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# Exploring User Recognition of Motion Pictograms Designed for Providing Disaster-Related Information

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A clear global trend exists toward compound disasters. In Taiwan, short message service (SMS) text messages are currently used to convey disaster-related information. However, due to word limits inherent to the technology, the content only consists of the time, place, and intensity as well as a safety reminder, meaning that information regarding prevention and shelter to mitigate compound disasters cannot be provided. To resolve this, the present study designed motion pictograms for presenting disaster information that can include diverse information about disasters and facilitate rapid communication and understanding across different languages and cultures. The experiment was based on four major disasters that can occur in Taiwan, namely earthquakes, tsunamis, typhoons, and torrential rains, as well as two follow-on disasters (i.e., flood and debris flow). This study invited design experts to design motion pictograms on the basis of a focus group method and conducted a recognition survey. The results showed that recognition of the six disaster emergency motion pictograms designed in this study was higher than the ISO standard of 66.7%. In addition, the optimal playback length of the motion pictograms should be between 0.2 and 0.5 seconds to avoid user fatigue or boredom.

***Keywords: motion pictogram; disaster emergency; visual presentation; recognition***

## 1 Introduction

### 1.1 Research background and aim

The Taiwan Science Report on Climate Change (2011) noted that, due to factors such as extreme climate conditions and land use changes, disaster patterns are gradually trending toward compound disasters. Apart from television, radio, and the Internet, the quickest disaster warning and prevention method in Taiwan is short message service (SMS) text message reminders. However, due to word limits inherent to the technology, information in the message can only provide the disaster time, location, and intensity as well as safety reminders. A lack of information regarding disaster response methods, prevention techniques, and evacuation locations can cause the public to not know how to respond in the event of a disaster.

Pictograms are often used as auxiliary tools for message transmission because they can quickly identify and convey information across languages and cultures while both informing and guiding the viewer. Due to the diverse media landscape of the modern world, people are

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spending less time reading and often prefer visual forms of communication. Problems caused by the use of a single pictogram such as those related to message presentation, miscommunication, and possible misunderstanding can be offset by the use of a motion pictogram. Motion pictograms can be used to present a more complete narrative context as well as the categories, attributes, and other information regarding an event. According to Solso(1994), people find motion pictograms attractive and functional. Therefore, by using motion pictograms that integrate disaster emergency messages with corresponding solutions, the effectiveness of disaster prevention awareness efforts and education can be improved.

To date, no countries employ motion pictograms to convey disaster emergency messages. Given the limits of SMS disaster emergency message content, and to provide the public with a more informative system, this study designed a series of disaster emergency motion pictograms and confirmed the effectiveness of their visual presentation and message transmission by testing people's recognition of the messages conveyed.

### 1.2 Research limitations

The motion pictograms in this study focused on common natural disasters in Taiwan. Graphics and motion transition were the main focuses of the designs in this study; colour and use of sound effects would be studied at the next stage. In the experimental part of the study, a digital native group (participants) as defined by Prensky (2001) was selected to confirm the recognition accuracy. The participants were aged between 20 and 30 years, familiar with digital technology, and were comfortable with controlling multimedia experiences. A questionnaire was employed as the experimental instrument, with recognition recorded by the participants using mobile phone displays.

## 2 Literature review

### 2.1 Motion pictogram design

Otto Neurath introduced the International System of Typographic Picture Education (Isotype), a "language-like" graphic design that has become a universal language in the field of education and public pictogram design (Chao & Hu, 2014). A pictogram is a meaningful shape that can replace linguistic transmission to ensure that a message is understood quickly. Hsu et al. (2015) asserted that graphic designs require two cognitive levels. The first level comprises visibility, readability, and simplicity, and the second level comprises construction (i.e., the overall effect of the image), semantics (i.e., the meaning of the image), and usage (i.e., the practicality of the image). Ōta (2003) argued that an efficient pictogram must undergo detail removal to present a simple and concise image that is highly recognizable and aesthetic so that its meaning can be understood in a short time.

The pictogram designs in this study were based on the study of Ho and Cheng (2013) on human attention and images. If a screen is viewed as a two-by-two grid, then most people's focus lies in the upper-left corner. However, if quadrant analysis is performed, messages in the second quadrant are the most effective, meaning that the most essential messages should be placed in the second quadrant of the screen. Moreover, Ōno et al. (2011) noted that graphics should employ clear actions, motions, and props to improve viewers' understanding of the intended meaning.

