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Participatory GIS for collaborative decision making development of village resource potential

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Abstract. This study aims to develop participatory GIS applications for village resource mapping decisions. This study consists of two stages, the first stage is mapping village resources using Quantum GIS and Tableau server software, and the second stage is collaborative decision making modeling using the borda voting method. The results showed that there were 67 potential resource points that could be mapped in the Summersari village area. Decision making to determine the priority ranking of the village resource potential that will be developed, can involve community representatives and collaborate with the village government.

1. Introduction

When facing local government issues, maps are a very effective tool. They can help in collecting facts about an area, bring issues to the table, allow for comparison between areas, act as a tool of communication with local decision makers, and identify key issues for action [1]. While the maps on their own do not alter the power relationships within which communities live their lives, many studies and examples have shown the purposeful role of mapping as part of community mobilisation and action [2], [3]. The use of maps and geographical information to address community concerns is integrating different areas, including participatory mapping [2], participatory geographic information systems (PGIS) or Public Participation GIS (PPGIS) [3] and the emerging area of citizen science [4].

Public Participatory Geographical Information Systems (PP GIS) is a field of research that focuses on the use of GIS by the general public and aims at involving the citizen in a decision-making processes. PP GIS is an abbreviation which indicates that public needs to be supported when addressing community based problems, since a variety of perspectives are common in different planning processes. Such recognition does not necessarily enhance the capabilities of a conventional GIS. PP GIS seeks to expand the use of GIS to the general public and non-governmental organizations that are not usually represented in traditional topdown GIS projects [5], [6].

Traditional planning methods only single to make various planning map, to manually create and modify tables, for planning map update is even more difficult to achieve. GIS can not only low cost but high to quickly generate a variety of programming with graph and table data, but also can realize the dynamic data updating [7]. Thus, GIS reduces the consumption of time, manpower and material resources planning, greatly improves the accuracy of planning operation efficiency and information, and the



implementation of the planning of science, rationality and operability. Therefore, GIS is the foundation of an indispensable tool in new rural planning [8]

The problem of developing village resource potential is a major problem in rural development. The village development program will succeed if the development problem is a proposal that involves community participation, and is supported in accordance with the available resource potential. A tool is needed that can map the potential and problems of village development, as a storage tool and collaboration for decision making. The information technology-based tool is a combination of GIS capabilities and group decision support system (GDSS) capabilities. This study aims to develop GIS applications that have the ability to facilitate community participation and collaboration in village development program decision making.

2. Methodology

This research consists of two stages, namely: the GIS mapping stage and the collaborative decision making modeling stage of the user (Figure 1).

2.1. The GIS mapping phase, the steps taken are as follows:

- Collecting data by conducting interviews and location surveys to obtain data on village resource potential.
- Perform GeoTagging to determine the coordinates of the location of village resources
- Digitize maps using QGIS software with predetermined location coordinates for village resource potential
- Upload the digitized map results to the server table

2.2. The collaborative decision making modeling phase, the steps taken are as follows:

- Identification of problems
- Identification of the decision maker
- Determine the model
- modeling
- Model validation

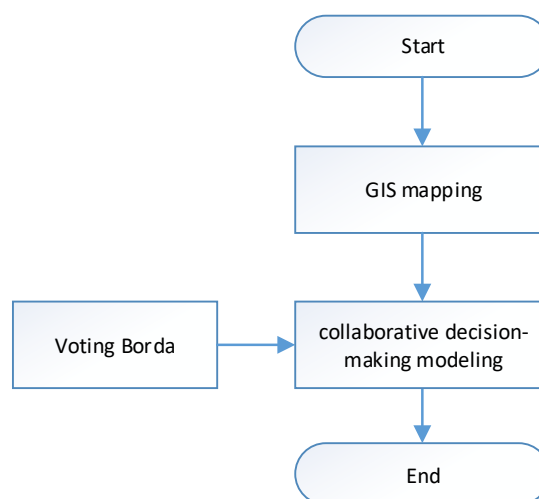


Figure 1. Stages of Research

3. Results and discussion

The system developed involves two types of users, namely the community and the decision maker. Communities are villagers who have potential resources that can be developed. The community participates in terms of proposing and managing resource data. Decision maker (DM) is a user who has the authority to decide on the priority of potential resources to be developed. DM is a community group

consisting of community leaders and representatives from the village government. Each DM prioritizes the proposed resource potential, then priority proposals are decided based on voting. The description of the user's relationship with the system can be seen through the usecase diagram as shown in figure 2.

