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E-B Environment - Behaviour Proceedings Journal

AicE-Bs2023Marrakech

https://www.amerabra.org

e-IPH e-International Publishing House Ltd., United Kingdom

11th ABRA International Conference on Environment-Behaviour Studies
Semiramis Hotel, Marrakech, Morocco, 01-07 Mar 2023

Analyzing Post-Disaster Reconstruction Stakeholder Networks: Malaysian rural housing

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Abstract
This article uses the social network analysis to identify resource coordination and information exchange of stakeholders in the inter-organizational network by studying the project-related interactions of rural housing reconstruction in Temerloh, Pahang that were funded by the Malaysian government, His Majesty the King and NGO. The data was collected through content analysis and interviews with 23 government agencies, NGOs, and community stakeholders. Findings from the analysis established that government agencies had the highest actor centralities, with the Rural Development Ministry and the local government level being the most central among the government agencies, whereas the homeowners had the lowest centralities.

Keywords: post-disaster housing reconstruction, social network analysis, rural Malaysia

DOI: https://doi.org/10.21834/ebpj.v8i23.4511

1.0 Introduction

Post-disaster reconstruction projects are characterized by governance, financial, technical, and socio-physical complexity (Paidakaki et al., 2017). According to Tierney (2012), complexity arises from the need to shift from government to governance, which requires the need to manage interconnected networks and elements that vary across different levels of government, as well as between non-governmental and civil society organizations and private sector. Munday (2015) emphasizes the importance of using a "systems" approach to develop and understand organizational systems that support complex stakeholder management and engagement in disaster recovery. Most housing reconstruction projects in developing countries fail to help the local communities recover after a disaster because they fail to identify stakeholders' specific needs and characteristics. As a result, social network analysis (SNA) can be used to understand networks' social and organizational characteristics that can impact the likelihood of collaboration, information sharing, and successful housing reconstruction in disaster recovery.

1.1 Stakeholder theory

To better develop post-disaster reconstruction outcomes, it is important to identify how stakeholders influence each other's decisions. Freeman (1984) proposed the stakeholder approach and the stakeholder 'theory of the firm' to examine the direct relationship and

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influence of focal organization with other individual stakeholders on a firm's operation with only the focal organization at the centre of the stakeholder set. Rowley adopted an alternative approach to advance stakeholder theory by using network concepts such as density and centrality of local firms in a broader societal sector of the environment in understanding the simultaneous influences and resistance to its stakeholder demands (Rowley, 1997). This approach recognizes that a firm does not operate in isolation but is embedded in a broader network of relationships with other organizations such as suppliers, customers, regulators, and funding sources. Density refers to the number of ties or connections between organizations in a network, while centrality refers to the relative importance of a particular organization within a network. As the network of relationships between organizations becomes denser, it becomes easier for information to flow between them, and to facilitate the voluntary diffusion of shared behavioural norms, expectations, and values. Centrality refers to the degree to which an individual or organization is connected to other actors within the network.

1.2 Social network analysis

Social network analysis is a method for determining the degree of influence by measuring the centrality metrics of each stakeholder in a network, how they affect one another's actions, and the network's overall connectivity, cohesiveness, clustering and brokerage potential (Prell, 2012). Bavelas established the concept of centrality and provided quantitative data and visual representations to understand the changes in roles and relationships of different categories of stakeholders according to their position in the network (Wasserman and Faust, 1994). The centrality is essential in the study of various social networks since it defines the structural characteristics of a node in a network and the extent to which stakeholders influence the decision-making processes. In one study, the results of network centrality measures indicate that, and collaboration mechanisms for resilience planning are centralized, in which a few major or central stakeholders dominate decision-making processes and intra-sector collaboration is more likely to happen than intersectoral collaboration (Ren et al., 2023). Another network study showed the Philippines had a more complex fragmented collaborative network than Japan which led to the inefficiency of disaster management and reliance on the central government (Hu et al., 2022). The low density and sparseness of regional disaster management networks reflect weak disaster management structures and relationships and low levels of trust and interdependence, which can further weaken the overall effectiveness of disaster recovery (Lara et al., 2022). Other network studies highlighted the important characteristics of disaster management networks involving many sectors such as NGOs, private industries, and community residents, public agencies contribute more to housing and infrastructure resilience planning processes (Bisri et al., 2016).

Just as network centralization can affect collaboration in disaster reconstruction, the strength of tie and homophily can affect how disaster assistance organizations collaborate. By examining the stakeholder categories from which actors and their immediate neighbours come, and how strongly tied central stakeholders are to these others, we can better understand whether an actor is linking across similar or dissimilar others in terms of norms, interests, values, and demographics (Prell et al., 2016). Organizational homophily is the tendency for people to form relationships with others who are like them in terms of background, interests, and other characteristics (Sapat et al., 2019). In the context of disaster reconstruction, this could mean that stakeholders who are similar to one another are more likely to collaborate. This could be beneficial for building trust and cooperation, but it could also lead to the exclusion of diverse perspectives and a lack of innovation.