Due to technological advancements and the diversified modern media landscape, the belief that multisensory experiences are preferable has led to an increased pursuit of using visual communication methods, which is demonstrated by the emergence of motion pictograms. According to Fang and Teng (2015), the emergence of motion pictograms satisfies the longterm preference of humanity for viewing moving images. In addition to maintaining advantages of static pictograms, motion pictograms can compensate for the weaknesses of static pictograms. Elements of motion graphics can be divided into object movement, color, form, sound, voice over, and camera movement (Tim et al., 2012). Graphics show the object's color and form while only indicating the movement, an, whereas motion pictograms can directly show the object's movement to convey messages dynamically and visually, which facilitates faster message recognition among viewers. However, designing motion pictograms is more challenging than nondynamic graphics in terms of complexity; each image, scene, and transition must involve the recognition, understanding, and aesthetics of graphic transmission. Motion pictograms can, through their meanings and guidance, symbolize and replace tangible objects and locations as well as intangible behaviors and values (Lin, 1996). Chen and Kuan (2012) also noted that motion pictograms must employ easily identifiable graphics that meet the aesthetic expectations of their era.

### 2.2 Image recognition and cognition

Nielsen et al. (1990) proposed 10 heuristic criteria for conducting evaluations of pictogram: (1) use simple conversations, (2) use language familiar to users, (3) reduce the need for users to memorize information, (4) employ a consistent interface, (5) have a user feedback mechanism, (6) utilize simple solutions, (7) design shortcut keys, (8) provide clear error messages, (9) prevent errors from occurring, and (10) explain the operational processes. These criteria were followed during the expert focus group to provide references for the designers of the motion pictograms.

In a vocabulary survey of motion pictograms, Chen (2014) proposed five groups of adjectives under the following headings: recognizability, likeability, comfortability, aesthetic quality, and noteworthiness. In this study, the ISO/TR 7239 standard regarding development and principles for application of public information symbols was used as the basis for recognition evaluation of the designed motion pictograms. The evaluation results referred to the ISO 9186-1 benchmark of 67% as indicating accurate recognition of basic motion pictograms (Easterby & Zwaga, 1984). Using the aforementioned evaluation criteria, this study designed an evaluation of the motion pictograms that examined basic recognition of graphic visibility, readability, and simplicity to provide a highly practical method of examining the pictograms' construction, semantics, and usage.

## 3 Methodology

### 3.1 Research framework and evaluation method

The framework of this study is outlined in Figure 1. First, confirmation and analysis of disaster definitions, situations, intensity levels, response methods, and warnings was conducted through interviews with disaster prevention experts familiar with common disasters in Taiwan. After data collection, six major disasters in Taiwan were summarized, and the narrative context of those disasters as well as the contingency and evacuation methods were utilized to create scripts that could help in creating visual depictions. Second, an expert focus group was held to help create the basic pictograms. Ten professional designers, each with more than a year of visual design experience, were invited to participate in the interviews and divided into two groups of three and one group of four. Each person was then asked to create a disaster emergency pictogram and an accompanying dynamic transition.

Subsequently, design elements that were suitable as representative graphics were consolidated from the three groups' disaster emergency pictogram designs and dynamic modes. The design elements were further refined in black and white drafts to produce smooth motion graphics; these were used as the samples for the recognition questionnaire. Motion pictograms with poor designs and low recognition were improved and corrected based on feedback from the questionnaire. Finally, adjustment and unification of the overall style were performed to produce a series of verified disaster emergency motion pictograms.

