ISSN 2354-9114 (online), ISSN 0024-9521 (print)
Indonesian Journal of Geography Vol 54, No 2 (2022): 185 –194
DOI: 10.22146/ijg.64931 website: https://jurnal.ugm.ac.id/ijg

INDONESIAN JOURNAL OF GEOGRAPHY

RESEARCH ARTICLE

Influence of Spatial Abilities on Spatial Data Quality in Participatory Mapping

Yoga Kencana Nugraha[1,2] and Purnama Budi Santosa[1]
[1]Department of Geodetic Engineering, Faculty of Engineering, Universitas Gajah Mada, Indonesia
[2]Universitas Jenderal Achmad Yani Bandung, Indonesia

Received: 2022-03-23
Accepted: 2022-06-20

Keywords:
participatory mapping; spatial ability; spatial data quality; Land and Building Tax

Correspondent email:
purnamabs@ugm.ac.id

Abstract Participatory mapping (PM) method has become an alternative in spatial data collection activities for various mapping activities, including updating data on Rural & Urban Land and Building Tax (PBB-P2). From several experiences in PM application, various quality results have been found. Differences in the levels of spatial abilities of PM actors are assumed to affect the quality levels of PM results. Therefore, this study aimed to determine the effects of spatial abilities on the quality of spatial data generated in PM activities. It consisted of several stages of preparing instruments for measuring spatial abilities, collecting spatial data through PM, and correlation analysis. The instrument used to measure the levels of spatial abilities of 28 subvillage chiefs was the Purdue Spatial Visualization Test. The quality of PBB-P2 spatial data in 28 subvillages was randomly selected and assessed in terms of position, area, and geometric accuracies with reference to the land registration map from National Land Agency. Results indicated a positive correlation between the visual spatial ability and the spatial data quality of the PM results with a value of r = 0.823. Our findings are expected to be used as references for parties who carry out PM activities to be able to plan such activities.

1. Introduction

The participatory mapping method for spatial data collection activities in Indonesia has increased significantly (IFAD, 2010; Aditya, 2010). In 2019, a number of government organizations and agencies have successfully mapped more than 13.57 million hectares of land in the Kalimantan, Java, Sumatra, Sulawesi and Papua regions using the participatory mapping method (Jaringan Kerja Pemetaan Partisipatif, 2019). Participatory mapping activities were successful because of the role and contribution of the community as sources of spatial information (Cochrane et al., 2014). The communities involved are generally represented by local community leaders who are considered to have the best knowledge of the areas mapped (Hemmerling et al., 2020).

Basically, in participatory mapping activities, a process of producing local knowledge by a group of people is conducted using participatory working maps (Aditya, 2010), participatory mapping media, which are often used, have various kinds, including photo maps/satellite imagery maps (Boissière et al., 2018; Astrisele & Santosa, 2019). The use of both maps as a medium for interpretation in participatory mapping activities is effective because it supports the spatial information transfer process that occurs between local communities and outsiders (researchers or government officials) (Marjuki, 2018; Mustofa, Aditya, & Sutanta, 2018).

In Land and Building Tax, participatory mapping has great potential. Several local government agencies in charge of managing Land and Building Tax for Urban and Rural (PBB-P2) in Indonesia have used participatory methods in updating their spatial data (Aristalindra, Santosa, Diyono, & Subaryono, 2020). Ideally, this activity should always be carried out every year for urban areas and every three years for rural areas (Supardi, 2010). The quality of spatial data generated from the PBB-P2 spatial data collection activities is important because the information in the data is used as a consideration in determining the amount of tax value on each land (Santosa, Subaryono, Diyono, & Pamungkas, 2016). The quality level of spatial data generated in participatory mapping activities can be determined by assessing position, area, and shape accuracies by referring to reference data (Badan Informasi Geospasial, 2014; Gharini & Santosa, 2017; Kariyono, 2018).

The existence of differences in the quality level of spatial data generated using the same collection method and mapping media can show the urgency of the role of humans as the main actors of participatory mapping (Hadi, Hartono, Danoedoro, & Wimbarwati, 2017; Literat, 2013). The visual spatial ability plays a role in the success of activities related to map reading (Sholl & Egeth, 1982). It is one part of cognitive intelligence that supports a person to find the meaning of a visual image and accurately reproduces his visual experience on an image medium (Howard, 2010). The level of a person's visual spatial ability can be measured using the Purdue Spatial Visualization Test (PSVT) instrument, which comprises indicators of spatial relation, spatial orientation, and spatial visualization (Maeda et al., 2013). Several studies have shown that the levels of visual spatial abilities that each person has are different, and this ability can be increased through certain treatments (Setiawan, 2015; Giorgis, 2015; Lee & Bednarz, 2009).

Currently, Pacitan Regency is one of the local governments that has carried out activities to update PBB-P2 data using a participatory method (Pemerintah Kabupaten Pacitan, 2018). The report on the results of participatory mapping activities in Pacitan Regency in 2017 revealed differences in the quality level of PBB-P2 spatial data produced in various villages. For example, the participatory map that resulted in Arjosari Village is categorized as good with the score at about 89%. The quality of the participatory map of Tremas Village is lower than that of Arjosari Village at about 73% (Pusat Studi Ekonomi dan Kebijakan Publik, 2017). The difference in spatial data quality resulting from participatory mapping is interesting to investigate, especially regarding the factors that cause differences in data quality. Producing maps from participatory mapping with no errors is impossible. However, similar quality levels of maps (with some degree of differences) must be produced by participatory mapping actors with similar abilities or quality levels because spatial abilities play important roles in activities related to spatial data (Hadi et al., 2017; Literat, 2013; Howard, 2010; Sholl and Egeth, 1982). Therefore, as part of the research by Nugraha (2020), our study attempts to analyze the effect of the visual spatial ability of PM actors on the quality of spatial data generated from participatory mapping activities in Pacitan Regency with a focus on updating the PBB-P2 spatial data. This research is important because the practice of participatory mapping has been widely carried out in recent years in Indonesia. Therefore, the results of this study are expected to provide an overview of the role of the spatial ability of participatory mapping actors on the quality of the resulting maps, especially in the process of updating land and building tax data.

