Understanding Waste Bank Management: A Study of Coordination Between Waste Banks Unit Using Social Network Analysis

Marini Ambo Wellang[1,2*], Hasniar Ambo Radde[3], Toru Matsumoto[1]

[1]Faculty of Environmental Engineering, Graduate School of Environmental Engineering, Hibikino 1-1 Wakamatsu, Kitakyushu, Fukuoka 802-8577, Japan

[2]Department of Sociology, Faculty of Political and Social Science, Bosowa University, Makassar City

[3]Department of Psychology, Faculty of Psychology, Bosowa University, Makassar City

E-mail: m.mallagennie@gmail.com; hasniar.ar@universitasbosowa.ac.id; matsumoto-t@kitakyu-u.ac.jp

*Corresponding author details: Marini Ambo Wellang; m.mallagennie@gmail.com

ABSTRACT

Waste banks are an innovation in waste management that is increasingly increasing in terms of quantity and type. This is because waste banks are a combination of elements of sustainable economic principles and community involvement. However, the effectiveness of waste bank management depends on a strong communication network among the network of parties involved in it. This study aims to determine the structure of the communication network between waste bank units (WBU) using social network analysis. The study was conducted on 43 waste bank units (WBU) in Makassar City. There were 4 findings in the study. First, the network structure showed a network that was still relatively low; only 2.2% of the total potential communication relationships were realized. This finding is relatively similar to the density of waste bank networks in developing countries. Second, WBU-AS emerged as a central actor in the WBU network. However, it appears that the distribution of centrality in the network is uneven, where WBU-AS emerged as a central actor while most WBUs were in peripheral positions with limited connections. Third, 2 other clusters were formed in the network with WBU-PB and WBU-LB each as supporting central actors. Fourth, it is necessary to further explore the factors causing many WBUs to be in isolated positions in the WBU network. Because there is a possibility that they will build their own communication channels with parties outside the network.

Keywords: waste banks management; waste bank unit; social network analysis.

INTRODUCTION

Municipal solid waste management has become one of the most pressing environmental challenges in the 21st century, especially in developing countries. Global waste production is expected to reach 3.4 billion tons by 2050 [1], and Indonesia as the fourth most populous country in the world, also faces significant challenges in managing urban waste which continues to increase along with urbanization and economic growth (Kaza et al., 2018). The way waste is managed also has an impact on the environment. Data from 2016 showed that as much as 1.6 billion CO_2 or around 3.2% of greenhouse gas emissions were produced from the waste management process [2]. One of the reasons is that the waste management system so far still tends to follow a linear economic system. However, currently, the waste management paradigm has evolved from a linear "take-make-dispose" approach to a circular economy concept that emphasizes reduction, reuse, and recycling [3].

In this context, community-based solid waste management has emerged as a promising approach to overcome the limitations of centralized solid waste management systems in developing countries [4].

Community-Based Solid Waste Management (CBSWM) has been recognized as an effective strategy to improve solid waste management systems in developing countries [5]. This approach involves active community participation in waste management activities, from sorting at source to processing and marketing of recycled materials [6]. Waste banks are one form of Community-Based Waste Management. Waste banks are a unique Indonesian innovation in community-based waste management that integrates environmental, social, and economic aspects [7]. This system operates like a conventional bank where the community can "save" sorted waste and receive economic compensation based on the value of recycled materials [8].

The concept of waste banks was first introduced in Bantul, Yogyakarta in 2008 and has grown rapidly throughout Indonesia [9]. As of 2021, there are more than 11,000 waste banks operating in Indonesia, involving more than 3 million customers [10].

In Makassar itself, the waste bank program has been growing since 2012 with the support of the city government and various non-governmental organizations [11]. However, the sustainability of waste banks faces significant challenges.

