

# Assessing Awareness, Perception, and Usage Intention of a Disaster Information System: A Case of SIKK Magelang

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SIKK Magelang (Sistem Informasi Kebencanaan Kabupaten Magelang) is a web map-based disaster information system built by a local disaster management agency in Magelang, Indonesia to serve as a disaster database and a one-way disaster risk communication tool. This article assesses awareness, perception, and usage intention of the information system with local risk managers, volunteers, and public audiences in a historical city in Indonesia, namely Magelang Regency. The study found that respondents were unfamiliar with the disaster information system but were willing to use SIKK Magelang as a source of disaster information after a usage trial.

**Keywords:** *SIKK Magelang, disasters, information system, web map*

## 1. Introduction

As one of the historical cities in Indonesia and possessing the Borobudur temple as its main cultural site, Magelang Regency (*Kabupaten* Magelang) attracts millions of visitors per year. Magelang Regency is also a home for many hidden sanctuaries such as the Mendut temple, Pawon temple, Ngawen temple, Lumbung temple, and Asu temple. Despite its richness of historical sites, Magelang is also at risk of volcanoes, landslides, and tectonic hazards. These circumstances urge the government of Magelang to develop a widely and publicly accessible source of disaster information to communicate threatening risks, particularly to those who are not familiar with the area. Using online map-based disaster information can be an alternative to communicating the risks.

Disasters and natural hazards have a substantial spatial component. Therefore, delivering spatial information about disasters can improve awareness and understanding of risks with a more spatial sense<sup>1</sup>. Spatial information, mostly presented as maps are one of the most common means used in visual risk communication<sup>3</sup>. Maps used for disaster management can be formed as traditional paper maps, digital maps, map-based information systems, simulations, or web-technology<sup>1,4-6</sup>. The contents of the maps ranged from the visualizations of areas exposed to a particular hazard or risks such as hazard maps or risk maps up to the spatial distribution disaster occurrences.

The presence of mobile devices, now with larger screens and improved location-based technologies, accelerated by the more available inexpensive access to the Internet, have revolutionized how local authorities disseminate disaster information to the public. Information about disasters is now more being web- or internet-based delivered. This information can also be adjusted to various kinds of mobile devices. Hence, it can be accessed anytime, anywhere, and on any device. With the embedded Location-Based System (LBS), this information can be more specific and personalized to the users' location. Information about disasters, including disaster profiles, disaster lists, databases on losses and impacts, which may have previously only been accessed

by visiting the emergency management offices, is now easily, quickly, and widely accessible.

Advances in technology have also transformed the way in which maps are created and disseminated. Supported by the widely available free and open-source mapping software or geospatial technology, these systems are now more accessible for the local governments, especially in developing countries, embedding interactive maps into their self-built disaster information system<sup>7)</sup>. This effort indicates the increasing utilization of web Geographic Information System (GIS) in e-Government. On a local level, particularly on a municipal level, developing online interactive maps as a comprehensive disaster information system has been enhanced by the use of online mapping services such as Google Maps API, OpenStreetMap, ESRI ArcGIS API, or Bing Maps API.

A vast amount of online interactive maps or disaster information systems with mapping services focusing on disasters created by local-level governments are now vastly available on the Internet. This availability, however, cannot be automatically translated into actual usage or continue uses. Instead, the focus should not be on the generation of vast amounts of unusable data or decision-support tools that are not adopted, used, and applied, but instead emphasize how the information system is used and later this usage, particularly in terms of how it ultimately leads to changing behavior or at least hazard awareness raising<sup>5)</sup>.

