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Analysis of the Disaster Management Network Across All Stages of a Disaster and the Development of Standard Operating Procedures in Nanggewer Village, Cibinong District, West Java

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Abstract

Throughout history, disaster often struck Indonesia and causes heavy losses which makes Indonesia develop disaster management system that consist of preparation, emergency response, and reparation. However, the process didn't always go smoothly. In Nanggewer, there are still citizens who don't get social aid because these citizens don't register their name to government's office. Previous researcher only mentions local office and citizens of Nanggewer. Disaster management requires a lot of actors to participate and help the process. In other previous research, authors use social network analysis to map the coordination between actors that are involved in disaster management. This research analyses the coordination of people and institutions that exist in disaster management system with the help of social network analysis in village of Nanggewer. The results show that Nanggewer Village Government interacts with the highest other agencies during disaster mitigation and the distribution of social assistance. During disaster response, the agency with the most interactions is the Regional Disaster Management Agency (BPBD). There are three standard operating procedures (SOPs) for disaster management in Nanggewer Subdistrict, and changes were made to the Social Network Analysis (SNA) following the development of these SOPs.

Keywords
Disaster, disaster management, social network analysis, coordination, standard operating procedures

1. Introduction
The Nanggewer Village in Cibinong, West Java, is frequently hit by disasters. From 2024 to 2026, six disasters have struck this village. These disasters have caused losses for Nanggewer Village, therefore, stakeholders have established a disaster management system to mitigate the impact of disasters, comprising pre-disaster measures, disaster response, infrastructure repairs, and the construction of public facilities (PMI 2007, as cited in Asadel et al. 2021) (Pramono and Suranto 2021). In addition to disaster management measures, the government also provides social assistance to residents still affected by the disaster, even after the disaster has passed (Nurahman et al. 2025). The disaster management process does not always run smoothly. There are still residents who do not coordinate effectively within the disaster management framework (Wahyudi et al.,2024). Another instance occurred when applying for social assistance in Nanggewer Village. In a previous study, it was noted that some residents of Nanggewer Village still did not know whom to coordinate with to register for social assistance, and forms of disaster management coordination were also not yet evident (Fuaddah and Fridayne 2023). Forms of coordination can be described qualitatively and quantitatively using SNA (Social Network Analysis). In SNA analysis, there are indicators such as density, cohesion, and centrality. The magnitude of these indicators signifies how well coordination occurs among actors in disaster management (Yadav et al. 2023). The journal article by Fuaddah & Fridayne (2023) has not yet conducted a

quantitative analysis of coordination mechanisms, and the journal article by Aung & Lim (2021) has not yet analyzed SNA for each phase of disaster management; furthermore, there are still journal articles that have not performed quantitative SNA measurements. In addition to coordination mechanisms, the parties involved in disaster management also require a standard operating procedure (SOP) as a guide for those involved in disaster management to address unforeseen issues caused by disasters (Steen-Tveit et al. 2024). Without SOPs, work processes will not run smoothly. SOPs must be documented in easily understandable language and meet standard quality criteria (Sailendra 2020). The process of implementing and developing SOPs does not always proceed smoothly. The Journal SOP (Sianturi et al. 2021) does not yet meet standard quality criteria. In Nanggewer Village itself, SOPs for all stages of disaster management have not been documented; there are no written guidelines or diagrams available for those involved in disaster management to view and read (Maemunah 2026). Therefore, it is important to understand the quantitative measures of the SNA and to understand the workflow of the disaster management SOP in Nanggewer Village.

1.1 Objectives
To improve coordination among stakeholders and clarify their respective roles in disaster management and social assistance by mapping and analyzing the coordination network among stakeholders in Nanggewer Village, providing a structural network analysis (SNA) of the existing coordination mechanisms, and design a comprehensive, written standard operating procedure (SOP) to serve as a standard reference for disaster management coordination at all stages for other stakeholders.

2. Literature Review
2.1 Disaster
Disaster is casualties caused by extreme natural phenomena such as earthquakes, landslides, floods, or human actions. The impacts of disasters are devastating, as they can result in loss of life, damage to infrastructure and homes, loss of property, and psychological distress among affected communities. Through these impacts and the resulting damage, disasters lead to the disruption of community functions, the disruption of community life, and the disruption of the community's very existence (Asadel et al. 2022).

2.2 Social Network Analysis
Social network analysis (SNA) is an analysis conducted to assess coordination among organizations or agencies. The mathematical approaches used in SNA are employed to analyze the strength of relationships among actors within a network. SNA can determine the success or failure of coordination based on the characteristics of the existing network. These characteristics are measured using several indicators, such as density, cohesion, in-degree centrality, out-degree centrality, and betweenness centrality (Yadav et al. 2023).

2.3 Standard Operating Procedures
SOP (Standard Operating Procedures) is the primary guidelines for carrying out work processes that must be followed by all parties involved in those processes. The content of an SOP consists of the steps of a work process documented in writing using simple language so that those involved in a process can easily follow the guidelines. Proper implementation of these guidelines results in good outcomes, work processes, and service quality (Sailendra, 2020). In disaster management, SOPs are used as a guide for disaster management when a disaster strikes so that the risks resulting from the disaster can be minimized (Putro et al., 2024). SOPs can be illustrated with flowcharts containing procedural instructions that must be followed by the parties involved in a process (Sailendra, 2020).

3. Methods
The method began with a literature review to identify issues in the field, followed by conducting interviews, gathering information on disasters in Nanggewer, and reviewing reports to examine the form of coordination among the actors involved in disaster management. The form of coordinations are mapped with software called SocNetV after that, the SNA indicators are calculated Following that, standard operating procedures (SOPs) were developed for the Nanggewer village, and the SNA analysis was conducted again (Figure 1- Figure 15).