Most of the materials used in this research were supporting data for participatory mapping activities. The data were specific only to the research location area. Two types of data were used.

a. High-resolution Upright Satellite Image (CSRT–Ortho) at scale 1:5000 in the form of image service of InaSDI-Geoportal, produced in 2015 at the spatial resolution of 0,5 m.
b. Topographic maps (Peta Rupa Bumi Indonesia) at scale 1:5000. Obtained from BIG.
c. Subvillage boundary maps at scale 1:8000 include its toponim in 2008, obtained from the village office.
d. Land registration maps at scale 1:1000 obtained from BPN's Geo-KKP in 2019.
e. List of PBB-P2 records in 2019 from the Regional Revenue Agency (BAPENDA) of Pacitan Regency.
f. List of subvillage chief personal identities.

This research was conducted in 28 subvillages located in three villages in the border area of East Java Province and Central Java. The details of the subvillages are as follows: 10 subvillages are in the Belah Village area, nine subvillages are in the Donorojo Village area, and nine subvillages are in the Sukodono Village area, Sukodono District, Pacitan Regency (Figure 1).

2. The Methods

Our research design refers to the concept of the relationship between GIS activities and spatial abilities (Golledge and Stimson, 1997). This concept explains the relationship between several components of spatial abilities and several GIS activities, as summarized in Table 1.

As presented in Table 1, Golledge and Stimson (1997) revealed three spatial abilities, namely, spatial orientation, spatial visualization, and spatial relation. Each of them was tested on participants, using a set of spatial ability tests guided by a psychologist who has competence in the area of assessing spatial intelligence. The test results were then correlated with the map of the results of the participatory mapping of each participant to determine the relationship between the two variables.

The study was divided into several stages, namely, the visual spatial ability test, participatory mapping, spatial data quality assessment, and analysis of the effects of spatial abilities. It was conducted in conjunction with the 2019 PBB-

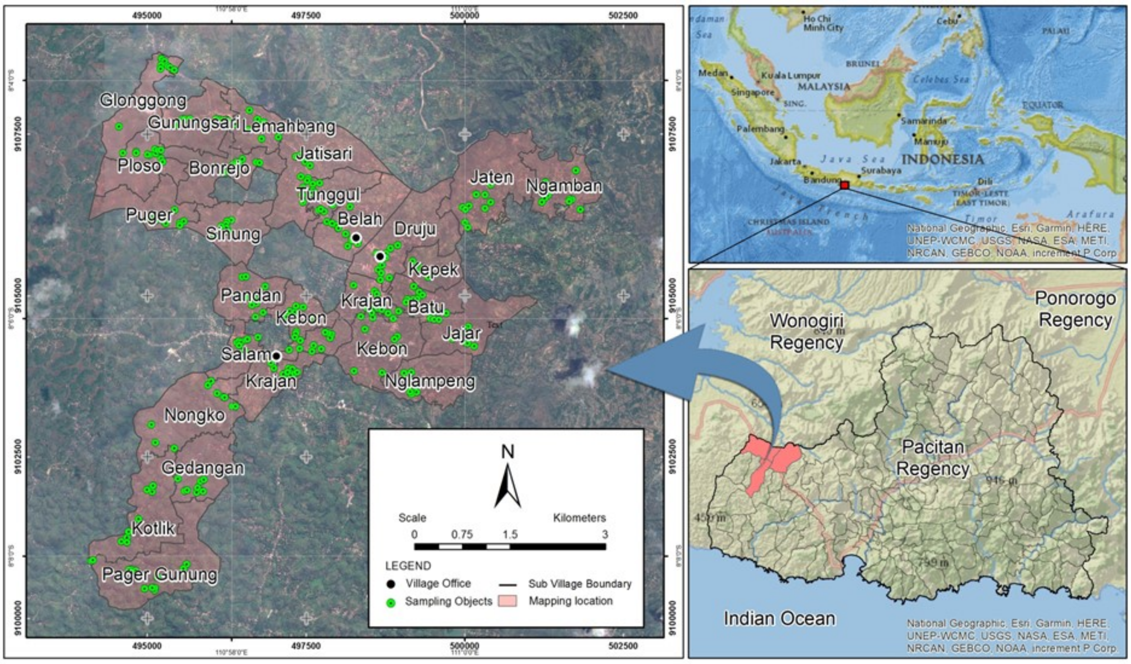

Figure 1. Map of participatory mapping locations (Source: BIG and the village office, with modification)

Table 1. Concept of the relationship between GIS activities and spatial abilities (Golledge & Stimson, 1997)

Spatial Ability	Description	Identified GIS Activity
Spatial Visualization	Mentally manipulating, rotating, twisting or inverting pictorially presented visual stimuli	Geometric transformation (e.g., map scale and projection) Map feature modification (e.g., reshape, mirror image) Geoprocessing (e.g., merge, clip, intersect, union 2D–3D visual transformation
Spatial Orientation	Remembering unconfused by changing orientations in which a configuration may be presented	2D–3D visual transformation Map orientation Aerial photo interpretation Data management (topology) Geocoding (georeferencing)
Spatial Relation	Recognizing spatial distributions and patterns	Spatial data classification Spatial statistics (interpolation) Pattern search Spatial data analysis
	Connecting locations	Spatial statistics (interpolation)
	Associating and correlating spatially distributed phenomena	Spatial data classification Spatial statistics (interpolation) Spatial data analysis
	Comprehending and using spatial hierarchies	Pattern search
	Orienting to real-world reference frames	Geocoding (georeferencing) Aerial photo interpretation 2D–3D visual transformation
	Imagining maps from verbal descriptions	
	Sketching maps	Drawing (or tracing) spatial features
	Comparing maps	Spatial data analysis
	Overlaying and dissolving maps	Geoprocessing (e.g., merge, clip, intersect, union) Spatial data analysis

P2 spatial data updating activities carried out by the Regional Revenue Agency (BAPENDA) of Pacitan Regency and Gadjah Mada University (Nugraha, 2020).
The visual spatial ability test was performed on 28 subvillage chiefs (Kepala Dusun) who participated in the participatory mapping. The test instrument used was PSVT, which comprised 21 multiple choice questions (Hababa, 2014). The validity of the PSVT test instrument was carried out by experts in the field of psychology. The instrument validation process has three stages, namely, the difficulty level through the proportion correct (pc) value, discrimination level through the point biserial (pb) value, and the test reliability level through the Cronbach's alpha (α) value. The difficulty level indicates that of questions to solve ranging from easy to difficult. The discrimination level shows the degree of difference between one question and another. The reliability level indicates the degree of reliability of each question.