This study aims to determine the structure of the communication network between waste bank units (WBU). Specifically, this study seeks to identify the structural characteristics of the waste bank unit communication network, determine the central actors who play an important role in the flow of information, analyze connectivity patterns and their implications for program effectiveness, and provide recommendations for strengthening the waste bank communication network. This study was conducted in Makassar City on WBUs in this city, considering that Makassar City is one of the biggest cities in Indonesia. Understanding the structure of this communication network is important for several reasons. First, effective communication between waste bank units is needed to share information about material prices, sorting techniques, and best practices. Second, a strong network can increase collective bargaining power in negotiations with collectors and the recycling industry. Third, the network structure affects the system's resilience to external shocks such as price fluctuations or policy changes.

The structure of the communication network between WBUs in Makassar City was analyzed using social network analysis (SNA). SNA allows researchers to analyze the structure of social relations and how these structures affect environmental management outcomes [12]. In the context of environmental management, SNA has been applied for various purposes. Bodin and Crona's research used SNA to analyze how social network patterns affect natural resource governance, and they found that certain network structures, such as centrality and density, correlated with management effectiveness [13].

METHODS
Data Collection

This study examines all active WBUs operating and spread across all sub-districts in Makassar City. The following are the steps taken in the data collection process in this study:

First, requesting data on active WBUs in Makassar City through the Makassar City Environmental Office (CEO). The CEO is a city-level government institution whose duties include managing the waste bank community in Makassar. The CEO is one of the stakeholders of the waste bank in Makassar City. According to data from the CEO, there are 344 WBUs that are officially registered and active in Makassar City. One form of communication between the CEO and all WBUs is that the CEO manages a WhatsApp group consisting of all WBUs in Makassar City, but only 273 WBUs join the WhatsApp group. This WhatsApp group is used by the CEO as a form of communication to facilitate communication in managing waste banks in Makassar City. This WhatsApp group is used by the CEO and all WBUs to convey information reciprocally, coordinate sales and waste collection, coordinate training activities, and others. The researcher was then included in the WhatsApp group by the CEO to make it easier to coordinate during the research data collection process.

Second, an online questionnaire was distributed to all WBUs in Makassar City through the WhatsApp group managed by the CEO. This questionnaire was filled in by the representative person from each WBU, and there were questions to obtain demographic data from the WBU representative person who filled it in. To find out the communication network, the researcher asked questions about who they interacted with, especially fellow waste banks in Makassar. The question asked, who do you ask/seek information about waste banks with (for example, price information, types of waste, waste bank rules, waste bank activities, meetings, etc.). Each waste bank will fill in the names of the actors who have interacted with them in relation to the waste bank.

Third, there are 50 WBUs that filled out the questionnaire given. However, as many as 43 questionnaires were filled in completely by the WBU and filled in by the WBU director, who is the representative person of the WBU. Therefore, the respondents for this study were 43 WBUs in Makassar City.

TABLE 1: Respondents of waste bank unit.

No	Waste Bank Unit (Initial)	District	No	Waste Bank Unit (Initial)	District
1	WBC PAC	Biringkanaya	9	BSU BER	Rappocini
2	WBS GEM SD	Rappocini	10	BSU BER BER	Rappocini
3	WBS GREEN BSW	Makassar	11	BSU BLO	Rappocini
4	WBU ANY	Manggala	12	BSU CR	Rappocini
5	WBU AS	Tamalate	13	BSU COK	Rappocini
6	WBU BAJP	Panakukang	14	BSU DAH	Rappocini
7	WBU BER	Tamalate	15	BSU GAM	Makassar
8	BSU BER TACO	Tamalate	16	BSU HO	Ujung Tanah

No	Waste Bank Unit (Initial)	District	No	Waste Bank Unit (Initial)	District
17	BSU KP	Rappocini	31	WBU PAC	Biringkanayya
18	BSU LB	Manggala	32	WBU PAD	Rappocini
19	WBU LSMSI	Ujung Pandang	33	WBU PEDL	Tamalate
20	WBU MAB	Makassar	34	WBU PP	Biringkanayya
21	WBU MADE	Ujung Tanah	35	WBU PB	Rappocini
22	WBU MAK	Biringkanayya	36	WBU PH	Rappocini
23	WBU MSE	Bontoala	37	WBU PHIT	Wajo
24	WBU MASA	Mamajang	38	WBU ROS	Manggala
25	WBU MT	Panakukang	39	WBU SR	Panakukang
26	WBU MAW	Tallo	40	WBU SIMO	Sangkarrang
27	WBU MEG	Biringkanayya	41	WBU SOM 4	Rappocini
28	WBU MSWA	Panakukang	42	WBU TAN	Tallo
29	WBU MERP	Tamalanrea	43	WBU TM	Panakukang
30	WBU NOW	Panakukang			

