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Article

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Abstract: Wastewater management in Bogor, Indonesia, faces significant challenges to achieving a sustainable state. The growth of self-help settlements which are sporadic, unplanned, unorganized, and very dense, has an impact on the government's difficulties in providing sustainable wastewater management services. The research aims to examine fast-growing areas of self-help settlements, identify critical elements as a basis for strategy, and map the roles and influence of stakeholders in managing fast-growing areas in self-help settlements based on domestic wastewater management. This research uses a case study approach. Data were collected through observation, interviews, and focus group discussions. Data in this study were analyzed using Mactor software. The result showed knowledge and understanding of the correct management of domestic wastewater are the basis for achieving the actors' goals. In an implementation, social capital is needed to increase community participation by providing incentives that can affect the management of domestic wastewater, and it is necessary to increase the capacity of actors to assist the community in managing domestic wastewater. Ease of implementation at the community level must be based on community-based planning with government assistance so that the community itself carries out the decision on the type of domestic wastewater management by considering the advantages and disadvantages of each wastewater management system.

Keywords: actor; influence; mactor analysis; policy; strategy

1. Introduction

Water, sanitation, and hygiene (WASH) have long been recognized as essential determinants of human health. Inadequate WASH is one of the main factors increasing the risk of diarrheal disease, a leading cause of death and disability worldwide (GBD Diarrhoeal Diseases Collaborators 2017). In addition, inadequate water and sanitation have been linked to several serious diseases, such as worm infections, malnutrition in children, and impaired cognitive development [1,2].

The importance of the role of the clean water and sanitation sector and the inclusion of WASH in the Millennium Development Goals (MDGs) and the United Nations (UN) International Decade of Action "Water for Life" 2005–2015 (UN 2015), there are still significant gaps in various countries. For example, in 2015, 2.3 billion people still lacked basic sanitation, and 844 million did not have essential drinking water services [3]. The Sustainable Development Goals (SDGs), which replaced the MDGs, aim to further increase attention to WASH by working to ensure safe drinking water and basic sanitation for all [4]. Within a country, urban populations are far more likely to have sewer connections and piped water supply. However, the fact remains that in some developing countries, access to urban areas has stagnated or increased only slightly, especially in informal settlements, which are growing in many developing countries.

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In developing countries, especially Indonesia, most settlements in urban areas are informal. Self-help settlements or informal settlements are settlements built by the community themselves; houses in self-help settlements are generally built by the community on the initiative of the community itself, which is carried out individually [5] or involving local institutions [6]. Self-help settlements have limited basic facilities in the form of services and infrastructure and public utilities or housing infrastructure [4,5]. The quality of the buildings and infrastructure needs to meet government technical standards [4], including the condition of building materials [5], design and construction [7], and the physical condition of unstructured buildings [5]. In several locations, self-supporting settlements occupy land that does not follow spatial planning, for example, standing in river-border areas, along railroad tracks, and disaster-prone areas [4,8], violating state regulations in terms of land ownership and urban planning [7], unclear land ownership [4], and development without planning [8].

Housing and settlement areas have yet to accommodate the needs of housing developments and self-help settlements, which low-income people mostly inhabit. If the government cannot control, direct, and foster the growth of self-help settlements, it will result in slums [9]. Slum self-help settlements generally lack proper and safe sanitation facilities [10]. Inadequate sanitation facilities can cause various diseases caused by infections, such as diarrhea [11]. Poor sanitation results in stunted growth of children; it is predicted that 50% of children's malnutrition cases are closely related to diarrhea and intestinal infections caused by poor water, sanitation, and hygiene conditions, where access to proper sanitation interventions can reduce stunting [12].

Efforts to prevent slum settlements need to be carried out starting from the beginning when settlements are formed, especially in settlements that are still underdeveloped but have the potential to grow fast and are prone to slums. Restructuring requires a considerable cost [5], in addition, there is also considerable resistance from the residents if the government repairs or rebuilds the settlement environment. Hence, the effort currently being carried out is to improve the infrastructure of the slum settlement environment by minimizing changes to the arrangement of buildings, most of which cannot be handled thoroughly and require very high costs.

Nowadays, there are few self-help settlements in Indonesia, especially in Bogor City, where building and sanitation arrangements in the slums have been incomplete. The growth of self-help settlements which are sporadic, unplanned, unorganized, and very dense, has an impact on the government's difficulties in providing sustainable sanitation and drinking water services. There must be a clear strategy for managing sanitation and wastewater in Indonesia, especially in Bogor City. In addition, the stakeholders in the sanitation and wastewater management system have yet to identify the role of each stakeholder. The problem of self-help settlements is also caused by stakeholders' need for optimal participation in the management of self-help settlements, including the government, community leaders, non-governmental organizations, the role of women, and other community groups. This can be reflected in the low sustainability of domestic wastewater management, including financing, technical and environmental aspects [13]. Therefore, stakeholder analysis is an essential instrument for determining the direction and strategy of sanitation and wastewater management policies appropriately in the future. The research aims to examine fast-growing areas of self-help settlements, identify critical elements as a basis for strategy, and map the roles and influence of stakeholders in managing fast-growing areas in self-help settlements based on domestic wastewater management.

2. Literature Review

2.1. Wastewater Management

The problems of domestic wastewater management problems are related to technical barriers and physical environmental conditions [14], soil conditions [15], uncertain housing conditions [15], economic and financial barriers [14,15], institutional barriers [14], and structural barriers that come from the government. In addition, structural obstacles are the most difficult to overcome due to

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conflicts of interest and policies [14], and political factors [16]. In addition, the process of making government policies that are centralized influences sanitation conditions and clean water supply [16].

The strategy for managing sanitation in self-help settlements is necessary for sustainability, including careful planning, appropriate technology, scope of service, and ability to operate and maintain. In addition, it is necessary to plan for sanitation development in the long term with clear development and financing targets [17]. From the community's point of view, the success of sustainable sanitation can be measured by independent and programmed management. Therefore, it is necessary to empower the community to increase self-reliance to actively maintain and manage domestic wastewater treatment facilities [18]. In addition, Afandi et al. [19] reported that the strategy for sustaining a communal domestic wastewater management system is building community and institutional wastewater management capacity, developing alternative financing for partnership-based wastewater management, and increasing coordination and division of roles in sanitation working groups.

Mitchell et al. [20] reported the sustainability of activity management in the context of the daily functioning of community-based sanitation through informal and formal institutional arrangements (governance) to improve governance by paying attention to aspects that need attention and the actors in charge. Mitchell et al. [21] recommend collaboration or formal collaboration to establish roles and responsibilities based on sanitation risks. The role of local government in managing sanitation in Indonesia includes ensuring the treatment of domestic wastewater according to quality standards and providing understanding to the public to pay for wastewater management, providing support at the construction stage, carrying out intensive socialization on environmental impacts caused by water pollution by domestic waste and implementing pollutant tariffs pays with affordability considerations [17].

Domestic wastewater management in urban areas is recommended to use septic tanks and a combination of a centralized and local wastewater management system, in contrast for locations that are densely populated and inhabited by low-income people, community-based sanitation is most suitable, namely domestic wastewater treatment facilities in the form of septic tanks that can accommodate waste from many households (maximum 200) or one septic tank equipped with several toilets and used together [22]. The community-based management approach is carried out through a community-based communal septic tank system that serves informal self-help settlement areas, preferably in slum areas [23].