The research for social network analysis for post-disaster housing reconstruction in Malaysia is limited. To fill in the research gap, the social network analysis in this study evaluates the roles and structural position of each stakeholder and their level of influence within the housing reconstruction network in Malaysia. Specifically, we pose the following research questions:

1. Which stakeholders have more connectivity than others in post-disaster housing reconstruction according to their positions within the network?
2. What interventions are likely to enhance collaborations and community participation in housing reconstruction?

Through these questions, we sought to identify areas of collaboration that can be enhanced to engage stakeholders and facilitate efficiency in addressing housing-related needs in rural homeowners. The activities within the network were modelled using information exchange classified by reference to the reconstruction activities.

2.0 Methods

The study uses content analysis to search data from these news articles, social media posts, situation reports and other online contents of the 2021-2022 Malaysia flood in Pahang were conducted with the 23 government agencies, village heads and NGO representatives to gather network data related to one another on the reconstruction projects. The following questions were asked, "Who do you communicate with on post-disaster reconstruction of houses in the Temerloh area." Interviewees were also asked questions about the procurement and contractual relationships, the relationships with other organizations, and their role in the project (project management, resource allocation and technical design stage).

Data collected were analyzed using SNA to identify the key actors and their roles within the network and the patterns of communication and collaboration among them for three post-disaster housing reconstruction case studies. The evaluation metrics chosen are shown in (Table 1). The network is represented as a graph, a set of nodes (or vertices) and lines (or edges) connecting pairs of nodes. This representation allows researchers to study the pattern of connections and identify key actors or groups within the network. The nodes are the organizations. The reconstruction activities in the network diagrams link the structure among the stakeholder networks. The connection (edges) between one actor with another actor denoted by coloured lines (edges) was made using reconstruction activities, namely 1) resource allocation (blue), 2) project management (red) and 3) design safety of building (green).

Table 1. Social Network Analysis (SNA) Evaluation Metrics

SNA Metrics	Definition
Network Density	The density presents in the ratio of existing ties relative to the maximum number of potential ties in the network is used to measure the extent to which actors in a network are tied to one another.
Degree Centrality	The degree centrality defines as the number of edges that intersect with a specific node. It can measure the number of actors of a specific node directly connected to another stakeholder.
Betweenness Centrality	The betweenness centrality measures the total number of the third node that pass through a particular node to reach the target node with the shortest distance. Actors with high betweenness centrality mediate more connections in the network
Closeness Centrality	The closeness centrality measures the total distance between two nodes. The closeness centrality is high when the distance path between the nodes is small.

2.1 Context and Case studies of network

The government of Malaysia, through the Ministry of Finance (MOF), finances a substantial portion of post-disaster reconstruction. Malaysia's 2021-2022 floods resulted in significant economic losses, with an estimated cost of RM6.1 billion or 0.4% of the country's gross domestic product. The case studies comprised three rural housing reconstructions in Temerloh. Case studies 1 and 2, sponsored by the government and His Majesty Yang Di-Pertuan Agong, respectively, followed the traditional procurement route involving a client (government/His Majesty Yang Di-Pertuan Agong), consultant (Ministry of Public Works – JKR) and contractors. In contrast, His Majesty the King's sponsored house was awarded based on direct negotiation. The third case study was a community-based house reconstruction funded by private donors and led by an NGO, and government actors were absent in this network. House in the case study 3 was different from the traditional procurement process since the NGO (the recipient of funds) acted as the contractor, and volunteers were employed to oversee the construction work directly. The actor communication networks are shown in Figure 1-3, which illustrates the connection between all the stakeholders' categories throughout the initial damage assessment, design and construction stages.

3.0 Results

3.1 Degree centrality

Based on the Gephi output in Table 2, the mean degree centrality for the King-driven network (1.110) is higher than the donor-driven (0.718) and government-driven network (0.297). His Majesty the King network has a much higher mean degree of centrality, showing that the network's immediate stakeholders are highly connected. High centrality and connectivity are likely due to His Majesty's philanthropic effort; the King personally donated through Al-Sultan Abdullah Foundation (YASA), a Pahang-based organization to ease the burden and aid flood victims. The possible explanation for the low level of degree centralization in the government-driven network because the government funds nearly all the houses in Malaysia, and the reconstruction process is largely top-down. The local government officers were responsible for implementing and managing the building works. This approach can have some advantages, such as having a clear chain of command and the ability to mobilize resources quickly.

