinking
<i>Encourages:</i>	Unconscious behavior changes	Conscious behavior changes	Forced, conscious behavior changes
<i>Protects liberty:</i>	Negative Liberty	Positive Liberty	Civil liberty
<i>Examples:</i>	Sirens, colored signs, emergency items' placement and availability in stores, message simplification, signaling default evacuation routes, etc.	Learning hazard maps, attending classes, reading textbooks, etc.	Building codes, compliance laws, driving restrictions, evacuation orders, etc.
<i>Dark side:</i>	Sludges	Incomplete education, misinformation	Despotism

It is important to note that sometimes a government approach to DRR might apply multiple NJO concepts at the same time. For example, using flashing lights to show the path to an evacuation shelter both transmits information (which is considered a judge) and appeals to people's tendency to follow a default route (which is considered a nudge). In reality, most choice architects' attempts will directly or indirectly result in some type of nudge even if they

are not intended or considered as such. A simple example is the arrangement of food in a school cafeteria line. Even if a school has not thought about nudging people's food choices, they will inevitably do so by how they arrange the food (Bucher *et al.* 2016). Simply put, it is impossible to avoid nudging in some cases.

Considering various methods already defined and studied in the field of health and risk communication, we could think about how these methods would be classified in terms of NJO. For example, the concept of invitational rhetoric as defined by Foss and Griffin(1995) constitutes an invitation to the audience to enter the rhetor's world and to see it as the rhetor does. As invitational rhetoric requires the use of a reflective system of thinking, it is closely related to the judge concept. On the other hand, the concept of "positive affect" used in health and risk messaging, intends to induce individuals' positive feelings such as happiness. According to Guan and Mohatan(2017), people who feel good when exposed to a health message tend to have more favorable attitudes towards the message. Because of the change in individual's attitudes as a consequence of "positive affect" messaging and the fact that positive affect appeals to a feeling (rather than logical thinking) makes it possible to categorize the "positive affect" strategy as a nudge. Simplification of forms and information presented to individuals is considered as a nudge by Thaler and Sustein (2008), as it makes it more likely that people will answer forms (see John and Blume, 2018 for an example of simplification nudge). It is therefore possible to see how another concept in the risk communication field, called "exemplification theory" could be considered a nudge, as the presence of an example makes an information easier to be remembered (Spence and Westerman, 2017). In fact, examples being remembered easily can become a problem if individuals apply it as anchoring bias.

Finally, in Table 1, we present what we believe to be the "dark side" of NJO: NJO methods can be used in unethical ways. We consider methods that focus on welfare, autonomy, dignity, and self-government to be ethical applications. As pointed out by Sunstein (2016), some methods focus more on one value than another and sometimes there are conflicts among the values. For example, a method that increases welfare might simultaneously undermine autonomy. Well-planned nudges (not sludges) are ethical in the sense that they increase welfare when they influence people to make better decisions. Sunstein also pointed out that the best nudges are those that also protect autonomy, dignity, and self-government. For example, disclosing the nutritional information of foods in a cafeteria can nudge users to select healthier options. This increases welfare while also promoting autonomy because it provides education to people about the nutrition of the foods.

In summary, the "dark side" of nudges would be the aforementioned sludges. For judges, the "dark side" would be any type of education that is incomplete or contains incorrect information that purposefully (or not) leads people to draw the wrong logical conclusions, which in the context of DRR might lead them to endanger themselves. As for the "dark side" of obligees, the closest term would be "despotism," which in colloquial terms would be understood as "an oppressive exercise of power."

3. ONLINE QUESTIONNAIRE SURVEY

There are many possible arguments against using nudges instead of rules or for simply doing nothing to change outcomes. Some of those arguments might come from the nature of certain nudges that might be more accurately described as “manipulation” and are considered by some to be unethical given that they affect people’s dignity (Sunstein 2016). But as seen in the previous section, in the same way that laws are not inherently unethical, nudges are also not inherently unethical. To grasp which nudges are considered acceptable and unacceptable in Japan, we created a questionnaire survey which was administered in January 2021 by an online survey company who sent the survey to their nationwide customers. We also wanted to use the survey to understand people’s expectations of which nudges might or might not be effective in influencing people to prepare for natural disasters.

