Final Report

EVALUATION OF OPENSTREETMAP DATA IN INDONESIA

(Case Study: Yogyakarta, Surabaya, Jakarta, Bandung, Padang, and Dompu)

Department of Geodetic and Geomatics Engineering, Faculty of Engineering, UGM

In collaboration with

Humanitarian OpenStreetMap Team

2012

Evaluation of OpenstreetMap Data in Indonesia
- A Final Report
2012
Department of Geodetic & Geomatics Engineering, Faculty of Engineering UGM
HOT (Humanitarian Openstreetmap Team)

Evaluation Team

PI/Coordinator : Dr. Trias Aditya
Co-PI : Dr. Nurrohmat Widjajanti
Fied Coordinator : Dany Laksono, S.T.
Surveyor : Rindi Kurniati, S.T.
Maratun Solihah, S.T.
Siti Purwanti, S.T.
Burhan Sidqi, S.T. (Dompu)
Adisty Paramitasari, S.T. (Yogyakarta)
Mulya Sina Diputra

Department of Geodetic & Geomatics Engineering, Faculty of Engineering UGM
Jl. Grafika No. 2 Yogyakarta 55281 Indonesia
Telp: +62-274-6292121 Fax: +62-274-520226

Acknowledgements

The evaluation activities would not be possible without contribution and helps from agencies and colleagues in assisting filed survey and providing reference data. We thank Kate Chapman of HOT for the grant that enable us to do evaluation and her kind support during the activities. We thank following persons for their support:

- Hery Purwanto, S.T., M.Si. from Survey and Mapping Unit of Agency for Spatial Planning of DKI Jakarta for his kind support for providing the reference data for South Jakarta area
- Dr. Ir. Muhally Hakim from Faculty of Earth Science and Technology, ITB and Ir. Lulu Mulyadi (PT. Damarwuri Utama) for his kind support for providing the reference data for ITB and surrounding areas
- Miftakhul Falah and Ahmad Muhajir from ITS Surabaya, Bramantyo Marjuki, S.Si from Ministry of Public Work and Eli Junaeti, S.T. from BIG/Bakosurtanal for their support and assistance during the evaluation activities.
- Didik Mulyono, SE and Muhammad Juarsa from Plan International Program – Unit Dompu, NTB for their cooperation and assistance during the field survey in Dompu.

During the groundtruthing or field survey activities, we got a wonderful support from two companies, PT. Hydronav and PT. Adhimulya Interniaga that let us use their MobileGPS devices during our field campaign in November and Desember 2011. The two GPS units that we used were Trimble Juno SC (from PT. Hydronav) and Ashtec MM 10 (from PT. Adhimulya).

Finally, we would also like to thank to management unit and staff of the Department of Geodetic and Geomatics Engineering UGM for their backup and support.

We do hope that this report will be useful for either further reference in the utilization of OSM data in Indonesia or for improving quality assessements of OSM data or any participatory spatial data.

Yogyakarta, March 23 2012

Team Coordinator: Trias Aditya

Abstract

As a disaster-prone country, Indonesia needs any available resources to strengthen the community's resilience to disaster and post-disaster responds and reliefs. The Indonesian National Disaster Management Agency (BNPN) as the responsible agency for disaster management in Indonesia is trying to develop a national exposure dataset that provides the government and communities with up-to-date spatial information to support detailed risk modeling and post-event impact assessment. OpenStreetMap (OSM) could be one of the alternatives to provide the data freely. While OSM could provide the data needed for the systems, its data quality for risk modeling and analysis still needs to be evaluated. Thus, OSM quality assessment was executed to evaluate and report the OSM data quality in Indonesia.

The OSM quality assessements were done against OSM contest data and OSM non contest data. OSM contest data refers to the data collected by OSM mapping competition to university students in 5 cities in 2011, while OSM non contest data refers to data collected by volunteers and community members through projects. The evaluation activities were conducted in six cities known to be a disaster-prone area in Indonesia: Yogyakarta, Surabaya, Jakarta, Bandung (only for contest data), Padang (for contest and non contest data), and Dompu (for contest data). The evaluations were conducted by comparing the OSM datasets with reference dataset (from field surveys or another existing reference datasets). The methods of evaluation consist of spatial accuracy; attribute accuracy, and contributor evaluations. The spatial accuracy evaluations for the Buildings feature of OSM dataset were conducted using three measures: polygon areas, circularity ratio, and centroid near-distance analysis, while the evaluations for Roads feature from OSM dataset were evaluated using Buffer-overlap and Line-Length Completeness analysis. The contributor evaluation examines the amount of each contributor's participation and its spreading relative to the study area. The results of each method were statistically tested using t-test with 90% confidence interval to obtain the overall qualitiy of the OSM datasets.

The results of the evaluation of spatial accuracy showed varied quality from city to city. In this regard, data quality is regarded from "very bad" to "very good". Majority of the data shows an acceptable quality within the confidence interval tests. The attribute quality showed a high number of empty records (such as building's name or level) in each city, with some of the records shows

wrong attribute values compared to the real conditions. The contributor evaluations indicated that each participant tends to input the data in a specific or clustered areas, such as around Campus or official buildings.

Contents

List of Figures

List of Tables

I. INTRODUCTION AND DEFINITION

I.1. OpenStreet Map (OSM)

a. *Background*

OpenStreet Map (OSM) is a collaborative project to create a free editable map of the world. Two major driving forces behind the establishment and growth of OSM have been restrictions on use or availability of map information in many places across the world and the rise of low-cost portable GPS devices.

The Humanitarian OpenStreetMap Team (HOT) in partnership with the Australia-Indonesia Facility for Disaster Reduction helps BNPB in a pilot to determine ways to collect exposure information utilizing OSM in order to support detailed risk modeling and assessments. The pilot includes the 2011 OSM student competition and participatory mapping to selected areas e.g., Padang and Sumbawa.

The Indonesian National Disaster Management Agency (BNPB) needs up to date exposure data to contribute to risk modelling and post-event impact analysis. In particular, BNPB is trying to develop a national exposure dataset that provides government and communities with the base information that they need on:

1. where people live
2. the construction type of public and private buildings
3. the location and characteristics of key infrastructure

Quality has been a raising issue when OSM is introduced to BNPB and national stakeholders. Thus, OSM Quality assessments for OSM Contest data need to be checked and reported.

b. *Objectives*

The quality evaluation/assessments were done in order to determine OSM data quality in Indonesia.

1. Specific Objectives:
    - To assess spatial accuracy of the OSM contest data in 5 cities and non OSM contest data for at least two areas.
    - To assess shape/feature matching of the OSM contest data in 5 cities and non OSM contest data for at least two areas.
    - To assess attribute accuracy and attribute completeness
    - To evaluate data completeness
2. Additional benefits:
    - To evaluate contributor roles
    - To collect lessons-learned OSM Quality assessments for OSM Contest data need to be checked and reported

c. *Scope of evaluation*

As mentioned in the objectives, the quality asessments of OSM were done into two sets of data:

1. The OSM contest data in five cities: Yogyakarta, Surabaya, Jakarta, Bandung and Padang
2. The OSM non contest data in two areas : Padang (west Sumatera) and Dompu (West Nusa Tenggara)

The quality assessments were done through field survey and data processing/studio work from November 2011 till March 2012. The scope of accuracy assessments include planimetric accuracy, area precision, and shape matching/precison as well as attribute accuracy. First, we start to introduce terms we used.

Absolute planimetric accuracy:

"Absolute planimetric accuracy is defined as the mean value of the positional uncertainties for a set of positions where the positional uncertainties are defined as the distance between a measured position and what is considered as the corresponding true position" (Source: INSPIRE Building Unit Data Specification 2012).

Related methods that were used to assess planimetric accuracy are: **polygon near distance**, **line buffer overlap analysis**, and **line completeness**.

The area precision:

"Statistical analysis on the difference of the building area derived from OSM with the corresponding buidling area derived from satellite images".

The related method that was used to assess area precision is ***polygon area***.

The shape precision:

"Statistical Analysis on the difference of the shape or coordinates of building footprints".

The related method that was used to assess shape precision is ***circularity ratio***.

Attribute accuracy:

"Statistical analysis on the quality of attribute data".

In this project, attribute accuracy assessements were to evaluate the attribute values entered by contributors.

The following section will discuss relevant methods used to evaluate OSM data in the project.

I.2. Literature Review

Ying, et. al. (2010) used circularity as one of the criterion to determine a polygon's shape complexity. The OSM data were evaluated with shape complexity measure for each object in the data. From these measures, an overall complexity score is calculated. If the score is above a pre-defined threshold, the data is then simplified. The study also used polygon area as one of the shape measures to classify the complexity of the polygon, together with some other descriptors.

The use of circularity as shape descriptor is also suggested by Rumor (1996). Circularity is one of the shape descriptors among Compactness Ratio, Radius Ratio, Eccentricity,

Elongatedness, and so forth. The circularity function is tightly connected to the polygon's boundary. The more convoluted the boundary, the more the circularity will approach zero.

A polygon to polygon comparison could also be conducted using nearest distance of its centroids. The JCS conflation suite (http://www.vividsolutions.com/jcs/) provides an API suite of interactive tools within the JUMP mapping platform. One of the features is polygon matcher tools which perform a one-on-one comparison. The comparison is based on several variables. One of the matching variables is centroid distance, which calculates the distance between two centroids of the polygon compared, in order to assess their spatial displacement.

Kounadi (2009) in her dissertation discuss about road accuracy evaluation of OSM line feature. The evaluations were conducted using the script built in MapBasic environment to automatically calculate line buffer overlap of adjacent road feature. An analysis is also conducted to assess the name and length completeness of roads feature, as well as the accuracy of road attribute data from OSM dataset. The reference is HMGS dataset in scale 1:10.000.

I.3. Methods of Evaluation

A. Reference and Evaluated Data

i. Reference Data

a. Existing Maps of the Area of Study

The main resource for reference dataset is any existing high-scale maps in the area of study, in form of topographic maps, city-planning maps, and so forth. The data, if available, usually came in form of vector data (i.e. in Autocad or Shapefile format), and were obtained from official bureaucracy in each city. Another form of the data is scanned topographic maps. This type of data needs to be digitized before the data could be used in comparison.

b. BING Satellite Imagery

Microsoft's BING High-Resolution satellite imageries are available in big cities in Indonesia and are quite up to date. The use of imagery in this study would fill the lack of reference data available in Indonesia.

The satellite imagery data is manually digitized in corresponding feature of OSM's buildings and roads data to perform vector data comparison. Thus, the highest resolution available in each city was used in the process of digitations.

c. Field Measurements

Field measurements were conducted using Mobile GPS/GIS device that could achieve accuracy up to sub-half meter using post-processing and up to 3-5 meter for real-time. The measurements were done to OSM buildings data by measuring the corner of each corresponding buildings as their exact conditions in real world. The results of measurements using Mobile GIS were shapefiles of the buildings that could be directly compared with the data from OSM dataset.

ii. OpenstreetMap as Evaluation Data

The evaluated datasets were the data from OpenStreet Map contributors, whether it is a contest data or non contest data. The contest data is the shapefile data that was uploaded by the participants in OpenStreet Map competition, held in some cities in Indonesia, while the so-called non contest data is the shapefile data downloaded directly from openstreetmap via Cloudmade (http://www.cloudmade.com) or Geofabrik (http://download.geofabrik.de).

B. Evaluation methodology

i. Evaluation method for Polygon Feature

a. Polygon Circularity Ratio

Circularity Ratio, among others, is a commonly used shape descriptor. Circularity ratio described as a measure of the convolutedness of a polygon's boundary (Rumor, et. al., 1996). The more convoluted the polygon's boundary, the more the Circularity Ratio will approach zero. The Circularity Ratio is a function of polygon's area and perimeter, and calculated as: $(4\pi \times \text{Area})/\text{Perimeter}^2$.

Circularity Ratio is an important shape characteristic with its value lies between 0 and 1 (Ying, et. al., 2010). A polygon with its Circularity Ratio close to 0 has a convoluted shape, and vice versa. For example, a polygon with circularity ratio of 0.5 has a closer shape to a circle than another polygon with circularity ratio of 0.01. In short, circularity has a close relationship to the polygon's shape and nodes number:

the bigger the number of polygon's node (and therefore the side), the more the polygon look like a circle and the more the circularity is close to 0 (Roussilon, 2007).

b. Polygon Near Distance

To assess the spatial displacement between the reference and evaluated data of polygon features, a method is developed to calculate the distance between the centroid of both the features. A simple approach to retrieve proximity of the polygons is to use the coordinate of its centroid and calculate the distance to its matching polygon in another dataset (Gregory and Ell, 2007).

Centroid defined as the point at the geographical centre of a polygon (Gregory and Ell, 2007). The use of centroid to represent a polygon in near distance calculation will simplify the calculation. Using this method, the closer the distance between two centroids means the higher the accuracy of evaluated dataset.

c. Polygon Area

Since circularity evaluation is insensitive to scale change, another method of evaluation is needed to assess the size discrepancy between reference dataset and evaluated dataset. A simple method is to use another polygon descriptor, polygon area (Rumor, et. al., 1996).

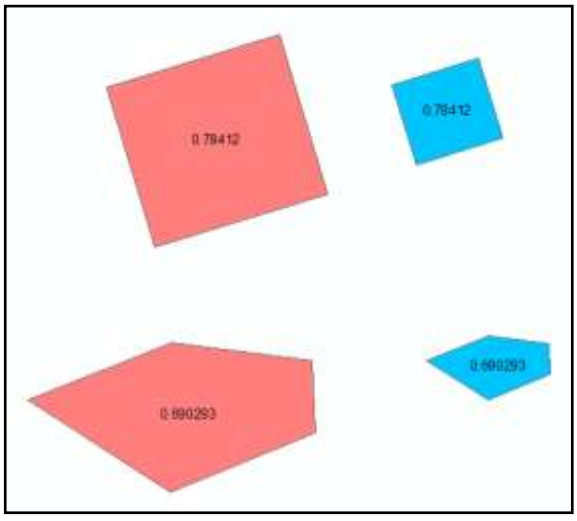


Fig I. 1. Same Circularity Ratio between two sets of polygon feature, despite of their difference in size and area

By assessing the differences between the two polygon datasets, a measure of accuracy could be obtained. A smaller area difference means that the evaluated dataset is similar to the reference dataset. If the circularity difference is also small (i.e. the shape is identical), then it means that the evaluated dataset is close in its geometric properties to the reference dataset.

d. Test Case for Polygon Comparison Methods

In order to obtain reasonable comparison methods, a test case is conducted with sample reference and evaluated data. The reference and evaluated data were made with slight to big difference; hence the results could be compared with its real condition. The test case is conducted as follows:

The reference and evaluation datasets were then calculated to obtain circularity, area and near distance difference. The results of calculation were then classified and given a score for each method. Score values for near-distance method were given twice bigger than other methods, with consideration that spatial discrepancies were more important. The results of the comparison are presented in the table below:

Table I. 1. Calculation of Comparison Results

No	ID_ Sample	Circularity Comparison		Area Comparison		Circularity Diff	Area Diff (m^2)	Near Distance (m)
		Reference	Evaluated	Reference	Evaluated			
1	Case1	0.488787	0.488787	561.222801	561.2228012540	0	0.000	9.948
2	Case2	0.488787	0.632658	561.222801	521.0452000420	0.143871	40.178	1.853
3	Case3	0.488787	0.589381	561.222801	500.0502556640	0.100594	61.173	1.096
5	Case4	0.488787	0.684763	561.222801	197.2568126190	0.195977	363.966	10.177
4	Case5	0.488787	0.602178	561.222801	182.6494091600	0.113392	378.573	18.340
6	Case6	0.488787	0.697440	561.222801	70.4557067742	0.208653	490.767	14.024

The scoring of each comparison methodology is conducted as follow:

Table I. 2. Circularity Difference Classes

Interval		Frequency	Quality	Score
0	0.041731	1	Very Good	25
0.041732	0.083461	0	Good	20
0.083462	0.125192	2	Medium	15
0.125193	0.166922	1	Bad	10
0.166923	0.208653	2	Very Bad	5

Table I. 3. Area Difference Classes

Interval		Frequency	Quality	Score
0	98.153419	3	Very Good	25
98.15342	196.306838	0	Good	20
196.306839	294.460257	0	Medium	15
294.460258	392.613676	2	Bad	10
392.613677	490.767094	1	Very Bad	5

Table I. 4. Near-Distance Classes

Interval		Frequency	Quality	Score
1.095643	4.544563	2	Very Good	50
4.544564	7.993483	0	Good	40
7.993484	11.442403	2	Medium	30
11.442404	14.891323	1	Bad	20
14.891324	18.340244	1	Very Bad	10

The final score are calculated as the total of circularity, area, and near-distance. The final score is:

Table I. 5. Calculation of Final Score

No	ID_Sample	Scoring			Final Score
		Circularity	Area	Near-Dist	
1	Case1	25	25	30	80
2	Case2	10	25	50	85
3	Case3	15	25	50	90
5	Case4	5	10	30	45
4	Case5	15	10	10	35
6	Case6	5	5	20	30

The result of the test case is presented below:

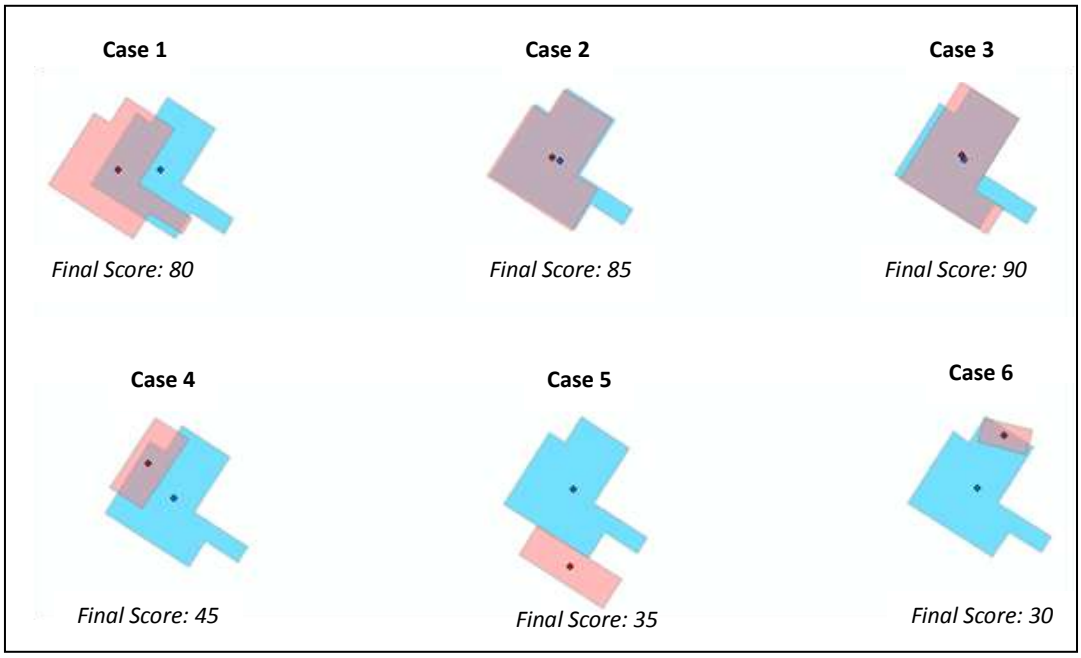


Fig I. 2. Test sample case of evaluation method

The results show that the final score are comparable to the visual appearance of the datasets. An unusual result is in sample case2 and case3, where final score in case3 is higher than the final score in case2. This result is caused by the weighting of near-distance method, which is twice the weight of circularity and area comparison.

ii. Evaluation method for Line Feature

a. Line Buffer Overlap Analysis

The buffer overlap analysis test the spatial position of line data of OSM feature (particularly, roads data) with the reference data of the same line feature (i.e. the same road) within a tolerance value. The tolerance values were in form of buffer zone outside the roads feature with a particular value representing the road's width.

The percentage values were calculated for each of the roads network. The analysis also aimed to reveal the relationship between the positional accuracy and the road type (Kounadi, 2009), and this was applied when the attribute data of road classes were available.

b. Line Completeness

The length completeness was calculated as the percentage of the dataset line feature's length to the reference dataset's length (Kounadi, 2009). The evaluations were carried out for each study area in grids. The final results were presented in form of grid's color, with darker grid color represent a more complete road feature in that particular grid.

iii. Attribute Accuracy

The attribute accuracy evaluation is performed to assess the quality of attribute data in OSM dataset. The evaluated fields were the same as the attribute data of OSM dataset, which were (1) name, (2) structure, (3) roof, (4) walls, (5) level, and (6) use. Each of the evaluated fields is scored with the criteria:

1. No data or misattributed data : zero (0) score
2. Suitable attribute data with the real world condition : 1

The results of the scoring were then summarized with maximum score of 6 for each of the record. The overall results of the evaluation were then classified into 3 classes which picture the completeness, availability and the accuracy of the OSM attribute data, which were: Good (total score: 5-6), Medium (total score: 3-4) and Bad (total score: 0-2).

The attribute were also evaluated to show the amount of the empty records in OSM attribute data. For each field, the sum of filled data were compared with the empty data and visualized in graphic chart view.

iv. Contributors Evaluation

Contributor evaluation method were conducted to show the amount and spreadness of each OSM contest contributors in a study area, while assessing the tendency of each contributors in OSM data input. Evaluations were done using spatial statistics methods, which consisted of:

1. *Frequency*, to assess the amount of data inputted from each contributor by person
2. *Standard Distance*, to inquire the tendency of data input from each contributors relative to the envelope of whole data in a study area
3. *Average Nearest Neighbour*, performed to check whether the spreadness of the data were clustered, random or dispersed.

C. Instrument Used for Evaluation

i. Ashtech Mobile Mapper 10

Ashtech Mobile Mapper 10 is a mobile GIS device that able to log coordinate data in real-time and post-processed accuracy. The device could directly record the coordinate as shapefiles (*.shp) data, which are compatible with wide range of GIS software. The accuracy of the data could be achieved to sub half-meter accuracy with post-processing, while the real-time accuracy could be achieved up to 1-2 meter with SBAS mode. Mobile Mapper 10 (will be called MM10 from this on) works on GPS L1 Frequency with 20 satellite channels.

ii. Trimble Juno SC

The Juno® SC handheld is a durable, lightweight field computer that integrates an array of powerful features. The device provides photo capture, cellular data transmission, and GPS receiver with 2 to 5 meter positioning accuracy in real time or 1 to 3 meter post-processed data.

Fig I. 3. Ashtech Mobile Mapper 10 (left) and Trimble Juno SC (right)

II. IMPLEMENTATIONS

II.1. Definition of Area of Study

The areas of study in this data validation for the purpose of OpenStreetmap evaluation covers the six cities in Indonesia, i.e. Yogyakarta, Surabaya, Jakarta, Bandung, Padang and Dompu. Each city consists of area of interest (AOI) with the district's area as its boundary. Below are the AOIs from each city:

a) City of Yogyakarta, DIY

Yogyakarta is the capital city of Daerah Istimewa Yogyakarta with an area of 32,5 km². The area of Yogyakarta City is located between 110° 24′ 19″ to 110° 28′ 53″ E and 7° 15′24″ to 7° 49′26″ S with an average altitude of 114 m above sea level. The city was infamous for its preserved Javanese culture and fine art, as well as its tight connection with the history of Indonesian Independence. Many Dutch colonial-era buildings could be found in this city. Yogyakarta is also well-known as international and local tourist destination, with the tourism objects ranging from natural landscape to a shopping center. Also, the main building of The Sultanate of Yogyakarta ("Keraton") could be found in the center of the city.

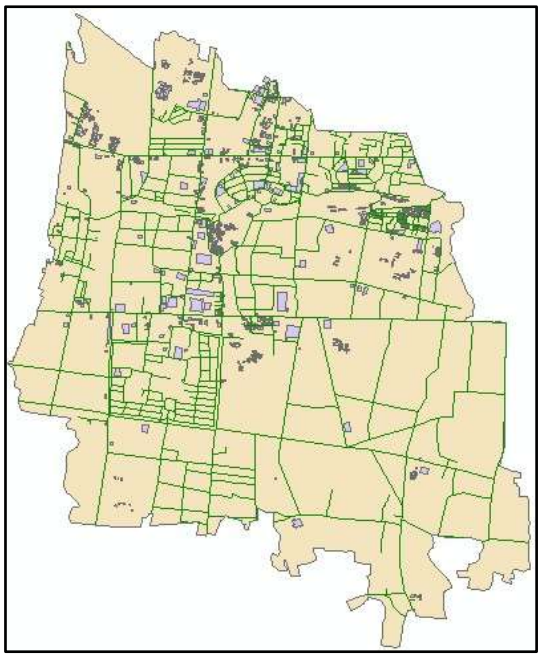


Fig. II. 1. OSM dataset in Yogyakarta

Yogyakarta is a disaster-prone area with the border of Australian and Eurasian plate in the southern of the city and the active Mount Merapi in its north. Thus, tectonic and volcanic activities in this area are relatively high, and due to the dense population of the city, the risks of victims being affected by the disaster are very high.

The OSM competition was held in this city at July-August, 2011, with the total of contributed data is 6441 buildings data and 812 roads data in Yogyakarta city alone.

b) Surabaya, East Java

Surabaya is the second largest city in Indonesia, and the capital of the Province of East Java. Surabaya has an area of 333 km^2, with the average elevation between 3-6 meters above the sea level. This city is renowned as the main seaport and commercial center in eastern region of Indonesia, with some skyscrapers being its identifiable landmark. Being 'the city of heroes' with tight connection to Indonesian independence struggle, this city still left some of the old war-era buildings amidst the newly built ones. Surabaya is also the home for some major universities, including Institut Teknologi Surabaya (ITS) and Universitas Airlangga (Unair). The OSM contest data in this city are mostly clustered around these universities, with the amount of 3866 buildings and 1328 roads data.

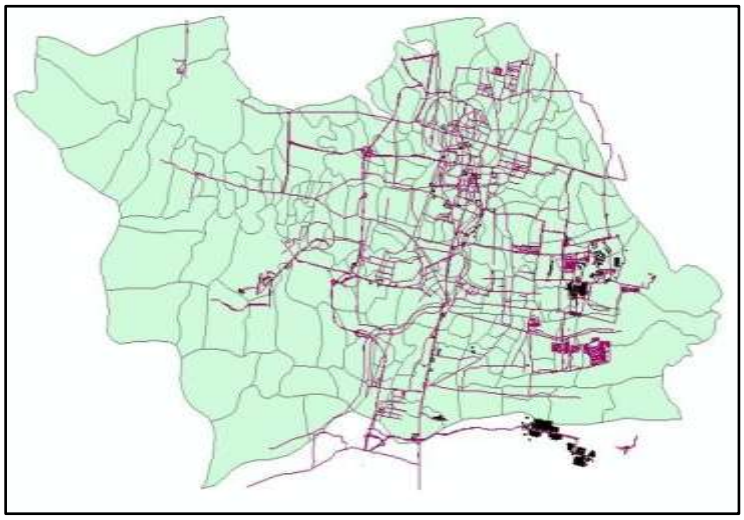


Fig. II. 2. OSM dataset in Surabaya

c) Southern of Jakarta, DKI

Jakarta is the capital of Indonesia and also its biggest and busiest city. A lot of high-rise buildings could be found easily in Jakarta, whether as government buildings, office area or

shopping center. Jakarta's area is about 661 km^2 with an average elevation of 8 meters above the sea level. Jakarta is divided into 5 Kotamadya, namely Central Jakarta, West Jakarta, South Jakarta, East Jakarta, North Jakarta, and 1 regency, Kepulauan Seribu. South Jakarta, with a total area of 141 km^2, is an official center, as well as shopping centers and residential area. With regards to technical and bureaucracy limitations, the OSM evaluation survey were conducted in South Jakarta alone, with 4264 buildings data and 5163 roads data from OSM dataset.

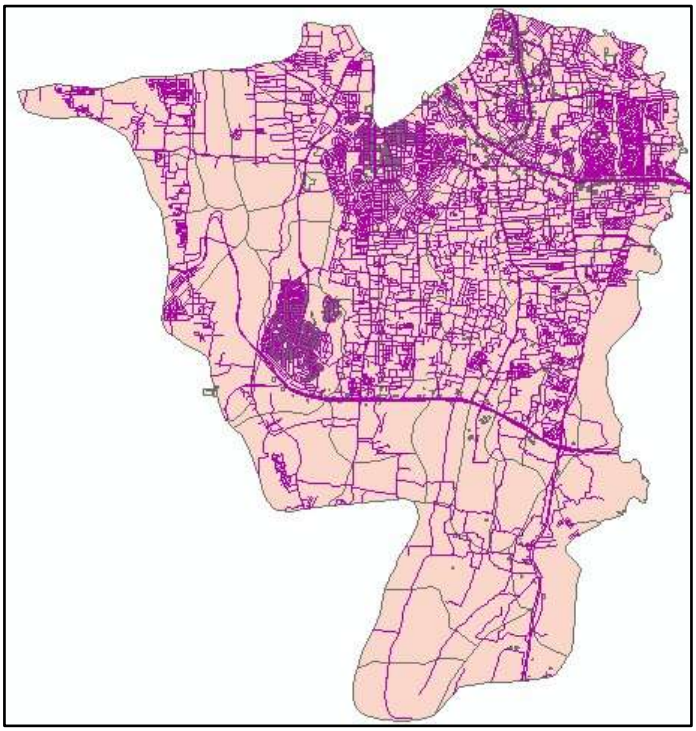


Fig. II. 3. OSM dataset in Jakarta

d) Bandung, West Java

Bandung is the capital of West Java province. Situated 768 meters above sea level in average made this 400 km^2 city has cooler temperature than most other cities in Indonesia. As any other big city in Indonesia, Bandung, or the *Paris van Java*, has a lot of Dutch-colonial buildings which was still stand up to this day, characterized with their unique architectural design. Bandung is the home for Institut Teknologi Bandung (ITB), one of the major universities in Indonesia, as well as many others. The OSM contest data in this city is 1593 buildings data and 1455 roads data.

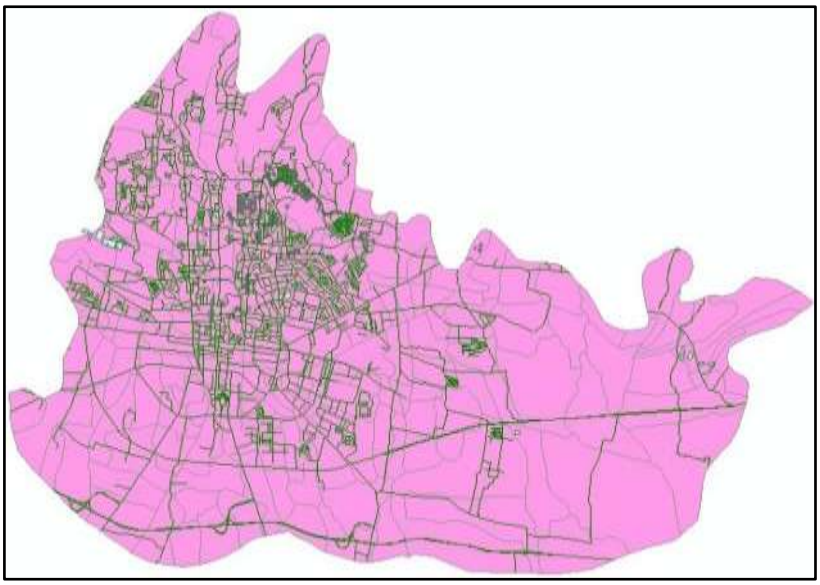


Fig. II. 4. OSM dataset in Bandung

e) Padang, West Sumatera

Padang is the capital and the largest city in West Sumatra province. It is located on the western coast of Sumatra Island at 0°57'0"S and 100°21'11"E, with an area of about 694 km^2. Situated just above the tectonic fault put Padang as a disaster-prone area, specifically from earthquakes and tsunamis. On September 30th, 2009, a 7.6-magnitude earthquake hit about 50 kilometers off the coast of Padang, caused more than a thousand casualties. The major university in this city is Universitas Andalas (Unand), together with many other universities. The OSM data in this city consist of 4454 buildings data and 749 roads data.

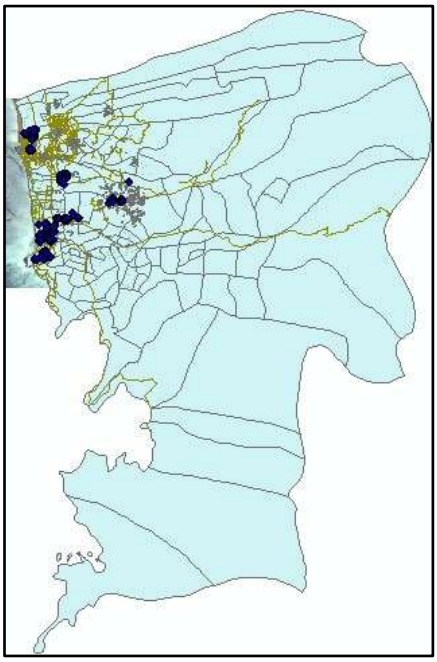


Fig. II. 5. OSM dataset in Padang

f) Dompu, Nusa Tenggara Barat

Dompu is a regency in the province of West Nusatenggara. It is located on the island of Sumbawa, with total area of 2321 km^2, with an average elevation of 100-500 meters above the sea level. Dompu has a tight culture connection with Bima and Sumbawa, with its house characteristics as rumah panggung. The OSM data in this city are 1861 of buildings and 435 of roads data.

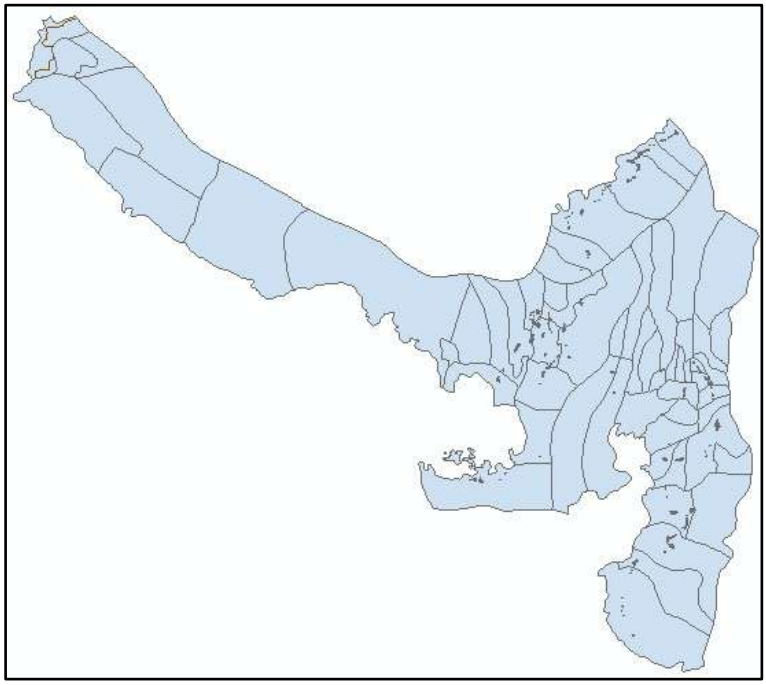


Fig. II. 6. OSM dataset in Dompu

II.2. Preparation of the datasets

The datasets prepared consists of two types of data, namely evaluation datasets and reference datasets.

1) Evaluation datasets (OSM datasets)

The evaluation datasets were OpenStreet Map data, which categorized into contest and non-contest datasets. The so-called "contest/competition datasets" were data from OSM's contest (namely, *The OpenStreetMap Mapping Competition*) which held in some cities in Indonesia on July-August 2011. Data layers in the competition were classified into Buildings, Roads, Waterways, Railways, Natural, Landuse, and Points of Interests. This evaluation only focused on the Buildings

and Roads layer from OSM datasets, for this two data layers have the most abundant data records compared to the others. The shapefile of this OSM datasets were downloaded from http://data.kompetisiosm.org/, and were subsequently clipped with the boundary of each city's AOI.

The non-competition datasets were the OSM's datasets as shown on http://www.openstreetmap.org/. The shapefiles of the datasets were obtained from *Cloudmade* (http://downloads.cloudmade.com/) or *Geofabrik* (http://download.geofabrik.de/osm/).

Table II. 1. Summary of competition dataset in evaluated cities

No	Cities	Number of Buildings	Number of Roads
1	Bandung	1593	1455
2	Jakarta	4264	5163
3	Surabaya	3866	1328
4	Yogyakarta	6441	812
5	Padang	4454	749
6	Dompu	1861	435

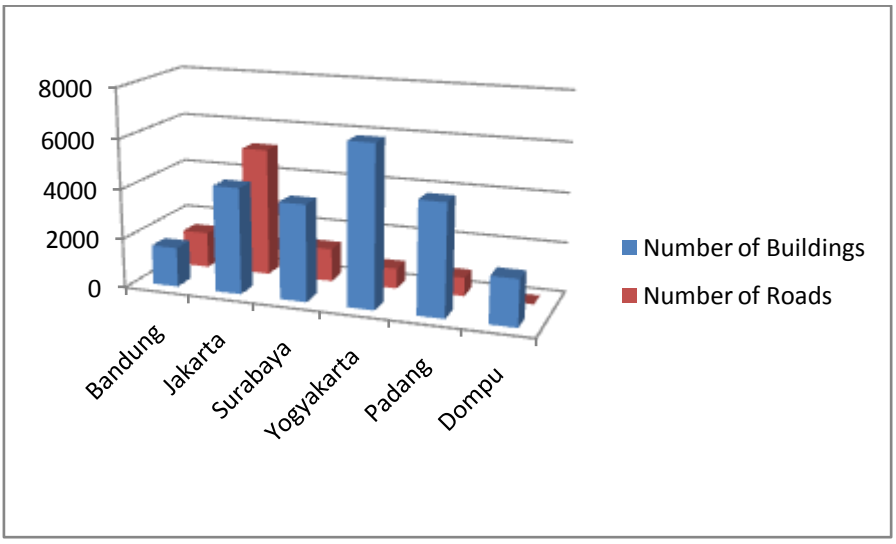


Fig. II. 7. Quantity of competition dataset all city

Table II. 2. Summary of non-competition datasets in evaluated study

No	Cities	Number of Buildings	Number of Roads
1	Bandung	1603	2197
2	Jakarta	4258	5166
3	Surabaya	1283	2416
4	Yogyakarta	2091	478
5	Padang	23313	4076
6	Dompu	11560	718
Number of Data		44108	15051

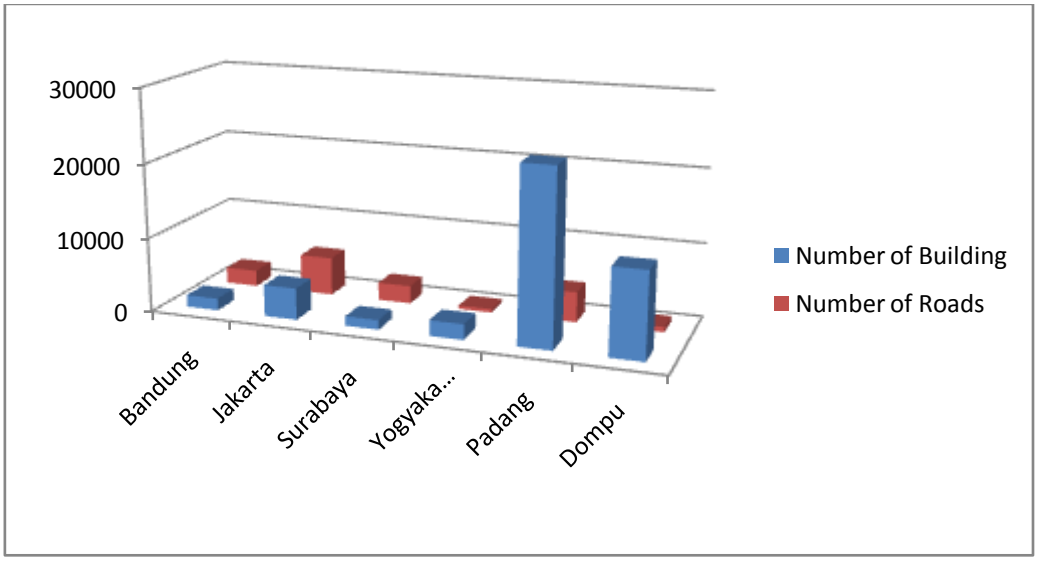


Fig. II. 8. Quantity of non competition dataset all city

2) Reference dataset

Evaluation datasets were then compared to the reference dataset using pre-mentioned methods of evaluation. The reference datasets were in form of existing maps of the study area (whether a topographic map, city-planning map and such), satellite imageries, and field measurements. The reference datasets for each city in study area are given below:

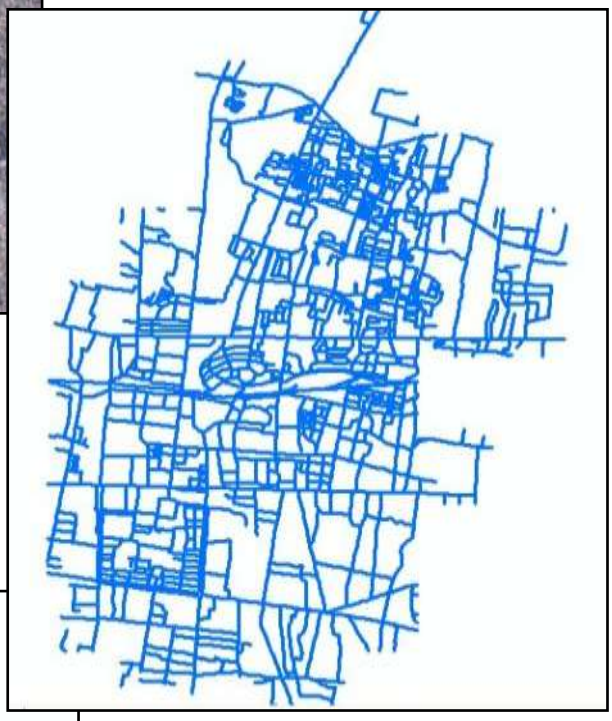
1. *Yogyakarta, DIY*

Bing Imagery of Yogyakarta

Image Resolution: 0.6 m

Data provider :Microsoft Bing

Data Acquisition: 2009

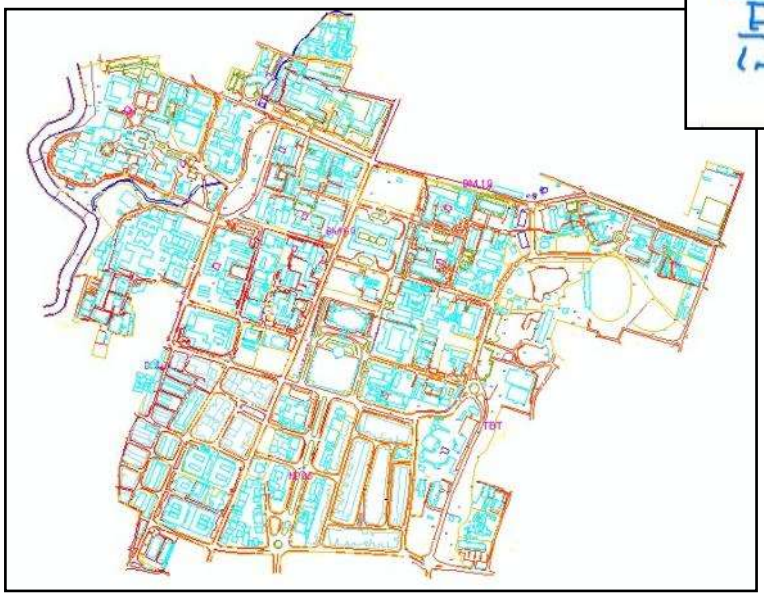


Yogyakarta Road Network

Scale : 1:5000

Data provider :Ministry of Public Works (DPU)

Data Acquisition: 2007



Field Measurements

Scale : 1:5000

Data provider : Department of Geodetic Engineering (UGM)

Data Acquisition : 2006

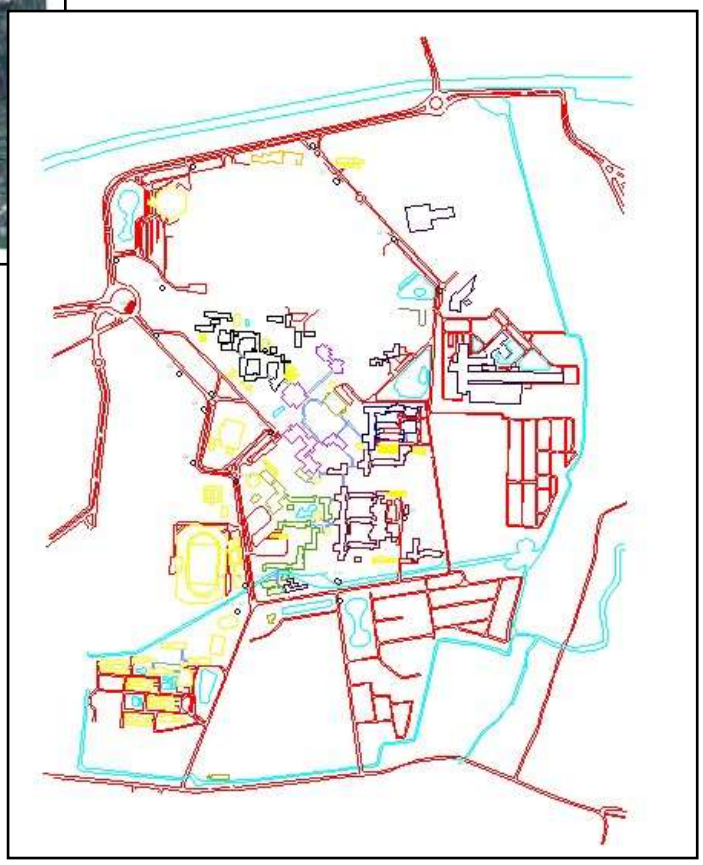
2. Surabaya, East Java

Bing Imagery

Image Resolution :0.6 m

Data provider : Microsoft Bing

Acquisition Date: 2010

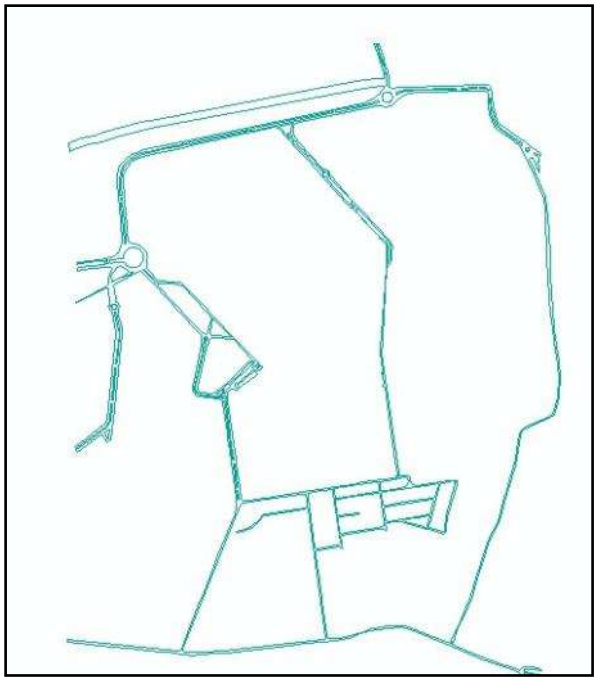


Satellite imagery digitation (Quickbird)

Image Resolution :0.6 m

Data provider : Department of Geodetic Engineering (ITS)

Acquisition Date: 2008

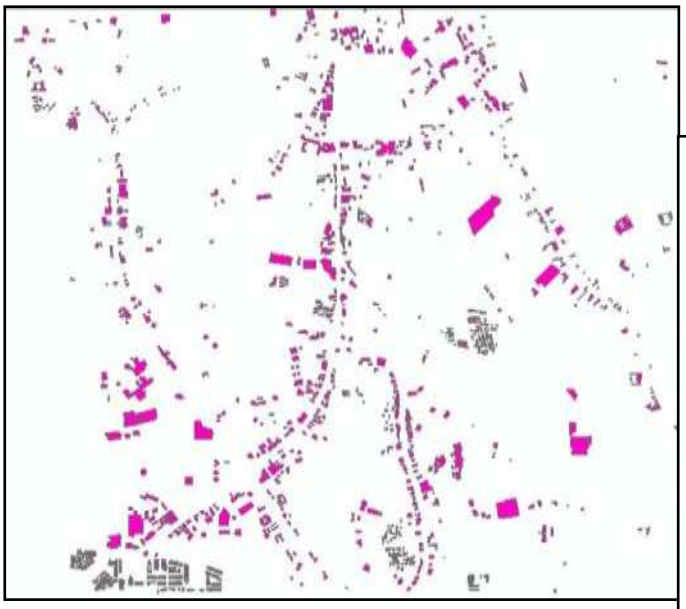


Satellite imagery digitation (Quickbird)

Image Resolution :0.6 m

Data provider : Department of Geodetic Engineering (ITS)

Acquisition Date: 2008

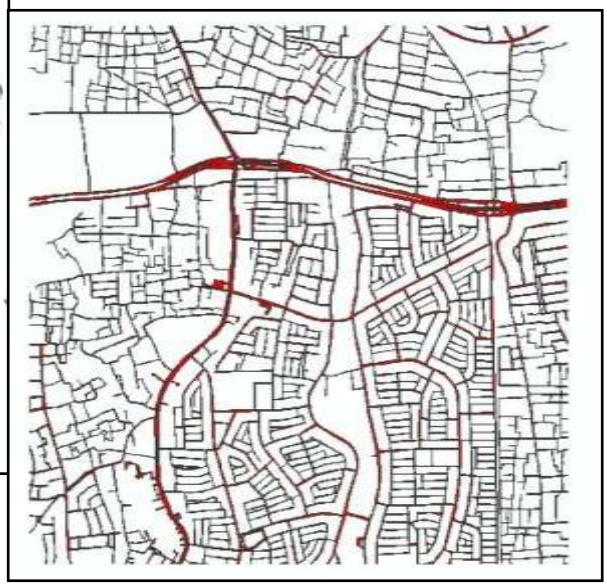


Topographic Map of Jakarta

Scale 1:5000

Data provider: Department of City Planning of Jakarta

Data Acquisition: 2008



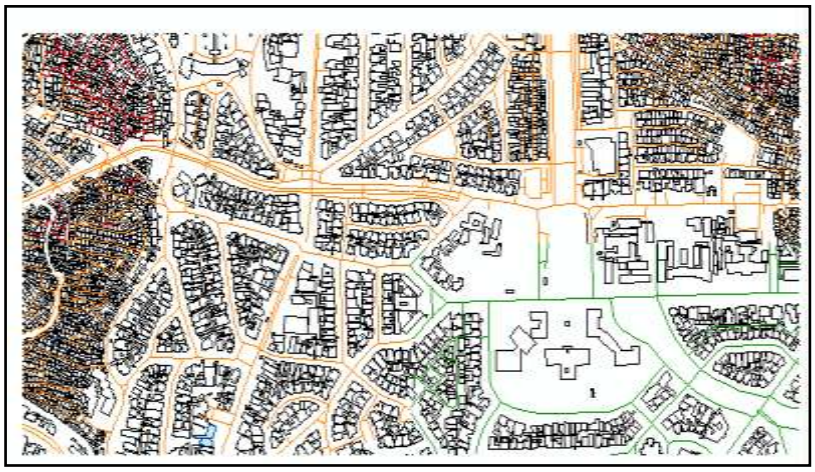
Road Network of Jakarta

Scale 1 : 5000

Data provider : Department of City Planning Jakarta

Data Acquisition:2008

4. Bandung, West Java

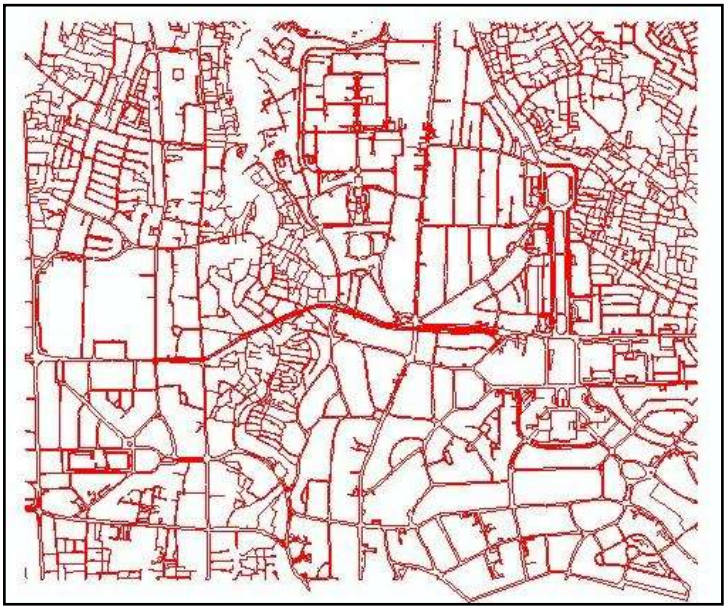


Bandung High Scale City-planning Map

Scale 1:1000

Data provider :Department of Geodetic Engineering (ITB)

Data Acquisition: 2008



Road Network of Bandung

Scale : 1:1000

Data provider :Department of Geodetic Engineering (ITB)

Data Acquisition: 2008

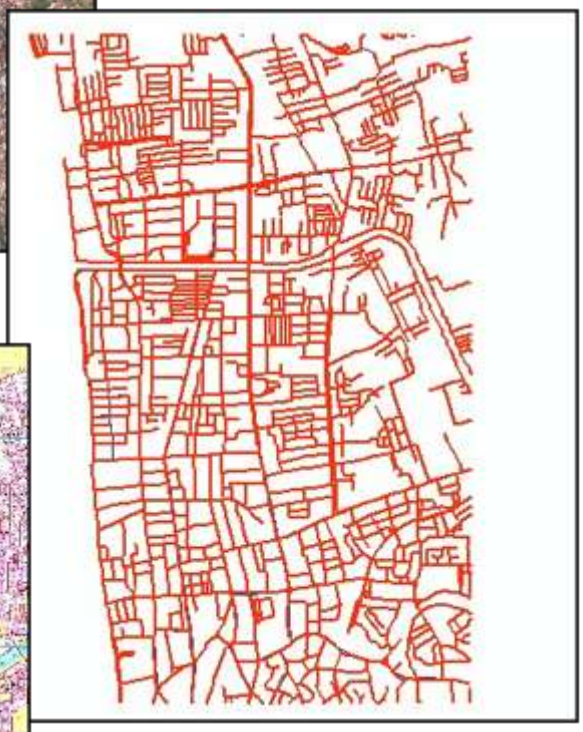
5. *Padang, West Sumatera*

Bing Imagery of Padang

Image Resolution :0.6 m

Data provider :Microsoft Bing

Data Acquisition:2010



Road Network from Topographic Map Digitation

Scale : 1:10000

Data provider :National Coordination Agency for Survey and Mapping (Bakosurtanal)

Data Acquisition :2008

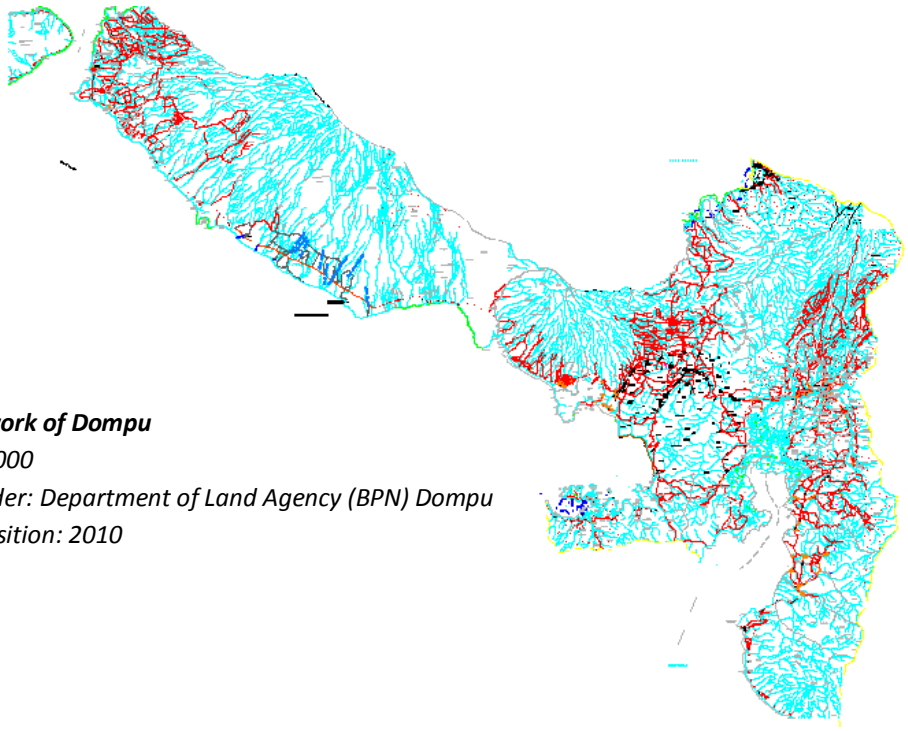
Topographic Map of Padang

Scale : 1:10000

Data provider :National Coordination Agency for Survey and Mapping (Bakosurtanal)

Data Acquisition :2008

6. *Dompu, Nusa Tenggara Barat*



Road Network of Dompu
Scale 1: 25000
Data provider: Department of Land Agency (BPN) Dompu
Data Acquisition: 2010

Bing Imagery of Dompu
Image Resolution: 0.6 m
Data provider: Microsoft Bing
Data Acquisition: 2008

II.3. Sample selection

A sample is a subset of data selected from the population, i.e. all possible measurements that can be made on particular items or procedure (Ghilani, 2010). In this case, the population is the whole competition dataset in the study area. Since the number of the OSM data in each city is very abundant, it is highly unlikely to perform a field survey to all of the data. Thus, some samples were selected from the population to reduce the number of data to be measured, and simplify the evaluation processes.

