ABSTRACT
In the last 10 years, Mount Bromo has erupted three times; 2010, 2015, and 2019. Mount Bromo is a mountain made by caldera with an area of about 10 square kilometers. This makes Mount Bromo relatively safe while an eruption occurs because volcanic material with a large size and weight will fall around the caldera, the only dust that is blown by the wind will be continued as far as miles from the Bromo caldera. Using the smartphone application as the Mount Bromo information facilities are one of an effort so that people and tourists can activate if an eruption occurs. There is important information about features made in the application such as distribution shelters, evacuation routes, health centers, photos, videos, and other important information. Assessment results in the application interface, the information conveyed, and also the features offered show that the application is very useful and gives a new perspective in conveying accurate information to the public and also tourists. The community satisfaction level is also quite good with the services provided by the Bromo preparedness application. Great expectations from the public and also respondents can see Mount Bromo further through CCTV cameras that are directly connected to the Android application.

KEYWORDS: Bromo Preparedness; Eruption; Evacuation; Shelter; Android Application.
spiritual life of the Tengger people who live around it. Based on historical records, the eruption or increased volcanic activity of Mount Bromo was recorded since 1804 by the Dutch. The eruptions could last a short period of a few days (example: 12-14 June 1860) but could also last one month or more continuously. The eruption cycle of Mount Bromo is erratic, namely, the shortest rest period is less than one year while the longest rest period is 16 years [1]. The activity of Mount Bromo that is currently happening is inseparable from the geological historical record of the Tengger Complex. Activities of Mount Bromo are generally in normal conditions characterized by thin white to thick white crater smoke, weak pressure with a height ranging from 75-150 m from the peak, the smell of sulfur is sharp [2]. Ashfall deposits or pyroclastic falls, which are dominated by fine sand, are characteristic of this volcanic complex. Rocks around and inside the Ocean Sand Caldera are formed from ash and sand deposits associated with the formation of the Sand Ocean Caldera and the crater of Mount Widodaren [3]. Mount Bromo eruption milestone in the 20th century occurred in 1972, 1980, 1984, 1995, 2000, 2004, and 2010 [4], with eruption cycles ranging from 4-11 years. Based on its history, the eruption has changed, allowing severe impacts to occur again.

The most severe eruption of Mount Bromo that occurred in 2010 (designated as a national disaster) was due to no preparation. The evacuation was directed to the Grand Bromo Hotel (now the Whiz Prime Hotel) but the people did not want to evacuate to the evacuation location provided by the government. Also, in Leces District, the Public Works Office built a refugee camp (semi-permanent) but the community still did not want to evacuate. The reason is that the community still has old-fashioned thoughts, where they think that when there is a disaster and their place of residence is abandoned, they will lose recognition of their land ownership rights so that people choose to stay in their respective homes. In January-February 2010, heavy rains occurred which caused Probolinggo City to overflow with cold lava originating from the eruption of Mount Bromo, causing hundreds of hectares of agricultural land to die. However, there is another positive impact, the village that flows with cold lava becomes rich in volcanic material which can increase village income. Also, villages around Mount Bromo that were hit by volcanic ash received blessings because the soil became loose so that the yields continued to increase.

When the eruption occurred, 2 districts were the worst affected by the eruption (Sumber District & Sukapura District). The villages that were affected by the eruption of Mount Bromo were Sumber District, namely Sumberanom, Ledokombo, Pandansari, and Gemito Villages and all villages in Sukapura District. The impact of the eruption is mainly volcanic ash which can change during the eruption from year to year due to differences in wind direction.

Android-base application with the name Bromo Alert is an information digital means to promote tourism area Mount Bromo as well as efforts to improve the community and tourist capacity in terms of preparedness Bromo eruption disaster. We think it is important because the Mount Bromo area is one of the main destination tourists in East Java with high-level visits. “Bromo Alert” Applications created and launched, to become one of the references to the public related to the important information in the Mount Bromo area. Bromo Alert Applications is an application based on Android. This application is available on the Google Play Store. The application is one of the efforts for the public to know the Mount Bromo current condition, and how to prepare against the Mount Bromo eruption hazard.