2.2. Matrix of Alliance, Conflicts, Tactics, Objective and Recomenndations (MACTOR) analysis

MACTOR analysis explores the strengths between actors, similarities, differences, and problems to achieve the goals of the studied system, which are influenced by issues or factors; this analysis interacts between actors and factors [24,25]. The relationship between actors and factors is influenced by several variables, including a. position, the variable that represents the actor's preference for the desired goal; b. salience, namely the priority of an objective to the achievement of the overall objectives of the actor; c. clout, namely the power of actors to directly influence objectives in various ways; d. influence, namely the power possessed by actors to influence the behavior of other actors. The output of MACTOR is mapping the role and influence of stakeholders, identifying and knowing the interactions of factors and actors that play a role in sustainability, mapping actors or entities to influence the desired outcomes on other actors, and identifying issues/problems in domestic wastewater management faced by actors.

Actor analysis is a set of methods to identify actors' strengths, weaknesses, and attitudes, rank actor positions on various strategic issues, assess convergence and divergence, and anticipate possible coalitions and conflicts among actors [26]. Through a reasonably comprehensive analysis, a multi-actor model is an approach that is of great interest to analysts because of its comprehensiveness and practicality [27].

The multi-actor model aims to gain an in-depth understanding of the system and its possible evolution by emphasizing the perspectives and interests of actors as well as the pattern of connectedness between all actors [28]. The multi-actor model will assist decision-makers in

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recognizing the leading roles actors play concerning their ability to influence important factors shaping the system's future. Multi-actor models are beneficial for identifying actor strategies that tend to be coherent and knowing the effects of actor actions on critical factors in the development of a system [29].

In the multi-actor approach, the system is formalized as a game pattern between actors who have positions, different interests (salience), and influencing of the results (influence) through the use of personal preferences (clout) [30]. From this approach, actors are defined as entities that have a position in the system being studied and play a role in mobilizing their resources to influence outcomes directly or indirectly through their influence on other actors [27]. By understanding the playing patterns of system actors, the system development process can be carried out in a directed manner to anticipate current and future conditions (Figure 1).

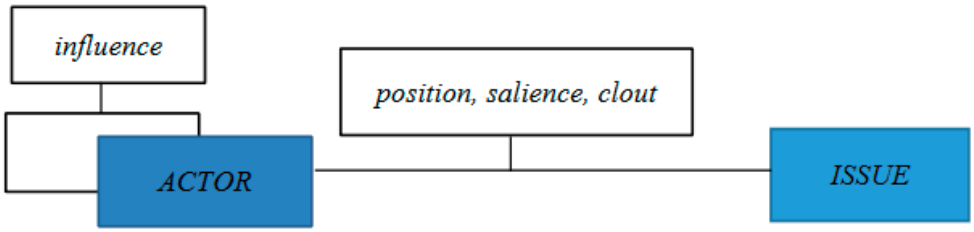

Figure 1. The Basic Concept of Multiactor [24].

MACTOR analysis conducts a relative strength analysis between actors or stakeholders and explores similarities and differences in various problems and objectives to be achieved [24]. In addition, Bendahan et al. [24] identified several variables that link actors/stakeholders and issues (factors), including: 1). Position, namely the variable that represents the actor's preference for the desired outcome/goal; 2). Salience, namely the priority that shows how vital the realization of an outcome is to achieving the overall goals of the actor/stakeholder; 3). Clout, which describes the power of actors to directly influence the outcome/objectives of an issue in their various ways; 4) Influence, namely the power possessed by actors/stakeholders to influence the behavior of other actors.

3. Materials and Methods

3.1. Study site

Bogor, Indonesia, is geographically located at 106º 48' East Longitude and 6º 36' South Latitude with a distance of ± 56 Km from the Capital City of Jakarta (Figure 2). Administratively, Bogor is divided into 6 Districts and 68 Sub-Districts, of which the built-up area of Bogor has reached 4,994 Ha. The topography of the Bogor Town area varies between flat and hilly (0 - 300 m above sea level). The slopes in Bogor range from 0-40%. Slope 0 — 2% (flat) for 1,763.94 ha, 2 — 15% (sloping) for 8,091.27 ha, 15 — 25% (slightly steep) for 1,109.89 ha, 25 — 40% (steep) for 764.96 ha, and > 40% (very steep) of 119.94 ha. The population density of the Bogor Town itself in 2019 reached 10,791 people per square kilometer. The total number of households in Bogor in 2019 increased by 49,250 to 310,035 from the initial 260,785 households in 2014.

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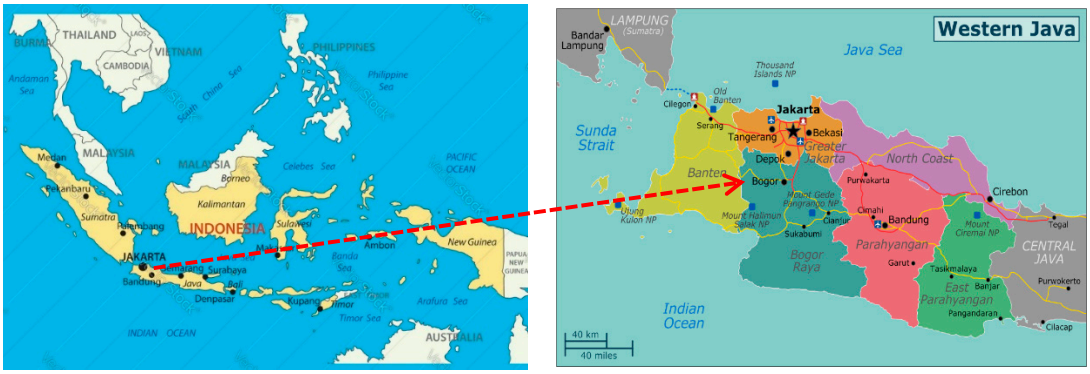

Figure 2. The geographical position of the study area within Indonesia, especially Bogor, West Java Province.

3.2. Data Collection

This research uses a case study approach. Data were collected through observation, interviews, and focus group discussions (FGD). Observation activities are intended to obtain an overview of the stakeholders involved in sanitation and wastewater management in the Bogor area. The observation activity aims to describe the sanitation and wastewater management stakeholders in the Bogor area. In-depth interviews were conducted with informants who were determined purposively based on the informants' involvement and understanding of sanitation and wastewater management in Bogor, West Java. Interviews were conducted by visiting the informant's location and assisted by an assistant. The interview asked about the informant's sanitation and wastewater management knowledge in Bogor, West Java. Meanwhile, the focus group discussion (FGD) aims to find out the interests and strengths of each stakeholder and the strategic goals that can be achieved in the development of sanitation and wastewater management in Bogor, West Java. FGDs with actors were held five times, namely two FGDs at the sub-district level (Mekarwangi Sub-District and Mulyaharja Sub-District) and one FGD at the town level.

There are 38 stakeholders (divided into three groups) involved in the data collection process, including: 1). Stakeholders from the government side include: the Ministry of Public Works and Human Settlements (KPUPR), West Java Province Housing and Settlements Agency, Bogor Town Regional Development Planning Agency, Bogor Town Public Works and Spatial Planning Agency (DPUPR), Health Service (Dinkes) Bogor Town, Bogor Town Housing and Settlement Service (Disperumkim), Bogor Town Environment Service (DLH), Regional Technical Implementation Unit (UPTD) Wastewater Management (PAL) at the Public Works and Spatial Planning Office (DPUPR) Bogor Town, District, Kelurahan, 2) Stakeholders in the form of groups whose members are a mixture of government and society, including the Bogor Town Sanitation Working Group (Pokja). Professional stakeholders include Sanitarians, Sanimas Field Facilitators (TFL), Kotaku Field Facilitators (TFL), and 3) Stakeholders from non-governmental organizations, including Non-Governmental Organizations (NGOs), Bogor Town Aksansi, USAID IUWASH PLUS in Bogor Town, Sanitation Microfinance Institutions (LKM), Islamic Boarding Schools, Religious Institutions, Political Parties Institutions. Stakeholders from the community at the grassroots level, both in the form of institutions/groups and individuals, include Village Community Empowerment Institutions (LPMK), Family Empowerment and Welfare Mobilization Teams (Kelurahan TP PKK), Community Self-Reliance Agencies (BKM), Community Self-Help Groups (KSM) Sanitation, Sanitation Non-Governmental Groups (KSM), Sanitation Utilizers and Maintainers (KPP) Groups, Youth Organizations, Posyandu Cadres, Housewives, Community Leaders, Youth Leaders, Religious Leaders, Female Leaders. Other stakeholders include the media, universities (PT), and companies/private sector.