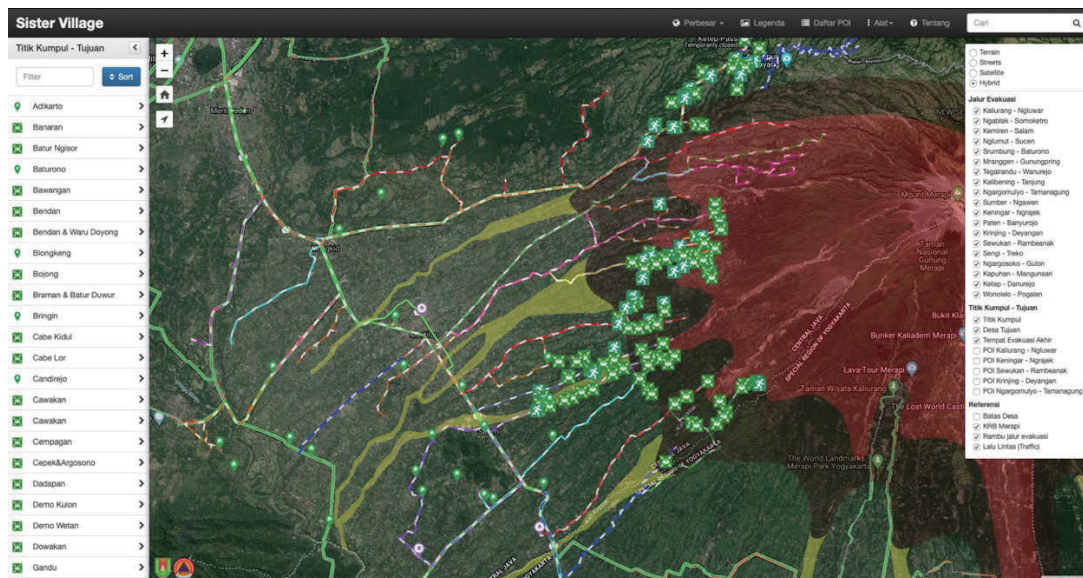
There have been extensive studies evaluating the usability and effectiveness of maps for risk communication purposes, which mostly focused on the designs of maps from the users' perspectives<sup>8-11)</sup>. These users may either be experts or laypeople. However, these studies lack in assessing how these maps are adopted and disseminated<sup>5)</sup>. In the Indonesian context alone, existing studies on online maps as part of e-government have been limited to the map availability with no specific focus on disasters<sup>12-14)</sup>. Studies on disaster maps in Indonesia are still limited to the development of the applications rather than evaluating the effectiveness or adoption of the existing maps<sup>15,16)</sup>. To fill this gap, this paper attempts to understand the adoption of maps with a technology management approach. It is necessary to understand this adoption because, without proper uses, a map or any other risk communication tools will lose its effectiveness in making the public understand the risks of hazards and actions they should take before, during, and after disasters.

A government-provided map-based disaster information system can be seen as an information system or e-government application. Therefore, the adoption or use of this kind of information system is probable to be assessed by using information system success models or e-government adoption/acceptance models. This study, in particular, adopts some constructs from the D&M IS Success Model<sup>17)</sup> to understand the adoption of a disaster information system.

By using SIKK Magelang or Magelang Regency Disaster Information System as a case study, this paper aims to explore how far a disaster information application developed by local government in a historical city, Magelang Regency is used or adopted by its potential users, such as local risk managers, volunteers, and public audiences. To explore whether this application is adoptable by these users, this study focuses on assessing awareness, perceptions, and usage intention. Local risk managers and volunteers may act as a user who personally uses the information system as a disaster information source. Moreover, they also play roles in disseminating and advertising SIKK Magelang to the public. This type of user can also use the information system to report an event directly from the field. Public audiences in this study can be both people in Magelang who are and are not residing in areas with a high risk of disasters. These audiences also include visitors or those who are not familiar with Magelang. Results of this work-in-progress study are essential for future studies that predict changes in people's and user behavior from the information system usage.

## **2. What is SIKK Magelang?**

Magelang Regency or *Kabupaten* Magelang is a historical city located in Central Jawa Province, Jawa, Indonesia. Jawa is the most populous region with rapid urbanization in Indonesia, which also makes it as the region most vulnerable to disasters caused by natural hazards. The region is at risk of multiple natural hazards, including flooding, landslides, volcanic eruptions, earthquakes, and tsunamis. Of 129 active volcanoes in Indonesia, one third (43 volcanoes) are located in Jawa. Magelang Regency, where one of the most important country's cultural heritage is located, the Borobudur Temple, is also part of the areas exposed to the most active volcano in Indonesia, Mount Merapi. Other than volcanoes, landslides are the most concerning natural hazards in Magelang. The city that comprises 24 sub-districts (*kecamatan*) and covers 110,385 hectares is also an economically strategic area because it is located in the corridor in between Semarang City, the capital of Central Java, and Yogyakarta. There has been a significant growth in tourism and commercial activities, including shopping centers and hotels.