There are several reasons why we chose to conduct this survey in Japan. First, people in Japan are aware of natural disasters because many different types of natural disasters occur in Japan (e.g., landslides, earthquakes, tsunamis, volcanic eruptions, snow storms, typhoons) and most people are at risk of being affected by at least one of these disasters in their lifetime. In addition, most people in Japan are familiar with the concepts of early warnings, evacuation areas, and evacuation drills. Therefore, it should be simple for them to answer survey questions about these matters. Second, in a previous questionnaire survey about nudges that was conducted across multiple countries by Sunstein and Reisch (2019), Japan was found to be an outlier, having one of the lowest approval rates for many different types of nudges, including placement of food in a cafeteria and placing food warnings on packages, and we hoped to better understand why this is the case through our own survey. The English version of the full survey is presented in Appendix A.

3.1 Method

The survey was divided into four parts. The first part comprised basic demographics questions about age, gender, and prefecture of residence. For the second and third parts, we asked respondents about many different NJOs; some of them actually exist in Japan, whereas others were invented for the sake of the survey. The second part asked the respondents how acceptable they thought the various NJO methods were, and the third part asked how effective they thought each NJO method would be in changing people’s behavior. Finally, the fourth part of the survey had an open-ended question asking the respondents to share their own ideas for methods that might be used to help people prepare for a disaster.

To organize the second and third parts of the survey, we separated the NJOs of common themes into questions; henceforth, each NJO method will be referred to as a “question item.” For example, if the goal of the NJO is to influence people to prepare an evacuation bag, the NJOs (question items) were placed under a question about evacuation bags. In each question,

five options were presented in a Likert-scale format for respondents to rank each NJO question item, as in the example question shown in Figure 2. To reduce the risk of our questionnaire unfairly nudging people's answers, we also randomized the order in which the question items appeared to the respondents (see Koppell and Steen 2004 as an example of how ordering can affect results).

3. How effective each option below is to push you to have an evacuation bag ? *

Evacuation bags are simply bags with necessary items for survival after a natural disaster occurs. The items inside the bag can include: food, first aid kits, radio, one set of clean clothes, among other items. Evacuation bags can be bought at a store or be homemade.

Please mark one option on each row.

	Very effective	Somewhat effective	Neither effective nor ineffective	Somewhat ineffective	Very ineffective
Watching a TV show that explains why you should have an evacuation bag	☒	☐	☐	☐	☐
Reading a local government brochure explaining the reasons why you should have an evacuation bag.	☐	☒	☐	☐	☐

Figure 2. Example survey question showing the format of the questions.

In Japan, local governments promote activities that encourage people to make preparations and take action in the event of a disaster. Each survey question was designed to focus on the following actions and activities: visiting evacuation areas or evacuation towers ahead of a disaster; preparing an evacuation bag in advance; evacuating early; checking the evacuation route map; securing the furniture in one's home; and participating in evacuation drills. As for the question items, we designed them so that at least one nudge, judge, and oblige were represented under each question.

To create a variety of NJO question items, we considered different methods of delivery. The oblige question items can include laws, rules, or the revocation of privileges. The judge question items varied in terms of the type of media considered, including pamphlets, television, or text messages. The largest number of question items involved nudges because they are the focus of our research and we wanted to compare various nudge approaches. A wide range of delivery methods were used for the nudge question items, including using objects to attract interest, adding interesting designs to objects, using celebrities to deliver messages, and using sounds or lights to attract people's attention, showing a default path, and so on.

The full list of questions and question items pertaining to the second and third parts of the survey and their reference numbers are presented in Appendix B. The reference numbers in Appendix B will be used to discuss the results in the next section.

3.2 Limitations

Questionnaire surveys on nudges can yield important results about what people consider to be acceptable and unacceptable in terms of nudges. For example, Hagman *et al.* (2015) conducted a survey and concluded that people with a more individualistic worldview are less likely to perceive nudges as acceptable, while those who are more prone to analytical thinking are less likely to perceive nudges as an intrusion on their freedom of choice.

Yet, because nudges often succeed without people realizing they have been nudged, and because there is often no indication that something is being used as a nudge, most people cannot effectively judge how effective a nudge might be in influencing their behavior in real life. Therefore, in the short term, surveys can be an important tool for measuring acceptability perception, but scientists and policymakers cannot use a questionnaire survey to determine the effectiveness of nudges. Sunstein *et al.* (2019) also pointed out this limitation in their study of nudges that involved a survey.