Table 2. Network density and mean degree, betweenness and closeness centralities

	Density	Mean Degree Centrality	Mean Betweenness centrality	Mean Closeness centrality
Government-driven network	0.147	0.297	0.527	0.417
His Majesty the King-driven network	0.6	1.110	0.939	0.604
Donor-driven network	0.25	0.718	0.813	0.786

3.2 Betweenness centrality

In Table 2, the King-driven network also dominates the mean betweenness centrality (0.939) followed by the donor-driven network (0.813) and government-driven network (0.527). The stakeholders with high betweenness centrality act as vital connections between many stakeholders and are important in controlling information flow. The government-driven network and donor-driven network have betweenness centralization higher than degree centralization measures. This means that there are many alternatives for actors in post-disaster reconstruction networks to reach others without dependent on single actors to do so. The lowest value is found in the government-driven network. Therefore, brokerage plays a more important role in the King-driven network and donor-driven network. The King network, led by the King's staff and local government, performs as gatekeepers since they disseminate technical advice, allocate funds, monitor project progress, and receive information on the people's needs. The level of collaboration is the highest in the King network compared to the others.

3.3 Closeness centrality

In the NGO-driven reconstruction, analysis shows it has a higher closeness centrality than government and King-driven network. The NGO was close to all the actors, i.e., the distance path of nodes was short in the network. Its influence in the effective delivery of

information and support was evident throughout the reconstruction life cycle from securing funds from donors to community consultation and sourcing community volunteers.

3.4 Density

The King-driven has a denser network followed by the donor-driven and lastly government-driven networks with density scores of 0.6, 0.25 and 0.147 respectively as shown in Table 2. In a dense network, there are many connections between actors, creating a network of high interconnectedness and interdependence. This is desirable because there are multiple pathways for the effective and quick reconstruction of newly built houses. The least dense government-driven reconstruction implied that relationships within the network are hierarchical, rigid and weak due to lower connectivity to others in the network which can potentially undermine the importance of local knowledge and bottom-up community involvement in decision-making. Collaborative approaches and technologies are needed to overcome governmental fragmentation and facilitate effective reconstruction and information sharing in the social network.

3.5 Comparing case studies actors' centrality measures

An actor's degree centrality is defined by the number of ties he or she has with another actor in the network. The NGO (Iqlas Care) in the donor-driven network has the highest centrality value (0.857) as shown in Table 3 followed by the local government in the King-driven network (0.75) and the Ministry of Rural Development (0.333) in the government-driven network. Figure 1-3 contrasts the case studies' actors' degree, betweenness and closeness centrality. JKR, the government authority responsible for damage assessment and structural engineering design has degree centrality values of 0.5 in the King-driven network & 0.167 in the government network whereas the community and homeowners have the lowest centrality (0.143).

The contractor in case study 2, the King-driven network, had a more prominent role than government-driven reconstruction with a centrality score of 0.5 vs 0.143, respectively. Direct negotiation in His Majesty's network produced more prominence for contractors than ballot voting in the government network and resulted in a shorter reconstruction. The centrality or prominence of the contractor in the King network was also attributed to the selection of top-performing, strong cash-flow contractors in the council's list of approved contractors to build new homes. Actors with a high degree of centrality have access to mostly all the actors and are often seen as influential and important in decision-making processes, as they have a greater ability to spread information or resources to other actors in the network.

