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# *Comparison Study of Crowdsource Geographic Information Services for Rural Mapping and Toponym Inventory*

## *(Case study in Kebondalem Lor, Prambanan, Klaten, Central Java)*

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***Abstract*—The development of geographic information science so rapidly both conceptually, applications and related technologies in the field. To support the study of geography, the Geographic Information (GI) is important in order to study geosphere. The existence of geographic information services (crowdsourcing mapping) such as Google Maps, Bing Maps, Here Maps, and also OpenStreetMaps. The quality of spatial data from geographic information listed there needs to be studied further. In the other hand, village as the smallest administrative unit autonomy need to map. Characteristics of the village needs to be studied, one of which may be through mapping and study geographical names in there. Especially with the village fund which the amounts consider aspects of population, poverty, area and geographical difficulty level where the information can be presented in the village maps. Based on this background, this study aims comparing geographic information services in order to support rural mapping and toponym inventory. The existing geographic services (crowdsourcing mapping) is compared by its features, both point, linear and also polygon features. We also compare the system features. Based on the result show that Google Map offers highly supports the rural mapping and contains more geographical names than the others. The facility/ add-on features in Google Maps also become benefit than the others. In the other hand, OpenStreetMaps show promising for crowdsourcing mapping. The user could invite the other people to map the area together.**

***Keywords—Ruralmapping, crowdsourcing mapping, Kebondalem Lor***

## I. INTRODUCTION

The development of geographic information science is so rapidly both conceptually, applications and related technologies in this sector. The development is supported by advances related disciplines such as cartography, remote sensing, math, science, computers, philosophy and other related fields (M. F. Goodchild, 1992). To support the study of geography, the presence of Geographic Information (GI) is important in order assessment geosphere phenomena can be comprehensively and sustainably. One of the media in learning geography is map (Rediscovering Geography Committee National Research Council, 1997).

Acquisition, storage, processing and presentation of information developed significantly as a response of technology information innovation. Since the introduction of computers around 1960, followed by the development of automated cartography in 1970, and after that the geographic information system was introduced around 1975, Geographic Information becomes a hot topic that developed among researchers, government and industry. The amount of attention in the field of geographic information, some parties declared that the standardization by the geographic information curriculum such as the emergence Body of Knowledge Geographic Information Science and Technology (D. DiBiase, 2006), as well as a thorough standardization in aspects related geospatial information in the ISO/TC 211 ,(2009) [4]. As described in the document ISO/TC, the presence of their spatial databases developed by information technology company and also the dissemination of geographic information through the Internet makes science and technology based on location (one of which geographic information science) is used and developed by many sector. The existence of geographic information dissemination through the internet makes several well-known companies such as Google, Microsoft, Nokia, and OpenStreetMap Foundation offer online geographic information services.

Geographic Information (GI) or there is a mention as geospatial information, own laws related to it (Undang-Undang Republik Indonesia Nomor 6 Tahun 2011). Referring

to the law, geospatial information becomes the basis data presented in topography maps called Rupa Bumi Indonesia (RBI) Maps. The maps contains the elements and Geographical names and own specifications technical presentation (BSNI, 2000). Current conditions, large-scale topographical maps are not fully available in remote areas. Presence information services the online geography makes one of the alternatives in obtaining information on the names and topographic features.

The location of research is the village area. According to Law No. 6 In 2014, the village is unity of the legal community who have borders with the authority to regulate and manage government affairs, the interests of the local community based community initiatives, the right of origin, and / or traditional rights recognized and respected in the governance system of the Republic of Indonesia (Undang-Undang Republik Indonesia Nomor 6 Tahun 2014). The existence of these laws is respecting the existence of the village as a traditional community that able to manage their own problem (Rijanta, 2016). Based on Minister Regulation No. 56 Year 2015 About the Code and Data Administration Area, nowadays the number of villages / villages in Indonesia are as many as 83 184 with details of the number of villages is 74 754 and the number of villages in Indonesia reached 8,430 (Peraturan Menteri Dalam Negeri Republik Indonesia Nomor 56 Tahun 2015).