Another limitation is that the general public may not be aware of nudges or how they work, and it can also be difficult to explain some nudges in the limited space available in a questionnaire survey form. Also, many of the nudges presented in our survey had never been used before (in contrast with the nudges used); therefore, people were likely not so familiar with them and this might have led to biased answers. Nevertheless, we hope that in the future, scientists testing nudges will be able to compare real-world tests of nudges with our survey results.

3.3 Results

A total of 800 people answered the survey. In terms of demographics, 50% were men and 50% were women, which is close to the gender distribution in Japan in 2019, which was 48.6% male and 51.4% female. The respondents ranged in age from 19 to 88 years, and about 33% were over the age of 60 years (in 2019 about 34.4% of people in Japan were over the age of 60 years). The areas of residence varied, but the largest number of respondents were from Tokyo (123), Kanagawa (77), and Osaka (75), which were the three most populated prefectures in Japan in 2019. The numbers mentioned in this paragraph are from the Statistics Bureau of Japan (2021). Even though our survey was conducted in 2021, the demographics can be reasonably expected to be basically the same as in 2019.

3.3.1 Opinions about acceptability

Respondents' answers regarding the acceptability of each NJO method are shown in Figure 3.

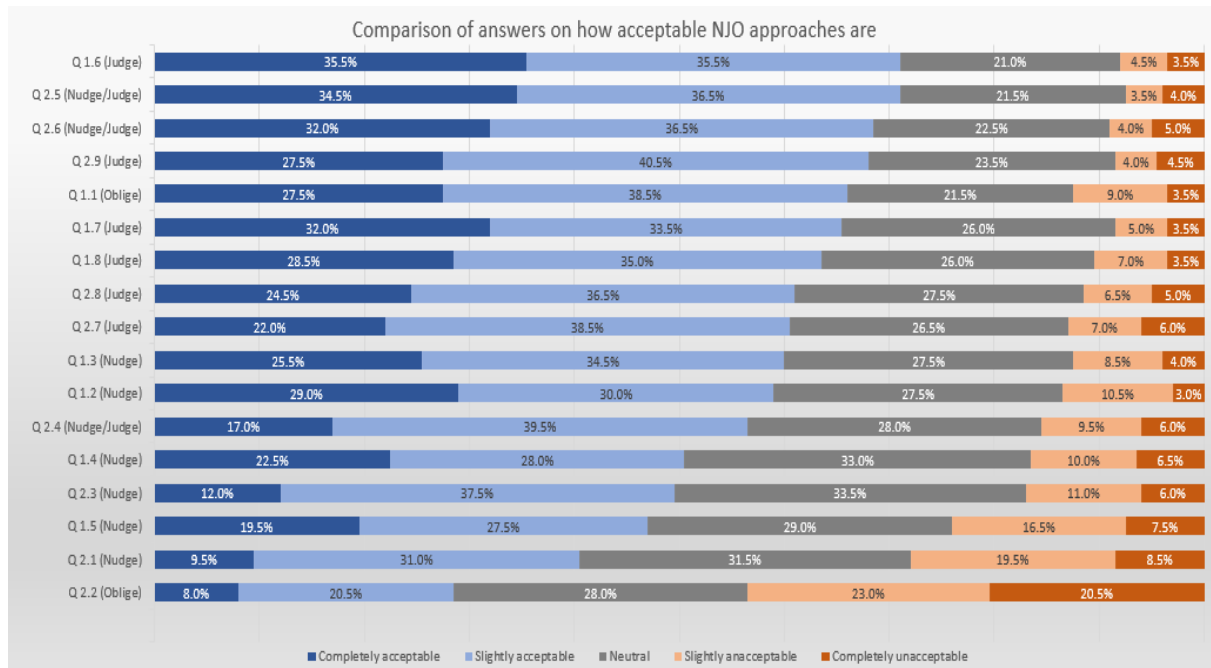


Figure 3. Results of respondents' opinions of NJO methods regarding how acceptable they are. "Q1" indicates that the method was presented in Question 1, "Q2" indicates that the method was presented in Question 2, and so on. As mentioned before, some methods cannot be purely described as only a nudge or only a judge, so some methods are classified as nudge/judge.