The difficulty level test of questions was measured through the difficulty index (IF), which has a value range between 0 and 1, with the assumption that the questions are judged more difficult the smaller the value. The general formula for the problem IF is shown in Equation 1 (Brown, 2001).

$$\mathrm{IF} = \frac{\mathrm{B}}{\mathrm{JS}} \quad (1)$$

then B = frequency with which the test subjects answered correctly, and
JS = number of test subjects.

The discrimination level of a question can be determined by the distinguishing power of each problem through the correlation value of pb, which has a value range between −1 and 1 with the assumption that the question is assessed as the value becomes worse and close to −1. The general formula for calculating the biserial correlation coefficient is presented in Equation 2 below (Arikunto, 2009).

$$r_{pbis} = \frac{M_p - M_t}{S_t}\sqrt{\frac{p}{q}} \quad (2)$$

Hence,
r_{pbis}= biserial correlation coefficient
M_t= average total score
M_p= average of the test subjects who answered correctly the questions on the validity test
S_t = standard deviation of the total score
P = proportion of test subjects who answered correctly
Q = proportion of test subjects who answered incorrectly

To determine the reliability level of each question, the reliability test was performed by calculating the reliability coefficient value, which ranged from 0 to 1, with a value close to 0, indicating a weak reliability level. The formula used to calculate the reliability coefficient is shown in Equation 3 below (Sugiyono, 2002).

$$r_i = \frac{k}{(k-1)}\left\{1 - \frac{\Sigma\,\sigma_i^2}{\sigma_i^2}\right\} \tag{3}$$

Hence,
ri = instrument reliability coefficient
k= number of questions
$\Sigma\,\sigma_i^2$ = sum of the variance in the score for each question
σ_i^2 = total variant

Participatory mapping activities were carried out through a series of meetings at the village office. The participatory mapping work map consists of a tracing map and a high-resolution upright satellite image map of A3 size, which is overlapped. The scoring process for the visual spatial ability test is conducted by giving a score of 1 on the correct answer and a score of 0 on the wrong answer (Nur'aini, 2018). The classification process was performed using the equal interval method, which divides the level of spatial visual ability into three classes, namely high, medium, and low.

The test of spatial data quality from the results of participatory mapping in this study was performed by calculating the position, area, and geometric accuracies of the tax objects resulting from participatory mapping of the land registration map as a reference object. Position accuracy test was conducted to evaluate the quality of the resulting spatial data in terms of geometrical position. Area quality test was carried out to measure area accuracy, whereas geometric quality test was performed to measure the quality of the shape of the spatial geometry. All the tests were done by sampling, where the sample was determined randomly. The spatial data quality scores were classified using the equal interval method, which divides the quality level of spatial data into three classes, namely, good, moderate, and bad.

The analysis of the relationship between spatial ability and spatial data quality was carried out using two methods, namely, based on quantitative evaluation and qualitative (visual) analysis. Quantitative analysis was performed using simple linear regression analysis and correlation analysis. This analysis was used to determine the direction and magnitude of the relationship between the level of visual spatial ability and the quality level of PBB-P2 spatial data produced in participatory mapping activities.

The specification of research design of this research is provided in Table 2.

Table 2. Specification of research design.

Criterion	Specification	Description
Number of participants in instrument validation	99 persons	High school students
Number of participants of participatory mapping	28 persons	
Participant profession	Subvillage chief	Each participant represents each subvillage
Participant sex type	Male	
Participant education	High school graduate	
Participatory mapping medium	High-resolution satellite image	
Test instrument	PSVT	To measure spatial capabilities
Objects of participatory mapping	PBB-P2 spatial data	
Spatial quality to be assessed	Area, geometry, position accuracies	
Spatial reference for spasial quality assessment	Land registration map	Has been validated, available in the ATR/BPN's online plot map information service
Date	July 1, 2019–September 30, 2019	

Table 3. Results of the validity test of the PSVT instrument

Test type	Class value	Attribute	Question type			Number of questions
			Spatial relation	Spatial orientation	Spatial visualization	
Point biserial (Pb)	−1–0,200	Bad	1	1	0	2
	0,201–0,400	Fairly good	3	1	5	9
	0,401–0,700	Good	4	6	3	13
	0,701–1	Very good	0	0	0	0
proportion correct (pc)	0–0,300	Difficult	2	4	3	9
	0,301–0,700	Moderate	4	0	4	8
	0,701–1	Easy	2	4	1	7
alpha cronbach (alpha)	0.771	n/a	8	8	8	24

3. Result and Discussion

Result of Spatial Visual Ability Assessment

The validity test of the test instrument is carried out by considering the distinguishing power of the questions through the pb value, the difficulty level through the pc value, and the test reliability level through the α value.

Figure 2. Suitability of spatial relation questions to PM activities

Figure 2 displays an example of the visual spatial ability test questions used to test a person's ability to identify a rotated object. In participatory mapping activities, this capability is used in the process of identifying the position of a tax object that is delineated according to the orientation on the map. The availability of a compass on the participatory mapping work map sheet is used to bring up the mental rotation of the interpreter. This capability helps interpreters in the process of delineating a tax object on the map, so that it matches its direction as the condition of the tax object in the field.

The results of each participant's visual spatial ability test are shown in Figure 3. Based on the scoring results of PSVT answers, variations exist in the three abilities of the levels of spatial visual abilities. Each participant has different advantages. Participants from Stump, Batu, and Kotlik have the highest scores on the spatial relation section, which is related to the ability to complete the task of identifying the shape of an object that is rotated in 2D and 3D planes. Furthermore, participants from Lemahbang Subvillage obtain the highest score on the spatial orientation section, which is related to the ability of participants to complete a task to identify the shape of an object from different perspectives. Several participants from Tunggul, Batu, Nglampeng, Kebon 2, and Krajan 2 Subvillages have high scores on the spatial visualization section. These high scores are related to the ability of participants to complete a task in identifying an object in a 3D field whose shape changes to an object in a 2D plane.