Geographic information for the village is an important tool to promote the accelerated development of the village and very useful as a support system in decision making in order to optimize the potential for rural development. The existence of online geographic information services is to support one of the principles in a region that is participatory mapping. Participation of local communities is expected to increase awareness of the importance of geographic information and results can be used directly by the community to support rural development. This research takes place in Kebondalem Lor village, Prambanan, Klaten. The purpose of this study is comparing geographic information services in order to support rural mapping and toponym inventory.

## II. METHOD

### *A. Literature Review of Geographic Information Services*

Geographic information services (IG) are available in real-time which available in Web map. Some examples of companies and consortia geographic information service provider or digital maps including Google, Microsoft, Nokia, Openstreetmap Foundation, and Wikimapia. Geographic information services in the form of digital maps in the dissemination website is usually customized their web name with the name of the provider such as Google put out Google Maps, Microsoft with Bing Maps, Nokia's Here Maps and OpenStreetMap Foundation with his OpenStreetMap.

Google Maps is a web-based mapping application provided by Google previously called Google Local (Google Maps, 2016)[10]. This application was launched in February 2005 which can be accessed free of charge by all internet users (Bantuan Maps, 2016). Applications are accessed via the website https://maps.google.com/ possible to include a map on the website by a third party because it is equipped with API facilities.

Bing Maps is one of the applications developed by Microsoft and is equipped with Bird's Eye Imagery (Bing Maps for Enterprise, 2016). Bird's Eye Imagery is a map view taken from an angle of 45 degrees, giving a 3 dimensions view that is clear, near, and real (Bing Maps, 2013). However, these facilities are still limited in some countries and Indonesia have not been included in and it cannot do unless additional data from the provider. Regional information presented by this application is detailed in the UK and the United States (Bing Maps, 2014). This application is launched at the All Things Digital conference in San Diego, USA, and was officially launched on June 1, 2009 (Microsoft's New Search at Bing.com Helps People Make Better Decisions, 2009). Applications that can be accessed via the website http://www.bing.com/maps use power set technology that presents a more accurate search results. License for the use of these applications is generally not charged but for the specific use of certain charged (Bing Maps Licensing, 2016).

Here Maps app is an application that was originally intended only for the Nokia product (Windows Phone), but at this time of this application can be used for android based applications (Keunggulan Aplikasi Here Maps Dibanding Google & Apple Maps, 2015). The advantage of this application can be used offline or without the use of the Internet network. Offline maps provided in more than 100 countries and also provides live traffic information for over 40 countries (Aplikasi Android Peta Offline Gratis Nokia HERE Maps, 2014).

OpenStreetMaps (OSM) is a web-based mapping application. Designed to simplify maps information access and provide spatial information across the globe the world via internet access. OSM was designed by Steve Coast in England in 2004 and expanded in April 2006. The area is complete early in the United Kingdom, and now it covers most of the countries in the world. In addition, data OpenStreetMaps can be downloaded in shapefile format (shp) which enables the data can be used as a reference in cartography "About (OpenStreetMap, 2015).

### *B. Source of data*

The data used in this study included RBI Maps scale 1: 25,000 sheets of Pakem and Klaten, High Resolution Satellite Imagery in the geographic information services, spatial data and monographs of the village, as well as content data in geographic information services. When conducting field research, we used a Garmin GPS with high accuracy, smartphone has a GPS sensor, and a digital camera to take pictures.

### *C. Study area*

The location study is Kebondalem Lor Village. The village is located in the district of Prambanan, Klaten, Central Java. This area is a rural area that borders the town, and small portions of this region enter into National Strategic Region.