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3.3. Data Analysis

All data in this study were analyzed using Mactor software (Matrix of Alliances and Conflicts Tactics, Objectives, and Recommendations). Mactor is a software developed by Michel Godet in 1991 to deeply analyze power relations between actors, actors' competitiveness, and actors' attitudes towards goals. Mactor's work is based on inter-actor influence, distinguished as direct, indirect, and competitive [31].

The stages of Mactor's analysis consist of: 1. determining system actors; 2. determining a set of goals; 3. describing the power relations of actors as measured by a scale of 0 (no influence) to 4 (powerful influence); and 4. describing the attitude (level of resistance) of actors towards goals as measured by a scale of (+) supports, (0) neutral and (-) opposes and the importance of goals for actors as measured by a scale of 0 (not important) to 4 (very important) [26].

Input data were obtained from the workshop and arranged in the form of matrices (Matrix Direct Influence (MDI) and Matrix Actor and Objective (MAO)) which were then processed by Mactor software to produce different analysis results. The analysis results are presented in graphs and tables, which describe the competitiveness of actors in sanitation and wastewater management in Bogor Town, Indonesia, descriptions of alliance patterns and possible conflicts between these actors, and descriptions of actor support for the goals to be achieved and realized from the development of sanitation and wastewater management.

4. Results and Discussion

The goal of sustainable wastewater management must consider issues, problems, and constraints in domestic wastewater management [32]. The results of the analysis show that the objectives of wastewater management in Bogor, Indonesia, are classified into five aspects, including social aspects, financial aspects, technical aspects, institutional aspects, and policy aspects.

Based on the social aspect, the objectives of wastewater management in Bogor, Indonesia, include: 1) The community is increasingly aware of how to manage domestic wastewater (SPAHAM) properly; 2) Realization of culture and habits of clean and healthy living (free open defecation) (SBUDAYA). Meanwhile, based on the financing aspect includes 1) Ease of access to financing for the construction of domestic wastewater infrastructure (DBANGUN); 2) Easy access to operation and maintenance financing in the form of non-financial assistance (DOM).

In addition, the objectives of wastewater management in Bogor, Indonesia, based on technical aspects, include 1) the Availability of a spatial plan based on domestic wastewater management in medium and long-term informal self-help housing (TRUANG); 2) There is control/supervision of buildings and the environment based on domestic wastewater management in informal self-help settlements (TKENDALI); 3) Increasing the construction of domestic wastewater treatment facilities that meet the technical requirements in informal self-help settlements (TBANGUN); 4) Increased maintenance of domestic wastewater treatment infrastructure (TPELIHARA); 5) Increased accessibility for disposal/absorption of feces sludge (TSEDOT); 6) Reducing water and soil pollution due to domestic wastewater (TMONEV); 7) Prevent disasters in the form of landslides or ground collapses due to the flow of domestic wastewater that enters the ground (Tlongsor).

Based on the institutional aspect, the objectives of managing wastewater management in Bogor, Indonesia, include: 1) Increasing the role of community institutions in managing domestic wastewater that can accommodate various aspects of management (LEMBAGA); 2) Increasing the capacity of the government (regional apparatus organizations) in managing domestic wastewater that can accommodate various aspects of management (LKAPEM); 3) Increased government assistance to the community in managing domestic wastewater in informal self-help housing (LDAMPEM); 4) Increased partnerships between stakeholders in domestic wastewater management (LMITRA).

Furthermore, based on the policy aspect, the objectives of wastewater management in Bogor, Indonesia, include: 1) There is a policy that supports the ease of implementation of domestic wastewater management plans in informal self-help housing (BIJAK); 2) Increased security for land assets and domestic wastewater treatment infrastructure (BASET); 3) Increasing the adequacy of

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funds to manage domestic wastewater in informal self-help housing (BDANA); 4) Existence of implementation rules as a derivative of regional regulations regarding the provision of incentives, disincentives, awards and sanctions (BATURAN).

Direct and indirect influence between actors

The FGD produced an initial matrix from Mactor's analysis in the form of Matrix Direct Influence (MDI) and Matrix Valued of Position (2MAO) (Figure 3). These two matrices are inputs for Mactor's overall analysis. Stakeholders in the first column are assessed for their influence on the actors in the first row. The level of influence of actors on each other is measured with 0 (no influence), 1 (influence on operational procedures), 2 (influence on work), 3 (influence on actor's mission), and 4 (very influence on actor's mission) (Figure 3a). The actor's attitude and judgment reflect the actor's position towards this goal on whether to support or reject the goal. This matrix is filled with 0 (goal has a dismal outcome), 1 (goal interferes with the actor's operational procedures), 2 (goal interferes with the success of the actor's work), 3 (goal interferes with the achievement of the actor's mission, and 4 (goal interferes with the actor's existence) (Figure 3b).

MDI

	DPRD	BANK	PDAM	TPPKK	BAPPEDA	DISDIK	DINKES	DPUPR	DLH	DISRUMKIM	DISKOMINFO	DPMPPA	POLPP	BPBD	KEC.TANSAR	KEC.BOSEL	OPERATOR	FKS	AKSANSI	PT	MEDIA	LKM	PUSAHA
DPRD	0	1	3	3	2	2	3	3	4	4	1	1	2	1	3	3	2	3	2	1	0	0	2
BANK	2	0	2	2	3	1	3	2	2	2	1	1	0	1	1	1	1	1	1	1	0	0	0
PDAM	2	1	0	3	4	2	4	3	3	3	2	1	2	2	3	2	1	4	1	1	2	2	1
TPPKK	2	0	3	0	2	0	4	0	2	3	0	3	0	0	3	3	1	4	0	0	0	0	0
BAPPEDA	1	1	2	3	0	1	4	4	1	3	0	1	1	1	3	3	4	4	0	1	1	1	1
DISDIK	1	0	1	2	2	0	3	3	1	2	1	1	1	0	2	2	3	2	1	1	0	0	0
DINKES	2	0	3	3	3	2	0	4	2	3	1	0	0	0	3	3	3	4	0	0	1	1	2
DPUPR	1	0	3	2	4	0	4	0	4	4	2	3	0	0	4	4	4	3	1	0	0	3	1
DLH	0	0	1	0	1	0	3	4	0	2	0	0	0	0	0	0	4	3	2	0	0	0	0
DISRUMKIM	3	1	3	1	3	3	3	3	3	0	3	2	1	1	3	3	3	3	1	2	1	1	2
DISKOMINFO	0	0	1	1	1	1	2	2	2	2	0	2	1	1	1	1	2	1	0	0	0	0	0
DPMPPA	0	1	2	3	2	1	3	3	2	3	1	0	0	0	2	2	3	3	0	0	0	0	0
POLPP	1	0	2	2	2	0	2	1	1	2	1	2	0	0	1	1	2	2	1	1	1	0	1
BPBD	0	0	1	3	2	2	3	2	0	0	1	1	0	0	1	1	1	0	0	1	1	0	0
KEC.TANSAR	0	0	4	3	2	2	3	3	1	2	1	3	0	1	0	3	2	1	0	0	0	2	0
KEC.BOSEL	1	2	3	3	2	1	4	3	1	3	1	1	0	0	3	0	3	3	0	1	0	0	0
OPERATOR	0	0	0	4	4	4	4	4	2	0	3	0	0	0	3	3	0	3	0	0	0	0	0
FKS	1	0	1	2	2	1	3	3	1	3	1	1	1	1	2	2	2	0	0	1	0	0	0
AKSANSI	0	0	0	1	1	0	1	0	1	1	0	3	1	1	2	2	1	4	0	3	3	0	1
PT	2	1	2	2	3	1	3	3	2	3	1	1	0	1	2	2	2	2	1	0	2	1	1
MEDIA	1	0	3	3	3	0	3	3	1	1	0	2	1	1	2	2	3	3	0	3	0	0	0
LKM	1	2	3	1	1	0	2	2	2	2	1	1	1	2	2	2	2	1	2	0	0	0	0
PUSAHA	2	1	1	2	2	1	3	3	1	2	1	0	0	0	2	2	3	2	0	1	2	1	0