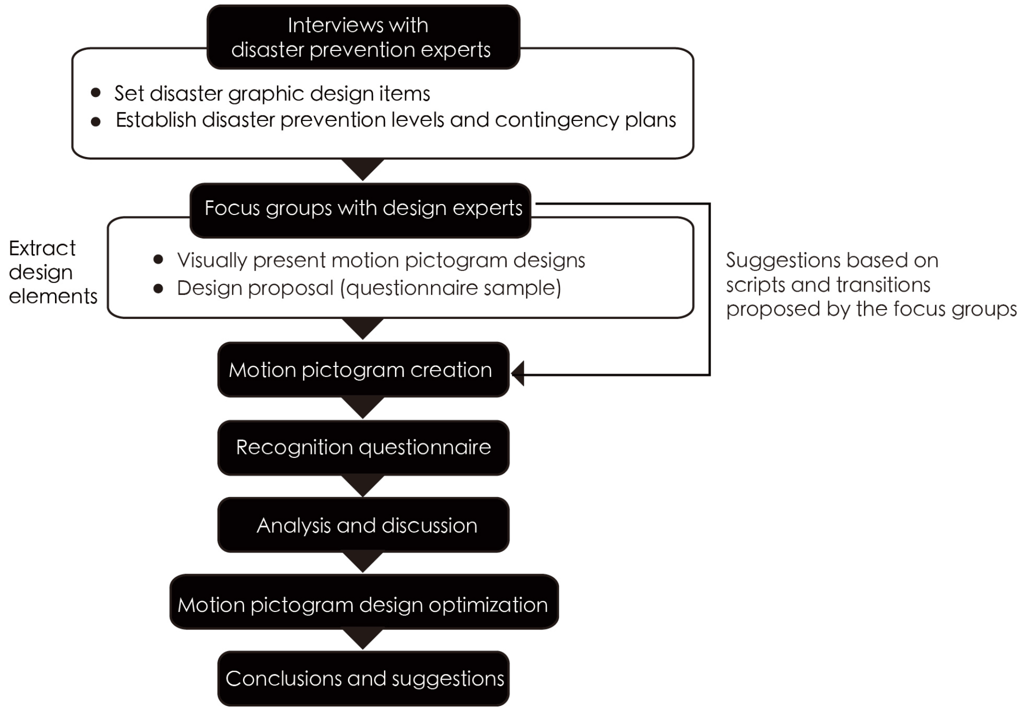


*Figure 1. Research framework*

## 3.2 Data processing and analysis

### 3.2.1 Research tool and data processing

The research tools used in this study were structured interviews, expert focus groups, and questionnaires. The advantage of structured interviews is that they could directly and effectively obtain appropriate strategies adopted by the Taiwan authorities for various disasters, including responses and evacuation methods, with a focus on the research questions.

During the expert focus groups, the research background and aim were first explained, and the disaster prevention interview materials and related pictogram examples were provided to the designers to provide them with inspiration. Each group was given an A4 sheet of white paper with a 5-$cm^2$ grid space in which to draw their pictogram (Figure 2). In addition, plain paper and stationery were provided to enable the designers to draft ideas and create a motion storyboard. During the group discussions, electronic products were permitted to help the groups search for information. Moreover, to avoid influence from extraneous factors, all images were depicted in black and white.

For the recognition questionnaire, the participants were asked to watch the disaster emergency motion pictograms on a mobile device and subsequently answer a questionnaire. The content of the questionnaire was divided into three parts. The first part was the participant's basic information. The second part employed a 5-point Likert scale to evaluate six disaster emergency motion pictograms. The evaluation referred to the items proposed by Chen (2014), and adjust the adjectives namely recognizability, comfortability, noteworthiness, and design quality. The third part was an open-ended question (i.e., suggest changes according to disaster types, response methods, and graphical correlation).

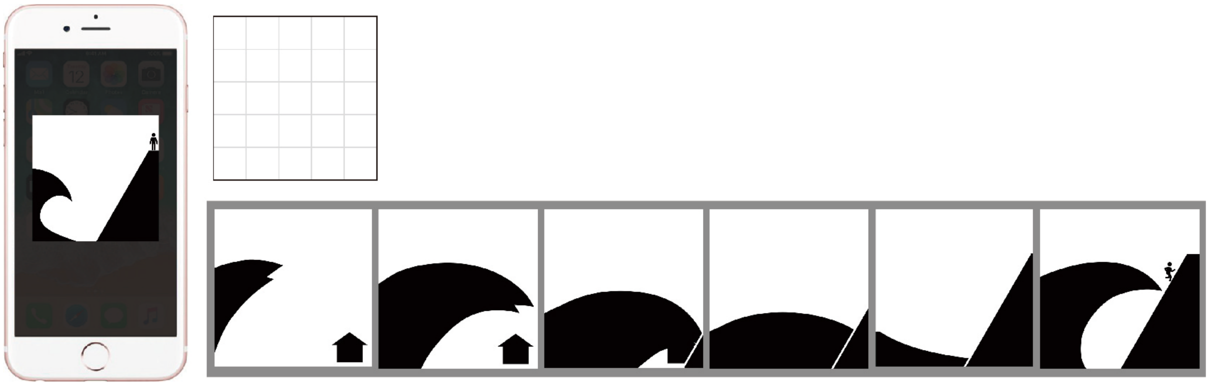

*Figure 2. Presentation of the motion pictogram on a mobile device*

3.2.2 Depiction and statistical analysis

Adobe Illustrator CC was employed to refine the black and white artwork, and Adobe After Effects CS6 was used for motion pictogram production. The motion pictogram was produced at 500 × 500 pixels.