Data Analysis

This study uses Social Network Analysis (SNA) as a data analysis technique. This method allows exploration of the structure and dynamics of social networks, which are represented as graphs with interconnected nodes, where nodes can be individuals or groups [14], [15], [16]. SNA in this study uses the help of UCINET 6.7 software, with this software it is possible to measure the value and strength of relationships between actors [17], and is equipped with the NetDraw feature for sociogram visualization, and network density and network centrality including degree centrality, closeness centrality, and betweenness centrality

Network density is measured by comparing the number of actual links to the number of potential links, providing an overview of the level of network connectivity [18], [19]. Centrality is related to the concentration of actors in the network [20]. The three centrality measures analyzed include: (1) degree centrality, which indicates the popularity of an actor based on the number of incoming and outgoing links, (2) betweenness centrality, which describes the role of an actor as an intermediary between other actors, and (3) closeness centrality, which indicates how close an actor is to all other actors in the network [21]. The collected data is entered into a matrix to see which actors have relationships with other actors. In this analysis, a relationship is created in an undirected format, because we only want to see the relationship without wanting to see who gives information and who receives information (directed).

RESULT
Respondent's Profile

The following are the results of the descriptive analysis from the director, who is the representative person of WBU:

TABLE 2: Characteristics of the representative person.

Demographic Characteristics		Σ	%
Gender	Female	26	60,5
	Male	17	39,5
Age	21-30 years	1	2,3
	31-40 years	5	11,6
	41-50 years	18	41,9
	51-60 years	16	37,2
	>60 years	3	7,0
Occupation	Housewife	13	30,2
	Private employee/teacher	12	27,9
	Private Business	10	23,3
	Government employees	4	9,3
	other	4	9,4
Education	Junior High School	3	7,0
	Senior High school	22	51,2
	Diploma/Bachelor's	15	34,9
	Magister	3	7,0
Income	< 2.000.000 IDR	28	65,1
	2.000.000 - 3.000.000 IDR	6	14,0
	3.000.000 - 5.000.000 IDR	6	14,0
	> 5.000.000 IDR	3	7,0
Reasons to join WBU	Environmental care	35	81,4
	Environmental care and income	9	20,9
	Other	1	2,3
how long in WBU	< 1 year	9	20,9
	1-3 years	5	11,6
	3-5 years	4	9,3
	> 5 tahun ke atas	25	58,1

From the results of the descriptive analysis, it is known that the majority of WBU leaders are women, aged over 40 years. In general, they work as housewives or work in the private sector, with the majority having a high school or bachelor's degree. Most of them earn an average income of under 2,000,000 IDR/month and have joined the waste bank for more than 5 years. Most of the directors of this waste bank admitted that they care about the environment, as the reason for joining the waste bank.

Network Structure Analysis

Network structure analysis will present the results of network density analysis and network centrality analysis. Network density shows the extent to which WBUs are directly connected to each other with other WBUs. While network centrality measures the most influential WBU in the network or WBU in crisis, it can also identify WBUs that are the main actors in the network, predict information flow, and understand the resilience of social networks formed between WBUs. The following table presents the results of the network density analysis:

TABLE 3: Analysis result of network density.