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(**a**)

2MAO

	SPAHAM	SBUDAYA	DBANGUN	DOM	TRUANG	TKENDALI	TBANGUN	TPELIHARA	TSEDOT	TMONNEV	TLONGSOR	LEMBAGA	LKAPEM	LDAMPEM	LMITRA	BUAK	BASET	BDANA	BATURAN
DPRD	2	2	1	-1	1	1	1	1	1	2	2	1	1	1	1	2	1	-1	1
BANK	1	3	2	3	-1	3	2	3	2	3	4	3	1	1	1	-1	1	1	-1
PDAM	3	2	1	2	-1	-1	1	1	2	2	1	2	2	2	2	1	2	1	1
TPPKK	3	1	1	1	-1	-1	1	2	1	1	1	2	2	2	1	-1	1	-1	-1
BAPPEDA	2	2	2	1	-1	-1	2	3	2	3	3	2	2	1	1	1	2	1	-2
DISDIK	2	2	1	1	-1	-1	-1	-1	1	1	1	1	3	2	1	-1	1	-1	-1
DINKES	3	3	3	0	-1	-1	2	2	2	2	1	2	2	2	2	2	2	2	-1
DPUPR	1	1	-1	1	-2	-3	2	2	1	1	1	2	1	3	1	-1	-2	1	-4
DLH	-1	-1	1	1	-1	-1	1	1	1	1	-1	-1	1	1	1	1	-1	-1	1
DISRUMKIM	2	2	2	-1	3	3	2	3	1	3	4	3	3	2	3	2	3	2	-1
DISKOMINFO	2	2	-1	-1	-1	-1	2	4	-1	3	4	4	-1	-1	3	-1	-1	-1	-1
DPMPPA	2	2	-1	1	1	2	2	2	2	2	-1	1	3	2	2	1	1	1	-1
POLPP	-1	2	-1	2	-1	-1	-1	2	1	-1	2	1	3	3	1	2	2	1	-1
BPBD	3	3	-1	-1	4	2	-1	-3	-4	2	4	2	1	-1	2	2	-1	-1	-1
KEC.TANSAR	-2	-2	-4	-3	-4	-3	-2	-1	-2	-2	1	1	-2	-1	-1	-1	-2	-2	-3
KEC.BOSEL	-1	-3	-2	-1	-1	1	1	1	-1	1	-1	1	2	1	1	-1	-1	-1	-1
OPERATOR	1	2	2	1	1	1	3	2	3	3	2	-1	3	2	3	2	3	2	-1
FKS	2	1	3	1	-1	-2	-1	2	2	1	2	1	1	2	1	-1	2	-1	-3
AKSANSI	-2	-1	1	1	1	-1	1	-1	-1	1	1	-1	-1	-1	-1	-1	-1	-1	4
PT	2	-1	-1	2	-1	-1	-1	2	1	1	1	2	2	3	2	2	2	1	1
MEDIA	-1	3	-1	-1	1	-1	3	2	1	1	-1	3	-3	-1	-1	-2	-2	-1	
LKM	-1	2	-1	-1	-1	-1	1	1	1	1	1	1	1	1	1	-1	-1	-1	1
PUSAHA	2	2	2	1	3	3	2	2	2	2	3	1	3	1	3	1	2	1	1

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(**b**)

Figure 3. a) Matrix of direct influence between actors (MDI); b) Matrix Valued of Position (2MAO).

The direct and indirect influences between actors are presented in Figure 4; the far right column (Ii) shows the value of the net effect (both direct and indirect effects) [33]. The bottom row (Di) denotes net dependencies (both direct and indirect dependencies). From the results of this matrix, the Housing and Settlements Agency (DISRUMKIM) has the most influence, followed by the Regional Drinking Water Company (PDAM), and the Regional People's Representative Council (DPRD). DISRUMKIM is influential because it is an agency that has a considerable budget to handle development and repairs, especially settlement infrastructure and repair of uninhabitable houses (RTLH), including the development of domestic wastewater infrastructure. PDAM ranks number two with the most substantial influence because it intervenes in drinking water/clean water to support domestic wastewater management. It also provides Corporate Social Responsibility by contributing to giving septic tanks. DPRD occupies the third position, which is very influential because the duties and functions of the DPRD, together with the government, determine and approve the amount of the regional budget and various policies.

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MDII	DPRD	BANK	PDAM	TPPKK	BAPPEDA	DISDIK	DINKES	DPUPR	DLH	DISRUMKIM	DISKOMINFO	DPMPPA	POLPP	BPBD	KEC.TANSAR	KEC.BOSEL	OPERATOR	FKS	AKSANSI	PT	MEDIA	LKM	PUSAHA	Ii
DPRD	19	9	34	36	37	22	43	39	31	39	21	25	10	11	39	38	38	41	11	14	12	12	12	574
BANK	16	7	24	25	27	18	28	25	24	26	17	18	10	11	26	26	26	27	10	11	8	9	11	423
PDAM	20	11	36	37	40	22	48	43	32	40	21	28	12	14	39	39	42	43	13	15	10	12	12	593
TPPKK	12	7	23	23	23	16	29	29	19	26	12	13	7	7	24	23	24	28	6	7	5	7	8	355
BAPPEDA	20	10	32	33	35	22	40	37	28	33	23	23	9	11	36	36	34	36	10	13	9	12	10	517
DISDIK	14	8	24	26	29	17	29	26	23	26	17	19	8	9	28	28	28	28	8	10	7	10	11	416
DINKES	18	8	29	32	34	19	39	36	27	35	18	20	11	10	36	35	33	37	9	10	7	11	9	484
DPUPR	15	10	30	32	33	20	43	40	29	35	18	19	9	11	34	33	37	37	8	9	7	11	9	489
DLH	8	3	11	15	18	11	19	18	14	15	10	10	5	5	18	18	18	18	5	7	6	7	8	253
DISRUMKIM	21	10	35	41	40	23	48	46	34	41	23	24	12	13	42	41	43	43	12	14	12	12	12	601
DISKOMINFO	12	5	18	18	20	14	21	20	20	18	15	15	6	6	19	19	21	20	7	9	6	7	8	309
DPMPPA	15	6	25	25	28	18	31	28	23	28	17	17	7	8	28	28	27	30	7	8	5	10	7	409
POLPP	16	8	22	24	26	17	26	23	24	24	16	17	9	11	25	25	24	26	7	11	9	9	11	401
BPBD	11	5	18	20	19	12	20	17	16	19	11	14	5	6	20	20	18	20	4	6	5	7	6	293
KEC.TANSAR	14	8	29	28	29	16	33	29	24	29	16	19	8	9	30	29	28	31	7	8	6	10	7	417
KEC.BOSEL	17	8	29	29	31	20	35	32	26	30	19	20	8	10	31	30	27	32	8	9	6	11	9	447
OPERATOR	9	3	21	23	23	12	32	28	17	27	10	15	4	4	24	24	26	27	4	4	2	7	4	324
FKS	15	8	26	24	28	18	28	26	23	25	18	19	7	8	27	27	27	26	8	10	7	10	10	399
AKSANSI	11	7	20	22	23	12	25	24	16	21	11	15	5	7	20	20	23	23	4	13	11	7	6	342
PT	20	10	32	33	37	22	38	35	30	34	21	23	12	13	36	36	36	36	11	14	10	12	11	548
MEDIA	15	8	28	31	33	17	35	32	24	31	17	19	7	9	32	31	29	32	7	11	9	11	9	468
LKM	15	9	24	26	28	19	29	27	25	25	18	19	9	12	26	25	25	26	10	12	9	9	10	428
PUSAHA	18	9	28	29	32	19	32	30	25	28	18	21	10	11	31	31	31	31	10	12	7	11	10	474
Di	332	170	562	609	638	389	712	650	540	614	372	415	181	210	641	632	639	672	182	223	166	215	200	9964

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Figure 4. Matrix of direct and indirect influence between actors (MDII).