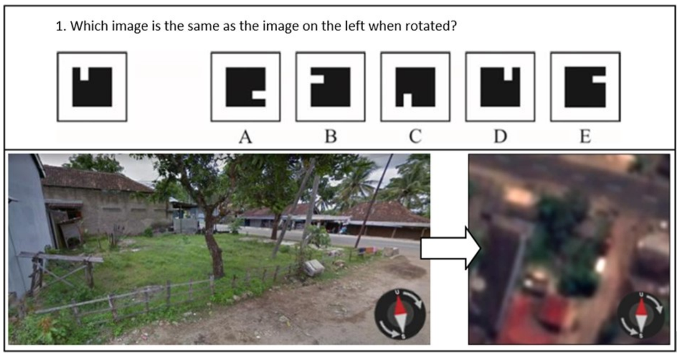

Figure 2. Suitability of spatial relation questions to PM activities

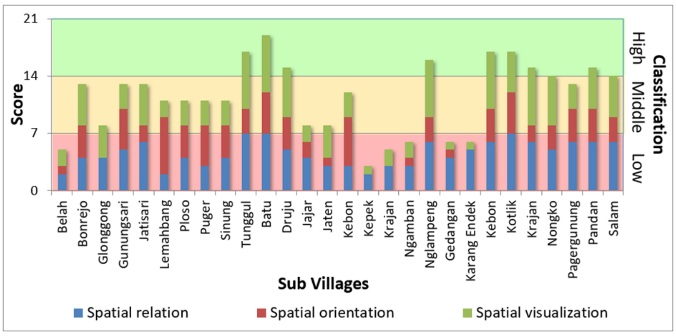

Figure 3. Levels of the spatial visual abilities of participants

The highest score of visual spatial ability is obtained by participants from Batu Subvillage, whereas the lowest score is generated by participants from Kepek Subvillage. The levels of spatial visual abilities possessed by each participant in participatory mapping is different. The average level of spatial visual ability is moderate with a value of 11,5. The level of visual spatial ability that a person has can be influenced by the quantity and quality of spatial experiences obtained in his daily life. From the questionnaire, most participants are not accustomed to using maps in their daily activities. As a result, only a few participants exhibit good spatial abilities.

Results of Spatial Data Quality

Spatial data quality is measured using three parameters, namely, position accuracy, area quality, and geometric quality.

Position Accuracy Test Results. From the test samples that have been selected in the previous stage on the land registration map and the participant delineation results in participatory mapping activities, the position accuracy test is performed using the near distance polygon method. The centroid distance of the PBB-P2 tax object result of participatory mapping as the test object, is compared with the parcel of land on the registration map as the reference object. The mean value of position deviation is 3.773 m, with the lowest and highest polygons near the distance test results are at about 0.297 and 22.424 m for Bonrejo and Pandan Subvillages, respectively (Figure 4). This range value (from the lowest to highest) is relatively high, especially by comparing this result with previous research conducted by Kariyono (2018) and Gharini and Santosa (2017) who showed range values from 0.170 to 1,681 m and from 0.247 to 13,689 m, respectively. This result is possible due to differences in data collection methods, media, locations, and numbers of participatory mapping participants, which then affect the difference in position accuracy quality.

Area Quality Test Results

Area quality is tested using the polygon area method. The area difference between the PBB-P2 tax object (result of participatory mapping) as the test object and the parcel of land on the registration map as the reference object is calculated. The average area deviation value is 68,252 m2**,** whereas the lowest and highest deviation values are 1.996 and 293.460 m2, respectively. This calculation is based on participants in Nglampeng and Kepek Subvillages, as shown in Figure 5. By conducting this test, a thorough

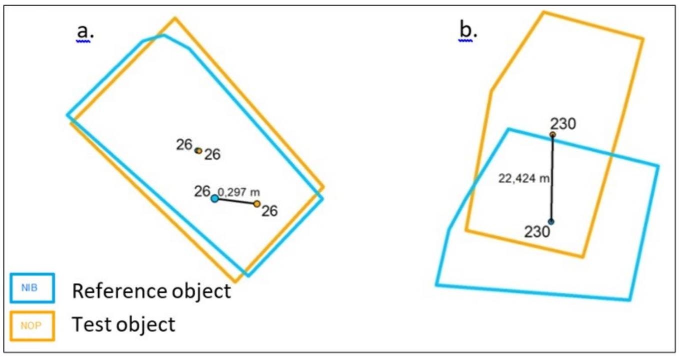

Figure 4. Test sample with (a) the smallest and (b) largest polygon near distance

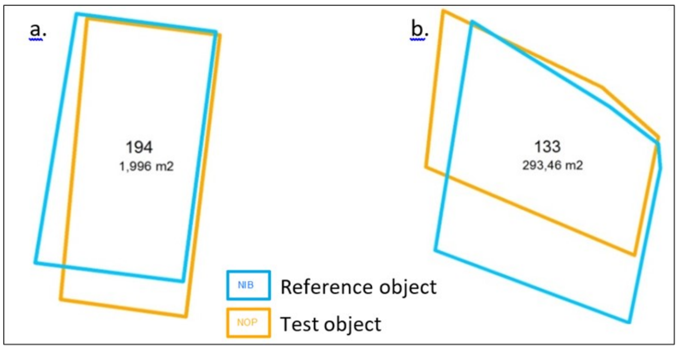

Figure 5. Test sample with (a) the smallest and (b) largest polygon area values

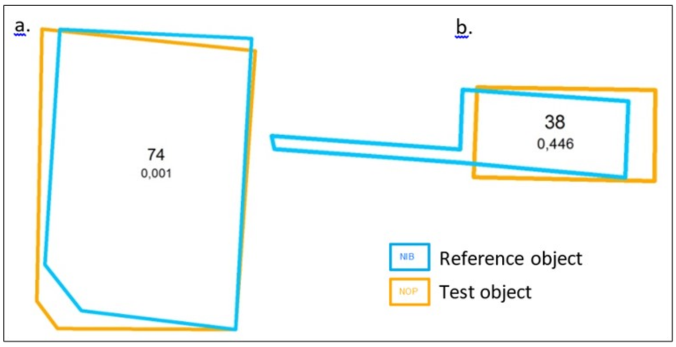

Figure 6. Sample with (a) the smallest and (b) largest polygon CR

Table 4. Classification of spatial data quality

Quality level	Test method: *polygon near distance*	*polygon area*	*polygon CR*	Score
I	9	9	9	27
II	8	8	8	24
III	7	7	7	21
IV	6	6	6	18
V	5	5	5	15
VI	4	4	4	12
VII	3	3	3	9
VIII	2	2	2	6
IX	1	1	1	3

understanding on the area quality of each polygon can be understood.

Geometric Quality Test Results

The final step in testing spatial data quality is to test geometric quality using the polygon circularity ratio (CR) method. The difference in the CR between the PBB-P2 tax object result of participatory mapping as the test object and the parcel of land on the registration map as the reference object is calculated. From the resulting map, the average polygon CR is 0.051, where the lowest and highest values are 0.001 and 0.446, respectively. The calculation is based on participants from Jajar and Druju Subvillages (Figure 6).