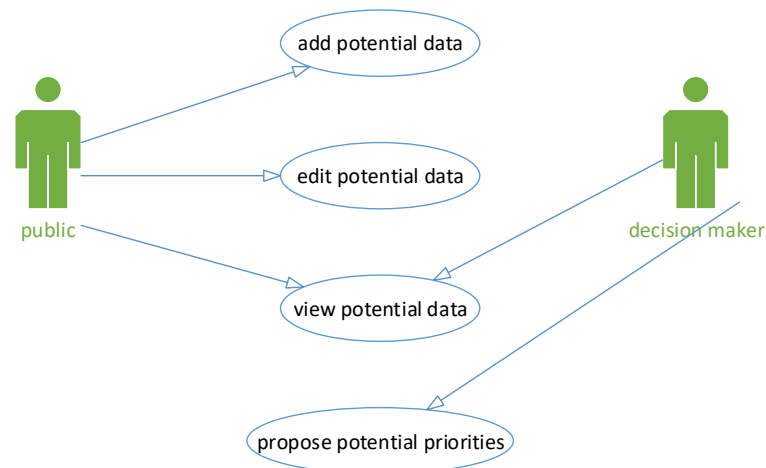


Figure 2. Usecase of Participatory GIS

3.1. Result of Participatory GIS

The first stage of the research is the development of GIS applications. There are 67 locations of potential village resources (PSD) that have been successfully mapped. Furthermore, the location of the PSD is depicted on the map of Summersari village based on the coordinates of its location (Figure 3).

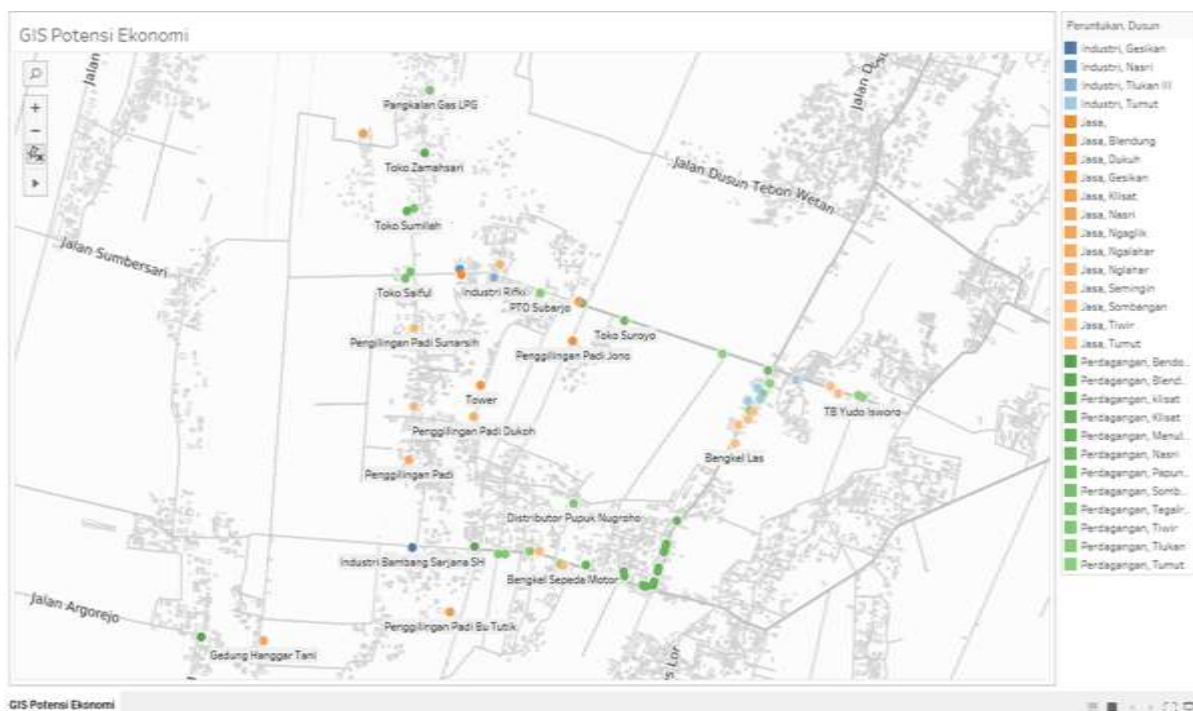


Figure 3. GIS Potency Map

Examples of summary data on village resource potential, with latitude x, longitude y, village name, hamlet name, sub-district name, potential name, and type of allocation can be seen in Table 1.