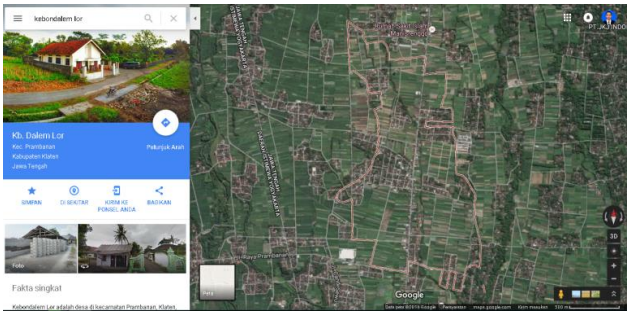


Fig. 1. Study area of Kebondalem Lor

Source : (C) GoogleMaps, 2016

### D. *Research Workflow*

Steps being taken in this study can be seen in Fig. 1 below.

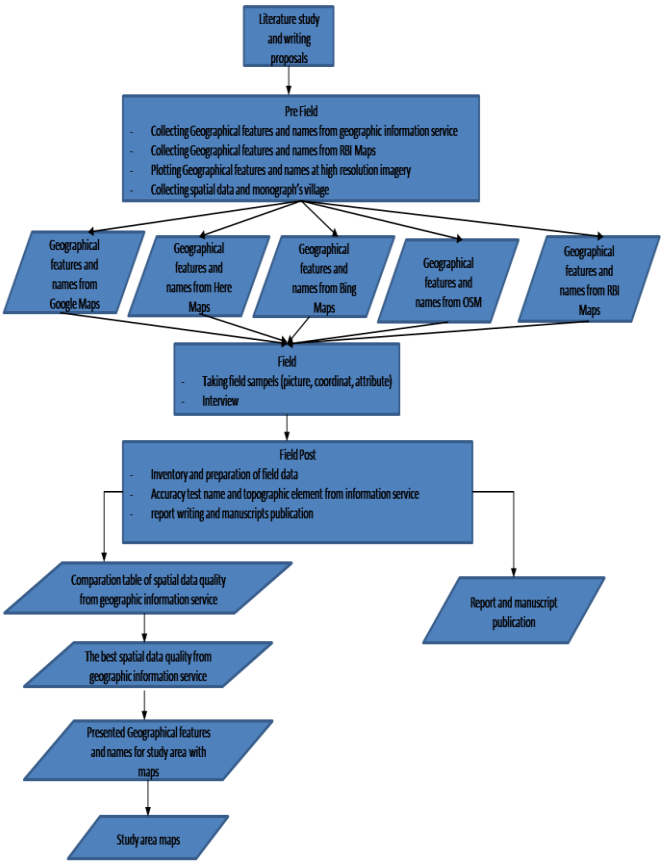


Fig. 2. Workflow of Research

## III. FINDING AND DISCUSSION

### A. *Framework Maps*

Framework map used in the study is an administration map of Kebondalem Lor Village. The data used in framework map-making include RBI Maps, administration map of Kebondalem Lor Village in 2009, and general facility data from field work results. RBI Maps was used as base maps in framework map-making. Administration map of Kebondalem Lor Village in 2009 used to obtain information related to the administrative borders of the Kebondalem Lor Village.

### B. *Geographical Names and Features Inventory*

Fieldwork was conducted a survey related to public facilities in the village Kebondalem Lor. The information obtained by plotting dots in all existing public facilities using Garmin GPS and smartphone GPS along with photos from the appearance of public facilities. Collection of geographical features information from this fieldwork will be used as a reference in comparing with the appearance of geographical features exists from each service information: Bing Maps, Google Maps, Here Maps and OpenStreetMaps).

In addition to information related to geographical features, information regarding geographical names is collected in fieldwork activities by conducting interviews to the village officer and village elders to gain information relating history and pronunciation of Geographical names in accordance with the local rules. Sub-village name, called *Dusun*, of Kebondalem Lor Village is information of Geographical name that successfully obtained. There are 17 sub-village, including *Dusun* Tegal Grejegan, *Dusun* Grejegan, *Dusun* Dukuh, *Dusun* Kios Kridomulyo, *Dusun* Tegal Sono, *Dusun* Tegal Serut, *Dusun* Tegal Sempu, *Dusun* Bugelan, *Dusun* Tegal Bugelan, *Dusun* Kembangan, *Dusun* Kebondalem, *Dusun* Tempel, *Dusun* Dongok Rangkah, *Dusun* Karangjoho, *Dusun* Dengok Wetan, *Dusun* Tegal Rejo and *Dusun* Kios Dengok.