The map of influence and dependence between actors is presented in Figure 5. Quadrant I, namely actors with a strong influence but low dependence [34,35]. In this study, quadrant I consisted of DPRD, universities (PT), entrepreneurs (PUSAHA), and media (MEDIA) (Figure 5). DPRD is an institution that determines and approves the budget. Universities (PT) have a strong influence as institutions that greatly help the government and provide input suggestions and counseling to the community through field visits and actual work lectures related to domestic wastewater management. Media is a stakeholder that can disseminate information and influence society. Furthermore, entrepreneurs as stakeholders can provide corporate social responsibility (CSR) to the community. On the other hand, there is a low dependency because it is not directly in contact with domestic wastewater management.

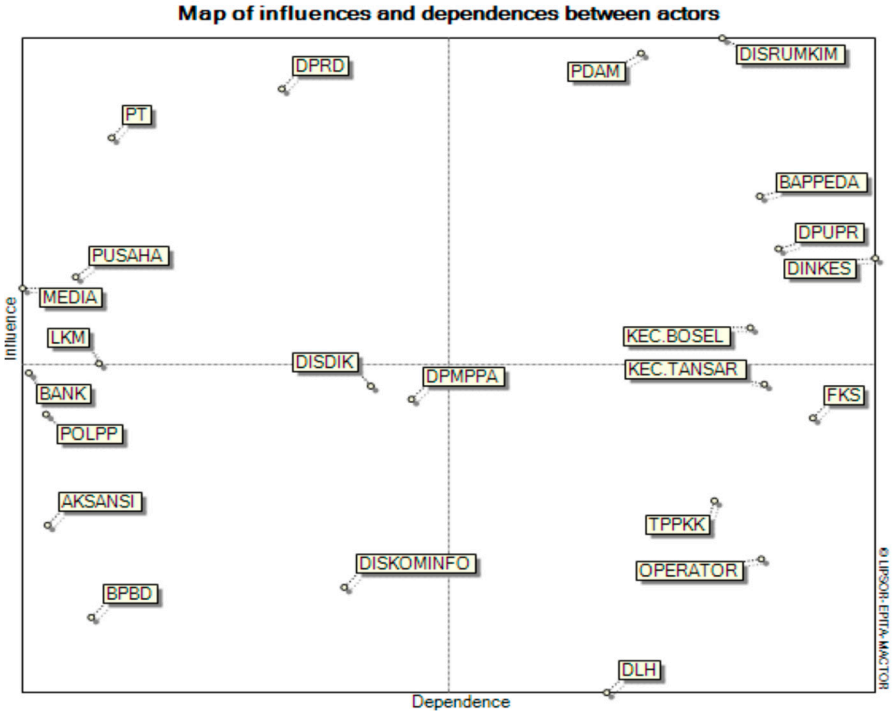

Figure 5. Map of influences and dependences between actors.

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Quadrant II is a stakeholder with strong influence and dependency [34,35]. In this study, PDAM, Disrumkim, BAPPEDA, DPUPR, and Health Office (Dinkes). These actors have the task of planning and budgeting as well as coordinating development related to domestic wastewater management.

Quadrant III comprises stakeholders with low influence but high dependency [34,35]. In this study, quadrant III consisted of Tanah Sareal District (KEC. TANSAR), Healthy City Forum (FKS), Bogor Town Family Empowerment and Welfare Mobilization Team (TPPKK), Regional Technical Implementation Unit (UPTD), Wastewater Management (PAL) at the Public Works and Spatial Planning Service (DPUPR) as the desludging operator (OPERATOR), and the Environment Service (DLH). The low influence is due to budget constraints; thus, there is a high dependency on the budget, which results in low community assistance performance.

In addition, operators of feces cleaning from the DPUPR as actors have low influence due to the community's need for more utilization of desecration operators.

Quadrant IV comprises actors with low influence and dependence [34,35]. Office of Education (DISDIK), Service for Empowerment and Protection of Women and Children (DPMPPA), Office of Communication and Information (DISKOMINFO), Civil Service Police Unit (POL PP), Regional Disaster Management Agency (BPBD), Microfinance Institutions (LKM), Banks in Bogor Town (BANK), the KSM Sanitation Association (AKSANSI) is included in quadrant IV. These actors are included in quadrant IV because the management of domestic wastewater has not been integrated with the duties and functions of the organization, for example, DISDIK by increasing/strengthening curriculum related to the Environment, DPMPPA related to increasing the role of women, DISKOMINFO by increasing/strengthening the role of social media in campaigning culture of clean and healthy living, POL PP by increasing/strengthening the function of space supervision/control and orderly use of water bodies, BPBD by increasing/strengthening the function of disaster mitigation caused by uncontrolled/absence of domestic wastewater management which can cause in disaster (landslide).

The scale of net influence among actors is presented in Figure 6. The actors who exert more influence than they receive are Universities (PT), Media, Entrepreneurs (PUSAHA), Banks, and DPRD. Stakeholders who give less influence than they receive are desecration operators, DLH, and Healthy Town Forum. Recommendations to increase the role of DLH in managing domestic wastewater by expanding its duties, not limited to testing the processed results of communal WWTPs, and monitoring houses where feces are still open, strengthening community capacity in managing domestic wastewater together with other OPDs. Increasing the desludging of sludge by desludging operators and increasing the role of the Healthy Town Forum to provide more advocacy to the community. Actors with high competitiveness are Universities (PT), followed by DPRD and Media. Thus, the role of DPRD, Media and Universities is needed as a lever for improving domestic wastewater management (Figure 7).