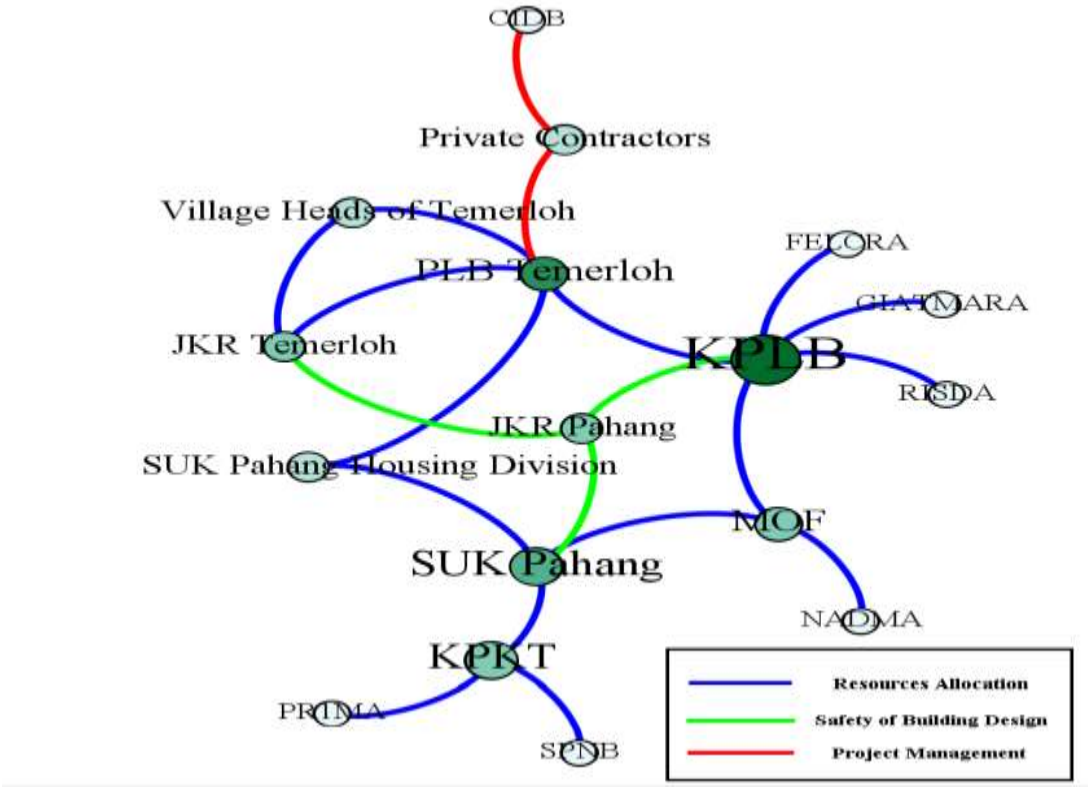

Fig. 1. Case study network 1: Government-driven reconstruction

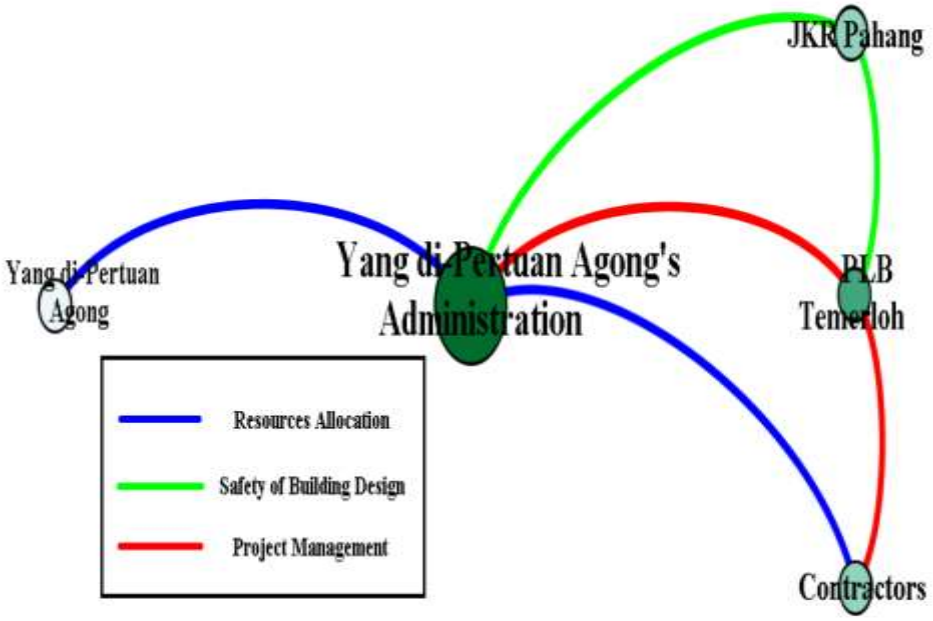

Fig. 2. Case study network 2: Yang di-Pertuan Agong's (King)-driven reconstruction