To calculate the sample size from OSM data in each city, a formula proposed by Isaac and Michael (1981) was used. The sample size was measured by:

1) Define the initial number of population from the dataset (N)
2) Define the chi-square value (χ^2) for N-sized data with selected margin of error (1%, 5% or 10%) according to the Chi-Square table.
3) Calculate the sample size using the formula (Krejcie and Morgan, 1970):

$$s = \frac{\chi^2 . N . P . (1 - P)}{d^2 . (N - 1) + \chi^2 . P . (1 - P)}$$

With χ^2 = table value of Chi-Square @ d.f. = 1 for desired confidence level

N = Population size

P = Population proportion (assumed to be .50)

d = degree of accuracy (expressed as proportion)

The calculated sample size (s) is then used as the number of the OSM feature dataset that should be evaluated by field measurement in each city. As the field measurements were depended by various conditions, this sample size is often hard to achieve. Thus, a smaller sample size is applied in condition where the ideal number of sample size is hard to obtain.

II.4. Accuracy analysis

The accuracy analyses were performed to spatial and attribute analysis with each corresponding statistical t-test analysis.

Spatial Accuracy

II.4.1.1 Building Analysis

1). Near-distance analysis

Near-distance methods calculate the closest distance between two centroids of the reference and evaluation buildings dataset. The smaller the displacement between the tested polygons, the closer the near-distance value is to zero. Steps conducted in ArcGIS to calculate the near-distance analysis are as follows:

- Calculate the sample size of the whole building data in AOI. The sample size calculation is based on the formula by Isaac and Michael as mentioned before.
- Choose the buildings feature from OSM dataset which were overlap the sample from reference dataset.

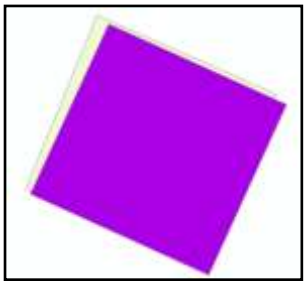


Fig. II. 9. Overlapped OSM and reference dataset

- Find the centroid for each polygon (building) feature in evaluation and reference dataset.

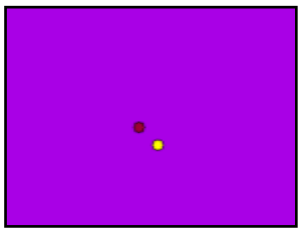


Fig. II. 10. Centroids of reference and OSM dataset

- Calculate the nearest distance between the corresponding centroids using proximity (near) tool
- The results refer to how far or close the polygons.
- Conduct a statistical calculation,

1. Calculate the standard deviation from the near-distance value of the adjacent

polygons

2. Calculate the average of standard deviations
3. Define the null hypothesis (ho ≤ 1).
4. Calculate the t-value from the obtained near-distance
5. Compare the t-value with the t-table value for the given degree of freedom and margin of errors. If the calculated t-value ≤ the t-table value, it could be concluded that the null hypothesis is accepted and both of the data are not significantly different. Otherwise, if the If the calculated t-value ≤ the t-table value, it could be concluded that the data are significantly different.

- Classify the data into 5 classes (Very Good, Good, Medium, Bad and Very Bad) using equal interval.
- Visualize the class data into bar chart with the quality of the data as a vertical axis.

2). Circularity analysis

The steps conducted to perform the circularity analysis are explained below:

- Calculate the sample size of the whole building data in AOI. The sample size calculation is based on the formula by Isaac and Michael as mentioned before.
- Choose the buildings feature from OSM dataset which overlap the sample from reference dataset.

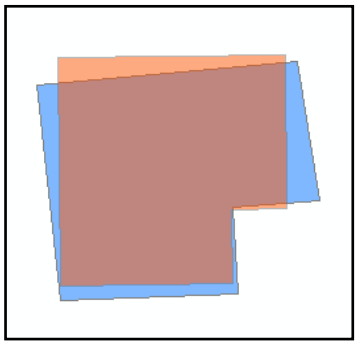


Fig. II. 11. Overlapped OSM buildings dataset

- Using field calculator, the circularity ratio were calculated from each polygon from both dataset using the Euclidean circularity equation (Ying, et.al., 2010): $4\pi * \text{area}/\text{perimeter}^2$. The results were circularity ratio for each of the adjacent polygon in both dataset.
- Calculate the difference between the circularity value from adjacent polygon in both

of the dataset

- Conduct a statistical calculation,

1. Calculate the standard deviation from the Circularity Ratio-difference value of the adjacent polygons
2. Calculate the average of standard deviations
3. Calculate the t-value from the obtained near-distance
4. Compare the t-value with the t-table value for the given degree of freedom and margin of errors. If the calculated t-value ≤ the t-table value, it could be concluded that the null hypothesis is accepted and both of the data are not significantly different. Otherwise, if the calculated t-value ≤ the t-table value, it could be concluded that the data are significantly different.

- Classify the data into 5 classes (Very Good, Good, Medium, Bad and Very Bad) using equal interval.
- Visualize the class data into bar chart with the quality of the data as a vertical axis.

3). Area analysis

The polygon area comparison is used to anticipate if there is any tested polygon with identical shape and position, but different in its size. The calculation steps were done as follows:

- Calculate the sample size of the whole building data in AOI. The sample size calculation is based on the formula by Isaac and Michael as mentioned before.
- Choose the buildings feature from OSM dataset which overlap the sample from reference dataset.

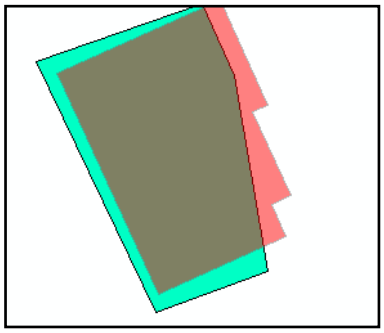


Fig. II. 12. Overlapped OSM buildings dataset

- Calculate the area of each adjacent polygon.
- Calculate the difference between the area of each polygon
- Conduct a statistical calculation,

1. Calculate the standard deviation from the Area difference value of the adjacent polygons
2. Calculate the average of standard deviations
3. Calculate the t-value from the obtained near-distance
4. Compare the t-value with the t-table value for the given degree of freedom and margin of errors. If the calculated t-value ≤ the t-table value, it could be concluded that the null hypothesis is accepted and both of the data are not significantly different. Otherwise, if the calculated t-value ≤ the t-table value, it could be concluded that the data are significantly different.

- Classify the data into 5 classes (Very Good, Good, Medium, Bad and Very Bad) using equal interval.
- Visualize the class data into bar chart with the quality of the data as a vertical axis.

II.4.1.2 Roads Accuracy Analysis

1). Line Buffer Analysis

The evaluation method using buffer-overlap analysis is used to know how far/close the displacement between two tested line-type data of the reference and evaluation dataset (Kounadi, 2009). The results of this method were presented as percentage of the data overlap. A 100% overlap means that the tested dataset are perfectly overlapped to the reference dataset within a tolerance value (e.g. the road's width).

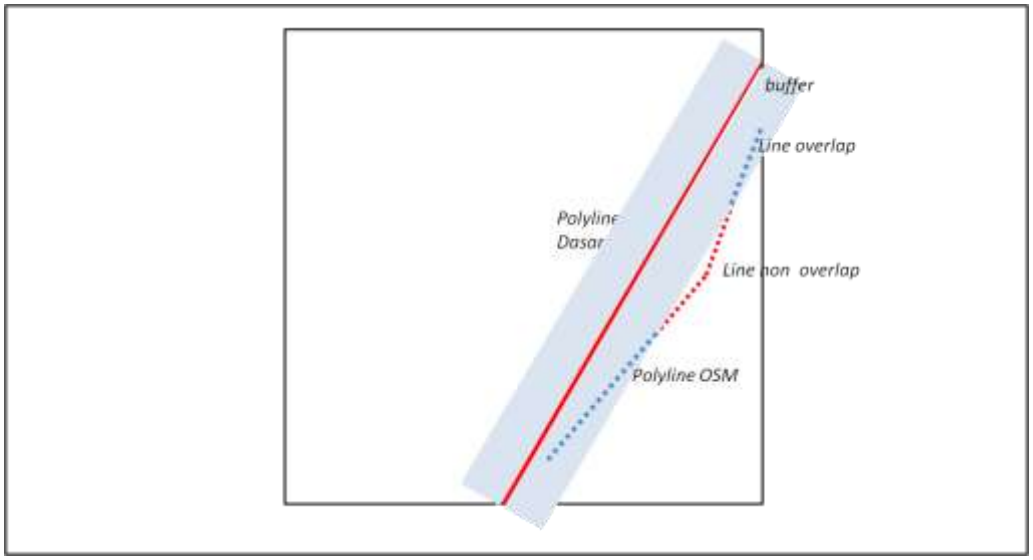


Fig. II. 13. Line buffer analysis

The buffer analysis is conducted as follows:

- Chose road feature from the OSM roads dataset that was overlapped with the reference dataset
- Classify the reference dataset into primary, secondary and tertiary.
- In case of the reference data from satellite imagery digitations, the reference dataset were digitized, and subsequently buffered with the given value (e.g. road's width)

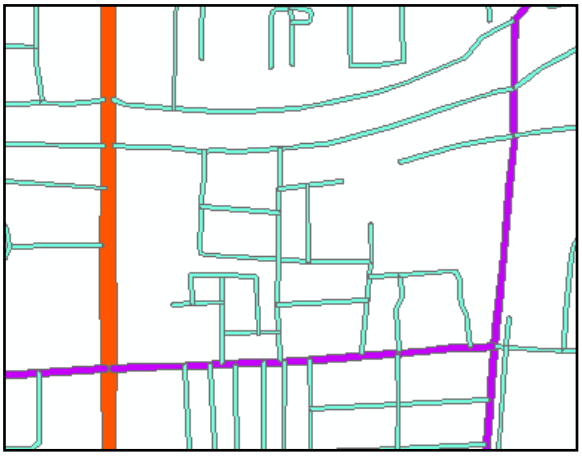


Fig. II. 14. The buffered reference data

- Calculate the intersect of the adjacent road data (from OSM dataset and reference dataset)

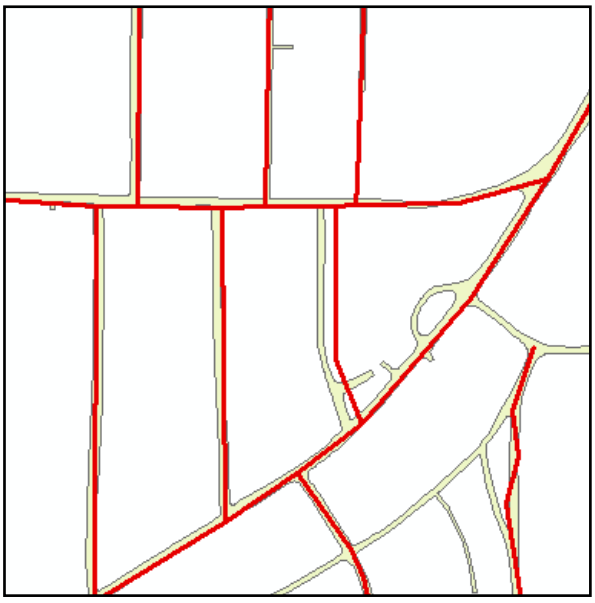


Fig. II. 15. Calculation of the intersect data reference and OSM dataset

- The results from intersect calculation were the overlapped a non-overlapped OSM roads with the buffered reference dataset.

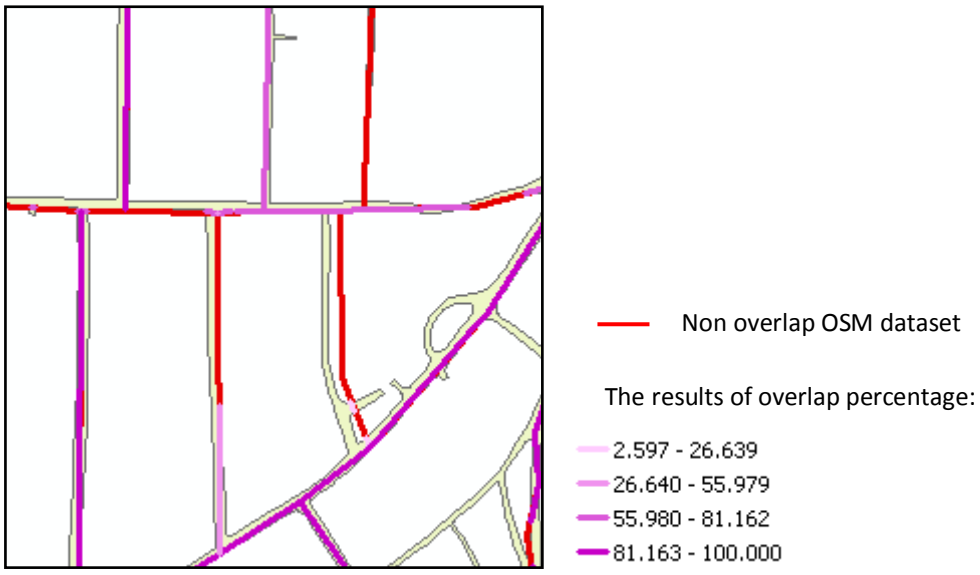


Fig. II. 16. Percentage of overlap between adjacent road features

- Calculate the line buffer percentage using the formula developed by Kounadi (2009) with slight modification:

$$\frac{Sum\ of\ Length\ of\ overlapped\ OSM\ dataset}{Total\ length\ of\ the\ OSM\ dataset} x\ 100\%$$

- Visualize the buffer-overlap results using *Natural Breaks (Jenks)* in ArcGIS
- Classify the data into 5 classes (Very Good, Good, Medium, Bad and Very Bad) using

equal interval.

- Visualize the class data into bar chart with the quality of the data as a vertical axis.

2). Line Completeness analysis

Line completeness analysis, as the name suggest, is used to know how complete the evaluated dataset (OSM dataset) compared to the reference dataset in a certain size grid, e.g. 1 x 1 km^2 (Kounadi, 2009). The result of this method is also presented as percentage value. The more complete the OSM data in a particular grid, the more likely for the percentage value to be 100%. The calculation steps are explained below:

- Chose road feature from the OSM roads dataset that was overlapped with the reference dataset
- Divide the AOI into grids with given size (for example, 1x1 km^2 grids)

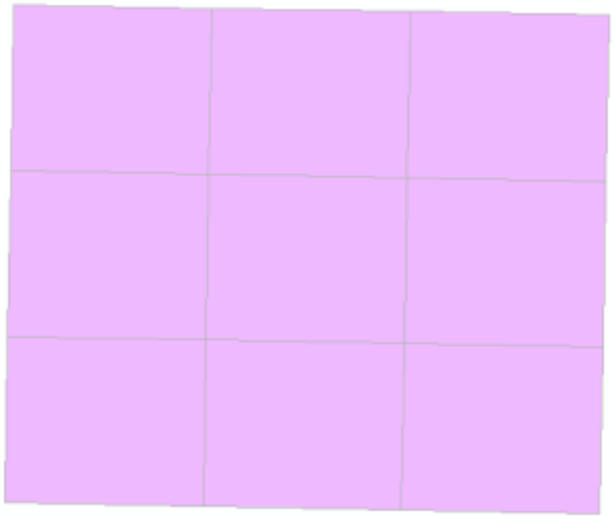


Fig. II. 17. Grids of Completeness analysis

- Calculate the total length of OSM road data in each single grid

Fig. II. 18. Calculation of completeness

- Calculate the total road length of reference dataset that were overlapped with the OSM dataset
- Calculate the line completeness ratio using the formula (Kounadi, 2009):

$$\frac{Sum\ of\ OSM\ road\ lengt\,h\ in\ a\ grid}{Total\ lengt\,h\ of\ road\ reference\ \ dataset\ \ in\ a\ grid}\ x\ 100\%$$

- Visualize the results using *Natural Breaks (jenks)* in ArcGIS

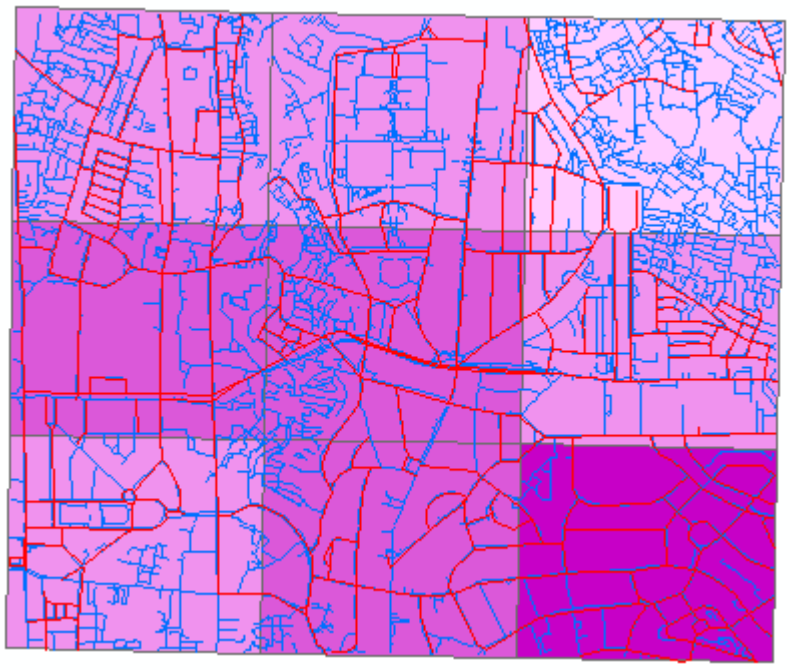


Fig. II. 19. Result of Completeness analysis

- Classify the data into 5 classes (Very Good, Good, Medium, Bad and Very Bad) using equal interval.
- Visualize the class data into bar chart with the quality of the data as a vertical axis.

Attribute Accuracy

The attribute accuracy evaluation is performed to assess the quality of attribute data in OSM dataset. The evaluated fields were the same as the attribute data of OSM dataset, which were (1) name, (2) structure, (3) roof, (4) walls, (5) level, and (6) use. Each of the evaluated fields is scored with the criteria:

a). No data or misattributed data : zero (0) score

b). Suitable attribute data with the real world condition : 1

The results of the scoring were then summarized with maximum score of 6 for each of the record. The overall results of the evaluation were then classified into 3 classes which picture the completeness, availability and the accuracy of the OSM attribute data, which were: Good (total score: 5-6), Medium (total score: 3-4) and Bad (total score: 0-2). Thus, a percentage of how well the data could be perceived.

Contributor Statistical Analysis

Contributor evaluation method were conducted to show the amount and spreadness of each OSM contest contributors in a study area, while assessing the tendency of each contributors in OSM data input, especially in the OSM contest dataset.

The calculation steps for contributor statistical analysis are as follows:

1. Calculate the frequency of each contributor input. A lower boundary is applied to the contributors which input data less than 5% of the total of the data. Only contributors with numbers of contribution more than the lower boundary were subsequently analyzed.
2. Select the feature that belongs to each contributor who passed the lower boundary (5% of the total input data)
3. Execute the *Average Nearest Neighbour Test* to whole data to assess whether the data is clustered, random, or dispersed according to its z-score value
4. Evaluate each contributor's input using *Standard Distance Test* to assess the tendency of each user's contribution relative to the *Envelope* of all the data in an AOI.
5. Calculate Average Nearest Neighbour Test to each contributor's input that passed the lower boundary to obtain the pattern of each contributor's input data.

II.4.4. Visualization of OSM Quality

OSM Quality Visualization is a summary of the scoring from each method of evaluation (particularly, spatial accuracy analysis) to a buildings feature of the OSM dataset. The method of interpolation used is Natural Neighbour. The final result of this visualization is presented in form of a heatmap.

The step-by-step of quality visualization is as follows:

1. Calculate the circularity difference, area difference, and near-distance from each OSM evaluated dataset
2. Classify the data quality for each analysis method into 5 classes (Very Good, Good, Medium, Bad and Very Bad). The classification is done using Equal Interval method. A sample of classification difference is as shown below:

Table II. 3. Classification of Cicularity Quality

Classes		Quality	Frequency
0	0.067	Very Good	201
0.068	0.133	Good	27
0.134	0.2	Medium	8
0.201	0.267	Bad	2
0.268	0.333	Very Bad	3
Number of data			**241**

3. Each evaluation method were given a suitable score for all of the evaluated OSM dataset

Table II. 4. Spatial Accuracy scoring

Spatial Accuracy			
Methods / **Quality**	**Near-Distances**	**Circularity**	**Area Comparison**
Very Bad (5)	10	5	5
Bad (4)	20	10	10
Medium (3)	30	15	15
Good (2)	40	20	20
Very Good (1)	50	25	25

The scoring processes above were performed using a VBScript in ArcGIS, such as shown below:

a. Quality Classification based on the range of the classes in each method (e.g. circularity evaluation method):

```
Dim nilai
If [sample_padang_citra.beda_circ] >= 0.268 then
nilai = "VERY BAD"
elseif [sample_padang_citra.beda_circ] >=0.201  Then
nilai = "BAD"
elseif [sample_padang_citra.beda_circ] >= 0.134 Then
nilai = "MEDIUM"
elseif [sample_padang_citra.beda_circ] >= 0.068 Then
nilai = "GOOD"
elseif [sample_padang_citra.beda_circ] >= 0  Then
nilai = "VERY GOOD"
end if
```

b. Score classification based on the class of each method (e.g. circularity evaluation method):

```
Dim scoring
If [nilai] = "SANGAT KURANG"  Then
scoring=5
elseif [nilai] = "KURANG"  Then
scoing= 10
elseif [nilai] ] = "SEDANG"  Then
scoring=15
elseif [nilai] = "BAIK"  Then
scoring= 20
elseif [nilai] = "SANGAT BAIK"  Then
scoring= 25
end if
```

4. Summarize the scores from evaluation methods. The results would represent a qualitative accuracy for a particular feature dataset.

$$\text{Final Score} = \text{Score of Circularity} + \text{Score of Near-Distance} + \text{Score of Area Difference}$$

5. Interpolize the Final Score using Natural Neighbour. The result of the visualization is in form of heatmap, which represent the overall quality of OSM dataset in particular location as well as the predicted quality in the study area.

III. RESULTS OF OSM QUALITY EVALUATION

III.1. YOGYAKARTA

III.1.1. Reference and Evaluation Data

The OSM competition dataset that has been evaluated consists of shapefiles of building and road features. The numbers of data were 6441 and 812 records, respectively. Out of those numbers, some samples were chosen from the data to be evaluated. The data selections were based on the quality, distribution, and accessibility of the OSM competition data.

In order to evaluate the quality of the OSM data, the selected samples were assessed against a reference data. For this purpose, the reference data that used in the process include:

(a). Bing Imagery in Yogyakarta, acquired in 2009.

(b). Topographic map resulted from Topographic survey of UGM's campus, conducted in 2006 using a terrestrial survey method. The data is in the form of AutoCAD's DWG with the scale at 1:5000.

(c). Map of Yogyakarta's Road Network from Ministry of Public Work (Former: Department of Public Works), with the scale at 1:5000.

III.1.2. Analysis Results

The comparison results between reference data (i.e. Imagery and DWG data) and evaluated data (OpenStreetMap data) are presented as follows:

a. Spatial Evaluation Results

i). Topographic Map of UGM Campus (in AutoCAD DWG format)

A sample size of 100 data was used to produce a comparative statistical analysis between reference data (Topographic Map) and the OSM sample data. The methods of analysis used were Polygon Circularity, Polygon Near-Distance, and Polygon Area. The results of quality assessments were then statistically tested using t-test. The results of quality assessments will be given in the following text.

> Polygon Circularity.

Polygon Circularity Analysis was conducted to show the suitability of geometric matching between the reference and evaluated data. The results of Polygon Circularity Analysis for OSM sample dataset in Yogyakarta City are summed in the table below:

Table III. 1. Statistical Characteristics from the Sample (Circularity)

Number of Data	100
Median	0.072995287
Maximum Data	0.586719276
Minimum Data	0.000808662
Standard Deviation	0.115453096
Average	0.099939260

The two-tailed t-test at 90% confidence level is 0.865626509, in which the t-table value for 100 data sample is 1.29016. Since the tested data gave the value that was below the level of confidence, then it can be concluded that the data are not significantly different (this means that the sample data are relatively accurate).

The calculated value of data quality was then classified into several classes to show overall comparison results. Classification method used is equal interval, which divides the data into 5 interval classes.

Table III. 2. Classes of Circularity Quality in Yogyakarta (reference data: UGM Topographic Survey)

Classes		**Quality**	**Frequency**
0.000	0.118	Very Good (1)	78
0.118	0.235	Good (2)	12
0.235	0.352	Medium (3)	5
0.352	0.470	Bad (4)	1
0.470	0.587	Very Bad (5)	4
Number of Data			**100**

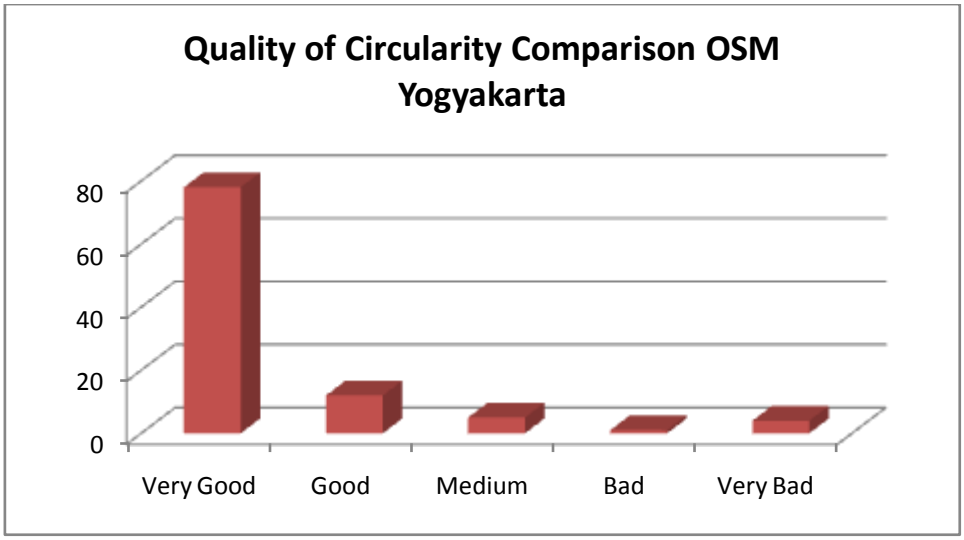


Fig. III. 1. Graphical presentation of OSM Data Quality Compared to UGM Topographic Map

From this quality comparison, it can be concluded that the overall quality of circularity comparison between OSM data and UGM Topographic Map in Yogyakarta is acceptable. Fairly said, the geometry shape of OSM data in this study area is geometrically close with the reference data, i.e. Topographic Map of UGM.

> Polygon Near-Distance

Another analysis that was conducted with the 100 sample data from UGM Topographic Map was Polygon Near-Distance. This method was implemented to show the spatial discrepancies between the reference and the evaluated data. The statistical characteristics of the data are given as follows:

Table III. 3. Statistical Characteristics from the Sample (Near-Distance)

Number of Data	100
Median	12.87605142
Maximum Data (m)	32.23236966
Minimum Data (m)	3.941312976
Standard Deviation	2.973866262
Average	12.933725247

The result of statistical comparison using t-test at 90% level of confidence with 100 sample data gives a calculated t-test value of 0.126897948. As the z value for 90% level of confidence for

100 sample data is 1.29016, then it can be concluded that OSM data are not significantly different (majority the polygon data are spatially accurate in their location).

Classification of the calculated data using equal interval is presented below:

Table III. 4. Classes of Near-Distance Quality Comparison in Yogyakarta

(reference data: UGM Topographic Map)

Classes		Quality	Frequency
0.000	9.600	Very Good (1)	6
9.600	15.258	Good (2)	87
15.258	20.916	Medium (3)	5
20.916	26.574	Bad (4)	1
26.574	32.232	Very Bad (5)	1
Number of Data			**100**

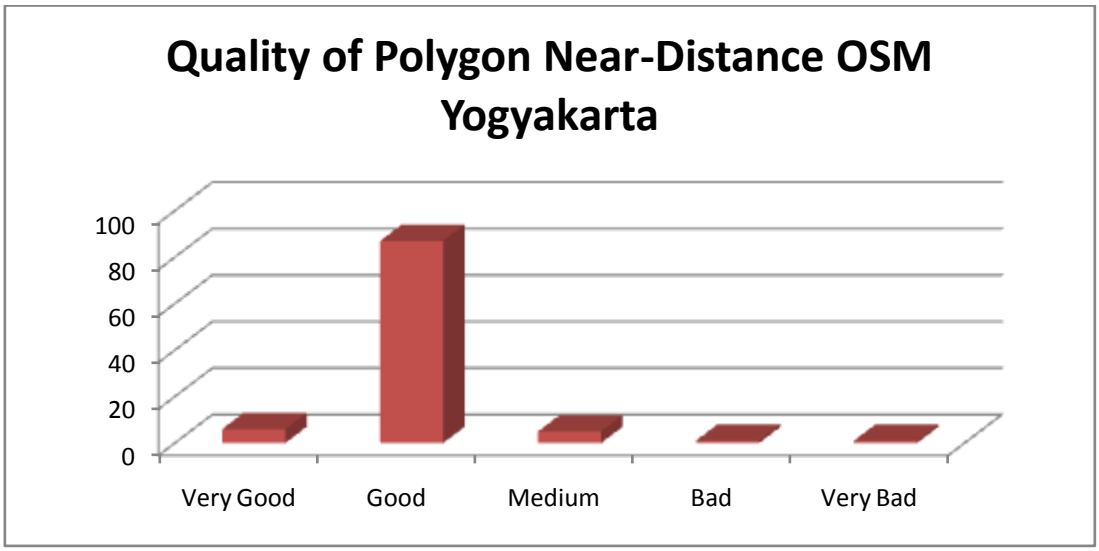


Fig. III. 2. Graphical presentation of Polygon Near-Distance (ref.: UGM Topographic Map)

From this quality comparison it can be concluded that the overall quality of polygon near-distance between OSM data and UGM Topographic Map in Yogyakarta is acceptable. Further said, the spatial distance of OSM data in this study area is match to the reference data, i.e. Topographic Map of UGM.

> Polygon Area

Polygon Area evaluation was conducted by comparing the values of buildings areas between OSM sample data and UGM Topographic Map. The statistical characteristics of the result are shown below:

Table III. 5. Statistical Characteristics of the Sample (Polygon Area Evaluation)

Number of Data	100
Median	218.369908
Maximum Data (m^2)	1689.387991
Minimum Data (m^2)	11.923258
Standard Deviation	288.037033
Average	282.9145758

The result of statistical comparison using t-test with sample size of 100 data is given below:

The two-tailed t-test at 90% confidence level is 0.982215977, while the t-table value for a 90% level of confidence for 100 data sample is 1.29016. So, the data are not significantly different (the differences in building areas are relatively low).

Result's classification using equal interval is presented below:

Table III. 6. Classes of Polygon Area Comparison in Yogyakarta (reference data: UGM Topographic Map)

Classes		**Quality**	**Frequency**
0.000	347.416	Very Good (1)	75
347.416	682.909	Good (2)	18
682.909	1018.402	Medium (3)	3
1018.402	1353.895	Bad (4)	2
1353.895	1689.388	Very Bad (5)	2
Number of Data			**100**

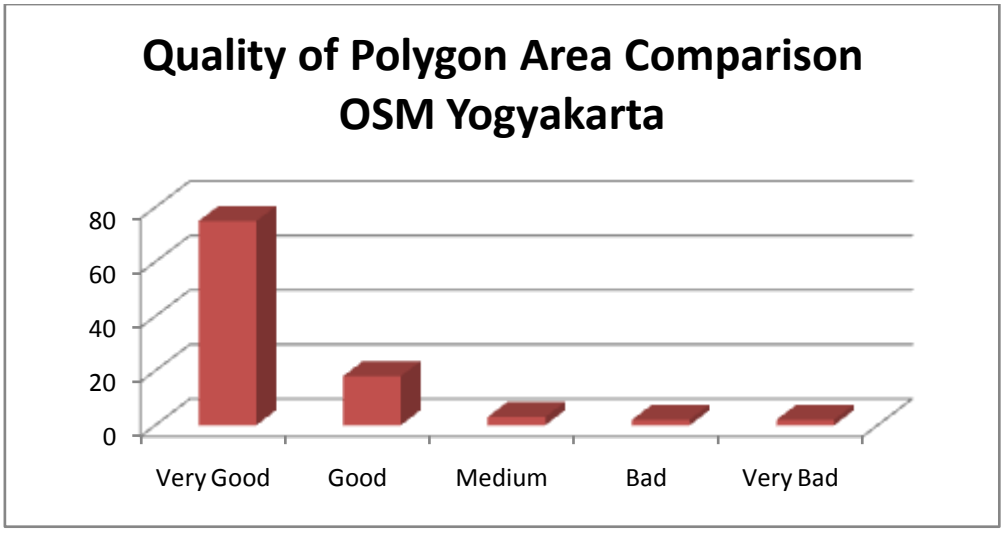


Fig. III. 3. Graphical presentation of Polygon Area (ref.: UGM Topographic Map)

From this quality comparison it can be concluded that the overall quality of polygon area comparison between OSM data and Topographic Measurement in Yogyakarta is acceptable. Further said, the OSM data in this study area have a spatial area accuracy compared to the reference data, i.e. Topographic Map of UGM.

ii). BING Satellite Imagery of Yogyakarta (2009)

Second reference data that are available in this study area is the Microsoft's BING satellite imagery. A latest BING imagery is available for most part of Yogyakarta. A sample size of 1000 buildings data were digitized (by visual interpretation) to be compared with its corresponding OSM building footprints.

> Polygon Circularity.

The result of comparison between OSM data and 1000 building features digitized from the BING Imagery are presented below:

Table III. 7. Statistical Characteristics from the Sample in Polygon Circularity evaluation

Number of Data	1000
Median	0.017165750
Maximum Data	0.420060952
Minimum Data	0.000005240
Standard Deviation	0.052951033
Average	0.035755993

The calculated t-test value is 0.67526528, while the t-table value for 90% confidence level and 1000 sample data is 1.645. Therefore, the sample data are not significantly different to digitized data (most of the geometry shape of references data are identical with evaluated data).

The results of quality assessments were then classified into 5 classes using the equal interval classification method.

Table III. 8. Classes of Circularity Quality in Yogyakarta (reference data: BING Imagery)

Classes		Quality	Frequency
0.000	0.225	Very Good (1)	981
0.225	0.450	Good (2)	19
0.450	0.676	Medium (3)	0
0.676	0.901	Bad (4)	0
0.901	1.126	Very Bad (5)	0
Number of Data			**1000**

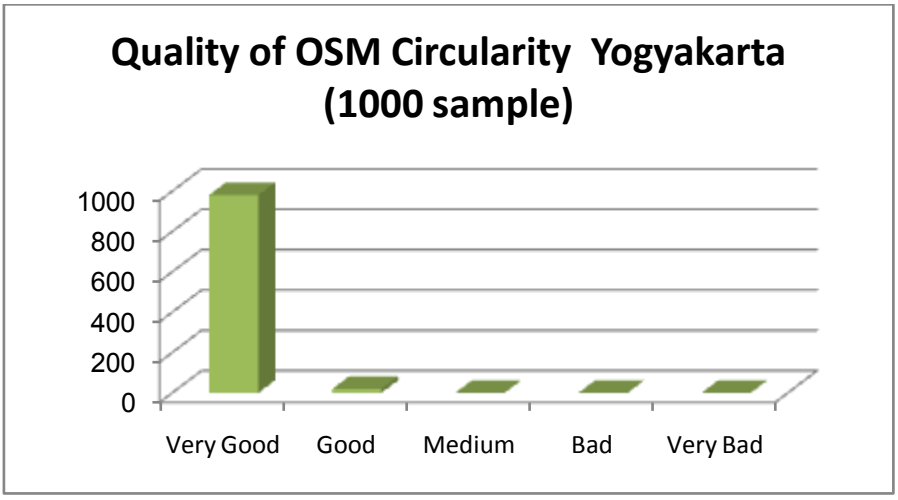


Fig. III. 4. Graphical Presentation of OSM Polygon Circularity Compared to BING Imagery

From this quality comparison, it can be concluded that the overall quality of circularity comparison between OSM data and BING Imagery in Yogyakarta is acceptable. Fairly said, the geometry shape of OSM data in this study area is close with the reference data, i.e. BING Imagery.

> Polygon Near-Distance

From 1000 samples selected, Polygon near-distance analysis was conducted to assess the spatial discrepancies. Some important statistical characteristics of the data are:

Table III. 9. Statistical Characteristics from the Sample (Near-Distance)

Number of Data	1000
Median	0.77038492
Maximum Data (m)	12.78048364
Minimum Data (m)	0.01391898
Standard Deviation	1.10516074
Average	1.084339941

The two-tailed t-test at 90% level of confidence resulted as 0.002413281, in which the t-table value for 1000 sample size is 1.645. Therefore, it can be concluded that the spatial distance of the buildings from reference data is match with the evaluated data.

Classification of the calculated data using equal interval is presented below:

Table III. 10. Classes of Near-Distance Quality Comparison in Yogyakarta (reference data: BING Imagery)

Classes		**Quality**	**Frequency**
0.000	2.567	Very Good (1)	932
2.567	5.121	Good (2)	55
5.121	7.674	Medium (3)	7
7.674	10.227	Bad (4)	4
10.227	12.780	Very Bad (5)	2
Number of Data			**1000**

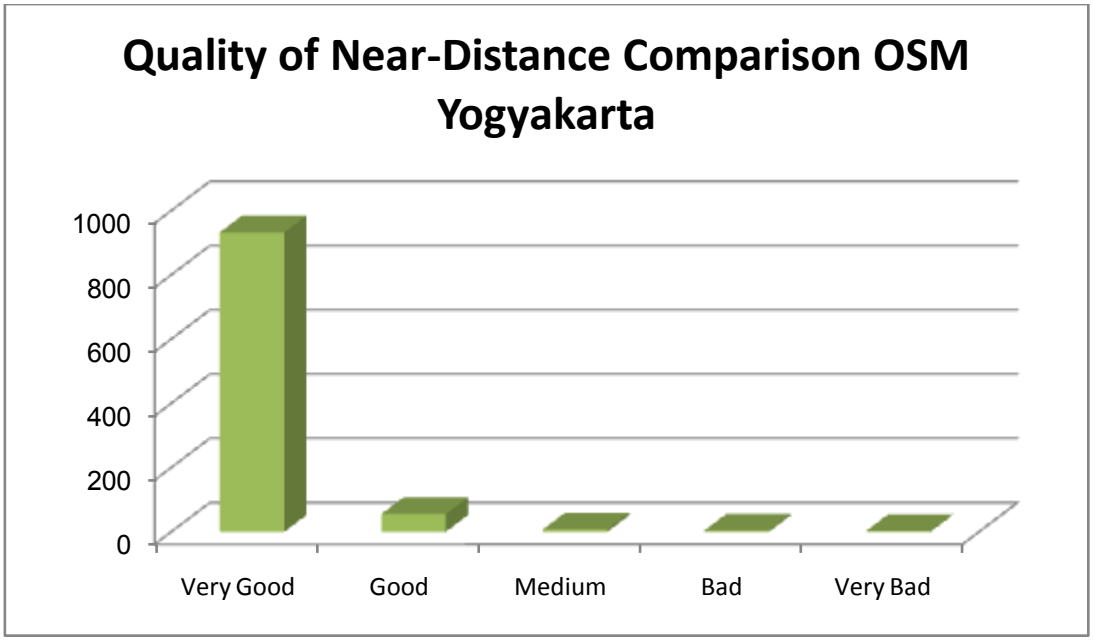


Fig. III. 5. Graphical presentation of Polygon Near-Distance (ref.: BING Imagery)

From this quality comparison it can be concluded that the overall quality of polygon near distance comparison between OSM data and BING Imagery in Yogyakarta is good. The spatial distance of OSM data in this study area is considered to be matched very well with the reference data, i.e. BING Satellite Imagery.

> Polygon Area

The statistical characteristics of the analysis result are shown below:

Table III. 11. Statistical Characteristics from the Sample (Polygon Area)

Number of Data	1000
Median	13.79944400
Maximum Data (m^2)	2928.3592295
Minimum Data (m^2)	0.0018309037
Standard Deviation	154.9143592
Average	48.372303660

The t-test value from calculated statistics of the data is 0.312251904, while the value of t-table with 90% confidence level and sample size of 1000 is 1.645. Thus, the data in question are not significantly different, i.e. most of the data has the same polygon area.

` Classification of the calculated data using equal interval is presented below:

Table III. 12. Classes of Polygon Area Comparison in Yogyakarta (reference data: BING Imagery)

Classes		Quality	Frequency
0.000	585.673	Very Good (1)	994
585.673	1171.345	Good (2)	3
1171.345	1757.016	Medium (3)	0
1757.016	2342.688	Bad (4)	1
2342.688	2928.359	Very Bad (5)	2
Number of Data			**1000**

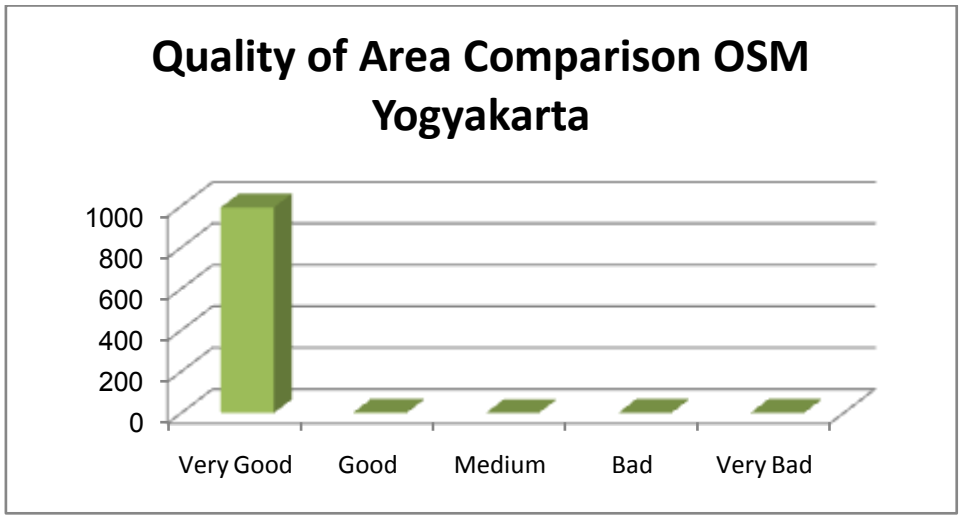


Fig. III. 6. Graphical presentation of Polygon Area (ref.: BING Satellite Imagery)

From this quality comparison it can be concluded that the overall quality of polygon area comparison between OSM data and BING Imagery in Yogyakarta is acceptable. Fairly said, the spatial area of OSM data in this study area is very close to the reference data, i.e. BING Imagery in Yogyakarta.

iii). Yogyakarta Road Network Map

Road Network Map was also used as a reference data in OSM competition data quality assessments in Yogyakarta. The reference data is used to perform comparative analysis between OSM Road features and the road featrures represented in the Yogyakarta Road Network Map. The

analysis conducted consists of Buffer-overlap analysis and Line completeness analysis. The following will explain the two further.

> Roads Buffer-Overlap Analysis

This method is used to investigate the discrepancies found between the reference data (Yogyakarta Road Network Map) and the evaluated data (OSM Roads Data in Yogyakarta) within a tolerance value. The tolerance value was defined based on the average width of a particular road class in real world (e.g. primary class road have a tolerance value of 8 meters). From the calculation then the results are presented as percentage values which represent the overlap of the evaluated data with the reference data. In this respect, a value of 100% gives us an interpretation that the particular roads are exactly within the tolerance value of the reference road. 203 samples are randomly selected from the existing OSM road features in Yogyakarta to be analyzed. The statistical characteristics from the sample are listed below:

Table III. 13. Statistical Characteristics from the Sample (Line Buffer-Overlap percentage)

Number of Data	203
Median	58.223516
Maximum Data	100.000
Minimum Data	0.000
Standard Deviation	37.6097918
Average	56.645968

To enhance the understanding about the data quality, the data were then classified as shown below:

Table III. 14. Statistical Characteristics of the Sample in Line Buffer-Overlap evaluation

Class (% overlap)		**Quality**	**Frequency**
0	20	Very Bad (5)	48
21	40	Bad (4)	29
41	60	Medium (3)	25
61	80	Good (2)	19
81	100	Very Good (1)	82
Number of Data			**203**

From the analysis, it is shown that major part of the sampled data (82 data or 40.4%) have a very good quality in comparison to the reference data, while some other (48 data or 23.6%) have a very bad quality. Thus, it can be concluded that the qualities of OSM roads data in Yogyakarta (using this method) are highly varied quality.

> Road Completeness Analysis

This method compares the geometric completeness between the reference and the evaluated data in each square grid. A grid has a size of 1x1 km squares, with in total there are 45 grids used in Yogyakarta. Below are the statistical results from the analysis:

Table III. 15. Statistical Characteristics from the Sample (Percentage of Completeness)

Number of Data	45
Median	72.87592502
Maximum Data	99.22729982
Minimum Data	21.03771147
Standard Deviation	23.22408851
Average	72.875925022

The classes are:

Table III. 16. Classes of Road Completeness Analysis in Yogyakarta

(reference data: Yogyakarta's Road Network Map)

Class (%)		**Quality**	**Frequency**
0	20	Very Bad (5)	0
21	40	Bad (4)	5
41	60	Medium (3)	7
61	80	Good (2)	11
81	100	Very Good (1)	22
Number of Data			45

It can be concluded that about half of the data have a Very Good quality, while the others have a varied quality from Bad to Good. The following figure shows the variation of the grid quality:

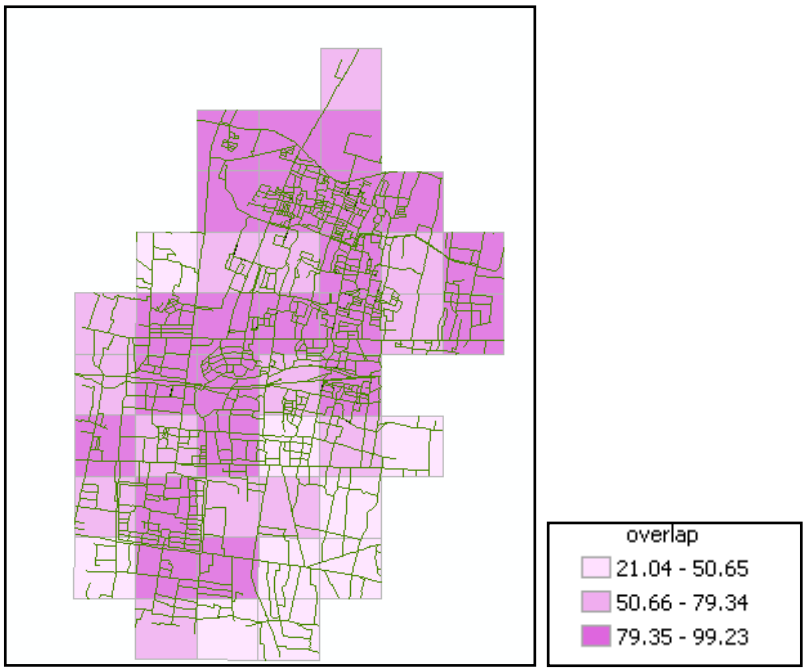


Fig. III. 7. Presentation of Roads Completeness Analysis

b. Attribute Evaluation Results

As the name suggests, this method analyzes the quality of attribute (or non spatial) data in OSM data (particularly, the building features). The attribute of the buildings are listed and compared with its real world condition based on the groundtruthing survey. A set of 213 sample dataset are chosen to be evaluated from the whole buildings data in Yogyakarta. The evaluation was done by comparing the OSM attribute values with the real world condition. For example: the attribute value of structure in a particular OSM building feature in Yogyakarta was filled in by a contributor as reinforce masonry whereas in the real world the structure was unreinforce masonry. The values for attribute assessments are: 1 for correct or matching, 0 for incorrect and no data.

The results are based on scorings of the matching between OSM data and the real world condition of the same building. The results are as follow:

Table III. 17. Classification of Attribute Quality Based on Score Value

Attribute Score	Attribute Quality	Frequency
≤ 2	Bad (3)	127
3	Medium (2)	76
5 ≥	Good (1)	10
Total		**213**

The result shows that majority of the data in Yogyakarta have a 'Bad' Attribute quality (i.e. unsuitable with real world condition). This could be the effect of misidentification of the buildings. But this is not always the case. Mostly, the 'Bad' attribute values came from empty records in the attribute of the data, which gave the low scores in the result.

c. Attribute Completeness

Attribute completeness is evaluation to represent the empty data and filled data from all of attributes OSM data competition.

Table III. 18. Classification of Attribute Completness

Attributes	No Data	Filled Data
Name	5801	640
Use	1241	5200
Structure	1239	5202
Walls	1238	5203
Roof	652	5789
Level	1237	5204
Number of Data		**6441**

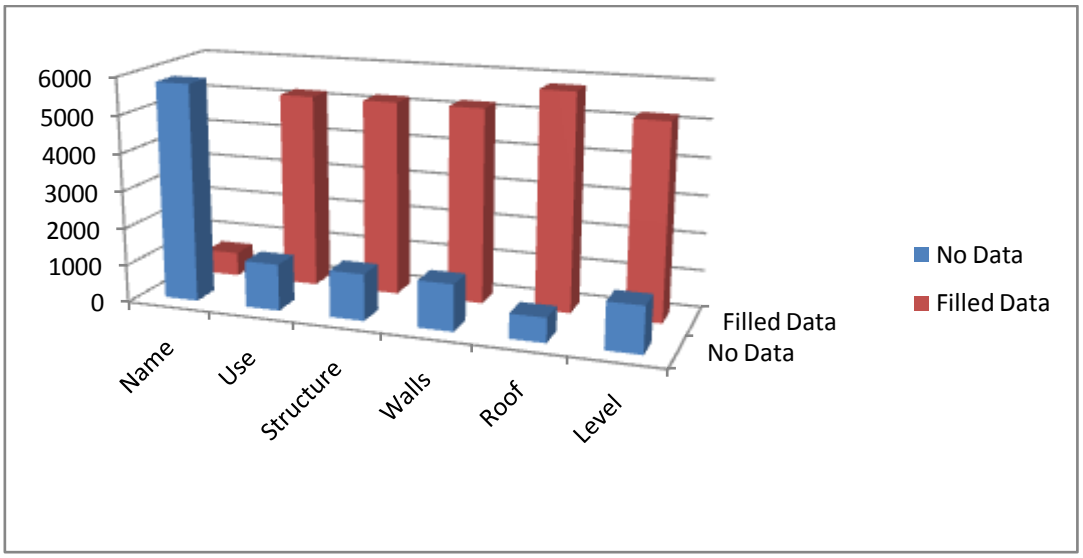


Fig. III. 8. Graphical presentation of Attribute Completeness in Yogyakarta

d. Contributor Evaluation

By contributor evaluation it means that this method assesses each contributor of the OSM competition data in the study area (in this case: around Yogyakarta): how much is the input data; how far does the coverage of his/her contribution; and how dispersed/clustered the data that he/she contributed.

Table III. 19. Amount of Input Data per Contributor

No	Contributors	Amount of Input	Percentage
1	bakhtiar arif mujianto	3654	56.73
2	imamidrisi	1354	21.02
3	iqnaul	862	13.38
4	Aisah_Rara	400	6.21
5	anggeresdoger	31	0.48
6	artan	23	0.36
7	Serpico	16	0.25
8	andrey pratama	14	0.22
9	habeebmaruu	10	0.16
10	Agung09	9	0.14
11	uut	9	0.14
12	xybot	9	0.14
13	angga_dwi	6	0.09
14	ssitipurwanti	6	0.09
15	marthin	5	0.08
16	kwuoko	4	0.06
17	tendrianadaru	4	0.06
18	wonderchook	4	0.06
19	reddevil	3	0.05
20	Devita Remala Sari	2	0.03
21	jeoyakarta	2	0.03
22	Maratun Sholihah	2	0.03
23	mulyasina	2	0.03
24	Nuril	2	0.03
25	rendhy	2	0.03

26	rivi_neritarani	2	0.03
27	Safirotul	2	0.03
28	dian putri imani sirait	1	0.02
29	Robert Whittaker	1	0.02
Total		6441	100.00

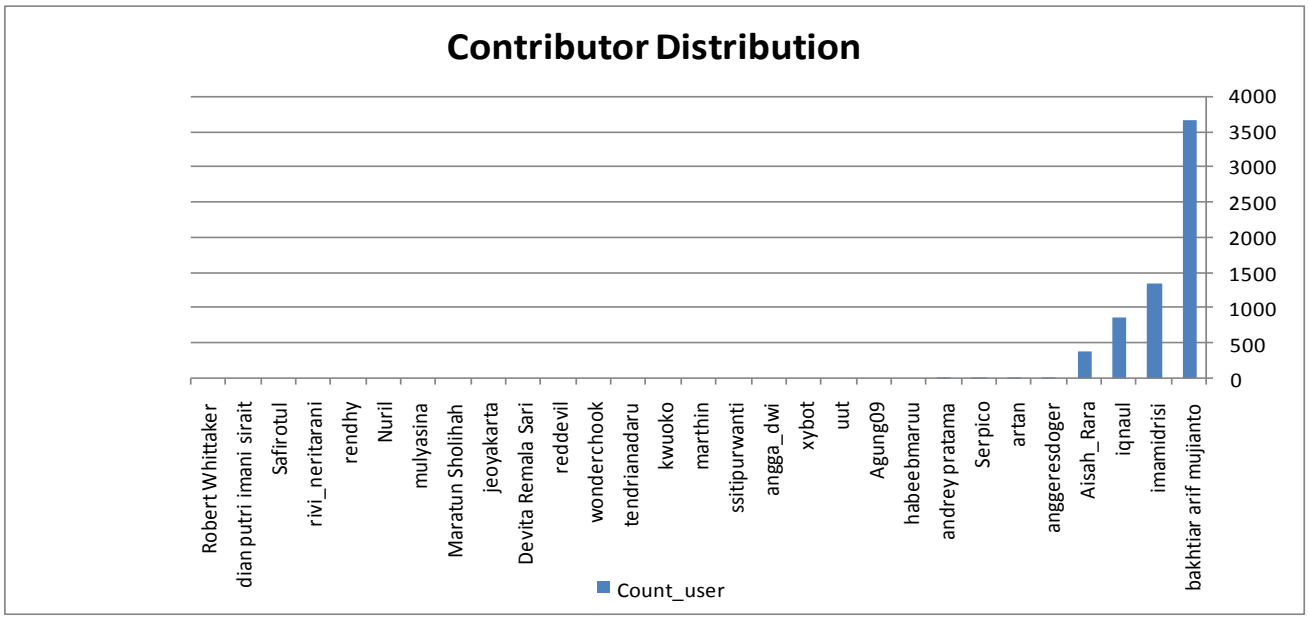


Fig. III. 9. Graphic of Contributor Distribution

I. Statistical Evaluation

Average Nearest Neighbour Test

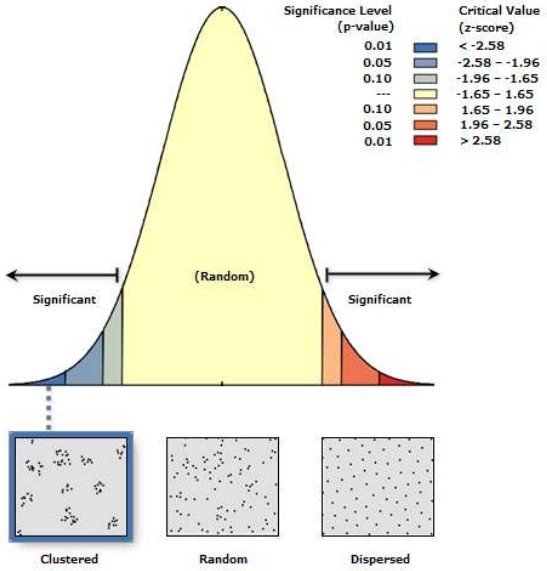


Fig. III. 10. Bell-Curve of Average Nearest Neighbour Critical Value

From the calculation above obtained z value of -113.89. There is a 1% likehood that contributors input the data randomly. That's means, there is a high probability to input the data based on specific pattern (the data is clustered).

II. Standard Distance

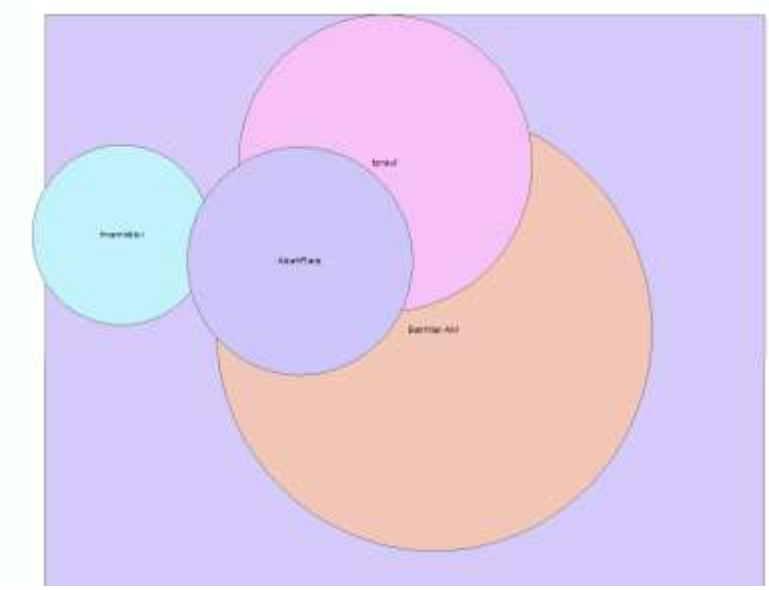


Fig. III. 11. Standard Distance of Contributor in Yogyakarta

Standard Distance shows the dispersion of each contributor around the center of data. The bigger circle in the above Figure represents the more amount of the data contributed, and the more dispersed the data is. Purple rectangle in the background represents the outer boundary of all the data in Yogyakarta city.