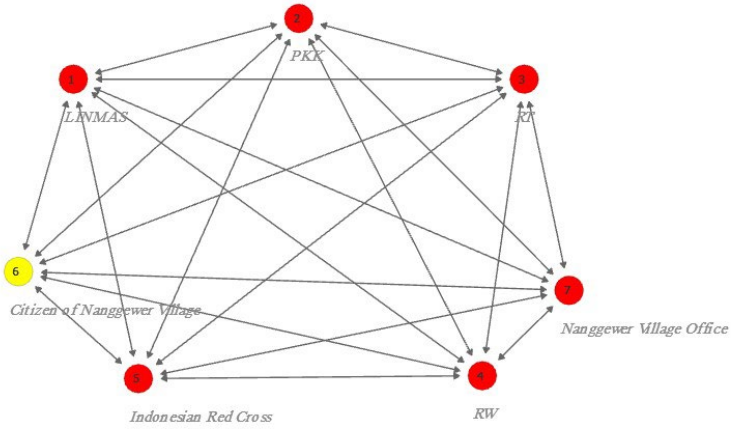

Figure 1. Visual coordination of SIBAT's mitigation process in nanggewer village

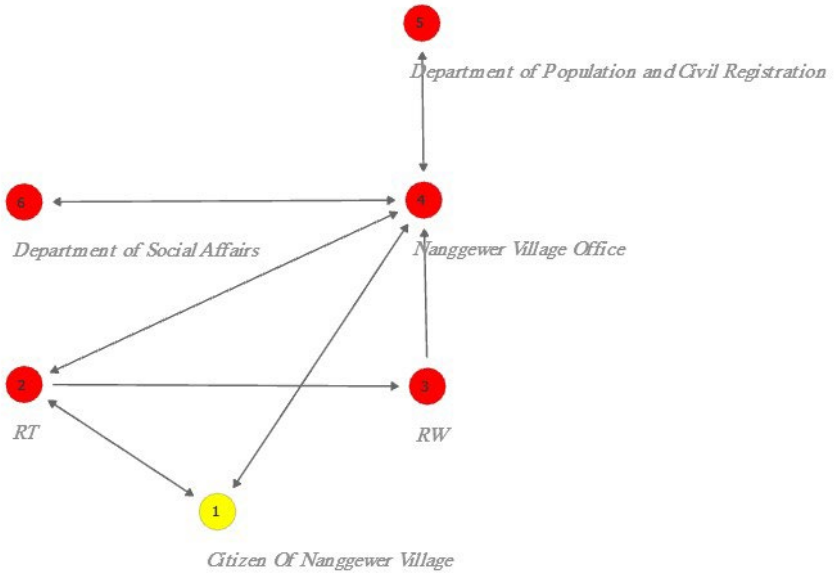

Figure 2. Visual coordination of social assistance process in nanggewer village

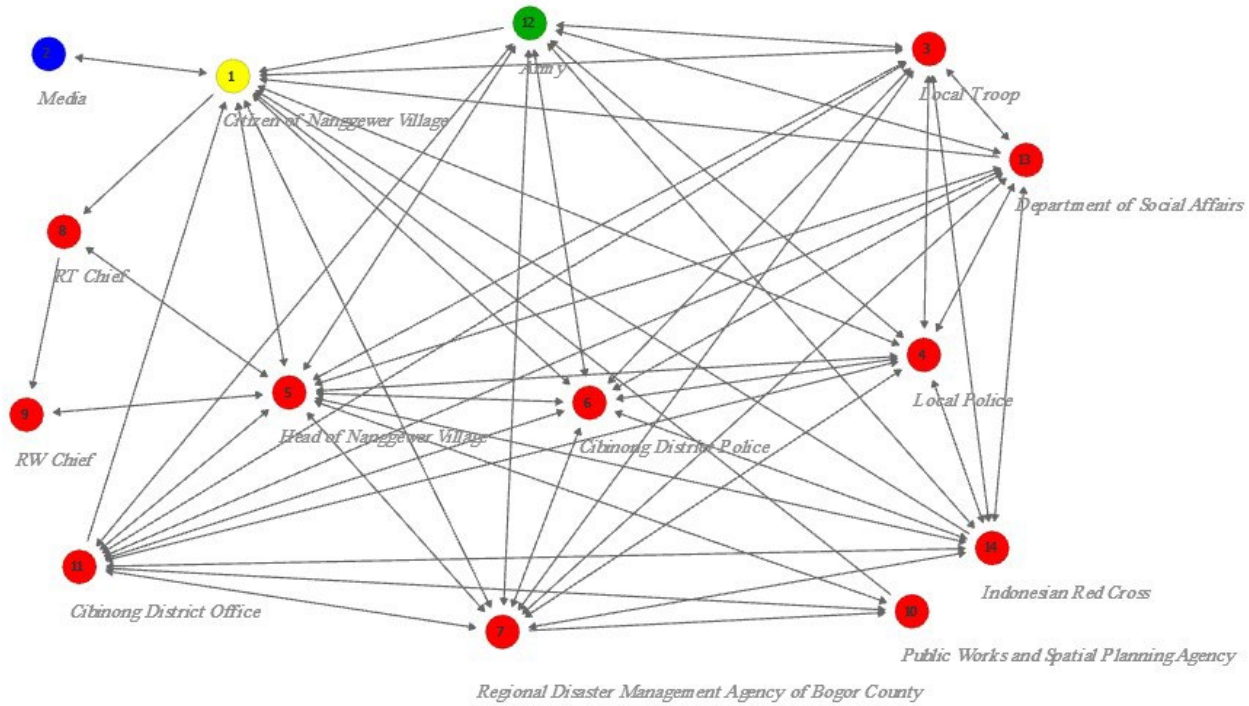

Figure 3. Visual coordination of disaster response in nanggewer village

4. Results and Discussion

4.1 Numerical Results

The first analysis is indicator analysis on SIBAT's mitigation coordination. The first thing to count is density. There are 42 networks, which is "M" and "n" is the number of actors that participated in mitigation coordination, so the density is:

$$\frac{M}{n(n-1)} = \frac{42}{7(7-1)} = 1$$

The next indicator is cohesion. The sum of shortest path from actor "i" to "j" is 42, while total actor is 7, which makes the cohesion is:

$$\frac{\sum bij}{n(n-1)} = \frac{42}{7(7-1)} = 1$$

Next indicator is in-degree centrality. Citizen of Nanggewer Village receive 7 coordination or contacts from 7 different parties, and there are 7 parties that participated in that coordination, so the in-degree centrality is:

$$\frac{\sum Xji}{n(n-1)} = \frac{6}{7(7-1)} = 0{,}143$$

The next thing is out-degree centrality. Citizen of Nanggewer gave contacts to 6 different, and total party is 7, which makes out degree centrality is:

$$\frac{\sum Xij}{n(n-1)} = \frac{6}{7(7-1)} = 0{,}143$$

The last thing is closeness centrality. The sum of shortest path from 1 party to another is 6, there are 7 institutes, so the closeness centrality is:

$$\frac{(N-1)}{\sum_{u=1}^{N} S(v,u)} = \frac{(7-1)}{6} = 1$$

Table 1. In and out degree centrality from Disaster Mitigation in Nanggewer Village

No.	Disaster Management Actors	In-degree centrality	Out-degree centrality
1	LINMAS	0.143	0.143
2	PKK	0.143	0.143
3	RT	0.143	0.143
4	RW	0.143	0.143
5	Indonesian Red Cross	0.143	0.143
6	Citizen of Nanggewer Village	0.143	0.143
7	Nanggewer Village Office	0.143	0.143

Table 2. Closeness Centrality from Disaster Mitigation in Nanggewer Village

No.	Disaster Management Actors	Closeness centrality
1	LINMAS	1
2	PKK	1
3	RT	1
4	RW	1
5	Indonesian Red Cross	1
6	Citizen of Nanggewer Village	1
7	Nanggewer Village Office	1

The first pre-disaster management activity carried out was disaster mitigation organized by the Indonesian Red Cross (PMI) for the Nanggewer Subdistrict. All institutions, such as LINMAS, PKK, RT, RW, PMI, the community, and Nanggewer Village Office, have the same in-degree centrality and out-degree centrality values of 0.143 and also have the same closeness centrality of 1 as well. The similarity in the values of in-degree centrality and out-degree centrality means that each actor receives coordination and provides coordination in equal measures. Similarly, regarding closeness centrality, all disaster management agencies have the same degree of closeness as other agencies. (Cai et al. 2023) (Zaefarian et al., 2022)

Table 3. In and Out Degree Centrality from the Social Assistance Distribution Process in Nanggewer Village