**MATERIALS AND METHODS**

There are two important parts in conducting this research, namely; (1) making an android application and (2) product feasibility testing. To assess the android application feasibility, the team did some assessment methods they are Importance Performance Analysis (IPA) and GAP Analysis.
1. Importance Performance Analysis (IPA)

Since Matrilla and James researching IPA methods in 1977, the IPA framework has been popular among the researchers in the study of service quality. [5] Simple tools such as Importance-Performance Analysis are very simple in applications to evaluate service quality. In this analysis, examining not only analyze the performance attributes, but also the importance of items such as determinant factors in satisfaction for the respondent. [6] IPA method has proven to be a tool that applies common that just to interpret the results in the wide use between the researchers in various fields and many research subjects. IPA is a way to promote the effective development strategy because the method is to facilitate the attributes interpretation and improve usability in decision-making and also determine the strategy. [7]

There is a significant relationship between service quality and service user satisfaction which has an influence on decisions for the continued use of services. When someone decides to choose, that person believes and looks for the best service quality which was promised by the services provider. Customers were satisfied with the service quality that he got, would recommend to others to use the service so it can gain the service experience satisfaction that is equally or even better. [8]

The assessment level result of important service attributes in IPA methods is plotted a vertical axis (y) and the assessment level result of performance attributes is plotted a horizontal axis (x). The value of the service level and interest divides the grid into the four quadrants; Q1 (Keep up the Good Work), Q2 (Concentrate Here), Q3 (Low Priority), and Q4 (Possible Overkill). Although the IPA method has been regarded as an effective technique, many researchers propose several approaches and conceptions are modified, based on two implicit assumptions about traditional IPA methods. [9]

In this study, sub-attributes were collected in three variables groups; (1) visual aspects of the application, (2) responses from users, and (3) main features quality of the application. There were around 110 respondents in the study to test the feasibility of the Bromo Alert application with 5 levels of assessment; 1 for the worst value and 5 for the best.

2. GAP Analysis

The GAP Analysis is used to determine service levels differences of all used variables in research. With the GAP analysis, it could be to target the required attributes improvement, attributes, and variables that require more attention and also know the application weaknesses based on the user’s opinion. GAP analysis is expected to produce a recommendation that is appropriate for the application of Bromo Alert service improvement. To assess the feasibility of the application of Bromo Alert, the GAP analysis can be used to identify the attributes which have the most important aspect based on the interest value compared with the application performance value.

RESULTS AND DISCUSSION

Explanation of android application with the name Bromo Alert will be described in the explanation below. Figure 1 is an application interface with the smartphone’s view.

![Figure 1. Application Interface with The Smartphone’s View](image-url)

Applications Bromo Alert has several features, namely, the weblog features at Home, Shelter, Vlog, and also CCTV. In launching this application, all the information and field findings results are the result of research that is conducted by a team of researchers from the
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Department of Regional and Urban Planning, Universitas Brawijaya, Malang. So the most major information and news that is presented in the application is the result of the research. A description of the features in the application as follows;

1. **Home**

This feature is the information related to Mount Bromo such as the history and eruption events of Mount Bromo, how eruptions occur, favorite tourism destination (major spot of Penanjakan to see the sunrise, Whispering Sand, Teletubbies Hill, Mount Batok, and so on). These features appear in the format of a weblog in which the material will be displayed in such a form, the news will appear in the layer of smartphones based on the latest manuscripts that were posted last time.

2. **Shelter**

This feature is one of the important features of this application. It is a collection of shelter distribution with attributes such as the shelter distribution, public infrastructure distribution, and the nearest residential area. The shelter distribution map and also the evacuation route can be accessed by scanning the available QR Code at each location. Examples of the use of QR code and an evacuation map can be seen in Figure 2 and Figure 3 below. By scanning the QR Code that exists at the shelter points specified in the potential location such as hall village, lodging, open space, mosques, schools, health centers, and temples, so public can know the shelter distribution that already displayed in lane evacuation map. [10]

**Figure 2. QR Code as a Link to Show the Shelter Distribution**

**Figure 3. Shelter Distribution Information and Travel Time to Shelter with Google Maps Facilities in Android Application of Bromo Alert**