II. Individual Contributor Evaluation

a. Contributor Bakhtiar AM

Average Nearest Neighbour

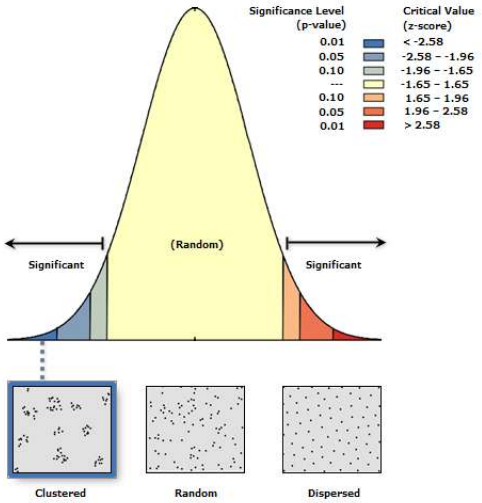


Fig. III. 12. Standard Distance of Contributor Bakhtiar AM

From the calculation above obtained z value of -101.60. There is a 1% likehood that contributors input the data randomly. That's means, there is a high probability to input the data based on specific pattern (the data is clustered).

b. Contributor Iqnaul

Average Nearest Neighbour

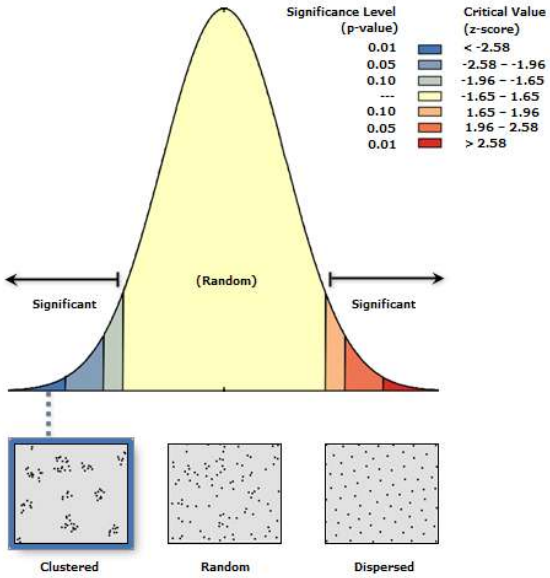


Fig. III. 13. Standard Distance of Contributor Iqnaul

From the calculation above obtained z value of -55.12. There is a 1% likehood that contributors input the data randomly. That's means, there is a high probability to input the data based on specific pattern (the data is clustered).

c. Contributor AisahRara

Average Nearest Neighbour

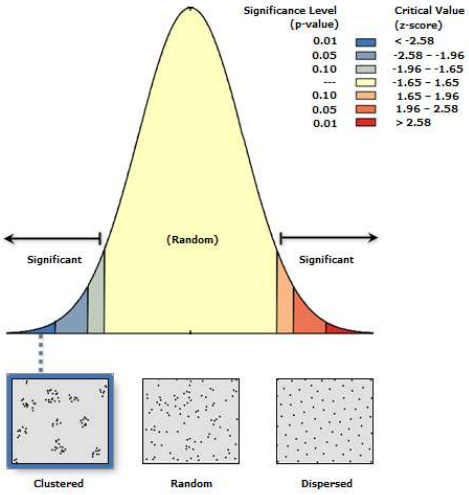


Fig. III. 14. Standard Distance of Contributor AisahRara

From the calculation above obtained z value of -43.63. There is a 1% likehood that contributors input the data randomly. That's means, there is a high probability to input the data based on specific pattern (the data is clustered).

d. Contributor Imamidrisi

Average Nearest Neighbour

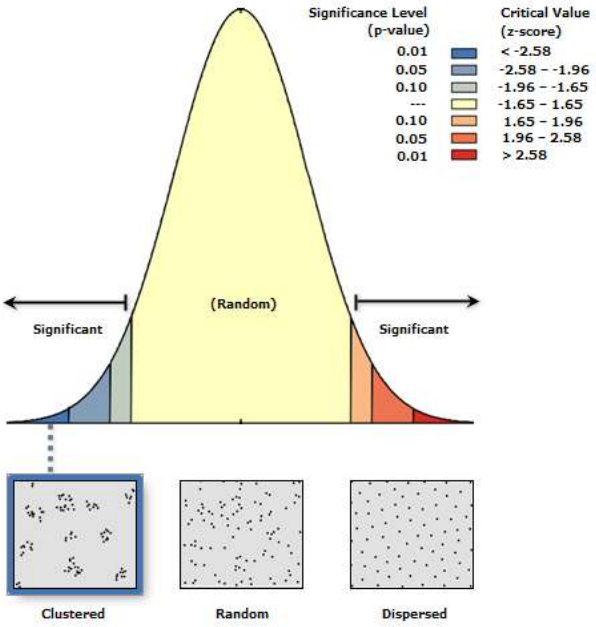


Fig. III. 15. Standard Distance of Contributor ImamIdrisi

From the calculation above obtained z value of -18.81. There is a 1% likehood that contributors input the data randomly. That's means, there is a high probability to input the data based on specific pattern (the data is clustered).

e. Sample Case

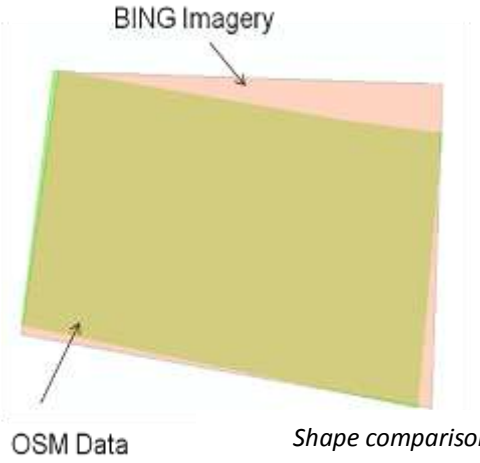
Here's a sample of the evaluation results. The sample is a building feature which is Bank BNI 46 located in Jl. Trikora No. 1.

OpenStreetMap Feature Attribute

ID_bgn	name	use	structure	walls	roof	levels
120424125	Bank BNI 46	commercial	reinforced_masonry	brick	tile	2

Attribute Evaluation (Based on Real World Condition. Score of '1' means 'correct')

name (1/6)	use (1/6)	structure (1/6)	walls (1/6)	roof (1/6)	levels (1/6)	SUM	Attribute_Quality
1	1	1	1	1	0	5	Good



Shape comparison

Evaluation Results

Evaluation Methods	Value	Quality
Near Distance	1.4049	Very Good
Circularity	0.0203	Very Good
Area	135.9640	Very Good

The Building of BNI 46 Yogyakarta: Side View

Front View

Rear View

The evaluation resulted in an overall Very Good quality of spatial distance, spatial area and geometry shape accuracies, while its attribute accuracy is assessed to be a good quality.

III.2. SURABAYA

III.2.1. Reference and Evaluation Data

The OSM competition dataset that has been evaluated in Surabaya consists of competition data in form of building and road features (stored as shapefile data). The numbers of the data are 3866 and 1328 records, respectively. Out of those numbers, some dataset are chosen as samples to be evaluated. The selection of dataset is based on the quality, distribution and accessibility of the OSM competition data in Surabaya itself.

In order to evaluate the quality of the OSM data, the selected samples were assessed against a reference data. For this purpose, the reference data that used in the process include:

a. Field Survey Data

   Field Survey using Ashtec Mobile Mapper 10, conducted during Dec 12th, 2011 – Dec 17th, 2012. The results of the survey are 128 measured buildings.

b. Topographic Map around Sepuluh November Institute of Technology (ITS) that was developed from Satellite Imagery Digitations. The digital map is in AutoCAD's DWG with the scale at 1: 10.000. This data consist of 32 buildings.

III.2.2. Analysis Results

The comparison results between the reference data (i.e. Field Survey data and DWG data) and the evaluated data (OpenStreetMap data) are presented as follows:

a. Spatial Evaluation Results

i). Field Survey Data

A sample size of 128 data is used to produce a comparative statistical analysis between reference data (Field Survey) and OSM sample data. The methods that were used to assess the OSM data quality are Polygon Circularity, Polygon Near-Distance, and Polygon Area. The results of quality assessments were statistically tested using t-test. The results of quality assessments are presented as follows.

> Polygon Circularity.

Polygon Circularity Analysis is conducted to show the suitability of geometry shape matching between the reference and evaluated data. The results of Polygon Circularity Analysis for OSM sample dataset in Surabaya City are summarized in the table below:

Table III. 20. Statistical Characteristics from the Sample (Circularity)

Number of Data	128
Median	0,04171669673
Maximum Data	0,28126383179
Minimum Data	0,00087476809
Standard Deviation	0,062175103
Average	0,06397443724

The result of statistical comparison using t-test with 128 samples is as follow: the two-tailed t-test at 90% confidence level is 1.028939782, in which the t-table value for 128 data sample is 1.28825. Since the tested data is below the level of confidence, then it can be concluded that the data are not significantly different. This means that the sample data are relatively accurate.

The calculated value of data quality was then classified into several classes to show overall comparison result. Classification method used was equal interval, which divides the data into 5 interval classes.

Table III. 21. Classes of Circularity Quality Comparison in Surabaya (reference data: Field Survey data)

Classes		Quality	Frequency
0,000	0,118	Very good (1)	106
0,118	0,235	Good (2)	20
0,235	0,352	Medium (3)	2
0,352	0,470	Bad (4)	0
0,470	0,587	Very Bad (5)	0
Number of Data			128

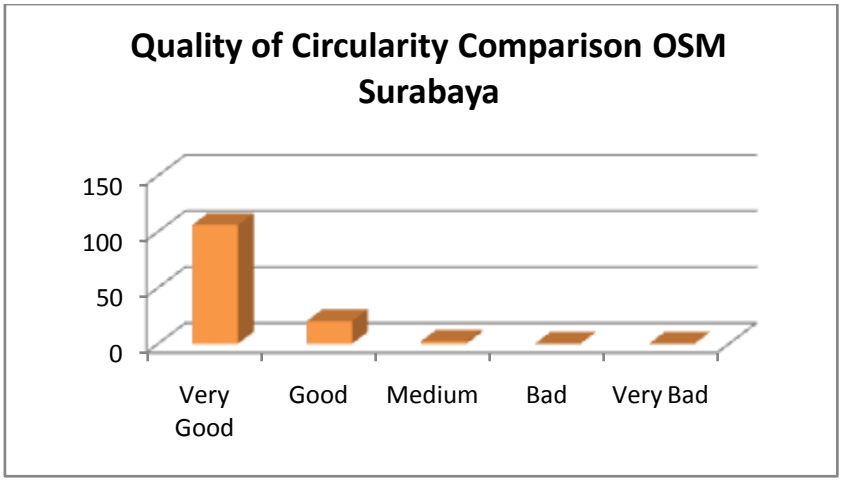


Fig. III. 16. Graphical Presentation of OSM Data Quality Compared to Field Survey Data

From this quality comparison, it can be concluded that the overall quality of circularity comparison between OSM data and Field Survey data in Surabaya tends to be very good with only few samples were good and medium. Fairly said, the geometry shape of OSM data in this study area is matched very well with the reference data, i.e. Field Survey data.

> Polygon Near-Distance

Another analysis that was conducted to 128 sample data from Field Survey data was Polygon Near-Distance. This method was implemented to show the spatial distance discrepancies between the reference and the evaluated data. The statistical characteristics of the data are:

Table III. 22. Statistical Characteristics from the Sample (Near-Distance)

Number of Data	128
Median	4,10915161887
Maximum Data	54,87590254510
Minimum Data	0,11950064684
standar deviation	6,383308953
Average	5,42458987331

The result of statistical comparison using t-test at 90% level of confidence with 128 sample data is as follow: the t-test calculated value from the data is 0,022271048, in which the t-table value for 128 data sample is 1,28825. Since the tested data is below the level of confidence, then it

can be concluded that the data are not significantly different (this means that the sample data are relatively accurate).

The calculated value of data quality is then classified into several classes to show overall comparison result. Classification method used was equal interval, which divides the data into 5 classes.

Table III. 23. Classes of Near-Distance Quality Comparison in Surabaya (reference data: Field Survey data)

Classes		Quality	Frequency
0.000	11.071	Very Good (1)	118
11.072	22.022	Good (2)	7
22.023	32.973	Medium (3)	0
32.974	43.925	Bad (4)	2
43.926	54.876	Very Bad (5)	1
Number of Data			**128**

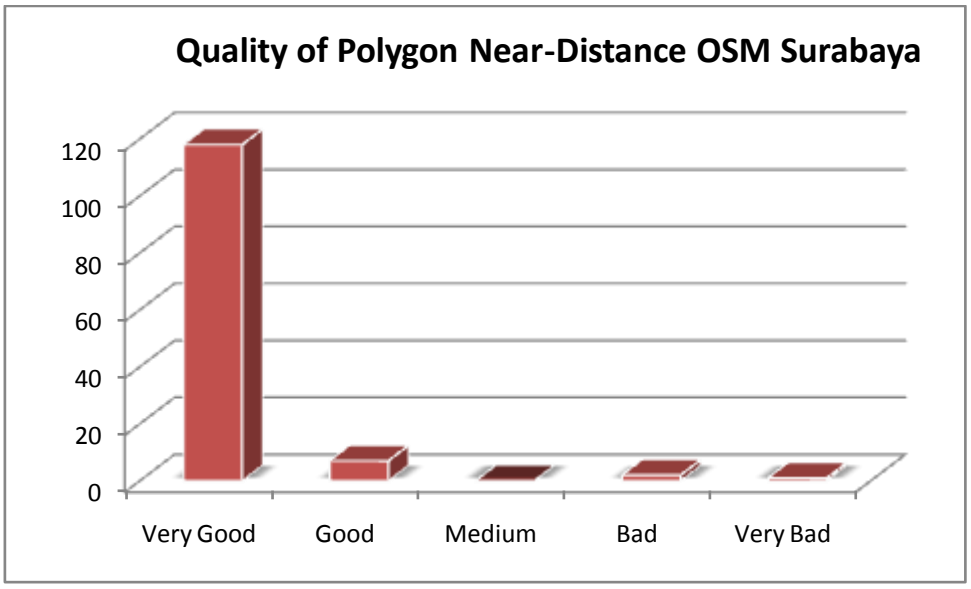


Fig. III. 17. Graphical presentation of Polygon Near-Distance (ref.: Field Survey Data)

From both the table and the graphic above it can be concluded that the overall quality of polygon near distance comparison between OSM data and Field Survey Data in Surabaya tends to be very good with only monor results were on bad and very bad. Further said, the spatial distance of OSM data in this study area is close to the reference data, i.e. Field Survey Data.

> Polygon Area

Polygon Area evaluation is conducted by comparing the value of OSM building's areas between OSM sample data and Field Survey Data. The statistical characteristics of the result are shown below:

Table III. 24. Statistical Characteristics of the Sample (Polygon Area Evaluation)

Number of Data	128
naideM	62.09224352250
Maximum Data	24222.24262850000
Minimum Data	1.18834277300
Standar Deviation	2172.810917
Average	440.89485424359

The result of statistical comparison using t-test with sample size of 128 data is as follow: the two tailed t-test at 90% confidence level is 0.202914506, while t-table value for 90% confidence value with 128 sample data is 1.28825. The result of statistical comparison using t-test with sample size of 128 data showed that t-value of the tested data is below the level of confidence, then it can be concluded that the data are not significantly different. This means that the sample data are relatively accurate.

The calculated value of data quality is then classified into several classes to show overall comparison result. Classification method used is equal interval, which divides the data into 5 interval classes.

Table III. 25. Classes of Polygon Area Comparison in Surabaya (reference data: Field Survey Data)

Classes		Quality	Frequency
0	4845,399	Very Good (1)	127
4845,4	9689,61	Good (2)	0
9689,611	14533,821	Medium (3)	0
14533,82	19378,032	Bad (4)	0
19378,03	24222,243	Very Bad (5)	1
Number of Data			128

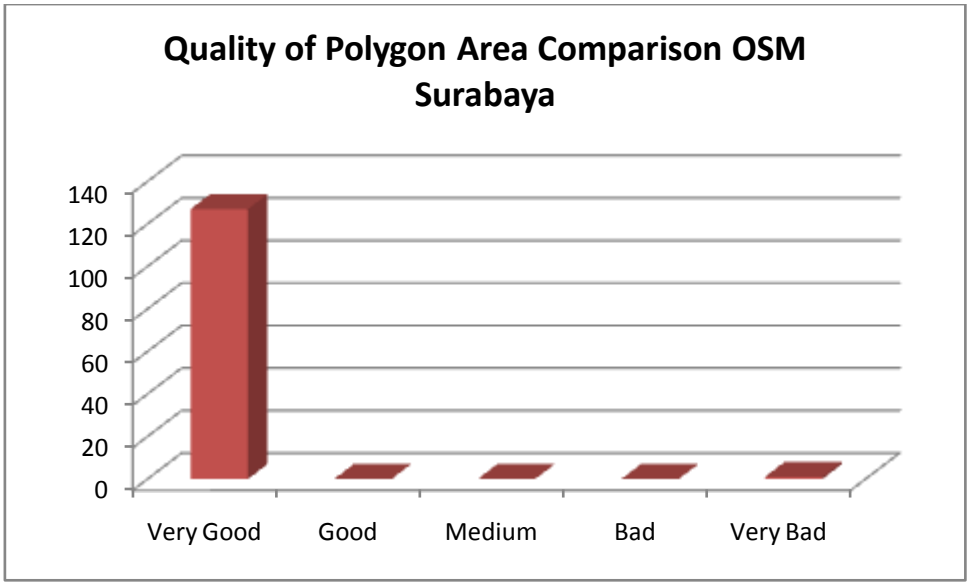


Fig. III. 18. Graphical Presentation of Polygon Area (ref.: Field Survey Data)

From this quality comparison, it can be concluded that the overall quality of polygon area comparison between OSM data and Field Survey Data in Surabaya is very good. Fairly said, the spatial area of OSM data in this study area is very close to the reference data, i.e. Field Survey Data in Surabaya.

ii) Topographic Map around Institute Teknologi Sepuluh November (DWG)

A sample size of 32 data was used to produce a comparative statistical analysis between reference data (Topographic Survey) and OSM sample data. The methods of analysis used were Polygon Circularity, Polygon Near-Distance, and Polygon Area. Calculated results from reference data are statistically tested using two tailed t-test with 90% level of confidence. The evaluation results are presented further as follows.

> Polygon Circularity.

Polygon Circularity Analysis was conducted to show the suitability of geometriy shape matching between the reference and evaluated data. The results of Polygon Circularity Analysis for OSM dataset in Surabaya City are summed in the table below:

Table III. 26. Statistical Characteristics from the Sample (Circularity)

Number of Data	32
Median	0.06019634965
Maximum Data	0.32142785394
Minimum Data	0.00103387278
Standar Deviation	0.087407102
Average	0.08518144223

The result of statistical comparison using t-test with 32 data sample is as follow: the two tailed t-test at 90% confidence level is 0.97453686, in which the t-table value for 32 data sample is 1.30946. Since the tested data is below the level of confidence, then it can be concluded that the data are not significantly different. This means that the sample data are relatively accurate.

The calculated value of data quality was then classified into several classes to show overall comparison results. Classification method used was equal interval, which divides the data into 5 interval classes.

Table III. 27. Classes of Polygon Circularity Quality Comparison in Surabaya (reference data: ITS Topographic Map)

Classes		Quality	Frequency
0.000	0.057	Very Good (1)	16
0.058	0.113	Good (2)	9
0.114	0.169	Median (3)	2
0.170	0.225	Bad (4)	1
0.226	0.281	Very Bad (5)	1
Number of Data			**29**

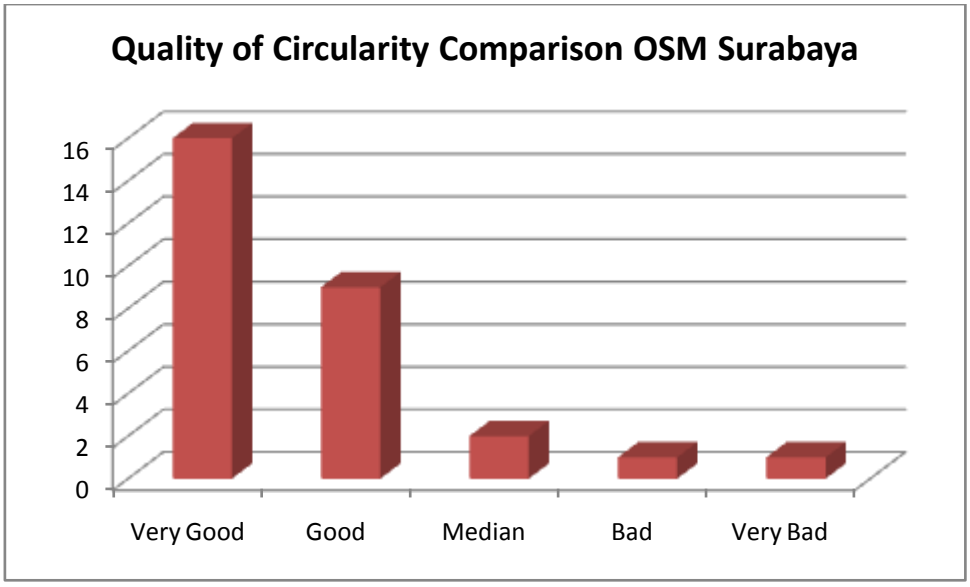


Fig. III. 19. Graphical Presentation of OSM Data Quality Compared to ITS Topographic Map

From this quality comparison it can be concluded that the overall quality of circularity comparison between OSM data and Topographic Map in Surabaya is acceptable. Fairly said, the geometry shape of OSM data in this study area is close with the reference data, i.e. Topographic Map.

> Polygon Near-Distance

Another analysis that was implemented into the 32 sample data from Topographic Map was Polygon Near-Distance. This method was used to show the spatial distance discrepancies between the reference and the evaluated data. The statistical characteristics of the data are:

Table III. 28. Statistical Characteristics from the Sample (Near-Distance)

Number of Data	32
Median	3.36986589552
Maximum Data	19.36695712050
Minimum Data	0.36565502866
standar deviation	3.167885971
Average	3.51891616628

The result of statistical comparison using t-test 32 data sample is as follow: the two tailed t-test at 90% confidence level is 0.025144568, in which the t-table value for 32 data

sample is 1.30946. Since the tested data is below the level of confidence, then it can be concluded that the data are not significantly different. This means that the sample data are relatively accurate.

The calculated value of data quality was then classified into several classes to show overall comparison results. Classification method used was equal interval, which divides the data into 5 interval classes.

Table III. 29. Classes of Near-Distance Quality Comparison in Surabaya (reference data: Topographic Survey data)

Class		Quality	Frequency
0.000	4.166	Very Good (1)	26
4.167	7.966	Good (2)	5
7.967	11.766	Medium (3)	0
11.767	15.567	Bad (4)	0
15.568	19.367	Very Bad (5)	1
Number of Data			**32**

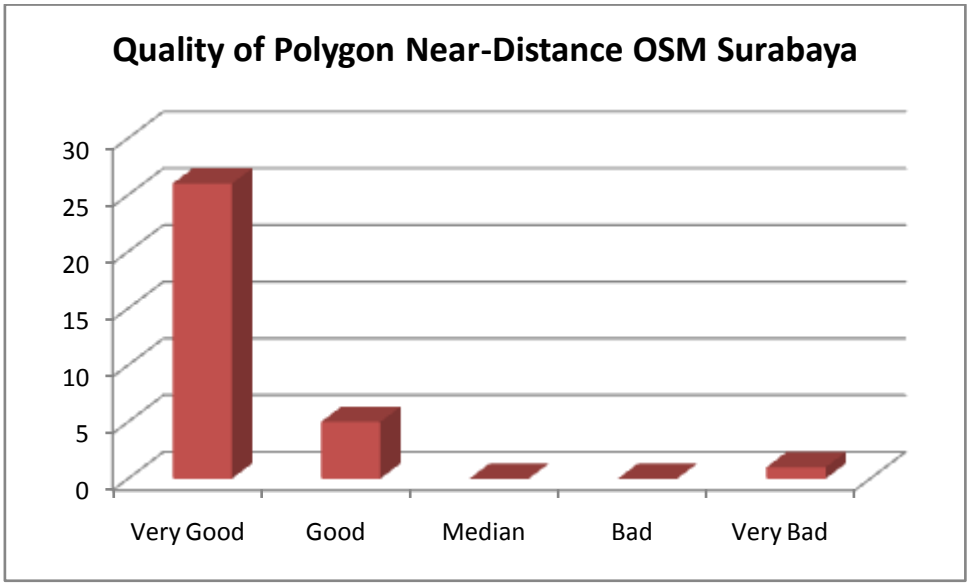


Fig. III. 20. Graphical Presentation of Polygon Near-Distance (ref.: Topographic Survey Data)

From this quality comparison, it can be concluded that the overall quality of polygon near distance comparison between OSM data and Topographic Map in Surabaya tends to be good.Further said, the spatial distance of OSM data in this study area is close to the reference data, i.e. ITS Topographic Map.

> Polygon Area

Polygon Area evaluation is conducted by comparing the area of OSM buildings data in Surabaya with the same buildings data from Topographic Map. The statistical characteristics of the result are shown below:

Table III. 30. Some Statistical Characteristics from the Sample (Polygon Area)

Number of Data	32
naideM	85,42270317950
Maximum Data	860,68784271000
Minimum Data	3,19584090000
Standard Deviation	205,5709288
Average	205,5709288

The result of statistical comparison using t-test with 32 data sample is as follow: the two-tailed t-test at 90% confidence value is 0.819899149, in which the t-table value for 32 data sample is 1.30946. Since the tested data is below the level of confidence, then it can be concluded that the data are not significantly different (This means that the sample data are relatively accurate).

The calculated value of data quality was then classified into several classes to show overall comparison results. Classification method used was equal interval, which divides the data into 5 interval classes.

Table III. 31. Classes of Polygon Area Comparison in Surabaya (reference data: ITS Topographic Map)

Classes		Quality	Frequency
0.000	174.694	Very Good (1)	25
174.695	346.193	Good (2)	2
346.194	517.691	Median (3)	1
517.692	689.189	Bad (4)	3
689.190	860.688	Very Bad (5)	1
Number of Data			**32**

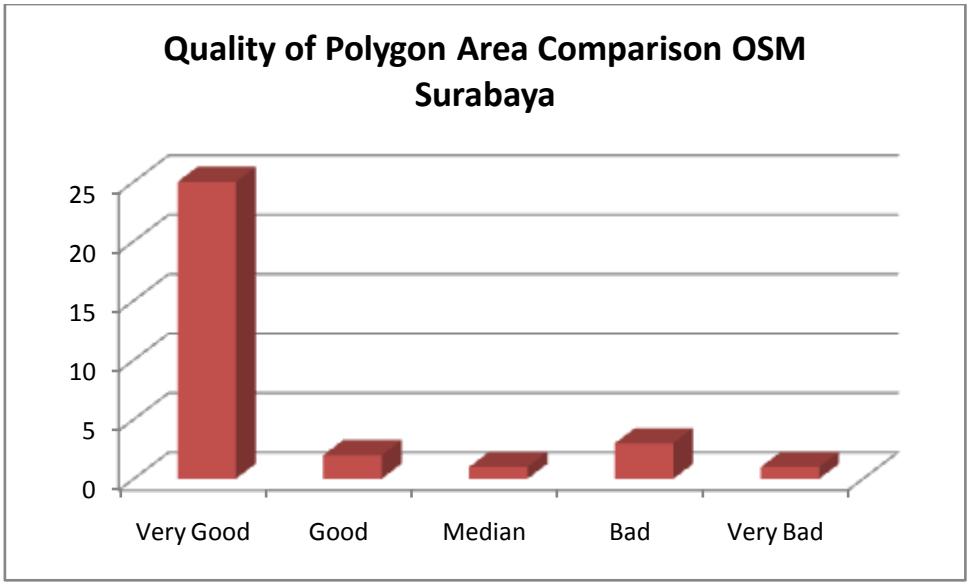


Fig. III. 21. Graphical Presentation of Polygon Area (ref.: Topographic Survey Data)

From this quality comparison, it can be concluded that the overall quality of polygon area comparison between OSM data and Topographic Survey Data in Surabaya is acceptable. Fairly said, the spatial area of OSM data in this study area is close with the reference data, i.e. Topographic Map.

iii). Surabaya's Road Network Map

Surabaya Road Network Map was used to perform comparative assessments between road features of OSM data and roads data of reference data in Surabaya. The analysis conducted consists of Buffer-overlap analysis and Line completeness analysis. The results of both methods will be presented as follows.

> Roads Buffer-Overlap Analysis

This method is used to investigate the discrepancies found between the reference data (Surabaya Road Network Map) and the evaluated data (OSM Roads Data in Surabaya) within a tolerance value. The tolerance value was defined based on the average width of a particular road class in real world (e.g. primary class road have a tolerance value of 8 meters). From the calculation then the results are presented as percentage values which represent the overlap of the evaluated data with the reference data. In this respect, a value of 100% gives us an interpretation that the particular roads are exactly within the tolerance value of the reference road. 42 samples are

randomly selected from the existing OSM road features in Surabaya to be analyzed. The statistical characteristics from the sample are listed below:

Table III. 32. Some Statistical Characteristics from the Sample (Line Buffer-Overlap percentage)

Number of Data	42
Median	71.2639
Maximum Data	100.0000
Minimum Data	0.0000
Standard Deviation	35.73225
Average	63.4636

To enhance the understanding of the data qualities, the data are then classified as shown below:

Table III. 33. Classes of Line Buffer-Overlap Comparison in Surabaya (reference data: ITS Topographic Map)

Classes (%)		**Quality**	**Frequency**
0	20	Very Good (1)	6
21	40	Good (2)	8
41	60	Medium (3)	3
61	80	Bad (4)	6
81	100	Very Bad (5)	19
Number of Data			**42**

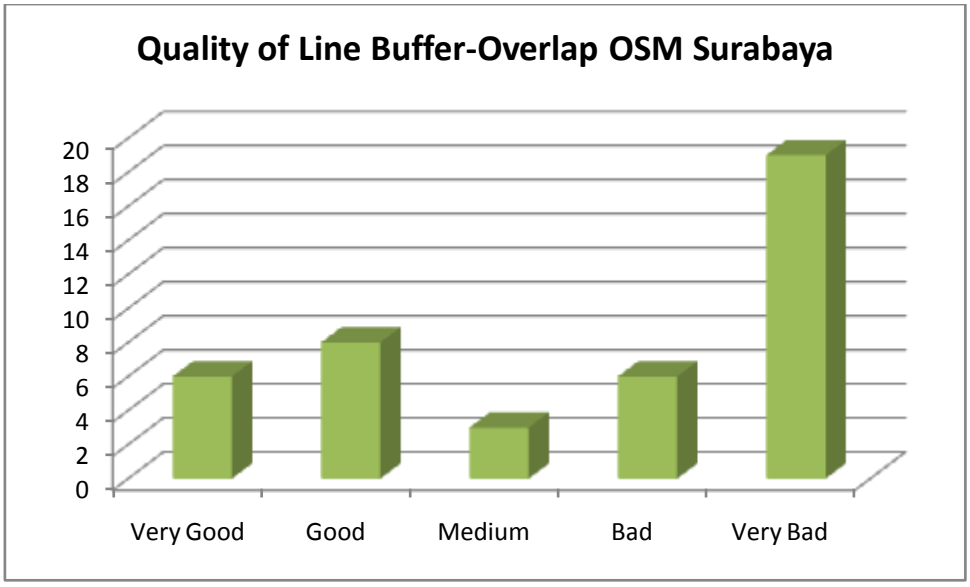


Fig. III. 22. Graphical Presentation of Quality Line Buffer-Overlap OSM Surabaya

From the analysis, it is shown that major part of the data sample (6 data or 14.3%) have a very good quality relative to the reference data; while some other (19 data or 45.2 %) had a very bad qualities. Thus, it can be concluded that the qualities of OSM roads data in Surabaya (using this method) are highly varied, relative to the reference data used.

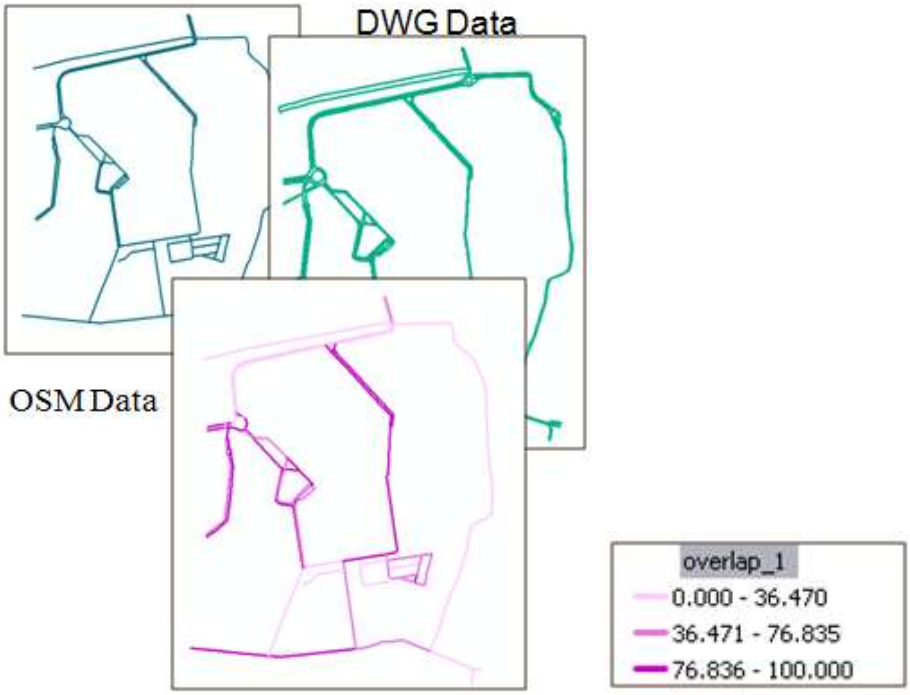


Fig. III. 23. Result of Roads Buffer-Overlap Analysis

b. Attribute Evaluation Results

This method analyze the quality of attribute (non spatial) data in OSM shapefile (particularly, the buildings layer). The attribute of the buildings in subject are listed and compared with its real world condition based on the groundtruthing survey. Some 128 samples are chosen to be evaluated from the whole buildings data in Surabaya. The results are based on scorings of the suitability between OSM data and the real world condition of the same building. The results are as follow:

Table III. 34. Classification of Attribute Quality Based on Score Value

Attribute Score	Attribute Quality	Frequency
≤ 2	Bad (3)	66
3	Medium (2)	52
5 ≥	Good (1)	10
Total		**128**

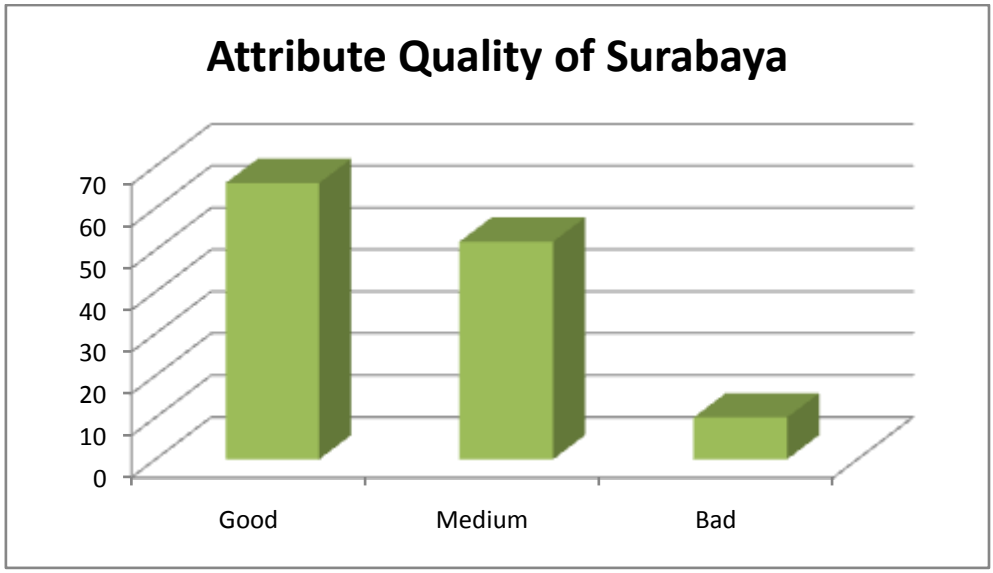


Fig. III. 24. Graphical Presentation of Attribut Quality OSM Surabaya

The result show that majority of the data in Surabaya have a 'Good' Attribute quality. Mostly, the 'Good' attribute qualities are a result of the full record in the attribute of the data, which affect the high scoring of the object in question.

c. Attribute Completeness

Attribute completeness is evaluation to represent the empty data and filled data from all of attributes OSM data competition.

Table III. 35. Classification of Attribute Completeness

Attributes	No Data	Filled Data
Name	3786	80
Use	73	3793
Structure	75	3791
Walls	80	3786
Roof	76	3790
Level	89	3777
Number of Data		3866

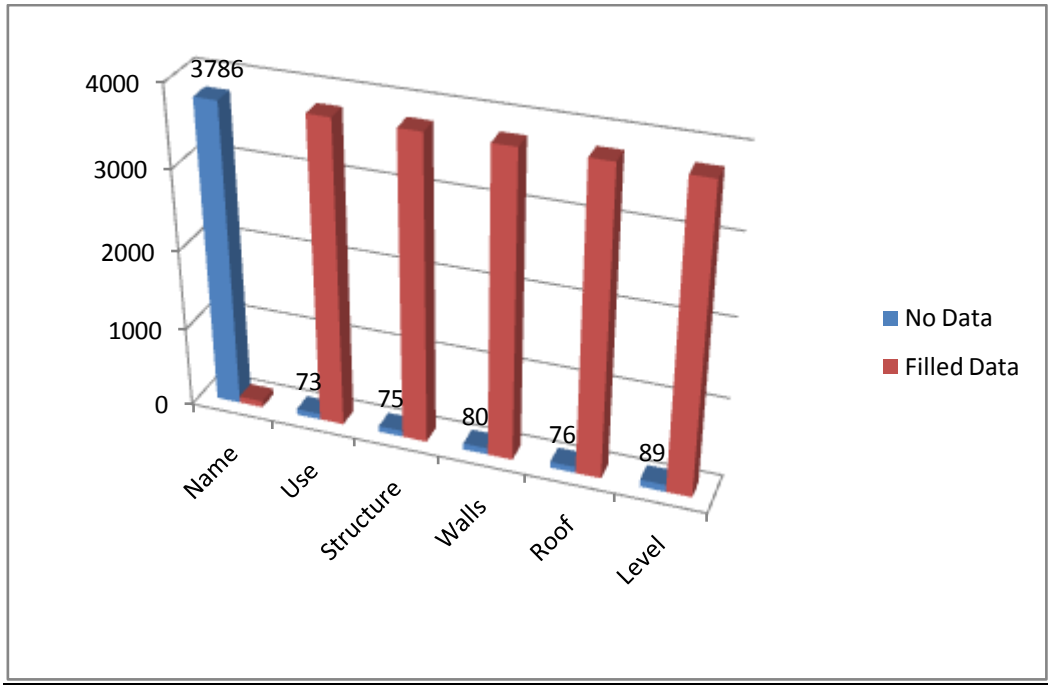


Fig. III. 25. Graphical Presentation of Attribut Completness

d. Contributor Evaluation

By contributor evaluation it means that this method assesses each contributor of the OSM competition data in the study area (in this case: around Surabaya): how much is the input data;

how far does the coverage of his/her contribution; and how dispersed/clustered the data that he/she contributed.

Table III. 36. Amount of Input Data per Contributor

No.	User	Count_user	Percentage (%)
1	andriysheva	2458	63,58
2	agunglaksono	777	20,10
3	bes_internal	430	11,12
4	armanke13	75	1,94
5	jerjozwik	54	1,40
6	Alhuda	25	0,65
7	imprasto	17	0,44
8	erviralin	14	0,36
9	jacksparrowbujana	5	0,13
10	anicintapooh	1	0,03
11	baihaqi-s50	1	0,03
12	cgu66	1	0,03
13	dawnbreak	1	0,03
14	Geogast	1	0,03
15	Ian Haylock	1	0,03
16	Kto	1	0,03
17	SteffenP	1	0,03
18	werner2101	1	0,03
19	Wira Soenaryo	1	0,03
20	wiyadi	1	0,03
Total		3866	100,00

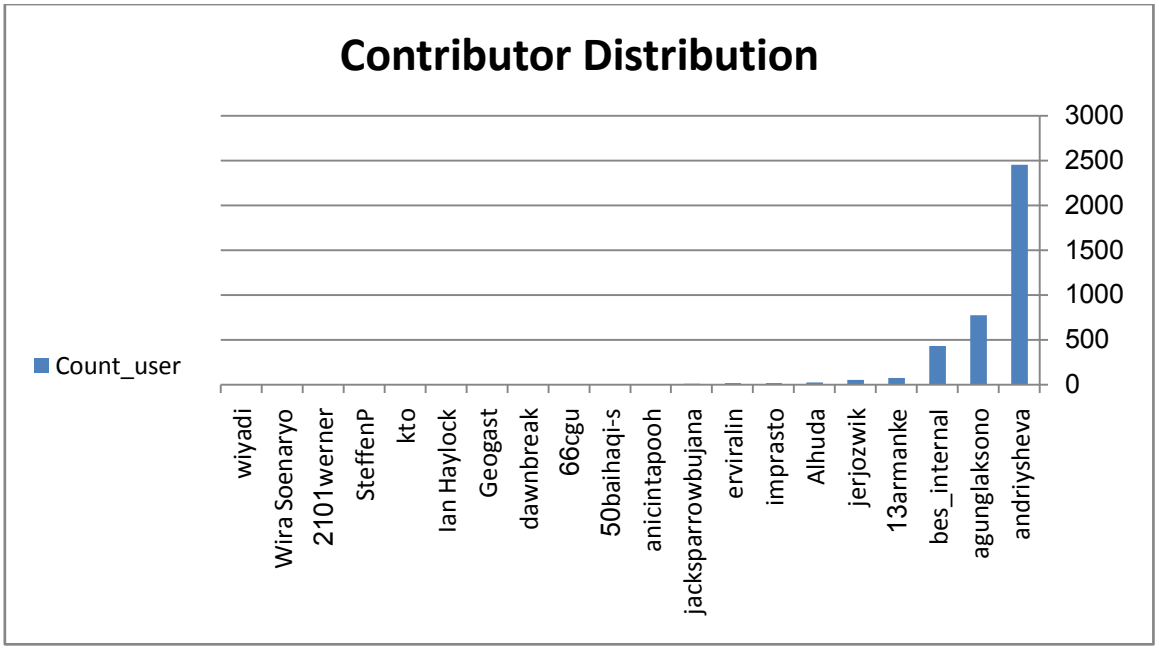


Fig. III. 26. Graphic of Contributor Distribution

III. Statistical Evaluation

Average Nearest Neighbour Test

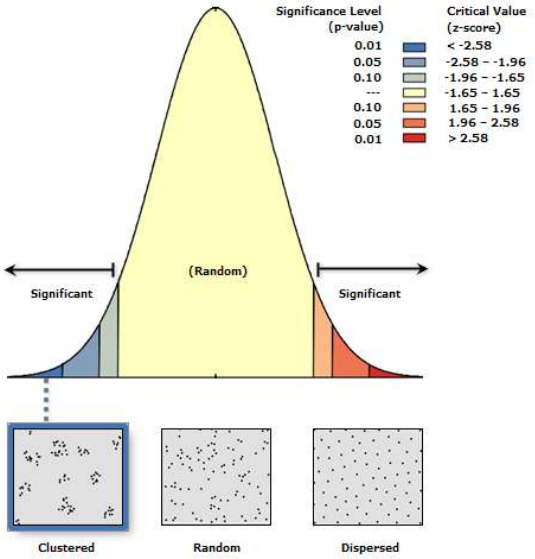


Fig. III. 27. Bell-Curve of Average Nearest Neighbour Critical Value

From the calculation above obtained z value of -97.602163. There is a 1% likehood that contributors input the data randomly. That's means, there is a high probability to input the data based on specific pattern (the data is clustered).

IV. Standard Distance

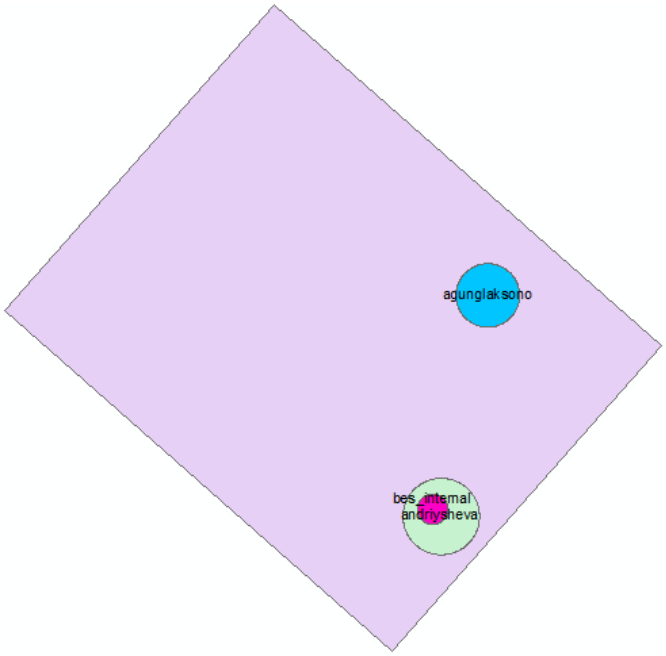


Fig. III. 28. Standard Distance of Contributor in Surabaya

Standard Distance shows the dispersion of each value around the center of data. The bigger circle in the above Figure means the more amount of the data, and the more dispersed the data is. Purple rectangle in background represents the outer boundary of all the data in Surabaya city.

V. Individual Contributor Evaluation

a. Contributor Andriysheva

Average Nearest Neighbour

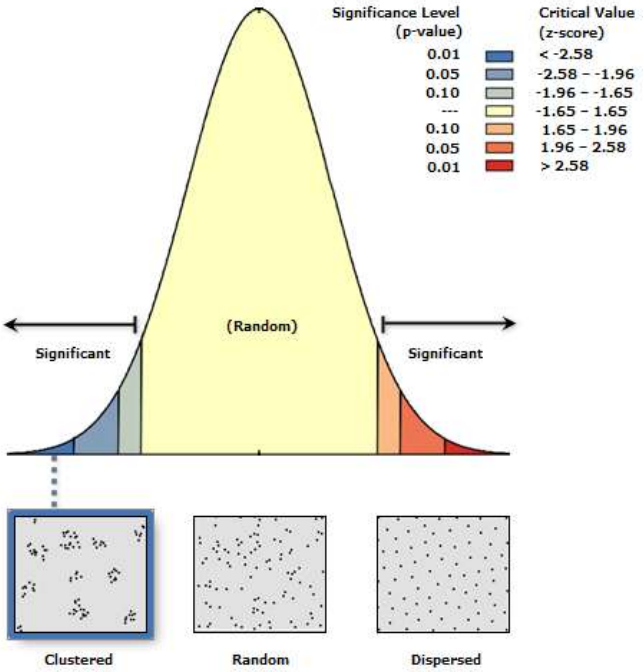


Fig. III. 29. Standard Distance of Contributor Andriysheva

From the calculation above obtained z value of -75.14. There is a 1% likehood that contributors input the data randomly. That's means, there is a high probability to input the data based on specific pattern (the data is clustered).

b. Contributor Agung Laksono

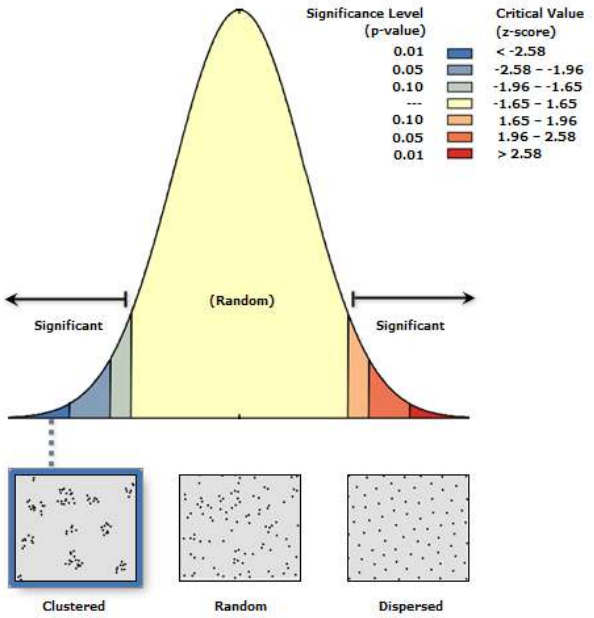


Fig. III. 30. Standard Distance of Contributor Agung Laksono

From the calculation above obtained z value of -29.06. There is a 1% likehood that contributors input the data randomly. That's means, there is a high probability to input th e data based on specific pattern (the data is clustered).

c. Contributor BesInternal

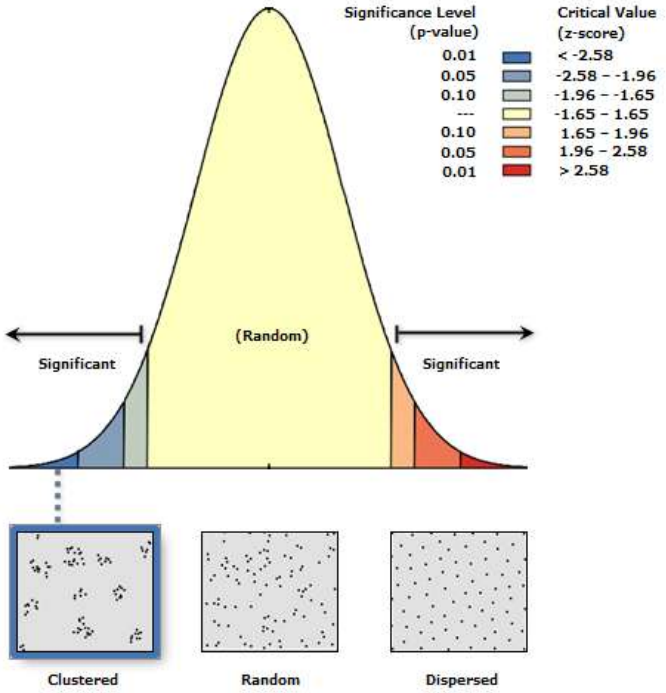


Fig. III. 31. Standard Distance of Contributor BesInternal

From the calculation above obtained z value of -18.25. There is a 1% likehood that contributors input the data randomly. That's means, there is a high probability to input the data based on specific pattern (the data is clustered).

d. Sample Case

Here's a sample of the evaluation results. The sample is a building feature which is Graha Sepuluh November building in real world, which situated in Sepuluh November Institute of Technology.

OpenStreetMap Feature Attribute

No.	osm_id	name	use	structure	walls	roof	levels
27	119276795	Graha Sepuluh Nopember	multipurpose	reinforced_masonry	brick		3

Attribute Evaluation (Based on Real World Condition. Score of '1' means 'correct'

namae (1)	use (1)	structure (1	walls (1)	roof (1)	level (1)	total (6)	Atribut_Quality
1	1	1	1	1	1	6	Good

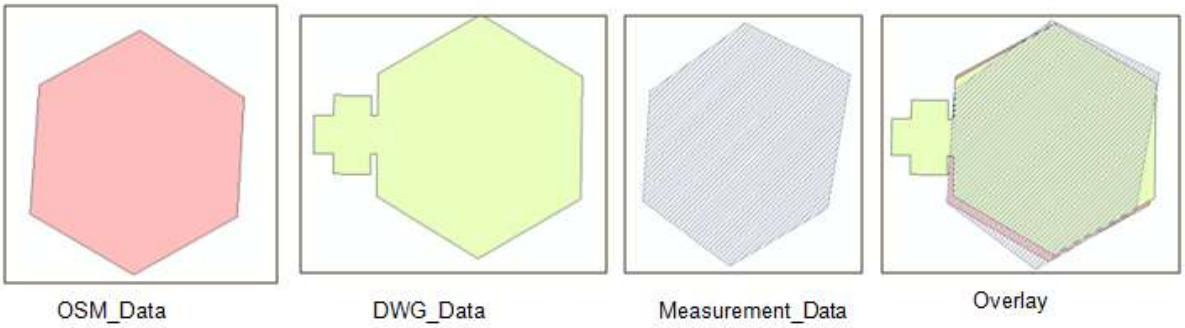


Fig. III. 32. Comparison of OSM Data, Survey Data, and Topographic (DWG) Data

Fig. III. 33. Figure of Graha 10 November, ITS (Front view)

Fig. III. 34. Figure of Graha 10 November, ITS (Rear view)

Fig. III. 35. Figure of Graha 10 November, ITS (Rear view)

The evaluation resulted in an overall Very Good quality of spatial and geometric accuracies, while attribute accuracy have a Good quality.

III.3. BANDUNG

III.3.1. Reference and Evaluation Data

OSM data in Bandung consist of buildings, roads, points, waterways, railways, natural, and landuse indicator. In order to simplify the evaluation, the OSM competition dataset that has been evaluated consists of shapefiles of buildings and road features, with amount of 1593 and 1455 data. The sampling methods of all competition data have 90% confidence interval or α = 10%.

Table III. 37. The sample calculation of OSM data in Bandung

No.	Indicator	Type	N	α = 10%
1	Points	Point	521	178
2	Waterways	Line	30	27
3	Roads	Line	1455	228
4	Railways	Line	6	6
5	Natural	Polygon	7	7
6	Landuse	Polygon	64	52
7	Buildings	Polygon	1593	231
Total			3676	730

Out of the numbers of data, some samples are chosen from the data to be evaluated. The data selections are based on the quality, distribution, and accessibility of the OSM competition data. In order to evaluate the quality of the OSM data, the selected samples were assessed against a reference data. For this purpose, the reference data that used in Bandung in the process include:

a. Groundtruthing (Field Survey) Data

   This data reference is produced from groundtruthing survey in Jan, 2nd – 5th 2012 using Mobile Mapper 10. The results of the survey are 94 buildings in Bandung. Because of some limitations during the survey, the GPS processing method of this data use Non Post-processing method instead of Post-processed one.

b. Topographic Measurement Data of Bandung

   This data is in the form of Autocad's DWG that was digitized from aerial photo's map with the scale at 1:1000.The aerial photo itself was conducted in 2003. Evaluation of this reference data involves 200 buildings and roads.

III.3.2. Analysis Result

The comparison results between reference data (i.e. Imagery and DWG data) and evaluated data (OpenStreetMap data) are presented as follows:

a) Spatial Evaluation Results

I. Groundtruthing Survey Using Mobile Mapper 10

A sample size of 94 data is used to produce a comparative statistical analysis between reference data (Groundtruthing Data) and the OSM sample data. The methods of analysis used are Polygon Circularity, Polygon Near-Distance, and Polygon Area. Calculated results from reference data are then statistically tested using t-test. These methods are explained further below.

1) Polygon Circularity

Polygon Circularity Analysis is conducted to show the geometric suitability between the reference and evaluated data. The results of comparative Polygon Circularity Analysis are summed in the table below:

Table III. 38. Statistical Characteristics from the Sample (Polygon Circularity)

Number of Data	94
Median	0.04318708174
Maximum Data	0.34253164319
Minimum Data	0.00185576364
Standard Deviation	0.061053412
Average	0.06286813753

The result of statistical comparison using t-test with sample size of 94 data is as follow:

The two-tailed t-test at 90% confidence level is 1.029723578, in which the t-table value for 94 data sample is 1.29072. Since the tested data is below the confidence level, then it can be concluded that the data are notare not significantly different (this means that the sample data are relatively accurate).

The calculated value of data quality is then classified into several classes to show overall comparison results. Classification method used is equal interval, which divide the data into 5 interval classes.

Table III. 39. Classes of Circularity Quality in Bandung (reference data: Groundtruthing Survey in Bandung)

Classes		Quality	Frequency
0.000	0.070	Very Good (1)	64
0.071	0.138	Good (2)	18
0.139	0.206	Medium (3)	10
0.207	0.274	Bad (4)	1
0.275	0.343	Very Bad (5)	1

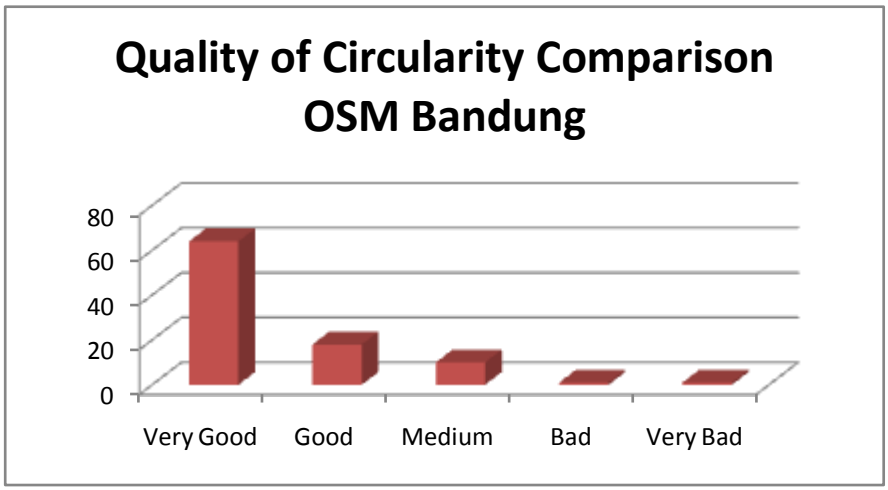


Fig. III. 36. Graphical presentation of OSM Data Quality Compared to groundtruthing survey data in Bandung

From this quality comparison, it can be concluded that the overall quality of circularity comparison between OSM data and groundtruthing survey in Bandung is quite good. Fairly said, the geometry shape of OSM data in this study area is close with the reference data, i.e. Field Survey Data.