**Fig. 1** The Interface of Sister Village Menu (Merapi Volcano Evacuation Plan Visualization) on SIKK Magelang

SIKK Magelang is an information system built by the Magelang Regency disaster management agency (Badan Penanggulangan Bencana Daerah or BPBD *Kabupaten* Magelang) that aims to collect, manage, and disseminate information about disasters to the public and relevant stakeholders. The system was initially developed as an information-sharing and disaster database platform used internally by the center of data and operation monitoring division (Pusdalops) of BPBD *Kabupaten* Magelang. Local risk managers, such as heads of villages or sub-district officials, may use this system to report events from the field to Pusdalops through the system. Concerning that, the information would also be valuable to the public, SIKK Magelang, then later have become publicly available. Disaster volunteers who are well-positioned to interact with the local population and are usually taking part in disaster simulation or public campaigns can have it as a complementary tool to spatially inform risks of hazards to the public. Furthermore, the public can individually access the system to learn about disasters threatening their living area. Those who live in areas at high risk of specific hazards can use this application to understand emergency evacuation plans (e.g., when severe eruptions of Merapi Volcano occur). BPBD *Kabupaten* Magelang claims that the system may also be valuable for stakeholders in deciding prioritized areas for disaster relief distribution.

This disaster information system is an example of how a local government in a developing country can optimally make use of free and open-source geographic information software for disaster management. Although faced with a limited budget, the local government of Magelang can still provide (usually at a high cost) spatially informative data to the public. Started only as a web-based platform (accessible at <https://sikk.bpbdmagelang.id>) in 2017, SIKK Magelang, since 2019, has also been available as a free mobile application for Android users. The web-based platform was built by using an open-source JavaScript software, PHP, and MySQL. The site also uses free base maps from commercial mapping APIs such as Google Maps (including Google Streets, Satellite, Hybrid, and Terrain) and OpenStreetMap. Compared to its web-based platform, the mobile application has an additional feature that can show users how far they are from the Merapi summit.

As SIKK Magelang is equipped with web-based map features, it can visualize the spatial distribution of disaster occurrences, areas exposed to risks of particular or multiple natural hazards, and evacuation-related information such as evacuation routes, shelters, and assembly points with a simple and easy-to-use interface. Recently, there have been two additional services on SIKK Magelang, namely GeoServer, which allows users to download disaster maps/layers and other attributes mostly in .KML files, and *Info Corona*, a feature that is showing the spatial distribution of positive suspected persons in Magelang.

There are two main menus of SIKK Magelang besides graphs and tables on the disaster database menu: *Pantauhan Bencana* and Sister Village. *Pantauhan Bencana* or Disaster Monitoring depicts areas that are likely to be affected by volcanic hazards in Magelang using traffic light color coding (where red is the most hazardous and dark green is the least hazardous). In contrast, Sister Village shows a visualization for Merapi Volcano evacuation plans (Fig. 1). Upon the opening of *Pantauhan Bencana*, points of disaster occurrences shown by different icons based on types of hazards are displayed within the map container as clusters. This first view offered users a clear idea of where most of the incidences are concentrated. On the other side of the map

container, there is a box displaying a list of the 90 most recent occurrences. A pop-up window with details of a disaster event will appear once users click on any listed disasters, and the map will automatically point at the location of the incident. Meanwhile, Sister Village appears when users click "Jalur Evakuasi" (evacuation route). Interestingly, the evacuation information visualized on this Sister Village menu was developed based on a local approach for Merapi Volcano crisis management called *desa paseduluran*, which matches villages located in high-risk areas with villages located at safer areas.