### C. *Participatory Mapping*

Fieldwork survey conducted to complete the necessary data in a village map. A fieldwork survey in this research is to plotting a public facility that aims to complement the general facility data of framework map. Other activities conducted in the village is participatory mapping. Participatory mapping aims to determine administrative boundaries and geographical features information with the participation of Kebondalem Lor Village society.

### D. *Comparison of Geographical Names*

Geographical names are collected by visual observation on the display of Bing Maps, Google Maps, Here Maps and OpenStreetMaps on the same scale. The geographical names in each service then recorded as far as the possible scale, such as district, sub-district, and village. Geographical name presented in geographic information services are different. Geographical names presented on Google Maps display are the name of the district, named Klaten District. More details of Geographical name are not presented in this information service. Geographical names presented on Bing Maps display are the village and the sub-district names. Name of the village from the study area and surrounding are also presented in this information service. In the information services provided by Bing Maps also provides the name of the sub-district, District Prambanan. On OpenStreetMaps information services, Geographical names only presented the name of the village itself and the names of surrounding villages. On Here Maps information services, Geographical names presented the name of the village and sub-district. Geographical names of the study area are presented along with the surrounding village name. From the four services information, Here Maps have more complete Geographical names than Google Maps, Bing Maps, and OpenStreetMaps as its provide Geographical names information of the level of the district to village level.

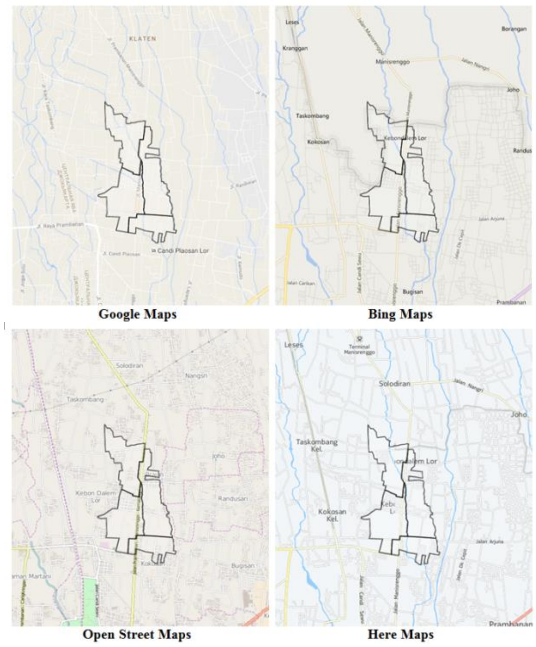


Fig. 3. Comparison of Geographical Names

## *E. Comparison of Geographical Features: Points*

Spatial data providers such as OpenStreetMaps, Here Maps, Bing Maps, and Google Maps have a different level of accuracy and completeness in presenting the geographical features. The accuracy of geographical features information is known by comparing the appearance contained in both field objects and absolute locations. Based on TABLE 1, its shows that the appearances of point object at Google Maps is more detail than others.