NS	DPRD	BANK	PDAM	TPPKK	BAPPEDA	DISDIK	DINKES	DPUPR	DLH	DISRUMKIM	DISKOMINFO	DPMPPA	POLPP	BPBD	KEC.TANSAR	KEC.BOSEL	OPERATOR	FKS	AKSANSI	PT	MEDIA	LKM	PUSAHA	Sum
DPRD		-7	14	24	17	8	25	24	23	18	9	10	-6	0	25	21	29	26	0	-6	-3	-3	-6	242
BANK	7		13	18	17	10	20	15	21	16	12	12	2	6	18	18	23	19	3	1	0	0	2	253
PDAM	-14	-13		14	8	-2	19	13	21	5	3	3	-10	-4	10	10	21	17	-7	-17	-18	-12	-16	31
TPPKK	-24	-18	-14		-10	-10	-3	-3	4	-15	-6	-12	-17	-13	-4	-6	1	4	-16	-26	-26	-19	-21	-254
BAPPEDA	-17	-17	-8	10		-7	6	4	10	-7	3	-5	-17	-8	7	5	11	8	-13	-24	-24	-16	-22	-121
DISDIK	-8	-10	2	10	7		10	6	12	3	3	1	-9	-3	12	8	16	10	-4	-12	-10	-9	-8	27
DINKES	-25	-20	-19	3	-6	-10		-7	8	-13	-3	-11	-15	-10	3	0	1	9	-16	-28	-28	-18	-23	-228
DPUPR	-24	-15	-13	3	-4	-6	7		11	-11	-2	-9	-14	-6	5	1	9	11	-16	-26	-25	-16	-21	-161
DLH	-23	-21	-21	-4	-10	-12	-8	-11		-19	-10	-13	-19	-11	-6	-8	1	-5	-11	-23	-18	-18	-17	-287
DISRUMKIM	-18	-16	-5	15	7	-3	13	11	19		5	-4	-12	-6	13	11	16	18	-9	-20	-19	-13	-16	-13
DISKOMINFO	-9	-12	-3	6	-3	-3	3	2	10	-5		-2	-10	-5	3	0	11	2	-4	-12	-11	-11	-10	-63
DPMPPA	-10	-12	-3	12	5	-1	11	9	13	4	2		-10	-6	9	8	12	11	-8	-15	-14	-9	-14	-6
POLPP	6	-2	10	17	17	9	15	14	19	12	10	10		6	17	17	20	19	2	-1	2	0	1	220
BPBD	0	-6	4	13	8	3	10	6	11	6	5	6	-6		11	10	14	12	-3	-7	-4	-5	-5	83
KEC.TANSAR	-25	-18	-10	4	-7	-12	-3	-5	6	-13	-3	-9	-17	-11		-2	4	4	-13	-28	-26	-16	-24	-224
KEC.BOSEL	-21	-18	-10	6	-5	-8	0	-1	8	-11	0	-8	-17	-10	2		3	5	-12	-27	-25	-14	-22	-185
OPERATOR	-29	-23	-21	-1	-11	-16	-1	-9	-1	-16	-11	-12	-20	-14	-4	-3		0	-19	-32	-27	-18	-27	-315
FKS	-26	-19	-17	-4	-8	-10	-9	-11	5	-18	-2	-11	-19	-12	-4	-5	0		-15	-26	-25	-16	-21	-273
AKSANSI	0	-3	7	16	13	4	16	16	11	9	4	8	-2	3	13	12	19	15		2	4	-3	-4	160
PT	6	-1	17	26	24	12	28	26	23	20	12	15	1	7	28	27	32	26	-2		-1	0	-1	325
MEDIA	3	0	18	26	24	10	28	25	18	19	11	14	-2	4	26	25	27	25	-4	1		2	2	302
LKM	3	0	12	19	16	9	18	16	18	13	11	9	0	5	16	14	18	16	3	0	-2		-1	213
PUSAHA	6	-2	16	21	22	8	23	21	17	16	10	14	-1	5	24	22	27	21	4	1	-2	1		274

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Figure 6. Net influence matrix.

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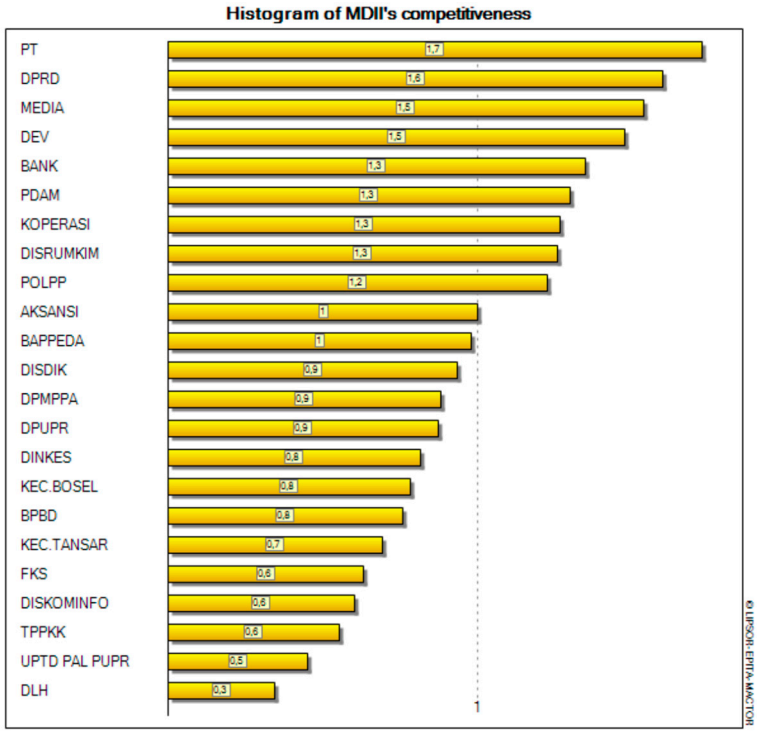

Figure 7. Histogram of competitiveness between actors.

The maximum direct and indirect influence matrix (MMDII) is presented in Figure 8. The maximum level of influence a stakeholder can have on other stakeholders (calculated from the far right column), where the most substantial influence in this study is by DPUPR, BAPPEDA, and DINKES. The maximum level of dependence that a stakeholder can have on other stakeholders (calculated from the bottom row), where the highest dependency in this study is FKS, DPUPR, and DINKES. Based on this, the actors who have the maximum influence and dependency are the DPUPR and the Health Office. According to the duties and functions of the agency, it is directly related to improving the performance of domestic wastewater management in the community.

MMDII	DPRD	BANK	PDAM	TPPKK	BAPPEDA	DISDIK	DINKES	DPUPR	DLH	DISRUMKIM	DISKOMINFO	DPMPPA	POLPP	BPBD	KEC.TANSAR	KEC.BOSEL	OPERATOR	FKS	AKSANSI	PT	MEDIA	LKM	PUSAHA	IMAXi
DPRD	0	2	3	3	3	3	3	4	4	4	3	3	2	2	3	3	4	3	2	2	2	3	2	63
BANK	2	0	3	3	3	2	3	3	2	3	2	2	2	2	3	3	3	3	2	2	2	2	2	54
PDAM	3	2	0	3	4	3	4	4	3	3	3	3	2	2	3	3	4	4	2	2	2	3	2	64
TPPKK	3	2	3	0	3	3	4	4	3	3	3	3	2	2	3	3	3	4	2	2	2	2	2	61
BAPPEDA	3	2	3	4	0	4	4	4	4	4	3	3	2	2	4	4	4	4	1	2	2	3	2	68
DISDIK	2	2	3	3	3	0	3	3	3	3	3	3	1	1	3	3	3	3	1	2	1	3	2	54
DINKES	3	2	3	3	4	3	0	4	4	4	3	3	2	2	4	4	4	4	2	2	2	3	2	67
DPUPR	3	2	4	4	4	4	4	0	4	4	3	3	2	2	4	4	4	4	2	2	2	3	2	70
DLH	2	1	3	4	4	4	4	4	0	4	3	3	1	1	4	4	4	3	2	2	2	3	2	64
DISRUMKIM	3	2	3	3	3	3	3	3	3	0	3	3	2	2	3	3	3	3	2	2	2	3	2	59
DISKOMINFO	2	1	2	2	2	2	2	2	2	2	0	2	1	1	2	2	2	2	2	2	1	2	2	40
DPMPPA	3	2	3	3	3	3	3	3	3	3	3	0	2	2	3	3	3	3	2	2	2	3	2	59
POLPP	2	1	2	2	2	2	2	2	2	2	2	2	0	2	2	2	2	2	1	2	2	2	2	42
BPBD	2	1	3	3	3	2	3	3	2	3	2	3	1	0	3	3	3	3	1	1	1	2	2	50
KEC.TANSAR	2	2	4	3	4	2	4	3	3	3	2	3	2	2	0	3	3	4	2	2	2	3	2	60
KEC.BOSEL	3	2	3	3	3	3	4	4	3	3	3	3	2	2	3	0	3	4	1	2	2	3	2	61
OPERATOR	2	2	3	4	4	4	4	4	4	4	3	3	1	1	4	4	0	4	2	1	1	3	2	64
FKS	3	2	3	3	3	3	3	3	3	3	3	3	1	1	3	3	3	0	1	2	1	3	2	55
AKSANSI	2	2	3	3	3	2	3	3	2	3	1	3	1	1	2	2	3	4	0	3	3	2	1	52
PT	3	2	3	3	3	3	3	3	3	3	3	3	2	2	3	3	3	3	2	0	2	3	2	60
MEDIA	2	2	3	3	3	3	3	3	3	3	3	3	2	2	3	3	3	3	1	3	0	3	2	59
LKM	2	2	3	3	3	2	3	3	3	3	2	2	2	2	3	2	2	3	2	2	2	0	2	53
PUSAHA	2	2	3	3	3	3	3	3	3	3	3	3	2	1	3	3	3	3	2	2	2	3	0	58
DMAXi	54	40	66	68	70	63	72	72	66	70	59	62	37	37	68	67	69	73	37	44	40	60	43	1337

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Figure 8. The maximum direct and indirect influence matrix (MMDII).