Nodes	Density	No. Ties	Std. Dev	Avg Degree
43	0.022	39	0.145	0.907

The results of the SNA analysis show that the network density that occurs in the network between WBUs is 0.022, which means that out of 43 waste banks studied, there are only 39 active communication relationships - this means that only 2.2% of all possible relationships actually occur. This network density figure shows that the network density between WBUs analyzed is in the low category. The average figure of 0.907 can be interpreted that most WBUs only have very few relationships with other WBUs. The following table presents the results of network centrality analysis which includes degree centrality, closeness centrality, and betweenness centrality:

TABLE 4: Analysis result of network centrality.

No	WBU	Degree	Closeness	Betweenness	No	WBU	Degree	Closeness	Betweenness
1	WBU AS	9	0,54	339	23	WBU MSW	1	0,29	0
2	WBU PB	5	0,27	110	24	WBU NOW	1	0,33	0
3	WBU HO	3	0,48	209	25	WBU PHIT	1	0,29	0
4	WBU ROS	3	0,42	183	26	WBU TM	1	0,29	0
5	WBU LB	4	0,45	129	27	WBU BAJP	1	0,27	0
6	WBU MS	4	0,36	84	28	WBU PEDL	1	0,39	0
7	WBU MASA	2	0,36	144	29	WBU PAC	1	0,32	0
8	WBU PH	2	0,31	125	30	WBU GSD	1	0,39	0
9	WBU PP	3	0,41	57	31	WBU GBS	1	0,39	0
10	WBU SR	3	0,43	56	32	WBU ANY	1	-	0
11	WBU BB	1	0,23	0	33	WBU BER	1	-	0
12	WBU COK	1	0,23	0	34	WBU BERH	1	-	0
13	WBU PAD	1	0,23	0	35	WBU BERK	1	-	0
14	WBU TAN	1	0,23	0	36	WBU BLO	1	-	0
15	WBU CR	2	0,34	29	37	WBU GAM	1	-	0
16	WBU KP	2	0,40	29	38	WBU LSM	1	-	0
17	WBU SBL	2	0,40	29	39	WBU MAB	1	-	0
18	WBU DAH	1	0,31	0	40	WBU MEG	1	-	0
19	WBU MAD	1	0,36	0	41	WBU MER	1	-	0
20	WBU MAK	1	0,32	0	42	WBU PACE	1	-	0
21	WBU MT	1	0,31	0	43	WBU SOM	1	-	0
22	WBU MAW	1	0,34	0					

From the results of the network centrality analysis, it can be seen that WBU-AS has a higher degree of centrality value in the network. WBU-AS has a degree centrality of 9, which means that WBU-AS is connected to 9 other WBUs, or is connected to at least 20% of the WBUs in the WBU network. This makes WBU-AS the center of the WBU network. Betweenness centrality shows the ability of WBU in its position as an intermediary for relations between other WBUs in the network.

The results of the analysis show that WBU-AS also has the highest betweenness value in the WBU network, which is 339. This indicates that WBU-AS is the WBU that most often acts as an intermediary between WBUs in the network. By becoming a center in the network and an information intermediary in the network, WBU-AS has a significant ability to control the flow of information in the WBU network. In other words, WBU-AS is the main actor in the WBU network in Makassar City.

WBU-PB is in second place in direct connections and as a connector in the network, which indicates its important role as a secondary connector in the WBU

network in Makassar City. WBU-LB and WBU-MSE with 4 connections each also play a role as important nodes in facilitating communication between units. An interesting finding was found in WBU-HOKI, which despite only having 3 direct connections, has a relatively high betweenness centrality reaching 209. This shows the strategic position of WBU-HOKI as a broker between different clusters in the network, where information must pass through this node to reach other parts of the network.