Regarding the acceptability of each NJO method, more than 50% of the respondents found all of the judge methods slightly or completely acceptable. As for the oblige methods, opinions varied, with about 68% of respondents answering that the oblige method in Q1.1 was slightly or completely acceptable, while about 56% of respondents said the oblige method in Q2.2 was slightly or completely unacceptable. As for the nudge methods, there was a tendency for nudges that also work as information sharing (loud sirens, flashing lights that lead to an evacuation area, large clocks showing the estimated time of the tsunami's arrival) to be considered very acceptable, while others were considered more acceptable than unacceptable, but not by a big margin. Only one nudge method was considered more unacceptable than acceptable, namely, Q2.1, which involved using TV to show the grief of family members who had lost loved ones in a disaster.

After comparing the results by the percentages of answers, we also performed an exploratory factor analysis to see which NJOs would be grouped together based on the answer patterns. Even though our data were not numerical, because we had ordinal data, it was still possible to use factor analysis. Our ordinal data ranged from 1 to 5, with 1 indicating completely acceptable and 5 indicating completely unacceptable. The extraction was by correlation matrix based on an eigenvalue greater than 1, a maximum number of iterations for convergence of 25, and suppressed coefficients smaller than 0.4. We obtained three factors, and the grouping of methods by factor are shown in Table 2

We expected that the groups would be composed of two different methods, but this is not the result that we obtained. As seen in Table 2, nudges paired with judges and judges only were grouped together under the first factor as along with one oblige method (Q1.1).

All NJOs in this factor were also those considered most acceptable compared with other NJOs, and they are all related to either sharing some relevant information or requiring people to do something to obtain information (such as in Q1.1) therefore this factor was labeled “Information sharing or seeking.” Under the second factor, we found four nudges (Q1.2, Q1.3, Q1.4, Q1.5) which were not considered as acceptable as those in the first factor, but the “acceptable” answers outweighed the “unacceptable answers” and a large portion of answers were “neutral”; Nudges in factor 2 were also always related to fun, relaxation, or entertainment. therefore, we named this factor “Entertainment nudges.”

Finally, the third factor included two nudges and one oblige method (Q2.1, Q2.2, Q2.3), and these three NJOs were also the ones considered least acceptable by respondents.

We expected that Q2.1 would be considered more unacceptable because it appeals to people’s fear or sadness. We also expected that the oblige in Q2.2 would be considered very unacceptable because it involves punishing people who do not comply by revoking their privileges of staying in a shelter. Although, Q2.1 and Q2.2 were not surprises, the nudge in Q2.3 (talking about assigning leading evacuation roles) was. One reason why Q2.3 might have been considered somewhat unacceptable is that in this method, the government asks people to collaborate on evacuation efforts (instead of other more passive approaches where evacuees do not have an active role except for evacuating themselves whenever they see fit). However, we

Table 2. Factor analysis results of the NJOs presented in acceptability questions

Factor 1: Information sharing and seeking	
Q2.9	Judge
Q2.5	nudge/judge
Q2.6	nudge/judge
Q2.7	judge
Q2.8	judge
Q1.6	judge
Q1.7	judge
Q1.8	judge
Q2.4	nudge/judge
Q1.1	oblige
Factor 2: Entertainment Nudges	
Q 1.4	nudge
Q 1.5	nudge
Q 1.2	nudge
Q 1.3	nudge
Factor 3: Controversial NO	
Q 2.2	oblige
Q 2.1	nudge
Q 2.3	nudge

can see from Figure 3 that the nudge in Q2.3 still received more answers in the “acceptable/slightly acceptable” category than not, and so we decided to name this factor “Controversial NO” (for nudge and oblige).

3.3.2 Opinions about effectiveness

As for the results about how effective each method of NJO was, judges were generally seen as quite effective, whereas oblige options followed the same trend as before; that is, some were seen as very effective while others were seen as very ineffective. Nudge options varied as well, with nudges appealing to emotions such as “fear” and “sadness” and those appealing to people having “fun” or following what a celebrity does on TV were seen as less effective than nudges that improve awareness and are coupled with information about disaster prevention. Figure 4 shows the results of the top 5 best-rated nudges according to effectiveness and Figure 5 shows the results of the top 5 worst-rated nudges according to effectiveness.