### 3. Methodology

This paper is a part of a study assessing the effectiveness of map-mediated disaster risk communication in Indonesia. However, the focus of this paper is limited to the awareness, perception, and intention to use a map-based disaster information system to understand the adoption of a map-based disaster information system. The examined variables are adopted from studies on technology management. Of the four variables, this paper's primary focus is on the usage intention that indicates the adoption of SIKK Magelang. Other variables, namely awareness, and perceptions, were used to predict factors that may be related to usage intention.

Awareness of innovation is an initial step in the innovation-decision period, during which an individual adopts or rejects an innovation<sup>18)</sup>. Existing literature argued that awareness of the availability of an online service is related to the use of the service<sup>19,20)</sup>. Moreover, the adoption of an information system is also influenced by users' perceptions of the quality of information and system<sup>21,22)</sup>.

Information quality refers to the desirable characteristics of the system output<sup>17)</sup>. Information quality has proven to be strongly associated with the use or intentions of future use and has been a critical factor in measuring the success of an information system<sup>22)</sup>. Quality of information in the context of an information system use is mostly measured in terms of completeness, ease of understanding, personalization, relevance, accuracy, timeliness, consistency, or security. In this study, information quality was measured on whether the maps and information about disasters provided on SIKK Magelang were useful, easy to understand, interesting, complete, and reliable, and trusted. We added 'up-to-date' when assessing local risk managers' and volunteers' perceptions of the information quality since their works urgently need up-to-date information on disasters.

System quality refers to the desirable characteristics of an information system<sup>17)</sup>. System quality is measured by several dimensions, such as ease of use, functionality, adaptability, availability, reliability, response time, importance, and usability<sup>22)</sup>. For the case of local risk managers, system quality was measured by thirteen items reflected the adaptability and usability of SIKK Magelang by the participants. Meanwhile, for public users, there are eight items to measure this system quality, which mainly reflected adaptability, reliability, and usability.

This study prefers to measure intentions to use rather than to measure the actual use because it was found from the usage statistics of SIKK Magelang that during the last one and a half years, there have been very low usages of this system. Thus, it was predicted that the usage trial during the survey would be the participants' first use. Intention to use was measured by participants' willingness to use the system in the future and desire to recommend the system to others.

Data were obtained from two field surveys comprised of a semi-workshop and questionnaire distribution by using close-ended multiple-choice questions held in Magelang Regency in June 2019 (local risk managers and volunteers) and December 2019-January 2020 (general public and community at risk) (See Table 1). Some survey items and operationalization may be different despite referring to the same variables or sub-variables. For the public survey, the questions and survey items were simplified (Table 2). The analysis is descriptive.

Local risk managers are those who fulfill a risk management function on a local level, such as emergency managers, spatial planners, heads of villages, and sub-district officials. These individuals work as local administrations and are responsible for technical protection or risk management in general. Disaster volunteers are a person or group of people who have the ability and concern to work voluntarily and sincerely in disaster management efforts. Based on the database of disaster volunteers of BPBD Kabupaten Magelang, in 2017, there were 3,976 disaster relief volunteers from 94 volunteer organizations in Magelang. Finally, public users refer to laypeople who potentially use SIKK Magelang: they can either reside or not reside in Magelang Regency. Those who reside in Magelang can be a community at high risk of a group of hazards or one living in a safer place.

Of the total 265 respondents, 58.5% were male, and 41.5% were female. The majority of respondents were those aged between 31 – 40 years old (32.1%). On the education level, the respondents are mostly graduated from senior high school. These situations are also applicable to each type of respondent (See Table 1).