Considering the need for urgency with emergency disaster graphic transmission and to avoid overly elaborate transitions, fade in–fade out and left to right transitions was set according to the different types of disasters. The pictogram had lengths of 2–5 seconds and was played on a loop. The file output format was MP4 (29.97 FPS).

SPSS 22.0 was used to analyze the quantitative data from the questionnaires. In addition to descriptive statistics, correlation coefficient analysis was employed to understand what factors correlated with recognition of the evaluated motion pictograms.

## 4 Results and discussion

### 4.1 Disaster emergency motion pictogram design items and visual presentation

After interviews with experts, six disaster types were recognized as well as 13 design items, as shown in Table 1. The graphics for each disaster needed to indicate whether follow-on disasters might occur, because flood and debris flow are follow-on disasters of typhoon and torrential rain that do not occur independently.

*Table 1 Design items for the disaster emergency motion pictogram*

| Disaster Item | Earthquake | Tsunami | Torrential rain | Typhoon | Typhoon and flood (vertical evacuation) | Torrential rain and debris flow |
|---|---|---|---|---|---|---|
| Response/ emergency evacuation method | (1) Protect your head and hide under the table (2) Escape the building and gather in an open space | Escape to higher ground | Stay indoors | Stay indoors | (1) Yellow alert: store water (2) Red alert: vertical evacuation | Evacuate to shelter |

Expert groups formed by 10 professional visual designers created the disaster emergency motion pictograms. The created motion graphics were used as samples for the recognition questionnaire (Figure 3).