2) Polygon Near Distance

The second analysis that was conducted with the 94 sample from groundtruthing survey data is Polygon Near-Distance. This method is developed to show the spatial discrepancies between reference and evaluated data. The statistical characteristics of the data are:

Table III. 40. Statistical Characteristics from the Sample (Polygon Near-Distance)

Number of Data	94
Median	4.77245242859
Maximum Data	23.70095534990
Minimum Data	0.51848906521
Standard Deviation	4.454019905
Average	5.96276866190

The result of statistical comparison using two-tailed t-test with 90% level of confidence is 0.035234805, while the t-table value for 90% level of confidence and 94 sample data is 1.29072. Therefore, the data are not significantly different (majority of the OSM polygon data in this location are spatially accurate in their location).

Classification of the calculated data using equal interval is presented below:

Table III. 41. Classes of Near-Distance Quality Comparison in Bandung (reference data: groundtruthing survey data)

Classes		Quality	Frequency
0	5.155	Very Good (1)	50
5.156	9.791	Good (2)	29
9.792	14.428	Medium (3)	10
14.429	19.064	Bad (4)	4
19.065	23.701	Very Bad (5)	1

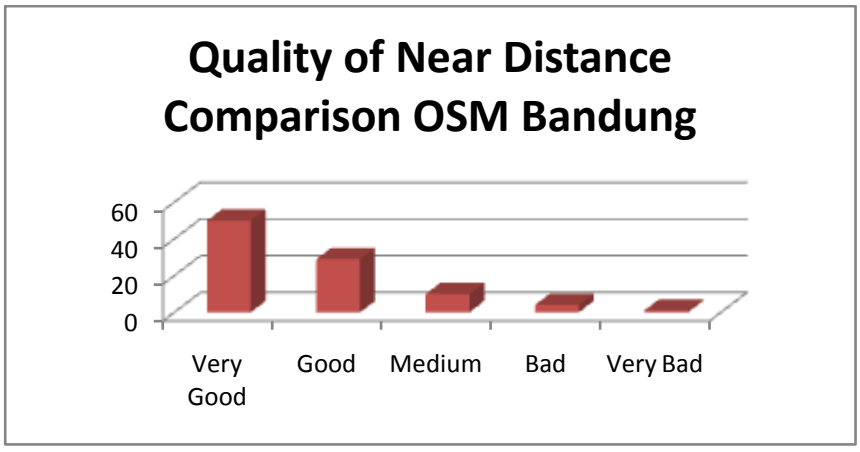


Fig. III. 37. Graphical presentation of Polygon Near-Distance comparison between OSM data quality and groundtruthing data.

From this quality comparison, it can be concluded that the overall quality of near distance comparison between OSM data and groundtruthing survey data in Bandung is very good. Further said, the spatial distance of OSM data in this study area is close to the reference data, i.e. Field Survey Data.

3) Polygon Area

Polygon Area evaluation is conducted by comparing the area of OSM buildings data in Bandung with the same buildings data from groundtruthing survey data. The statistical characteristics of the result are shown below:

Table III. 42. Statistical Characteristics from the Sample (Polygon Area)

Number of Data	94
Median	225.66560802000
Maximum Data	2512.53129270000
Minimum Data	0.99820731400
Standard Deviation	570.2607331
Average	441.59995890370

The result of statistical comparison using t-test with sample size of 94 data is given below:

The two-tailed t-test at 90% confidence level is 0.774382547, in which the t-table value for 94 data sample is 1.29072. So, the data are not significantly different (majority of the polygon OSM data have an acceptable spatial accuracy compared to the reference data).

Classification of the calculated data using equal interval is presented below:

Table III. 43. Classes of Polygon Area Comparison in Bandung (reference data: groundtruthing survey data)

Classes		Quality	Frequency
0.000	503.305	Very Good (1)	74
503.306	1005.611	Good (2)	6
1005.612	1507.918	Medium (3)	7
1507.919	2010.225	Bad (4)	4
2010.226	2512.531	Very Bad (5)	3

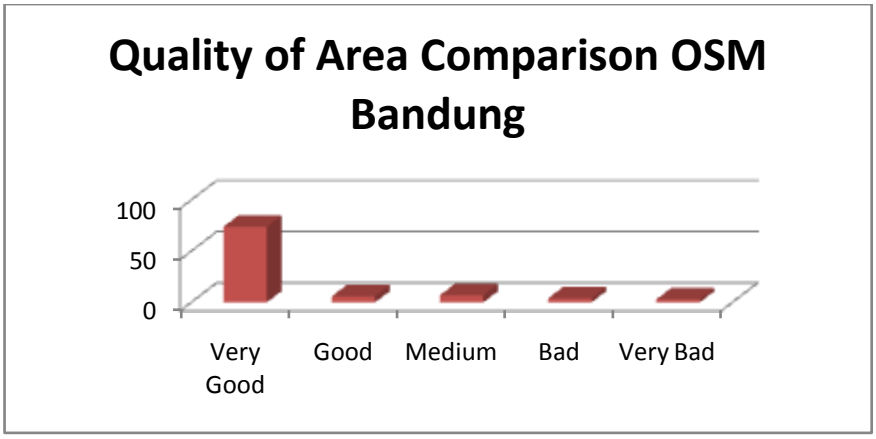


Fig. III. 38. Graphical presentation of Polygon Area Comparison (ref.: groundtruthing survey data)

From this quality comparison, it can be concluded that the overall quality of polygon area comparison between OSM data and groundtruthing survey data in Bandung is quite good. Fairly said, the spatial area of OSM data in this study area is close with the reference data, i.e. Field Survey Data.

II. Topographic Map in Bandung (in DXF format data)

A sample size of 200 data is used to produce a comparative statistical analysis between reference data (Topographic Map) and the OSM sample data. The methods of analysis used are Polygon Circularity, Polygon Near-Distance, and Polygon Area. Calculated results from reference data are then statistically tested using t-test. These methods are explained further below.

1) Polygon Cicularity

Polygon Circularity Analysis is conducted to show the suitability of geometry shape matching between the reference and evaluated data. The results of Polygon Circularity Analysis from OSM sample dataset in Bandung City are summed in the table below:

Table III. 44. Statistical Characteristics from the Sample (Polygon Circularity)

Number of Data	200
Median	0.06125999122
Maximum Data	0.54351205249
Minimum Data	0.00054766803
Standard Deviation	0.140885687
Average	0.12073838558

The result of statistical comparison using t-test with 200 data sample is as follow: The two tailed t-test at 90% confidence level is 0.856995402, in which the t-table value for 200 data sample is 1.28582. Since the tested data is below the level of confidence, then it can be concluded that the data are not significantly different (this means that the data are relatively accurate).

The calculated value of data quality is then classified into several classes to show overall comparison results. Classification method used is equal interval, which divide the data into 5 interval classes.

Table III. 45. Classes of Circularity Quality in Bandung (ref.data: Topographic Map)

Classes		Quality	Frequency
0.000	0.109	Very Good (1)	129
0.110	0.218	Good (2)	30
0.219	0.326	Medium (3)	17
0.327	0.435	Bad (4)	13
0.436	0.544	Very Bad (5)	10
Number of data			200

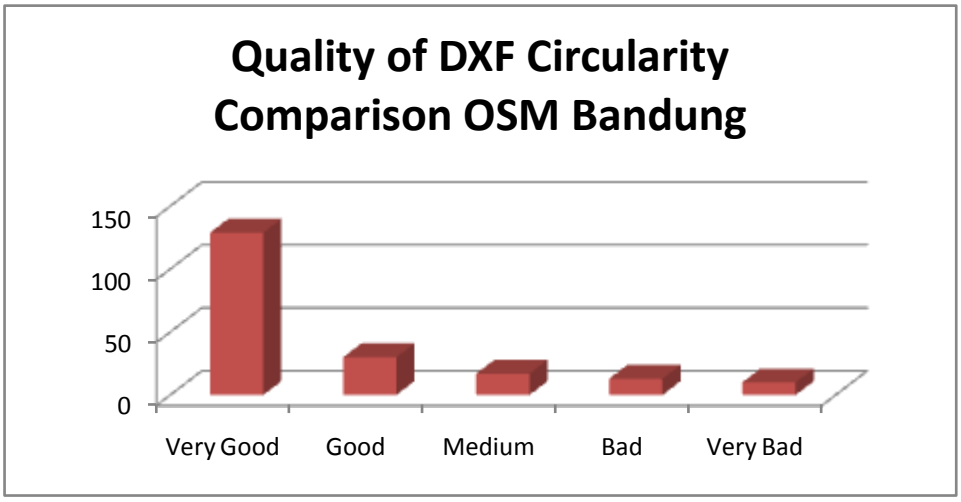


Fig. III. 39. Graphical presentation of OSM Data Quality Compared to Topographic Map in Bandung

From both the table and the graphic above it can be concluded that the overall quality of circularity comparison between OSM data and Topographic Map in Bandung is quite good. Further said, the geometry shape of OSM data in this study area is close with the reference data, i.e. Topographic Map.

> Polygon Near Distance

Another analysis that was conducted with the 200 sample data from Topographic Map is Polygon Near-Distance. This method is developed to show the spatial distance discrepancies between the reference and the evaluated data. Some statistical characteristics of the data are:

Table III. 46. Some Statistical Characteristics from the Sample (Polygon Near-Distance)

Number of Data	200
Median	4.08782870067
Maximum Data	31.22578629950
Minimum Data	0.23000496908
Standard Deviation	5.108900889
Average	5.81531676111

The result of statistical comparison using t-test at 90% level of confidence with sample size of 200 data give a calculated t-test value of 0.029805567, while the t-table value for 90% level of confidence and 200 sample data is 1.28582. Then, it can be concluded that the OSM data are not significantly different (majority of the polygon data are accurate in their location). Further said, the spatial distance of OSM data in this study area is close to the reference data, i.e. Topographic Map.

Classification of the calculated data using equal interval is presented below:

Table III. 47. Classes of Near-Distance Quality Comparison in Bandung (reference data: Topographic Measurement)

Classes		**Quality**	**Frequency**
0.000	6.429	Very Good (1)	152
6.43	12.628	Good (2)	30
12.629	18.827	Medium (3)	10
18.828	25.027	Bad (4)	5
25.028	31.226	Very Bad (5)	3
Number of data			**200**

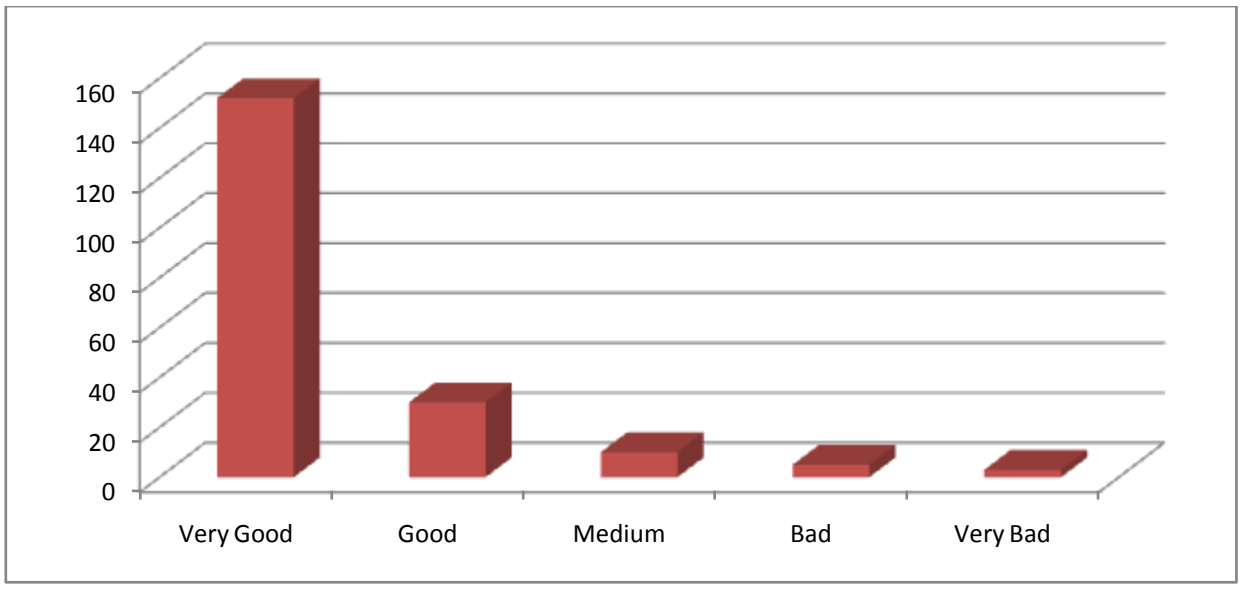


Fig. III. 40. Graphical presentation of Polygon Near-Distance (ref.: Topographic Measurement)

From this quality comparison, it can be concluded that the overall quality of near distance comparison between OSM data and Topographic Measurement in Bandung is very good. Further said, the spatial distance of OSM data in this study area is spatially close to the reference data, i.e. Topographic Map.

> Polygon Area

Polygon Area evaluation is conducted by comparing the area of OSM buildings data in Bandung with the same buildings data from Topographic Map. The statistical characteristics of the result are shown below:

Table III. 48. Statistical Characteristics from the Sample (Polygon Area)

Number of Data	200
Median	98.44714223080
Maximum Data	4433.43732147000
Minimum Data	0.11795945850
Standard Deviation	482.1605467
Average	241.83223982710

The result of statistical comparison using two-tailed t-test at 90% confidence level with sample size of 200 data is given below:

The t-test value of calculated statistics is 0.501559577, while the t-table value for a 90% level of confidence and sample size of 200 is 1.28582. So, the data are not significantly different. Classification of the calculated data using equal interval is presented below:

Table III. 49. Classes of Polygon Area Comparison in Bandung (reference data: Topographic Map)

Classes		Quality	Frequency
0.000	886.782	Very Good (1)	191
886.783	1773.446	Good (2)	5
1773.447	2660.11	Medium (3)	2
2660.111	3546.773	Bad (4)	1
3546.774	4433.437	Very Bad (5)	1
Number of data			**200**

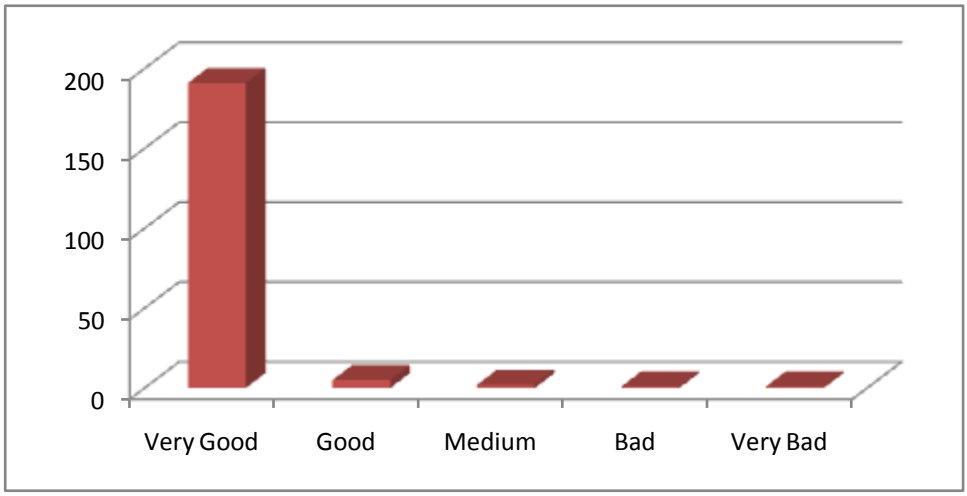


Fig. III. 41. Graphical presentation of Polygon Area (ref.: Topographic Map)

From this quality comparison, it can be concluded that the overall quality of polygon area comparison between OSM data and Topographic Measurement in Bandung is quite good. In a sum, the spatial area of OSM data in this study area is close with the reference data, i.e. Topographic Map.

> Line Buffer-Overlap analysis

This evaluation use line type of reference data, i.e. from the topographic map of Bandung. This kind of reference data is used to perform comparative analysis on line type of OSM data, i.e.

roads data in Bandung. The analysis conducted consists of Buffer-overlap analysis which results will be explained further.

This method is used to investigate the discrepancies between the reference data (Bandung Road Network Map) and the evaluated data (OSM Roads Data in Bandung) within a tolerance value. The tolerance value chosen are based on the average width of a particular road class in real world (e.g. primary class road have a tolerance value of 8 meters). The results are percentage values which represent the overlap of the evaluated data with the reference data, which means that 100% value give us a presentation that the particular roads are exactly within the tolerance value of the reference road. 155 samples are randomly chosen from the whole roads data in Bandung to be analyzed. The statistical characteristics from the sample are listed below:

Table III. 50. Statistical Characteristics from the Sample (Line Buffer-Overlap percentage)

Number of Data	155
Median	59.74937772000
Maximum Data	100.00000000200
Minimum Data	2.59717493939
Standard Deviation	29.90166438
Average	59.53177093126

To enhance the understanding of the data qualities, the data are then classified as shown below:

Table III. 51. Some Statistical Characteristics from the Sample in Bandung (Line Buffer-Overlap percentage)

Classes (%)		**Quality**	**Frequency**
0	20	Very Bad (5)	21
21	40	Bad (4)	24
41	60	Medium (3)	33
61	80	Good (2)	29
81	100	Very Good (1)	48
Number of data			**155**

(a) OSM roads data (b) Topographic Map roads data (DXF)

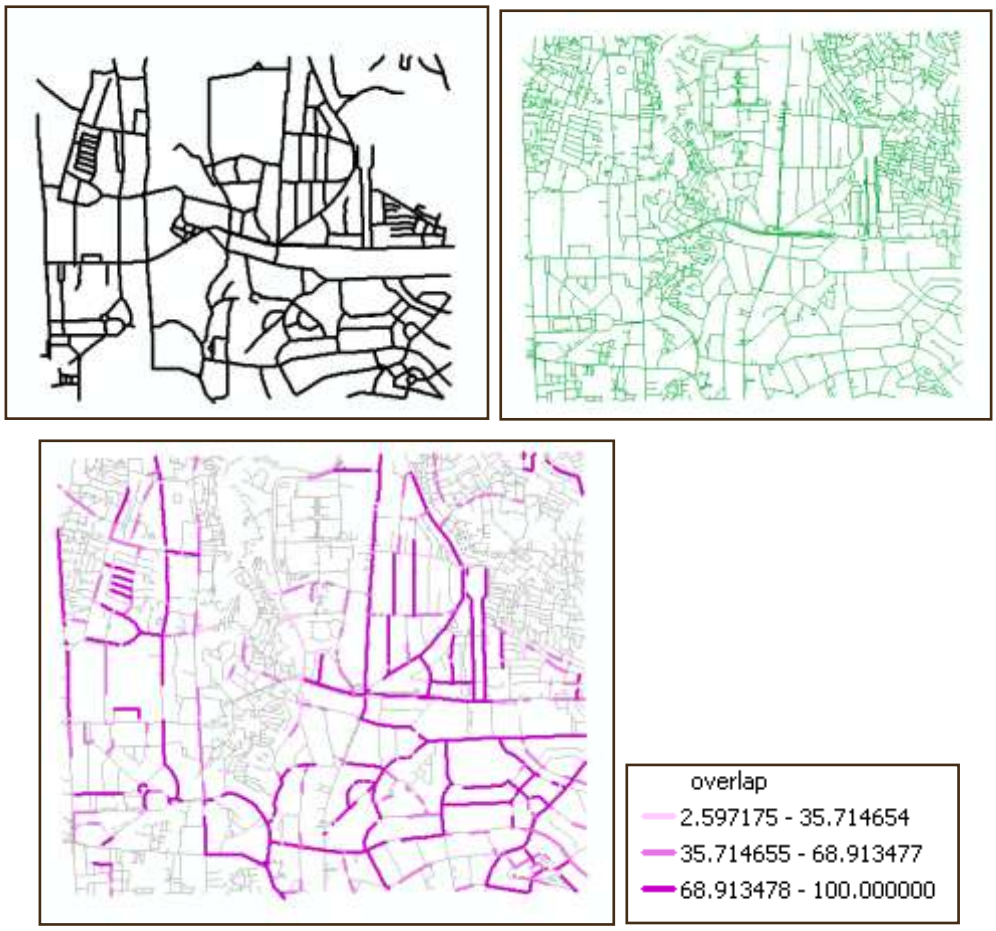


Fig. III. 42. Graphical evaluation results of buffering method (ref.: Topographic Map data)

From the analysis, it is shown that major part of the sampled data (48 data) have a Very Good (1) quality relative to the reference data; while some others (21 data) had a very bad (5) qualities. Thus, it can be concluded that the qualities of OSM roads data in Bandung (using this method) are highly varied, relative to the reference data used.

> Line Completeness analysis

This method compares the completeness between reference and evaluated data in each square grid. The analysis grids have a size of 1x1 km squares, with total of 9 grids used in Bandung. Below are the statistical results from the analysis:

Table III. 52. Statistical Characteristics from the Sample (Percentage of Completeness)

Number of Data	9
Median	38.47408147360
Maximum Data	74.33602316690
Minimum Data	17.47823442910
Standard Deviation	16.93480804
Average	40.17080928537

The classes are:

Table III. 53. Statistical Characteristics from the Sample (Percentage of Completeness)

Classes (%)		Quality	Frequency
0.000	20.000	Very Bad (5)	1
21.000	40.000	Bad (4)	4
41.000	60.000	Medium (3)	3
61.000	80.000	Good (2)	1
81.000	100.000	Very Good (1)	0
Number of grid			9

Figure below show the distribution of the grid qualities:

(a) OSM roads data (b) Topographic Map roads data

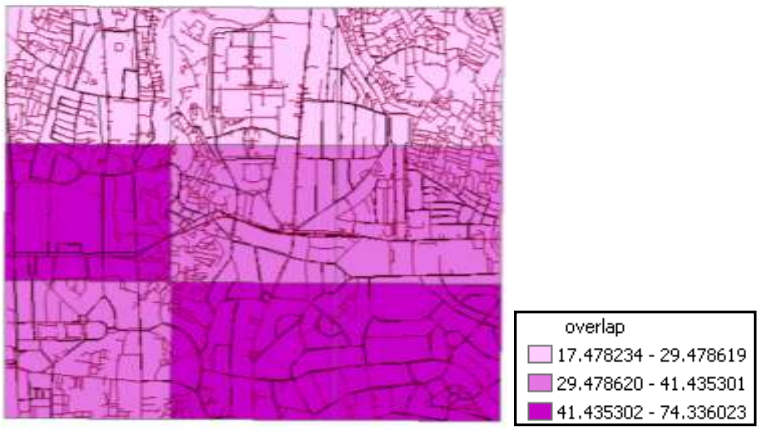


Fig. III. 43. Graphical evaluation result of completeness method (ref.: Topographic Map data)

b) Attribute Evaluation Results

This method analyze the quality of attribute (non spatial) data in OSM shapefile (particularly, the buildings layer). The attribute of the buildings in subject are listed and compared with its real world condition based on the groundtruthing survey. Some 94 samples are chosen to be evaluated from the whole buildings data in Bandung. The results are based on scorings of the suitability between OSM data and the real world condition of the same building. The results are as follow:

Table III. 54. Classification of Attribute Quality Based on Score Value

Number of value	Quality	Frequency
≤ 5	Good (1)	31
3	Medium (2)	58
2 ≥	Bad (3)	5
Total		**94**

The result shows that majority of the buildings data in Bandung have a 'medium' Attribute quality.

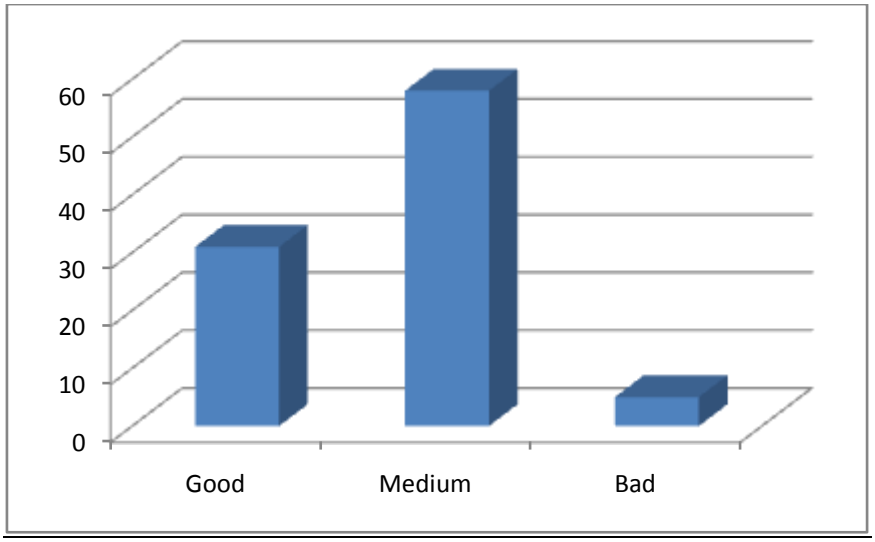


Fig. III. 44. Graphical presentation of Buildings Attribute Quality Based on Score Value

c. Attributes Completeness

Attribute completeness is evaluation to represent the empty data and filled data from all of attributes OSM data competition.

Table III. 55. Classification of attribute OSM data in Bandung

Attributes	No Data	Filled Data
Name	1400	193
Use	71	1522
Structure	76	1517
Walls	82	1511
Roof	77	1516
Level	81	1512
Number of Data		1593

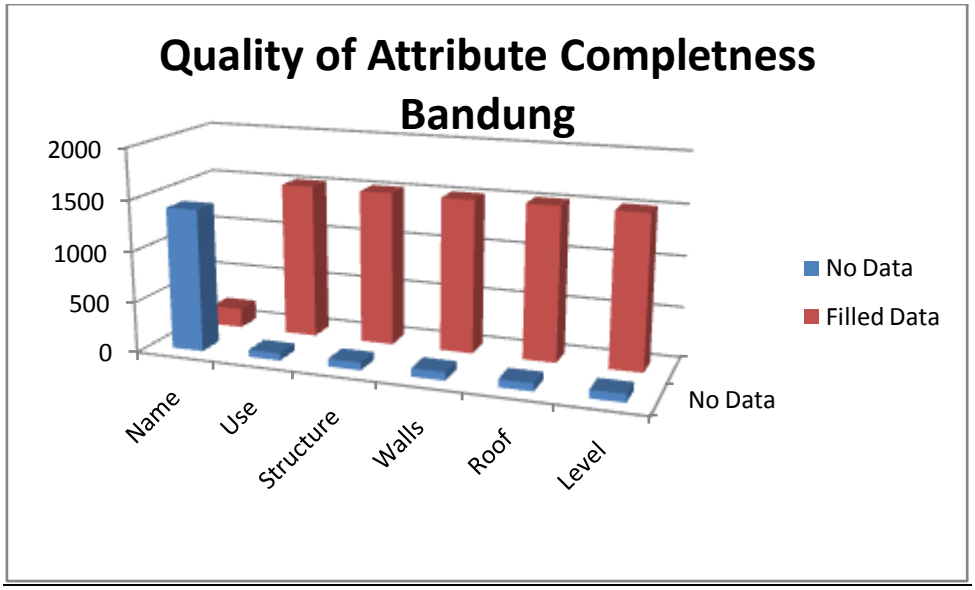


Fig. III. 45. Graphic of quality attribute completeness roads in Bandung

i. Contributor Evaluation

By contributor evaluation it means that this method assesses each contributor of the OSM competition data in the study area (in this case: around Bandung): how much is the input data; how far does the coverage of his/her contribution; and how dispersed/clustered the data that he/she contributed.

Table III. 56. Amount of Input Data per Contributor

No	user	Count_user	Percentage (%)
1	Irwan	1084	68,05
2	Juniansyah Fauzi	298	18,71
3	Debby Rahmi	98	6,15
4	ArjanO	40	2,51
5	addifa	17	1,07
6	myas	8	0,50
7	Notaris	7	0,44
8	adhitya	6	0,38
9	katpatuka	6	0,38
10	wonderchook	6	0,38
11	Yescha Nuradisa	6	0,38

12	manic12	4	0,25
13	agungrizkyfajri	3	0,19
14	zudha	3	0,19
15	ayugantoro	2	0,13
16	Andre68	1	0,06
17	dawnbreak	1	0,06
18	evo2mind	1	0,06
19	werner2101	1	0,06
20	xybot	1	0,06
Total		1593	100,00

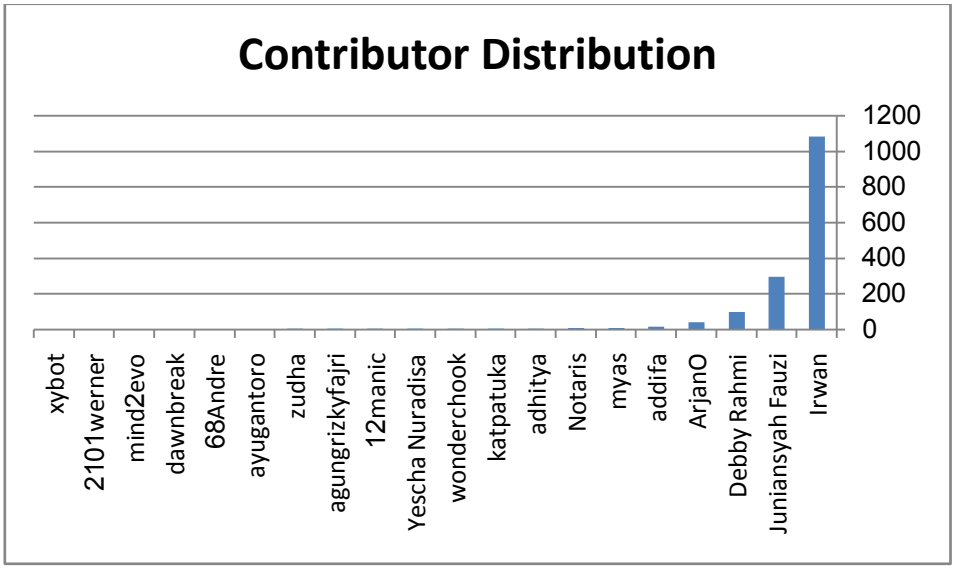


Fig. III. 46. Graphic of Contributor Distribution

ii. Statistical Evaluation

- *Average Nearest Neighbour*

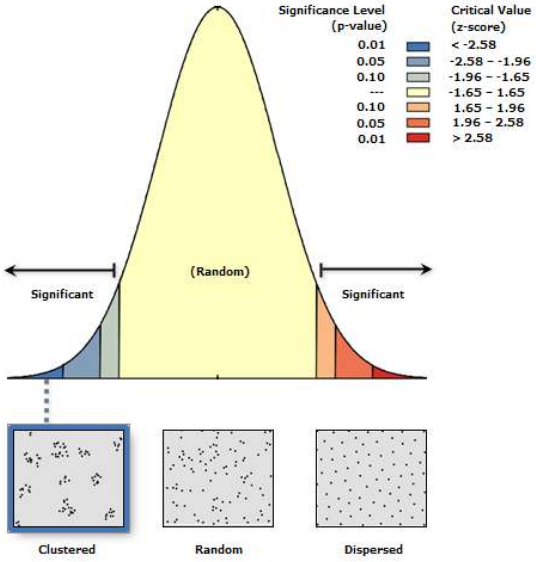


Fig. III. 47. Average Nearest Neighbour

From the calculation above obtained z value of -59.53. There is a 1% likehood that contributors input the data randomly. That's means, there is a high probability to input the data based on specific pattern (the data is clustered).

iii. Standard Distance

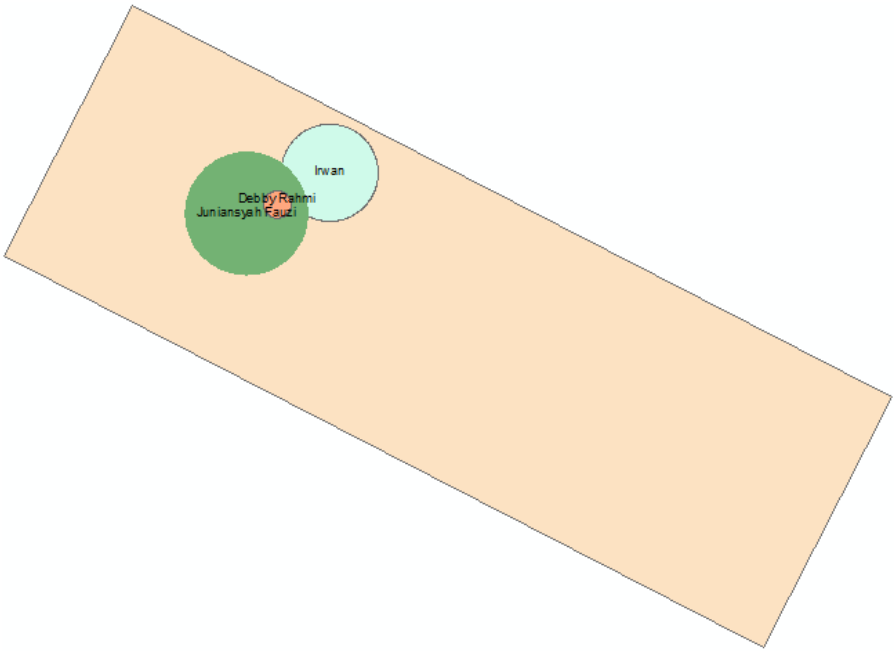


Fig. III. 48. Standard Distance of Contributor in Bandung

Standard Distance shows the dispersion of each value around the center of data. The bigger circle in the above Figure means the more amount of the data, and the more dispersed the data is. Peach colored rectangle in the background represents the outer boundary of all the data in Bandung city.

iv. Individual ContributorEvaluation

- *Contributor Irwan*

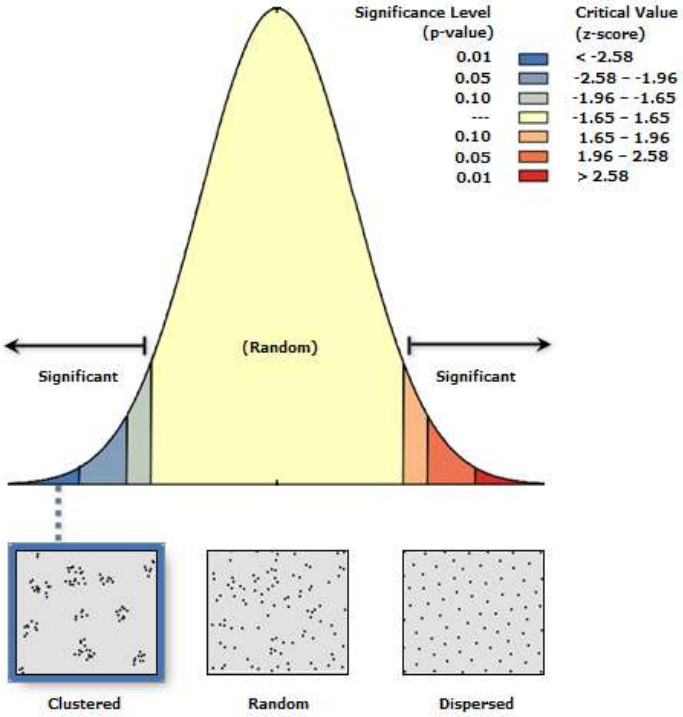


Fig. III. 49. Evaluation contributor of iwan

From the calculation above obtained z value of -42.80. There is a 1% likehood that contributors input the data randomly. That's means, there is a high probability to input the data based on specific pattern (the data is clustered).

➢ *Contributor Juniansyah Fauzi*

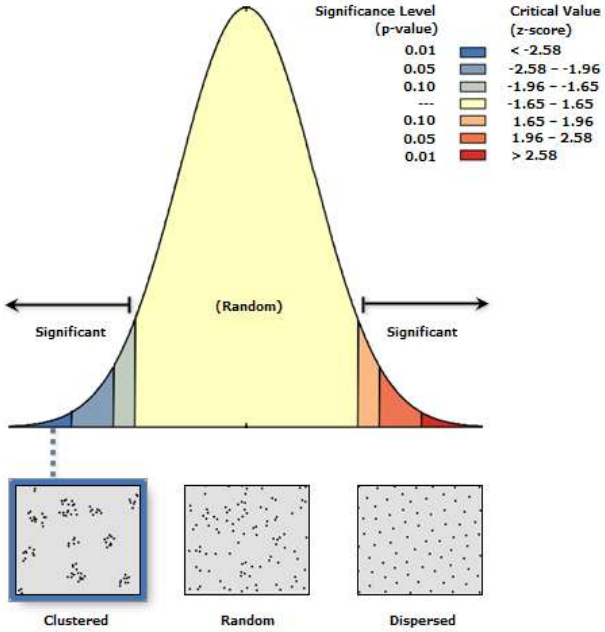


Fig. III. 50. Evaluation contributor of Juniansyah Fauzi

From the calculation above obtained z value of -26.14. There is a 1% likehood that contributors input the data randomly. That's means, there is a high probability to input the data based on specific pattern (the data is clustered).

➢ *Contributor Debby Rahmi*

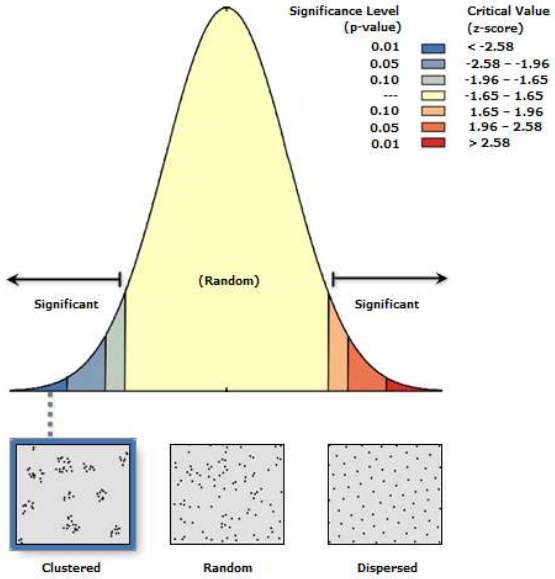


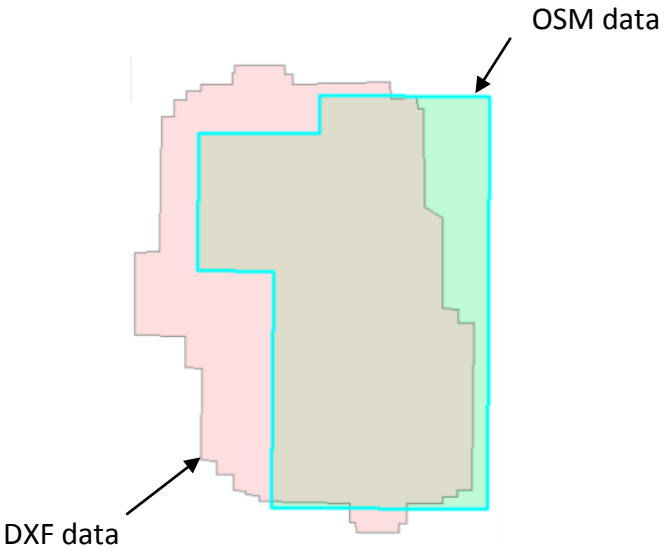
Fig. III. 51. Evaluation contributor of Debby Rahmi

From the calculation above obtained z value of -12.32. There is a 1% likehood that contributors input the data randomly. That's means, there is a high probability to input the data based on specific pattern (the data is clustered).

c) Sample Case

Here is a sample of the evaluation results. The sample is a building feature which is ITB Central Library that is located at Jl.Ganesha 10.

- Shape comparison between evaluated data (OSM data) and reference data (dxf data)



- OSM feature attribute

OSM_id	name	use	structure	walls	roof	levels	Contributor	date
119439453	ITB Central Library	education	reinforced_masonry	brick	concrete	4	Juniansyah Fauzi	2011-06-28T10:24:20Z

- Attribute evaluation (based on survey the real world of the building), 1 = correct, 0 = incorrect

name (1)	use(1)	structure(1)	walls(1)	roof(1)	level(1)	total (6)	Atribute_Quality
1	1	1	1	1	1	6	Baik

- Below are the evaluation results according to spatial and attribute evaluation method of that building:

Building evaluation Methods	Value	Quality
Circularity	0.0374023	Very Good
Near distance	7.8130734	Very Good
Area	387.99289	Very Good

- The pictures of ITB Central Library :

(a) Front view (b) Side view

(c) Back view (d) Side view

Fig. III. 52. The ITB central library building.

III.4. JAKARTA

III.4.1. Reference and Evaluation Data

The OSM competition dataset that has been evaluated in Jakarta consist of competition data in form of buildings and roads shapefile data. The number of the data 4258 and 5166 data, respectively. Out of that numbers, some samples are chosen from the data to be evaluated. The data selections are based on the quality, distribution and accessibility of the OSM competition data itself.

In order to evaluate the quality of the OSM data, the selected samples were assessed against a reference data. For this purpose, the reference data that used in the process include:

1) Field Survey Data

   Field Survey using Mobile Mapper 10, conducted in Dec 28th, 2011 – Jan 1st, 2012. The results of the survey are 100 measured buildings.

2) Topographic Map with the scale at 1: 5000, generated from Aerial Photo digitations (acquired in 2008). The form of the data is AutoCAD's DWG.

III.4.2. Analysis Results

The comparison results between reference data (i.e. field survey and DWG data) and evaluated data (OpenStreetMap data) are presented as follows:

a. Spatial Evaluation Results

i). Field Survey in Jakarta

A sample size of 100 data is used to produce a comparative statistical analysis between reference data (field survey) and the OpenStreetMap sample. The methods of analysis used are Polygon Circularity, Polygon Near-Distance, and Polygon Area. Calculated results from reference data are then statistically using t-test. The methods are explained further below.

> Polygon Circularity.

Polygon Circularity Analysis is conducted to show the suitability of geometry shape matching between the reference and evaluated data. The results of Polygon Circularity Analysis for OSM sample dataset in Jakarta City are summed in the table below:

Table III. 57. Statistical Characteristics from the Sample (Circularity)

Number of Data	100
Median	0.03498785737
Maximum Data	0.32569999444
Minimum Data	0.00007981167
Standard Deviation	0.065459482
Average	0.05278439280

The result of statistical comparison using t-test with 100 data sample is as follow: the two-tailed t-test at 90% confidence level is 0.865626509, in which the t-table value for 100 data sample is 1.29016. Since the tested data is below the level of confidence, then it can be concluded that the data are not significantly different (this means that the data are relatively accurate).

The calculated value of data quality is then classified into several classes to show overall comparison result. Classification method used is equal interval, which divides the data into 5 interval classes.

Table III. 58. Classes of Circularity Quality in Jakarta (reference data: field survey)

Classes		Quality	Frequency
0.000	0.065	Very Good (1)	73
0.066	0.13	Good (2)	15
0.131	0.195	Medium (3)	5
0.196	0.261	Bad (4)	4
0.262	0.326	Very Bad (5)	3
Number of data			100

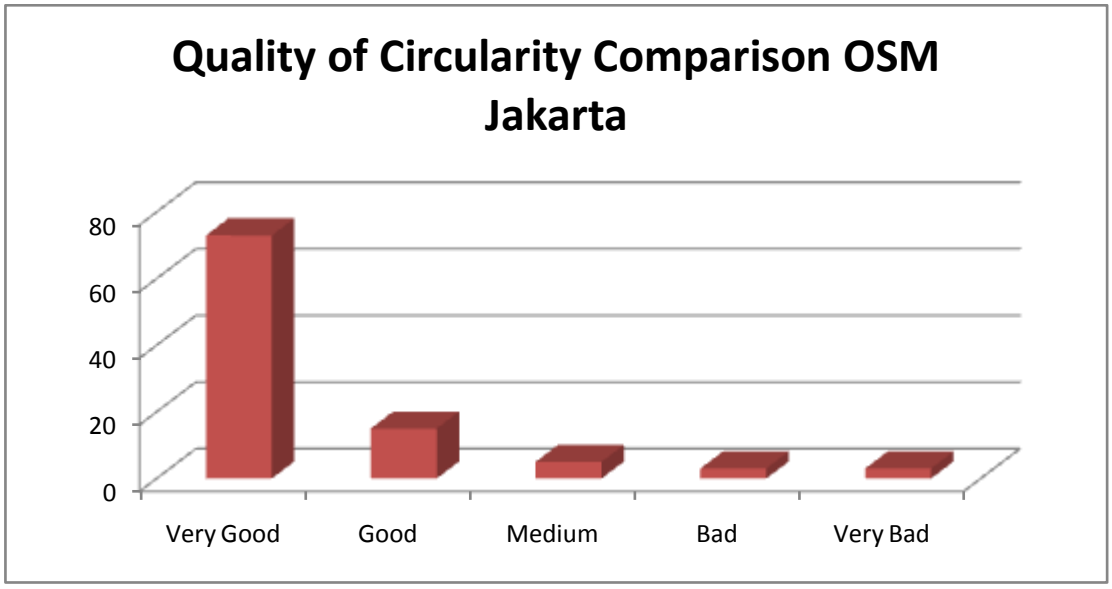


Fig. III. 53. Graphical presentation of OSM Data Quality Compared to Field Survey

From this quality comparison, it can be concluded that the overall quality of circularity comparison between OSM data and field survey in Jakarta is acceptable. Fairly said, the geometry shape of OSM data in this study area is close with the reference data, i.e. Field Survey Data.

> Polygon Near-Distance

Another analysis that was conducted with the 100 sample data from field survey is Polygon Near-Distance. This method is developed to show the spatial distance discrepancies between the reference and the evaluated data. Some statistical characteristics of the data are:

Another analysis that was conducted with the 100 sample from GMU Topographic Measurement is Polygon Near-Distance. This method is developed to show the spatial discrepancies between reference and evaluated data. The statistical characteristics of the data are:

Table III. 59. Statistical Characteristics from the Sample (Near-Distance)

Number of Data	100
Median	4.85749709688
Maximum Data	83.99416709200
Minimum Data	0.40721868281
Standard Deviation	10.81793944
Average	8.08460841047

The result of statistical comparison using t-test at 90% level of confidence with 100 sample data gives a calculated t-test value of 0.020709581. As, the z value for 90% level of confidence for 100 sample data is 1.29016, then, it can be concluded that OSM data are are not significantly different .

Classification of the calculated data using equal interval is presented below:

Table III. 60. Classes of Near-Distance Quality Comparison in Yogyakarta (reference data: field survey)

Classes		Quality	Frequency
0.000	17.125	Very Good	92
17.126	33.842	Good	6
33.843	50.559	Medium	1
50.56	67.277	Bad	0
67.278	83.994	Very Bad	1
Number of data			**100**

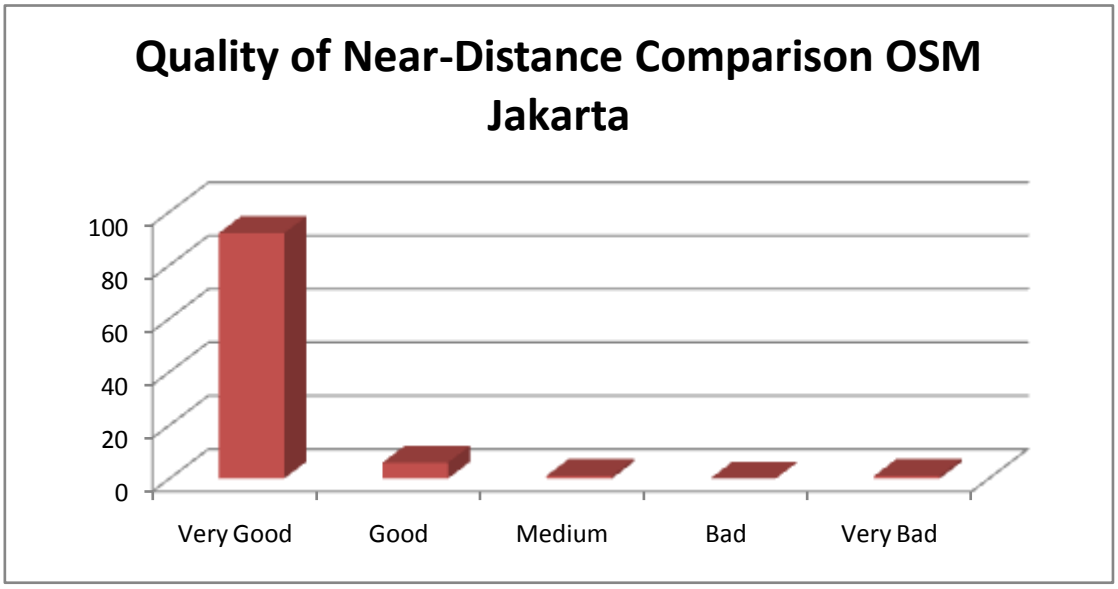


Fig. III. 54. Graphical presentation of Polygon Near-Distance (ref.: Field Survey)

From this quality comparison, it can be concluded that the overall quality of Near-Distance comparison between OSM data and Field Survey is very good. Fairly said, the spatial distance of OSM data in this study area have a very good accuracy compared to the reference data, i.e. Field Survey in Jakarta.

> Polygon Area

Polygon Area evaluation is conducted by comparing the values of OSM buildings' areas between OSM sample data and field survey. The statistical characteristics of the result are shown below:

Table III. 61. Statistical Characteristics of the Sample (Polygon Area Evaluation)

Number of Data	100
Median	364.56462565400
Maximum Data	7833.51221364000
Minimum Data	66.91160659
Standard Deviation	1240.646145
Average	842.94359427876

The result of statistical comparison using t-test with sample size of 100 data is given below:

The two-tailed t-test at 90% confidence level is 0.679439176, while the t-table value for a 90% level of confidence for 100 data sample is 1.29016. So, the data are not significantly different (the differences in building areas are relatively low).

Result's classification using equal interval is presented below:

Table III. 62. Classes of Polygon Area Comparison in Jakarta (reference data: Field Survey)

Classes		Quality	Frequency
0.000	1620.232	Very Good (1)	84
1620.233	3173.552	Good (2)	12
3173.553	4726.872	Medium (3)	2
4726.873	6280.192	Bad (4)	1
6280.193	7833.512	Very Bad (5)	1
Number of data			**100**

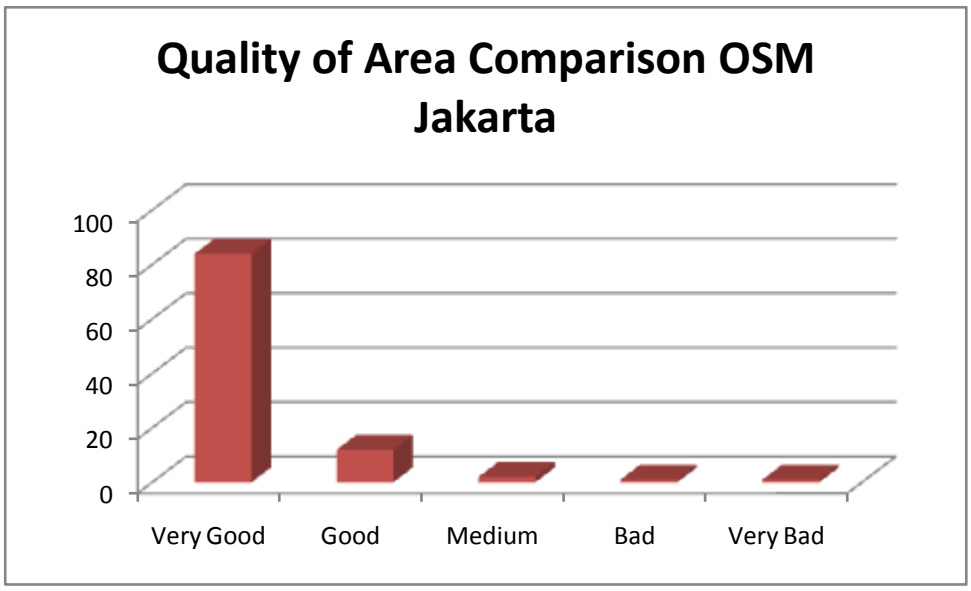


Fig. III. 55. Graphical presentation of Polygon Near-Distance (ref.: field survey in Jakarta)

From this quality comparison, it can be concluded that the overall quality of polygon area comparison between OSM data and Field Survey is quite good. Fairly said, the spatial area of OSM data in this study area have a good accuracy compared to the reference data, i.e. field survey in Jakarta.

ii). DWG of South Jakarta 1:5000 Topographic Map (2008)

Second reference data that are available in this study area is Topographic Map obtained from aerial photo (2008) with scale at 1: 5000. A sample size of 200 buildings data are selected to be compared with its corresponding OSM buildings data.

> Polygon Circularity.

The result of comparison between 1000 OSM data and the topographic map are presented below:

Table III. 63. Statistical Characteristics from the Sample (Circularity)

Number of Data	200
Median	0.097294372
Maximum Data	0.45131961689
Minimum Data	0.000302489
Standard Deviation	0.108014678
Average	842.9435943

The calculated t-test value is 1.101736451, while the t-table value for 90% confidence level and 200 sample data is 1.28582. Therefore, the sample data are not significantly different to the reference data.

The results of quality assessments are then classified into 5 classes using equal interval classification method.

Table III. 64. Classes of Circularity Quality in Jakarta (reference data: Topographic Map of South Jakarta)

Class		Quality	Frequency
0.000	0.091	Very Good (1)	96
0.092	0.181	Good (2)	51
0.182	0.271	Medium (3)	33
0.272	0.361	Bad (4)	12
0.362	0.451	Very Bad (5)	8
Number of data			200

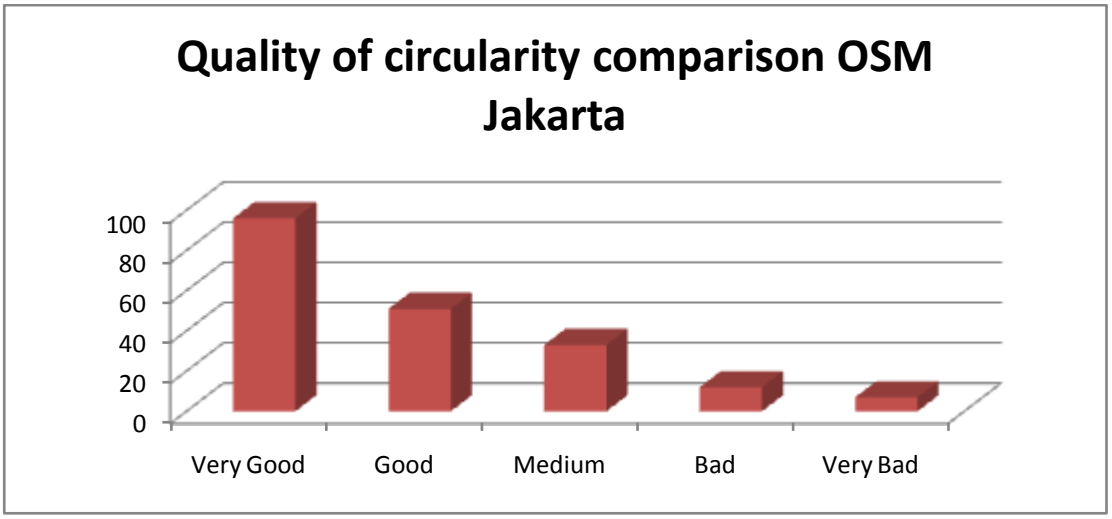


Fig. III. 56. Graphical Presentation of OSM Data Quality Compared to Topographic Map of South Jakarta

From this quality comparison, it can be concluded that the overall quality of circularity comparison between OSM data and Jakarta Topograhic Map is good. Fairly said, the geometry shape of OSM data in this study area are close with the reference data.

> Polygon Near-Distance

From 200 samples selected, Polygon near-distance analysis was conducted to assess the spatial discrepancies. Some important statistical characteristics of the data are:

Table III. 65. Statistical Characteristics from the Sample (Near-Distance)

Number of Data	200
Median	4.95921883415
Maximum Data	27.28955086
Minimum Data	0.404924971
Standard Deviation	4.598029423
Average	6.367904825

The two-tailed t-test at 90% level of confidence resulted as 0.036917566, in which the t-table value for 200 sample size is 1.28582. Therefore, it can be concluded that majority of the buildings from reference and evaluated data are considered to be matched very well. Further said, the spatial distance of OSM data in this study area is close to the reference data, i.e. Topographic Map.

Classification of the calculated data using equal interval is presented below:

Table III. 66. Classes of Near-Distance Quality Comparison in Jakarta (reference dataTopograhic Map of South Jakarta)

Classes		Quality	Frequency
0.000	5.782	Very Good (1)	113
5.783	11.159	Good (2)	61
11.16	16.536	Medium (3)	17
16.537	21.913	Bad (4)	7
21.914	27.29	Very Bad (5)	2
Number of data			**200**

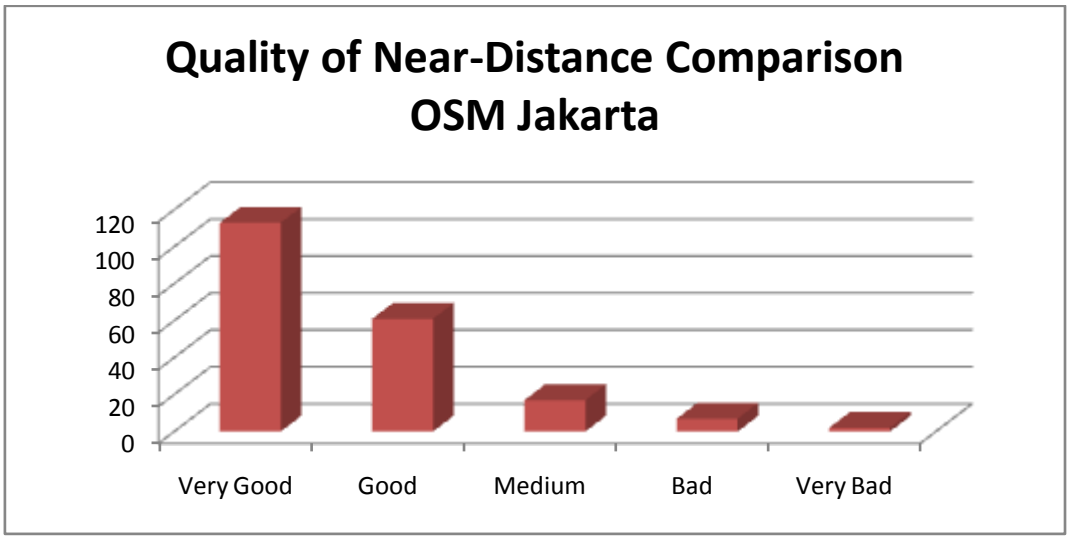


Fig. III. 57. Graphical presentation of Polygon Near-Distance (ref.: Topographic map of South Jakarta)

From this quality comparison, it can be concluded that the overall quality of polygon near distance comparison between OSM data and Jakarta Topograhic Map is good. Fairly said, the spatial distance of OSM data in this study area are close with the reference data.