**Table 1** Research methodology and demography of respondents from each survey

	Local risk managers and volunteers	Public audiences
Date of the study (month/year)	28 June 2019 with around one-month follow-up (waiting for the post-questionnaire filling)	December 2019 – January 2020
Study location	The meeting hall of BPBD <i>Kabupaten</i> Magelang	1. Sumber Village, Magelang (representing a community at high risk of volcanic hazards) 2. <i>Alun-Alun</i> (the city plaza) of Magelang Regency 3. Villages close to the Borobudur temple
Data collection method	A semi-workshop meeting with pre- and post-questionnaire distribution and SIKK Magelang usage trial, which initially invited 150 local risk managers, were conducted in collaboration with the BPBD <i>Kabupaten</i> Magelang. There were only 112 persons attended. One hundred seven respondents were willing to fill pre-questionnaire, but only 45 respondents filled both pre- and post-questionnaire.	A questionnaire distribution was conducted with the SIKK Magelang usage trial.
Number of respondents	45 respondents	220 respondents
Demography of surveyed people	<ul style="list-style-type: none"> <li>• Sex: 13.3% Female, 86.7% Male</li> <li>• Age: dominated by 31–40 years old (42.2%)</li> <li>• Education background: Senior High School (71.1%)</li> </ul>	<ul style="list-style-type: none"> <li>• Sex: 47.3% Female, 52.7% Male</li> <li>• Age: dominated by 31–40 years old (30.0%)</li> <li>• Education background: Senior High School (51.8%)</li> </ul>

## 4. Results and Discussions

### (1) Awareness of SIKK Magelang

This study shows that respondents in the majority were not familiar with the disaster information system. It is shown by very few respondents that have ever heard or use SIKK Magelang before this study survey. Two-third of our respondents who are coming from local risk managers and volunteers (31 respondents or 68.9%) said that they have ever heard or used the system before the survey. On the other hand, less than eight percent (16 respondents) of our public respondents were aware of the availability of this disaster information system.

Local risk managers and volunteers first knew the presence of SIKK Magelang in the last one month (55.6%). Most of them received information about SIKK Magelang for the first time from their friends, family members, and colleagues (53.3%) and social media (42.2%). They were found more aware of the availability of SIKK Magelang, perhaps because they are more actively involved in disaster management activities. Besides, they may also get the information more quickly and directly from BPBD.

Less awareness of public respondents indicates that BPBD needs more efforts to spread the awareness of the information system or to promote the use of SIKK Magelang more frequently. These efforts should also include manual training or a demonstration so that potential users can learn how to use it properly and get the maximum benefits provided by SIKK Magelang.

### (2) Perceptions of SIKK Magelang

In general, this study found that both local risk managers and disaster volunteers and public users expressed positive perceptions on the system and information quality of SIKK Magelang, although, in the previous section, their awareness of the presence of this information was quite low.

For the case of local risk managers and disaster volunteers, findings indicated that our respondents expressed high agreement on the system quality of the information system (Fig. 2). Almost all respondents agreed that when they were accessing SIKK Magelang, they are able to locate the evacuation sites, assembly points, and evacuation routes, which are essential for the emergency situation. They also agreed that they were able to understand colors and symbols used for the visualization of hazards from the maps on SIKK Magelang.

Public users also showed high agreement on the system quality of SIKK Magelang (Fig. 3). More than 60% of the respondents agreed and strongly agreed that SIKK Magelang is reliable as a source for knowing evacuation sites, evacuation routes, and assembly points. Around two-thirds of the respondents also agreed and strongly agreed that SIKK Magelang is reliable as a source of disaster maps. More than half of the public respondents perceived that SIKK Magelang is easy to operate, easy to access anytime and anywhere. More than 60% of the respondents also agreed that SIKK Magelang is easily accessible through any device. Both types of respondents also showed high agreement on the information quality of SIKK Magelang. Overall, most

of the respondents agreed that maps and information provided on SIKK Magelang are useful, easy to understand, interesting, reliable, complete, and up-to-date. Public user respondents also agreed that the information on SIKK Magelang is trusted (Table 2).