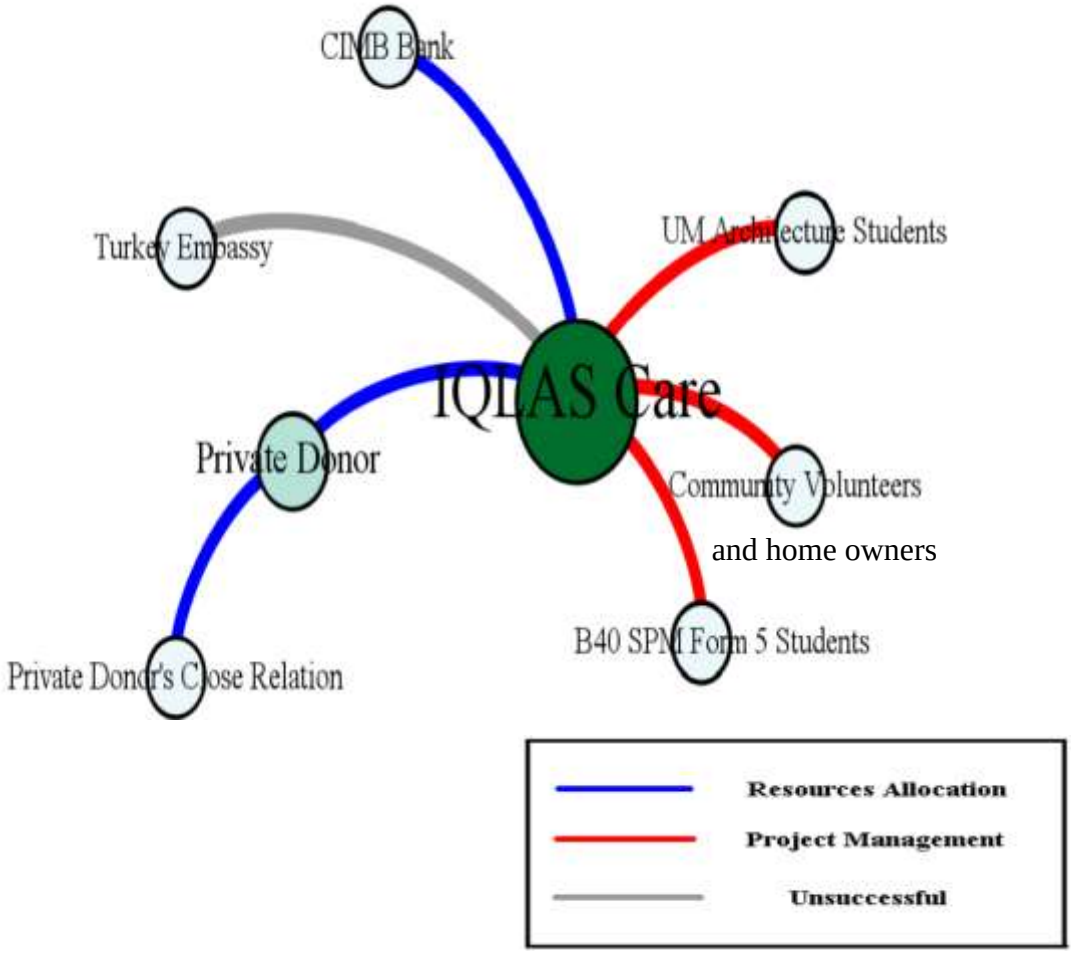

Fig. 3. Case study network 3: Donor-driven reconstruction

Table 3: Case studies stakeholder' categories and centrality measures

Stakeholders (Case study 1: Government-driven reconstruction network)	Organizations	Degree centrality (connectivity)	Betweenness centrality (brokerage)	Closeness centrality
MOF (Ministry of Finance)	Government	0.167	0.444	0.192
KPLB (Ministry of Rural Development)	Government	0.333	0.500	0.449
NADMA (National Disaster Management Agency)	Government	0.056	0.314	0.000
SUK Pahang (State Secretary)	Government	0.222	0.457	0.364
KPKT (Ministry of Housing and Local Government)	Government	0.167	0.348	0.242
Village Heads of Temerloh	Village heads	0.111	0.432	0.000
SUK Pahang Housing Division	Government	0.111	0.457	0.117
JKR Pahang (Public Works Department – State level)	Government	0.167	0.390	0.144
JKR Temerloh (Public Works Department – District level)	Government	0.167	0.485	0.038
PLB Temerloh (Temerloh Municipal Council)	Government	0.278	0.340	0.372
RISDA (Rubber Industry Smallholders Development Authority)	Government	0.056	0.340	0.000
FELCRA (Federal Land Consolidation and Rehabilitation Authority)	Government	0.056	0.340	0.000
GIATMARA (Youth technical & vocational training center)	Government	0.056	0.262	0.000
SPNB (National Housing Corporation Malaysia)	Government	0.056	0.262	0.000
PR1MA (1Malaysia Housing Programme)	Government	0.056	0.262	0.000
Private Contractor	Contractor	0.111	0.348	0.125
CIBD (Construction Industry Development Board)	Government	0.056	0.262	0.000
	Mean+2SD	0.297	0.527	0.417
Stakeholders (Case study 2: His Majesty Yang di-Pertuan Agong-driven reconstruction network)				
His Majesty Yang di-Pertuan Agong	His Majesty the King	0.25	0.571	0.000
Administration of His Majesty Yang di-Pertuan Agong	His Majesty the King	1	1.000	0.583
JKR (Public Works Department)	Government	0.5	0.667	0.000
PLB Temerloh (Temerloh Municipal Council)	Government	0.75	0.800	0.083
Contractors	Contractor	0.5	0.667	0.000
	Mean+2SD	1.110	0.939	0.604
Stakeholders (Case study 3: NGO-driven reconstruction network)				
CIMB Bank Berhad	Commercial bank	0.143	0.500	0.000
IQLAS Care (NGO)	NGO	0.857	0.875	0.952
Private Donor	Local donor	0.286	0.583	0.286
Community Volunteers & Homeowners	Public volunteers & Homeowners	0.143	0.500	0.000
B40 SPM Form 5 Volunteers (School leavers)	Public volunteers	0.143	0.500	0.000
Universiti Malaya (UM) Architecture Students	Public volunteers	0.143	0.500	0.000
Private Donor's Close Relation	Local donor	0.143	0.389	0.000
Turkey Embassy	International donor	0.143	0.500	0.000
	Mean+2SD	0.718	0.813	0.786