> Polygon Area

The statistical characteristics of the analysis result are shown below:

Table III. 67. Statistical Characteristics from the Sample (Polygon Area)

Number of Data	200
Median	222.216
Maximum Data	12096.67
Minimum Data	1.288937
Standard Deviation	960.1343
Average	461.6987

The results of statistical comparison using t-test with sample size of 200 data are as follow: the two-tailed t-test at 90% level of confidence is 0.312251904, in which the value of t-table of 1000 data sample is 1.645. Thus, the data are not significantly different, i.e. most of the data has the same polygon area.

Classification of the calculated data using equal interval is presented below:

Table III. 68. Classes of Polygon Area Comparison in Jakarta (reference data: Topographic Map of South Jakarta)

Classes		**Quality**	**Frequency**
0.000	2420.365	Very Good (1)	197
2420.366	4839.441	Good (2)	2
4839.442	7258.517	Medium (3)	0
7258.518	9677.593	Bad (4)	0
9677.594	12096.669	Very Bad (5)	1
Number of data			**200**

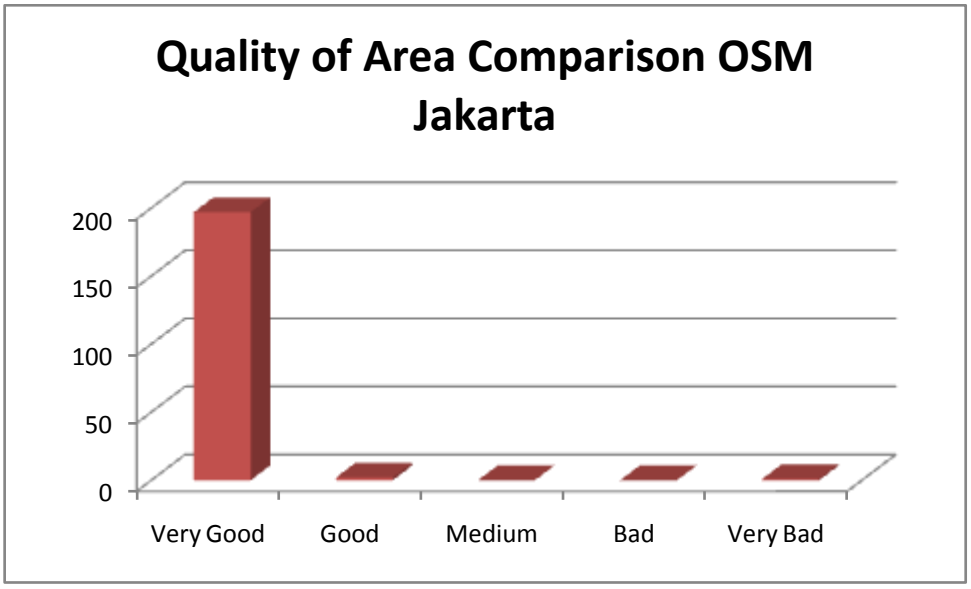


Fig. III. 58. Graphical Interpretation of Area (ref.: Topographic Map of South Jakarta)

From this quality comparison, it can be concluded that the overall quality of area comparison between OSM data and aerial photo digitation is very good. Fairly said, the spatial area of OSM data in this study area is close with the reference data.

iii). Jakarta's Road Network Map

This kind of reference data is used to perform comparative analysis on line type of OSM data, i.e. roads data in Jakarta. The analysis conducted is Buffer-overlap analysis, which results will be explained further.

> Roads Buffer-Overlap Analysis

This method is used to inquire the discrepancies between the reference data (South Jakarta Topographic Map) and the evaluated data (OSM Roads Data in Jakarta). The results are percentage values which represent the overlap of the evaluated data with the reference data, which means that 100% value give us an interpretation that the particular roads are exactly within the tolerance value of the reference road. 516 samples are randomly chosen from the whole roads data in Jakarta to be analyzed. The statistical characteristics from the sample are listed below:

Table III. 69. Statistical Characteristics from the Sample (Line Buffer-Overlap percentage)

Number of Data	516
Median	51.24961989
Maximum Data	100.0006198
Minimum Data	1.378734781
Standard Deviation	32.20393301
Average	50.39209991

To enhance the understanding of the data qualities, the data are then classified as shown below:

Table III. 70. Classes of line buffering Comparison in Jakarta (reference data: Topographic Map)

Class (%)		**Quality**	**Frequency**
0.000	20.000	Very Bad (5)	137
21.000	40.000	Bad (4)	78
41.000	60.000	Medium (3)	82
61.000	80.000	Good (2)	102
81.000	100.000	Very Good (1)	117
Number of sample			**516**

From the analysis, it is shown that major part of the sampled data (117 data or 22.6 %) have a very good quality relative to the reference data; while some other (137 data or 26.5%) had a very bad qualities. Thus, it can be concluded that the qualities of OSM roads data in Jakarta (using this method) are highly varied, relative to the reference data used.

Aerial Photo Digitation OSM Roads Data in Jakarta

Fig. III. 59. Overlap between reference data (Topographic Map of South Jakarta) and OSM Roads Data

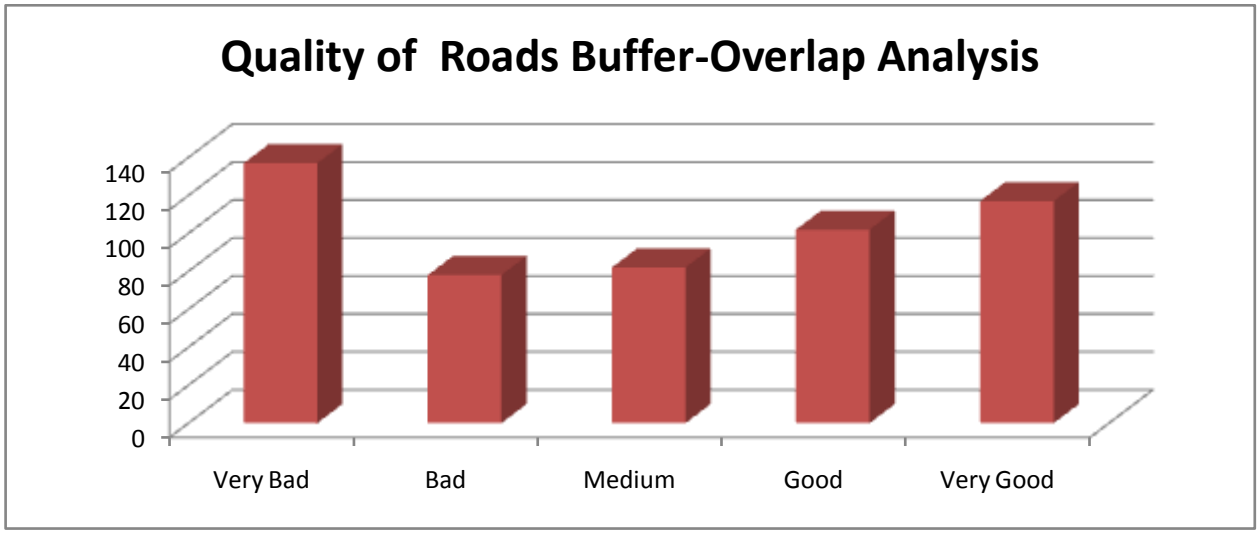


Fig. III. 60. Graphical of Roads Buffer – Overlap Analysis (ref.: Topographic Map of South Jakarta)

b. Attribute Evaluation Results

This method analyze the quality of attribute (non spatial) data in OSM shapefile (particularly, the buildings layer). The attribute of the buildings in subject are listed and compared with its real world condition based on the field survey. Some 100 samples are chosen to be evaluated from the whole buildings data in Jakarta. The results are based on scorings of the suitability between OSM data and the real world condition of the same building. The results are as follow:

Table III. 71. Classification of Attribute Quality Based on Score Value

Attribute Score	Attribute Quality	Frequency
≤ 2	Bad (3)	19
3	Medium (2)	31
5 ≥	Good (1)	50
Total		**100**

Fig. III. 61. Graphical of Attribute Jakarta

The result show that majority of the data in Jakarta have a 'Good' Attribute quality (i.e. suitable with real world condition). Mostly, the 'Bad' attribute qualities are misidentification and empty record.

a. Attributte completness

Attribute completeness is evaluation to represent the empty data and filled data from all of attributes OSM data competition.

Table III. 72. Classification of Attribute completness

Attributes	No Data	Filled Data
Name	3976	288
Use	115	4149
Structure	116	4148
Walls	116	4148
Roof	115	4149
Level	124	4140
Number of Data		**4264**

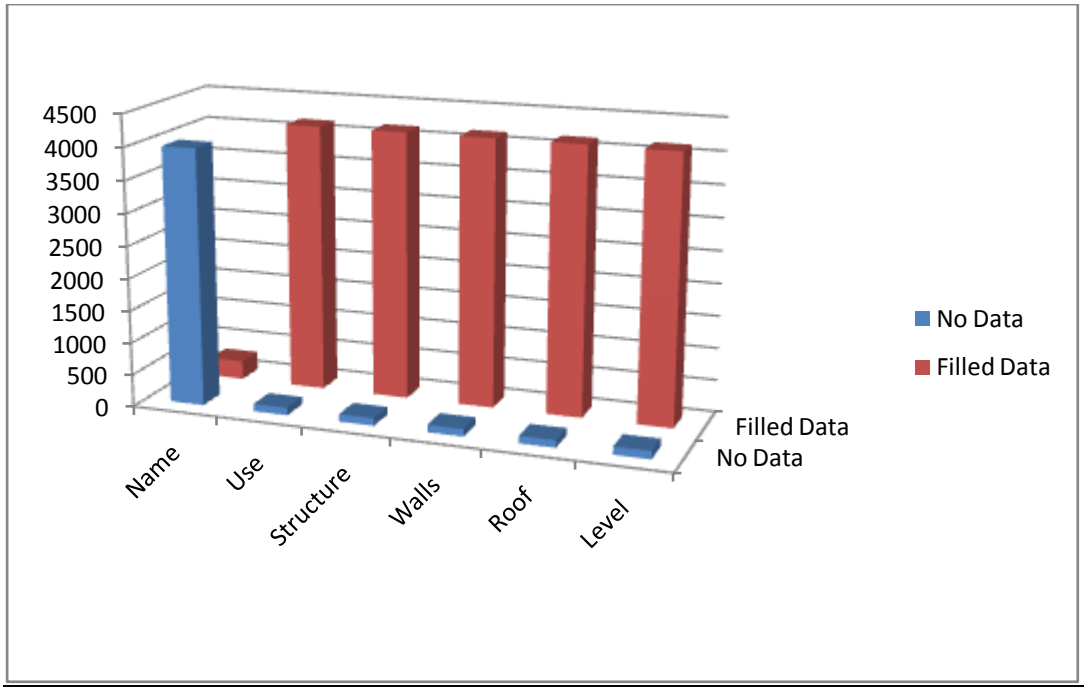


Fig. III. 62. Graphical of Attribute Completness Jakarta

d. Contributor Evaluation

By contributor evaluation it means that this method assesses each contributor of the OSM competition data in the study area (in this case: around Jakarta): how much is the input data; how far does the coverage of his/her contribution; and how dispersed/clustered the data that he/she contributed.

Table III. 73. Amount of Input Data per Contributor

No.	user	Count_user	Percentage (%)
1	dimdim02	4047	94,91
2	arumnw	53	1,24
3	Firman Hadi	38	0,89
4	gnemok	36	0,84
5	dwiprasetyo	31	0,73
6	milovanderlinden	17	0,40
7	Koepz Loekmann	16	0,38
8	bintang	7	0,16
9	ariefrachman	5	0,12
10	amai	3	0,07

11	esoedjasa	2	0,05
12	Fidelis Awig Atmoko	2	0,05
13	tika yulianidar	2	0,05
14	xybot	2	0,05
15	anbr	1	0,02
16	dawnbreak	1	0,02
17	wonderchook	1	0,02
Total		4264	100,00

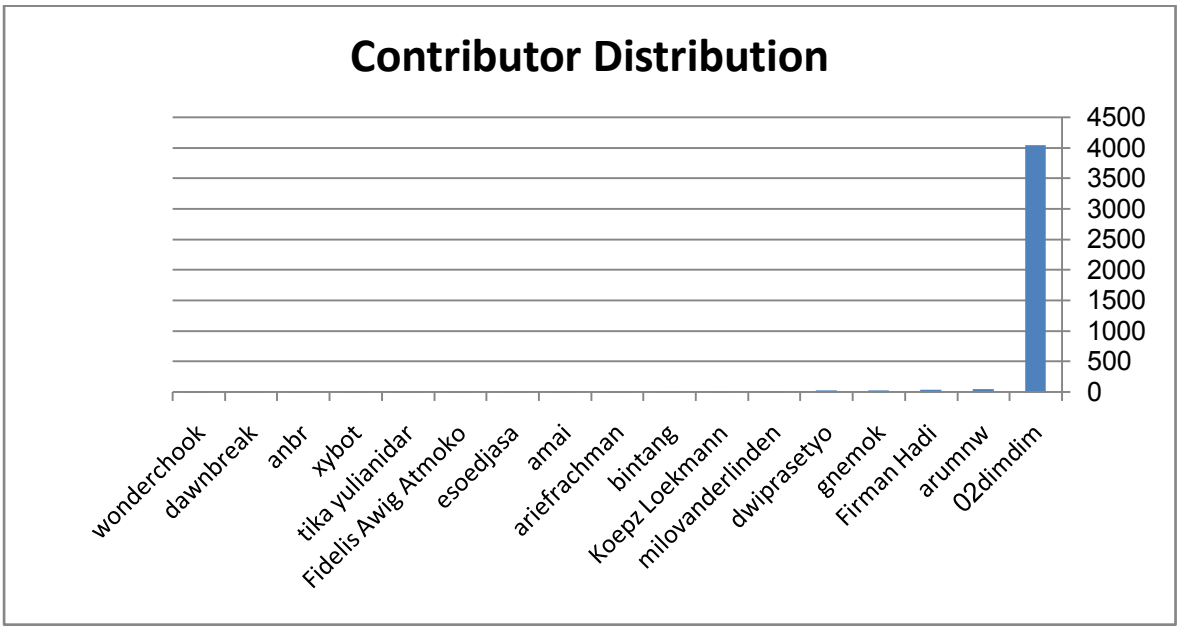


Fig. III. 63. Graphic of Contributor Distribution

VI. Statistical Evaluation

Average Nearest Neighbour Test

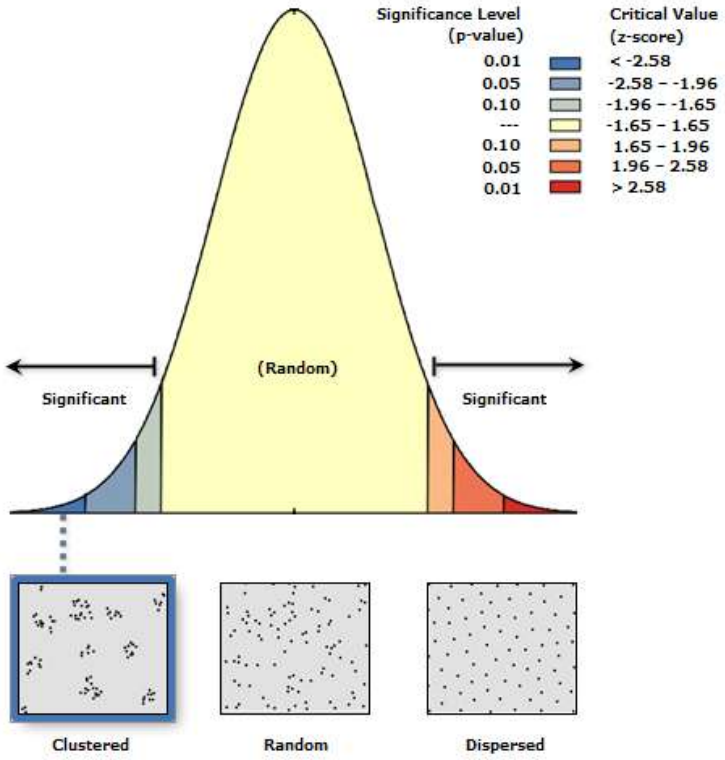


Fig. III. 64. Bell-Curve of Average Nearest Neighbour Critical Value

From the calculation above obtained z value of -86.32. There is a 1% likehood that contributors input the data randomly. That's means, there is a high probability to input the data based on specific pattern (the data is clustered).

VII. Standard Distance

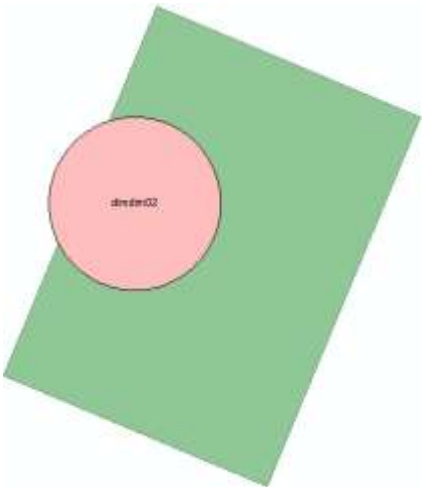


Fig. III. 65. Standard Distance of Contributor in Jakarta

Standard Distance shows the dispersion of each value around the center of data. The one circle in the above Figure means the amount of the data, and the dispersed the data is. Green rectangle in background represents the outer boundary of all the data in Jakarta city.

VIII. Individual Contributor Evaluation

a. Dimdim02

Average Nearest Neighbour

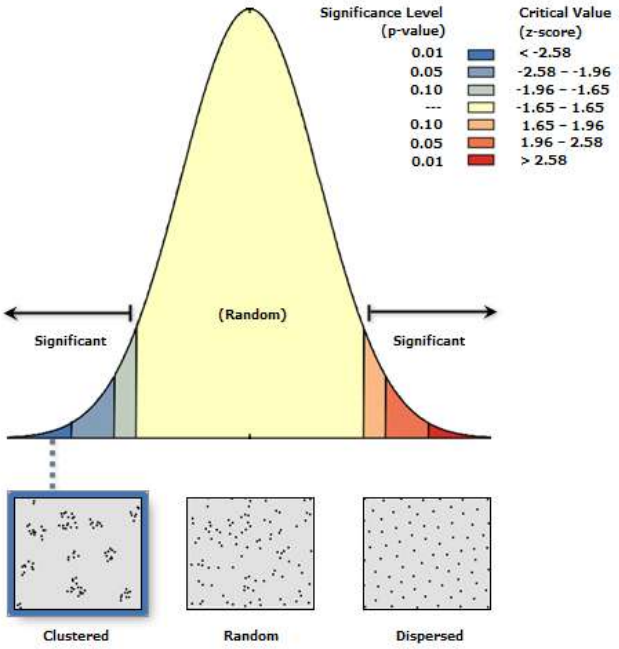


Fig. III. 66. Evaluation contributor of Dimdim02

From the calculation above obtained z value of -89.11. There is a 1% likehood that contributors input the data randomly. That's means, there is a high probability to input the data based on specific pattern (the data is clustered).

d. Sample Case

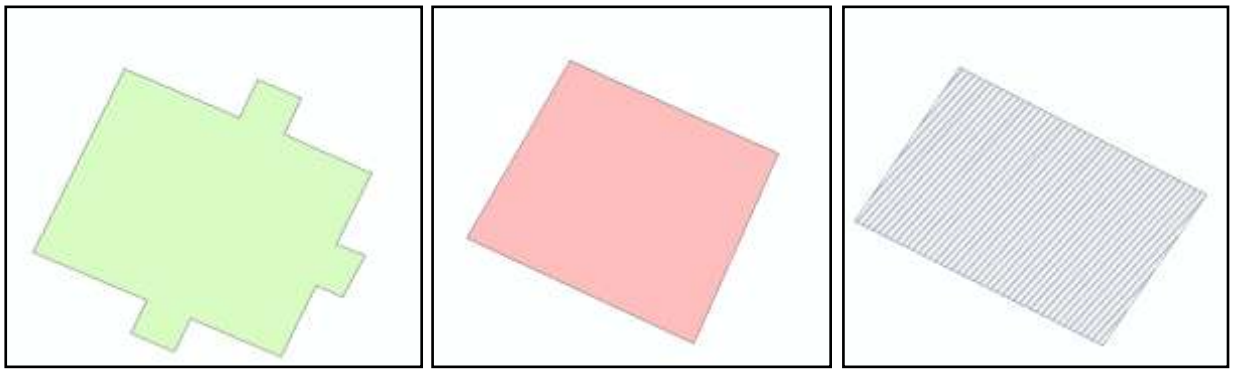
Here's a sample of the evaluation results. The sample is a building feature which is Al-Azhar Mosque building, which situated in South Jakarta.

OpenStreetMap Feature Attribute

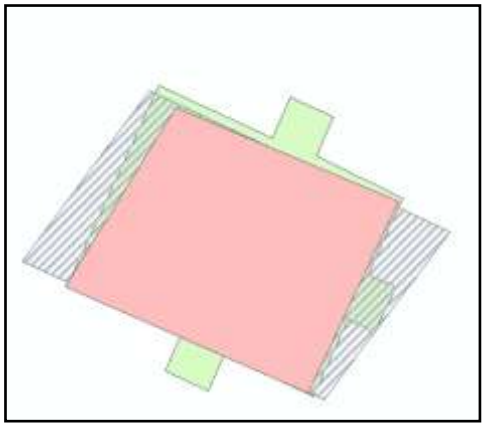
osm_id	name	type	use	structure	walls	roof	levels	user	timestamp
122159885	Masjid Al Azhar		place_of_worship	confined_masonry	brick	concrete	2	dimdim02	2011-07-18T19:33:50Z

Attribute Evaluation (Based on Real World Condition. Score of '1' means 'correct'

name(1)	use(1)	structure	walls(1)	roof(1)	level(1)	total(6)	Atribute_Quality
1	1	0	1	0	1	4	Sedang



DWG Data OSM Data Field Data



Overlay

Fig. III. 67. Comparison of OSM Data, Survey Data, and Topographic (DWG) Data

Fig. III. 68. Figure of Al-Azhar Mosque (Front view)

Fig. III. 69. Figure of Al-Azhar Mosque (Rear view)

The evaluation resulted in an overall Medium quality of spatial and geometric accuracies, while attribute accuracy have a Medium quality.

e. Heatmap visualization of accuracy evaluation

Heatmap is a map visualization method used in this study to present the extent of OSM's buildings data. All evaluation methods previously used are combined to evaluate OSM buildings data. A different weighted value are applied to each evaluation methods as follows:

Table III. 78. Scoring of spatial accuracy

Spatial Accuracy			
Methods / Quality	Near-Distances	Circularity	Area Comparison
Very Bad (5)	10	5	5
Bad (4)	20	10	10
Medium (3)	30	15	15
Good (2)	40	20	20
Very Good (1)	50	25	25

Results of weighting the three methods above are then summed to obtain final results of accuracy. Maximum value of the addition are 100 for each buildings. The final results of heatmap visualization are presented below:

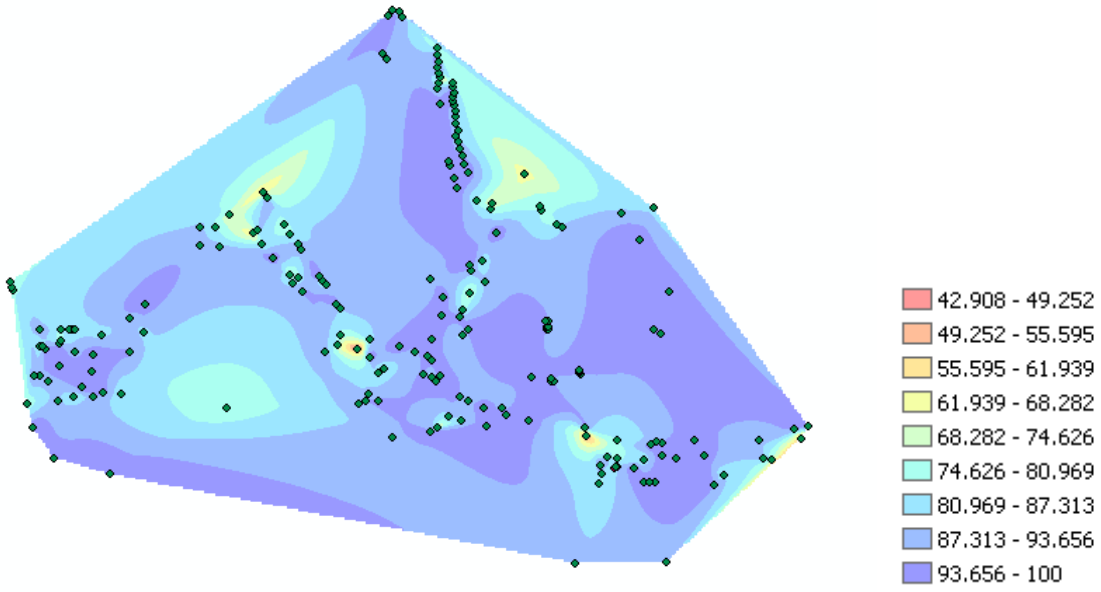


Fig. III. 70. Heatmap visualization in buildings measurement of Jakarta

III.5. PADANG

III.5.1. Reference and Evaluation Data.

The OSM competition dataset that has been evaluated in Padang consist of competition data in form of buildings and roads shapefile data. The number of the data is 4454 and 749 data, respectively. Out of that numbers, some samples are chosen from the data to be evaluated. The data selections are based on the quality, distribution and accessibility of the OSM competition data itself.

In order to evaluate the quality of the OSM data, the selected samples were assessed against a reference data. For this purpose, the reference data that used in the process include:

1. Field Survey Data

   Field Survey using Mobile Mapper 10, conducted in Feb 10th, 2011 – Feb 16th, 2012. The results of the survey are 241 measured buildings.
2. Topographic Map of Padang with scale at 1 : 10000. The data is obtained from National Coordination Agency for Survey and Mapping (Bakosurtanal) in 2008.
3. Road Network from Topographic Map Digitation with scale at 1: 10000. The data is obtained from National Coordination Agency for Survey and Mapping (Bakosurtanal) in 2008.

III.5.2. Analysis Result

The comparison results between reference data (i.e. imagery) and evaluated data (OpenStreetMap data) are presented as follows:

A. Spatial Evaluation Results

I. Groundtruthing Survey Using Mobile Mapper 10

A sample size of 241 data is used to produce a comparative statistical analysis between reference data (Groundtruthing Data) and the OSM sample data. The methods of analysis used are Polygon Circularity, Polygon Near-Distance, and Polygon Area. Calculated results from reference data are then statistically tested using t-test. These methods are explained further below.

1. Polygon Circularity

Polygon Circularity Analysis is conducted to show the geometric suitability between the reference and evaluated data. The results of comparative Polygon Circularity Analysis are summed in the table below:

Table III. 74. Statistical Characteristics from the Sample (Polygon Circularity)

Number of Data	241
Median	0.533658054
Maximum Data	0.795035941
Minimum Data	0.13896180899
Standard Deviation	0.106272223
Average	0.523860894

The result of statistical comparison using t-test with sample size of 241 data is as follow: The two-tailed t-test at 90% confidence level is 4.929424432, in which the t-table value for 241 data sample is 1.969856158. Since the tested data is below the confidence level, then it can be concluded that the data are significantly different.

The calculated value of data quality is then classified into several classes to show overall comparison results. Classification method used is equal interval, which divide the data into 5 interval classes.

Table III. 75. Classes of Circularity Quality in Padang (reference data: Groundtruthing Survey in Padang)

class		Quality	Frequency
0	0.27	Very Good	5
0.271	0.401	Good	19
0.402	0.533	Medium	96
0.534	0.664	Bad	103
0.665	0.795	Very Bad	18

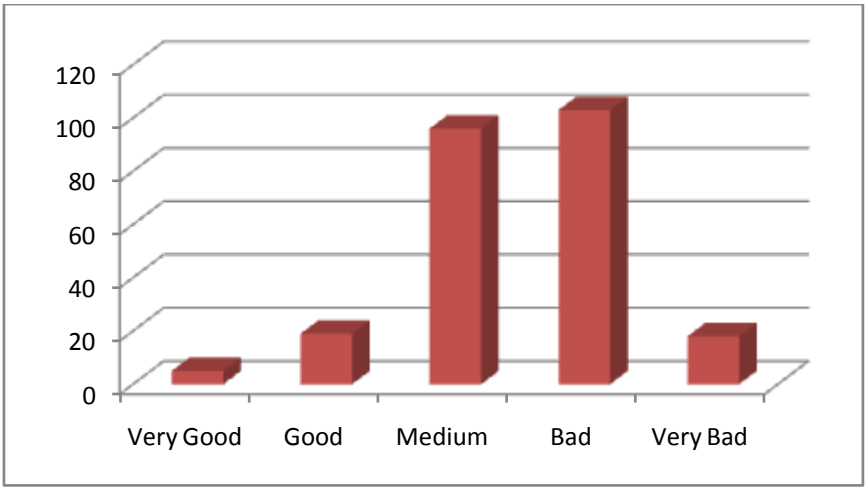


Fig. III. 71. Graphical presentation of OSM Data Quality Compared to groundtruthing survey data in Padang

From this quality comparison, it can be concluded that the overall quality of circularity comparison between OSM data and groundtruthing survey in Padang is Bad. Fairly said, the geometry shape of OSM data in this study area is different with the reference data, i.e. Field Survey Data.

2. Polygon Near Distance

The second analysis that was conducted with the 241 sample from groundtruthing survey data is Polygon Near-Distance. This method is developed to show the spatial discrepancies between reference and evaluated data. The statistical characteristics of the data are:

Table III. 76. Statistical Characteristics from the Sample (Polygon Near-Distance)

Number of Data	241
Median	2.248839
Maximum Data	18.78839
Minimum Data	0
Standard Deviation	2.785174
Average	3.105029

The result of statistical comparison using two-tailed t-test with 90% level of confidence is 0.023900429, while the t-table value for 90% level of confidence and 241 sample data is

1.969856158. Therefore, the data are not significantly different (majority of the OSM polygon data in this location are spatially accurate in their location).

Classification of the calculated data using equal interval is presented below:

Table III. 77. Classes of Near-Distance Quality Comparison in Padang (reference data: groundtruthing survey data)

class		Quality	Frequency
0	3.758	Very Good	171
3.759	7.515	Good	51
7.516	11.273	Medium	15
11.274	15.031	Bad	2
15.032	18.788	Very Bad	2

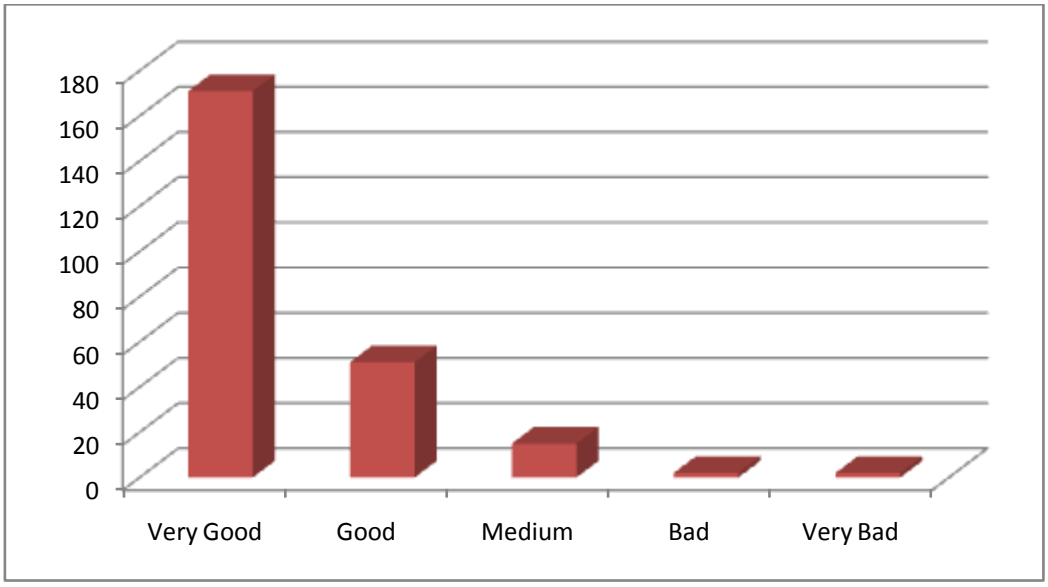


Fig. III. 72. Graphical presentation of Polygon Near-Distance comparison between OSM data quality and groundtruthing data.

From this quality comparison, it can be concluded that the overall quality of near distance comparison between OSM data and groundtruthing survey data in Padang is very good.Further said, the spatial distance of OSM data in this study area is close to the reference data, i.e. Field Survey Data.

3) Polygon Area

Polygon Area evaluation was conducted by comparing the area of OSM buildings data in Bandung with the same buildings data from groundtruthing survey data. The statistical characteristics of the result are shown below:

Table III. 78. Statistical Characteristics from the Sample (Polygon Area)

Number of Data	241
Median	224.5725
Maximum Data	542.9621
Minimum Data	12.19879
Standard Deviation	1136.102
Average	600.8554

The result of statistical comparison using t-test with sample size of 241 data is given below: The two-tailed t-test at 90% confidence level is 0.52887474 , in which the t-table value for 241 data sample is 1.969856158. So, the data are not significantly different (majority of the polygon OSM data have an acceptable spatial accuracy compared to the reference data).

Classification of the calculated data using equal interval is presented below:

Table III. 79. Classes of Polygon Area Comparison in Padang (reference data: groundtruthing survey data)

Class		Quality	Frequency
0	2215.561	Very Good	231
2215.562	4418.923	Good	6
4418.924	6622.285	Medium	2
6622.286	8825.647	Bad	1
8825.648	11029.009	Very Bad	1

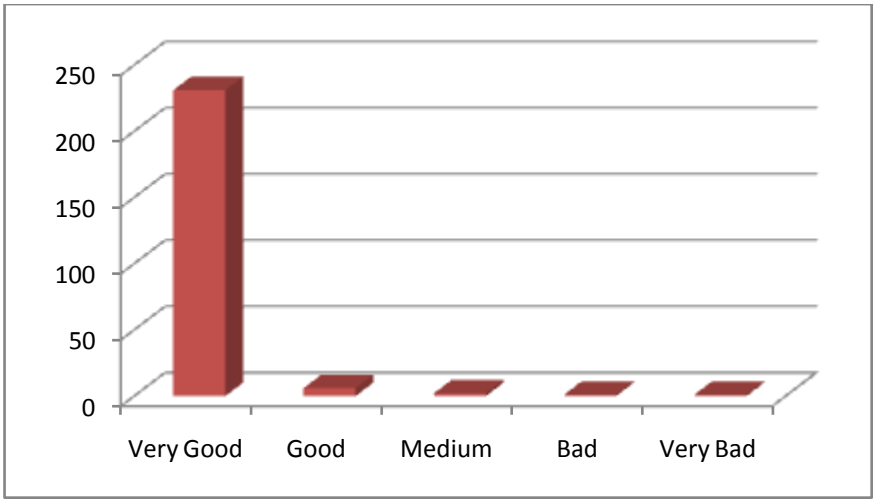


Fig. III. 73. Graphical presentation of Area (ref.: groundtruthing survey data)

From this quality comparison, it can be concluded that the overall quality of polygon Area comparison between OSM data and groundtruthing survey data in Padang is very good. Fairly said, the spatial area of OSM data in this study area is close with the reference data, i.e. Field Survey Data.

II. Imagery in Padang

A sample size of 241 data is used to produce a comparative statistical analysis between reference data (Imagery) and the OSM sample data. The methods of analysis used are Polygon Circularity, Polygon Near-Distance, and Polygon Area. Calculated results from reference data are then statistically tested using t-test. These methods are explained further below.

1) Polygon Cicularity

Polygon Circularity Analysis was conducted to show the suitability of geometry shape matching between the reference and evaluated data. The results of Polygon Circularity Analysis from OSM sample dataset in Padang city are summed in the table below:

Table III. 80. Statistical Characteristics from the Sample (Polygon Circularity)

Number of Data	241
Median	0.01858945086
Maximum Data	0.33345561759
Minimum Data	0.00005457877
Standard Deviation	0.048955633
Average	0.03629081741

The result of statistical comparison using t-test with 241data sample is as follow: The two tailed t-test at 90% confidence level is 0.741300138 , in which the t-table value for 241 data sample is 1.969856158. Since the tested data is below the level of confidence, then it can be concluded that the data are not significantly different (this means that the data are relatively accurate).

The calculated value of data quality was then classified into several classes to show overall comparison results. Classification method used is equal interval, which divide the data into 5 interval classes.

Table III. 81. Classes of Circularity Quality in Padang (ref.data: Imagery)

Classes		Quality	Frequency
0	0.067	Very Good	201
0.068	0.133	Good	27
0.134	0.2	Medium	8
0.201	0.267	Bad	2
0.268	0.333	Very Bad	3
Number of data			**241**

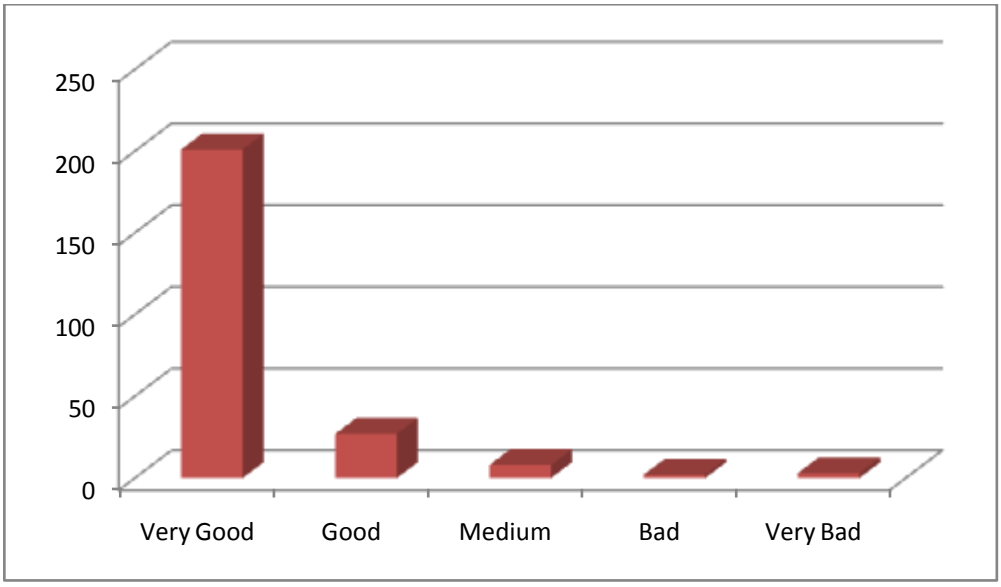


Fig. III. 74. Graphical presentation of OSM Data Quality Compared to imagery in Padang

From both the table and the graphic above it can be concluded that the overall quality of circularity comparison between OSM data and Imagery in Padang is very good. Further said, the geometry shape of OSM data in this study area is close with the reference data, i.e. Imagery

2) Polygon Near Distance

Another analysis that was conducted with the 241 sample data from Imagery is Polygon Near-Distance. This method is developed to show the spatial distance discrepancies between the reference and the evaluated data. Some statistical characteristics of the data are:

Table III. 82. Some Statistical Characteristics from the Sample (Polygon Near-Distance)

Number of Data	241
Median	1.10178599563
Maximum Data	20.44032872400
Minimum Data	0.02567701880
Standard Deviation	1.995740583
Average	1.68505879697

The result of statistical comparison using t-test at 90% level of confidence with sample size of 241 data give a calculated t-test value of 0.010854848, while the t-table value for 90% level of confidence and 241 sample data is 1.969856158. Then, it can be concluded that the OSM data are not significantly different (majority of the polygon data are accurate in their location). Further said, the spatial distance of OSM data in this study area is close to the reference data, i.e imagery.

Classification of the calculated data using equal interval is presented below:

Table III. 83. Classes of Near-Distance Quality Comparison in Bandung (reference data: Imagery)

Classes		**Quality**	**Frequency**
0.026	4.109	Very Good	220
4.11	8.192	Good	16
8.193	12.274	Medium	5
12.275	16.357	Bad	0
16.358	20.44	Very Bad	0
Number of data			241

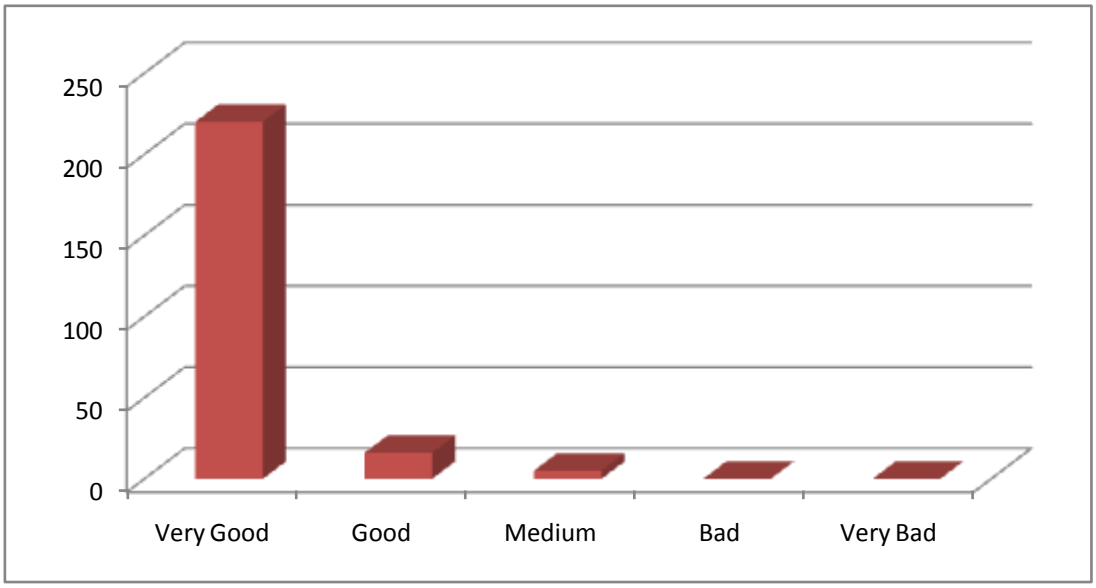


Fig. III. 75. Graphical presentation of Polygon Near-Distance (ref.: Imagery)

From this quality comparison, it can be concluded that the overall quality of near distance comparison between OSM data and Imagery in Padang is very good. Further said, the spatial distance of OSM data in this study area is spatially close to the reference data, i.e. Imagery.

3) Polygon Area

Polygon Area evaluation was conducted by comparing the area of OSM buildings data in Padang with the same buildings data from Imagery. The statistical characteristics of the result are shown below:

Table III. 84. Statistical Characteristics from the Sample (Polygon Area)

Number of Data	241
Median	45.32568348000
Maximum Data	4388.36584800000
Minimum Data	0.00785864740
Standard Deviation	372.265009
Average	123.71867456976

The result of statistical comparison using two-tailed t-test at 90% confidence level with sample size of 241 data is given below:

The t-test value of calculated statistics is 0.332340326, while the t-table value for a 90% level of confidence and sample size of 241 is 1.969856158. So, the data are not significantly different. Classification of the calculated data using equal interval is presented below:

Table III. 85. Classes of Polygon Area Comparison in Padang (reference data: Imagery)

Classes		Quality	Frequency
0.008	877.679	Very Good	236
877.68	1755.351	Good	2
1755.352	2633.023	Medium	0
2633.024	3510.694	Bad	1
3510.695	4388.366	Very Bad	2
Number of data			**241**

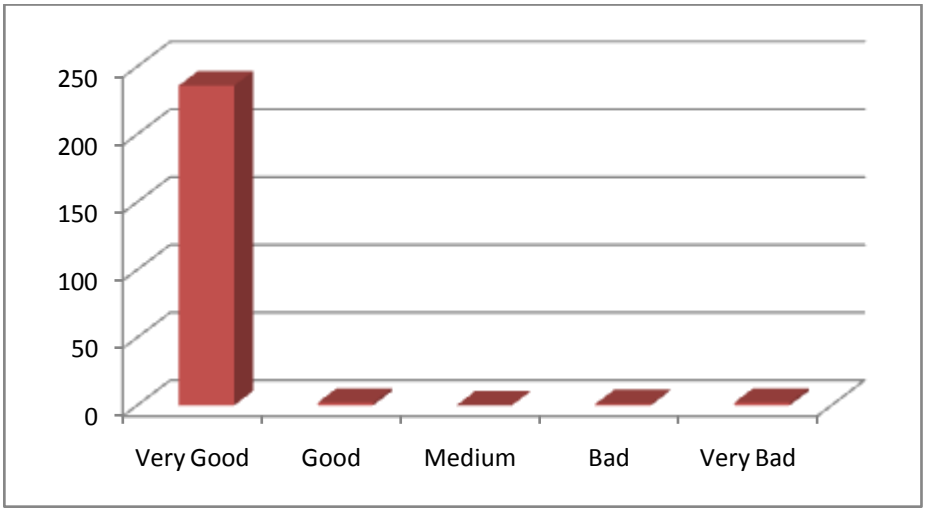


Fig. III. 76. Graphical presentation of Polygon area comparison (ref.: Imagery)

From this quality comparison, it can be concluded that the overall quality of polygon area comparison between OSM data and Imagery in Padang is very good. Further it can be said that the spatial area of OSM data in this study area is close with the reference data, i.e. Imagery.

> Line Buffer-Overlap analysis

This evaluation use line type of reference data, i.e. from the topographic map of Padang. This kind of reference data is used to perform comparative analysis on line type of OSM data, i.e.

roads data in Padang. The analysis conducted consists of Buffer-overlap analysis which results will be explained further.

This method is used to investigate the discrepancies between the reference data (Padang Road Network Map) and the evaluated data (OSM Roads Data in Padang) within a tolerance value. The tolerance value chosen are based on the average width of a particular road class in real world (e.g. primary class road have a tolerance value of 8 meters). The results are percentage values which represent the overlap of the evaluated data with the reference data, which means that 100% value give us a presentation that the particular roads are exactly within the tolerance value of the reference road. 155 samples are randomly chosen from the whole roads data in Bandung to be analyzed. The statistical characteristics from the sample are listed below:

Table III. 81. Statistical Characteristics from the Sample (Line Buffer-Overlap percentage)

Number of Data	51
Median	53.58336451720
Maximum Data	100.00000762000
Minimum Data	1.653323244
Standard Deviation	35.22597664
Average	52.49996268823

To enhance the understanding of the data quality, the data were then classified as shown below:

Table III. 86. Some Statistical Characteristics from the Sample in Bandung (Line Buffer-Overlap percentage)

Class		Quality	Frequency
<	20	Very Bad	15
21	40	Bad	4
41	60	Medium	8
61	80	Good	8
81	<	Very Good	16

(b) OSM roads data (b) Topographic Map roads data

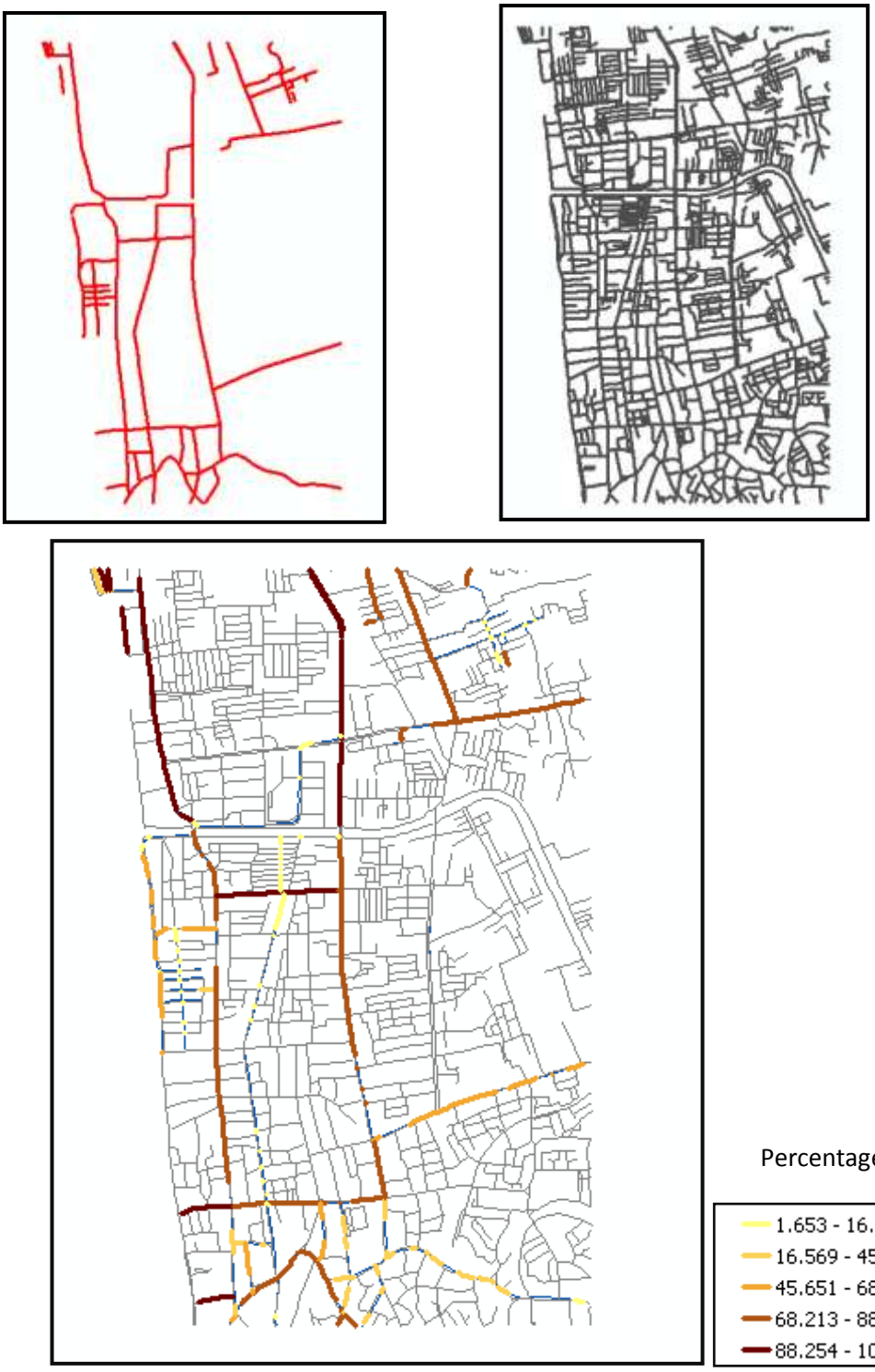


Fig. III. 77. Graphical evaluation results of buffering method (ref.: Topographic Map data)

From the analysis, it is shown that major part of the sampled data (16 data) have a Very Good (1) quality relative to the reference data; while some others (15 data) had a very bad (5) qualities. Thus, it can be concluded that the qualities of OSM roads data in Padangg (using this method) are highly varied, relative to the reference data used.

> Line Completeness analysis

This method compares the completeness between reference and evaluated data in each square grid. The analysis grids have a size of 1x1 km squares, with total of 15 grids used in Padang. Below are the statistical results from the analysis:

Table III. 87. Statistical Characteristics from the Sample (Percentage of Completeness)

Number of Data	15
Median	28.91931724880
Maximum Data	39.29482145
Minimum Data	2.71835741508
Standard Deviation	11.70948546
Average	18.20687324

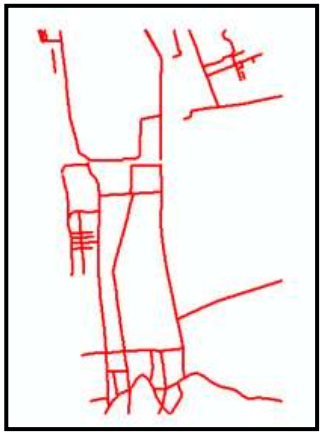
The classes are:

Table III. 88. Statistical Characteristics from the Sample (Percentage of Completeness)

Class		Quality	Frequency
<	20	Very Bad	10
21	40	Bad	5
41	60	Medium	0
61	80	Good	0
81	<	Very Good	0

Figure below show the distribution of the grid qualities:

(b) OSM roads data



(b) Topographic Map roads data

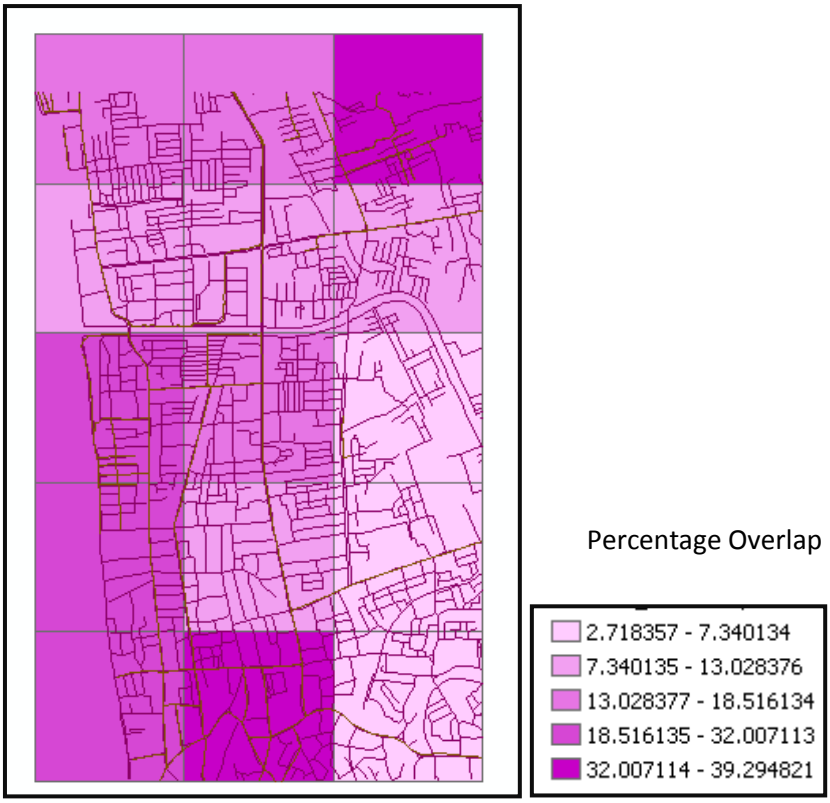


Fig. III. 78. Graphical evaluation result of completeness method (ref.: Topographic Map data)

d) Attribute Evaluation Results

This method analyze the quality of attribute (non spatial) data in OSM shapefile (particularly, the buildings layer). The attribute of the buildings in subject are listed and compared with its real world condition based on the groundtruthing survey. Some 382 samples are chosen to be evaluated from the whole buildings data in Padang. The results are based on scorings of the suitability between OSM data and the real world condition of the same building. The results are as follow:

Table III. 89. Classification of Attribute Quality Based on Score Value

Number of value	Quality	Frequency
≤ 5	Good (1)	167
3	Medium (2)	161
2 ≥	Bad (3)	54
Total		**382**

The result shows that majority of the buildings data in Padang have a 'good' and ‘ medium’ Attribute quality.

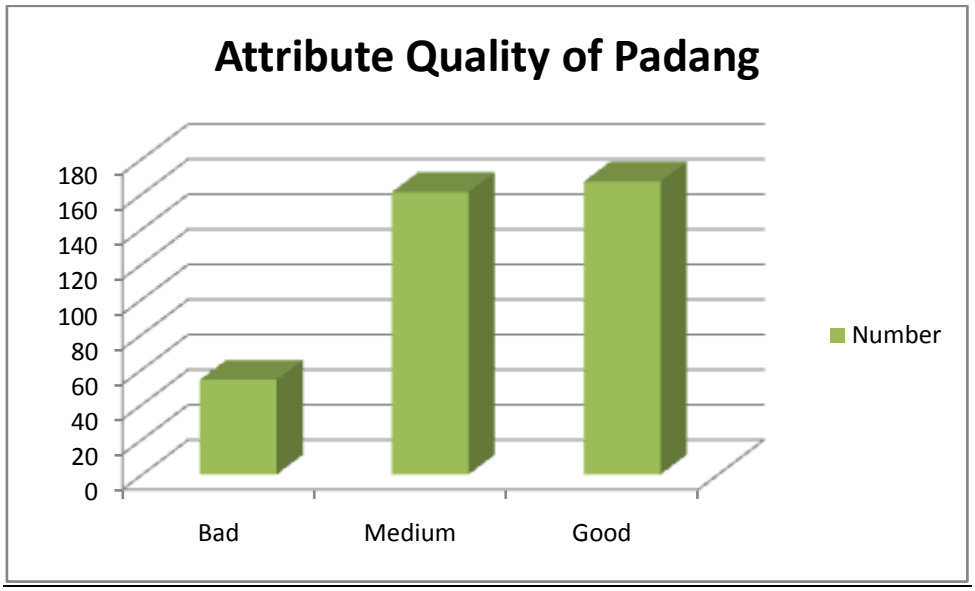


Fig. III. 79. Graphical presentation of Buildings Attribute Quality Based on Score Value

c. Attributes Completeness

Attribute completeness is evaluation to represent the empty data and filled data from all of attributes OSM data competition.