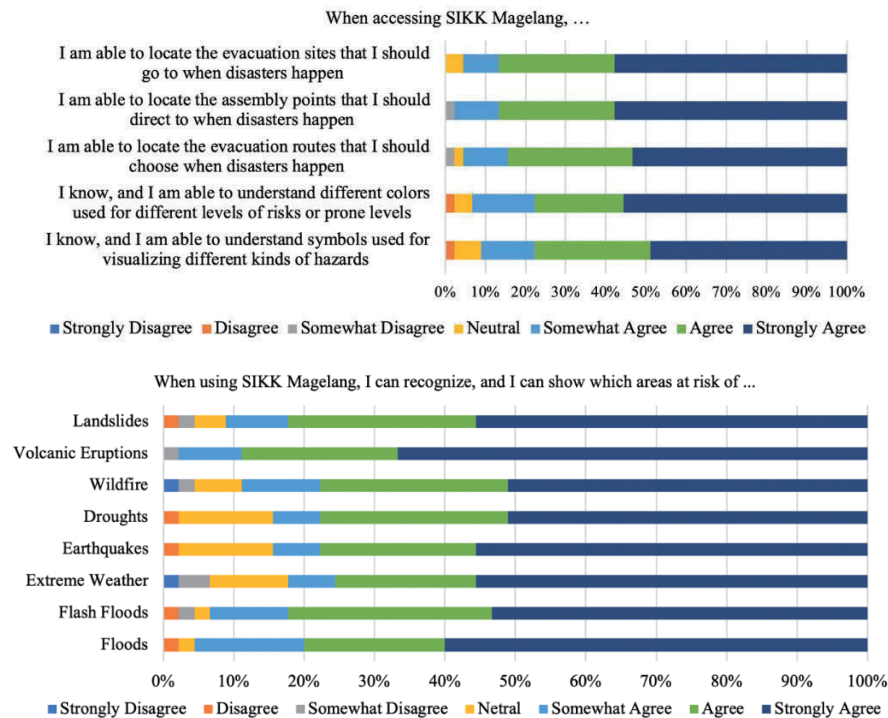


Fig. 2 Perceptions of local risk managers and disaster volunteers on the system quality of SIKK Magelang

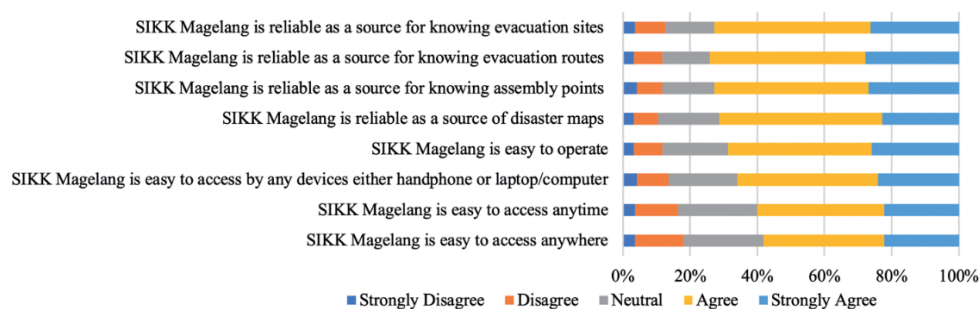


Fig. 3 Perceptions of public user respondents on the system quality of SIKK Magelang

### (3) Intentions to Use of SIKK Magelang

Interestingly, this study found that although respondents were not familiar with the system, once they tried using SIKK Magelang, they are willing to use the system in the future, shown by the high percentage of respondents agree to use SIKK Magelang as a source of information system. Almost all respondents from local risk managers and disaster volunteers showed favorable agreements (somewhat agree, agree, strongly agree) for all the statements representing their intention to use SIKK Magelang. They were also willing to recommend SIKK Magelang to their family, friend, and colleagues. The same findings also expressed by public respondents. More than 70% of our public respondents agreed to use SIKK Magelang as a source of disaster information and as a supporting tool for decision-making. Most of this group of respondents also agreed to recommend the information system to their family and friends.

### (4) Factors affecting Usage Intention

This study found that users' intention to use SIKK Magelang as a source of disaster information both for two types of users (local risk managers – volunteers and the general public) is positively correlated to the perceptions of both the system quality and information quality of SIKK Magelang (Table 3). This finding

suggested that to increase the adoption of SIKK Magelang by public users, BPBD Magelang should maintain its information quality and system quality to a level that met users' expectations.