The classification of spatial data quality from the results of the participatory mapping was calculated on the basis of the assessment scores of the three test models, namely, the area quality test, the position accuracy test, and the shape quality test. The classification process is carried out by

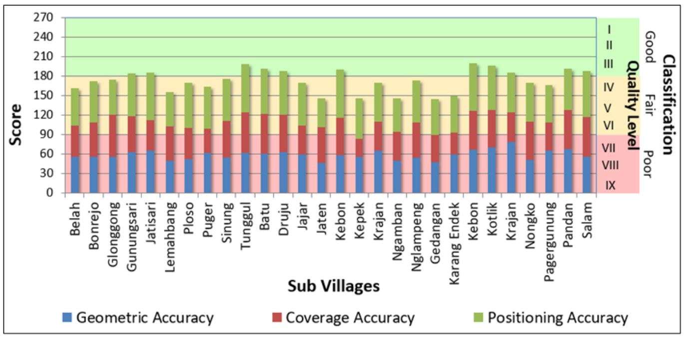

Figure 7. Classification of spatial data quality results

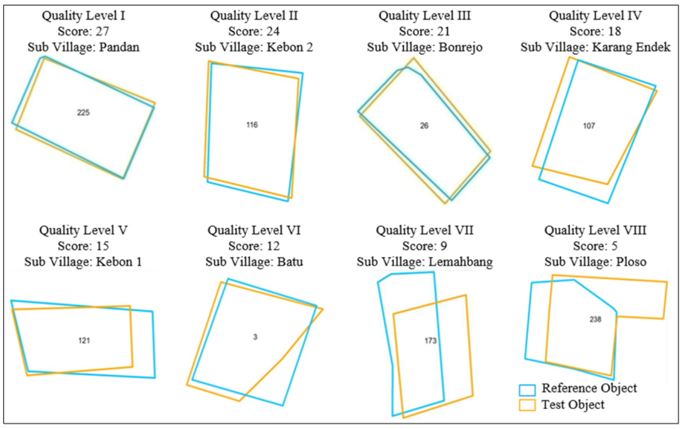

Figure 8. Visualization of the results of the spatial data quality test

referring to Table 4. Spatial data quality is quantitatively classified into nine classes on the basis of the total score obtained.

The summary of the quality level of spatial data produced by each participant in participatory mapping activity is shown in Figure 7. A variation is observed in the scores on the three test components (position, geometric, and area qualities). Thus, each participant produces various quality levels of spatial data. Figure 7 illustrates that 11 participants (39.3%) can produce good quality spatial data at class III of quality level. The remaining participants (60.7%) can produce spatial data at fair quality (ranging from level V to IV).

The visualization of the spatial data quality class from the participatory mapping results can be seen in Figure 8, where each picture represents each data quality class from classes I to VIII (none of the participatory mapping results in this study are included in the class IX category). Tax objects that have high scores tend to show similarities to the reference object in terms of position, size, and geometry, rather than tax objects that have low scores, and vice versa. We conclude that the higher the number of scores obtained through the spatial data quality test, the better the quality of the resulting spatial data.

Result of Correlation Analysis

Based on the correlation analysis of statistical data, the visual spatial ability score has a strong relationship (r = 0.823) with spatial data quality. The percentage of the relationship between the two is 67.7% (R2 = 0.677), whereas the remaining percentage of 32.3% is influenced by other factors unexamined. From the correlation coefficient, the order of the magnitude of the influence that occurs on