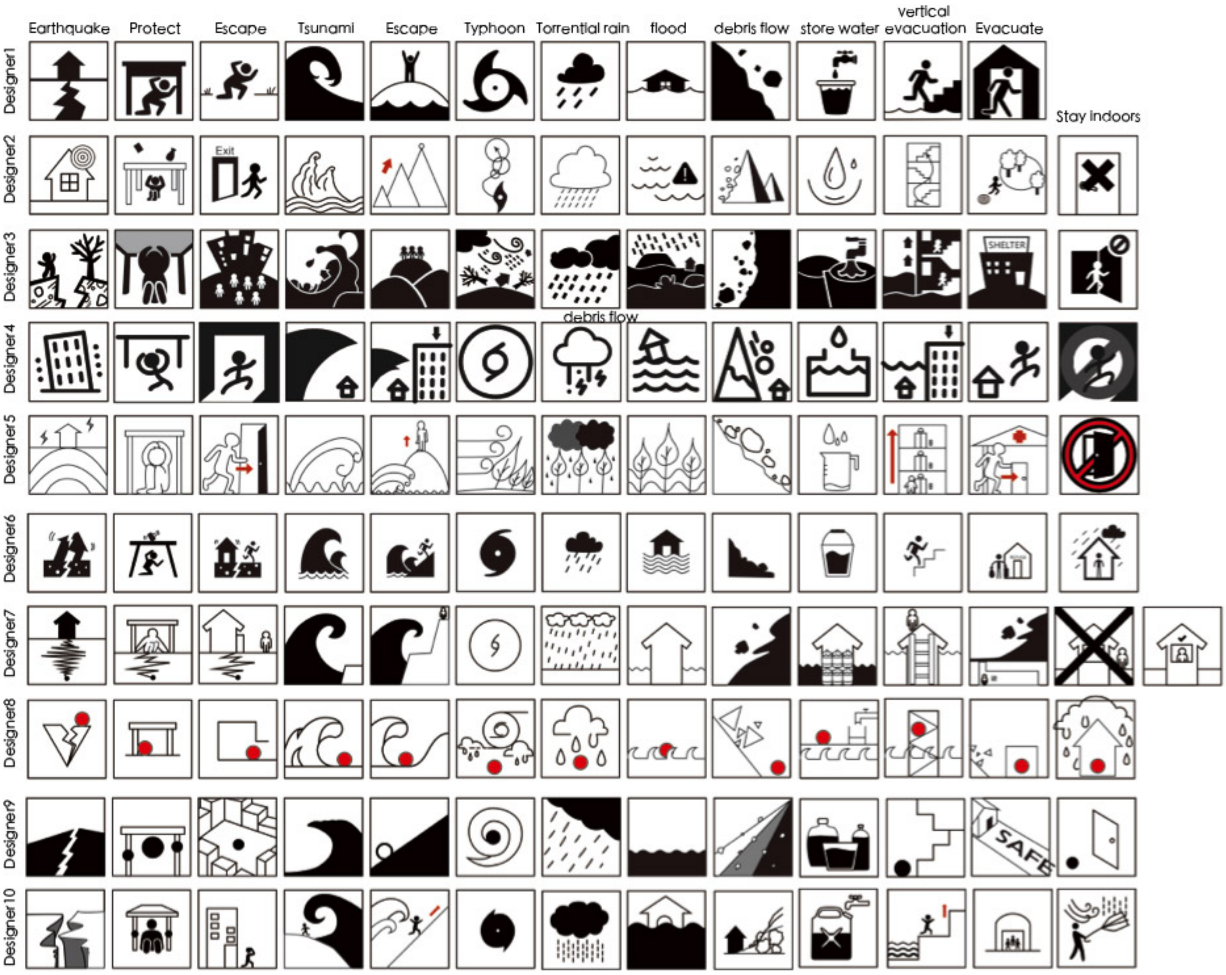


*Figure 3. Storyboard for visual representation of the disaster emergency pictograms*

The groups' analyses of the design items and sample pictograms came to the following conclusions: (1) pictographic representation should be adopted, with combination images used as alternatives. Combined graphics should be used only when pictograms cannot accurately illustrate the concept, such as for shock waves and typhoons. (2) Colors and lines should be used together, because designers rarely only use one. (3) Houses should be drawn with a pointed roof because house shapes are mostly designed with pointed roofs, 45° eaves, and a square main body. (4) Graphics should use two-dimensional designs. Although graphics can be presented in three-dimensional forms, all graphics should be unified into two-dimensions considering style uniformity and ease of understanding. (5) The motion graphics should move from left to right because people often evacuate from the left to the right.

### 4.2 Recognition questionnaire results

#### 4.2.1 Depiction and statistical analysis

A total of 40 valid questionnaire responses were obtained, with an even distribution of male and female respondents. The respondents were degree holders aged between 20 and 30 years, with 67.5% having a design background. Up to 85% of the participants had previously received SMS disaster emergency messages, with the most common category of disaster emergency for which they had received a notification being an earthquake. The evaluation results of the criteria (i.e., recognizability, comfortability, noteworthiness, and design quality) are presented in Table 2.

*Table 2 Statistical results of recognition*

| Item (Correct answer) | | Earthquake | | Tsunami | | Torrential rain (Stay indoors) | | Typhoon and flood (Store water) | | Typhoon and flood (Vertical evacuation) | | Torrential rain and debris flow | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Recognizability | Understand type of disasters | 97.5% | | 97.5% | | 72.5% | | 97.5% | | 95% | | 90% | | |
| | Understand-ing disaster response methods | • Hide under the table (85%)<br>• Run away (60%)<br>• Leave the building (32.5%)<br>• Gather at open space (5%)<br>• Avoid falling objects (2.5%)<br>• Escape the building when the earthquake stops (17.5%) | | • Run to a higher place (85%)<br>• Run away (2.5%)<br>• Escape from the shore (2.5%) | | • Stay indoors (97.5%) | | • Store water (92.5%)<br>• Stay indoors (7.5%) | | • Run to a higher floor (97.5%) | | • Run away (35%)<br>• Escape to shelter (32.5%)<br>• Escape to a safe zone (20%) | | |
| | | MD | SD | MD | SD | MD | SD | MD | SD | MD | SD | MD | SD | Overall average |
| Comfortability | Speed of motion is too fast | 3.25 | .82 | 3.50 | .77 | 3.90 | .76 | 3.40 | .91 | 3.55 | .86 | 3.65 | .90 | 3.54 |
| | Motion pictogram contains too much information | 3.70 | 1.00 | 3.80 | .81 | 3.95 | .83 | 3.82 | .99 | 3.42 | .91 | 3.67 | .87 | 3.72 |
| | The motion pictogram is aesthetic | 3.06 | .81 | 3.22 | .85 | 3.32 | .78 | 3.37 | .85 | 3.25 | .85 | 3.27 | .89 | 3.24 |
| Noteworthiness | The images drew my attention | 3.64 | 1.10 | 3.85 | 1.10 | 3.82 | .89 | 3.82 | .99 | 3.70 | .97 | 3.82 | .94 | 3.77 |
| | This images were interesting | 3.67 | 1.07 | 3.85 | 1.03 | 3.75 | .99 | 3.77 | 1.03 | 3.60 | 1.06 | 3.80 | 1.00 | 3.74 |
| | The pictogram would be helpful when a disaster occurred | 3.35 | 1.09 | 3.65 | 1.10 | 3.65 | .98 | 3.52 | 1.13 | 3.45 | 1.09 | 3.65 | 1.01 | 3.54 |
| Design quality | Playback of the motion pictogram was smooth | 3.83 | .93 | 4.00 | .86 | 3.85 | .79 | 3.80 | .84 | 3.82 | .83 | 3.90 | .76 | 3.86 |
| | I like the style of the motion pictogram. | 3.19 | .90 | 3.15 | .79 | 3.22 | 98 | 3.15 | .96 | 3.02 | .87 | 3.30 | .87 | 3.17 |