The following graph is a sociogram from the results of the social network analysis between WBUs in Makassar City:
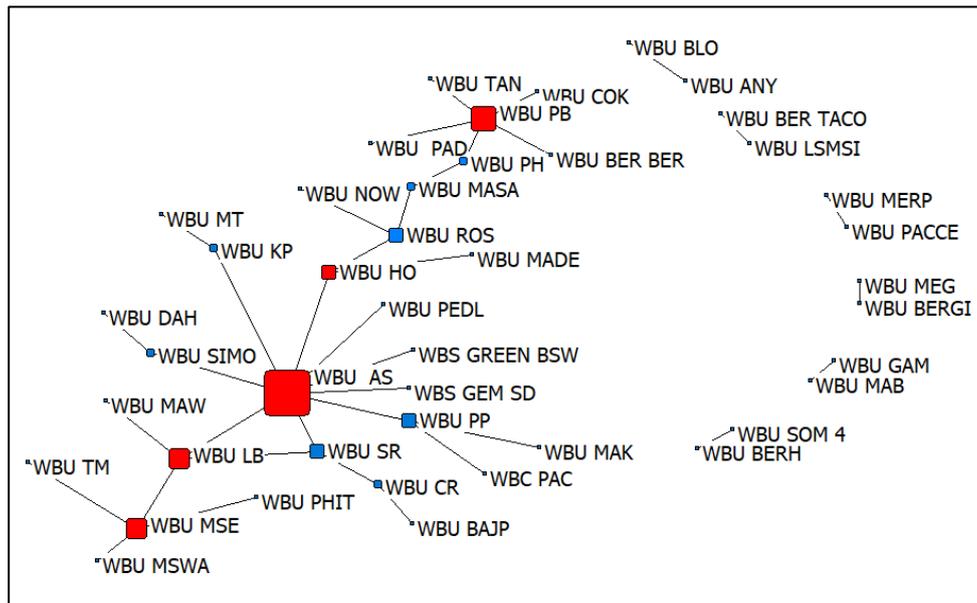

FIGURE 1: Sociogram of SNA result.

Node (Dot): Each node represents one waste bank unit (WBU). Node Size: Large node (red, square): Actor with high degree centrality (>3 connections). Medium node (blue, square): Actor with medium degree centrality (2-3 connections). Small node (blue, circle): Actor with low degree centrality (1 connection). Node Color: Red: Main hub and central actor (WBU AS, WBU PB, WBU LB, WBU MSE, WBU HO). Blue: Connecting and peripheral actor. Connecting Line: Indicates communication/interaction between waste bank units. Node Position: Network center: Actor with high centrality. Network periphery: Peripheral actor with limited connections.

Based on the sociogram, WBU-AS which has the highest degree centrality and the highest betweenness centrality is clearly visible as a node located at the center of the WBU network with a larger size compared to other WBU nodes. The position of WBU-AS in the sociogram emphasizes that WBU-AS not only has the most direct connections but also acts as the main link between various WBU clusters in the network. Visually, almost all communication flows to other WBUs must pass through WBU-AS. This confirms its role as an information gatekeeper in the WBU network in Makassar City. WBU-PB as a secondary node also forms a cluster. Its position in the sociogram shows its role as an indirect link between WBU-AS and several WBUs located on the edge of the sociogram, namely WBU-COK, WBU-PAD, and WBU-TAN. This indicates that WBU-PB acts as a sub-hub that helps distribute information from the center of the network, in this case, WBU-AS, to certain WBUs. WBU-PB is able to form a network cluster in the WBU network even though the information flow it obtains does not come directly from WBU-AS as the center of the WBU network.

Similarly, WBU-LB also forms a cluster in the network and becomes a transmitter of information from the center, namely WBU-AS to WBU-MAW, WBU-TM, WBU-MSE, and WBU-SR. Although the degree centrality value of WBU-LB is lower than WBU-PB, WBU-LB has a higher betweenness centrality value. This indicates that WBU-LB's ability is more strategic as an intermediary for information from WBU-AS as the center, compared to WBU-PB's ability.

WBU-HOKI shows an interesting phenomenon in the sociogram. Although it only has 3 direct connections (degree centrality 3), its position in the sociogram shows an important role as a bridge between the main cluster that has a direct connection to the center of the network with isolated WBUs such as WBU-ROS, which then forwards it to other WBUs until it reaches WBU-PB which forms a network cluster. WBU-HOKI has a relatively high betweenness centrality in the network, due to its position as the only path to reach several peripheral nodes, creating a significant communication bottleneck.