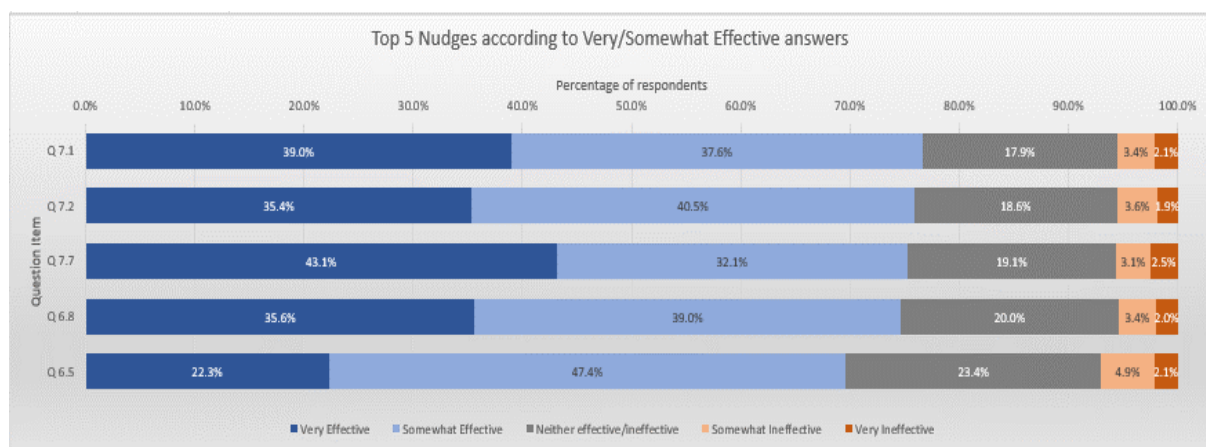


Figure 4. Top 5 most-effective nudges according to respondents’ answers

It is interesting to note that although the majority of respondents agreed that the judge options were very effective, there was a large number of neutral answers for many of the least effective nudges; Q4.6, Q6.6, Q4.3, and Q5.3 received more “neutral” answers than both “somewhat/very effective” and “somewhat/very ineffective” answers. This shows that many people were undecided about the efficacy of nudges, which is only natural given that nudging is a somewhat recent concept that is not taught in schools and is rarely talked about in the media.

As can be seen from Q5.3 in Figure 5, most respondents did not think that playing a game featuring an evacuation route map was an effective method for motivating people to check their evacuation map (“very ineffective,” “ineffective,” and “neither effective/ineffective” accounted for 63% of the responses to Q5.3). Despite this discouraging result related to game-based nudges, we have decided to test as a future work what people’s real-life reactions to a

game involving nudges would be. We want to compare the results obtained from testing the game with the results of the present survey because, as discussed before, questionnaire surveys are not a reliable way of testing the effectiveness of nudges.

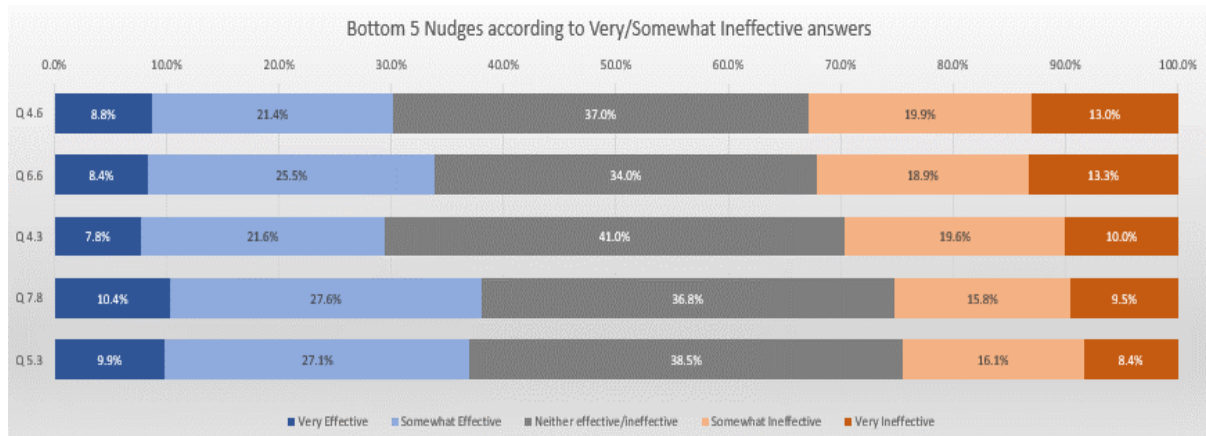


Figure 5. Top 5 least-effective nudges according to respondents' answers

3.3.3 Open-ended question results

The final item of the questionnaire was a non-mandatory open-ended question, which read as follows: "If you have any suggestion of things that can push people to prepare for a natural disaster or evacuate their houses, feel free to comment below." Of the 800 respondents, 190 (about 24%) shared their thoughts.