The shelter feature also provided information about the shelter, such as; building name, building location, floors number, capacity, and it is located in the zone of Disaster Prone Area. On the shelter features are also providing direction facilities, where the application customers can easily reach the shelter with click button direction and the user will be guided by the map-based application to reach the shelter location along with a description of travel time that is required. Figure 3a and 3b are figures related to shelter information, while Figure 3c shows the travel time that required to reach the shelter by using google maps technology. Figure 3c is a mode direction figure if about to head to the shelter from the current locations point. With google maps facilities the meeting of the two points will be immediately known how the travel distance from the location point is toward the shelter point or to the public service point. Direction services provided in the shelter feature and the feature is inherent in the application and can be used well as long as they are internet signal at the location.

3. **Vlog**

In the following feature, the information that will be obtained by the user is a video that has been uploaded by vloggers of Mount Bromo tourist. From this vlog, the tourist will receive information in a different form, especially for the foreign tourist. Deliberately displayed in the form of a vlog, due to the tendency of generation Y and Z who are more active in using smartphones. The intensity of the community in using smartphones, not only in the form of news,
blogs, or social media but also access videos on the YouTube page.

One of the interesting content that can be presented in the vlog feature is the local wisdom of the people around Mount Bromo [11]. The people around the Tengger Mountains are dominated by the Tengger Tribe who have been living on the mountain slopes for generations. Agriculture is the main activity of the Tengger Tribe to make ends meet. The skills of farming were passed on by their ancestors and passed on to their children and grandchildren. The slope of the Tengger is the most ideal place to stay for the Tengger Tribe despite temperatures reaching 15°C. Mount Bromo, which became one of the threats live in the slope of the Tengger regarded as brothers by the communities themselves. The eruption of Mount Bromo did not make the community evacuate even though their livelihoods were completely dead during the eruption period because they considered Mount Bromo as the source of life like old people. The Tengger Tribe who has lived on the slopes of Mount Bromo for hundreds of years has their views of Mount Bromo. Mount Bromo is considered as the center of cosmology, beliefs, mothers, and siblings who inhabit the mountain. According to local myths and legends from Tengger tribal elders, Mount Bromo is the incarnation of Raden Kusuma, the son of Joko Seger and Roro Anteng who became a sacrifice for Mount Bromo so as not to get angry. The Tengger Tribe consider the community to be part of the mountain environment. Soil, water, and forests are the source of life, even ash and sand from the eruption can be used. This assumption is included in myths and community customs such as the origin of Tengger (Joko Seger and Roro Anteng). People are not afraid to face the eruption of Mount Bromo and believe in a legend that has existed for hundreds of years, as told by one of the Tengger Tribe elders. The way people read nature’s signs also affects their perceptions. Natural signs such as abundant yields are a sign for them that Mount Bromo will erupt again. Some signs are around the environment, people use it as a danger alarm, it is believed by the community even though it cannot be studied from a scientific perspective. The perception that is built in the Tengger Tribe about the dangers of the eruption of Mount Bromo is positive. Perceptions of hazards are built by the knowledge of a person/society about the hazard. The perception that is formed in society is influenced by a strong cultural sector and has been passed down from generation to generation [12]. This affects people’s mindsets about mountains and their dangers. The disaster was still accepted by the Tengger Tribe sincerely and they even considered this a blessing from Sang Hyang Widi. At the time of the eruption, there were no people who fled because of their belief that Mount Bromo would not endanger their lives. This mindset has led to the formation of positive perceptions in the Tengger Tribe. The Tengger Tribe no longer felt that Mount Bromo was dangerous, so no response was given when Mount Bromo erupted. This is a form of community agreement with nature that people accept the risk of living in a mountain area by considering threats as a blessing.