Table 1. Resource potential GIS data

ID. Potency	Latitude X	LongitudeY	Village	Hamlet	sub-district	Name	type of allocation
PSD1	419360.55	9140144.1	Sumbersari	Nasri	Moyudan	Industri H Zuhair	Industry
PSD2	419513.36	9140108.9	Sumbersari	Tlukan III	Moyudan	Industri Rifki	Industry
PSD3	419716.27	9140046.4	Sumbersari	Tlukan	Moyudan	PTO Subarjo	Trading
PSD4	419886.88	9140010.3	Sumbersari	Nasri	Moyudan	Bengkel Sugiyanto	Service
PSD5	419901.44	9140003.4	Sumbersari	Nasri	Moyudan	PTO Krempyeng	Trading
PSD6	420089.79	9139930.3	Sumbersari	Papungan	Moyudan	Toko Suroyo	Trading
PSD7	419123.3	9140105.1	Sumbersari	Sombangan	Moyudan	Toko Saiful	Trading
PSD8	419163.5	9139573.7	Sumbersari	Sombangan	Moyudan	Bengkel Asfandi	Service
PSD9	419160.13	9138980.9	Sumbersari	Gesikan	Moyudan	Industri Bambang	Industry
PSD10	419147.3	9140131.6	Sumbersari	Sombangan	Moyudan	Toko Mujiono	Trading
PSD11	419429.51	9138993.9	Sumbersari	Blendung	Moyudan	Toko Besi	Trading
PSD12	419672.45	9138974	Sumbersari	Tiwir	Moyudan	Toko Driyo Pawiro	Trading
PSD13	419536.88	9138962.5	Sumbersari	Tiwir	Moyudan	Toko Sunaryo	Trading
PSD14	419567.12	9138960.2	Sumbersari	Tiwir	Moyudan	Toko Sajiyo	Trading
PSD15	419717.14	9138973.6	Sumbersari	Tiwir	Moyudan	Bengkel Tiga Karya	Service
PSD16	419921.98	9138917.5	Sumbersari	Menulis	Moyudan	Toko Riyanto	Trading
PSD17	419938.95	9138900.4	Sumbersari	Menulis	Moyudan	Toko Erna	Trading
PSD18	420090.38	9138872.8	Sumbersari	Menulis	Moyudan	Toko Toko Sriyatun	Trading
PSD19	420185.54	9138829.4	Sumbersari	Menulis	Moyudan	Toko Ririn	Trading
PSD20	420630.55	9139524	Sumbersari	Tumut	Moyudan	Salon Walristo	Service
PSD21	420656.31	9139558.4	Sumbersari	Tumut	Moyudan	Modiste Windi	Service
PSD22	420685.86	9139607.7	Sumbersari	Tumut	Moyudan	Genteng H Sigit	Industry
PSD23	420697.33	9139630.1	Sumbersari	Tumut	Moyudan	Toko Juwandono	Trading
PSD24	420725.33	9139671.2	Sumbersari	Tumut	Moyudan	Toko Tejo Suparjo	Trading
PSD25	420717.8	9139724.7	Sumbersari	Papungan	Moyudan	Toko H Suharto	Trading
PSD26	420673.49	9139654.1	Sumbersari	Tumut	Moyudan	Industri Saiful	Industry
PSD27	420632.28	9139598.3	Sumbersari	Tumut	Moyudan	Genteng H Kafni	Industry
PSD28	420842.9	9139688.7	Sumbersari	Tumut	Moyudan	Industri Kuntari	Industry
PSD29	420991.72	9139661.1	Sumbersari	Tumut	Moyudan	Bengkel Widodo	Service
PSD30	421117.64	9139621.4	Sumbersari	Tumut	Moyudan	TB Suwarno	Trading
PSD31	421135.65	9139613.7	Sumbersari	Tumut	Moyudan	TB Yudo Isworo	Trading
PSD32	421028.25	9139628.9	Sumbersari	Tumut	Moyudan	Bengkel Bambang	Service
PSD33	419809.64	9138918.8	Sumbersari	Tiwir	Moyudan	Toko Kelontong & Laundry	Trading
PSD34	419819.24	9138916.6	Sumbersari	Tiwir	Moyudan	Bengkel Sepeda Motor	Service
PSD35	420218.72	9138847.6	Sumbersari	Menulis	Moyudan	Toko Purwojo, Salon & Pakan Ternak	Trading
PSD36	420230.56	9138880.6	Sumbersari	Menulis	Moyudan	Toko Erna	Trading
PSD37	420234.96	9138891	Sumbersari	Menulis	Moyudan	Toko Sapari	Trading
PSD38	420238.8	9138906.4	Sumbersari	Menulis	Moyudan	Toko Mujiyo, Bakso, & Pakan Burung	Trading