After reviewing the responses, we were able to classify them into 29 topics, although 11 answers could not be classified because they were too vague. Table 3 shows the top 10 most-mentioned topics. Because some comments touched on more than one topic, they were classified according to multiple themes, and thus the number of classifications (234) exceeded the number of answers (190).

Regarding what could be considered as nudges, 12 comments mentioned that it would be good for disaster victims to share their experiences. Listening to survivors sharing their experiences can give us real lessons, but they can also influence us to take action to reduce risks. In addition, eight people expressed a desire for more straightforward and easier-to-understand information, which can be considered a nudge. A particularly notable result was that eight people mentioned wanting more realistic disaster simulations (some mentioned using virtual reality and others mentioned conducting more realistic disaster drills). The following comment (translated from Japanese) from a respondent explains why it is important for people to participate in simulations.

"Earthquakes and big typhoons have happened but people say 'it is not a problem!' They don't care much about disasters. If people have never experienced a disaster, their caution

can be zero. Visiting some facilities and having them experience an earthquake and typhoon would be effective for helping people to quickly understand.”

Table 3. Top 10 most-mentioned topics by respondents

Answer Topic	Total answers
Get free benefits, more affordable prices, wider availability of emergency goods	19
Restrict freedom and/or apply punishment	18
Evacuation drills (for school children or everyone)	18
Information could be shared on TV	17
Use of neighborhood associations, local community activities	17
Each person has their own responsibility to prepare and remain vigilant	12
The local government is responsible for distributing information	12
Disaster victims could share their experiences to increase people’s awareness	12
Information could be shared via pamphlets	9
Information could be shared via non-specified media	9

Seventeen respondents mentioned that they would like to strengthen ties with neighborhood associations or participate in community activities. This is a very good method not only for preparing for a disaster but also for increasing community resilience. Neighborhood associations can have an impact by providing nudges because people can learn what others in their community are doing to reduce risks, and as a result, they may be influenced to do the same. The following is a comment from a respondent about this topic.

“In the event of a disaster, I think it’s best to cooperate with people in the neighborhood, so I think that regular calls and disaster prevention drills by the neighborhood association are essential.”

As for judges, many people mentioned sharing disaster prevention information and hazard information through the media, with TV being the most mentioned type of media (17 mentions), followed by pamphlets (9), the Internet (8), SNS(7), and radio (4). In addition, six people mentioned that schools should teach DRR, and three people mentioned that they would like to learn about the history of local disasters.

As for responses pertaining to oblige methods, 18 people mentioned ideas involving restricting freedoms through laws or applying punishment for people who do not follow guidelines. The idea behind many of these comments is that people will not act or they will think it is not important to prepare unless it is mandatory to do so, as illustrated by the following comment.

“I myself have been the victim of various disasters, but I regretted that it took so much time to take action, even though I prepared to evacuate based on what I saw on TV. But, I don’t think I’ll work so hard to prepare in advance until the disaster is happening, and I don’t think most people will do it unless it’s mandatory.”

The most important takeaway from the results of the open-ended question is that each person has different needs and different opinions about which methods will most likely contribute to saving lives in the event of a natural disaster. On the upside, nudges, judges, and obliges are not mutually exclusive, and a multitude of them can be applied in different situations and circumstances. For example, a town can conduct mandatory evacuation drills (oblige) while simultaneously educating people through pamphlets (judge) and requiring shops to place emergency goods near the entrance to influence people to buy them (nudge).

4. DISCUSSION AND CONCLUSION

Although nudges often occur naturally, they can also be used as an intentional method by governing bodies and organizations to help people understand important DRR information, attend drills, and act in their own self-interest to protect their lives when a natural disaster occurs. This can be seen in past DRR research where, even though the term “nudge” was not used, nudges were shown to be involved.

Moreover, the application of nudges requires a nuanced approach because not all nudges will be accepted by people in the same way. For example, it is apparent from the present survey that a nudge involving showing the grief of families who have lost loved ones in a disaster was not viewed as acceptable by a significant number of people (36.2% of respondents). It is also important to bear in mind that when testing nudges, be it in the form of surveys, simulations, or real-life situations, the results concerning effectiveness and acceptability will vary according to culture. Because our research was done in Japan, our results are a reflection of Japanese culture. One solution to increase acceptance is to make transparent the goals that the government or decision-maker is trying to reach by using nudges and which nudges they are using. Of course, the same nuance and consideration should be applied in other behavior-changing approaches, including those that limit freedom of choice (obliges) and those that involve education (judges).