Table III. 90. Classification of attribute OSM data in Bandung

Attributes	No Data	Filled Data
Name	3914	540
Use	1502	2952
Structure	1517	2937
Walls	1517	2937
Roof	1515	2939
Level	1516	2938
Number of Data		4454

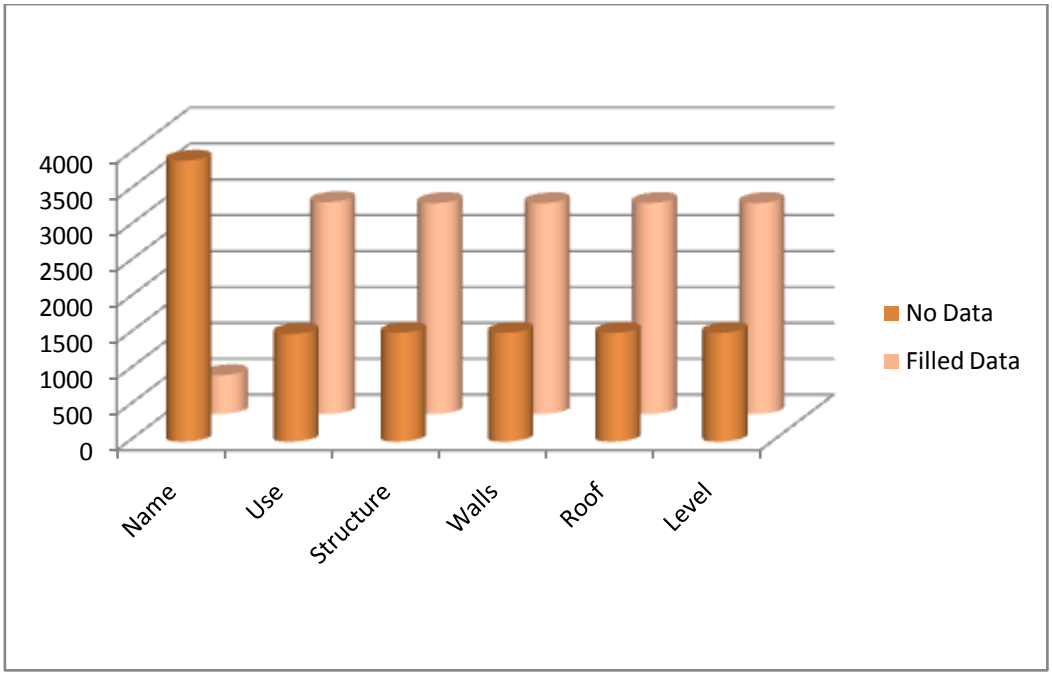


Fig. III. 80. Graphic of quality attribute completeness roads in Padang

i. Contributor Evaluation

By contributor evaluation it means that this method assesses each contributor of the OSM competition data in the study area (in this case: around Padang): how much is the input data; how far does the coverage of his/her contribution; and how dispersed/clustered the data that he/she contributed.

Table III. 91. Amount of Input Data per Contributor

No	user	Cnt_user	Percentage (%)
1	irwanmaryon	1882	42,25
2	habibullah	752	16,88
3	kartamap	344	7,72
4	maning	326	7,32
5	Harry Wood	276	6,20
6	Tim McNamara	240	5,39
7	Davidgogishvili	221	4,96
8	EdLoach	124	2,78
9	Humberto_Yances	95	2,13
10	MStorm	68	1,53

11	WingedStone	42	0,94
12	pprawiradiputra	18	0,40
13	wonderchook	18	0,40
14	rukeli	17	0,38
15	Waai	10	0,22
16	dawnbreak	8	0,18
17	xybot	8	0,18
18	vanpuk	4	0,09
19	Archam_iim	1	0,02
	Jumlah	4454	100,00

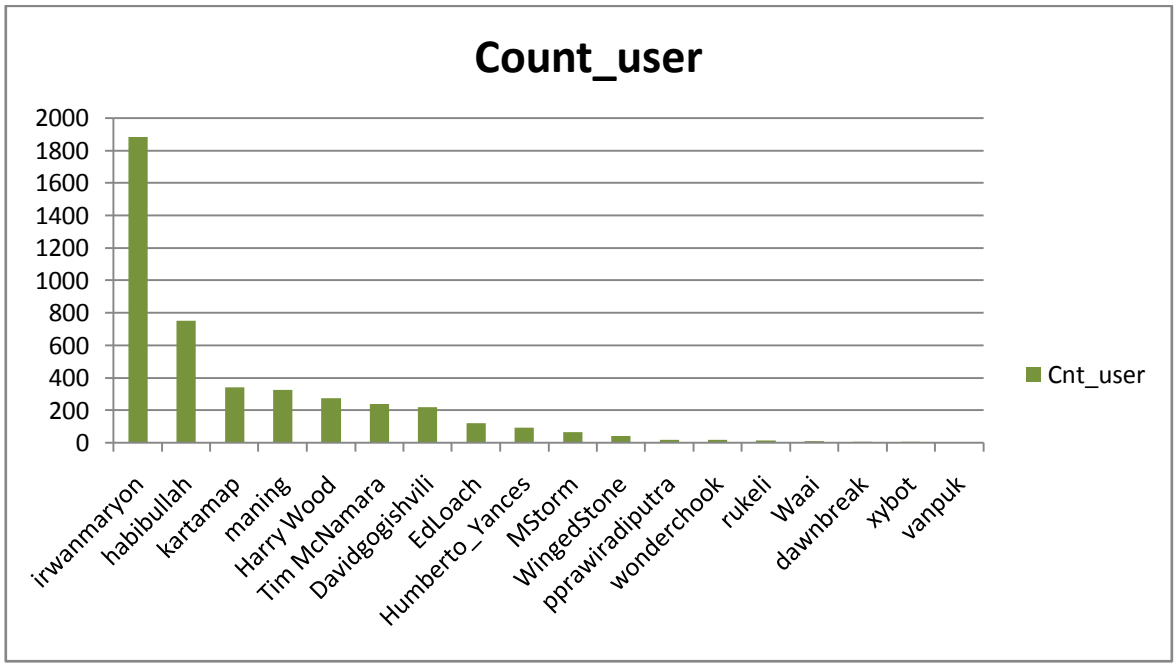


Fig. III. 81. Graphic of Contributor Distribution

ii. Statistical Evaluation

- *Average Nearest Neighbour*

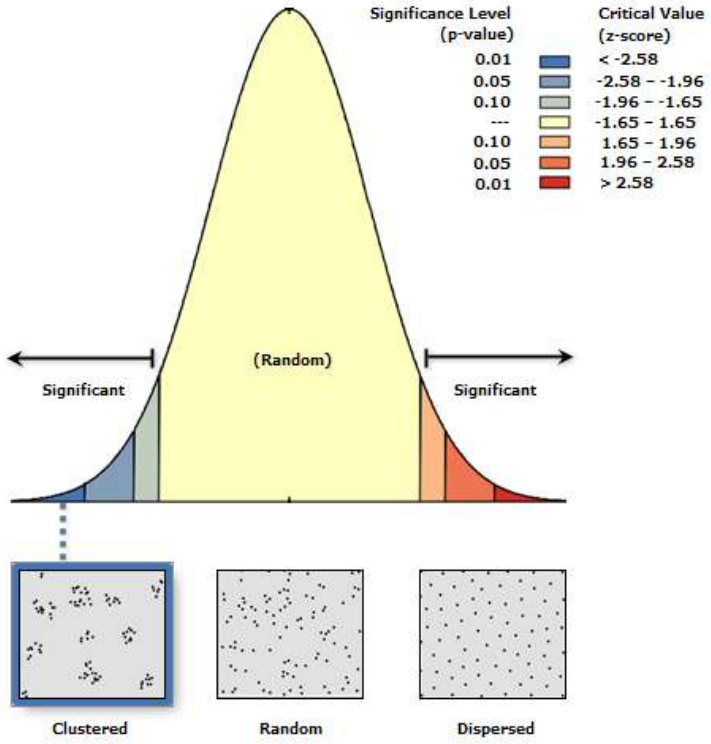


Fig. III. 82. Average Nearest Neighbour

From the calculation above obtained z value of -84.680653. There is a 1% likehood that contributors input the data randomly. That's means, there is a high probability to input the data based on specific pattern (the data is clustered).

iii. Standard Distance

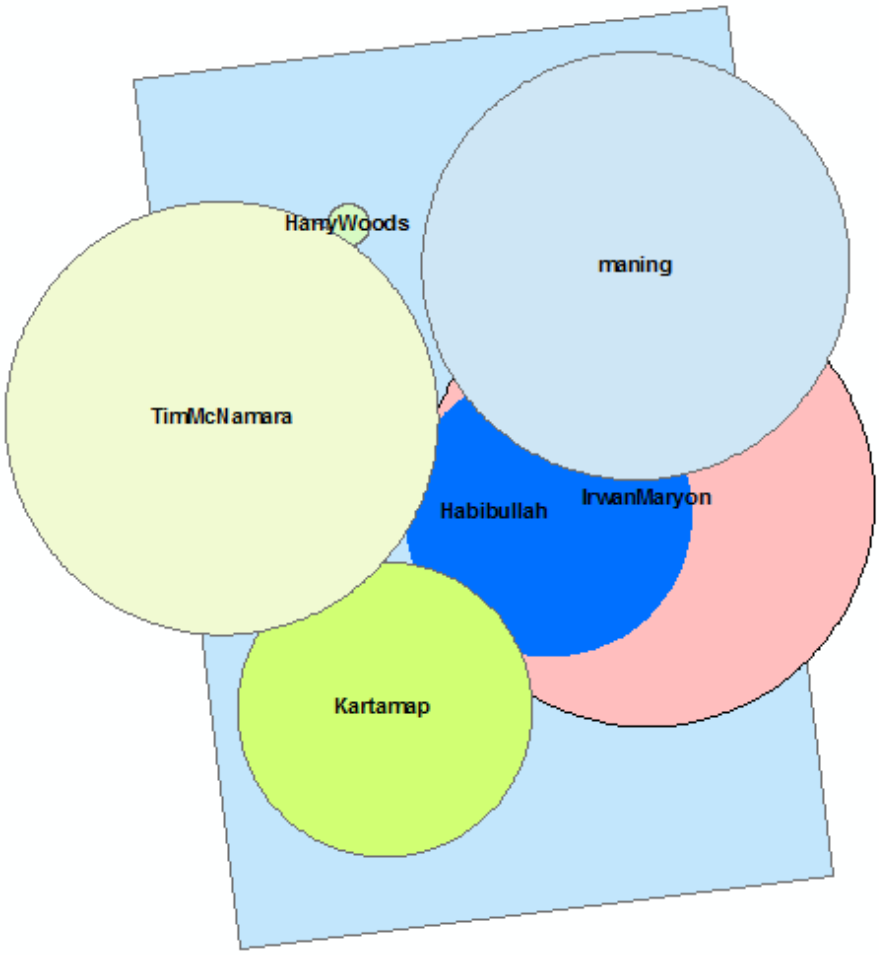


Fig. III. 83. Standard Distance of Contributor in Padang

Standard Distance shows the dispersion of each value around the center of data. The bigger circle in the above Figure means the more amount of the data, and the more dispersed the data is. Blue colored rectangle in the background represents the outer boundary of all the data in Padang city.

iv. Individual ContributorEvaluation

- *Contributor Irwan Maryon*

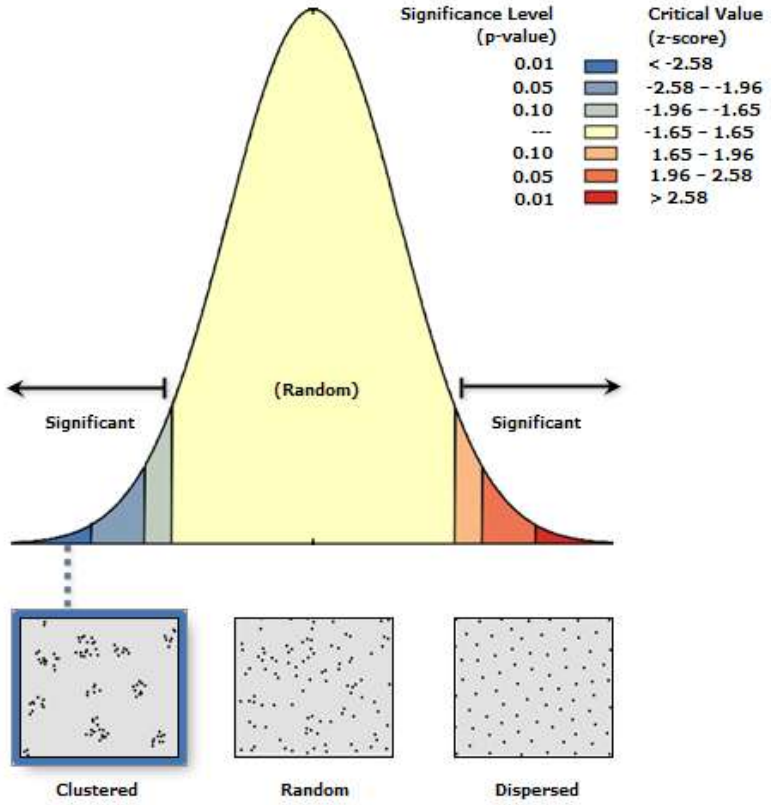


Fig. III. 84. Evaluation contributor of Irwan

From the calculation above obtained z value of -60.168545. There is a 1% likehood that contributors input the data randomly. That's means, there is a high probability that the contributor input the data based on a specific pattern (the data is clustered).

- *Contributor Habibullah*

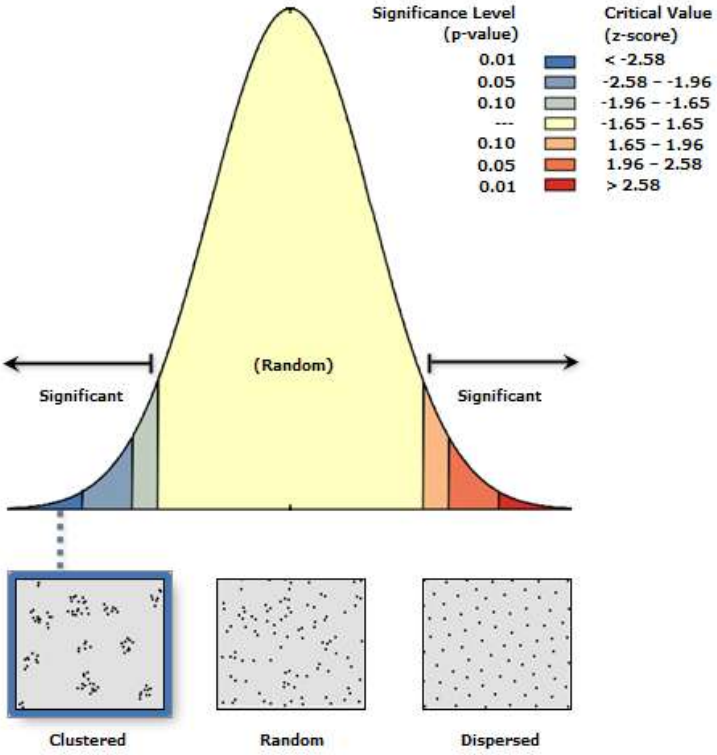


Fig. III. 85. Evaluation contributor of Habibullah

From the calculation above obtained z value of -38.185422 . There is a 1% likehood that contributors input the data randomly. That's means, there is a high probability to input the data based on specific pattern (the data is clustered).

- *Contributor Kartamap*

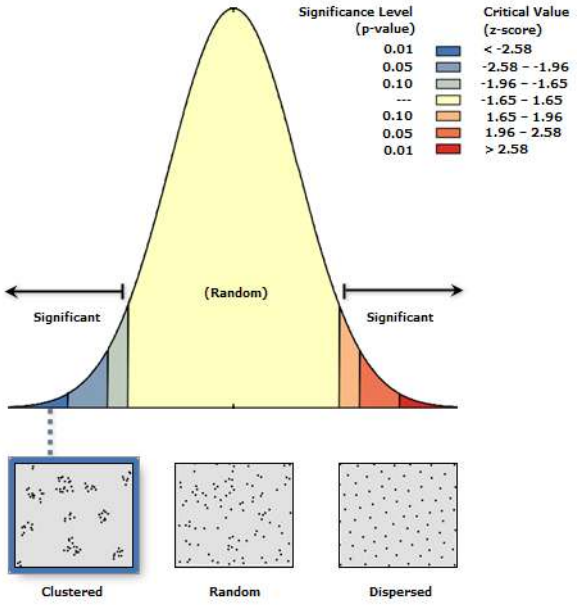


Fig. III. 86. Evaluation contributor of Kartamap

From the calculation above obtained z value of -24.936233. There is a 1% likehood that contributors input the data randomly. That's means, there is a high probability to input the data based on specific pattern (the data is clustered).

- *Contributor Maning*

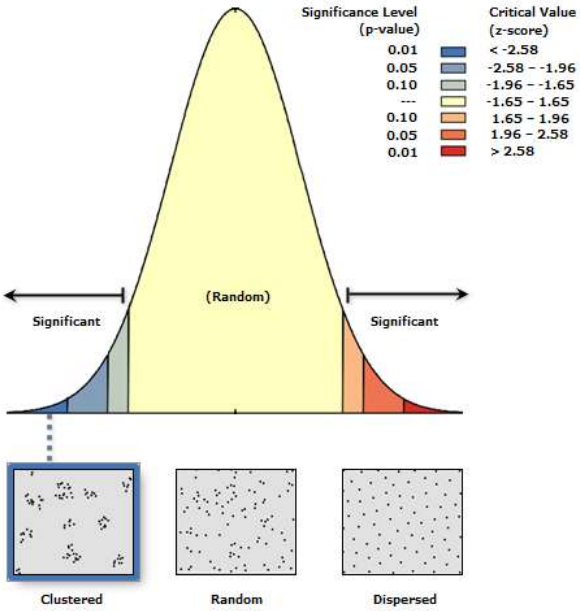


Fig. III. 87. Evaluation contributor of Maning

From the calculation above obtained z value of -24.501746. There is a 1% likehood that contributors input the data randomly. That's means, there is a high probability to input the data based on specific pattern (the data is clustered).

- *Contributor Harry Wood*

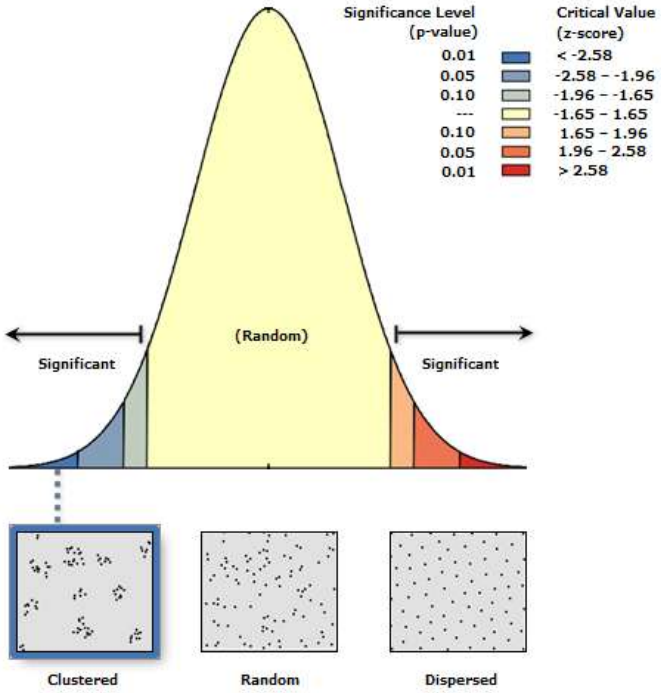


Fig. III. 88. Evaluation contributor of Hary Wood

From the calculation above obtained z value of -6.604890. There is a 1% likehood that contributors input the data randomly. That's means, there is a high probability to input the data based on specific pattern (the data is clustered).

➢ *Contributor Tim Mcnamara*

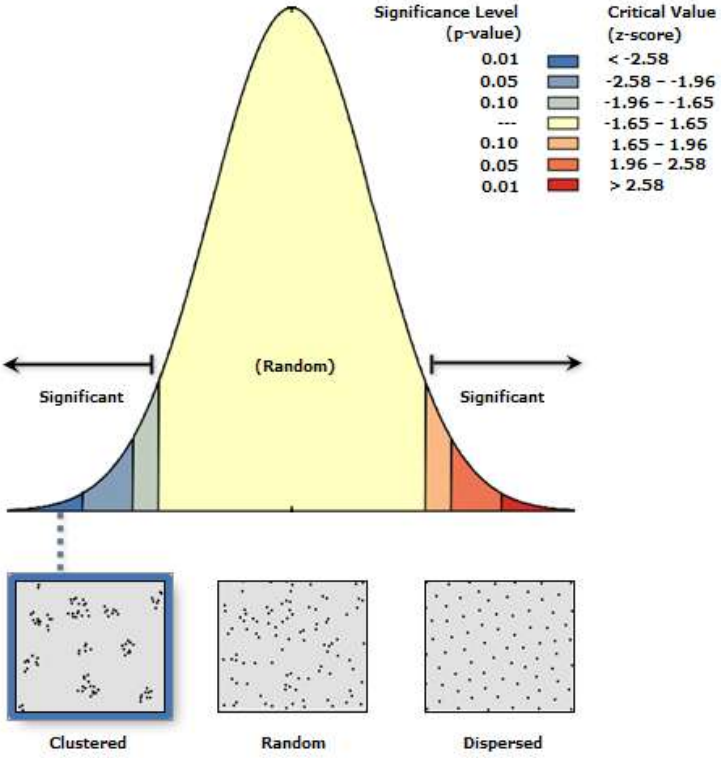


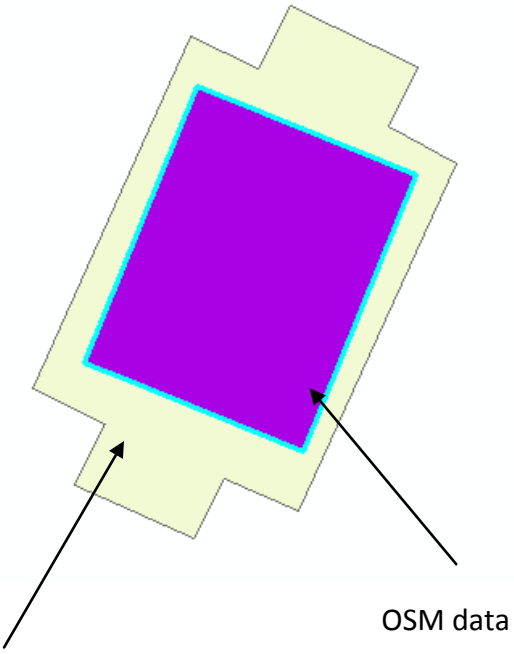
Fig. III. 89. Evaluation contributor of Tim Mcnamara

From the calculation above obtained z value of -22.149747 . There is a 1% likehood that contributors input the data randomly. That's means, there is a high probability to input the data based on specific pattern (the data is clustered).

e) Sample Case

Here is a sample of the evaluation results. The sample is a building feature which is Nurul Iman Mosque in Padang.

- Shape comparison between evaluated data (OSM data) and reference data (Imagery)



- OSM feature attribute

osm_id	name	Use	structure	walls	roof	levels	User	Timestamp
123658822	Nurul Iman	place_of_worship	reinforced_masonry	brick	tin	2	irwanmaryon	2011-07-30T00:31:25Z

- Attribute evaluation (based on survey the real world of the building), 1 = correct, 0 = incorrect

name (1)	use(1)	structure(1)	walls(1)	roof(1)	level(1)	total (6)	Atribute_Quality
0	**1**	**0**	**1**	**0**	**1**	**3**	**Medium**

- The pictures of Nurul Iman Mosque :

-

(b) Front view

(b) Side view

(c) Back view

(d) Side view

Fig. III. 90. Nurul Iman Mosque

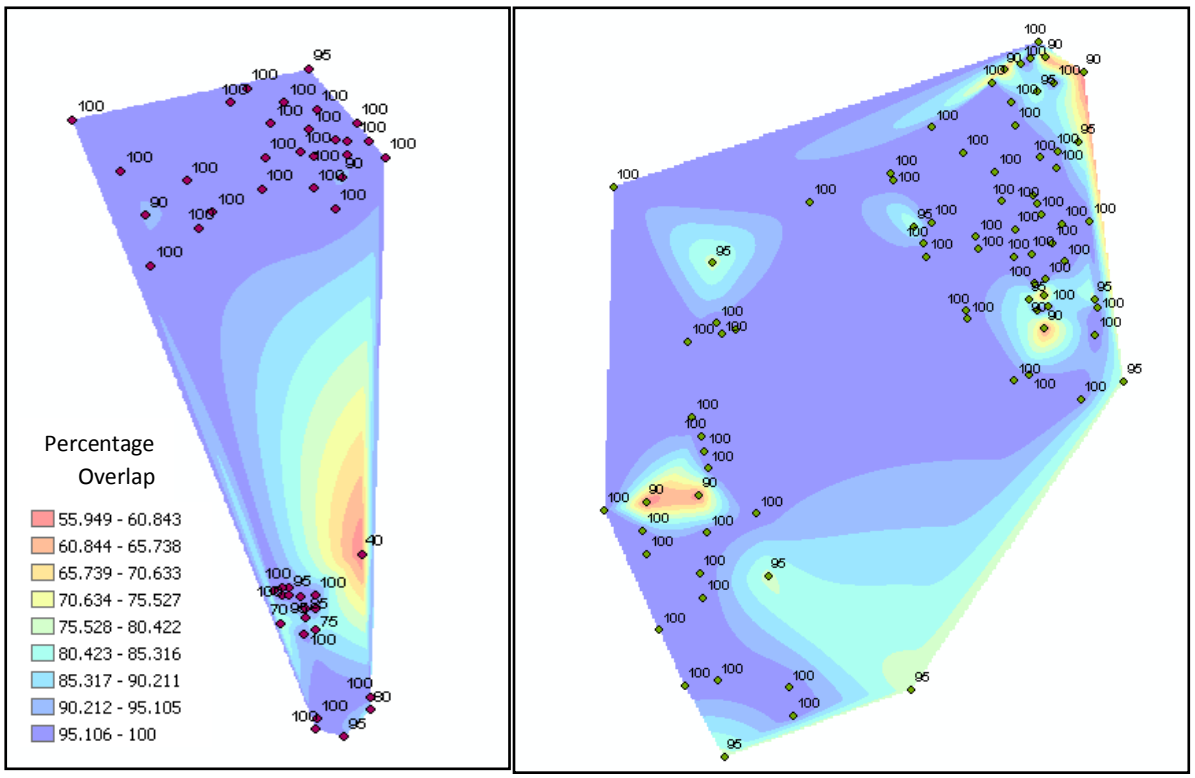
e. Heatmap visualization of accuracy evaluation

Heatmap is a map visualization method used in this study to present the extent of OSM's buildings data. All evaluation methods previously used are combined to evaluate OSM buildings data. A different weighted value are applied to each evaluation methods as follows:

Table III. 92. Scoring of spatial accuracy

Spatial Accuracy			
Methods / Quality	Near-Distances	Circularity	Area Comparison
Very Bad (5)	10	5	5
Bad (4)	20	10	10
Medium (3)	30	15	15
Good (2)	40	20	20
Very Good (1)	50	25	25

Results of weighting the three methods above are then summed to obtain final results of accuracy. Maximum value of the addition are 241 for each buildings. The final results of heatmap visualization are presented below:



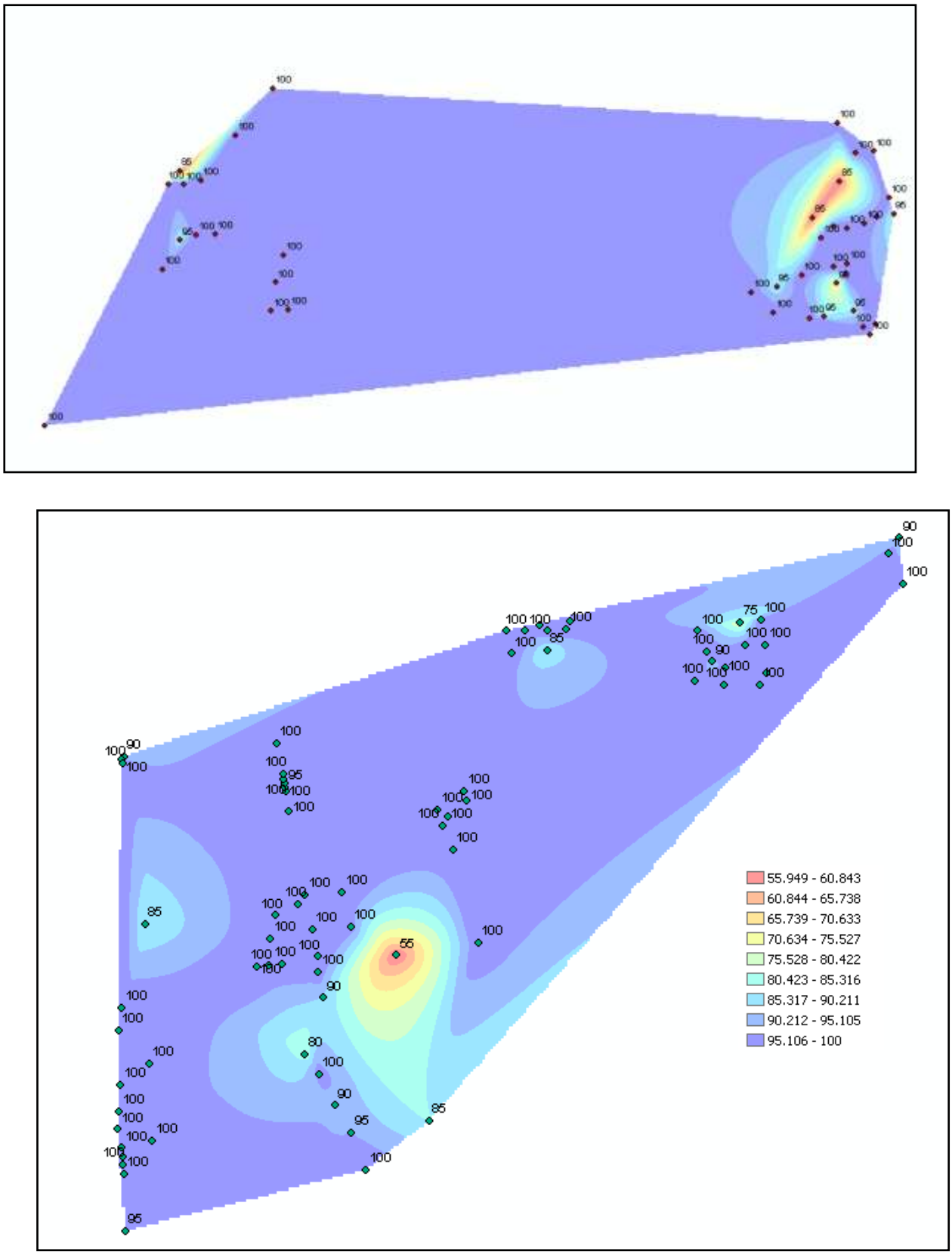


Fig. III. 91. Heatmap visualization in buildings measurement of Padang

III.6. DOMPU

III.6.1. Reference and Evaluation Data

OSM data in Dompu consist of buildings, roads, points, waterways, railways, natural, and landuse indicator include Competition's Dataset and Non-Competition's Dataset. In order to simplify the evaluation, the OSM competition dataset that has been evaluated consists of shapefiles of buildings and road features. The sampling methods of all competition data have 90% confidence interval or α = 10%.

Table III. 93. The sample calculation of OSM data in Dompu

No	Indikator	Tipe	Competition's data		Non-competition's data	
			N	α = 10%	N	α = 10%
1	Points	Point	1537	230	0	0
2	Waterways	Line	8	8	8	8
3	Roads	Line	749	199	749	199
4	Railways	Line	0	0	0	0
5	Natural	Polygon	7	7	7	7
6	Landuse	Polygon	23	21	23	21
7	Building	Polygon	1861	236	11560	264
Number of data			4185	701	12347	499

Out of the numbers of data, some samples are chosen from the data to be evaluated. The data selections are based on the quality, distribution, and accessibility of the OSM competition data. In order to evaluate the quality of the OSM data, the selected samples were assessed against a reference data. For this purpose, the reference data that used in Dompu in the process include:

c. Groundtruthing (Field Survey) Data

This data reference is produced from groundtruthing survey in Feb, 29th – March, 6th 2012 using Mobile Mapper 10. of the results of the survey are 294 buildings in Dompu that consist of 279 competition's data. Because of some limitations during the survey, the GPS processing method of this data use Non Post-processing

d. Topographic Measurement Data of Dompu

This data is in the form of Autocad's DWG with scale at 1:2500. The Data was obtained from Department of Land Agency Dompu in 2010.

III.6.2. Analysis Result

The comparison results between reference data (i.e. Imagery and DWG data) and evaluated data (OpenStreetMap data) are presented as follows:

a. Spatial Evaluation Results

i. Groundtruthing Survey Using Mobile Mapper 10

A sample size of 294 data is used to produce a comparative statistical analysis between reference data (Groundtruthing Data) and the OSM sample data. The methods of analysis used are Polygon Circularity, Polygon Near-Distance, and Polygon Area. Calculated results from reference data are then statistically tested using t-test. These methods are explained further below.

1) Polygon Circularity

Polygon Circularity Analysis is conducted to show the geometric suitability between the reference and evaluated data. The results of comparative Polygon Circularity Analysis are summed in the table below:

Table III. 94. Statistical Characteristics from the Sample (Polygon Circularity)

Number of Data	294
Median	0.03671793854
Maximum Data	0.52593631612
Minimum Data	0.00016130615
Standard Deviation	0.069060827
Average	0.05897117532

The result of statistical comparison using t-test with sample size of 294 data is as follow:

The two-tailed t-test at 90% confidence level is 0.85390195, in which the t-table value for 294 data sample is 1.65012. Since the tested data is below the confidence level, then it can be concluded that the data are not significantly different (this means that the sample data are relatively accurate).

The calculated value of data quality is then classified into several classes to show overall comparison results. Classification method used is equal interval, which divide the data into 5 interval classes.

Table III. 95. Classes of Circularity Quality in Dompu (reference data: Groundtruthing Survey in Dompu)

Classes		Quality	Frequency
0	0.105	Very Good (1)	245
0.106	0.21	Good (2)	37
0.211	0.316	Medium (3)	8
0.317	0.421	Bad (4)	3
0.422	0.526	Very Bad (5)	1
Number of data			**294**

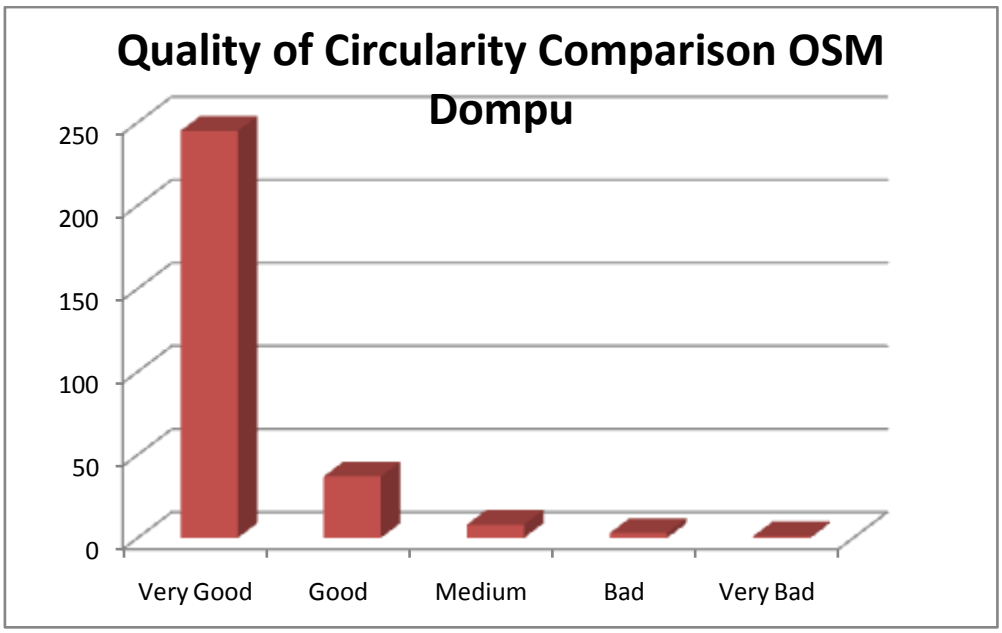


Fig. III. 92. Graphical presentation of OSM Data Quality Compared to groundtruthing survey data in Dompu

From this quality comparison, it can be concluded that the overall quality of circularity comparison between OSM data and groundtruthing survey in Dompu is very good. Fairly said, the

geometry shape of OSM data in this study area is close with the reference data, i.e. Field Survey Data.

2) Polygon Near Distance

The second analysis that was conducted with the 294 sample from groundtruthing survey data is Polygon Near-Distance. This method is developed to show the spatial discrepancies between reference and evaluated data. The statistical characteristics of the data are:

Table III. 96. Statistical Characteristics from the Sample (Polygon Near-Distance)

Number of Data	294
Median	6.04332702920
Maximum Data	17.16806800800
Minimum Data	0.11599565749
Standard Deviation	2.778198238
Average	6.40917130840

The result of statistical comparison using two-tailed t-test with 90% level of confidence is 0.0615697, while the t-table value for 90% level of confidence and 294 sample data is 1.65012. Therefore, the data are not significantly different (majority of the OSM polygon data in this location are spatially accurate in their location).

Classification of the calculated data using equal interval is presented below:

Table III. 97. Classes of Near-Distance Quality Comparison in Dompu (reference data: groundtruthing survey data)

Classes		Quality	Frequency
0	3.526	Very Good (1)	37
3.527	6.937	Good (2)	150
6.938	10.347	Medium (3)	83
10.348	13.758	Bad (4)	21
13.759	17.168	Very Bad (5)	3
Number of data			**294**

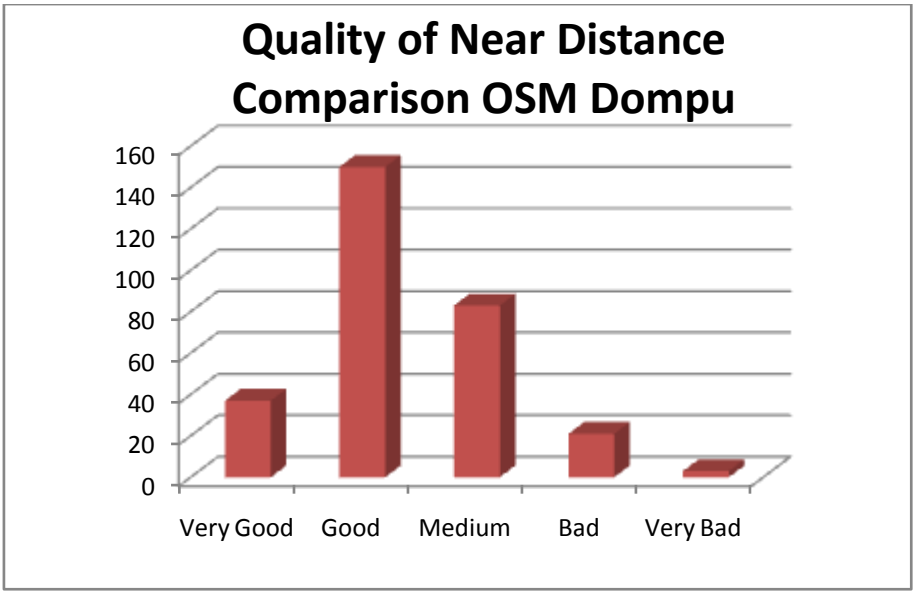


Fig. III. 93. Graphical presentation of Polygon Near-Distance comparison between OSM data quality and groundtruthing data.

From this quality comparison, it can be concluded that the overall quality of Near Distance comparison between OSM data and groundtruthing survey data in Dompu is quite good.Further said, the spatial distance of OSM data in this study area is close to the reference data, i.e. Field Survey Data.

3) Polygon Area

Polygon Area evaluation is conducted by comparing the area of OSM buildings data in Dompu with the same buildings data from groundtruthing survey data. The statistical characteristics of the result are shown below:

Table III. 98. Statistical Characteristics from the Sample (Polygon Area)

Number of Data	294
Median	22.35494640180
Maximum Data	3489.25271346000
Minimum Data	0.02169436310
Standard Deviation	217.0160025
Average	45.20745590203

The result of statistical comparison using t-test with sample size of 294 data is given below:

The two-tailed t-test at 90% confidence level is 0.2083139, in which the t-table value for 294 data sample is 1.65012. So, the data are not significantly different (majority of the polygon OSM data have an acceptable spatial accuracy compared to the reference data).

Classification of the calculated data using equal interval is presented below:

Table III. 99. Classes of Polygon Area Comparison in Dompu (reference data: groundtruthing survey data)

Classes		Quality	Frequency
0	697.868	Very Good (1)	292
697.869	1395.714	Good (2)	1
1395.715	2093.56	Medium (3)	0
2093.561	2791.407	Bad (4)	0
2791.408	3489.253	Very Bad (5)	1
Number of data			**294**

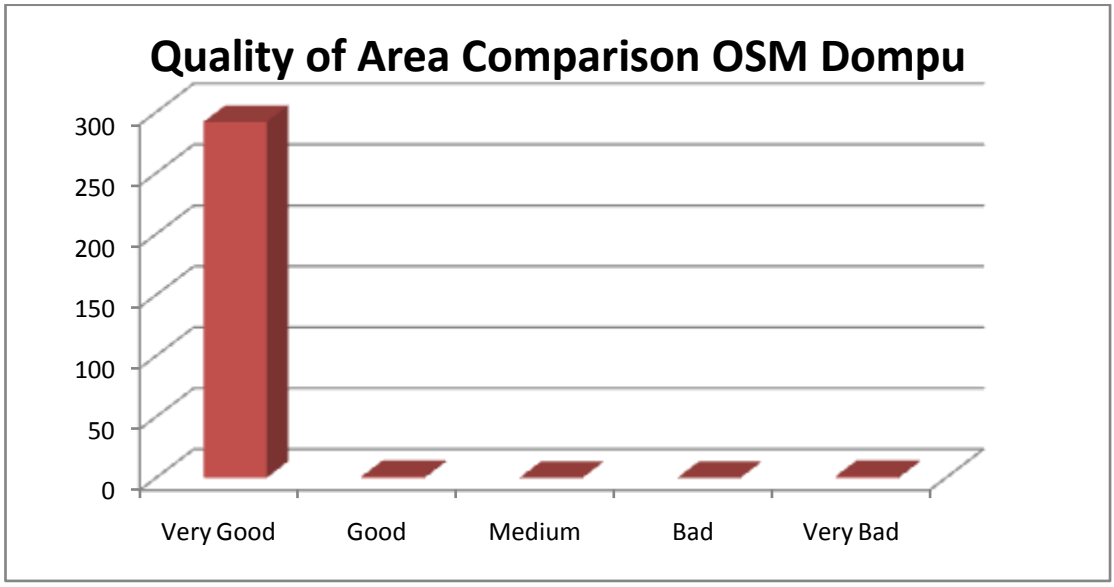


Fig. III. 94. Graphical presentation of Polygon Near-Distance (ref.: groundtruthing survey data)

From this quality comparison, it can be concluded that the overall quality of Area comparison between OSM data and groundtruthing survey data in Dompu is very good. It

can be concluded that the spatial area of OSM data in this study area is close with the reference data, i.e. Field Survey Data.

ii. Bing Imagery

A sample size of 294 data is used to produce a comparative statistical analysis between reference data (Citra) and the OSM sample data. The methods of analysis used are Polygon Circularity, Polygon Near-Distance, and Polygon Area. Calculated results from reference data are then statistically tested using t-test. These methods are explained further below.

1) Polygon Cicularity

Polygon Circularity Analysis is conducted to show the suitability of geometry shape matching between the reference and evaluated data. The results of Polygon Circularity Analysis from OSM sample dataset in Dompu City are summed in the table below:

Table III. 100. Statistical Characteristics from the Sample (Polygon Circularity)

Number of Data	294
Median	0.01888243574
Maximum Data	0.29104262051
Minimum Data	0.00005813588
Standard Deviation	0.037663765
Average	0.03191779399

The result of statistical comparison using t-test with 294 data sample is as follow: The two tailed t-test at 90% confidence level is 0.847440335776834, in which the t-table value for 294 data sample is 1.65012. Since the tested data is below the level of confidence, then it can be concluded that the data are not significantly different (this means that the data are relatively accurate).

The calculated value of data quality is then classified into several classes to show overall comparison results. Classification method used is equal interval, which divide the data into 5 interval classes.

Table III. 101. Classes of Circularity Quality in Dompu (ref.data: Citra)

Classes		Quality	Frequency
0	0.058	Very Good (1)	244
0.059	0.116	Good (2)	37
0.117	0.175	Medium (3)	6
0.176	0.233	Bad (4)	2
0.234	0.291	Very Bad (5)	5
Number of data			294

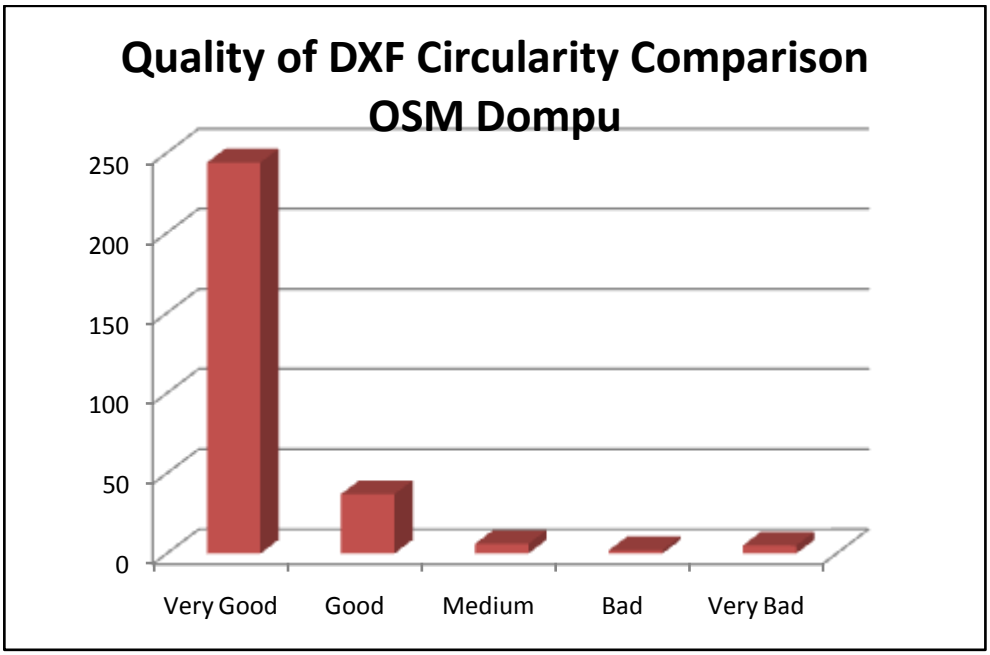


Fig. III. 95. Graphical presentation of OSM Data Quality Compared to Citra in Dompu

From both the table and the graphic above it can be concluded that the overall quality of circularity comparison between OSM data and Citra in Dompu is very good. Further said, the geometry shape of OSM data in this study area is close with the reference data, i.e. Bing Imagery.

2) Polygon Near Distance

Another analysis that was conducted with the 294 sample data from Citra is Polygon Near-Distance. This method is developed to show the spatial distance discrepancies between the reference and the evaluated data. Some statistical characteristics of the data are:

Table III. 102. Some Statistical Characteristics from the Sample (Polygon Near-Distance)

Number of Data	294
Median	6.88960027523
Maximum Data	15.65414943200
Minimum Data	0.76725170780
Standard Deviation	2.383418156
Average	6.73192518928

The result of statistical comparison using t-test at 90% level of confidence with sample size of 294 data give a calculated t-test value of 0.0760501841915943, while the t-table value for 90% level of confidence and 294 sample data is 1.65012. Then, it can be concluded that the OSM data are not significantly different (majority of the polygon data are accurate in their location). Further said, the spatial distance of OSM data in this study area is close to the reference data, i.e. Bing Imagery.

Classification of the calculated data using equal interval is presented below:

Table III. 103. Classes of Near-Distance Quality Comparison in Dompu (reference data: Bing Satellite imagery)

Classes		**Quality**	**Frequency**
0	3.745	Very Good (1)	35
3.746	6.722	Good (2)	100
6.723	9.699	Medium (3)	133
9.7	12.677	Bad (4)	19
12.678	15.654	Very Bad (5)	7
Number of data			**294**

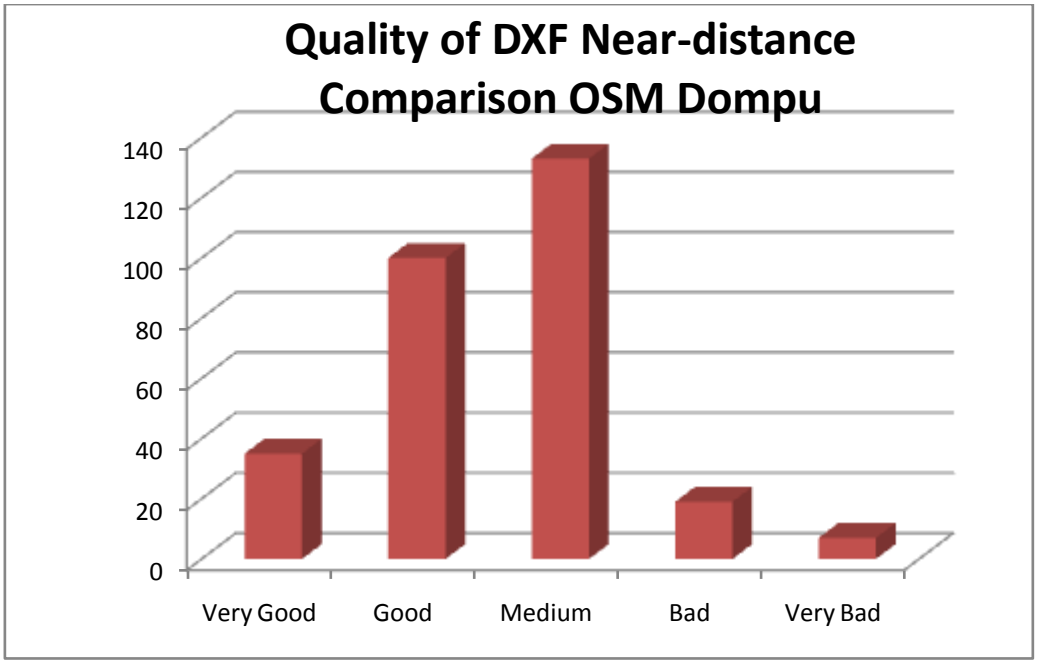


Fig. III. 96. Graphical presentation of Polygon Near-Distance (ref.: BING satellite imagery)

From this quality comparison, it can be concluded that the overall quality of Near Distances comparison between OSM data and citra in Dompu is medium. Further said, the spatial distance of OSM data in this study area is spatially close to the reference data, i.e. Bing Imagery.

3) Polygon Area

Polygon Area evaluation is conducted by comparing the area of OSM buildings data in Dompu with the same buildings data from citra. The statistical characteristics of the result are shown below:

Table III. 104. Statistical Characteristics from the Sample (Polygon Area)

Number of Data	294
Median	19.81347508315
Maximum Data	3375.88284656000
Minimum Data	0.04343388970
Standard Deviation	211.952015
Average	43.68047519628

The result of statistical comparison using two-tailed t-test at 90% confidence level with sample size of 294 data is given below:

The t-test value of calculated statistics is 0.20608662389887, while the t-table value for a 90% level of confidence and sample size of 294 is 1.65012. So, the data are not significantly different .

Classification of the calculated data using equal interval is presented below:

Table III. 105. Classes of Polygon Area Comparison in Dompu (reference data: Bing satellite imagery)

Classes		Quality	Frequency
0	675.211	Very Good (1)	292
675.212	1350.379	Good (2)	1
1350.38	2025.547	Medium (3)	0
2025.548	2700.715	Bad (4)	0
2700.716	3375.883	Very Bad (5)	1
Number of data			**294**

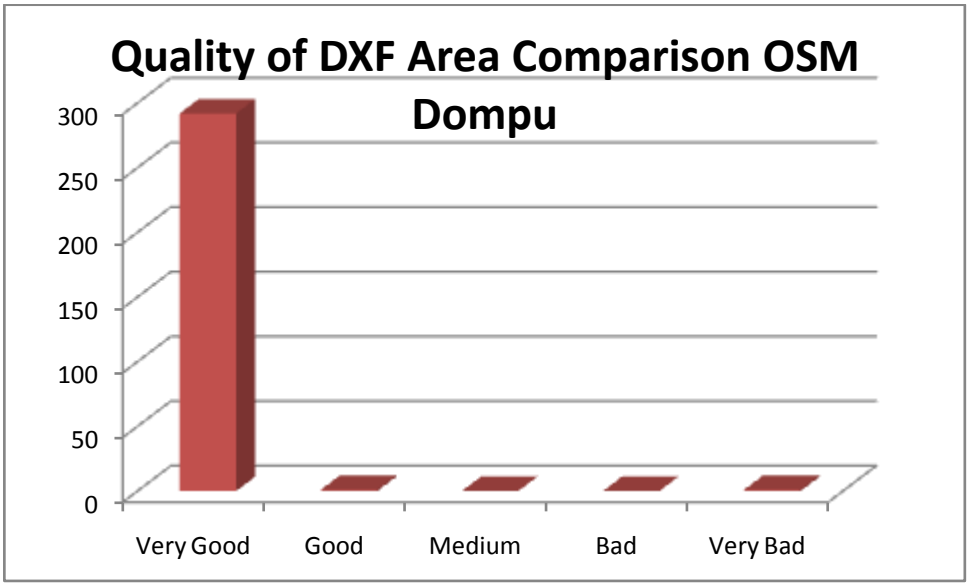


Fig. III. 97. Graphical presentation of Polygon Near-Distance (ref.: Bing satellite imagery)

From this quality comparison, it can be concluded that the overall quality of Area comparison between OSM data and Bing satellite imagery in Dompu is very good. Fairly said, the spatial area of OSM data in this study area is close with the reference data, i.e. Bing Imagery.

> Line Buffer-Overlap analysis

This evaluation use line type of reference data, i.e. from Bing Imagery of Dompu. This kind of reference data is used to perform comparative analysis on line type of OSM data, i.e. roads data in Dompu. The analysis conducted consists of Buffer-overlap analysis which results will be explained further.

This method is used to inquire the discrepancies between the reference data (Dompu Road Network Map) and the evaluated data (OSM Roads Data in Dompu) within a tolerance value. The tolerance value chosen are based on the average width of a particular road class in real world (e.g. primary class road have a tolerance value of 8 meters). The results are percentage values which represent the overlap of the evaluated data with the reference data, which means that 100% value give us a presentation that the particular roads are exactly within the tolerance value of the reference road. 460 samples are randomly chosen from the whole roads data in Dompu to be analyzed. The statistical characteristics from the sample are listed below:

Table III. 106. Statistical Characteristics from the Sample (Line Buffer-Overlap percentage)

Number of Data	460
Median	80.12463563620
Maximum Data	100.00000036900
Minimum Data	0.41519764818
Standard Deviation	32.26199911
Average	68.23515342388

To enhance the understanding of the data qualities, the data are then classified as shown below:

Table III. 107. Some Statistical Characteristics from the Sample in Dompu (Line Buffer-Overlap percentage)

Classes (%)		**Quality**	**Frequency**
0	20	Very Bad (5)	63
21	40	Bad (4)	40
41	60	Medium (3)	66
61	80	Good (2)	61
81	100	Very Good (1)	230

Number of data	460

(a) OSM roads data (b) Bing Imagery of Dompu

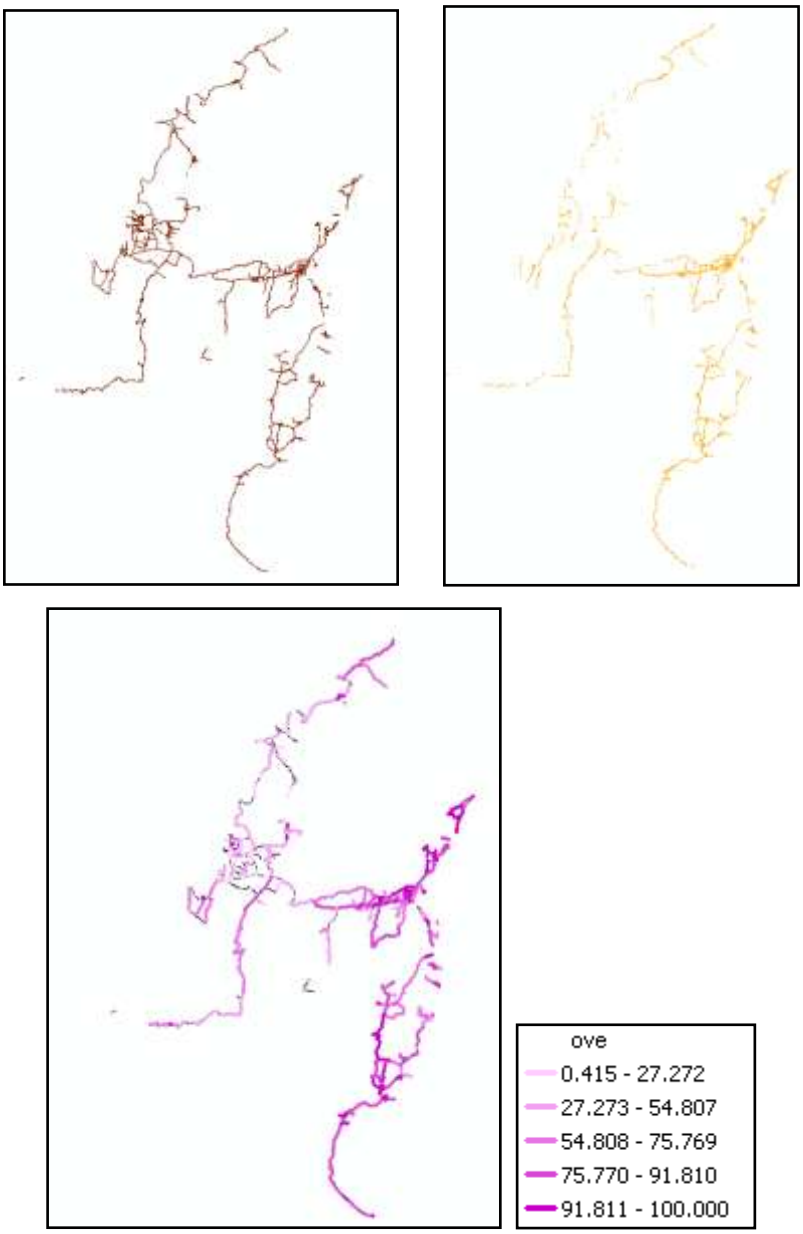


Fig. III. 98. Graphical evaluation results of buffering method (ref.: Topographic Map data)

From the analysis, it is shown that major part of the sampled data (230 data) have a Very Good (1) quality relative to the reference data; while some others (6 data) had a very bad (5) qualities. Thus, it can be concluded that the qualities of OSM roads data in Dompu (using this method) are very good, relative to the reference data used.

f) Attribute Evaluation Results

This method analyze the quality of attribute (non spatial) data in OSM shapefile (particularly, the buildings layer). The attribute of the buildings in subject are listed and compared with its real world condition based on the groundtruthing survey. Some 302 samples are chosen to be evaluated from the whole attributes buildings data in Dompu. The results are based on scorings of the suitability between OSM data and the real world condition of the same building. The results are as follow:

Table III. 108. Classification of Attribute Quality Based on Score Value

Number of value	Quality	Frequency
≤ 5	Good (1)	27
3	Medium (2)	39
2 ≥	Bad (3)	236
Total		**302**

The result shows that majority of the buildings data in Dompu have a 'bad' attribute quality.