ID. Potency	Latitude X	LongitudeY	Village	Hamlet	sub-district	Name	type of allocation
PSD39	420262.94	9138969.7	Sumbersari	Menulis	Moyudan	Toko Roti Aneka & Counter Hp	Trading
PSD40	420266.24	9138977.9	Sumbersari	Menulis	Moyudan	Toko Kelontong Harsilah	Trading
PSD41	420272.27	9138992.1	Sumbersari	Menulis	Moyudan	Warung Belut Aurel	Trading
PSD42	420275.29	9139005.8	Sumbersari	Menulis	Moyudan	Toko Bangunan H. Harno	Trading
PSD43	420318.75	9139101.9	Sumbersari	Menulis	Moyudan	Toko Roti Aneka 2	Trading
PSD44	420170.06	9138832.7	Sumbersari	Menulis	Moyudan	Toko Darsono	Trading
PSD45	420177.77	9138830.1	Sumbersari	Menulis	Moyudan	Toko Sarjiyo	Trading
PSD46	420614.1	9139541.6	Sumbersari	Tumut	Moyudan	Toko Kayu	Trading
PSD47	420666.02	9139579	Sumbersari	Tumut	Moyudan	Toko Kayu	Trading
PSD48	419233.51	9140887.2	Sumbersari	Tegalrejo	Moyudan	Pangkalan Gas LPG	Trading
PSD49	419370.36	9140122.3	Sumbersari		Moyudan	P. Padi Arjuno	Service
PSD50	419538.62	9140163	Sumbersari	Semingin	Moyudan	P. Padi Jono	Service
PSD51	418939.13	9140707	Sumbersari	Klisat	Moyudan	Penggilingan Padi Nanang	Service
PSD52	420590.69	9139498	Sumbersari	Tumut	Moyudan	Bengkel Motor Widayat	Service
PSD53	419865.79	9139171.4	Sumbersari	Tiwir	Moyudan	Distributor Pupuk Nugroho	Trading
PSD54	419862.8	9139846.7	Sumbersari	Blendung	Moyudan	Penggilingan Padi Jono	Service
PSD55	418230.83	9138613.7	Sumbersari	Bendosari	Moyudan	Distributor Pupuk Pak Impun	Trading
PSD56	419324.45	9138719	Sumbersari	Gesikan	Moyudan	P. Padi Bu Tutik	Service
PSD57	420519.42	9139793.4	Sumbersari	Tumut	Moyudan	Pengepul Rosok Pak Kasman	Trading
PSD58	419153.17	9139903.9	Sumbersari	Sombangan	Moyudan	P. Padi Sunarsih	Service
PSD59	419143.47	9139350.9	Sumbersari	Ngalahar	Moyudan	P. Padi	Service
PSD60	419427.42	9139532.2	Sumbersari	Nglahar	Moyudan	P. Padi Dukoh	Service
PSD61	419134.22	9140384.7	Sumbersari	Klisat	Moyudan	Toko Sumilah	Trading
PSD62	419163.15	9140394.6	Sumbersari	Tegalrejo	Moyudan	Toko Ana	Trading
PSD63	419208.71	9140626.7	Sumbersari	klisat	Moyudan	Toko Zamahsari	Trading
PSD64	420501.08	9138832.8	Sumbersari	Menulis	Moyudan	Indomart	Trading
PSD65	418504.48	9138599.5	Sumbersari	Ngaglik	Moyudan	G. Hanggar Tani	Service
PSD66	420571.98	9139423.8	Sumbersari	Tumut	Moyudan	Bengkel Las	Service
PSD67	419458.84	9139663.3	Sumbersari	Dukuh	Moyudan	Tower	Service

3.2. DSS collaborative

The collaborative DSS referred to in this research is decision making involving groups, namely farmer groups, cooperatives, or cadets. While the other groups are groups that represent the government, namely the village government. Each group member votes (voting) for determining the priority of potential to be developed. The voting method used in this study is the Borda method.