As for the effectiveness of nudges compared with other methods, nudges that are used in emergency situations (e.g., the use of sirens when a disaster is known to be imminent and people need to evacuate) and also help to deliver information are viewed to be as effective as judges. However, some nudges that appeal to people’s desire for fun or relaxation are not so effective, according to the survey respondents. This might be due to the fact these nudges are novel and may not have an obvious connection to DRR unless a lengthy explanation is provided. Also, as previously mentioned, questionnaire surveys are not the best way to grasp the

effectiveness of nudges because many biases might be at play when people answer. Another point to consider is that nudges work somewhat unconsciously. For example, people might not realize that DRR-related goods have been placed at the entrance of a shop in order to influence shoppers to buy them. This is why real-world testing is preferred, and if that is not possible in the DRR field, then it is important to perform as realistic a test as possible, such as by using virtual reality.

The open-ended question of our survey also shed light on many points. First, people have a clear belief about the effectiveness of a wide variety of DRR methods. Many mentioned obligees, but many also mentioned judges and nudges. Second, the large number of responses to the open-ended question and great length of some of them shows that people want to engage on this topic. Some people even used the survey as a way to express their worries and feelings as well as share problems with their city's preparedness (*e.g.*, the lack of evacuation towers in coastal towns).

There is still a lot of room for studies involving nudge approaches in the field of DRR. From the results of the present survey and literature review, it is our opinion that nudges should be used to complement current DRR methods rather than replace them because a variety of approaches based on education or law enforcement have already been shown to be effective in previous studies. Decision-makers should avoid using nudges deemed to be manipulation or sludges, and schools should teach about nudges so that the general public will be able to watch out for them. Private companies are already using sludges to help their bottom line. Therefore, giving people the tools to understand how these soft methods work to influence decision-making should empower them in many other areas of life.

5. FUTURE WORK: NUDGE EXPERIMENTATION

In this part, we discuss our reasons for creating the game Kuroshio no Himitsu ("The Secret of Kuroshio" in English). In short, the game aims to nudge people to visit tsunami evacuation sites while enjoying sightseeing spots in Kuroshio, a town in Kochi Prefecture, and to familiarize themselves with cultural, historical, and disaster-related information.

According to the survey results, judges are the top category in terms of effectiveness and acceptability, followed by nudges that also convey information (the "nudges/judges" approach). Nudges that appeal to people's desire for fun, including those in Q1.2, Q1.4, and Q1.5 (see section 3.2.1), were more often viewed as "somewhat/completely acceptable" (57.6%, 42.3%, 39.2%, respectively) than as "somewhat/completely unacceptable" (13.2%, 19%, 24.3%). Even though the number of people who found these nudges acceptable exceeded the number of people who found them unacceptable, there were still many neutral answers (29.3%, 38.8%, 36.6% respectively).

Nevertheless, given the limited ability of questionnaire surveys to evaluate the effectiveness of nudges, we decided to attempt a real-world test of a nudge. Because the best nudges in terms of acceptability seem to be those that also convey information (i.e., nudges paired with judges), we decided to test a nudge that appeals to people's desire for fun while also conveying DRR-related information. The result was Kuroshio no Himitsu.

There are quite a few reasons why we decided to specifically use a game to test the nudge concept. First, as mentioned before, our research did not show good results for game-based nudges, and thus a real-world test is needed to verify the true effectiveness. Second, because this research was conducted during the COVID-19 pandemic, we could not test a nudge approach involving large groups of volunteers gathered in the same place at the same time. Third, we wanted to minimize biases caused by the presence of the researchers while the volunteers tested the nudge approach. A mobile game that can be downloaded independently and played individually avoids the risks presented by the COVID-19 pandemic and enables volunteers to respond to an online survey about the game without the researchers being present. Finally, previous research on a digital game for disaster-prevention learning by Huang *et al.* (2013) showed that playing the game increased both the players' willingness to learn and their satisfaction, demonstrating the potential for games that are paired with education.