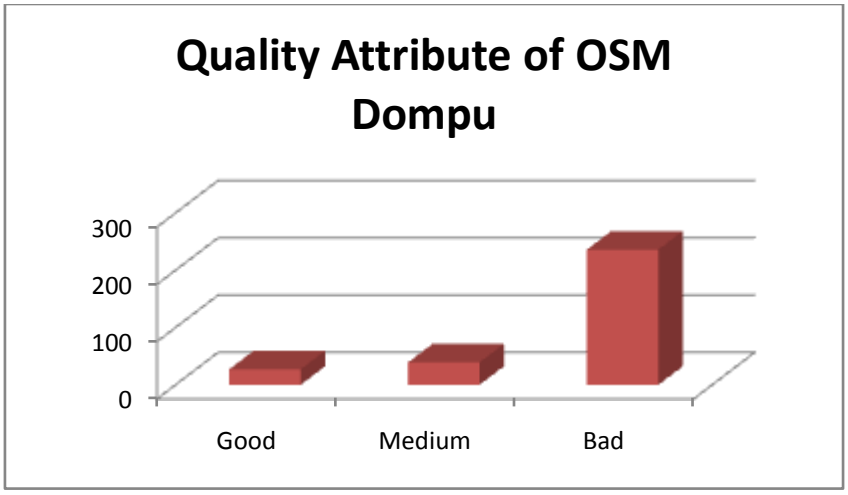


Fig. III. 99. Graphical presentation of Buildings Attribute Quality Based on Score Value

c. Attributes Completeness

Attribute completeness is evaluation to represent the empty data and filled data from all of attributes OSM data competition.

Table III. 109. Classification of attribute OSM data in Dompu

Attributes	No Data	Filled Data
Name	1818	43
Use	266	1595
Structure	1627	234
Walls	1610	251
Roof	1609	252
Level	1653	208
Number of Data		1861

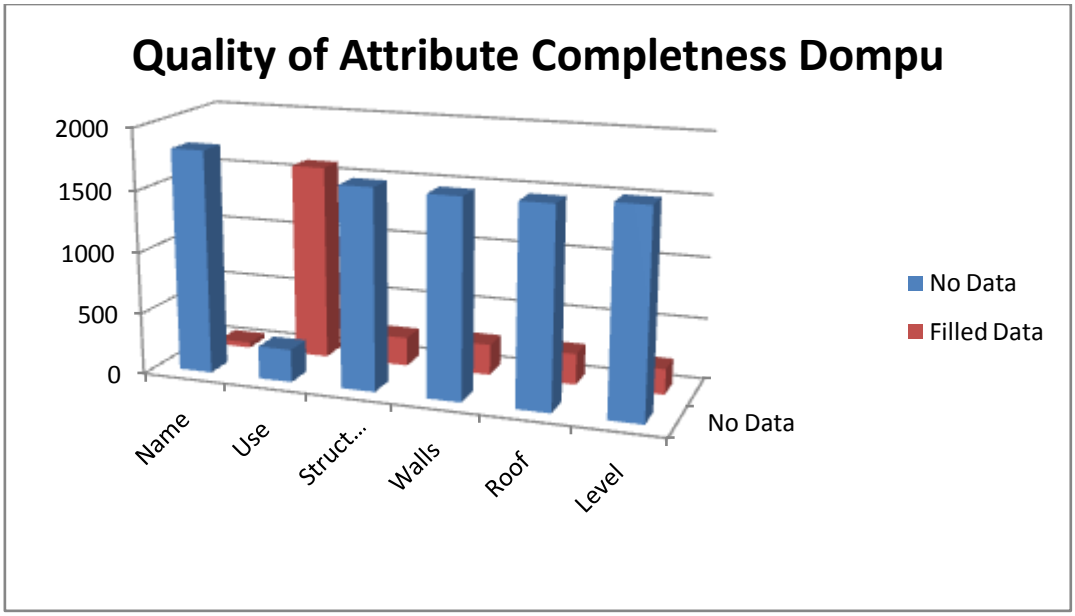


Fig. III. 100. Graphic of quality attribute completeness roads in Dompu

(b) Contributor Evaluation

By contributor evaluation it means that this method assesses each contributor of the OSM competition data in the study area (in this case: around Dompu): how much is the input data; how far does the coverage of his/her contribution; and how dispersed/clustered the data that he/she contributed.

Table III. 110. Amount of Input Data per Contributor

No	user	Count_user	Percentage (%)
1	Arifuddin	1343	72,16550242
2	Sandhy	333	17,89360559
3	rukeli	97	5,212251478
4	iiN-Dah	56	3,009134874
5	Ethy	31	1,665771091
6	fahil19	1	0,053734551
Total		1861	100

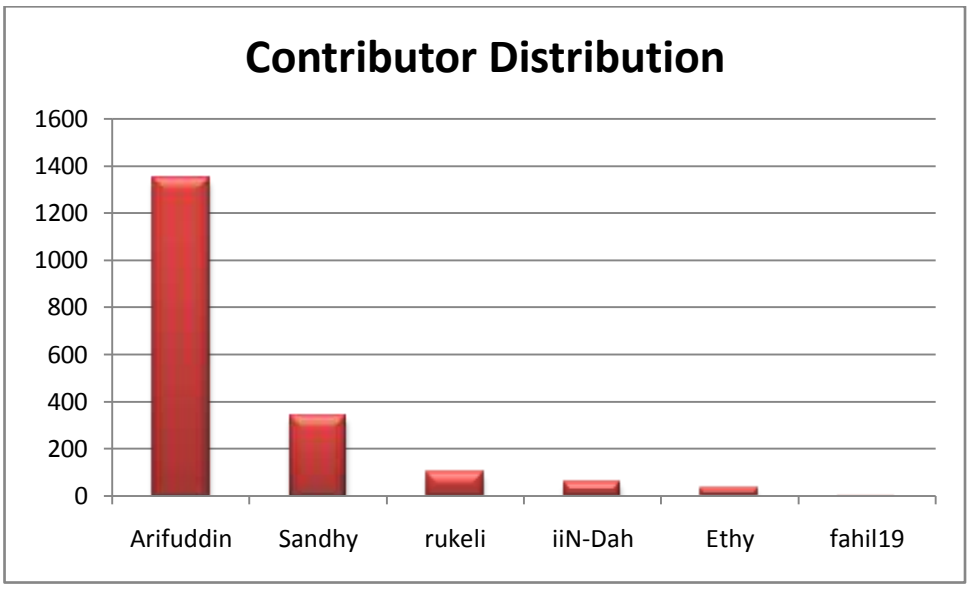


Fig. III. 101. Graphic of Contributor Distribution

(c) Statistical Evaluation

- *Average Nearest Neighbour*

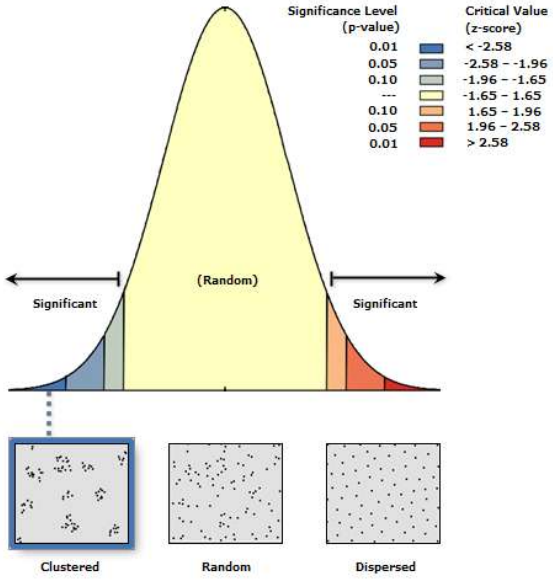


Fig. III. 102. Average Nearest Neighbour

From the calculation above obtained z value of -73.587590. There is a 1% likehood that contributors input the data randomly. That's means, there is a high probability to input the data based on specific pattern (the data is clustered).

(d) Standard Distance

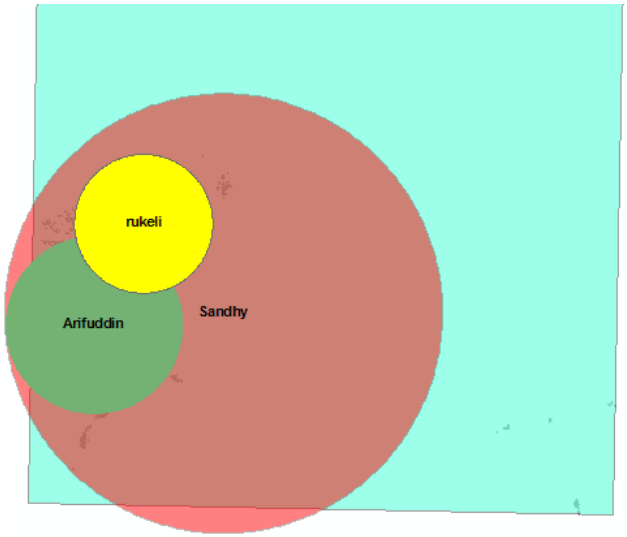


Fig. III. 103. Standard Distance of Contributor in Dompu

Standard Distance shows the dispersion of each value around the center of data. The bigger circle in the above Figure means the more amount of the data, and the more dispersed the data is. Blue colored rectangle in the background represents the outer boundary of all the data in Dompu city.

(e) Individual ContributorEvaluation

- *Contributor Arifudin*

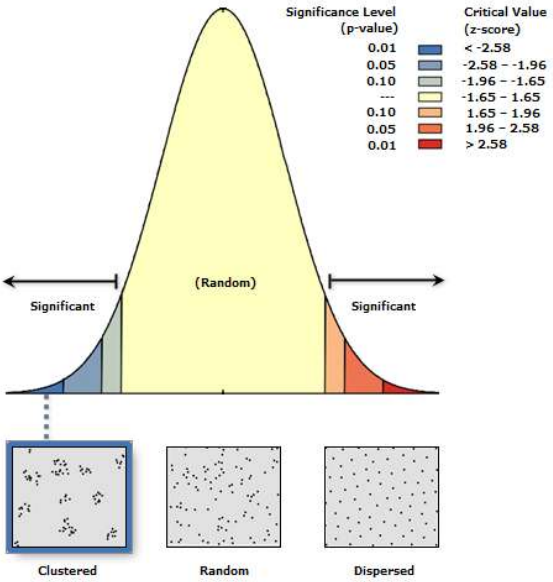


Fig. III. 104. Evaluation contributor of Arifudin

From the calculation above obtained z value of -57.456874. There is a 1% likehood that contributors input the data randomly. That's means, there is a high probability to input the data based on specific pattern (the data is clustered).

- *Contributor Shandy*

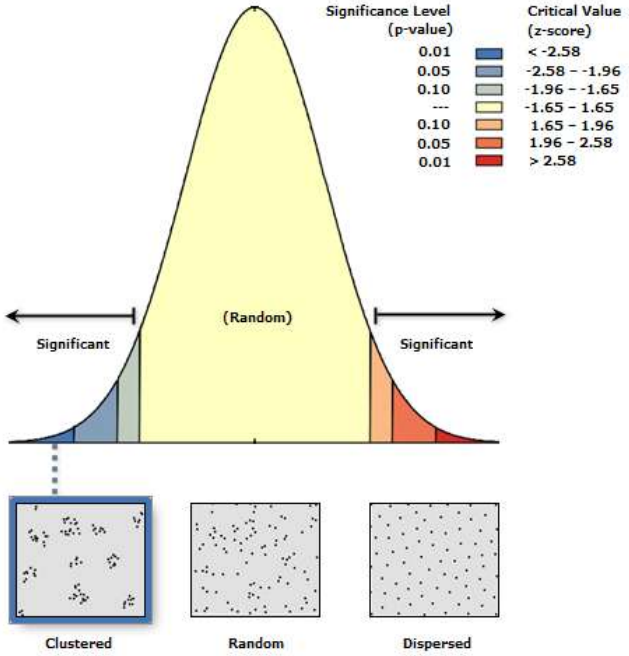


Fig. III. 105. Evaluation contributor of Shandy

From the calculation above obtained z value of -31.615496. There is a 1% likehood that contributors input the data randomly. That's means, there is a high probability to input the data based on specific pattern (the data is clustered).

- *Contributor Rukeli*

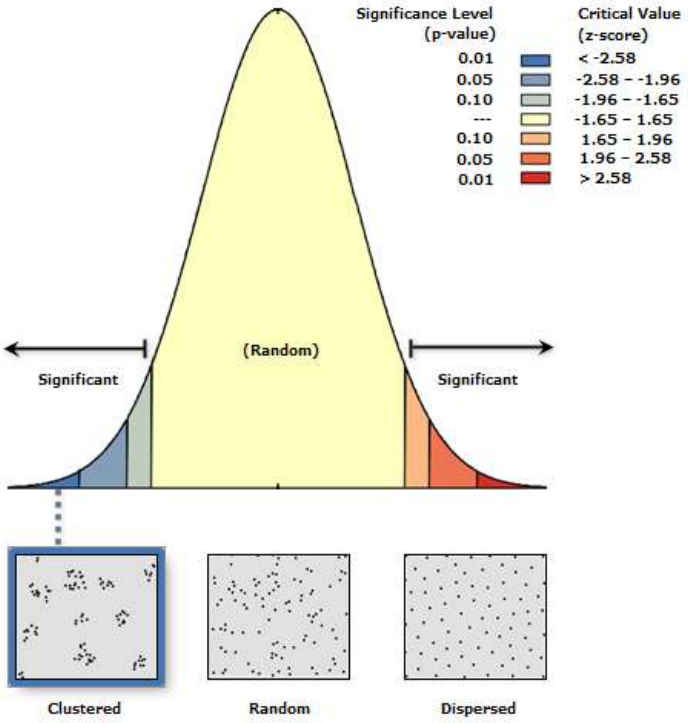


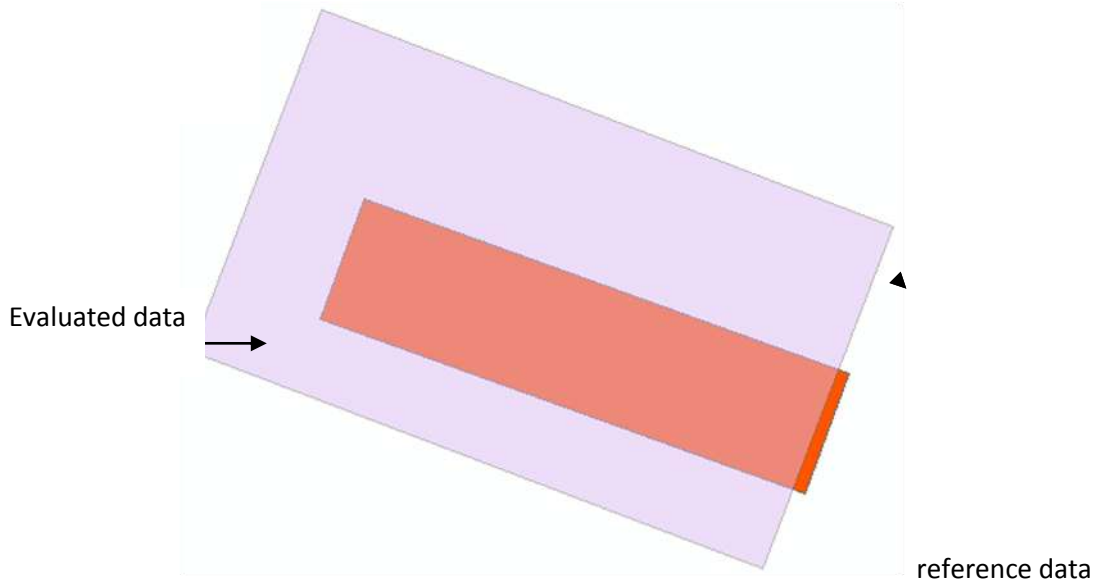
Fig. III. 106. Evaluation contributor of Rukeli

From the calculation above obtained z value of -11.952276. There is a 1% likehood that contributors input the data randomly. That means, there is a high probability that contributors tend to input the data in a specific pattern (the data is clustered).

g) Sample Case

Here is a sample of the evaluation results. The sample is a building feature which is known as SDN 21 Manggalewa, located at Kampung Bali.

- Shape comparison between evaluated data (OSM data) and reference data (Bing Imagery)



- OSM feature attribute

osm_id	Name	Use	Structure	Walls	Roof	levels
126079789		residential				

- Attribute evaluation (based on survey the real world of the building), 1 = correct, 0 = incorrect

Name (1)	Use (1)	Structure	Walls (1)	Roof (1)	Level (1)	Total (6)	Quality
0	1	0	0	0	0	1	Bad

- The pictures of SD N 21 Manggalewa :

(c) Front view

(b) Side view

(c) Back view (d) Side view

Fig. III. 107. SD N 21 Manggelewa Building, Dompu.

e. Heatmap visualization of accuracy evaluation

Heatmap is a map visualization method used in this study to present the extent of OSM's buildings data. All evaluation methods previously used are combined to evaluate OSM buildings data. A different weighted value are applied to each evaluation methods as follows:

Table III. 111. Scoring of spatial accuracy

Spatial Accuracy			
Methods / Quality	Near-Distances	Circularity	Area Comparison
Very Bad (5)	10	5	5
Bad (4)	20	10	10
Medium (3)	30	15	15
Good (2)	40	20	20
Very Good (1)	50	25	25

Results of weighting the three methods above are then summed to obtain final results of accuracy. Maximum value of the addition are 241 for each buildings. The final results of heatmap visualization are presented below:

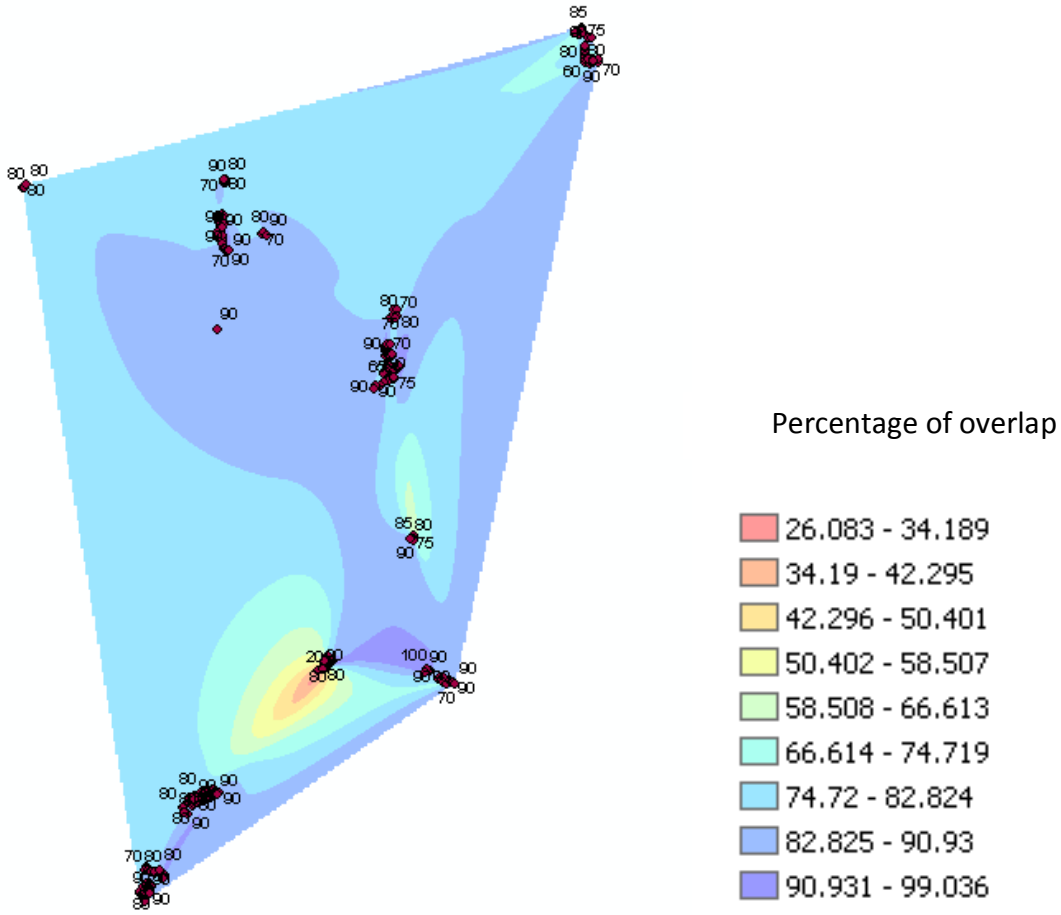


Fig. III. 108. Heatmap visualization of spatial accuracy in Dompu.

IV. LESSONS LEARNT AND CONCLUSION

IV.1. Lessons Learnt

Some issues during the OpenStreetMap evaluation in Indonesia could be noted here.

1. With very limited time to evaluate the OSM data, quick but dependable measurement methods should be applied when conducting the groundtruthing survey. A rapid survey with GPS RTK-NTRIP is proven to be time and cost consuming, with only few data sample can be collected in a day. Thus, measurement activities using Mobile GIS were applied to the groundtruthing survey to ensure the time spent for the survey is as minimum as possible, while maintaining the accuracy within an acceptable tolerance.
2. Reference data is often hard to obtain. Topographic basemap in some cities is only available up to 1:25.000 in scale, and is not available at higher scale.
3. The groundtruthing activities (i.e. GPS measurements and the team deployment), highly depend on the weather condition and the distribution of the sample data. The more distributed the sample data, more time and mobility to evaluate sample data are required.
4. The heterogeneity of OSM data input makes the evaluation processes become more complex. For example, in some cases, the contributor draws a group of buildings as a single feature, while in some other cases a single building in real world was digitized as a group of features.
5. Most contributors digitize the building based only by the looking on the roof's shape, while the actual shape of the buildings are often strictly different from the true shape of the buildings. This also caused some inaccurate attribute values, since the participants did not exactly know the true condition of the feature.
6. It is often hard to get a permission to conduct a field survey on some government or private office buildings.
7. Lots of skycrapers and another high-rise buildings caused obstruction in GPS measurement using Mobile GIS, which could affect the results of the survey.
8. Another case in competition data is that some buildings were digitized twice by two or more different contributors.

9. Based on field survey, some of the OSM buildings were digitized by the contributors altogether with its land boundary (as an example, a school area is digitized along its fence boundary). This will influence the results of analysis significantly (especially in the analysis of area and circularity).
10. The percentage of contributor evaluation shows that there is no specific pattern of each contributor's participation. However it tends that the data each contributor collected to be clustered in the same area, e.g. in the area of ITB Campus in Bandung.
11. The categories of buildings' attribute (e.g. tile roof, reinforced masonry walls) are insufficient with the variety of the real building's conditions in field. Some conditions, such as a building with no roof or walls, are common in real conditions.
12. An interesting note must be addressed to non contest data especially for community in rural areas. From the field survey, some buildings in the Dompu could have been moved or demolished, leave the actual field condition to be different with the evaluated dataset. A lot of the residential buildings in Dompu area (known as "Rumah Panggung") have been moved to another location hundreds of meter away. This dynamic change could significantly affect the evaluation results.

IV. 2. Spatial conclusion of OSM data quality (Building)

a) Yogyakarta

Table IV. 1. Spatial Conclusion in Yogyakarta

Data	Evaluation Method	t-value calculation	t-table	Remarks
UGM Topographic Map Data	**Polygon Area**	0.982215977	1.29016	The data are not significantly different
	Polygon Circularity	0.865626509	1.29016	The data are not significantly different
	Near distance	0.126897948	1.29016	The data are not significantly different
Bing Imagery	**Polygon**	0.312251904	1.645	The data are not

in Yogyakarta	**Area**			significantly different
	Polygon Circularity	0.67526528	1.645	The data are not significantly different
	Near distance	0.002413281	1.645	The data are not significantly different

b) Surabaya

Table IV. 2. Conclusion of spatial analysis in Surabaya

Data	Evaluation Method	t-value calculation	t-table	Remarks
Field Survey Data	**Polygon Area**	0,202914506	1,28825	the data are not significantly different
	Polygon Circularity	1,028939782	1,28825	the data are not significantly different
	Near distance	0,022271048	1,28825	the data are not significantly different
Topographic Survey Data	**Polygon Area**	0,819899149	1,30946	the data are not significantly different
	Polygon Circularity	0,97453686	1,30946	the data are not significantly different
	Near distance	0,025144568	1,30946	the data are not significantly different

c) Bandung

Table IV. 3. Spatial conclusion in Bandung

Data	Evaluation Method	t-test	t-table	Remarks
Groundthruthing Data Number of sample data = 94	Area	0.7743825	1.2907200	the data are not significantly different
	Circularity	1.0297236	1.2907200	the data are not significantly different
	Near-Distance	0.0352348	1.2907200	the data are not significantly different

Topographic Map Data Number of sample data = 200	Area	0.5015596	1.2858200	the data are not significantly different
	Circularity	0.8569954	1.2858200	the data are not significantly different
	Near-Distance	0.0298056	1.2858200	the data are not significantly different

d) Jakarta

Table IV. 4. Spatial Conclusion in Jakarta

Data	Evaluation Method	t-value calculation	t-table	Remarks
Field Survey Data	**Polygon Area**	0.679439176	1.29016	the data are not significantly different
	Polygon Circularity	0.865626509	1.29016	the data are not significantly different
	Near distance	0.020709581	1.29016	the data are not significantly different
Topographic Survey Data	**Polygon Area**	0.312251904	1.645	the data are not significantly different
	Polygon Circularity	1.101736451	1.28582	the data are not significantly different
	Near distance	0.036917566	1.28582	the data are not significantly different

e) Padang

Table IV. 5. Spatial conclusion in Padang

Data	Evaluation Method	t-test	t-table	Remarks
Groundthruthing Data Number of sample data = 241	Area	0.52887474	1.969856158	the data are not significantly different
	Circularity	4.929424432	1.969856158	the data are significantly different
	Near-Distance	0.023900429	1.969856158	the data are not significantly different

Topographic Map Data Number of sample data = 241	Area	0.332340326	1.969856158	the data are not significantly different
	Circularity	0.741300138	1.969856158	the data are not significantly different
	Near-Distance	0.010854848	1.969856158	the data are not significantly different

f) Dompu

Table IV. 6. Spatial conclusion in Dompu

Data	Evaluation Method	t-test	t-table	Remarks
Groundthruthing Data Number of sample data = 294	Area	0.2083139	1.65012	the data are not significantly different
	Circularity	0.8539019	1.65012	the data are not significantly different
	Near-Distance	0.0615697	1.65012	the data are not significantly different
Satellite Imagery Number of sample analisisdata = 294	Area	0.2060866	1.65012	the data are not significantly different
	Circularity	0.8474403	1.65012	the data are not significantly different
	Near-Distance	0.0760501	1.65012	the data are not significantly different

IV.3. Spatial conclusion of OSM data quality (Roads)

a) Yogyakarta

Table IV. 7. Classes of Line Buffer-Overlap evaluation in Yogyakarta

(Reference data: Yogyakarta's Road Network Map)

Classes (% overlap)		Quality	Frequency
0	20	Very Bad (5)	48
21	40	Bad (4)	29

41	60	Medium (3)	25
61	80	Good (2)	19
81	100	Very Good (1)	82
Number of Data			**203**

Table IV. 8. Classes of Road Completeness Analysis in Yogyakarta

(Reference data: Yogyakarta's Road Network Map)

Classes (% completeness)		Quality	Frequency
0	20	Very Bad (5)	0
21	40	Bad (4)	5
41	60	Medium (3)	7
61	80	Good (2)	11
81	100	Very Good (1)	22
Number of Data			45

b) Surabaya

Table IV. 9. Classes of Line Buffer-Overlap evaluation in Surabaya

(Reference data: ITS Topographic Map)

Classes (% overlap)		Quality	Frequency
0	20	Very Bad (5)	6
21	40	Bad (4)	8
41	60	Medium (3)	3
61	80	Good (2)	6
81	100	Very Good (1)	19
Number of Data			**42**

c) Bandung

Table IV. 10. Classes of Line Buffer-Overlap evaluation in Bandung

(Reference data: Topographic map)

Classes (% overlap)		Quality	Frequency
0	20	Very Bad (5)	21

21	40	Bad (4)	24
41	60	Medium (3)	33
61	80	Good (2)	29
81	100	Very Good (1)	48
Number of data			**155**

Table IV. 11. Classes of Road Completeness Analysis in Bandung

(Reference data: Topographic Map)

Classes (% completeness)		Quality	Frequency
0	20	Very Bad (5)	1
21	40	Bad (4)	4
41	60	Medium (3)	3
61	80	Good (2)	1
81	100	Very Good (1)	0
Number of grid			9

d) Jakarta

Table IV. 12. Classes of Line Buffer-Overlap evaluation in Jakarta

(Reference data: Jakarta Topographic Map)

Classes (% overlap)		Quality	Frequency
0	20	Very Bad (5)	137
21	40	Bad (4)	78
41	60	Medium (3)	82
61	80	Good (2)	102
81	100	Very Good (1)	117
Number of sample			**516**

e) Padang

Table IV. 13. Classes of Line Buffer-Overlap evaluation in Padang

(Reference data: Padang Topographic Map)

Classes (% overlap)	Quality	Frequency

0	20	Very Bad (5)	15
21	40	Bad (4)	4
41	60	Medium (3)	8
61	80	Good (2)	8
81	100	Very Good (1)	16

Table IV. 14. Classes of Road Completeness Analysis in Padang

(Reference data: Padang Topographic Map)

Classes (% completeness)		Quality	Frequency
0	20	Very Bad (5)	10
21	40	Bad (4)	5
41	60	Medium (3)	0
61	80	Good (2)	0
81	100	Very Good (1)	0

f) Dompu

Table IV. 15. Classes of Line Buffer-Overlap evaluation in Dompu

(Reference data: Bing Imagery)

Classes (% overlap)		Quality	Frequency
0	20	Very Bad (5)	63
21	40	Bad (4)	40
41	60	Medium (3)	66
61	80	Good (2)	61
81	100	Very Good (1)	230

IV.4. Concluding Remarks

In regard to data quality related to building feature, it can be concluded that quality assessments for OSM buidling data were giving a satisfying result (not significantly different with reference dataset and groundtruthing). Below will be given the conclusion for OSM data quality for building feature for each city/area.

In regard to data quality related to road feature, it can be concluded that data quality for OSM road data were not giving a perfect result. Numbers of OSM road data that fit into very good and good criteria in case of buffer-overlap and road completeness were easily found in Yogyakarta and Dompu, whereas in other areas, the results that fit into very bad, bad, medium, good, and very good seem to be equally distributed. From field survey it can be concluded that most of OSM data were existing in the field but often contributors did digitize the road features not as accurate as the condition on the field (shorter or longer than the actual roads).

In regard to data quality related to attribute values, it can be concluded from the evaluation results that attribute values mostly were at 'medium' quality in terms of attribute completeness and correctness. In Dompu, the attribute values can be considered as the worst, either not accurate or not completed (most of the OSM building data submitted were without attribute values).

It can be noted that it tends that spatial accuracy of OSM data were considered to be adequate when compared to reference data (with a scale at 1:5.000) and when verified on the field. Unfortunately, attribute values related to building features seem to be less accurate/trustful. This can be a serious consideration for any GIS system that will use OSM building features in 6 cities/areas for risk modelling. In this regard, data selection and filtering to OSM building data with good or medium criteria in their attribute values would be needed.

REFERENCES

http://www.vividsolutions.com/jcs/

Gregory, Ian N. and Ell, Paul S., (2007). Historical GIS: Technologies, Methodologies and Scholarship. Cambridge University Press, New York.

Ghilani, Charles D. (2010*). Adjustment computations - Spatial Data Analysis*. John Wiley and sons Inc. Canada

INSPIRE Thematic Working Group Building. (2011). *INSPIRE Data Specification on Building – Draft Guidelines*, Infrastructure for Spatial Information in Europe. http://inspire.jrc.ec.europa.eu/documents/Data_Specifications/INSPIRE_DataSpecification_BU_v2.0.pdf

Isaac, Stephen., Michael, William B., (1981). *Handbook in research and evaluation: A collection of principles, methods, and strategies useful in the planning, design, and evaluation of studies in education and the behavioral sciences*. EDITS Publishers. San Diego, California.

Krejcie, Robert P., Morgan, Daryle W., (1970). *Determining Sample Size for Research Activities - Educational and Psychological Measurement*. University of Minnesota, Duluth, Minnesota.

Kounadi, Ourania. (2009). Assessing the quality of OpenStreetMap data. University College of London, Department of Civil, Environmental and Geomatic Engineering, London.

Rumor, M., McMillan, R., Ottens., H. F. L., (1996). *Geographical Information: From Research to Application through Cooperation*. IOS Press, Amsterdam.

Roussillon, Tristan., Tougne, Laure., Sivignon, Isabelle., (2007). *Discrete Circularity Measure*. *http://liris.cnrs.fr/Documents/Liris-3245.pdf. Laboratoire LIRIS, Universit´e de Lyon, France.*

Ying, F., Mooney, P., and Corcoran, P., (2010). *Using Shape Complexity to Guide Simplification of Geospatial Data for Use in Location-based Services*. http://www.cs.nuim.ie/~pmooney/websitePapers/LBS2010-China-Paper-11_final.pdf

ANNEX

1. Some Excerpt from the Forms of Field Surveys

1). Surabaya

osm_id	name-ev	Use-ev	Structure-ev	walls-ev	roof-ev	levels-ev
28716803	Taman Makam Pahlawan Kusuma Bangsa	Ruang Terbuka Hijau	-	-	-	1
30411458	Pasar Atum	Shop	confined_masonry	Brick	Concrete	4
35927711	Twin Tower Hotel	Commercial	confined_masonry	Brick	Concrete	17
119488176	Teknik Informatika ITS	education	reinforced_masonry	brick	tile	4
119489994	Masjid As-Sa'dah	place_of_worship	unreinforced_masonry	brick	concrete	2
119489995	Desain Produk ITS	Education	reinforced_masonry	brick	tile	3
119490012	Gedung Guglielmo Marconi	Doormitory	reinforced_masonry	brick	Tile	3
119490387	Mushola An-Nahl	place_of_worship	reinforced_masonry	brick	tile	2
119744018	Deretan Ruko	Commercial	reinforced_masonry	brick	concrete	3
119744022	Car Wash	Commercial	confined_masonry	Brick	tile	1
119744025	Dentist	medical	confined_masonry	brick	tile	1
119744027	Deretan Ruko	ruko	reinforced_masonry	brick	tile	4
119744040	Global Super Store	Commercial	confined_masonry	brick	tile	2
119744054	Nur Pacific Hotel	commercial	reinforced_masonry	Brick	Tile	6
119770582	Mesjid Darul Fallah	place_of_worship	unreinforced_masonry	brick	Tile	2
119968639	Perumahan	residential	confined_masonry	brick	Asbes	2
121123011	Perumahan	residential	confined_masonry	brick	tile	1
121123012	Perumahan	residential	confined_masonry	brick	Tile	1
121123013	Perumahan	residential	confined_masonry	brick	Tile	1
121123015	Perumahan	residential	confined_masonry	brick	Tile	1

121123016	Perumahan	residential	confined_masonry	brick	Tile	1
121123019	Perumahan	residential	confined_masonry	brick	Tile	2
121123021	Perumahan	residential	confined_masonry	brick	Tile	2
121123023	Perumahan	residential	confined_masonry	brick	Tile	2
121123024	Perumahan	residential	confined_masonry	brick	Tile	2
121123025	Perumahan	residential	confined_masonry	brick	asbestos	2
121123027	Perumahan	residential	unconfined	brick	Asbestos	2
121123028	Perumahan	residential	confined_masonry	brick	asbestos	1
121123029	Perumahan	residential	confined_masonry	brick	Tile	1
121123030	Perumahan	residential	confined_masonry	brick	Tile	2
121123031	Perumahan	residential	confined_masonry	brick	Tile	1
121123032	Perumahan	residential	confined_masonry	brick	Tin	1
121123035	Perumahan	residential	confined_masonry	brick	asbestos	1
121123037	Perumahan	residential	confined_masonry	brick	Tile	1
121123039	Perumahan	residential	confined_masonry	brick	TIle	1
121123043	Perumahan	residential	confined_masonry	brick	Tile	2
121123045	Perumahan	residential	confined_masonry	brick	Tile	1
121123047	Perumahan	residential	confined_masonry	brick	asbestos	2
121123048	Perumahan	residential	confined_masonry	brick	Tile	1
121123049	Perumahan	residential	confined_masonry	brick	Tile	1
121123051	Perumahan	residential	confined_masonry	brick	Tile	2
121123053	Perumahan	residential	confined_masonry	brick	Tile	2
121123054	Perumahan	residential	confined_masonry	brick	Tile	1
121123055	Perumahan	residential	confined_masonry	brick	asbestos	1
121123056	Perumahan	residential	confined_masonry	brick	Tile	2
121123057	Perumahan	residential	confined_masonry	brick	tile	1
121123058	Perumahan	residential	confined_masonry	brick	Tile	1
121123061	Perumahan	residential	confined_masonry	brick	Tile	1
121123062	Perumahan	residential	confined_masonry	brick	Tile	2
121123064	Perumahan	residential	confined_masonry	brick	asbestos	2

121123065	Perumahan	residential	confined_masonry	brick	Tile	1
121123068	Perumahan	residential	confined_masonry	brick	Asbestos	3
121123070	Perumahan	residential	confined_masonry	brick	Tile	2
121123073	Perumahan	residential	confined_masonry	brick	Tile	2
121123077	Perumahan	residential	confined_masonry	brick	tile	2
121785807	Sakinah Supermarket	shop	confined_masonry	brick	tin	1
123122667	Yayasan Pendidikan Yapita	education	reinforced_masonry	brick	tile	3
123122669	Yayasan Pendidikan Yapita	education	reinforced_masonry	brick	tile	3
124371841	Perumahan	residential	confined_masonry	brick	tile	1
124371845	Perumahan	residential	confined_masonry	brick	tile	1
124371878	Perumahan	residential	confined_masonry	brick	tile	2
124371930	Perumahan	residential	confined_masonry	brick	tile	2
124371960	Perumahan	residential	confined_masonry	brick	tile	1
124371983	Perumahan	residential	confined_masonry	brick	tile	1
124371993	Perumahan	residential	confined_masonry	brick	tile	1
124372012	Perumahan	residential	confined_masonry	brick	tile	2
124372022	Perumahan	residential	confined_masonry	brick	tile	2
124372044	Perumahan	residential	confined_masonry	brick	tile	1
124372049	Mesjid Al-Hidayah	place_of_worship	unreinforced_masonry	brick	Tile	1
124372051	Perumahan	residential	confined_masonry	brick	tile	2
124372060	Perumahan	residential	confined_masonry	brick	tile	1
124372081	Perumahan	residential	confined_masonry	brick	tile	2
124372086	Perumahan	residential	confined_masonry	brick	tile	1
124372099	Perumahan	residential	confined_masonry	brick	tile	1
124372113	Perumahan	residential	confined_masonry	brick	tile	1
124372163	Perumahan	residential	confined_masonry	brick	tile	1
124372167	Perumahan	residential	confined_masonry	brick	tile	2
124372189	Perumahan	residential	confined_masonry	brick	tile	1
124372197	Perumahan	residential	confined_masonry	brick	tile	2
124372234	Perumahan	residential	confined_masonry	brick	tile	1

124372250	Perumahan	residential	confined_masonry	brick	tile	1
124372253	Perumahan	residential	confined_masonry	brick	tile	2
124372271	Perumahan	residential	confined_masonry	brick	tile	3
124372296	Perumahan	residential	confined_masonry	brick	tile	2
124372298	Perumahan	residential	confined_masonry	brick	tile	1
124372301	Perumahan	residential	confined_masonry	brick	tile	1
124372358	Perumahan	residential	confined_masonry	brick	tile	1
124372371	Perumahan	residential	confined_masonry	brick	tile	1
124372435	Perumahan	residential	confined_masonry	brick	tile	2
124892496	Perumahan	residential	confined_masonry	brick	tile	1
124892519	Perumahan	residential	confined_masonry	brick	tile	1
124892528	Pom Bensin	commercial	unreinforced_masonry	brick	Concrete	1
119276795	Graha Sepuluh Nopember	multipurpose	reinforced_masonry	brick	tile	3
119290341	Teknik Geomatika	education	reinforced_masonry	brick	tile	7
119290342	PERPUSTAKAAN ITS	education	reinforced_masonry	brick	tile	6
119291932	si	education	reinforced_masonry	brick	tile	3
119293001	Gedung UPMB - Pascasarjana ITS	multipurpose	reinforced_masonry	brick	tile	4
119293108	Mushola	place_of_worship	reinforced_masonry	brick	tile	1
119293435	REKTORAT	Education	reinforced_masonry	brick	tile	3
119293444	UPT BAHASA	education	reinforced_masonry	brick	tile	2
119293456	Asrama PENS-ITS	residential	reinforced_masonry	brick	tile	3
119293458	Asrama PENS-ITS	residential	reinforced_masonry	brick	tile	3
119293459	Asrama PENS-ITS	residential	reinforced_masonry	brick	tile	3
119487703	Lab_bahasa	education	reinforced_masonry	brick	tile	2
119487706	Teknik Sipil	education	reinforced_masonry	brick	tile	3
119487707	Lab_bahasa	government	reinforced_masonry	brick	tile	2
119487711	Manarul Ilmi Mosque	place_of_worship	reinforced_masonry	brick	tile	2
119487717	SCC	commercial	reinforced_masonry	brick	tile	3
119487725	BAUK	Education	reinforced_masonry	brick	tile	2
119489991	Asrama	residential	reinforced_masonry	brick	tile	2

119489999	GOR	commercial	reinforced_masonry	brick	tin	1
119490014	ppns	education	reinforced_masonry	brick	concrete	2
119744012	AXA life	commercial	confined_masonry	brick	asbestos	1
119744031	Gedung Jamsostek	commercial	reinforced_masonry	brick	tile	2
119744035	Mandiri	commercial	reinforced_masonry	brick	tile	2
119744051	Nav Karaoke	commercial	reinforced_masonry	tile	asbestos	2
119744058	Gedung Flexi	commercial	reinforced_masonry	brick	concrete	4
119770572	Giant	shop	reinforced_masonry	brick	concrete	1
121270332	Masjid Ahmad Yani	place_of_worship	unreinforced_masonry	brick	concrete	1
122095225	parkiran SI	tempat parkir	rangka kayu	-	tile	1
122095226	parkiran upt	tempat parkir	penguat kayu	-	tile	1
123115867	Gedung Perencanaan Wilayah dan Kota	education	reinforced_masonry	-	tile	3
123295103	kantin ITS	commercial	reinforced_masonry	wood	tile	1
123295104	Bank BNI	commercial	reinforced_masonry	brick	tile	1
123295105	SAC	commercial	reinforced_masonry	brick	tile	1
123295106	M-Web	education	reinforced_masonry	brick	tile	2
124371846	blok perumahan	residential	confined_masonry	brick	tile	2
124371858	blok perumahan	residential	confined_masonry	brick	tile	1
124371913	blok perumahan	residential	confined_masonry	brick	tile	1
124371923	blok perumahan	residential	confined_masonry	brick	tile	1
124371933	blok perumahan	residential	confined_masonry	brick	tile	1
124371978	blok perumahan	residential	confined_masonry	brick	tile	2
124372003	blok perumahan	residential	confined_masonry	brick	tile	1
124372073	blok perumahan	residential	confined_masonry	brick	tile	2
124372095	blok perumahan	residential	confined_masonry	brick	tile	1
124372111	blok perumahan	residential	confined_masonry	brick	tile	1
124372135	blok perumahan	residential	confined_masonry	brick	tile	1
124372145	blok perumahan	residential	confined_masonry	brick	tile	1
124372349	blok perumahan	residential	confined_masonry	brick	tile	2
124372365	blok perumahan	residential	confined_masonry	brick	tile	1

124372376	blok perumahan	residential	confined_masonry	brick	tile	1
124372406	blok perumahan	residential	confined_masonry	brick	tile	2
124892501	Bengkel Citra Motor	commercial	confined_masonry	brick	asbestos	3
35310898	BCA	commercial	reinforced_masonry	brick	concrete	3
35679649	ITC surabaya	commercial	reinforced_masonry	brick	concrete	7

2). Bandung

osm_id	name	use	structure	walls	roof	levels
119759609	apotekkimiafarma	commercil	**reinforced_masonry**	brick	tile	1
119414694	aula barat	multipurpose	**reinforced_masonry**	brick	tile	1
119419739	aula timur	education	**reinforced_masonry**	brick	asbestos	1
119755867	bandung indah plaza	commercial	**reinforced_masonry**	brick	concrete	6
119557709	basic science center a	education	**reinforced_masonry**	brick	tile	5
119423239	campus center timur	commercial	**reinforced_masonry**	tin	concrete	3
120624429	desain interior	education	**reinforced_masonry**	brick	asbestos	4
119763460	desain komunikasi visual	education	**reinforced_masonry**	brick	asbestos	4
120624440	desain produk	education	**reinforced_masonry**	brick	asbestos	3
119524759	dir sarpras	education	**reinforced_masonry**	brick	tile	1
119451756	dpk dmk masjid salman	multi purpose	**confined_masonry**	brick	tile	1
124282337	fak ekonomi	education	**reinforced_masonry**	brick	concrete	2
124282327	fak hukum	education	**reinforced_masonry**	brick	concrete	2
119417500	fak ilmu & teknologi kebumian	education	**reinforced_masonry**	brick	asbestos	2
119422840	fak senirupa & desain	education	**reinforced_masonry**	brick	tile	3
124282357	gd fe bag krjasama	education	**reinforced_masonry**	brick	concrete	3
124282354	gd rektorat lama	education	**reinforced_masonry**	brick	concrete	2
119423055	gd.program tahap persiapan ber	education	**reinforced_masonry**	brick	asbestos	2
119419851	gdg bisnis dan manajemen	education	**reinforced_masonry**	brick	concrete	3
119419852	gdng matematika	education	**reinforced_masonry**	brick	tile	4
119446869	gdung c	commercial	**reinforced_masonry**	brick	tile	1

124282349	gedung 4 hukum	education	**reinforced_masonry**	brick	tile	4
119424000	gedung kimia	education	**reinforced_masonry**	brick	tile	3
120624407	gedung laboraturium	education	**reinforced_masonry**	brick	asbestos	1
119423057	gedung pln	education	**reinforced_masonry**	brick	tile	2
119418834	gedung sipil	education	**reinforced_masonry**	brick	tile	1
119756387	gelanggang generasi muda	goverment	**reinforced_masonry**	brick	tile	2
119422833	geodesi-lingkungan	education	**reinforced_masonry**	brick	tile	6
119419737	gku barat	education	**reinforced_masonry**	brick	concrete	3
119424003	GKUtimur	commercial	**reinforced_masonry**	brick	tile	4
120624425	GOR argo	multipurpose	**reinforced_masonry**	brick	tin	2
120334239	graha sanusi harjadinata	education	**reinforced_masonry**	brick	asbestos	2
119758974	gramedia	commercil	**reinforced_masonry**	brick	concrete	4
119419846	gsg	education	**reinforced_masonry**	brick	tile	2
120624422	gsg 13	education	**reinforced_masonry**	brick	tin	2
98109684	gubernur jabar	goverment	**reinforced_masonry**	brick	tile	3
119423134	HMTL	education	**reinforced_masonry**	brick	tile	1
119756389	Holand Bakery	commercial	**reinforced_masonry**	brick	tile	0
119424002	kimia	education	**reinforced_masonry**	brick	tile	3
120624443	lab beton sipil	education	**reinforced_masonry**	brick	tin	4
119423377	lab mekanika tanah	education	**reinforced_masonry**	brick	tile	3
120624437	lab pancaka ayudawara 6	education	**reinforced_masonry**	brick	asbestos	1
119557713	lab.elektronikadaninformasi	education	**reinforced_masonry**	brick	tile	1
119419731	lab.pkonversienergielektrik	education	**reinforced_masonry**	brick	concrete	3
119419836	labmetalurgi	education	**reinforced_masonry**	brick	concrete	2
119419842	labtek 11	education	**reinforced_masonry**	brick	concrete	4
119414691	labtek vii farmasi	education	**reinforced_masonry**	brick	tile	4
119422837	labtek viii f.mipa	education	**reinforced_masonry**	brick	tile	4
119419843	labtek12	education	**reinforced_masonry**	brick	concrete	3
119419735	labtek5	education	**reinforced_masonry**	brick	concrete	4
119419729	labtek6	education	**reinforced_masonry**	brick	concrete	4

119419732	Lembaga penyelidikan dan afili	education	**reinforced_masonry**	brick	tile	2
119451616	litbang	goverrntment	**reinforced_masonry**	brick	concrete	5
120624427	loka buana lamba 8	education	**reinforced_masonry**	brick	asbestos	3
119449796	lpik	education	**reinforced_masonry**	brick	tile	1
119423812	magister geodesi	education	**reinforced_masonry**	brick	tile	2
87499891	masjid agung al-ukhuwah	place of worship	**reinforced_masonry**	brick	tile	3
124282351	masjid al ikhlas	place of worship	**reinforced_masonry**	brick	tile	1
119427734	masjid salman itb	place of worship	**reinforced_masonry**	brick	tile	2
119423999	masjid unpad	place of worship	**reinforced_masonry**	brick	asbestos	2
119446867	mba itb	education	**reinforced_masonry**	brick	tile	2
120625383	mesjid itenas	place of worship	**reinforced_masonry**	brick	tile	2
125174070	museum geologi	education	**reinforced_masonry**	brick	tile	1
119762183	museum pos indo	government	**reinforced_masonry**	brick	tile	3
124282334	paap					0
119418835	pasca sipil	education	**reinforced_masonry**	brick	tile	1
119419855	pascasarjana	education	**reinforced_masonry**	brick	tile	3
119415594	pau itb	education	**reinforced_masonry**	brick	concrete	3
120624410	perpus	education	**reinforced_masonry**	brick	tin	3
124282342	perpus dan pii fe	education	**reinforced_masonry**	brick	concrete	2
124282339	perpus hukum	education	**reinforced_masonry**	brick	tile	4
124282353	ppti jabar	goverment	**reinforced_masonry**	brick	tile	3
119446868	pt.lapi	commercil	**reinforced_masonry**	brick	tile	1
120624435	rektorat itenas	education	**reinforced_masonry**	brick	asbestos	2
119423378	rmh kaca	education	**reinforced_masonry**	brick	concrete	3
119422838	sappk	education	**reinforced_masonry**	brick	tile	4
119425704	subunit pol kendaraan	education	**confined_masonry**	brick	asbestos	1
119419847	t.industri	education	**reinforced_masonry**	brick	tile	4
120624417	t.industri	education	**reinforced_masonry**	brick	tin	3
120624409	t.informatika	education	**reinforced_masonry**	brick	tin	4
120624431	t.mesin	education	**reinforced_masonry**	brick	tin	3

119414202	t.sipil	education	**reinforced_masonry**	brick	tile	1
119418837	t.sipil	education	**reinforced_masonry**	brick	tile	1
120624405	t.sipil	education	**reinforced_masonry**	brick	tin	3
119422841	teknik arsitektur	education	**reinforced_masonry**	brick	tile	5
119763461	teknik arsitektur	education	**reinforced_masonry**	brick	asbestos	4
120624414	teknik elektro	education	**reinforced_masonry**	brick	asbestos	4
120624439	teknik geodesi	education	**reinforced_masonry**	brick	asbestos	4
119417572	teknik geologi	education	**reinforced_masonry**	brick	tile	4
119448264	telkom itb sme creative center	educartion	**reinforced_masonry**	brick	tile	1
120624447	univ bndung rya fak.ekonomi	education	**reinforced_masonry**	brick	concrete	4
119524766	upt kesehatan	education	**reinforced_masonry**	brick	asbestos	1
119439453	upt perpustakaan	education	**reinforced_masonry**	brick	concrete	4
120624441	upt tik	education	**reinforced_masonry**	brick	asbestos	2

3). Jakarta

osm_id	name	use	structure	walls	roof	levels
121158373	ariobimo sentral	commercial	reinforced_masonry	tin	concrete	16
121129228	atrium mulya	commercial	reinforced_masonry	tin	asbestos	8
122152218	at-taufieq	place of worship	reinforced_masonry	brick	tile	2
119540863	blok M square	commercial	reinforced_masonry	brick	concrete	8
121986336	carrefour	commercial	reinforced_masonry	brick	concrete	3
122140783	Carrefour Mampa	commercial	reinforced_masonry	brick	tin	2
120840869	citra graha	commercial	reinforced_masonry	brick	concrete	10
28934538	city plan build	government	reinforced_masonry	brick	concrete	17
121129270	danamon	commercil	reinforced_masonry	brick	concrete	7
28948519	dirjentataruang	government	reinforced_masonry	brick	concrete	8
122140854	gd.dr.suardi	government	reinforced_masonry	brick	concrete	11
121129325	gedung wirausah	commercil	reinforced_masonry	brick	concrete	17
119546672	gor bulungan	sport	reinforced_masonry	brick	concrete	2

121158372	granadi	commercial	reinforced_masonry	brick	concrete	12
119540851	hotel maharadja	commercial	reinforced_masonry	brick	concrete	7
122140853	jasa raharja	commercial	reinforced_masonry	brick	concrete	6
28948505	kantin darma wanita	commercial	confined_masonry	brick	asbestos	2
28948523	kementrian PU	goverment	reinforced_masonry	brick	concrete	8
28948509	klinik	medical	reinforced_masonry	brick	concrete	2
28948506	koperasi riwpu	government	reinforced_masonry	brick	concrete	2
121129213	kpp pratama setiabud	goverment	reinforced_masonry	brick	concrete	4
121129301	lina	commercial	reinforced_masonry	brick	concrete	5
121870309	mall blok M	commercial	reinforced_masonry	brick	concrete	6
122159885	masjid al azhar	place of worship	reinforced_masonry	brick	tile	2
119540861	melawaii plaza	commercial	reinforced_masonry	brick	concrete	6
104760621	menara anugrah	===	reinforced_masonry	brick	concrete	28
120840850	menara bank meg	commercial	reinforced_masonry	brick	concrete	27
120691313	menara cakrawla	commercial	reinforced_masonry	brick	concrete	16
121129276	menara duta	commercial	reinforced_masonry	brick	concrete	7
121129294	menara gracia	commercial	reinforced_masonry	brick	concrete	10
121158377	menara kadin	commercial	reinforced_masonry	brick	concrete	20
121129330	menara selatan	commercial	reinforced_masonry	brick	concrete	10
121129308	menara utara	commercial	reinforced_masonry	brick	concrete	10
122152164	mj baitul ilmi	place_of_worship	reinforced_masonry	brick	tile	5
121158399	palma one	commercial	reinforced_masonry	brick	concrete	14
122152092	parkir citra graha	parking lot	reinforced_masonry	brick	concrete	5
119540871	pasar mampang prapat	commercial	reinforced_masonry	brick	concrete	3
120840847	patra tower	commercil	reinforced_masonry	brick	concrete	20
121158391	PEPeNERO	commercial	confined_masonry	brick	concrete	0
122219153	perumahan hangtuah	residential	reinforced_masonry	brick	concrete	2
122219154	perumahan hangtuah	residential	reinforced_masonry	brick	concrete	2
122219155	perumahan hangtuah	residential	reinforced_masonry	brick	concrete	2
122219168	perumahan hangtuah	residential	reinforced_masonry	brick	concrete	2