TABLE 1 COMPARISON OF POINT'S DATA OF GEOGRAPHICAL FEATURES

| Open Street Maps | Here Maps | Bing Map | Google Map | Data Lapangan | Koordinat | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | WebGIS | | Lapangan | |
| - | - | - | Gedung Shelter Merapi Merbabu | Gedung Shelter Merapi Merbabu | X: 445053 | Y: 9145137 | X: 445069 | Y: 9145108 |
| - | - | - | Kantor Kepala Desa Kebondalem Lor | Kantor Kepala Desa Kebondalem Lor | X: 445039 | Y: 9145546 | X: 431285 | Y: 9133216 |
| - | - | - | Pasar Nasakom | Pasar Nasakom (Kridomulyo) | X: 445022 | Y: 9145991 | X: 445072 | Y: 9145984 |
| - | - | - | MTs N Prambanan | MTs N Prambanan | X: 445120 | Y: 9145050 | X: 445105 | Y: 9145070 |
| - | - | - | SMA N 1 Prambanan | SMA N 1 Prambanan | X: 445102 | Y: 9145262 | X: 445042 | Y: 9145285 |
| - | - | - | Masjid Nuur Huda | Masjid Nurul Huda | X: 445033 | Y: 9145640 | X: 445051 | Y: 9145629 |
| - | - | - | Masjid Al Mutaqin | | X: 445316 | Y: 9145545 | X: | Y: |
| - | - | - | Masjid Nur Khasanah | | X: 445653 | Y: 9144937 | X: | Y: |
| - | - | - | Mushola Darusalam | Mushola Darusalam | X: 445103 | Y: 9145056 | X: 445096 | Y: 9145060 |
| - | - | - | GKN Betania | | X: 445514 | Y: 9145445 | X: | Y: |
| - | - | - | - | Puskemas Kebondalem Lor | X: - | Y: - | X: 445049 | Y: 9145600 |
| - | - | - | - | Paud Tetuko | X: - | Y: - | X: 445005 | Y: 9145550 |
| - | - | - | - | MAN Prambanan | X: - | Y: - | X: 444975 | Y: 9146006 |
| - | - | - | - | SD N 1 Kebondalem Lor | X: - | Y: - | X: 445031 | Y: 9145040 |
| - | - | - | - | Masjid Al Firdaus | X: - | Y: - | X: 445007 | Y: 9145954 |
| - | - | - | - | SD N 2 Kebondalem Lor | X: - | Y: - | X: 445439 | Y: 9145459 |
| - | - | - | - | Masjid Al Maulana | X: - | Y: - | X: 444987 | Y: 9144942 |
| - | - | - | - | Mushola Al Ikhlas | X: - | Y: - | X: 445374 | Y: 9144765 |
| - | - | - | - | Makam | X: - | Y: - | X: 445025 | Y: 9145630 |
| - | - | - | - | Makam | X: - | Y: - | X: 445012 | Y: 9144892 |

Sumber: Survey, 2016

The data used as reference is a building public facilities object in Kebondalem Lor Village. Based on comparisons with field data, four spatial data providers have different accuracy and completeness. OpenStreetMaps, Here Maps, and Bing Maps do not present the object of public facilities at all. Based on 20 field data, those three providers do not present any object of public facilities. The appearances of the interface include information of roads and some elements of toponyms in the study area. Google Maps has enough information by displaying some spatial data that is public facilities object. The number of public facilities presented on Google Maps as many as 10 locations from 20 locations of public facilities. The accuracy of Google Maps is good enough. Each object has accuracy of approximately 4 to 6 meters when compared with the field data.

## *F. Comparison of Geographical Features on GIServices in 1:25.000 map scale*

Presentation of Kebondalem Lor Village information in different scales in Here Maps and OpenStreetMaps are not showed significant differences (see Fig. 4). On a 1: 25,000 scale in Here Maps only contained information relating village toponym only, no information related to administrative boundaries, buildings or public facilities. Road information are only divide into collector roads and local roads, as well as the appearance of existing land cover only show some river.

On OpenStreetMaps scale 1: 25.000 view, toponym information presents the name of the main street, the name of the village and its surroundings. The building appearance only in the form of settlements blocks that became the only land cover and there are no related public facilities information contained in the study area (see TABLE 2). Road information divided into collector roads and local roads, but there is no information related to the street name. On the display at this scale, there are boundaries of the village, but not the boundaries of the study area, yet the boundary of next village.

The appearance of Bing Maps and Google Maps spatial data is on the decreased when presented on a 1: 25000 scale. Visible information in both data providers is such as road network data. Toponym element in Bing Maps are available in the study area, the street name is available only on the collector roads class remaining there are no street names. The road network is presented by symbol color and size to differentiate the grade levels. Information of administrative boundaries, buildings, public facilities, and land cover is not available. Comparison of the appearance can be seen in TABLE 3.