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Stakeholders who have competitiveness with a score of > 1 include the Media, Universities (PT), DPUPR, DPRD, BAPPEDA, PUSAHA, DINKES, DLH, PDAM, BANKS, OPERATORS, and AKSANSI (Figure 9). Based on the results of the Histogram of the competitiveness of the MDII matrix and the MMDII matrix (Figures 7 and 9), MEDIA's position in the MDII matrix is at number 3 below PT and DPRD. In contrast, MEDIA's position in the MMDII matrix is at number 1; it showed that MEDIA's competitiveness is higher than that of PT. and DPRD.

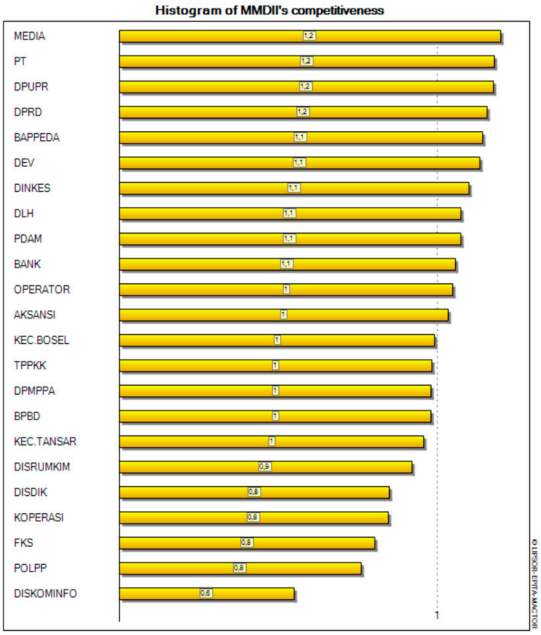

Figure 9. Competitiveness based on the MMDII matrix.

The actors who experienced obstacles in achieving the SBUDAYA goal (realizing a culture and habit of clean and healthy living) were DLH, TANSAR KEC, BOSEL KEC, AKSANSI, and PT (Figure 10). Based on interviews with these actors, this goal could not be achieved because the habit of open defecation has become a culture, and many people do it; on the other hand, there are limited government resources (budget) to eliminate open defecation. However, in this SBUDAYA goal, more actors agree, and the position scale tends to the left, which illustrates that more actors are optimistic that this goal will be achieved (with a positive sign (+)) (Figure 10).

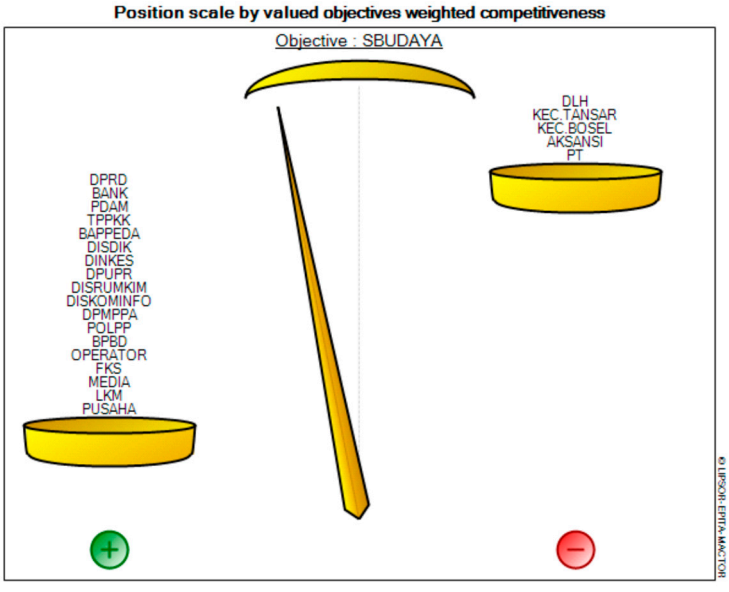

Figure 10. The scale of the actor's competitiveness position based on the achievement of SBUDAYA goal.

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Actor relations and goals

The relationship between actors and the order 1 goal is presented in Figure 11. DPRD is the most influential actor because it participates in determining the direction of development and budget approval, as well as with low dependency, states that the objectives of Ease of access to operation and maintenance financing are in the form of non-financial assistance (DOM). Increasing the adequacy of funds to manage domestic wastewater in informal self-help housing (BDAN) is challenging.

1MAO	SPAHAM	SBUDAYA	DBANGUN	DOM	TRUANG	TKENDALI	TBANGUN	TPELIHARA	TSEDOT	TMONNEV	TLONGSOR	LEMBAGA	LKAPEM	LDAMPEM	LMITRA	BIJAK	BASET	BDANA	BATURAN	Absolute sum
DPRD	1	1	1	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1	1	19
BANK	1	1	1	1	-1	1	1	1	1	1	1	1	1	1	1	-1	1	1	-1	19
PDAM	1	1	1	1	-1	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	19
TPPKK	1	1	1	1	-1	-1	1	1	1	1	1	1	1	1	1	-1	1	-1	-1	19
BAPPEDA	1	1	1	1	-1	-1	1	1	1	1	1	1	1	1	1	1	1	1	-1	19
DISDIK	1	1	1	1	-1	-1	-1	-1	1	1	1	1	1	1	1	-1	1	-1	-1	19
DINKES	1	1	1	0	-1	-1	1	1	1	1	1	1	1	1	1	1	1	1	-1	18
DPUPR	1	1	-1	1	-1	-1	1	1	1	1	1	1	1	1	1	-1	-1	1	-1	19
DLH	-1	-1	1	1	-1	-1	1	1	1	1	-1	-1	1	1	1	1	-1	-1	1	19
DISRUMKIM	1	1	1	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1	19
DISKOMINFO	1	1	-1	-1	-1	-1	-1	1	1	-1	1	1	1	-1	-1	1	-1	-1	-1	19
DPMPPA	1	1	-1	1	1	1	1	1	1	1	-1	1	1	1	1	1	1	1	-1	19
POLPP	-1	1	-1	1	-1	-1	-1	1	1	-1	1	1	1	1	1	1	1	1	-1	19
BPBD	1	1	-1	-1	1	1	-1	-1	-1	1	1	1	1	-1	1	1	-1	-1	-1	19
KEC.TANSAR	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	1	1	-1	-1	-1	-1	-1	-1	-1	19
KEC.BOSEL	-1	-1	-1	-1	-1	1	1	1	-1	1	-1	1	1	1	1	-1	-1	-1	-1	19
OPERATOR	1	1	1	1	1	1	1	1	1	1	1	-1	1	1	1	1	1	1	-1	19
FKS	1	1	1	1	-1	-1	-1	1	1	1	1	1	1	1	1	-1	1	-1	-1	19
AKSANSI	-1	-1	1	1	1	-1	1	-1	-1	1	1	-1	-1	-1	-1	-1	-1	-1	1	19
PT	1	-1	-1	1	-1	-1	-1	1	1	1	1	1	1	1	1	1	1	1	1	19
MEDIA	-1	1	-1	-1	-1	1	-1	1	1	1	1	-1	1	-1	-1	-1	-1	-1	-1	19
LKM	-1	1	-1	-1	-1	-1	1	1	1	1	1	1	1	1	1	-1	-1	-1	1	19
PUSAHA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	19
Number of agreements	16	18	13	14	7	9	15	19	19	20	20	19	21	18	19	13	14	11	7	
Number of disagreements	-7	-5	-10	-8	-16	-14	-8	-4	-4	-3	-3	-4	-2	-5	-4	-10	-9	-12	-16	
Number of positions	23	23	23	22	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	

Figure 11. Actor relations matrix and 1st order goals.