UN 2009 Risk and Poverty in the book Asian Tsunami [13] which states that the highest global disaster losses are concentrated in poor countries. The book further exacerbates disaster risk in poor countries, namely weak government, vulnerable communities, especially in rural areas, and environmental (ecosystem) degradation. In the case of other disasters and especially the Tsunami, which in the book proves
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this, the Tengger Tribe can deal with disasters through knowledge, experience, and local wisdom that has existed for hundreds of years. The local wisdom of the Tengger Tribe seems to answer the findings of the United Nations, with local knowledge and wisdom through all activities there are no casualties, the government is helped by community cooperation, and of course with local wisdom, the Tengger Mountains environment is still well preserved. The experience of the people who have lived on the slopes of the mountain for a long time provides the community with knowledge to learn about nature and adapt to the dangers of Mount Bromo. In general, the Tengger Tribe is known to adhere to very strong Hindu beliefs. This teaching becomes a life guide for the Tengger Tribe in treating each other, nature, and the Creator. The enactment of customary law is the social controller for the Tengger Tribe. Tengger Tribe still holds the fear of karma. Religious and customary institutions also played a role during the eruption and post-eruption by collaborating with the Probolinggo Regency Government and related institutions. Religious and customary institutions are highly trusted by the community, therefore when an eruption occurs, religious and customary institutions are very important. The community will fully implement the decision to evacuate or stay in the village. Although religious institutions with adat can read Mount Bromo activities with their knowledge and beliefs, they also follow the development of science to Mount Apian and collaborate with the Center of Vulcanology and Geology Disaster Mitigation and other institutions. The conception of space through the Pujan Mubeng (Nurundhung) ritual which aims to ask for the safety of the village and to clean the village from disturbances and disasters, such as:
1. Tombs in the north, far from settlement sites (fixed area),
2. Temple in the east for facing the sun,
3. Fields/ moor in the south, north, and east, and
4. Mount Bromo in the south as a shaft (pancer) is identified as the throne of Bromo or Lord Brahma, being the orientation of the burial position, praying, chanting a mantra facing south, the main door or crater rim, holy places, and aim to always observe Mount Bromo every time. moment.

The system of tenure and land ownership with a traditional system, ojo jowal-jawil (not disturbing other people), hard work, and maintaining the property from generation to generation shows the wisdom of protecting the environment and protecting it from outside interference in spatial management. Changes in raw materials and residential structures take into account climate change, for example; shift from the use of tile to zinc because zinc is more appropriate to use in cold areas. Also, the 45° roof will make it easier for the volcanic ash that has accumulated on the roofs of the houses which will knock down residents' houses. During the eruption period and after the eruption, the community can withstand disasters, one of which is the strong cultural influence of the Tengger Tribe. The culture of society is different from other societies because the social system of social relations is based on the unity of life, namely the existence of a bond where we live together [14]. The existence of this relationship is influenced by religious relationships because the Tengger Tribe is known to be very strong adherents of Hindu beliefs. Religious relations occur between residents, they interact and relate to each other because they are based on a common goal. Environmental degradation in poor countries does not appear to be occurring in the Tengger Tribe. This can be seen from the way of farming by placing strong-rooted plants, for example, many pine trees are planted in fields/ moor to prevent landslides and erosion, the strong roots, the wood can be used as a building material. The type of fertilizer used prioritizes the use of manure/ compost which according to the Tengger Tribe is environmentally friendly and does not damage the texture and fertility of the soil. Laying a cage that is located far from human settlements, is a
form of environmental wise action. Also, the Tengger Tribe classify forests and make use of them. The Tengger Tribe has a high awareness of managing the forest. This attitude in forest management and protection is based on the slogan that is adhered to, which reads "cut one plant two" which means that if you cut one tree, you must plant at least two trees of the same type. This social system is an advantage for the Tengger Tribe because it can be used as a force when a disaster occurs. Apart from this social system, local knowledge inherited from the ancestors of the Tengger Tribe is also useful in overcoming the eruption of Mount Bromo. This knowledge is passed down from generation to generation with intertwined interactions from various media such as traditional ceremonies such as the kasodo ceremony and tumang/tungku (gathered in the kitchen). The local values of the Tengger Tribe are transformed into economic life, farming systems, land management, respect for nature, and living side by side with Mount Bromo [15]. The existence of initiatives from the community to seek DRR methods in their way shows this is an independent disaster mitigation effort from the community by utilizing local wisdom and experience.