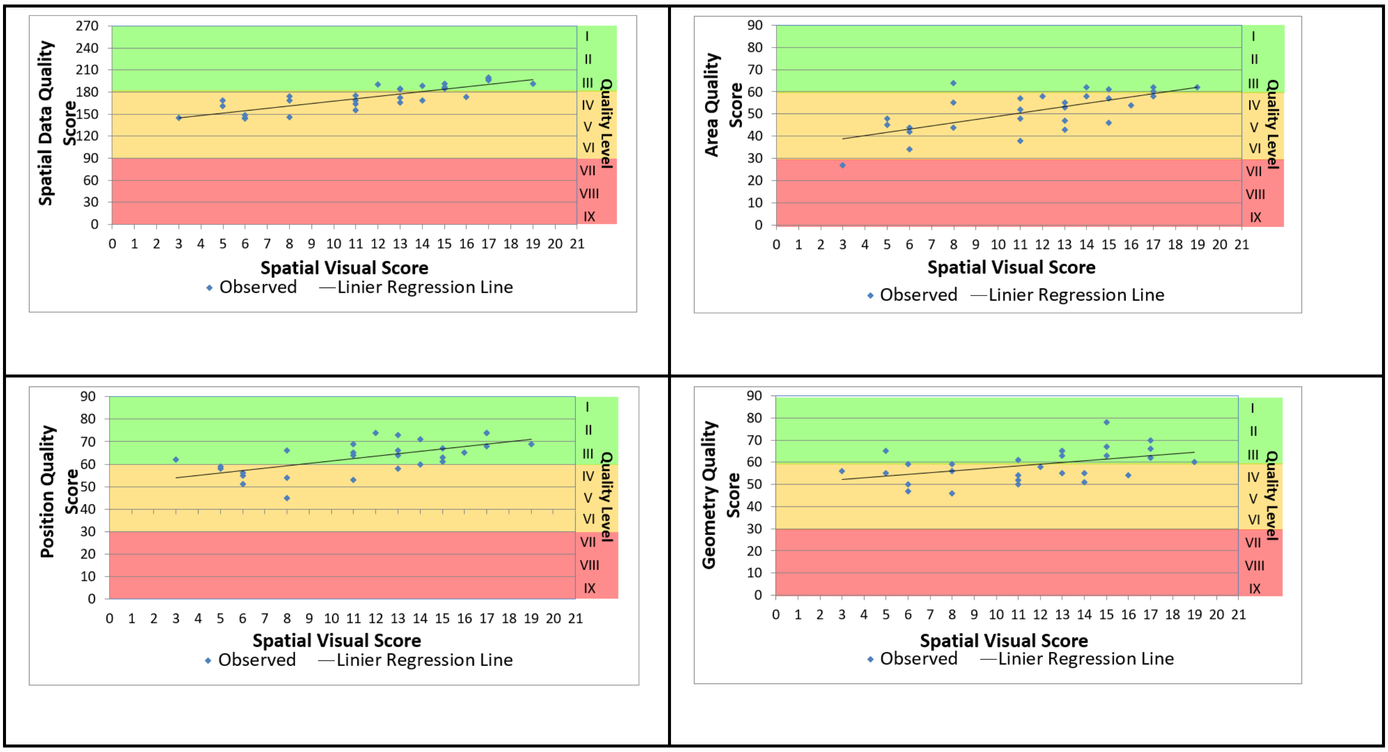

Figure 9. Correlation between spatial ability and spatial data quality

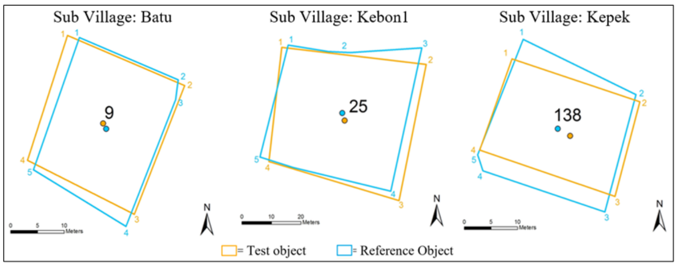

Figure 10. Spatial quality comparison

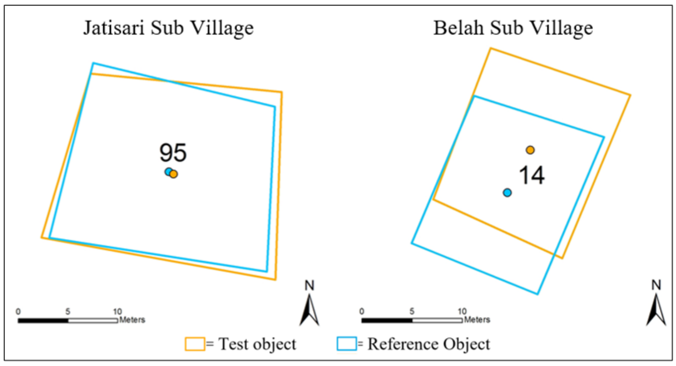

Figure 11. Spatial comparison for the case of the spatial ability of spatial visualization

the three components of spatial data quality, namely, area accuracy (Strong; r = 0.672), position accuracy (Strong; r = 0.616), and geometric accuracy (Enough; r = 0.453) can be seen. The regression line in the curve shows a positive linear relationship, where every 1 increase in the spatial visual ability score is estimated to affect the increase in the quality level score of data by 3 (Figure 9). It proves statistically that participants who have high visual spatial abilities tend to produce spatial data that have high accuracy and good quality.

Visual analysis is carried out on spatial data generated by participants in Batu, Kebon 1, and Kepek Subvillages (Figure 10). Three participants in the three subvillages are those who have high, medium, and low spatial ability levels. Visually, the spatial data generated by participants in Batu Subvillage have a higher level of similarity to reference data than the spatial data generated by participants in Kebon 1 and Kepek Subvillages. The similarity level can be seen through the proximity of the midpoint position (centroid of the land parcel), object size, and the number of corner points that represent the shape. Through the comparative analysis of spatial data, participants who have high levels of visual abilities tend to produce better and more accurate spatial data quality than others.

To analyze in detail the three components of spatial ability, namely, spatial evaluation, spatial orientation, and spatial relation, as presented by Golledge and Stimson (1997) in Table 1, visual analysis is performed on the basis of participatory mapping results of each participant.

The spatial ability of spatial visualization is related to mentally manipulating maps, including map transformation, map feature reshaping, and object boundary identification on the map. This ability can be analyzed by comparing the spatial data produced by the participant from Jatisari Subvillage who has a high spatial visualization score with the participant from Belah Subvillage who has a low spatial visualization score (Figure 11). Errors in identifying object shapes and boundaries on the map affect the quality level of spatial data, comprising position, area, and geometric accuracies.

The spatial ability of spatial orientation determines the ability to identify object shapes viewed with different orientations on the map to conduct aerial photo interpretation. It is analyzed by comparing the spatial data produced by a participant from Bonrejo Subvillage who has a high spatial orientation score with a participant from Jaten Subvillage who has a low spatial orientation score (Figure 12). The ability to orient objects on the map between the two participants shows a significant difference.

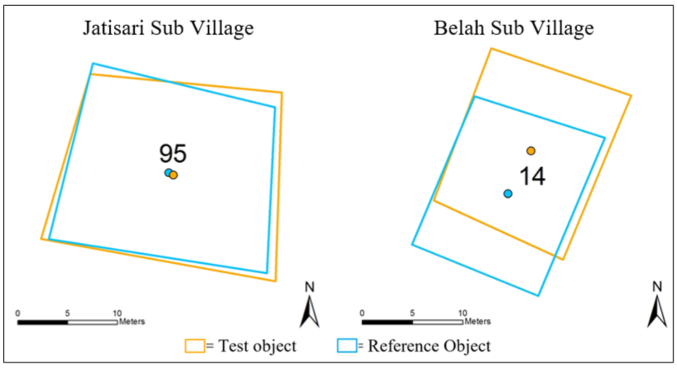

Figure 11. Spatial comparison for the case of the spatial ability of spatial visualization

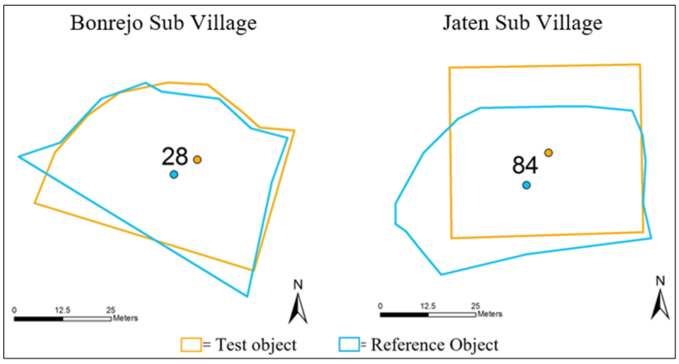

Figure 12. Spatial comparison for the case of the spatial ability of spatial orientation

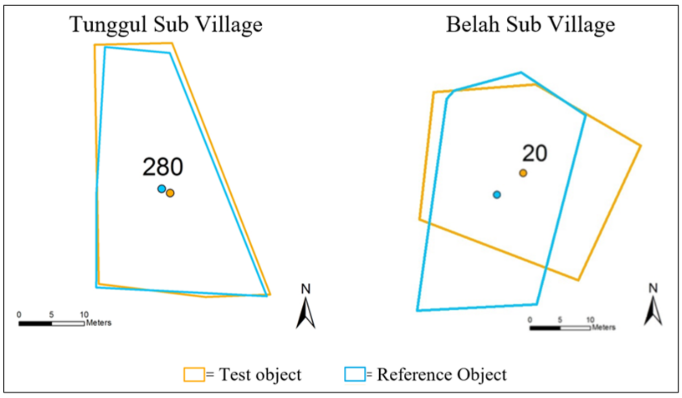

Figure 13. Spatial comparison for the case of the spatial ability of spatial relation

Spatial ability related to spatial relation comprises the ability to perform three tasks, such as recognizing spatial distributions and patterns, connecting locations, and orientating to real-world reference frames in the map. This ability can be seen and analyzed by comparing the spatial data produced by a participant from Tunggul Subvillage who has a high spatial relation score with a participant from Kepek Subvillage who has a low spatial relation score (Figure 13). The Kepek Subvillage map shows lacking map orientation and spatial pattern quality.