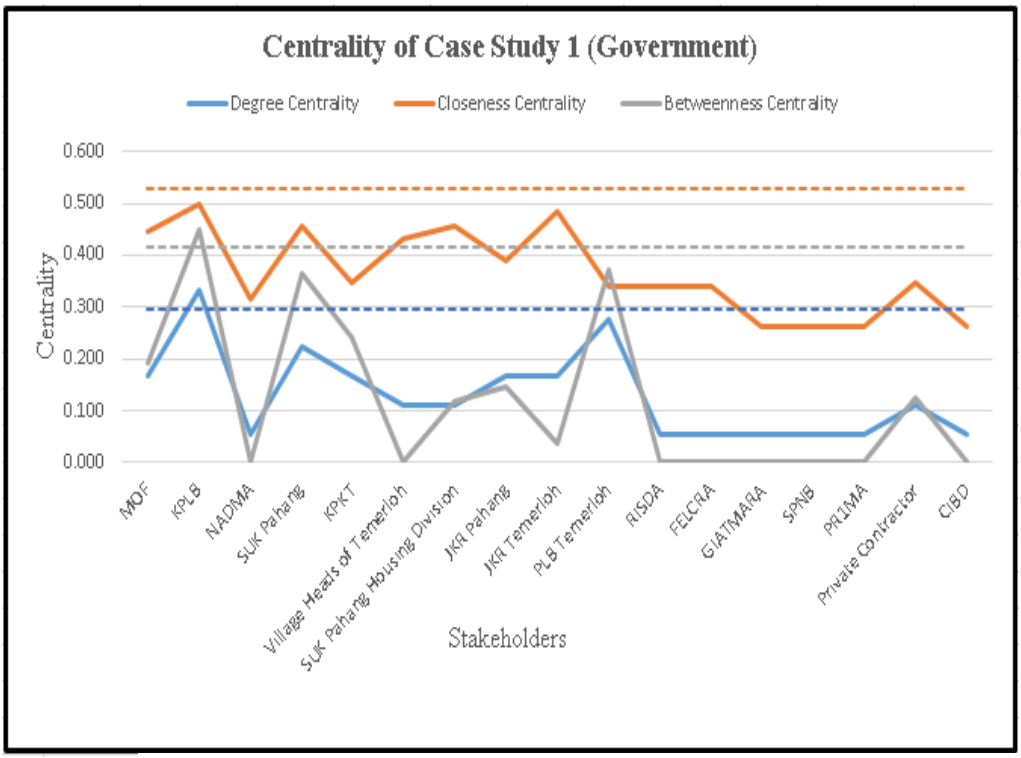

Fig. 4. Centrality metrics for case study 1 (Government-driven house reconstruction)