4. **CCTV**

This feature is a means for the public to know the current and updated condition, especially the view that instantly shows the latest Mount Bromo condition in LIVE. In the activities implementation plan, the cameras will be scattered at some point which is flanked directly to Mount Bromo. By knowing the current condition of observed Mount Bromo, expected that the public will be more beware and avoid hoax news who often associate the condition after the eruption of Mount Bromo with another issue. If the Mount Bromo eruption happened, people just have to look at the CCTV that can be viewed through applications Bromo Alert, so that the public can be spared from hoax news exaggerated by people who do not take responsibility.

The attributes used for IPA assessment are (1) application interface; user-friendly, eye-catching, color, icon, and application name, (2) feedback from users; comment, and notification, (3) main features of application; uniqueness, importance level, and simple. Table 1 below is the result of the calculation based on the respondent’s opinion. From Table 1, it can be seen that respondents provide feedback based on their experience using the application of Bromo Alert.

The following explanations describe each IPA quadrant following the results in Table 1 above;

1. “Keep Up The Good Work” Quadrant (I)
   According to respondents, the application display color is very good, with the application name that is easy-knowing, as well as the application icon selection.

2. “Concentrate Here” Quadrant (II)
   While the application uniqueness, interest, and also the application simply needs to be increased again. It is seen from the user's satisfaction level is quite low, with a mean only on the value of 2.25 up to 3.41. By thus, need to increase the attribute application performance.

3. “Low Priority” Quadrant (III)
   Comment and notification attributes are not a service priority of the application. Can be seen in Table 1 above where application public users were sufficient to service these and also not consider that service is important in the application.

4. “Possible Overkill” Quadrant 4. (IV)
   In this quadrant, there are two attributes: user-friendly and eye-catching. Based on the
results of the questionnaire, this attribute is not very significant. This attribute is quite important for the users and has been offset well by the excellent service of the application of Bromo Alert.

<table>
<thead>
<tr>
<th>No.</th>
<th>Code</th>
<th>Attribute</th>
<th>Coordinate of Attribute</th>
<th>GAP Perf-Imp</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A.1</td>
<td>Interface of Application</td>
<td>X = \sum x_i \bar{x}</td>
<td>Y = \sum y_i \bar{y}</td>
</tr>
<tr>
<td>1</td>
<td>A.2</td>
<td>User Friendly</td>
<td>4.31</td>
<td>3.94</td>
</tr>
<tr>
<td>2</td>
<td>A.3</td>
<td>Eye Catching</td>
<td>4.60</td>
<td>3.99</td>
</tr>
<tr>
<td>3</td>
<td>A.4</td>
<td>Nice Color</td>
<td>4.34</td>
<td>4.33</td>
</tr>
<tr>
<td>4</td>
<td>A.5</td>
<td>Icon of Application</td>
<td>4.69</td>
<td>4.37</td>
</tr>
<tr>
<td>5</td>
<td>A.6</td>
<td>Name of Application</td>
<td>4.37</td>
<td>4.18</td>
</tr>
</tbody>
</table>

While GAP with quite significant value based on the questionnaire results, there is main features attribute of the application such as uniqueness attribute, importance levels, and application simplicity. The value difference was pretty big and require little services improvement effort. The GAP value difference that occurs on the attributes of this until 2.16 on importance level attribute and 2.02 at the uniqueness attribute, it shows that users feel less satisfied with these attributes. By knowing the GAP was pretty much on the interest level and the service level given by the application, then the services increase concentration can be focused on the attributes mentioned above. While other attributes inclined already provide better services even exceed the application user expectation level.

Based on the assessment results using IPA and GAP Analysis methods, it can be seen how the application user’s opinions based on the attributes and variables used as assessment material on the application of Bromo Alert. Visually, the user application was very satisfied with the whole application’s appearance. This is shown from the visual display attributes position that is in quadrant I and IV. While the attributes that require a lot of improvement are in the main function’s attributes such as the application importance level, ease, and simplicity of application use, and application uniqueness. Users want the attributes performance can be increased again because for them the attributes are the main features that should be able to serve the user application.

**CONCLUSIONS and SUGGESTION**

Application is expected to be able to provide education to the user application, this would only be an impact on the increasing awareness and society preparedness when Mount Bromo eruption. Other preventive efforts can learn and read through the application of Bromo Alert as a reference for the user application from the public and also the tourist.

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REFERENCES