MD: Mean Deviation, SD: Standard Deviation

The overall recognition scores reveal that recognition of the six motion pictograms achieved recognition of over 67%. Specifically, torrential rain (stay indoors) had the lowest recognition at only 72.5%. The pictogram for this disaster had a lightning sign inserted to distinguish between heavy and torrential rain. However, according to the open-ended survey, most of the participants misunderstood the lightning sign in the graphics to mean thunderstorm. A possible cause of the misunderstanding is that the lightning sign accounted for half of the upper image, which may have attracted participants' attention. This result is also supported in the literature, with one study finding that crucial items occupying half of the upper area during motion graphics playback are particularly likely to draw the attention of users (Ho & Cheng, 2013).

Regarding the arrangement of motion pictogram scripting and presentation time, confused interpretation can occur if images are arranged in the order of major disasters, follow-on disasters, and response methods. In addition, the length of the disaster motion pictogram should be between 0.2 and 0.5 seconds to achieve the greatest communicative and warning effects. Therefore, pictograms for the representative major disasters in this study should include representations for both the primary and follow-on disasters to enhance the efficiency of visual communication.

With regard to design quality, the overall average score for all disasters was 3.24, and the average score for liking the motion pictogram was 3.17. The average score for the design quality of the typhoon and flood (store water) pictogram was the highest with 3.37, whereas for the earthquake pictogram it was the lowest with only 3.06. The torrential rain (debris flow) pictogram had the highest score for liking the pictogram at 3.30, and the typhoon and flood (store water) and tsunami pictograms had the lowest, each being 3.15.

#### 4.2.2 Correlation coefficient analysis

Correlation analysis of the questionnaire items is shown in Table 3. Among the six disaster emergency motion pictograms, the noteworthiness of the image is highly and positively correlated with user's interest. Therefore, designs that focus on immediately drawing users' attention are crucial. Furthermore, the design qualities of the motion pictograms are highly and positively correlated with having a likeable style. Thus, deciding on a consistent and fixed style before designing can effectively improve the user's aesthetic experience.

*Table 3 Correlation coefficient analysis of user recognition*

| Item | Earthquake | Tsunami | Torrential rain (Stay indoors) | Typhoon and flood (Store water) | Typhoon and flood (Vertical evacuation) | Torrential rain (debris flow) | Item |
|---|---|---|---|---|---|---|---|
| Noteworthiness | 0.88<br>.000** | 0.94<br>.000** | 0.85<br>.000** | 0.95<br>.000** | 0.89<br>.000** | 0.91<br>.000** | Interest-ing to watch |
| Design quality | 0.73<br>.000** | Nonsigni-ficant | 0.84<br>.000** | 0.78<br>.000** | 0.72<br>.000** | 0.76<br>.000** | Likable style |

*** $p < 0.001$ represents high significance*

### 4.3 Design optimization and proposal

Based on the questionnaire results, this study determined the optimized design for disaster emergency motion pictograms, which requires presenting compound disasters by combining information regarding primary and follow-on disasters and deleting image elements that may cause misunderstanding in order to maximize visual communication efficiency. In addition, the length of the motion graphics should be between 0.2 and 0.5 seconds. The improved graphic design is shown in Figure 4.