While for public users, level of education and awareness of the availability of SIKK Magelang are positively correlated to their intention to use, these two variables were insignificant for users from local risk managers and volunteers. This may indicate that public users with a certain level of education are more willing to use the information system. Also, as they are getting more aware of its availability, the more they intend to use SIKK Magelang as a source of information. Therefore, if SIKK Magelang is prioritizing public users as its audience, awareness of the availability of this system should further be concerned because lack awareness of the availability of SIKK Magelang by its potential users will lead to lack of usage.

**Table 2** Perceptions of the Quality of Information displayed on SIKK Magelang

	Mean and Standard Deviation of Perceived Information Quality						
	Useful	Easy to Understand	Interesting	Reliable	Complete	Up to date	Trusted
<b>A. Local Risk Managers and Volunteers - Seven-point Likert Scale (7 = strongly agree, and 1 = strongly disagree)</b>							
1. Maps showing areas prone to disasters	6.67 (0.56)	6.49 (0.73)	6.49 (0.76)	6.16 (1.02)	6.36 (0.91)	6.31 (0.67)	n/a (0.62)
2. Maps visualizing the spatial distribution of disaster occurrences	6.62 (0.54)	6.33 (0.74)	6.47 (0.69)	6.36 (0.74)	6.40 (0.54)	6.36 (0.68)	n/a (0.57)
3. The visualization of evacuation routes	6.62 (0.61)	6.42 (0.84)	6.53 (0.66)	6.38 (0.68)	6.29 (0.76)	6.33 (0.77)	n/a (0.61)
4. The visualization of assembly points	6.60 (0.65)	6.40 (0.81)	6.47 (0.66)	6.24 (0.80)	6.22 (0.82)	6.31 (0.76)	n/a (0.66)
5. The visualization of evacuation sites	6.58 (0.69)	6.36 (0.77)	6.42 (0.78)	6.40 (0.78)	6.33 (0.71)	6.27 (0.72)	n/a (0.67)
6. The visualization of evacuation signages	6.56 (0.73)	6.40 (0.75)	6.38 (0.83)	6.24 (0.83)	6.31 (0.79)	6.24 (0.83)	n/a (0.73)
<b>B. Publics - Five-point Likert Scale (5 = strongly agree, and 1 = strongly disagree)</b>							
Disaster's information and maps shown on SIKK Magelang	4.05 (0.88)	3.88 (0.90)	3.90 (0.90)	n/a	3.81 (0.91)	n/a	3.95 (0.91)

**Table 3** Person Correlations between Level of Education, Awareness, Perceived System Quality, Perceived Information Quality, and Intention to Use SIKK Magelang

Bivariate Analysis	Local Risk Managers and Volunteers	Public Audience
Level of Education – Intention to Use	-0.13	0.40**
Awareness – Intention to Use	0.12	0.18**
Perceived System Quality – Intention to Use	0.58**	0.76**
Perceived Information Quality – Intention to Use	0.76**	0.85**

\*\* Correlation is significant at the 0.01 level (2-tailed)

## 5. Conclusions

This paper found that SIKK Magelang has not been familiarized by its potential users indicated by the low awareness. However, interestingly, after they have tried to use the information system (since this study included usage trial), respondents show a high intention of to use SIKK Magelang as a source of disaster information. This paper also found that both local risk managers-disaster volunteers and public respondents expressed high agreement on the information and system quality of SIKK Magelang, which indicated that SIKK Magelang has a good quality of system and information despite its still low usage. Moreover, this article has also significantly proven that some factors highly associated with users' usage intention, namely perceived information quality and perceived system quality. These findings are significant for further analysis of the impact of using SIKK Magelang for behavior-changing regarding disaster preparedness and risk reduction. Moreover, based on the findings, due to the positive perceptions on the information and system quality of SIKK Magelang as well as respondents' high desire to use, this paper suggests more promotion should be done by BPBD *Kabupaten* Magelang so that awareness of the presence of this information system will be increased. One of the ways can be optimizing the promotion of SIKK Magelang on most used social media platforms such as Facebook, WhatsApp, and Instagram. Through a better promotion, SIKK Magelang will not only be reached by the citizens of Magelang, but also by the visitors who are not familiar with the area of this historical city.

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