No.	Disaster Management Actors	In-degree	Out-degree
1	Citizen of Nanggewer Village	0.067	0.067
2	RT	0.067	0.100
3	RW	0.033	0.033
4	Nanggewer Village Office	0.167	0.133
5	Department of Population and Civil Registration	0.033	0.033
6	Department of Social Affairs	0.033	0.033

Table 4. Closeness centrality from the Social Assistance Distribution Process in Nanggewer Village

No.	Disaster Management Actors	Closeness centrality
1	Citizen of Nanggewer Village	0.625
2	RT	0.714
3	RW	0.556
4	Nanggewer Village Office	0.833
5	Department of Population and Civil Registration	0.500
6	Department of Social Affairs	0.500

The table (Table 1- Table 6). shows that the highest in-degree and out-degree centrality values are found in The Nanggewer Village Office, with values of 0.167 and 0.133, because it receives and provides coordination and acts as a liaison between residents, RTs, RWs, and district government agencies such as the Social Affairs Office and the Population and Civil Registration Office. From the form of coordination, it is evident that in the provision of social assistance, the sub-district government also plays a leading role because it connects RTs and residents with the Social

Affairs Office and the Population and Civil Registration Office. This indicates the highest closeness centrality for the sub-district, and the shortest distance to other agencies (Saragih et al., 2024).

Table 5. In and Out degree centrality of Disaster Response in Nanggewer Village

No	Disaster Management Actors	*In-degree*	*Out-degree*
1	Citizen of Nanggewer Village	0.060	0.038
2	Media	0.005	0.005
3	Local troop	0.049	0.049
4	Local police	0.049	0.049
5	Head of Nanggewer Village	0.066	0.066
6	Cibinong District Police	0.049	0.049
7	Regional Disaster Management Agency of Bogor County	0.049	0.055
8	Ketua RT	0.011	0.011
9	Ketua RW	0.011	0.005
10	Public Works and Spatial Planning Agency	0.016	0.011
11	Cibinong District Office	0.044	0.055
12	Army	0.044	0.049
13	Department of Social Affairs	0.044	0.049
14	Indonesian Red Cross	0.044	0.049

Table 6. Closeness centrality of Disaster Response in Nanggewer Village

No	Aktor Manajemen Bencana	Closeness centrality
1	Citizen of Nanggewer Village	0.684
2	Media	0.419
3	Local troop	0.765
4	Local police	0.765
5	Head of Nanggewer Village	0.929
6	Cibinong District Police	0.765
7	Regional Disaster Management Agency of Bogor County	0.813
8	Ketua RT	0.520
9	Ketua RW	0.500
10	Public Works and Spatial Planning Agency	0.542
11	Cibinong District Office	0.813
12	Army	0.765
13	Department of Social Affairs	0.765
14	Indonesian Red Cross	0.765

Disaster management at this stage involves more parties contributing to these activities. This figure shows that there are two parties with high in-degree centrality: the village head and the residents. The village head has the highest in-degree centrality value of 0.066, and their out-degree centrality is equally high. This is because the village head receives the most coordination, ranging from receiving information from residents, RTs, and RWs, to receiving information from disaster management agencies such as BPBD (Regional Disaster Management Agency of Bogor County) and PMI (Indonesian Red Cross). Residents also have a high in-degree centrality value of 0.06 because they receive assistance from various parties; however, the village head's value is still higher because the village head also receives coordination from the RW. Meanwhile, residents do not receive coordination from the RW, while the residents' out-degree centrality is not particularly high because residents receive more assistance than they provide coordination to other parties. An example of coordination can be seen in the army of Nanggewer Village office, which helps residents, but the army does not receive information from citizen regarding disasters. The army receives disaster information from the village head. The village head's score reached.

0.929, meaning the village head is very closely connected to other agencies and linked to many stakeholders, while residents' closeness centrality scored 0.684, indicating that residents' connections to other parties are not as close as the village head's connections to other parties. Furthermore, there are parties who went into the field alongside the village head to assist affected residents, including the BPBD, army, Cibinong District Office, local army, local police

officers, the Social Affairs Office, the Indonesian Red Cross (PMI), and the Cibinong District Police The in-degree centrality of this group is 0.044 and 0.049 for the BPBD and the Cibinong District Police, respectively. They coordinate with one another but do not coordinate with the RT and RW. The in-degree centrality values of BPBD and the Cibinong District Police are higher because residents provide disaster-related information to the BPBD and the Cibinong District Police. The group with an in-degree centrality value of 0.044 only sends assistance to residents. The next institutions are the RT and RW, both of which have an in-degree centrality value of 0.011 because they both receive coordination from two parties. The RT receives coordination from residents and the village head, while the RW receives coordination from the RT and the village head; however, the RW's out-degree centrality is lower than the RT's because the RW only provides information to the village head, whereas the RT provides information to both the RW and the village head. The final party is the media, which has the lowest in-degree and out-degree centrality values, at just 0.005. This is because the media only coordinates with citizens. The media asks questions and receives answers from citizens. The closeness centrality value is also low, at 0.419 far from 1, which indicates that the media is distant from other parties. In disaster response, the BPBD leads the process; it directs other parties to assess the disaster site, evacuating affected citizens, and issue warnings for residents to exercise caution in conditions that remain hazardous (Bakti & Fadlurrahman, 2020). However, local governments such as Village of Nanggewer office remain the most connected to a wider range of stakeholders compared to the BPBD. This includes receiving reports from residents, as well as assembling disaster response teams such as village military officers, police stations, and social services to assist and provide social assistance to citizens (Flecha et al., 2023). From the tables, it shows that Village of Nanggewer Office or Head of Village of Nanggewer has the highest score in all centralities which means, Village of Nanggewer Office or Head of Village of Nanggewer connected to the most of parties. But village of Nanggewer Office doesn't have a disaster management standard process. So the next step is designing SOP for Village of Nanggewer Office.

4.2 Proposed Improvements

4.2.1 SOP of Disaster Mitigation in Nanggewer Village

The SOP of Disaster Mitigation in Nanggewer Village are presented below.

PEMERINTAH KABUPATEN BOGOR KECAMATAN CIBINONG **KELURAHAN NANGGEWER** Jl. Roda Pembangunan No 57 Nanggewer, Cibinong – 16912 L aman kel-nanggewer.bogorkab.go.id , Pos-el Kel.nanggewer@bogorkab.go.id		Date of SOP Making	March 26th 2026
		Date of Revision	April 13 th 2026
		Date of Approval	April 14th 2026
		Approved by	The village secretary, as behalf of the village head
Nanggewer Village			
Cibinong District			
Bogor County, West Java Kabupaten Bogor, Jawa Barat		SOP Titile Judul SOP	Disaster Mitigation of Disaster Management in Nanggewer

Statutory Basis		Equipments
1. Law No. 24, 2007 about disaster management		1. Disaster management document
		2. Laptop, Mobile phone, scanner, book, stationery
Implementer Qualification		3. WI-FI

1. Understand disaster mitigation procedures	4. Disaster Risk document
Warning	
If the SOP is not followed, disaster mitigation efforts will not not be implemented and village will not have disaster threat Data.	Data Collection
	1. SIBAT Team discussion result