The sociogram also reveals several sub-structures or clusters in the network. The central cluster, consisting of forms a dense network core. Around this core, there are several nodes with moderate connections, such as WBU-MSE, WBU-PP, and WBU-SR, which act as a link between the core and the periphery. The peripheral part of the network shows a worrying pattern, where many WBUs such as WBU-BLO, WBU-ANY, WBU-LSMSI, WBU-BERTACO, WBU-MERP, WBU-PACCE, WBU-MEG, WBU-BERGI, and WBU SOM are in very isolated positions because they are not connected to other WBUs or to clusters in the network. This indicates that these WBUs have information flows outside the central WBU or other WBUs in the network.

DISCUSSIONS

The finding of a network density of 0.022 indicates a low level of network density in the WBU communication network in Makassar City [22]. This finding indicates that the relationship between WBUs in Makassar City has not shown strong cohesiveness and is not interconnected with each other. Although small clusters are formed in the network, on the other hand, there are WBUs that are isolated and not connected to other WBUs. The low network density condition in the findings of this study is relatively the same as the finding of a network density value of 0.098 in the waste bank network in Indonesia [23].

Although there are most WBUs that interact and communicate with each other, there are also WBUs that are managed with a direct communication flow to other parties outside the network. Information for internal needs in WBU management is usually things like waste transportation, which is communicated with the CEO as a stakeholder from the government, who specifically handles waste banks. Also, other information, that is not related to other WBUs, is only limited to information on WBU needs that are communicated to the CEO. This factor seems to be what makes WBUs in the WBU network in Makassar City not connected to each other cohesively, which is indicated by the low network density value.

Although the WBU network shows low density and is not yet cohesive, a communication flow is still formed in the WBU network with WBU-AS as the center. This study only analyzes the network between WBUs and does not examine the network between WBUs and stakeholders other than WBUs. It is possible that other WBUs also communicate with other waste bank stakeholders, other than with fellow WBUs. However, it seems that WBU-AS is able to bridge the communication flow from outside the WBU network with WBUs in the network, in addition to being an intermediary for information between WBUs in the WBU network. Although not all WBUs in the network are included in the WBU-AS communication circle.

The existence of an actor who tends to be the only center in the network risks making the WBU network vulnerable if a crisis occurs in that actor [24].

However, this seems difficult to happen, even though WBU-AS is the center, the network still has low cohesiveness, coupled with a number of WBUs that are isolated in the network and their information flow does not depend on WBU-AS as the central actor in the network. This allows other WBUs to communicate with other parties when the main actor in this case WBU-AS is in crisis. This situation on the other hand can make the existing WBUs more resilient [13].

Low network density with a value below 0.1 is a common characteristic of waste bank management networks in developing countries, which still need development [25]. Isolated WBUs may be because they have other communication networks outside the network that are not tied to the WBU-AS as the central actor. However, the isolated condition in this low-cohesiveness network can also be interpreted as a possibility of a capacity gap between WBUs in the network [26]. If isolated WBUs get a different communication flow than those in the network, then this tends not to be a problem, but if not, this isolated condition can hinder their performance and operational sustainability [26].

The findings of this study have several important implications for the development of the waste bank program in Makassar. Actors with high centrality such as WBU AS, WBU PB, and WBU LB have great potential to optimize their role as information hubs that become the center for distributing the latest information on regulations, waste prices, and best practices for waste bank management. They can also function as training centers that organize training and capacity building for other unit waste banks, as well as act as network coordinators that facilitate communication and coordination between unit waste banks throughout Makassar.

The low density of 0.022 indicates the need for systematic efforts to improve network connectivity. This can be done through networking programs that organize regular meetings between unit waste bank administrators, the development of digital communication platforms such as WhatsApp groups or other digital platforms to facilitate real-time communication and the implementation of a mentoring system that connects established unit waste banks with those that are still in the development stage. Although there are WhatsApp groups for active waste banks in Makassar City, the communication that occurs is more about the aspect of collecting recycled waste.