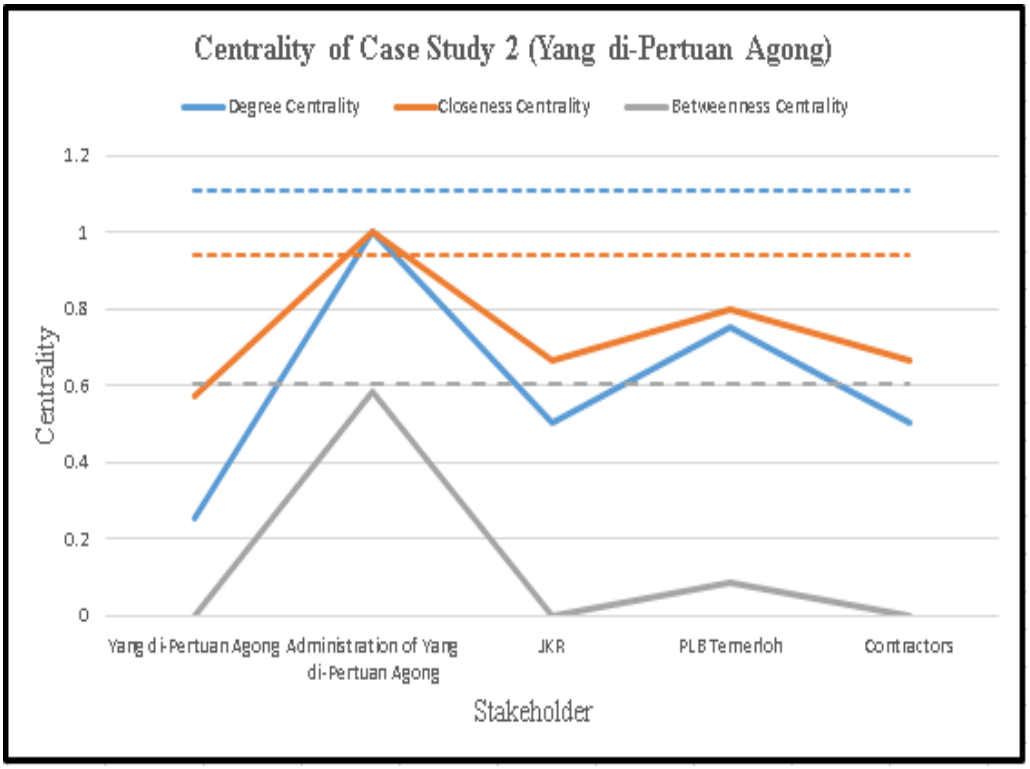

Fig. 5. Centrality metrics for case study 2 (King-driven house reconstruction)

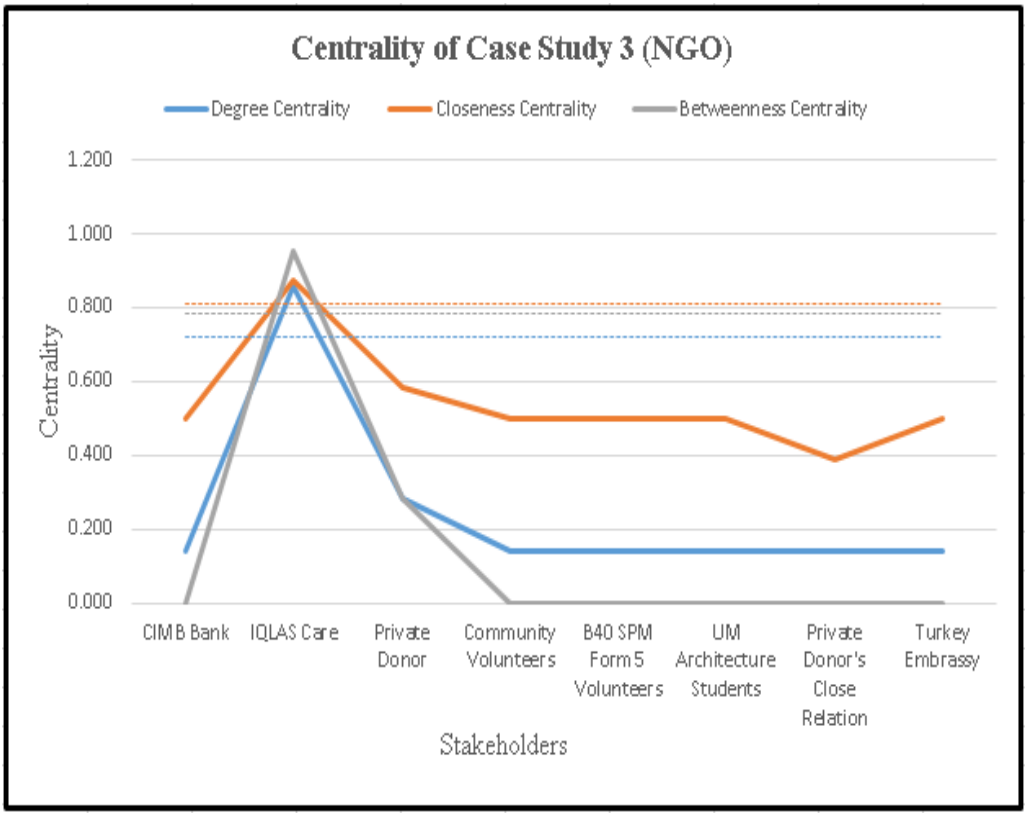

Fig. 6. Centrality metrics for case study 3 (Donor-driven house reconstruction)

4.0 Discussion

A highly centralized network is one characterized by one or a few individuals who have the highest connectivity or ties with others in the network. The highest centrality measures belong to the categories of decision makers (NGO) and government agencies such as the Ministry of Finance which finance all of the government-driven reconstruction the Ministry of Rural Development at the federal level and the local government which oversees the planning and project management of the reconstruction. The central actors are identified as key players who can influence the financial resources, design and project management of reconstruction activities. Increasing the number of connections with these key players will enhance collaboration and communication between stakeholders who are isolated and on the peripheral and central actors.