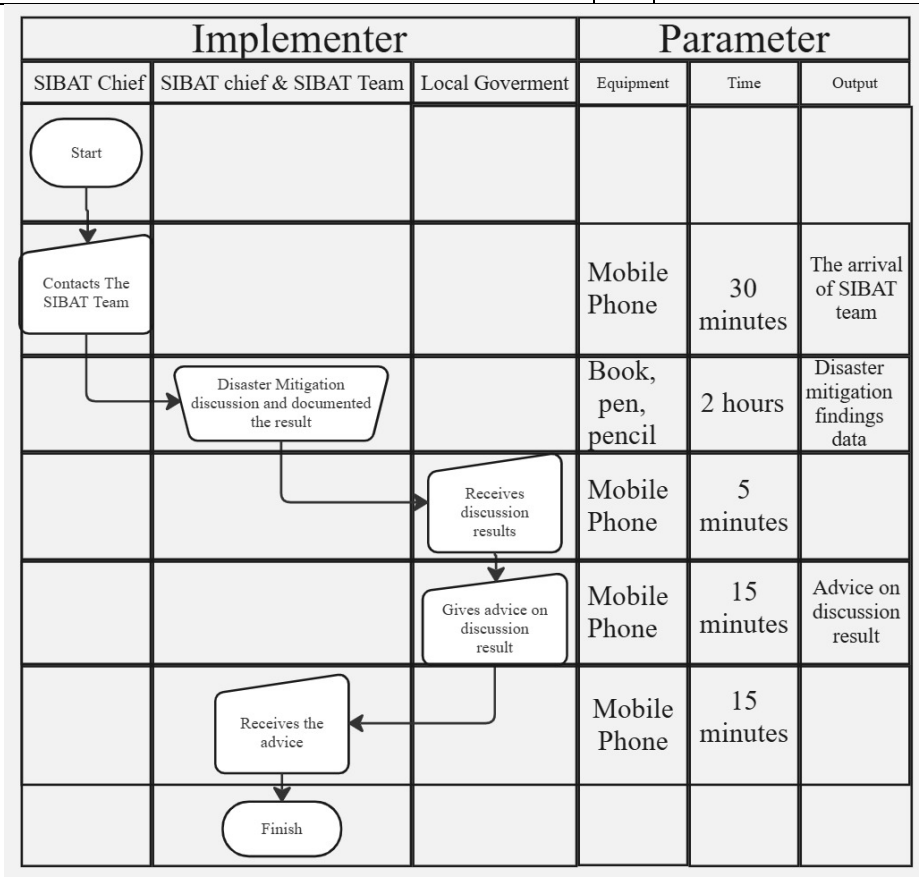

Figure 4. Disaster Mitigation in Nanggewer Village

4.2.2 SOP of Social Assistance Distribution in Nanggewer

The SOP of Social Assistance Distribution in Nanggewer are presented below.

PEMERINTAH KABUPATEN BOGOR KECAMATAN CIBINONG **KELURAHAN NANGGEWER** Jl. Roda Pembangunan No 57 Nanggewer, Cibinong – 16912 aman kel-nanggewer.bogorkab.go.id , Pos-el Kel.nanggewer@bogorkab.go.id		SOP Making Date	March 26th 2026
		Revision Date	April 13 th 2026
		Approval Date	April 14th 2026
		Approved by	The village secretary, as behalf of the village head
Nanggewer Village			
Cibinong District			
Bogor County, West Java		SOP title	Distribution of Social Assitance in Nanggewer

Statutory Basis		Equipments
1. Law No. 13 year of 2011 about assistance for the poor		
		1. Laptop, mobile phone, scanner, books, stationery 2. WI-FI
Implementer Qualification		
1. Understand the process of citizen registration 2. Understand social assistance distribution process		
Warning		
If the SOP is not implemented, citizen will not get any help		
		Data Collection
		1. Citizen's Identity Data
		2. Data of Citizen who proposed for help

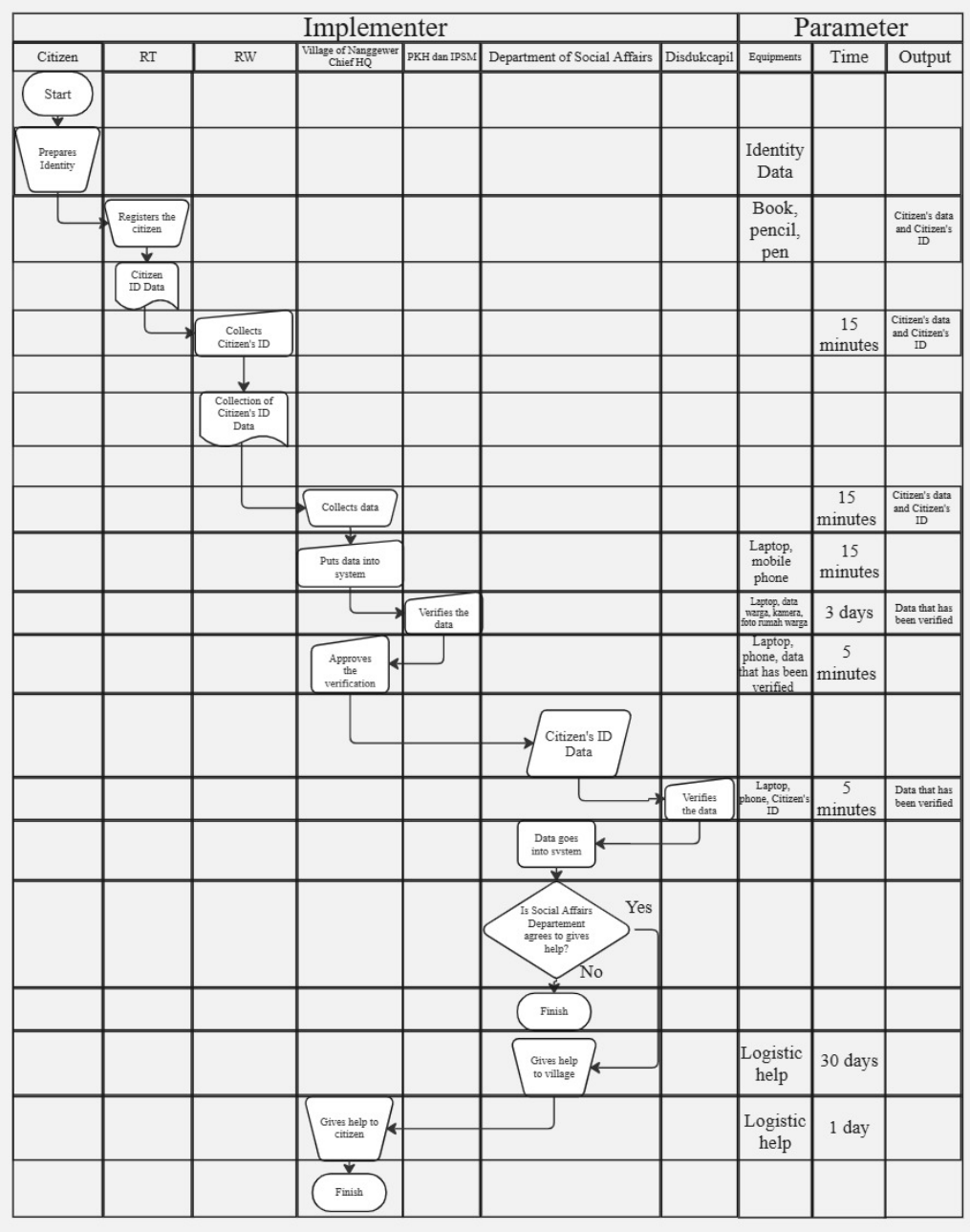

Figure 5. SOP of Social Assistance Distribution in Nanggewer

4.2.3 SOP of Disaster Response and Infrastructure Repairs

The SOP of Disaster Response and Infrastructure Repairs are presented below.