Next, we had to decide the purpose of the game, that is, what we want to nudge people to do. In Japan, many coastal towns are at risk of inundation by tsunamis, and after an earthquake occurs, people usually have very little time to evacuate. Therefore, to evacuate quickly, it is important for people (both local residents and visitors) to be aware of the evacuation areas around town as well as how to get to them. Thinking about this issue, we developed a smartphone game with the aim of nudging people to physically visit evacuation areas during normal times when there is no imminent disaster. The target area for the game is Kuroshio, which was chosen because of its proximity to the Nankai Trough, which is expected to be the site of a massive earthquake and tsunami in the future (Garrett *et al.* 2016). Kuroshio has a small population of around 10,000 people, according to the most recent national census (Statistics Bureau of Japan, 2020), but the town receives many tourists from all over Japan, who come for the surfing, sightseeing, and local cuisine (most famously, bonito fish dishes, known as katsuo in Japanese). Tourists are especially vulnerable to tsunamis because they are less likely to be familiar with the town's evacuation areas and routes and may not be aware of the region's history of disasters.

The game uses the player's GPS coordinates to localize them on the map and then shows them points of interest (Figure 6). If the player wants to advance in the game, they have to walk to the points of interest shown on the map. When the player arrives at a point of interest, they have to scan a QR code that has been placed there. In total, 20 points of interest have been added to the game. These points include evacuation areas and towers in addition to important places for the local community such as beaches, parks, museums, and local businesses.

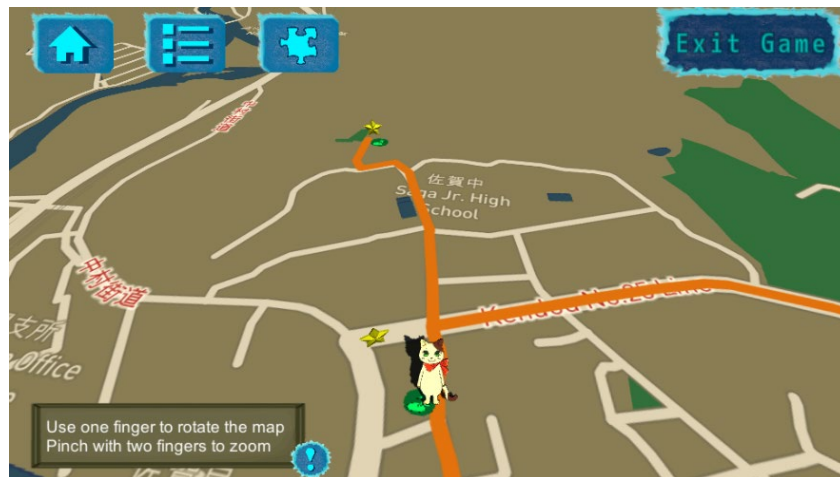


Figure 6. Screenshot of the game Kuroshio no Himitsu showing, a map with the player's GPS location (the cat) and the points of interest (stars).

There are a few ways players are nudged to visit all the locations (to keep them from quitting the game before checking in at all 20 places). First, the game has characters and a story, and the end of the story is revealed only when the game has been finished. Second, each time a player visits a new location they receive a few pieces of a jigsaw puzzle, which they can put together to complete a picture. Third, as shown in Figure 6, there is an orange path that shows a suggested “default route,” which is intended to simplify the player’s decision about which streets to use.

The game helps players learn in two ways. First, by physically walking around the town, they can memorize the landscape more effectively than by simply reading a map, according to a study by Presson and Hazelrigg (1984). Of course, in this game, players also look at the map on their phone, so they can benefit from seeing both the map and the actual places as they walk around town. Second, the characters in the game sometimes talk about past disasters that happened in the town, as well as share a few facts about the evacuation towers and the pine tree forest (which has been conserved between the ocean and the town with the aim of lessening the impact of a tsunami).

As for testing the game, we plan to test Kuroshio no Himitsu with volunteers. The game will not be advertised as a game for disaster risk reduction or learning purposes. There are two ways the game’s effects will be tested. First, the players will be asked within the game itself to complete an online questionnaire. Second, we will record on the game’s server which players visit which locations in order to obtain concrete data.

In the future, it would also be interesting to know how this type of game would perform in different towns and to compare the results among them. Other forms of nudges should also be tested in the same town in order to adequately compare different methods. The researchers hope that the game Kuroshio no Himitsu can set a good example of the use of such nudges in future studies.

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