Discussion

A series of statistical analysis results and visual analysis show that visual spatial ability has a strong influence on spatial data quality (on three test components: position, geometric, and area qualities) generated in participatory mapping with positive correlation. Each participant produces various quality spatial data from class quality levels III to V (Figure 7). That is, if the community involved in PM has a high-level spatial ability, then it tends to produce good quality PBB-P2 spatial data; if participatory mapping actors' spatial abilities are low, then the spatial data quality that they produce tend to be on low quality. This finding suggests that in participatory mapping, considering the levels of spatial abilities of the actors is important to obtain the expected results of spatial data quality.

Examples of minimum education standard implementation have been demonstrated by two government institutions. The Ministry of Finance of the Republic of Indonesia stipulates minimum education standards for PBB-P2 data operators at high school or vocational high school level Kementerian Keuangan Republik Indonesia (2014). Likewise, LAPAN's Remote Sensing Utilization Center sets minimum education standards and additional requirements for employees. LAPAN provides standard criteria for personnel in charge of processing and interpreting satellite imagery in the form of a minimum education level of diploma 3, along with additional requirements, such as eye health, skills in operating computers and image processing software, and abilities related to accuracy and perseverance through psychological tests (Arifin and Hidayat, 2014). This standard can also be referred to in participatory mapping implementation to determine the minimum education standards for participatory mapping actors, with modification.

In addition to the minimum education requirements for participants in participatory mapping, spatial abilities can also be improved through a series of long- and short-term trainings, prior to the implementation of participatory mapping activities. The quantity and quality levels of GIS training materials affect the improvement of one's spatial abilities that indirectly improves such abilities, so it can affect the quality of spatial data produced in participatory mapping. GIS materials can be in the form of map readings and image interpretation exercises or through mapping simulations. This strategy is in accordance with what was done by Lee and Bednarz (2009 who argued that learning GIS can improve a person's spatial abilities and is based on the concept initiated by Golledge and Stimson (1997) who were the firsts to investigate the relationship of a person's cognitive abilities (especially spatial abilities) with GIS activities. Table 1 provides the information of the relationship between GIS activities and spatial abilities. This information can be used as a guidance of what activities must be improved with respect to each component of spatial ability.

4. Conclusion

This study has evaluated the correlation between spatial abilities and spatial data quality in participatory mapping activities in Pacitan Regency. The evaluation concludes that spatial abilities have a strong relationship with the quality of participatory mapping results. The level of visual spatial ability possessed by each participant is proven to be one of the factors affecting the quality of spatial data generated in participatory mapping activities, with a positive correlation at r = 0.823. That is, spatial visual ability affects spatial data quality in three areas of spatial data quality, namely, area, position, and geometric accuracies (shape correctness). This finding is also confirmed from the visual analysis, which visually evaluates the resulting spatial data according to spatial visualization, spatial orientation, and spatial relation.

Given that spatial data quality in participatory mapping activities correlates positively with spatial abilities, involving local communities who have good levels of visual spatial abilities to obtain good quality spatial data is necessary. Therefore, minimum education standards for PM actors must be considered. Specific trainings should also be provided to them prior to the execution of a participatory mapping activities.

Acknowledgment

The authors would like to thank the Regional Revenue Agency (BAPENDA) of Pacitan Regency, the Province of East Jawa, and the UGM Center for Economic and Public Policy Studies (PSEKP) for its contribution during research data collection. Our sincere gratitude also goes to Khamidan Khabib, S.Psi, M.Psi., a psychometric expert who tremendously helped us in preparing test instruments for visual spatial abilities using the PSVT method.

Reference

Aditya, T. (2010). Usability Issues in Applying Participatory Mapping for Neighborhood Infrastructure Planning. Transactions in GIS, 14, 119–147. https://doi.org/10.1111/j.1467-9671.2010.01206.x

Arifin, S., & Hidayat, T. (2014). Kriteria Standar Pengolahan Klasifikasi Visual Berbasis Data Inderaja Multispektral untuk Informasi Spasial Penutup Lahan. Retrieved from Kajian Kriteria Standar Pengolahan Klasifikasi Visual Berbasis Data Inderaja Multispektral Untuk Informasi Spasial Penutup Lahan website: http://repository.lapan.go.id

Arikunto, S. (2009). Prosedur Penelitian: Suatu Pendekatan Praktek (4th ed.). Jakarta: PT Rineka Cipta.

Aristalindra, F., Santosa, P. B., Diyono, & Subaryono. (2020). Evaluasi Pemanfaatan Citra Tegak Satelit Resolusi Tinggi untuk Percepatan Pembuatan Peta Blok Pajak Bumi dan Bangunan (PBB-P2) secara Partisipatif di Desa Triharjo, Kabupaten Bantul, DIY. JGISE Journal of Geospatial Information Science and Engineering, 3(1), 20–27. https://doi.org/https://doi.org/10.22146/jgise.55788

Badan Informasi Geospasial (BIG), & Jaringan Kerja Pemetaan Partisipatif (JKPP). (2014). Standard Operating Procedures (SOP) Penyelenggaraan Pemetaan Partisipatif Dan Pengendalian Kualitas Peta Partisipatif. Bogor: Pusat Pengelolaan dan penyebarluasan Informasi Geospasial.

Boissière, M., Duchelle, A. E., Atmadja, S., & Simonet, G. (2018). Technical guidelines for participatory village mapping exercise. Bogor: CIFOR. https://doi.org/10.17528/cifor/007282

Brown, H. D. (2001). Principles of Language Learning and Teaching. New York: Addison Wesley Longman, Inc.