PEMERINTAH KABUPATEN BOGOR KECAMATAN CIBINONG **KELURAHAN NANGGEWER**		SOP Making Date	March 26th 2026
		Revision Date	April 13 th 2026
		Approval Date	April 14th 2026

Jl. Roda Pembangunan No 57 Nanggewer, Cibinong – 16912 aman kel-nanggewer.bogorkab.go.id , Pos-el Kel.nanggewer@bogorkab.go.id		Approved by	The village secretary, as behalf of the village head
Nanggewer Village			
Cibinong District			
Bogor County, West Java		SOP Ttitle	Disaster Response and Infrastructure Repairs

Statutory Basis		Equipments
1. Law No. 24 year of 2007 about disaster management		1. Disaster management document 2. Disaster risk document 3. Mobile phone and stationery 4. WI-FI
Implementer Qualification		
1. Understand disaster response process 2. Understand the process after disaster strikes		
Warning		
If The SOP not implemented, the citizen will not get any help and the infrastructure will not be fixed		
		Data collection
		1. Citizen's affected 2. Area affected 3. Citizen's condition that got affected

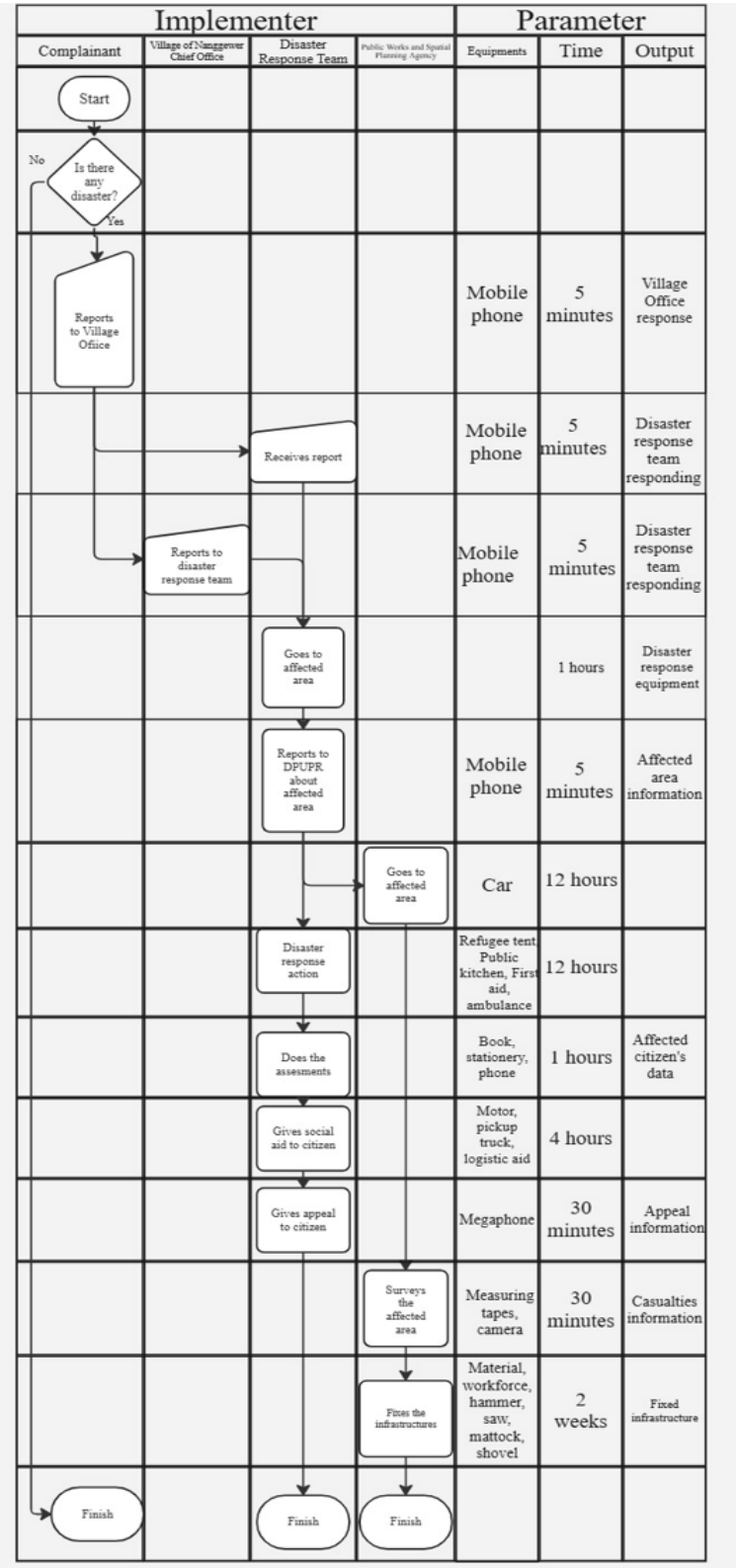

Figure 6. SOP of Disaster Response and Infrastructure Repairs

The designed SOPs include workflow diagrams and specify the personnel responsible for carrying out disaster

management and quality control activities. The SOPs consist of disaster mitigation SOPs, which outline the SIBAT team's discussion process—from the initial discussion through the preparation of documents regarding disaster vulnerability and risk mapping—until these are submitted to local government. The SOP for social assistance distribution outlines the activities to be carried out from data registration until residents receive the assistance, while the SOP for disaster response and public infrastructure repair details the workflow from resident reporting until residents receive aid and the public infrastructure repairs are completed. The disaster mitigation SOP differs from the disaster mitigation SOP of Nae Village. The form of mitigation in Nanggewer Village involves community discussions to map disaster risks, while the form of mitigation in Nae Village outlines actions to be taken when a disaster begins to occur. However, the Nae Village disaster mitigation SOP does not specify the implementers or quality standards within its SOP (Nae Village). Meanwhile, regarding the SOP for social assistance distribution, the journal (*Wahidah et al*., 2022) provides more detailed information; the form of social assistance consists of a cash balance on a card funded by the government. However, the SOP in this journal does not yet specify quality standards. The final SOP is the disaster response and public infrastructure repair SOP. The disaster response SOP from Nae Village is indeed more detailed regarding the disaster response process. However, the activities are intended solely for residents. The Nae Village has not included the activities of other parties involved in disaster management, and the Nae Village's disaster response SOP also does not specify quality standards (Nae Village).