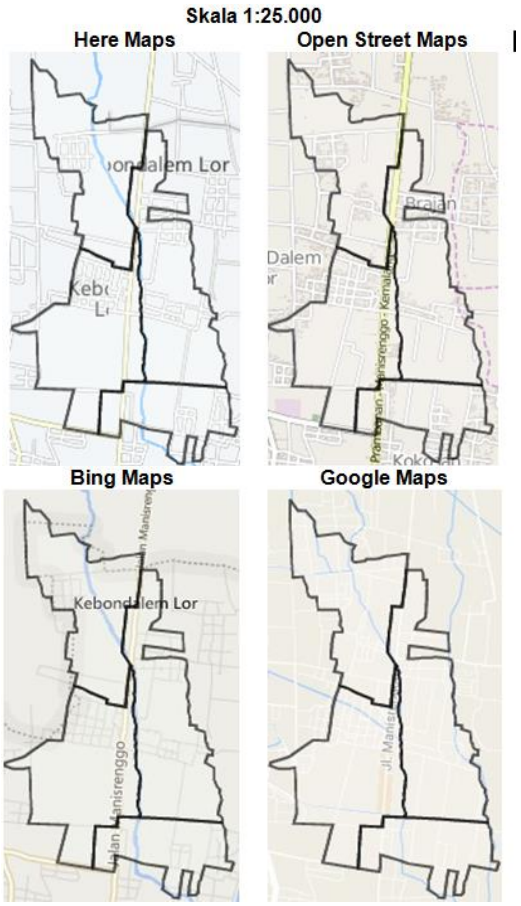


Fig. 4. Comparison in 1: 25.000 map scale

TABLE 2. COMPARISON OF HERE MAPS AND OSM IN 1:25.000 MAP SCALE

| Spatial Data Quality | Here Maps | OpenStreetMaps |
|---|---|---|
| Toponymy | Village name | Primary road name and village name |
| Built and Public Facility | None | Block of settlement and none public facility |
| Road Network | Collector and local | Collector and local |
| Land Cover | River | Block of settlement |
| Administrations Boundaries | None | Sub-district boundaries |

TABLE 3. COMPARISON OF BING MAPS AND GOOGLE MAPS IN 1:25.000 MAP SCALE

| Spatial Data Quality | Bing Maps | Google Maps |
|---|---|---|
| Toponymy | Name of study area and road name informatin at colecctor roads class | Road name information at collector roads class |
| Built and Publict Facility | None | None |
| Road Network | Road class presented by size and color | All road class presented with same symbol |
| Land cover | None | None |
| Administrations boundaries | None | None |

### *G. Comparison of Geographical Features on GIServices in 1:10.000 map scale*

Presentation in scale 1: 10:00 should present information that is more detailed than the scale of 1: 25,000, but in fact is not like that. Here Maps on display at 1: 10.000 scales just presenting information related to street names, the village name is not shown in this scale. Information related to buildings and public facilities as well have not been presented in this scale. Road information is presented on a scale ranging from collector roads, local roads and other roads but just like in the scale of 1: 25,000 there is no information related to the name of the street. The appearance of the land cover presented on this scale is rivers and administrative boundaries. Administration boundary presented surrounding village boundaries, not the study area's village boundary.

In OpenStreetMaps scale 1: 10.000 view, the presented information is similar with the scale of 1: 25.000. There is just toponym which forms the main street name and the name of the village. The presented road is divided into collector roads and local roads, but there has been no information regarding the street name. Land cover information is only settlement blocks and there is no information related to existing public facilities in the study areas. The appearance of Bing Maps and Google Maps spatial data's are decrease when it is presented on a scale of 1: 10000.