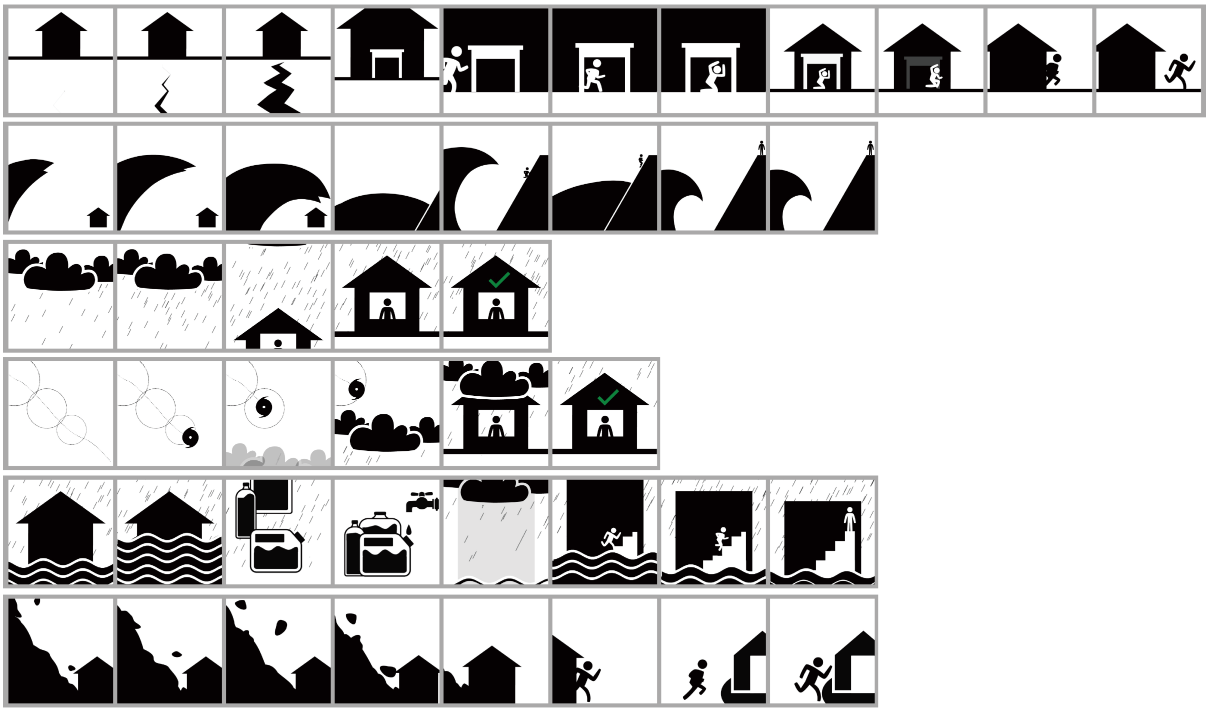

*Figure 4. Optimized design proposal for disaster emergency motion pictograms*

## 5 Conclusions and suggestions

Disaster emergency messages are a vital source of disaster and early prevention information. According to the survey, recognition of the motion pictograms designed in this study attained a recognition level greater than the ISO standard of 66.7%, indicating their applicability for practical use. Motion pictograms could replace mobile phone SMS notifications by conveying information within a short time without text, and this study showed that such images could obtain positive responses from people with disaster prevention knowledge. When designing motion pictograms, it should be noted that objects occupying more than half of the screen that appear at the start of the image are highly attractive. If the screen is divided into nine blocks, key moving objects should be placed in the upper middle position to most effectively convey the message. To avoid boredom and misunderstanding, the length of motion graphics should be set between 0.2 and 0.5 seconds.

Designs of pictograms can further be strengthened in the future for international and universal applicability. According to the questionnaire results, many participants suggested adding colour elements to indicate warning levels and urgency. Use of colour in motion graphics and discussion of its symbolic meaning are worth exploring in terms of their effects on visual emotion.

The results of this study can be applied to the development of programs and software for practical use in mobile devices. Moreover, experiments should be conducted on real-world applications to determine any potential problems and help contribute to disaster warning and education.

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