4.3 Graphical Results

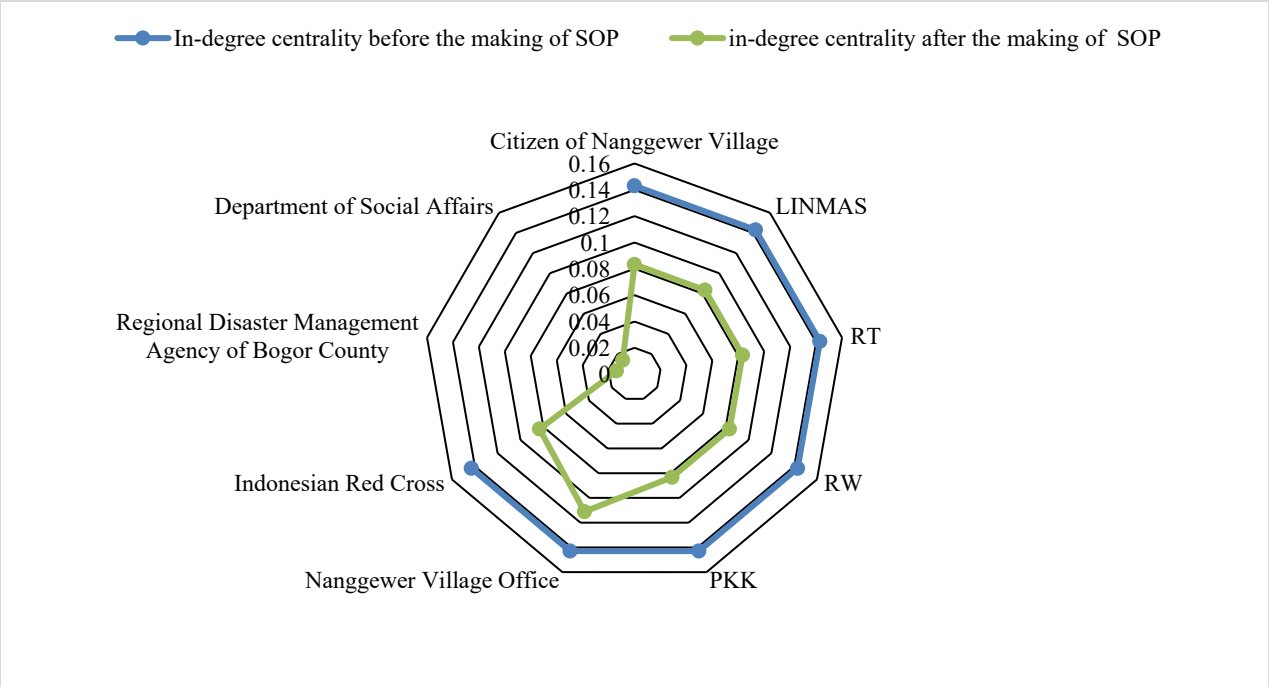

Figure 7. Radar chart comparison in in-degree centrality of SIBAT's disaster mitigation before and after the making of SOP

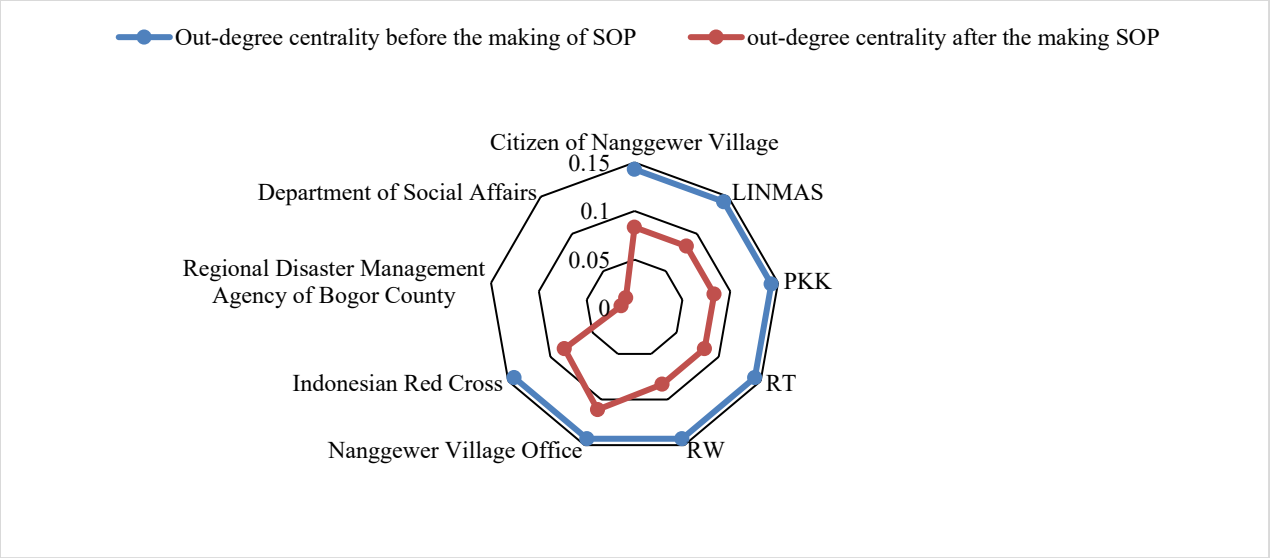

Figure 8. Radar chart comparison in out-degree centrality of SIBAT's disaster mitigation before and after the making of SOP

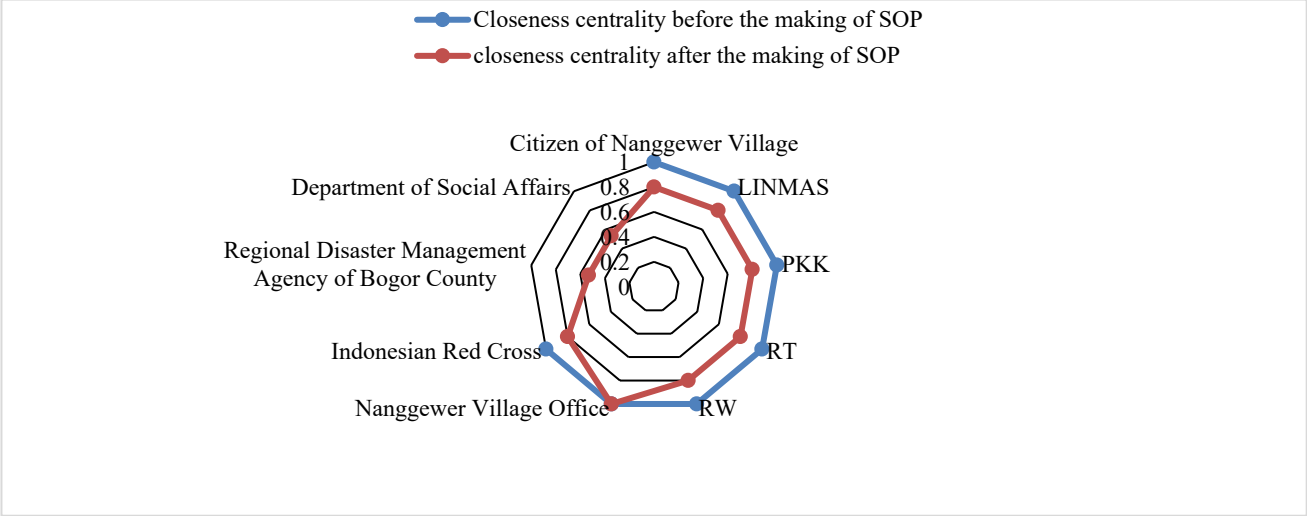

Figure 9. Radar chart comparison in closeness centrality of SIBAT's disaster mitigation before and after the making of SOP