TABLE 4. COMPARISON OF HERE MAPS AND OPENSTREETMAPS IN 1:10.000 MAP SCALE

| Data Spatial Quality | Here Maps | OSM |
|---|---|---|
| Toponymy | Primary road name | Primary road name and village name |
| Built and Public Facility | None | Block of settlement and none public facility |
| Road Network | Collector road, local road and another road | Collector road and local road |
| Land cover | River | Block of settlement |
| Administrations boundaries | Sub-district boundaries | Sub-district boundaries |

TABLE 5. COMPARISON OF BING MAPS AND GOOGLE MAPS IN 1:10.000 MAP SCALE

| Data Spatial Quality | Here Maps | OSM |
|---|---|---|
| Toponymy | Road information presented collector road name and local road name | Road information presents collector road to village road |
| Built and Public Facility | None | None |
| Road Network | Road class visualized by size and color | All road class represented with same symbol |
| Land cover | None | None |
| Administrations boundaries | None | None |

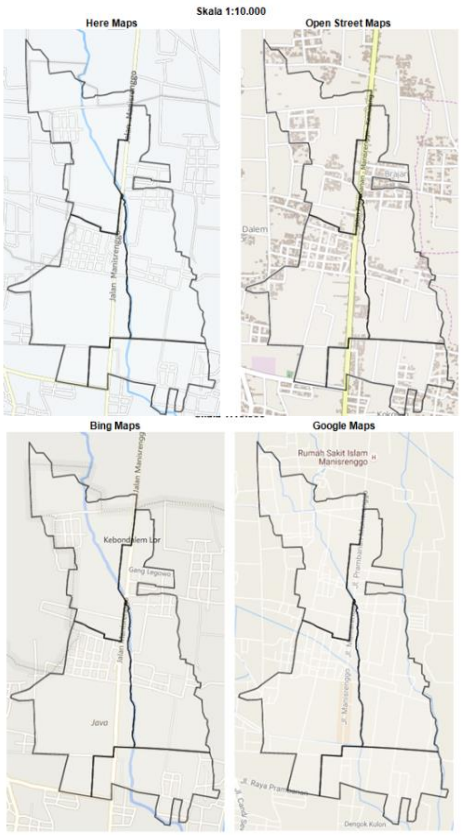


Fig. 5. Comparison of Maps in 1:10.000 map scale

### *H. Comparison of Geographical Features on GIServices in 1:5.000 map scale*

Presentation of spatial information in scale 1: 5,000 in Here Maps is similar with the presentation in scale of 1: 10.000. Toponym information is only presented the name of the main street. Buildings and public facilities information are not presented in this scale. Road information is divided into collector roads, local roads, and other roads, but there has been no information regarding the road name. Some village have its administrative boundaries, but others not.

In the OpenStreetMaps at 1: 5000 scales, presented information is almost the same as on the scale of 1: 10,000. Toponym information presented only a main road name, the name of the village is no longer presented in this scale. The building appearance presented only by settlement blocks and there are no public facilities information presented. Land cover presented well only on settlement blocks. The river is not presented in this scale while in the same scale in Here Maps they present the river. Administration boundary presented surrounding village boundaries, not the study area's village boundary.

There is just few spatial data information presented by Bing Maps on a scale of 1: 5000. Overall, it just presents the road network with a simple complexity. Toponym information of study area is not available. Toponyms are presented the road names that include collector road and local roads. The road network information presented using different colors and sizes on different road classes. The location of public buildings and facilities are not presented as well as the administrative boundaries and land cover.

Spatial data information on Google Maps as a whole presents a lot more information on the same scale. Google Maps interface looks more crowded with road network information with complexity resembles the actual appearance.