Unit waste banks that are in peripheral positions need special attention through mentoring programs that provide intensive mentoring to improve operational and managerial capacity. Providing participation incentives can encourage them to participate more actively in the communication network, while capacity-building programs can improve the technical and managerial capabilities of administrators to manage waste banks more effectively.

CONCLUSIONS

This study successfully revealed the structure of the communication network between WBUs in Makassar City using the Social Network Analysis approach. There were 4 findings in the study, first, the network structure showed a network that was still relatively low, only 2.2% of the total potential communication relationships were realized. This finding is relatively no different from the density of waste bank networks in developing countries. Second, WBU-AS emerged as a central actor in the WBU network. However, it appears that the distribution of centrality in the network is uneven, where WBU-AS emerged as a central actor while most WBUs were in peripheral positions with limited connections. Third, 2 other clusters were formed in the network with WBU-PB and WBU-LB each as supporting central actors. Fourth, it is necessary to further explore the factors causing many WBUs to be in isolated positions in the WBU network. Because there is a possibility that they build their own communication channels with parties outside the network.

These findings provide valuable insights for relevant stakeholders to develop more effective strategies for managing waste bank programs. Key recommendations include optimizing the role of central actors as information hubs, increasing network connectivity through structured networking programs, and strengthening the capacity of peripheral unit waste banks. As well as analyzing more diverse types of relationships within the unit waste bank network to gain a more comprehensive understanding of the communication ecosystem of the waste bank program.

REFERENCES

[1] UNEP, Ed., Beyond an age of waste: turning rubbish into a resource. in Global waste management outlook, no. 2024. Nairobi: UNEP, 2024.

[2] CCET, "Waste Bank." [Online]. Available: https://ccet.jp/projects/waste-bank

[3] V. Prieto-Sandoval, C. Jaca, and M. Ormazabal, "Towards a consensus on the circular economy," Journal of Cleaner Production, vol. 179, pp. 605–615, Apr. 2018, doi: 10.1016/j.jclepro.2017.12.224.

[4] R. E. Marshall and K. Farahbakhsh, "Systems approaches to integrated solid waste management in developing countries," Waste Management, vol. 33, no. 4, pp. 988–1003, Apr. 2013, doi: 10.1016/j.wasman.2012.12.023.

[5] J. Anschütz, J. IJgosse, and A. Scheinberg, "Putting Integrated Sustainable Waste Management into Practice," Waste, Netherlands Agency for International Cooperation (DGIS), Ministry of Foreign Affairs., Netherland, 2004. [Online]. Available:https://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/schwerpunkte/sesp/CLUES/Toolbox/t12/D12_1_Anschuetz_et_al_2004.pdf

[6] M. Colon and B. Fawcett, "Community-based household waste management: Lessons learnt from EXNORA's 'zero waste management' scheme in two South Indian cities," Habitat International, vol. 30, no. 4, pp. 916–931, Dec. 2006, doi: 10.1016/j.habitatint.2005.04.006.

[7] S. Raharjo, T. Matsumoto, T. Ihsan, I. Rachman, and L. Gustin, "Community-based solid waste bank program for municipal solid waste management improvement in Indonesia: a case study of Padang city," J Mater Cycles Waste Manag, vol. 19, no. 1, pp. 201–212, Jan. 2017, doi: 10.1007/s10163-015-0401-z.

[8] D. R. Wijayanti and S. Suryani, "Waste Bank as Community-based Environmental Governance: A Lesson Learned from Surabaya," Procedia - Social and Behavioral Sciences, vol. 184, pp. 171–179, May 2015, doi: 10.1016/j.sbspro.2015.05.077.

[9] N. Indrianti, "Community-based Solid Waste Bank Model for Sustainable Education," Procedia - Social and Behavioral Sciences, vol. 224, pp. 158–166, Jun. 2016, doi: 10.1016/j.sbspro.2016.05.431.

[10] A. Budiyarto, B. Clarke, and K. Ross, "Overview of waste bank application in Indonesian regencies," Waste Manag Res, vol. 43, no. 3, pp. 306–321, Mar. 2025, doi: 10.1177/0734242X241242697.