In addition to the centrality measure, it is It is important to consider the strength of tie and homophily when analyzing stakeholder networks in the reconstruction effort. In the donor-driven network, the NGO formed strong ties with donors and community stakeholders and homeowners. The NGO in this network attempted to obtain funds from international donors i.e Turkey embassy but unsuccessfully due to lengthy approval processes from authorities. This confirms previous studies that reported a low density of collaboration ties among NGOs themselves and with international donors, although they share high homophily (actors interact with those like them) i.e., to serve and give to charitable causes. NGO stated that it was difficult to find volunteers, especially those skilled in building work. Faith-based status can be a factor that motivates FBOs (Faith-Based Organizations) in seeking or avoiding collaboration with other organizations. Sapat (2019) argues that FBOs may be motivated to seek collaboration with other FBOs because of shared religious beliefs, values, and missions. Iqlas Care, a Muslim-based NGO, can use its influential position in social networks to coordinate with other religious organizations and community groups in mobilizing volunteers and resources. The Council of Religion of Islam and Malay Customs for the State of Pahang is one of many Islamic religious organizations that are active in the disaster relief phase in Temerloh.

In case study 3, there was no technical expertise involved in the structural design and ensuring the repair of the houses meet technical requirements. NGO repaired homes by replacing damaged parts following the original design and sizes. In rural areas, it is not uncommon for some houses to be built without following proper design codes or building standards, which can lead to unsafe conditions, especially during disasters. According to stakeholder theory, identifying and managing relationships between stakeholder groups is crucial for effective crisis management (Ha, 2022). The Ministry of Public Works, the private sector and academia can play crucial roles in building back more sustainable and resilient homes, but they will need to build the capacity to influence village heads, NGOs, and homeowners to collaborate and drive change in their communities (Charlesworth and Fine, 2022).

The network diagram shows that the central actors in case studies 1 (government-driven) and 2 (King-driven) are strongly tied to mostly actors within the government agency stakeholders, i.e., actors like themselves. A comparison of centrality scores in as shown in Table 2 in the government-driven network, alongside the composition of actors' neighbours' categories, revealed local government held the second highest central position (0.278) behind the Ministry of Rural Development at the federal level (0.333). The local government had immediate ties with more diverse stakeholders other than government agencies, such as the contractors and village heads. Local government performs the role of broker in the network by establishing strong connections to the head of the local government, which in turn has links to the state government or/and by facilitating the flow of information across the state. Local government plays an influential role in connecting and linking officials from other organizations that may be disconnected from parts of the network (Ha, et al., 2022). Thus, the rural development department at the local level involvement is crucial to help identify post-disaster resourcing issues, develop community-based collaborations between local government and private-public sectors, and build back holistic and sustainable local housing and communities after a disaster (Masuda et al., 2022).

5.0 Conclusion

The local government, the King's administrative staff and NGO were the central actors having the greatest influence on the post-disaster reconstruction networks, while homeowners had the lowest centralities and has some level of influence in the decision-making process in the donor-driven network and are passive in the King-driven and government network. The government network is less dense than the donor-driven network. In a less dense network, where the connections between stakeholders are sparse and fragmented, the exchange of information can be impeded and may not have as many opportunities to interact and collaborate with other stakeholders especially non-governmental stakeholders and communities. The donor-driven network appears to be centralized and the dense network of relationship with donors and community stakeholders helps to foster people-centred reconstruction. This research shows that SNA has the potential to analyse stakeholders' influence on post-disaster reconstruction and would allow specific interventions in each case study to be designed to increase collaborations and ensure homeowners are not marginalized. It is suggested that future studies include manufacturers and suppliers to trace the origins and certifications of materials in the supply network and determine if procurement collaboration is possible.

The main limitation of this study is the response rate of the network actor. More response rates from stakeholders would give a better result. This study examines only the macro level of analysis i.e. the overall structural characteristic and relationship (density and centrality) at the network level for housing reconstruction financed by different stakeholders. Micro-level analysis at the organizational level using hypotheses testing can be used to test the significance of centrality measures for different types of housing reconstructions to complement the network analysis.

Acknowledgements

This research is part of a research fund supported by the Ministry of Higher Education (MoHE) through Fundamental Research Grant Scheme Project FRGS/1/2022/SS05/UTAR/03/2.

Paper Contribution to Related Field of Study

This empirical study contributes to the body of knowledge and expands our understanding of information-sharing and collaborative networks' characteristics in Malaysia's rural post-disaster housing reconstruction. We demonstrated evidence of using SNA in mapping post-disaster reconstruction as a governance network of relationships between the funders, central network actors, consultants and contractors.

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