122219174	perumahan hangtuah	residential	reinforced_masonry	brick	concrete	2
122219185	perumahan hangtuah	residential	reinforced_masonry	brick	concrete	2
122219191	perumahan hangtuah	residential	reinforced_masonry	brick	concrete	2
122219209	perumahan hangtuah	residential	reinforced_masonry	brick	concrete	2
122219240	perumahan hangtuah	residential	reinforced_masonry	brick	concrete	2
122219242	perumahan hangtuah	residential	reinforced_masonry	brick	concrete	2
122219244	perumahan hangtuah	residential	reinforced_masonry	brick	concrete	2
122221714	perumahan mentri	residential	reinforced_masonry	brick	tile	2
122221719	perumahan mentri	residential	reinforced_masonry	brick	tile	2
122221728	perumahan mentri	residential	reinforced_masonry	brick	tile	2
122221736	perumahan mentri	residential	reinforced_masonry	brick	tile	2
122221744	perumahan mentri	residential	reinforced_masonry	brick	tile	2
122221747	perumahan mentri	residential	reinforced_masonry	brick	tile	2
122221764	perumahan mentri	residential	reinforced_masonry	brick	tile	2
122221781	perumahan mentri	residential	reinforced_masonry	brick	tile	2
122221798	perumahan mentri	residential	reinforced_masonry	brick	tile	2
122221799	perumahan mentri	residential	reinforced_masonry	brick	tile	2
121129277	plasa setyabudi	commercial	reinforced_masonry	brick	concrete	8
121129298	plaza centris/migas	goverment	reinforced_masonry	brick	concrete	15
121158376	plaza great river in	commercial	reinforced_masonry	brick	concrete	16
97550317	plaza sarinah	commercial	reinforced_masonry	brick	concrete	14
121129218	plaza setiabudi	commercial	reinforced_masonry	brick	concrete	6
122219165	prmhn hang tua	residential	reinforced_masonry	brick	tile	2
122219197	prmhn hang tua	residential	reinforced_masonry	brick	tile	2
122219202	prmhn hang tua	residential	reinforced_masonry	brick	tile	2
122219203	prmhn hang tua	residential	reinforced_masonry	brick	tile	2
122219216	prmhn hang tua	residential	reinforced_masonry	brick	tile	2
122219219	prmhn hang tua	residential	reinforced_masonry	brick	tile	2
122219231	prmhn hang tua	residential	reinforced_masonry	brick	tile	2
122219234	prmhn hang tua	residential	reinforced_masonry	brick	tile	2

122219260	prmhn hang tua	residential	reinforced_masonry	brick	tile	2
122219268	prmhn hang tua	residential	reinforced_masonry	brick	tile	2
122221712	prmhn-menteri	residential	reinforced_masonry	brick	tile	2
122221722	prmhn-menteri	residential	reinforced_masonry	brick	tile	2
122221725	prmhn-menteri	residential	reinforced_masonry	brick	tile	2
122221727	prmhn-menteri	residential	reinforced_masonry	brick	tile	2
122221731	prmhn-menteri	residential	reinforced_masonry	brick	tile	2
122221732	prmhn-menteri	residential	reinforced_masonry	brick	tile	2
122221750	prmhn-menteri	residential	reinforced_masonry	brick	tile	2
122221756	prmhn-menteri	residential	reinforced_masonry	brick	tile	2
122221775	prmhn-menteri	residential	reinforced_masonry	brick	tile	2
122221782	prmhn-menteri	residential	reinforced_masonry	brick	tile	2
122221800	prmhn-menteri	residential	reinforced_masonry	brick	tile	2
122221802	prmhn-menteri	residential	reinforced_masonry	brick	tile	2
122221805	prmhn-menteri	residential	reinforced_masonry	brick	tile	2
28948489	pusdata PU	goverment	reinforced_masonry	brick	concrete	4
121129268	rs.mmc	medical	reinforced_masonry	brick	concrete	5
121986299	ruko	commercial	reinforced_masonry	brick	concrete	3
121986334	ruko	commercial	reinforced_masonry	brick	concrete	3
122140805	twinks	commercial	reinforced_masonry	brick	concrete	8
122159900	univ.al-azhar	education	reinforced_masonry	brick	concrete	4
121129250	wisma budi	commerciial	reinforced_masonry	brick	concrete	9
121129311	wisma kodel	commercial	reinforced_masonry	brick	concrete	11
122140779	wisma tendean	commercial	reinforced_masonry	brick	concrete	5
121129317	wisma tugu	commercil	reinforced_masonry	brick	concrete	6
122152128	ytki	government	reinforced_masonry	brick	concrete	3
122152142		education	reinforced_masonry	brick	tile	4

4). Padang

osm_id	name	use	structure	walls	roof	levels
123633019	Bank Mandiri	commercial	reinforced_masonry	brick	concrete	**3**
123658823	Bank Indonesia	commercial	reinforced_masonry	brick	concrete	**2**
124280902	GOR UNP	education	reinforced_masonry	brick	concrete	**1**
124280923	teater FBSS UNP	multipurpose	reinforced_masonry	-	tin	**1**
124538587	Ruko	commercial	reinforced_masonry	brick	concrete	**2**
124542819	Ruko-ruko	commercial	reinforced_masonry	brick	concrete	**2**
124542823	perumahan	residential	reinforced_masonry	brick	concrete	**2**
124548885	Rumah	residential	confined_masonry	brick	tile	**1**
124548887	Rumah	residential	confined_masonry	brick	tile	**1**
124553469	Pasar	shop	confined_masonry	wood	tin	**1**
124553471	Pasar	shop	confined_masonry	wood	tin	**1**
124575365	perumahan jl pariang indah	residential	unreinforced_masonry	brick	tin	**2**
124575407	pertokoan	commercial	unreinforced_masonry	brick	tin	**1**
124575447	perumahan jl pariang indah	residential	unreinforced_masonry	wood	tin	**2**
124575515	pertokoan	commercial	unreinforced_masonry	brick	tin	**2**
124575612	perumahan jl pariang indah	residential	unreinforced_masonry	brick	tin	**2**
124693720	perumahan jl pariang indah	residential	unreinforced_masonry	batako	concrete	**1**
130599064	Shop Market	commercial	unreinforced_masonry	brick	tin	**1**
130599065	Rumah Warga	residential	confined_masonry	brick	tin	**1**
130599069	Gudang	Storage	unreinforced_masonry	brick	tin	**1**
130599118	Kantor PLN	government	reinforced_masonry	brick	tin	**2**
130599119	CV. Tranex	commercial	unreinforced_masonry	brick	tin	**1**
130599128	Rumah Penyimpanan Barang Sitaan Negara (Rupbasan)	government	reinforced_masonry	brick	tin	**1**
130599129	Kantor PLN	government	unreinforced_masonry	brick	tin	**1**
130599130	Rumah Warga	residential	confined_masonry	brick	tin	**2**
130607300	Ruko-ruko	commercial	reinforced_masonry	brick	concrete	**3**

130607301	Kementrian Hukum dan HAM	government	reinforced_masonry	brick	tin	**2**
130607302	Mushola Asy-syuro	Place of worship	unreinforced_masonry	brick	tin	**2**
140402237	Rumah	residential	confined_masonry	wood	tin	**1**
140402254	Rumah	residential	unreinforced_masonry	brick	tin	**1**
140402265	Gudang	storage	confined_masonry	wood	tin	**1**
140402279	Rumah	residential	confined_masonry	wood	tin	**1**
140402297	Rumah	residential	confined_masonry	wood	tin	**1**
140404524	Rumah	residential	confined_masonry	wood	tin	**1**
140404528	Rumah	residential	confined_masonry	wood	tin	**1**
140404530	Rumah	residential	confined_masonry	wood	tin	**1**
140404554	Rumah	residential	confined_masonry	wood	tin	**1**
140404585	Hotel Havilla Maranatha no. 8	commercial	reinforced_masonry	brick	concrete	**2**
140594169	ruko	commercial	reinforced_masonry	brick	concrete	**2**
140594212	komplek perumahan	residential	reinforced_masonry	brick	tin	**1**
140594257	Gudang	Storage	reinforced_masonry	brick	tin	**1**
141266690	Gedung dr	Storage	reinforced_masonry	brick	tin	**1**
141266825	Gudang	Storage	reinforced_masonry	brick	tin	**1**
141267220	Kantor PT. Dinamika Sumber Jaya	commercial	reinforced_masonry	brick	tin	**1**
141267338	Workshop PT Dinamika Sumber Jaya	commercial	confined_masonry	wood	tin	**1**
141808873	Drs. Gafar Salim	commercial	reinforced_masonry	brick	tile	**2**
141808875	Rumah	residential	reinforced_masonry	brick	tin	**2**
141808939	Gudang	Storage	reinforced_masonry	brick	tin	**1**
141808957	Rumah	residential	reinforced_masonry	brick	tin	**1**
141808965	Rumah	residential	reinforced_masonry	brick	tile	**2**
141808979	Bank Mandiri	commercial	reinforced_masonry	brick	tin	**2**
141808980	Rumah	residential	reinforced_masonry	brick	tile	**1**
123560821	Pasar Raya Barat Tahap III	commercial	reinforced_masonry	brick	concrete	**3**
123563485	PT Pos Indonesia Cabang Padang	commercial	reinforced_masonry	brick	tile	**2**
123563486	Pertokoan Komplek Rajawali	shop	reinforced_masonry	brick	tin	**2**
123563487	Pasar Raya Barat	commercial	reinforced_masonry	brick	concrete	**2**

123563488	Pasar Raya Barat Blok C	commercial	reinforced_masonry	brick	concrete	**2**
123563489	Pasar Raya Barat Blok E	shop	reinforced_masonry	brick	concrete	**2**
123563490	Pertokoan Jl. M. Yamin	commercial	reinforced_masonry	brick	tin	**3**
123563491	Pasar Raya I	shop	reinforced_masonry	brick	concrete	**1**
123563492	Pasar Raya Barat Blok D	shop	reinforced_masonry	brick	concrete	**2**
123563493	Pasar Raya Barat Blok A	shop	reinforced_masonry	brick	concrete	**2**
123563494	Pasar Raya Barat Blok B	shop	reinforced_masonry	brick	concrete	**2**
123757239	Balaikota Padang	government	confined_masonry	brick	tin	**2**
123757247	Hotel Bundo	accomodation	reinforced_masonry	brick	concrete	**4**
123757260	Polresta Padang	government	reinforced_masonry	brick	tin	**2**
123771364	Bank Bukopin	commercial	reinforced_masonry	brick	tile	**2**
123771378	Dinas Kependudukan & Catatan Sipil	government	reinforced_masonry	brick	tile	**1**
123771381	Dinas Kependudukan & Catatan Sipil	government	reinforced_masonry	brick	tin	**1**
123771383	Dinas Kependudukan & Catatan Sipil	government	reinforced_masonry	brick	tin	**1**
123771394	PT Garuda Indonesia	commercial	reinforced_masonry	brick	concrete	**1**
124280893	Gedung FT UNP	education	reinforced_masonry	brick	tin	**1**
124280894	Mesjid Raya Al-Azhar	place_of_worship	reinforced_masonry	brick	tin	**2**
124280904	Gedung Kuliah UNP	education	unreinforced_masonry	brick	tin	**1**
124280912	Gedung FT UNP	education	reinforced_masonry	brick	tin	**1**
124280919	Musahala FBSS UNP	place_of_worship	reinforced_masonry	brick	tin	**1**
124280920	FIK UNP	education	reinforced_masonry	brick	tin	**2**
124280921	Gedung kuliah UNP	education	reinforced_masonry	brick	tin	**1**
124280922	Gedung Kuliah UNP	education	reinforced_masonry	brick	tin	**1**
124280930	mesjid kebenaran	place_of_worship	reinforced_masonry	brick	concrete	**1**
124280931	Gedung Kuliah UNP	education	reinforced_masonry	brick	tin	**1**
124280932	Gedung Kuliah UNP	education	reinforced_masonry	brick	tin	**1**
124280934	Gedung Kuliah UNP	education	reinforced_masonry	brick	tin	**1**
124280936	REKTORAT UNP	education	reinforced_masonry	brick	tin	**3**
124280940	Gedung FT UNP (Sipil)	education	reinforced_masonry	brick	tin	**1**
124280941	Gedung Seni Rupa UNP	education	reinforced_masonry	brick	tin	**2**

124280965	Rumah Dinas Yonif Air Tawar	residential	confined_masonry	brick	tin	**1**
124280966	Rumah Dinas Yonif Air Tawar	residential	confined_masonry	brick	tin	**1**
124280967	rumah dinas yonif air tawar	residential	confined_masonry	brick	tin	**1**
124297067	Pasar Simpang Haru	commercial	reinforced_masonry	brick	tin	**1**
124297070	Pasar Simpang Haru	commercial	reinforced_masonry	brick	tin	**1**
124387037	AIA Financial, Bumida Bumiputera	commercial	reinforced_masonry	brick	concrete	**3**
124387038	Adira Finance	commercial	reinforced_masonry	brick	concrete	**3**
124387039	Dell Computer	shop	reinforced_masonry	brick	tin	**2**
124387050	LKKAM, Bundo Kanduang Padang Sumbar	government	reinforced_masonry	brick	tin	**3**
124387051	Museum Adtywarman	museum	reinforced_masonry	wood	tin	**2**
124387054	PT Teten Gazali, Avrist, ANIF	commercial	reinforced_masonry	brick	concrete	**3**
124387057	Edotel Bundo Kanduang	accomodation	reinforced_masonry	brick	concrete	**3**
124387061	Gallery (Taman Budaya Padang)	art gallery	reinforced_masonry	brick	tin	**1**
124387062	hp Service Center, Rumah Zakat, Olympic Furniture	commercial	reinforced_masonry	brick	concrete	**3**
124532641	Mesjid Nurush Shobirin	Place of worship	reinforced_masonry	brick	tin	**1**
124532647	SDN	education	reinforced_masonry	brick	tile	**2**
124538536	Rumah	residential	reinforced_masonry	brick	tin	**1**
124538579	Rumah	residential	reinforced_masonry	brick	tin	**1**
124540052	perumahan	residential	reinforced_masonry	brick	tin	**2**
124542690	Rumah	residential	reinforced_masonry	brick	tin	**1**
124542695	perumahan	residential	reinforced_masonry	brick	tile	**1**
124542752	Rumah	residential	reinforced_masonry	brick	tin	**1**
124542782	perumahan	residential	reinforced_masonry	brick	tile	**1**
124542784	perumahan	residential	unreinforced_masonry	brick	tin	**1**
124542788	perumahan	residential	reinforced_masonry	brick	tin	**1**
124542789	perumahan	residential	reinforced_masonry	brick	tin	**1**
124542807	perumahan	residential	unreinforced_masonry	brick	tin	**1**
124542821	perumahan	residential	unreinforced_masonry	brick	tin	**1**
124544559	perumahan	residential	reinforced_masonry	brick	tin	**2**
124552146	Masjid Mukhlisin	place_of_worship	unreinforced_masonry	brick	tin	**1**

124552148	perumahan jl pariang indah	residential	reinforced_masonry	brick	tin	**1**
124553462	Rumah	residential	reinforced_masonry	brick	tin	**1**
124575272	Rumah	residential	reinforced_masonry	brick	tin	**1**
124575335	Rumah	residential	reinforced_masonry	brick	tin	**1**
124575362	Rumah	residential	reinforced_masonry	brick	tin	**1**
124575498	Rumah	residential	reinforced_masonry	brick	tin	**1**
124721763	Bengkel PJKA	industrial	-	brick	tin	**1**
124721764	Bengkel PJKA	industrial	-	brick	tin	**1**
124721765	Gedung PJKA	industrial	confined_masonry	brick	tin	**1**
124722677	rumah dinas yonif air tawar	residential	confined_masonry	brick	tin	**1**
124722678	rumah dinas yonif air tawar	residential	confined_masonry	brick	tin	**1**
124280965	Gedung Yonif Air tawar	government	confined_masonry	brick	tin	**1**
124722681	rumah dinas yonif air tawar	residential	confined_masonry	brick	tin	**1**
124722687	rumah dinas yonif air tawar	residential	confined_masonry	brick	tin	**1**
124722689	rumah dinas yonif air tawar	residential	confined_masonry	brick	tin	**1**
124280965	Gedung Yonif Air tawar	government	confined_masonry	brick	tin	**1**
124280965	Gedung Yonif Air tawar	government	confined_masonry	brick	tin	**1**
124280965	Gedung Yonif Air tawar	government	confined_masonry	brick	tin	**1**
124280965	Gedung Yonif Air tawar	government	confined_masonry	brick	tin	**1**
124280965	Gedung Yonif Air tawar	government	confined_masonry	brick	tin	**1**
124280965	Gedung Yonif Air tawar	government	confined_masonry	brick	tin	**1**
124722711	rumah dinas yonif air tawar	residential	confined_masonry	brick	tin	**1**
124280965	Gedung Yonif Air tawar	government	confined_masonry	brick	tin	**1**
124280965	Gedung Yonif Air tawar	government	confined_masonry	brick	tin	**1**
124722722	rumah dinas yonif air tawar	residential	confined_masonry	brick	tin	**1**
124280965	Gedung Yonif Air tawar	government	confined_masonry	brick	tin	**1**
124280965	Gedung Yonif Air tawar	government	confined_masonry	brick	tin	**1**
124280965	Gedung Yonif Air tawar	government	confined_masonry	brick	tin	**1**
124280965	Gedung Yonif Air tawar	government	confined_masonry	brick	tin	**1**
124280965	Gedung Yonif Air tawar	government	confined_masonry	brick	tin	**1**

124722735	rumah dinas yonif air tawar	residential	confined_masonry	brick	tin	**1**
124722736	rumah dinas yonif air tawar	residential	confined_masonry	brick	tin	**1**
124280965	Gedung Yonif Air tawar	government	confined_masonry	brick	tin	**1**
124722738	rumah dinas yonif air tawar	residential	confined_masonry	brick	tin	**1**
124280965	Gedung Yonif Air tawar	government	confined_masonry	brick	tin	**1**
124280965	Gedung Yonif Air tawar	government	confined_masonry	brick	tin	**1**
124280965	Gedung Yonif Air tawar	government	confined_masonry	brick	tin	**1**
124722742	rumah dinas yonif air tawar	residential	confined_masonry	brick	tin	**1**
124722746	rumah dinas yonif air tawar	residential	confined_masonry	brick	tin	**1**
124722752	rumah dinas yonif air tawar	residential	confined_masonry	brick	tin	**1**
124722756	rumah dinas yonif air tawar	residential	confined_masonry	brick	tin	**1**
124280965	Gedung Yonif Air tawar	government	confined_masonry	brick	tin	**1**
124774161	RSUP M DJAMIL	medical	reinforced_masonry	brick	tin	**1**
124774163	Instalasi Rawat Inap RSUP M DJAMIL	medical	reinforced_masonry	brick	tin	**1**
124774164	RSUP M DJAMIL (unit rawat inap jantung)	medical	reinforced_masonry	brick	tin	**1**
124774165	RSUP M DJAMIL	medical	reinforced_masonry	brick	tin	**3**
124774166	RSUP M DJAMIL (Unit penyakit mata)	medical	reinforced_masonry	brick	tin	**1**
124774171	RSUP M DJAMIL (penyakit syaraf)	medical	reinforced_masonry	brick	tin	**1**
124774173	RSUP M DJAMIL	medical	reinforced_masonry	brick	tin	**1**
124774174	RSUP M DJAMIL (IGD)	medical	reinforced_masonry	brick	tin	**3**
124774176	RSUP M DJAMIL (rawat inap penyakit paru	medical	reinforced_masonry	brick	tin	**1**
124774177	RSUP M DJAMIL (Pusat Jantung Regional)	medical	reinforced_masonry	brick	tin	**1**
124774178	RSUP M DJAMIL (penyakit jiwa)	medical	reinforced_masonry	brick	tin	**2**
124774179	RSUP M DJAMIL	medical	reinforced_masonry	brick	tin	**3**
124774180	RSUP M DJAMIL	medical	reinforced_masonry	brick	concrete	**2**
124774183	RSUP M DJAMIL	medical	reinforced_masonry	brick	tin	**1**
124774184	RSUP M DJAMIL (Smf bedah)	medical	reinforced_masonry	brick	tin	**2**
124776650	Kantor Pajak	government	reinforced_masonry	brick	tin	**2**
124776651	BASKO	accommodation	reinforced_masonry	brick	concrete	**6**
124776652	BANK BNI UNP	commercial	reinforced_masonry	brick	tile	**1**

124811402	Bintang Photo	commercial	reinforced_masonry	brick	tin	**2**
124811404	Hotel Garuda	accommodation	reinforced_masonry	brick	tin	**3**
124811405	Kude Shop	shop	reinforced_masonry	brick	concrete	**2**
124811406	Neraca Shop - Lockers Stuff - Toko Nena	shop	reinforced_masonry	brick	concrete	**2**
124811409	Perlengkapan & Accesories Sari Anggrek	shop	reinforced_masonry	brick	concrete	**2**
124811410	Permindo Sport & Music - The Ed Salon	commercial	reinforced_masonry	brick	concrete	**3**
124811411	RM Semalam Suntuk - Toko Dunia Elektronik	commercial	reinforced_masonry	brick	concrete	**2**
124811412	Ratu Salon - Planet Distro - Gaya Cellular	commercial	reinforced_masonry	brick	concrete	**2**
124811414	Suzuya Superstore - Rocky Hotel	commercial	reinforced_masonry	brick	concrete	**4**
124811415	Toko Ardi - New Variatex - Denzer	shop	reinforced_masonry	brick	concrete	**2**
124811416	Toko Bali Busana - Six 2 Six Distro	shop	reinforced_masonry	brick	concrete	**2**
124811417	Toko Buku & Swalayan Sari Anggrek - Toko Boedi	commercial	reinforced_masonry	brick	concrete	**2**
124811418	Toko Ceria Busana - Adidas	shop	reinforced_masonry	brick	concrete	**2**
124811419	Toko Citra Busana	shop	reinforced_masonry	brick	concrete	**2**
124811420	Toko DMK Shoes	shop	reinforced_masonry	brick	concrete	**3**
124811421	Toko Digital Elektronik - Mikasa Sport	shop	reinforced_masonry	brick	concrete	**2**
124811423	Toko Golden Bakery - Thessa Shop - Athena Arloji	shop	reinforced_masonry	brick	concrete	**3**
124811424	Toko Grand Citra	shop	reinforced_masonry	brick	concrete	**2**
124811425	Toko Insider - Optik Tanjung	ruko	reinforced_masonry	brick	tin	**2**
124811426	Toko Ivo Busana	shop	reinforced_masonry	brick	concrete	**2**
124811427	Toko Lisa House - Sumatera Jaya - Toko Tas Raphita	shop	reinforced_masonry	brick	concrete	**3**
124811428	Toko New Protel - Kharisma Refleksi - Bunga Collec	commercial	reinforced_masonry	brick	concrete	**2**
124811429	Toko Nilam Mode Fashion	shop	reinforced_masonry	brick	tin	**3**
124811430	Toko Ratu Textil	shop	reinforced_masonry	brick	concrete	**3**
124811431	Toko Select Lime	shop	reinforced_masonry	brick	concrete	**2**
124811432	Toko Silungkang Music & Sport - Gallery	shop	reinforced_masonry	brick	tin	**2**
124811433	Toko Texas	shop	reinforced_masonry	brick	concrete	**2**
124811434	Toserba Rio	shop	reinforced_masonry	brick	concrete	**2**
124811435	U do Proshop	shop	reinforced_masonry	brick	concrete	**2**
124826828	Madrasah Aliyah PGAI - jalan H Abdulah Ahmad	education	reinforced_masonry	brick	tin	**2**

124826829	Madrasah Aliyah PGAI - jalan H Abdulah Ahmad	education	reinforced_masonry	brick	tin	**2**
124826830	Masjid Darul Ulum	place_of_worship	reinforced_masonry	brick	tin	**1**
124826831	Panti Asuhan Yatim Piatu PGAI	sosial	confined_masonry	brick	tin	**2**
124826837	SMP PGAI	education	confined_masonry	brick	tin	**1**
124826838	SMP PGAI	education	reinforced_masonry	brick	tin	**1**
124826839	SMP PGAI	education	confined_masonry	brick	tin	**1**
124844456	Direktorat Jenderal Pajak Wilayah Sumbar & Jam	government	reinforced_masonry	brick	tin	**2**
124844482	Six 2Six - Andre Boutique - CV Geha Pratama	commercial	reinforced_masonry	brick	concrete	**4**
124844487	Toko Jelita	shop	reinforced_masonry	brick	concrete	**4**
124894150	PT Kredo Bajatama Persada - Toko Arai Pinang	commercial	reinforced_masonry	brick	concrete	**3**
124894151	PT Natraco Spices Indonesia	commercial	reinforced_masonry	brick	concrete	**3**
124894152	Purwahadi	commercial	reinforced_masonry	brick	concrete	**3**
124894153	Sinar Mulia Computer	commercial	reinforced_masonry	brick	concrete	**3**
124894154	Taman Budaya Padang	government	reinforced_masonry	brick	tile	**1**
123474987	Masjid Taqwa Muhammadiyah - Pasar Raya	place_of_worship	reinforced_masonry	brick	concrete	**2**
123658822	Nurul Iman	place_of_worship	reinforced_masonry	brick	concrete	**2**
123771375	Bank Mandiri	commercial	reinforced_masonry	brick	asbes	**3**
124214624	mesjid Jami' Atul Huda Ketaping	place_of_worship	reinforced_masonry	brick	tile	**2**
124280896	bengkel	commercial	unreinforced_masonry	-	tin	**1**
124280897	Sekretariat Panitia Sertifikasi Guru	education	unreinforced_masonry	brick	tin	**1**
124280901	Gedung FT UNP	education	reinforced_masonry	brick	tin	**1**
124280907	Bank Bni Unp	commercial	reinforced_masonry	brick	tin	**1**
124280909	perumahan jl pariang indah	residential	unreinforced_masonry	brick	tin	**1**
124280933	Gedung kuliah UNP	education	reinforced_masonry	brick	tin	**1**
124280939	perumahan jl pariang indah	residential	unreinforced_masonry	brick	tin	**2**
124280943	mesjid UNP	place_of_worship	reinforced_masonry	brick	concrete	**3**
124387042	Fujiyama Photo Studio	commercial	reinforced_masonry	brick	concrete	**3**
124387049	Karia Theatre	commercial	reinforced_masonry	brick	concrete	**2**
124387058	Substance Distro & Karia Theatre	commercial	reinforced_masonry	brick	concrete	**2**
124532639	Asrama Polri	residential	unreinforced_masonry	brick	tin	**1**

124532642	Asrama Polri	residential	unreinforced_masonry	brick	tin	**1**
124538556	Ruko	commercial	reinforced_masonry	brick	tin	**1**
124538562	Mesjid Ikhlas	Place of worship	reinforced_masonry	brick	tin	**2**
124538570	Asrama Polri	residential	unreinforced_masonry	brick	tin	**1**
124538574	Asrama Polri	residential	unreinforced_masonry	brick	tin	**1**
124538586	UD. Barisan Teknik dan Apotek	commercial	reinforced_masonry	brick	tin	**1**
124538588	Ruko	commercial	confined_masonry	brick	concrete	**1**
124538589	Rumah	residential	reinforced_masonry	brick	tin	**2**
124538597	Rumah	residential	unreinforced_masonry	brick	tin	**1**
124538599	Rumah	residential	confined_masonry	brick	tin	**1**
124538613	UD. Barisan Teknik dan Apotek	commercial	reinforced_masonry	brick	tin	**2**
124538625	Ruko	commercial	reinforced_masonry	brick	tin	**2**
124542691	Rumah	residential	confined_masonry	brick	tin	**1**
124542692	Rumah	residential	confined_masonry	brick	tin	**1**
124542693	Rumah	residential	confined_masonry	brick	tin	**1**
124542694	Rumah	residential	confined_masonry	brick	tin	**1**
124542696	Rumah	residential	confined_masonry	brick	tin	**1**
124542698	perumahan	residential	unreinforced_masonry	brick	tin	**1**
124542699	Rumah	residential	confined_masonry	brick	tin	**1**
124542700	Rumah	residential	confined_masonry	brick	tin	**1**
124542701	Rumah	residential	confined_masonry	brick	tin	**1**
124542704	Rumah	residential	confined_masonry	brick	tin	**1**
124542705	Rumah	residential	confined_masonry	brick	tin	**1**
124542706	Rumah	residential	confined_masonry	brick	tin	**1**
124542709	Rumah	residential	confined_masonry	brick	tin	**1**
124542710	Rumah	residential	confined_masonry	brick	tin	**1**
124542717	Rumah	residential	confined_masonry	brick	tin	**1**
124542720	Rumah	residential	confined_masonry	brick	tin	**1**
124542726	perumahan	residential	unreinforced_masonry	brick	tin	**1**
124542730	perumahan	residential	unreinforced_masonry	brick	tin	**1**

124542738	Rumah	residential	confined_masonry	brick	tin	**1**
124542740	Rumah	residential	confined_masonry	brick	tin	**1**
124542742	Rumah	residential	confined_masonry	brick	tin	**1**
124542744	Rumah	residential	confined_masonry	brick	tin	**1**
124542747	perumahan	residential	reinforced_masonry	brick	tile	**2**
124542750	Rumah	residential	confined_masonry	brick	tin	**1**
124542753	Rumah	residential	confined_masonry	wood	tin	**1**
124542756	Rumah	residential	confined_masonry	brick	tin	**1**
124542758	Rumah	residential	confined_masonry	brick	tin	**1**
124542761	Rumah	residential	confined_masonry	brick	tin	**1**
124542765	Rumah	residential	confined_masonry	brick	tin	**1**
124542769	Rumah	residential	confined_masonry	brick	tin	**1**
124542775	Rumah	residential	confined_masonry	brick	tin	**1**
124542777	Rumah	residential	confined_masonry	brick	tin	**1**
124542779	Rumah	residential	confined_masonry	brick	tin	**1**
124542790	Rumah	residential	confined_masonry	brick	tin	**1**
124542793	Rumah	residential	confined_masonry	brick	tin	**1**
124542794	Rumah	residential	confined_masonry	brick	tin	**1**
124542795	perumahan	residential	reinforced_masonry	brick	tile	**2**
124542796	Rumah	residential	confined_masonry	brick	tin	**1**
124542797	perumahan	residential	reinforced_masonry	brick	tile	**1**
124542800	Rumah	residential	confined_masonry	brick	tin	**1**
124542808	perumahan	residential	reinforced_masonry	brick	tin	**2**
124542809	Rumah	residential	confined_masonry	brick	tin	**1**
124542810	Rumah	residential	confined_masonry	brick	tin	**1**
124542811	Rumah	residential	confined_masonry	brick	tin	**1**
124542812	Rumah	residential	confined_masonry	brick	tin	**1**
124542813	Rumah	residential	confined_masonry	brick	tin	**1**
124542814	perumahan	residential	reinforced_masonry	brick	tile	**2**
124542815	Rumah	residential	confined_masonry	brick	tin	**1**

124542816	perumahan	residential	reinforced_masonry	brick	tin	**2**
124542817	Rumah	residential	confined_masonry	brick	tin	**1**
124542818	Rumah	residential	confined_masonry	brick	tin	**1**
124542820	Rumah	residential	confined_masonry	brick	tin	**1**
124542822	perumahan	residential	reinforced_masonry	brick	tile	**1**
124542824	Rumah	residential	confined_masonry	brick	tin	**1**
124542827	Rumah	residential	confined_masonry	brick	tin	**1**
124542829	Rumah	residential	reinforced_masonry	brick	concrete	**1**
124544538	Rumah	residential	confined_masonry	brick	tin	**2**
124544547	Rumah	residential	confined_masonry	brick	tin	**1**
124544548	perumahan	residential	reinforced_masonry	brick	tile	**1**
124544553	Rumah	residential	confined_masonry	brick	tile	**2**
124544555	Rumah	residential	confined_masonry	brick	tile	**2**
124544556	perumahan	residential	unreinforced_masonry	brick	tin	**1**
124544557	Rumah	residential	confined_masonry	brick	tin	**1**
124544561	perumahan Kel. Alai	residential	unreinforced_masonry	brick	tin	**1**
124544562	Mushola amanah	place_of_worship	unreinforced_masonry	brick	tin	**1**
124544563	perumahan Kel. Alai	residential	reinforced_masonry	brick	tile	**2**
124544565	perumahan Kel. Alai	residential	reinforced_masonry	brick	tile	**2**
124544568	perumahan Kel. Alai	residential	unreinforced_masonry	brick	tin	**1**
124548879	perumahan	residential	reinforced_masonry	brick	tile	**1**
124548884	perumahan Kel. Alai	residential	reinforced_masonry	brick	tile	**2**
124548889	perumahan Kel. Alai	residential	reinforced_masonry	brick	concrete	**2**
124548891	perumahan Kel. Alai	residential	unreinforced_masonry	brick	tin	**1**
124548892	Rumah	residential	confined_masonry	brick	tile	**2**
124548894	perumahan	residential	unreinforced_masonry	brick	tin	**1**
124548896	perumahan Kel. Alai	residential	reinforced_masonry	brick	concrete	**2**
124548902	perumahan Kel. Alai	residential	unreinforced_masonry	brick	tin	**1**
124548906	perumahan Kel. Alai	residential	reinforced_masonry	brick	tile	**1**
124548907	perumahan Kel. Alai	residential	reinforced_masonry	brick	tile	**2**

124548908	perumahan	residential	reinforced_masonry	brick	tile	**1**
124548909	perumahan Kel. Alai	residential	unreinforced_masonry	brick	tin	**1**
124548910	perumahan Kel. Alai	residential	unreinforced_masonry	brick	tin	**1**
124548911	perumahan Kel. Alai	residential	reinforced_masonry	brick	concrete	**2**
124548912	perumahan Kel. Alai	residential	reinforced_masonry	brick	tile	**1**
124548914	perumahan	residential	reinforced_masonry	brick	tile	**1**
124548915	perumahan Kel. Alai	residential	unreinforced_masonry	brick	tin	**1**
124548917	perumahan jl pariang indah	residential	reinforced_masonry	brick	tin	**2**
124548918	Rumah	residential	reinforced_masonry	brick	tile	**2**
124548919	Rumah	residential	reinforced_masonry	brick	tile	**2**
124548921	perumahan Kel. Alai	residential	reinforced_masonry	brick	tile	**2**
124548923	perumahan Kel. Alai	residential	reinforced_masonry	brick	tile	**1**
124553150	perumahan Kel. Alai	residential	unreinforced_masonry	brick	tin	**1**
124553153	perumahan Kel. Alai	residential	reinforced_masonry	brick	concrete	**1**
124553463	Rumah	residential	confined_masonry	brick	tin	**2**
124553465	Toko Kelontong	shop	confined_masonry	brick	tin	**1**
124553466	Toko Obat Dhiya Farma	commercial	reinforced_masonry	brick	tin	**1**
124553467	Rumah	residential	unreinforced_masonry	brick	tin	**1**
124553468	service elektronik	shop	confined_masonry	brick	tin	**1**
124575220	perumahan jl pariang indah	residential	unreinforced_masonry	brick	tin	**1**
124575238	Rumah	residential	confined_masonry	brick	tin	**1**
124575299	perumahan jl pariang indah	residential	unreinforced_masonry	brick	tin	**1**
124575305	Rumah	residential	confined_masonry	brick	tin	**1**
124575342	Rumah	residential	confined_masonry	brick	tin	**1**
124575345	perumahan jl pariang indah	residential	unreinforced_masonry	brick	tin	**2**
124575369	Rumah	residential	confined_masonry	brick	tin	**1**
124575398	Rumah	residential	confined_masonry	brick	tin	**1**
124575449	Rumah	residential	unreinforced_masonry	brick	tin	**1**
124575460	perumahan jl pariang indah	residential	unreinforced_masonry	brick	tin	**1**
124575462	perumahan jl pariang indah	residential	unreinforced_masonry	brick	tin	**1**

124575528	perumahan jl pariang indah	residential	reinforced_masonry	brick	tin	**2**
124575548	Mesjid Baitul Mukminin	place_of_worship	reinforced_masonry	brick	tin	**2**
124575562	Rumah	residential	confined_masonry	brick	tin	**1**
124575572	Ruko	commercial	reinforced_masonry	brick	tin	**2**
124575584	perumahan jl pariang indah	residential	unreinforced_masonry	brick	tin	**1**
124575643	perumahan jl pariang indah	residential	unreinforced_masonry	brick	tin	**1**
124575659	Rumah	residential	confined_masonry	wood	tin	**1**
124693845	perumahan jl pariang indah	residential	unreinforced_masonry	brick	tin	**1**
124693888	Ruko	commercial	reinforced_masonry	brick	tin	**1**
124694085	perumahan jl pariang indah	residential	unreinforced_masonry	brick	tin	**1**
124694086	perumahan jl pariang indah	residential	unreinforced_masonry	brick	tin	**1**
124694099	perumahan jl pariang indah	residential	unreinforced_masonry	brick	tin	**1**
124694104	perumahan jl pariang indah	residential	unreinforced_masonry	brick	tin	**1**
124694108	perumahan jl pariang indah	residential	unreinforced_masonry	brick	tin	**1**
124694114	perumahan jl pariang indah	residential	unreinforced_masonry	brick	tin	**1**
124701088	perumahan jl pariang indah	residential	unreinforced_masonry	brick	tin	**1**
124701102	perumahan jl pariang indah	residential	unreinforced_masonry	brick	tin	**1**
124721762	Bengkel PJKA	industrial	confined_masonry	brick	tin	**1**
124722725	Rumah	residential	confined_masonry	brick	tin	**1**
124722731	Rumah	residential	confined_masonry	brick	tin	**1**
124722747	Rumah	residential	confined_masonry	brick	tin	**1**
124722755	Rumah	residential	confined_masonry	brick	tin	**1**
124774169	RSUP M DJAMIL (Bag Forensik FK Unand)	medical	reinforced_masonry	brick	tin	**1**
124774175	UPF Ilmu Kesehatan Anak RSUP M DJAMIL	medical	reinforced_masonry	brick	tile	**3**
124774182	RSUP M DJAMIL	medical	reinforced_masonry	brick	concrete	**1**
124811422	Toko Fatimah Souvenir - Raya Motor	shop	reinforced_masonry	brick	concrete	**2**

5). Dompu

OSM_ID_1	Name_1	Use_1	Structur_1	Walls_1	Roof_1	Level
124156923	House	residential	unreinforced_masonry	wood	tile	1
124156962	Balai pertemuan	multipurpose	unreinforced_masonry	brick	tin	1
124156972	House	residential	confined_masonry	brick	tile	1
124281630	House	residential	confined_masonry	brick	tile	1
124281632	House	residential	unreinforced_masonry	wood	tile	1
124281633	House	residential	unreinforced_masonry	wood	tile	1
124478922	House	residential	unreinforced_masonry	wood	tin	1
124478929	House	residential	unreinforced_masonry	wood	tin	1
124479914	House	residential	unreinforced_masonry	wood	tin	1
124479945	House	residential	unreinforced_masonry	brick	tin	1
124479948	House	residential	unreinforced_masonry	wood	tile	1
124479960	House	residential	unreinforced_masonry	wood	tin	1
124479961	House	residential	unreinforced_masonry	wood	rumbia	1
124479966	TPQ	school	unreinforced_masonry	wood	tin	1
124156919	House	residential	unreinforced_masonry	wood	tin	1
124156964	House	residential	confined_masonry	brick	tin	1
124281631	Mushola	place_of_worship	confined_masonry	brick	tile	1
124281638	House	residential	confined_masonry	brick	tin	1
124281781	House	residential	confined_masonry	brick	tile	1
124281786	House	residential	confined_masonry	brick	tile	1
124281912	House	residential	confined_masonry	brick	tile	1
124281913	House	residential	confined_masonry	brick	tile	1
124281914	House	residential	confined_masonry	brick	asbestos	1
124281915	House	residential	confined_masonry	brick	tile	1
124281916	House	residential	confined_masonry	brick	tile	1
124281918	House	residential	confined_masonry	brick	tile	1

124477439	House	residential	unreinforced_masonry	wood	tile	1
124478923	House	residential	unreinforced_masonry	wood	tile	1
124478924	House	residential	unreinforced_masonry	wood	tin	1
124479911	House	residential	unreinforced_masonry	wood	tin	1
124479936	House	residential	unreinforced_masonry	wood	tin	1
124479958	House	residential	unreinforced_masonry	wood	tin	1
124479949	House	residential	unreinforced_masonry	wood	rumbia	1
124479952	House	residential	unreinforced_masonry	wood	rumbia	1
124479965	House	residential	unreinforced_masonry	wood	tin	1
124478973	House	residential	confined_masonry	brick	tin	1
124479912	House	residential	unreinforced_masonry	wood	tin	1
124479917	House	residential	unreinforced_masonry	wood	tin	1
124479964	House	residential	unreinforced_masonry	wood	tin	1
124281634	House	residential	unreinforced_masonry	wood	tin	1
124281635	House	residential	unreinforced_masonry	wood	tin	1
124281637	House	residential	unreinforced_masonry	wood	tin	1
124281779	House	residential	unreinforced_masonry	wood	tin	1
124281910	House	residential	unreinforced_masonry	wood	tin	1
124281911	House	residential	unreinforced_masonry	wood	tin	1
124479919	House	residential	unreinforced_masonry	wood	tin	1
124479920	House	residential	unreinforced_masonry	wood	tin	1
124479922	House	residential	unreinforced_masonry	wood	tin	1
124479925	House	residential	unreinforced_masonry	wood	tin	1
124479927	House	residential	unreinforced_masonry	wood	tin	1
124479932	House	residential	confined_masonry	brick	tin	1
124479953	House	residential	unreinforced_masonry	wood	tin	1
124479954	House	residential	unreinforced_masonry	wood	tin	1
124479955	House	residential	unreinforced_masonry	wood	tin	1
124479956	House	residential	unreinforced_masonry	wood	tin	1
124156905	House	residential	unreinforced_masonry	wood	tile	1

124156929	House	residential	unreinforced_masonry	wood	tile	1
124156932	House	residential	unreinforced_masonry	wood	tile	1
124156955	House	residential	confined_masonry	brick	tile	1
124281626	House	residential	confined_masonry	brick	tile	1
124281627	House	residential	confined_masonry	brick	tile	1
124281776	House	residential	unreinforced_masonry	wood	tile	1
124281777	House	residential	confined_masonry	brick	tile	1
124281780	House	residential	unreinforced_masonry	bamboo	tile	1
124281917	House	residential	unreinforced_masonry	wood	tile	1
124479934	House	residential	unreinforced_masonry	wood	asbestos	1
124156935	Mushola	place_of_worship	confined_masonry	brick	tile	1
124479913	House	residential	unreinforced_masonry	wood	tile	1
124479991	Gudang	storage	unreinforced_masonry	brick	tin	1
124478928	TPQ	school	unreinforced_masonry	wood	tin	1
124479942	House	residential	unreinforced_masonry	wood	tin	1
124475128	House	residential	unreinforced_masonry	wood	tin	1
124479930	House	residential	unreinforced_masonry	wood	tile	1
124479946	House	residential	confined_masonry	wood	tile	1
124360568	Masjid Nahdhatul Ummah	place_of_worship	confined_masonry	brick	tile	1
124475127	House	residential	unreinforced_masonry	wood	tin	1
124475131	House	residential	unreinforced_masonry	brick	tin	1
124479576	House	residential	unreinforced_masonry	wood	tile	1
124479577	House	residential	unreinforced_masonry	bamboo	tin	1
124479579	House	residential	unreinforced_masonry	wood	tin	1
124479581	Warehouse	storage	unreinforced_masonry	bamboo	tile	1
124479582	House	residential	confined_masonry	brick	tile	1
124479584	House	residential	unreinforced_masonry	bamboo	tin	1
124479591	House	residential	unreinforced_masonry	wood	tin	1
124479593	House	residential	confined_masonry	brick	tile	1
124479594	House	residential	unreinforced_masonry	wood	tin	1

124479598	House	residential	unreinforced_masonry	wood	tin	1
124479600	House	residential	unreinforced_masonry	bamboo	tin	1
124479602	House	residential	unreinforced_masonry	wood	asbestos	1
124479621	House	residential	unreinforced_masonry	brick	tin	1
124479622	House	residential	unreinforced_masonry	wood	asbestos	1
124479623	House	residential	confined_masonry	brick	asbestos	1
124479626	House	residential	unreinforced_masonry	bamboo	tin	1
124479630	school	school	reinforced_masonry	brick	tile	1
124479631	House	residential	confined_masonry	brick	tile	1
124479640	House	residential	unreinforced_masonry	wood	tin	1
124479642	House	residential	confined_masonry	brick	tile	1
124479643	House	residential	unreinforced_masonry	wood	tin	1
124479647	House	residential	unreinforced_masonry	wood	asbestos	1
124479648	House	residential	confined_masonry	brick	tile	1
124479651	House	residential	unreinforced_masonry	wood	tin	1
124479653	House	residential	unreinforced_masonry	wood	tile	1
124479656	House	residential	confined_masonry	brick	tile	1
124479657	House	residential	unreinforced_masonry	brick	tile	1
124479661	House	residential	confined_masonry	brick	tile	1
124479664	House	residential	unreinforced_masonry	wood	tile	1
124479666	House	residential	confined_masonry	brick	tile	1
124479671	House	residential	confined_masonry	brick	tile	1
124479673	House	residential	unreinforced_masonry	wood	tin	1
124479684	House	residential	confined_masonry	brick	tile	1
124479685	House	residential	unreinforced_masonry	wood	tile	1
124479686	House	residential	unreinforced_masonry	wood	tile	1
124479687	House	residential	confined_masonry	brick	tile	1
124479688	House	residential	unreinforced_masonry	wood	tile	1
124479691	House	residential	unreinforced_masonry	wood	tin	1
124479692	House	residential	unreinforced_masonry	wood	tin	1

124479693	House	residential	unreinforced_masonry	wood	tin	1
124479694	House	residential	unreinforced_masonry	wood	tin	1
124479696	House	residential	unreinforced_masonry	wood	tin	1
124479702	House	residential	unreinforced_masonry	wood	tin	1
124479706	House	residential	confined_masonry	brick	tile	1
124479713	House	residential	unreinforced_masonry	wood	tile	1
124479714	House	residential	unreinforced_masonry	wood	tin	1
124479720	House	residential	confined_masonry	brick	tile	1
124479722	House	residential	unreinforced_masonry	wood	tile	1
124479726	House	residential	unreinforced_masonry	wood	tile	1
124479730	House	residential	unreinforced_masonry	wood	tile	1
124479732	House	residential	unreinforced_masonry	wood	tin	1
124479733	House	residential	unreinforced_masonry	wood	tin	1
124479735	House	residential	unreinforced_masonry	wood	tile	1
124479739	House	residential	unreinforced_masonry	wood	tile	1
126048085	House	residential	unreinforced_masonry	wood	tin	1
126048090	House	residential	unreinforced_masonry	wood	tin	1
126048092	House	residential	unreinforced_masonry	wood	tin	1
126048096	House	residential	unreinforced_masonry	wood	tin	1
126048097	House	residential	unreinforced_masonry	wood	tin	1
126048101	House	residential	unreinforced_masonry	wood	tin	1
126048111	House	residential	confined_masonry	brick	asbestos	1
126048114	House	residential	unreinforced_masonry	bamboo	tile	1
126048120	House	residential	unreinforced_masonry	wood	tin	1
126048122	House	residential	unreinforced_masonry	wood	tin	1
126048123	House	residential	unreinforced_masonry	wood	tile	1
126048125	House	residential	unreinforced_masonry	wood	tin	1
126048127	House	residential	unreinforced_masonry	wood	tile	1
126048130	House	residential	confined_masonry	brick	asbestos	1
126048132	House	residential	unreinforced_masonry	wood	tin	1

126048133	House	residential	confined_masonry	brick	tile	1
126048134	House	residential	unreinforced_masonry	wood	tile	1
126048136	House	residential	unreinforced_masonry	wood	tin	1
126048137	House	residential	unreinforced_masonry	wood	tin	1
126048138	House	residential	unreinforced_masonry	wood	tile	1
126048142	House	residential	unreinforced_masonry	wood	tile	1
126048148	House	residential	unreinforced_masonry	wood	rumbia	1
126048149	House	residential	unreinforced_masonry	wood	tin	1
126048151	House	residential	unreinforced_masonry	wood	tin	1
126048155	Masjid Nurul Huda	place_of_worship	reinforced_masonry	brick	tin	1
126048156	House	residential	unreinforced_masonry	wood	tin	1
126048157	House	residential	unreinforced_masonry	wood	tin	1
126048160	House	residential	unreinforced_masonry	wood	tin	1
126048161	House	residential	unreinforced_masonry	wood	tile	1
126048165	House	residential	confined_masonry	brick	tin	1
126048170	House	residential	unreinforced_masonry	wood	tin	1
126048173	House	residential	unreinforced_masonry	bamboo	tin	1
126048174	House	residential	unreinforced_masonry	wood	tile	1
126048175	House	residential	confined_masonry	brick	tin	1
126048178	House	residential	unreinforced_masonry	bamboo	tin	1
126048179	House	residential	unreinforced_masonry	wood	tin	1
126048183	House	residential	unreinforced_masonry	bamboo	tin	1
126048184	House	residential	confined_masonry	brick	tin	1
126068625	House	residential	unreinforced_masonry	wood	tin	1
126068630	House	residential	unreinforced_masonry	wood	tin	1
126068633	House	residential	confined_masonry	brick	tin	1
126068635	House	residential	unreinforced_masonry	wood	tile	1
126068639	House	residential	unreinforced_masonry	wood	tin	1
126068653	House	residential	confined_masonry	brick	tile	1
126068663	House	residential	confined_masonry	brick	tile	1

126068671	House	residential	unreinforced_masonry	wood	tile	1
126068676	House	residential	confined_masonry	brick	tin	1
126068681	House	residential	unreinforced_masonry	wood	tile	1
126068693	House	residential	unreinforced_masonry	wood	asbestos	1
126068698	House	residential	unreinforced_masonry	wood	tin	1
126068703	House	residential	unreinforced_masonry	wood	tile	1
126068706	House	residential	unreinforced_masonry	wood	tin	1
126068718	House	residential	unreinforced_masonry	wood	tin	1
126068725	House	residential	unreinforced_masonry	wood	tin	1
126068726	House	residential	unreinforced_masonry	wood	tin	1
126068753	Poskeswan	medical	unreinforced_masonry	wood	tin	1
126068765	House	residential	unreinforced_masonry	wood	tin	1
126068766	House	residential	unreinforced_masonry	wood	tile	1
126068770	House	residential	confined_masonry	brick	tile	1
126068780	House	residential	confined_masonry	brick	tile	1
126068782	House	residential	unreinforced_masonry	wood	tile	1
126068783	House	residential	confined_masonry	brick	tile	1
126068792	House	residential	confined_masonry	brick	tin	1
126068794	House	residential	unreinforced_masonry	wood	tin	1
126068797	House	residential	unreinforced_masonry	wood	tile	1
126068802	House	residential	unreinforced_masonry	wood	tile	1
126068804	House	residential	unreinforced_masonry	wood	tin	1
126068817	House	residential	unreinforced_masonry	wood	tin	1
126068818	House	residential	unreinforced_masonry	wood	tin	1
126068820	House	residential	unreinforced_masonry	wood	tile	1
126068824	House	residential	confined_masonry	brick	tile	1
126068838	House	residential	unreinforced_masonry	wood	tin	1
126068846	House	residential	unreinforced_masonry	wood	tin	1
126068848	House	residential	unreinforced_masonry	wood	tin	1
126068850	House	residential	unreinforced_masonry	wood	tile	1

126068862	House	residential	unreinforced_masonry	wood	tile	1
126068870	House	residential	unreinforced_masonry	wood	tile	1
126068912	House	residential	unreinforced_masonry	wood	tin	1
126068928	House	residential	confined_masonry	brick	tile	1
126068937	House	residential	unreinforced_masonry	wood	tile	1
126068938	House	residential	unreinforced_masonry	wood	tin	1
126068942	House	residential	unreinforced_masonry	brick	tile	1
126068948	House	residential	confined_masonry	brick	tile	1
126068951	House	residential	unreinforced_masonry	wood	tile	1
126068954	Masjid Nurul Amin	place_of_worship	confined_masonry	brick	tin	1
126068961	House	residential	confined_masonry	brick	tile	1
126068964	House	residential	unreinforced_masonry	wood	tin	1
126068974	House	residential	unreinforced_masonry	wood	tin	1
126068975	House	residential	unreinforced_masonry	wood	tin	1
126068977	House	residential	unreinforced_masonry	wood	tin	1
126068980	House	residential	unreinforced_masonry	wood	tin	1
126068987	House	residential	unreinforced_masonry	wood	tin	1
126068989	House	residential	unreinforced_masonry	wood	tin	1
126068997	House	residential	unreinforced_masonry	wood	tin	1
126069001	House	residential	unreinforced_masonry	wood	tin	1
126069004	House	residential	unreinforced_masonry	wood	tin	1
126069021	House	residential	unreinforced_masonry	bamboo	tin	1
126069038	House	residential	unreinforced_masonry	wood	tin	1
126069043	House	residential	unreinforced_masonry	wood	tin	1
126069074	Warehouse	storage	unreinforced_masonry	bamboo	tile	1
126069082	House	residential	unreinforced_masonry	wood	tin	1
126069083	House	residential	confined_masonry	brick	tile	1
126069089	House	residential	unreinforced_masonry	bamboo	tile	1
126069099	House	residential	confined_masonry	brick	tile	1
126069103	House	residential	unreinforced_masonry	wood	tin	1

126069107	House	residential	unreinforced_masonry	wood	tin	1
126069116	House	residential	confined_masonry	brick	tile	1
126069119	House	residential	unreinforced_masonry	wood	tin	1
126069120	House	residential	unreinforced_masonry	wood	tile	1
126069123	House	residential	confined_masonry	brick	tile	1
126069131	House	residential	unreinforced_masonry	wood	tin	1
126069137	House	residential	unreinforced_masonry	wood	tin	1
126069139	House	residential	unreinforced_masonry	wood	tile	1
126069148	House	residential	unreinforced_masonry	bamboo	tin	1
126069176	House	residential	unreinforced_masonry	bamboo	tin	1
126069179	House	residential	unreinforced_masonry	wood	tin	1
126069182	House	residential	unreinforced_masonry	wood	tile	1
126069198	House	residential	unreinforced_masonry	wood	tin	1
126069199	House	residential	unreinforced_masonry	wood	tin	1
126069221	House	residential	confined_masonry	brick	tile	1
126069229	House	residential	unreinforced_masonry	wood	tin	1
126069230	House	residential	unreinforced_masonry	wood	tin	1
126069232	House	residential	unreinforced_masonry	wood	tile	1
126069238	House	residential	confined_masonry	brick	tin	1
126069244	House	residential	unreinforced_masonry	wood	tile	1
126069246	SDN Manggalewa	school	reinforced_masonry	brick	tin	1
126079769	House	residential	confined_masonry	brick	tile	1
126079776	House	residential	confined_masonry	brick	tile	1
126079778	Gudang	storage	unreinforced_masonry	bamboo	tile	1
126079784	House	residential	unreinforced_masonry	bamboo	tile	1
126079787	House	residential	unreinforced_masonry	bamboo	asbestos	1
126079789	SD N 21 MANGGELEWA	school	reinforced_masonry	brick	tin	1
126082070	House	residential	unreinforced_masonry	brick	tile	1
126082073	House	residential	confined_masonry	brick	tile	1
126082088	House	residential	confined_masonry	brick	tile	1

126082089	House	residential	confined_masonry	brick	tile	1
126082090	House	residential	confined_masonry	brick	tile	1
126082092	House	residential	unreinforced_masonry	wood	tin	1
126082097	House	residential	unreinforced_masonry	bamboo	asbestos	1
126082098	House	residential	unreinforced_masonry	brick	tin	1
126110295	House	residential	unreinforced_masonry	brick	tin	1
126110304	House	residential	unreinforced_masonry	brick	tin	1
126197711	House	residential	confined_masonry	brick	tile	1
126197712	House	residential	unreinforced_masonry	wood	tile	1
126197713	House	school	confined_masonry	brick	tin	1
126197714	House	residential	unreinforced_masonry	wood	tile	1
126197715	House	residential	unreinforced_masonry	wood	tile	1
126197716	House	residential	unreinforced_masonry	wood	tile	1
126197717	House	residential	unreinforced_masonry	wood	tin	1
126197718	House and shop	ruko	unreinforced_masonry	wood	tin	1
126197719	House	residential	unreinforced_masonry	wood	tin	1
126197720	House	residential	unreinforced_masonry	wood	tin	1
126197721	House	residential	unreinforced_masonry	wood	tile	1
126197722	House	residential	unreinforced_masonry	wood	tin	1
126197723	House	residential	unreinforced_masonry	wood	tile	1
126625646	House	residential	unreinforced_masonry	brick	rumbia	1
131710605	House	residential	unreinforced_masonry	wood	tile	1
131710608	House	residential	unreinforced_masonry	wood	tin	1
131710611	House	residential	unreinforced_masonry	wood	asbestos	1
131710623	House	residential	confined_masonry	brick	tile	1
131710631	House	residential	unreinforced_masonry	wood	asbestos	1
131710637	House	residential	confined_masonry	brick	tile	1
131710643	House	residential	unreinforced_masonry	wood	tile	1
131710660	House	residential	unreinforced_masonry	wood	tin	1
131710661	House	residential	unreinforced_masonry	wood	tin	1

132191074	Warehouse	storage	reinforced_masonry	brick	tin	1
132191077	House	residential	confined_masonry	brick	tile	1
132191078	House	residential	confined_masonry	brick	tile	1
132191079	Shop	shop	reinforced_masonry	brick	tin	1
132191080	House and Shop	ruko	unreinforced_masonry	wood	tin	1
132191081	Workshop	commercial	reinforced_masonry	brick	concrete	1

2. Some documentation of the field survey

1). Documentation of Yogyakarta

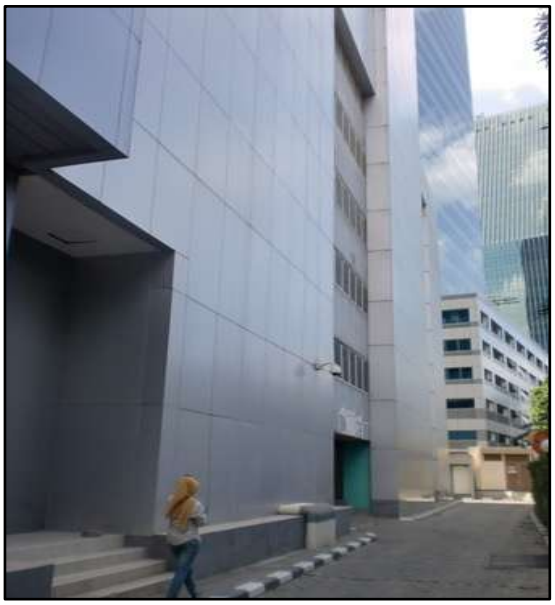
2). Documentation of Surabaya






3). Documentation of Bandung

4). Documentation of Jakarta



5). Documentation of Padang

6). Documentation of Dompu