Unlike other popular voting systems, in the Borda count it is possible for a candidate who is the first preference of an absolute majority of voters to not be elected; this is because the Borda count affords greater importance to a voter's lower preferences than most other systems, including other preferential methods such as instant-runoff voting and Condorcet methods.

The Borda count tends to favor candidates supported by a broad consensus among voters, rather than the candidate who is necessarily the favorite of a majority [9] for this reason, its supporters see the Borda count as a method that promotes unity and avoids the 'tyranny of the majority', and the resulting divisiveness and even violence that it can lead to.

Simulation of calculations in this study, using 5 proposals for village resource potential (PSD) chosen by the government to be developed, as illustrated in Table 2.

No. Rank	ID. Potency	Latitude X	LongitudeY	Village	Hamlet	sub-district	Name	type of allocation
1	PSD1	419360.5495	9140144.053	Sumbersari	Nasri	Moyudan	Industri H Zuhair	Industry
2	PSD2	419513.3619	9140108.944	Sumbersari	Tlukan III	Moyudan	Industri Rifki	Industry
3	PSD3	419716.2705	9140046.401	Sumbersari	Tlukan	Moyudan	PTO Subarjo	Trading
4	PSD4	419886.8759	9140010.273	Sumbersari	Nasri	Moyudan	Bengkel Sugiyanto	Service
5	PSD5	419901.4431	9140003.357	Sumbersari	Nasri	Moyudan	PTO Krempyeng	Trading

Table 2. Proposed development of PSD from the government

Furthermore, the DM consisting of community representatives and village government representatives, totaling 12 people (DM₁, ... DM₁₂) voted on the five candidates for the PSD proposal, as illustrated in Table 3. Recapitulation of the number of votes can be seen in Table 4.

No. Rank	DM ₁	DM ₂	DM ₃	DM ₄	DM ₅	DM ₆	DM ₇	DM ₈	DM ₉	DM ₁₀	DM ₁₁	DM ₁₂
1	PSD1	PSD1	PSD2	PSD3	PSD1	PSD1	PSD1	PSD1	PSD2	PSD2	PSD1	PSD1
2	PSD2	PSD2	PSD1	PSD2	PSD2	PSD4	PSD4	PSD2	PSD1	PSD1	PSD2	PSD2
3	PSD3	PSD4	PSD3	PSD1	PSD4	PSD3	PSD3	PSD3	PSD3	PSD3	PSD3	PSD3
4	PSD4	PSD3	PSD4	PSD4	PSD3	PSD2	PSD2	PSD4	PSD4	PSD4	PSD4	PSD4
5	PSD5	PSD5	PSD5	PSD5	PSD5	PSD5	PSD5	PSD5	PSD5	PSD5	PSD5	PSD5

Table 3. Voting Proposed PSD development

No. Rank	4	2	3	1	2
1	PSD1	PSD1	PSD2	PSD3	PSD1
2	PSD2	PSD2	PSD1	PSD2	PSD4
3	PSD3	PSD4	PSD3	PSD1	PSD3
4	PSD4	PSD3	PSD4	PSD4	PSD2
5	PSD5	PSD5	PSD5	PSD5	PSD5

Table 4. The summary of the number of votes cast

Calculation of the total number of votes collected from the voting process can be seen in Table 5.

No. Rank	PSD1	PSD2	PSD3	PSD4	PSD5
1	(4+2+2)x5=40	3 x 5 = 15	1 x 5 = 5	0	0
2	3 x 4 = 12	(4+2+1)x4=28	0	2 x 4 = 8	0
3	1 x 3 = 3	0	(4+3+2)x3=27	2 x 3 = 6	0
4	0	2 x 2 = 4	2 x 2 = 4	(4+3+1)x1=8	0
5	0	0	0	0	(4+2+3+1+2)x1=6
Total	55	47	36	22	6

Table 5. Illustration of Borda's Count

Based on the results of the final calculation, the ranking sequence is as follows:

- Rank 1: PSD1 with 55 votes
- Rank 2: PSD2 with 47 votes
- Rank 3: PSD3 with 36 votes
- Rank 4: PSD4 with 22 votes
- Rank 5: PSD5 with 6 votes

4. Conclusion

The conclusions of this study are as follows:

- The application developed can facilitate the community to participate in proposing and managing data on village resource potential
- This study succeeded in mapping 67 PSD points, with the attribute coordinates of location, potential name, hamlet, village, sub-district and type of allocation.
- The community and village government can collaborate in making decisions on the priority ranking of the PSD to be developed.

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