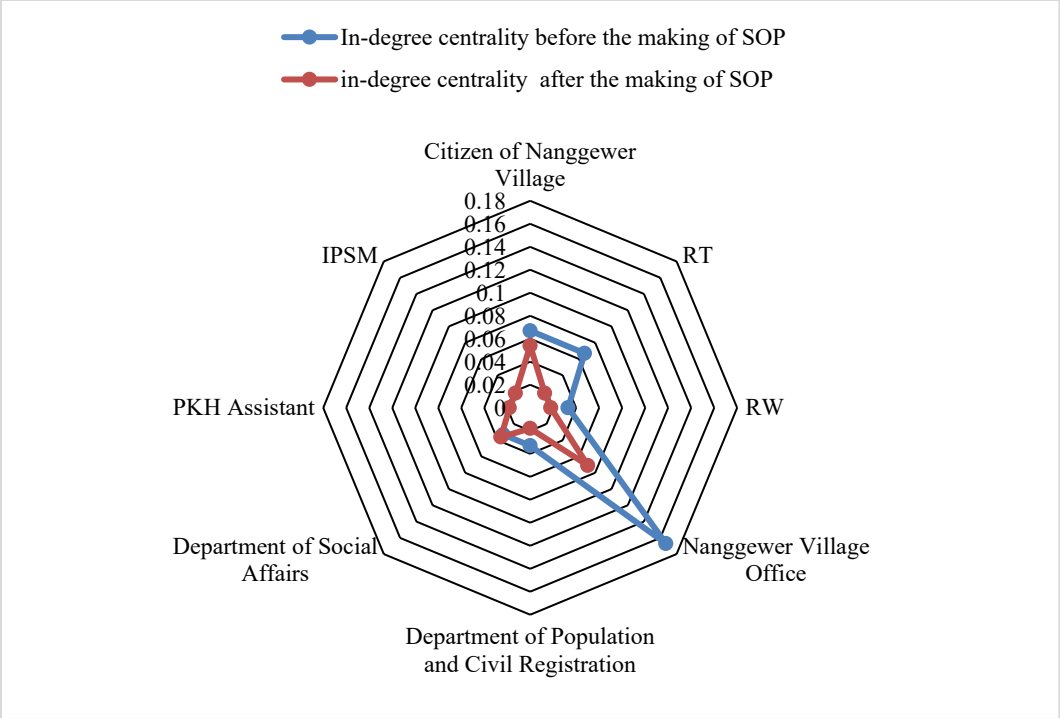

Figure 10. Radar chart comparison of in-degree centrality in process of social assistance before and after making the SOP

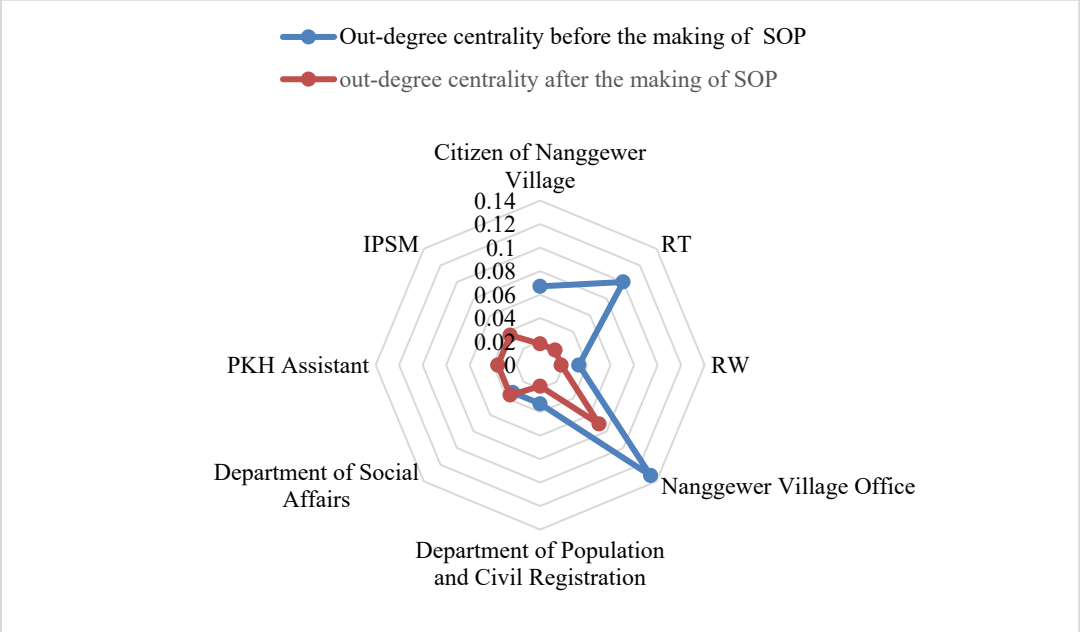

Figure 11. Radar chart comparison of out-degree centrality in process of social assistance before and after making the SOP

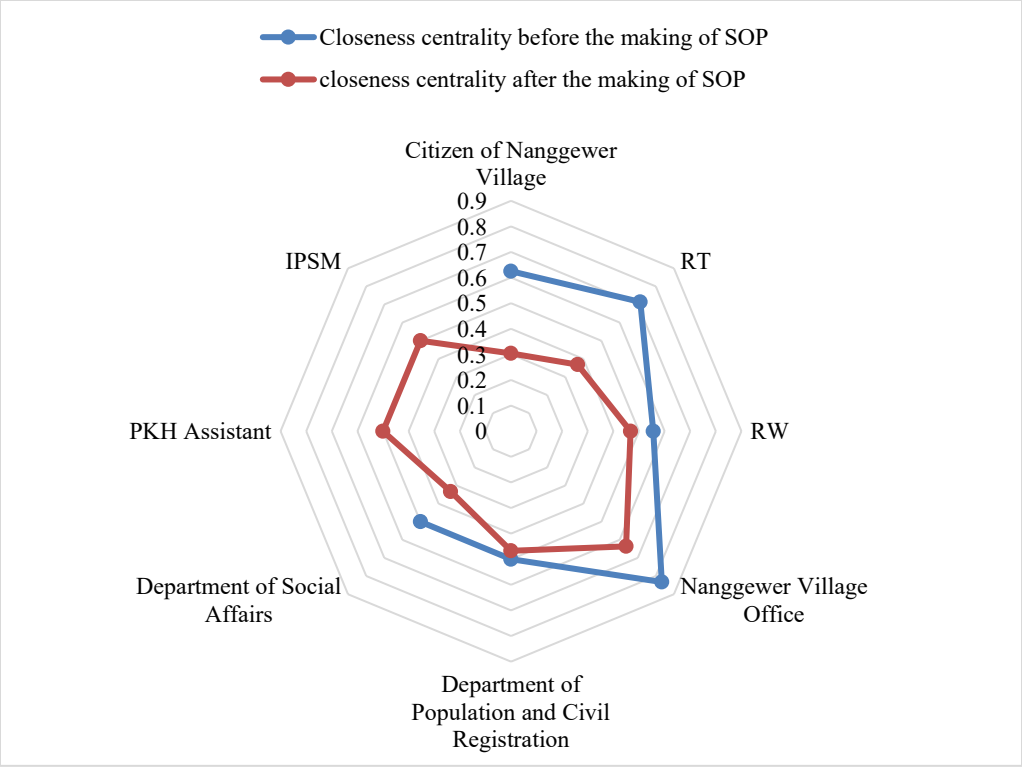

Figure 12. Radar chart comparison of closeness centrality in process of social assistance before and after making the SOP