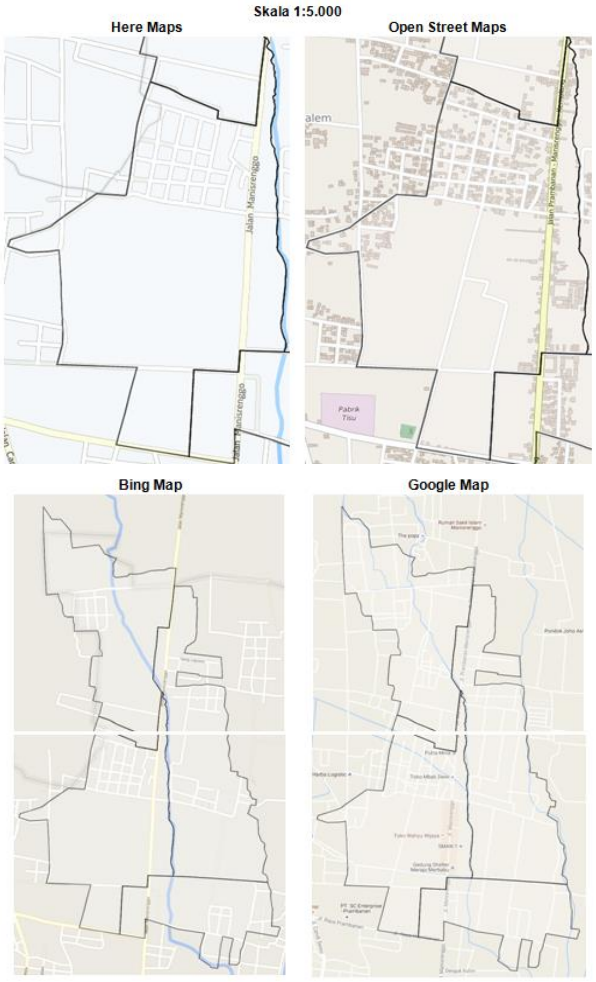


Fig. 6. Comparison of Maps in 1:5.000 map scale

TABLE 6. COMPARISON OF HERE MAPS AND OPENSTREETMAPS IN 1:5.000 MAP SCALE

| Data Spatial Quality | Here Maps | OSM |
|---|---|---|
| Toponymy | Primary road name | Primary road name |
| Built and Public Facility | None | Block of settlement and none publict facility |
| Road Network | Collector road, local road and another road | Collector road and local road |
| Land cover | River | Block of settlement |
| Administrations boundaries | Village boundaries | Village boundaries |

TABLE 7. COMPARISON OF BING MAPS AND GOOGLE MAPS IN 1:5.000 MAP SCALE

| Data Spatial Quality | Bing Maps | Google Maps |
|---|---|---|
| Toponymy | Road information presented collector road name and local road name | Road information presents collector road to village road |
| Built and Publict Facility | None | Built and public facility visualized bay communicative symbol |
| Road Network | Road class visualized by size and color | All road class represented with same symbol |
| Land cover | None | None |
| Administrations boundaries | None | None |

### *I. Comparison of Additional Tools on GIServices*

Each geographic information services provider has its own uniqueness. Generally, all information services in Here Maps, OpenStreetMaps, Bing Maps, and Google Maps has base map satellite imagery facilities as well as a navigation tool. The advantage of Google Maps and Bing Maps is possible displaying in three dimensions view. Google Maps can be used to see the road frequently traveled. Moreover, it can be used to view the location frequently visited by people. The road and location which are often passed or visited by people will be blue colored. 360-degree photos are presented using a blue round icon. Google Street View becomes an additional feature only in Google Maps. Users can feel as if they had ever been to a location. Features 'Contribution' is a feature that used to assess the visited location. Assessment can be done in the form of reviews and additional photos on the visited location. Other features called 'Timeline' feature is a feature that shows the locations that have been visited. Information filter can be done based on the desired time. While the existing facilities at the OpenStreetMaps is the editing process that can be directly through the internet browser as well as through additional JAVA based software such as JOSM. Excellence OSM facilities compared to the others is the export function into shapefile format. Users can also create framework map so that if it is done by collective, the part will not overlap.

## IV. CONCLUSIONS AND SUGGESTIONS

Based on the results of this research show that: 1) Service for the best geography information in terms of content and supporting facilities is Google Maps; 2) The best service information that can be used as an opportunity for mapping participatory with the division of framework maps and contributions of many people is the OpenStreetMaps. Suggestions from us for further research are: 1) Future studies are expected to examine the accuracy up to geometric accuracy; 2) Map users in rural societies need to be involved in the research to measure how far the use of geographic information services in the community; 3) Training with mapping materials to society need to be encouraged; 4) The need to develop an integrated system in the village, for example with a smart village.

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