[11] M. Selomo, A. B. Birawida, and A. Mallongi, "BANK SAMPAH SEBAGAI SALAH SATU SOLUSI PENANGANAN SAMPAH DI KOTA MAKASSAR," vol. 12, no. 4, 2016.

[12] C. Prell, K. Hubacek, and M. Reed, "Stakeholder Analysis and Social Network Analysis in Natural Resource Management," Society & Natural Resources, vol. 22, no. 6, pp. 501–518, Jun. 2009, doi: 10.1080/08941920802199202.

[13] Ö. Bodin and B. I. Crona, "The role of social networks in natural resource governance: What relational patterns make a difference?," Global Environmental Change, vol. 19, no. 3, pp. 366–374, Aug. 2009, doi: 10.1016/j.gloenvcha.2009.05.002.

[14] S. Rani and M. Mehrotra, "Community Detection in Social Networks: Literature Review," J. Info. Know. Mgmt., vol. 18, no. 02, p. 1950019, Jun. 2019, doi: 10.1142/S0219649219500199.

[15] U. Gupta, G. Trivedi, and D. Singh, "Human AI: Social network analysis," in Emotional AI and Human-AI Interactions in Social Networking, Elsevier, 2024, pp. 213–235. doi: 10.1016/B978-0-443-19096-4.00004-3.

[16] P. Filenta and D. Kydros, "The Application of Social Network Analysis to Economic and Regional Development: Tertiary Educational Attainment by Sex and Nuts 2 Regions," Studies in Business and Economics, vol. 18, no. 2, pp. 124–139, Aug. 2023, doi: 10.2478/sbe-2023-0028.

[17] W. Deng, "Research on Interactive Behavior of Online Discussion Board Based on Social Network Analysis," in 2021 4th International Conference on Education Technology Management, Tokyo Japan: ACM, Dec. 2021, pp. 201–205. doi: 10.1145/3510309.3510341.

[18] J. Scott, Social network analysis, 4th edition. Los Angeles London New Delhi Singapore Washington, DC Melbourne: SAGE, 2017.

[19] S. Wasserman and K. Faust, Social network analysis: methods and applications. in Structural analysis in the social sciences, no. 8. Cambridge ; New York: Cambridge University Press, 1994.

[20] S. P. Borgatti, "Centrality and network flow," Social Networks, vol. 27, no. 1, pp. 55–71, Jan. 2005, doi: 10.1016/j.socnet.2004.11.008.

[21] L. C. Freeman, "Centrality in social networks conceptual clarification," Social Networks, vol. 1, no. 3, pp. 215–239, Jan. 1978, doi: 10.1016/0378-8733(78)90021-7.

[22] W. Zhang and J. Jian, "Research Hotspots, Research Frontiers, and Management Significance: A Bibliometric Analysis and Review of Global Food Waste of Students Research Based on CiteSpace," Sustainability, vol. 16, no. 8, p. 3145, Apr. 2024, doi: 10.3390/su16083145.

[23] D. Wulandari, S. H. Utomo, and B. S. Narmaditya, "Waste Bank: Waste Management Model in Improving Local Economy," International Journal of Energy Economics and Policy, vol. 7, no. 3, pp. 36–41, 2017.

[24] S. Kumar et al., "Challenges and opportunities associated with waste management in India," R. Soc. open sci., vol. 4, no. 3, p. 160764, Mar. 2017, doi: 10.1098/rsos.160764.

[25] N. Ferronato and V. Torretta, "Waste Mismanagement in Developing Countries: A Review of Global Issues," IJERPH, vol. 16, no. 6, p. 1060, Mar. 2019, doi: 10.3390/ijerph16061060.

[26] P. Wang, B. McCarthy, and A. B. Kapetanaki, "To be ethical or to be good? The impact of 'Good Provider' and moral norms on food waste decisions in two countries," Global Environmental Change, vol. 69, p. 102300, Jul. 2021, doi: 10.1016/j.gloenvcha.2021.102300.