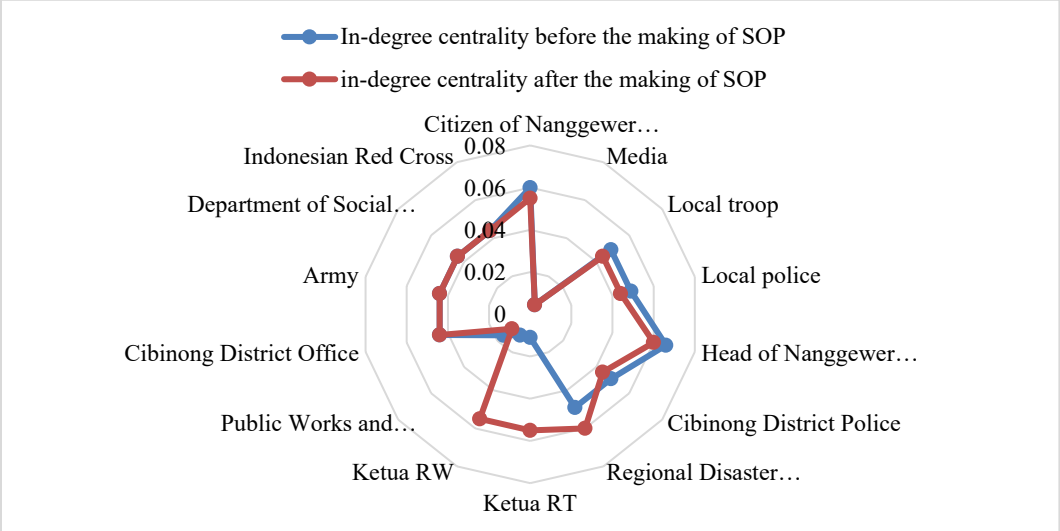

Figure 13. Radar chart comparison of in-degree centrality in disaster response before and after the making of SOP

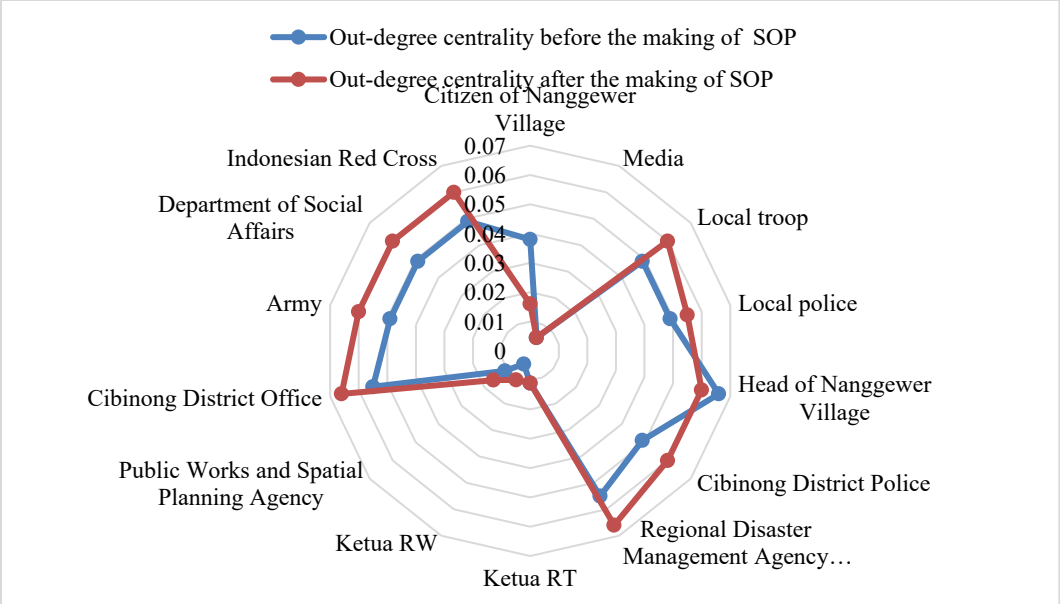

Figure 14. Radar chart comparison of out-degree centrality in disaster response before and after the making of SOP

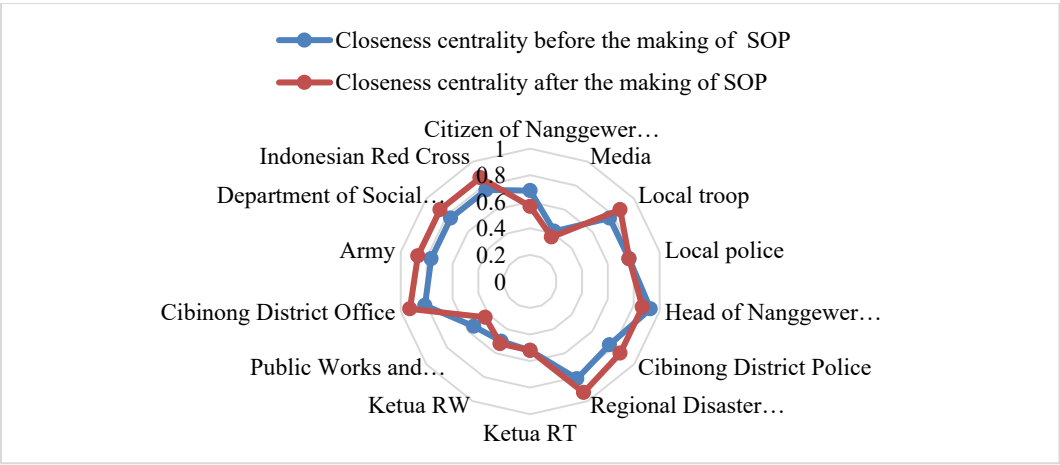

Figure 15. Radar chart comparison of closeness centrality in disaster response before and after the making of SOP

Following the establishment of the standards, it is evident that the highest SNA indicator score in the disaster response and public infrastructure repair processes is held by the BPBD. The BPBD is connected to numerous parties, ranging from residents to other government agencies such as the Social Affairs Office, the Nanggewer Subdistrict Office, and the Indonesian Red Cross (PMI). The BPBD also receives coordination from residents and disaster response teams. The BPBD coordinates with disaster response teams, the Public Works and Spatial Planning Agency (DPUPR), and residents. Meanwhile, for disaster mitigation and social assistance in the sub-district, the highest indicator score is held by Nanggewer village, which is connected to many parties ranging from residents to the Social Affairs Office. When the standards were established, the SNA changed. The indicator score decreased because there were new disaster management actors involved in the process (Yadav et al. 2023).

5. Conclusion

The SNA quantitative analysis radar chart illustrates differences in disaster coordination approaches following the development of the SOP. This radar chart also demonstrates the dynamics of disaster coordination in Nanggewer Village, which can serve as a model for other villages, as the SOP outlines the steps to be taken during disaster mitigation, social assistance registration, and during actual disasters. The SOP includes designated personnel, flowcharts, and quality standards.

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