Cochrane, L., Corbett, J., & Keller, P. (2014). Impact of Community-based and Participatory Mapping.

Gharini, D. ., & Santosa, P. . (2017). Pemutakhiran dan Uji Kualitas Data Geospasial Pajak Bumi dan Bangunan Menggunakan Peta Pendaftaran Tanah. Prosiding Forum Ilmiah Tahunan (FIT) 2017 Ikatan Surveyor Indonesia (ISI), 268–278. Pekanbaru, Riau.

Giorgis, S. (2015). Google Earth Mapping Exercises for Structural Geology Students - A Promising Intervention for Improving Penetrative Visualization Ability. Journal of Geoscience Education, 63(2). https://doi.org/10.5408/13-108.1

Golledge, R. G., & Stimson, R. J. (1997). Spatial Behaviour:A Geographic Perspective. New York: Guilford Press.

Hababa, A. . (2014). Pengaruh Kecerdasan Spasial dan Kecerdasan Matematis Terhadap Kemampuan Menggambar Teknik Siswa pada Mata Pelajaran Pembacaan dan Pemahaman Gambar Teknik di SMK Negeri 3. Universitas Negeri Yogyakarta.

Hadi, B. S., Hartono, Danoedoro, P., & Wimbarwati, S. (2017). Pengaruh Penggunaan Citra Multiresolusi Spasial dalam Pembelajaran Penginderaan Jauh Terhadap Kemampuan Berpikir Spasial Mahasiswa Calon Guru Geografi (Gadjah Mada University). Gadjah Mada University. Retrieved from http://etd.repository.ugm.ac.id/home/detail_pencarian/127768

Hemmerling, S. A., Barra, M., Bienn, H. C., Baustian, M. M., Jung, H., Meselhe, E., … White, E. (2020). Elevating Local Knowledge Through Participatory Modeling: Active Community Engagement in Restoration Planning in Coastal Louisiana. Journal of Geographical Systems, 22(2), 241–266. https://doi.org/10.1007/s10109-019-00313-2

Howard, G. (2010). The Theory of Multiple Intelligences. New York: Basic Books.

IFAD. (2010). The IFAD Adaptive Approach to Participatory Mapping. International Fund for Agricultural Development (IFAD).

Jaringan Kerja Pemetaan Partisipatif. (2019). No Title. Retrieved from jkpp.org website: https://jkpp.org/2019/12/09/peta-sebaran-pemetaan-partisipatif-di-indonesia-2019/

Kariyono. (2018). Evaluasi Kualitas Data Spasial Peta Informasi Bidang Tanah Desa / Kelurahan Lengkap Hasil Pemetaan Partisipatif. Gadjah Mada Univerity.

Kementerian Keuangan Republik Indonesia. (2014). Pedoman Umum Pengelolaan Pajak Bumi dan Bangunan Perdesaan dan Perkotaan (PBB-P2). Jakarta.

Lee, J., & Bednarz, R. S. (2009). Effect of GIS Learning on Spatial Thinking. Journal of Geography in Higher Education, 33(2), 183–198. https://doi.org/10.1080/03098260802276714

Literat, I. (2013). Participatory mapping with urban youth: the visual elicitation of socio-spatial research data. Learning, Media and Technology, 38(2), 198–216. https://doi.org/10.1080/17439884.2013.782037

Maeda, Y., Yoon, S., Kim-Kang, K., & Imbrie, P. K. (2013). Psychometric Properties of the Revised PSVT: R for Measuring First Year Engineering Students' Spatial Ability. International Journal of Engineering Education, 29(3), 763–776.

Marjuki, B. (2018). Penerapan Teknik Pemetaan Partisipatif Untuk Mendukung Penyusunan Basis Data Spasial Penggunaan Lahan Dan Sumberdaya Desa. Seminar Nasional Geomatika 3, 1–9. Bogor: BIG. https://doi.org/10.24895/SNG.2018.3-0.929

Mustofa, F. C., Aditya, T., & Sutanta, H. (2018). Evaluation of participatory mapping activities to develop parcel-based maps for village based land registration purpose. International Journal of Geoinformatics, 14(2), 45–55. https://doi.org/10.5281/zenodo.1409285

Nugraha, Y. K. (2020). Pengaruh Kemampuan Visual Spasial Terhadap Kualitas Data Spasial Dalam Kegiatan Pemutakhiran PBB-P2 Melalui Pendekatan Partisipasi Masyarakat (Gadjah Mada University). Gadjah Mada University. Retrieved from http://etd.repository.ugm.ac.id/penelitian/detail/191028

Nur'aini, S. (2018). Analisis Butir Psikometri Purdue Spatial Visual Test (PSVT). Universitas Gadjah Mada.

Pemerintah Kabupaten Pacitan. (2018). Keputusan Bupati Pacitan Nomor 188.45/477/KPTS/408.12/2018 tentang Pembentukan Tim Pendampingan Pemutakhiran Data Base, Data Spasial dan Pembaruan Zona Nilai Tanah PBB-P2. Retrieved from https://kabpacitan.jdih.jatimprov.go.id/?wpfb_dl=11050

Pusat Studi Ekonomi dan Kebijakan Publik (PSEKP). (2017). Laporan Kegiatan Penyusunan Data Spasial PBB-P2 Kelurahan Arjosari dan Kelurahan Tremas Kabupaten Pacitan. Yogyakarta.

Santosa, P. B., Subaryono, Diyono, & Pamungkas, S. D. (2016). Kondisi Data Geospasial dalam Mendukung Pelayanan Pajak Bumi dan Bangunan. Prosiding FIT-ISI Dan CGISE 2016, 408–415. Yogyakarta.

Setiawan, I. (2015). Peran Sistem Informasi Geografis (SIG) dalam Meningkatkan Kemampuan Berpikir Spasial (Spatial Thingking).

Jurnal Geografi GEA, 15(1), 83–89. https://doi.org/10.17509/gea.v15i1.4187

Sholl, M. J., & Egeth, H. E. (1982). Cognitive correlates of map-reading ability. Intelligence, 6(2), 215–230. https://doi.org/https://doi.org/10.1016/0160-2896(82)90015-0

Sugiyono. (2002). Statistika Untuk Penelitian. Bandung: CV Alfabeta.

Supardi, U. (2010). Membedah Pengelolaan Administrasi PBB dan BPHTB : Pengalaman di Pemerintah Pusat, Referensi untuk Implementasi Pajak Daerah. Jakarta: Mitra Wacana Media.