The difference between the number of stakeholders who agreed to be reduced and did not agree showed that more stakeholders disagreed with providing a spatial plan based on domestic wastewater management in informal self-supporting housing for the medium and long term (TRUANG), the existence of control/supervision of buildings and environmental management based on domestic wastewater in informal self-help settlements (TKENDALI), increased adequacy of funds to manage domestic wastewater in informal self-help housing (BDANA), and the existence of implementing regulations as derivatives of regional regulations regarding the provision of incentives, disincentives, awards and sanctions (BATURAN). The relationship between actors and goals of 2nd order is presented in Figure 12. The histogram shows the position of the actor's relationship with the specified goals, for example, strenuous or easy, whether or not there are activities that support the goals. This shows that the most challenging goals are TRUANG, TK CONTROL, BODANA, and BATURAN.

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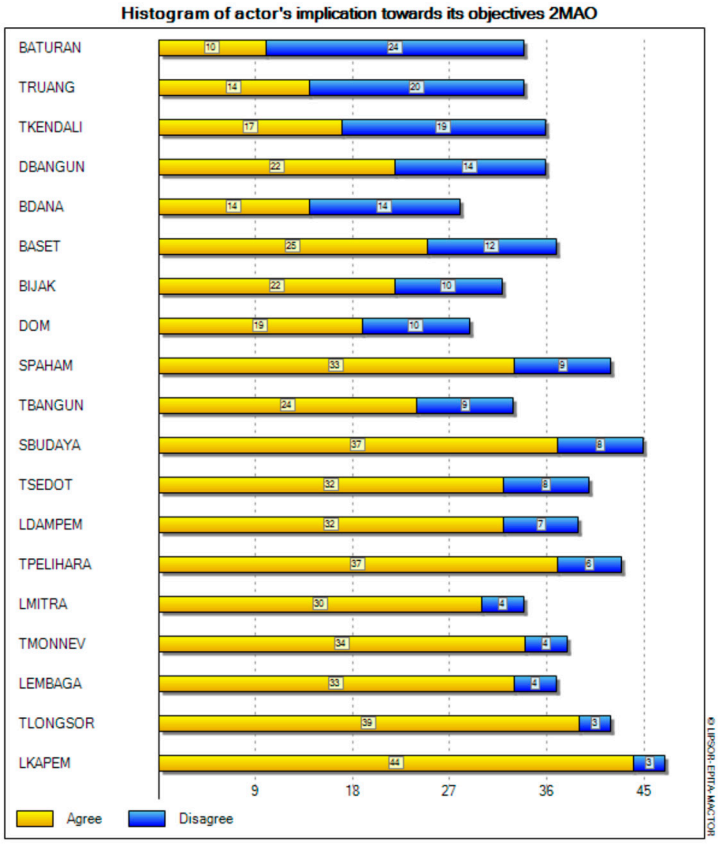
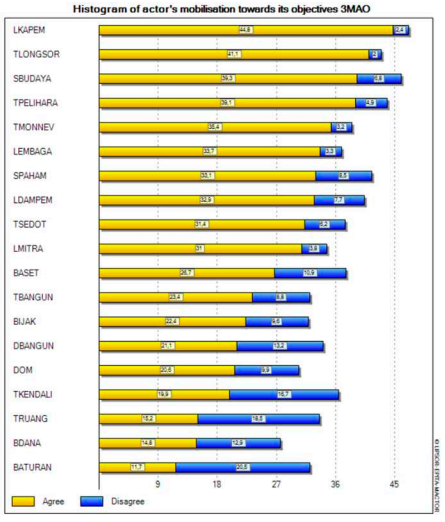


Figure 12. Actors mobilization to achieve goals based on matrix 2MAO.

The relationship between actors and third-order goals in the 3MAO matrix is presented in Figure 13a, where the actors are the most active (the rightmost column is DISRUMKIM, PT, and PUSAHA), while the bottom row describes the degree of goal mobilization that activates the actors, namely LKAPEM (Increased capacity of the government (regional apparatus organizations) in managing domestic wastewater that can accommodate various aspects of management), SBUDAYA (Creation of culture and habits of clean and healthy living (free open defecation), TPELIHARA (Increased maintenance of domestic wastewater treatment infrastructure), and TONGSOR (Preventing disasters in the form of landslides or subsidence due to the flow of domestic wastewater into the ground.

3MAO	SPAHAM	SBUDAYA	DBANGUN	DOM	TRUANG	TKENDALI	TBANGUN	TPELIHARA	TSEDOT	TMONNEV	TLONGSOR	LEMBAGA	LKAPEM	LDAMPEM	LMITRA	BIJAK	BASET	BDANA	BATURAN	Mobilisation
DPRD	3,2	3,2	1,6	-1,6	1,6	1,6	1,6	1,6	1,6	3,2	3,2	1,6	1,6	1,6	1,6	3,2	1,6	-1,6	1,6	38,2
BANK	1,3	4,0	2,7	4,0	-1,3	4,0	2,7	4,0	2,7	4,0	5,4	4,0	1,3	1,3	1,3	-1,3	1,3	1,3	-1,3	49,7
PDAM	3,9	2,6	1,3	2,6	-1,3	-1,3	1,3	1,3	2,6	2,6	1,3	2,6	2,6	2,6	2,6	1,3	2,6	1,3	1,3	38,9
TPPKK	1,7	0,6	0,6	0,6	-0,6	-0,6	0,6	1,1	0,6	0,6	0,6	1,1	1,1	1,1	0,6	-0,6	0,6	-0,6	-0,6	13,8
BAPPEDA	2,0	2,0	2,0	1,0	-1,0	-1,0	2,0	2,9	2,0	2,9	2,9	2,0	2,0	1,0	1,0	1,0	2,0	1,0	-2,0	33,2
DISDIK	1,9	1,9	0,9	0,9	-0,9	-0,9	-0,9	-0,9	0,9	0,9	0,9	0,9	2,8	1,9	0,9	-0,9	0,9	-0,9	-0,9	22,4
DINKES	2,4	2,4	2,4	0,0	-0,8	-0,8	1,6	1,6	1,6	1,6	0,8	1,6	1,6	1,6	1,6	1,6	1,6	1,6	-0,8	28,5
DPUPR	0,9	0,9	-0,9	0,9	-1,7	-2,6	1,7	1,7	0,9	0,9	0,9	1,7	0,9	2,6	0,9	-0,9	-1,7	0,9	-3,5	27,1
DLH	-0,3	-0,3	0,3	0,3	-0,3	-0,3	0,3	0,3	0,3	0,3	-0,3	-0,3	0,3	0,3	0,3	0,3	-0,3	-0,3	0,3	6,6
DISRUMKIM	2,5	2,5	2,5	-1,3	3,8	3,8	2,5	3,8	1,3	3,8	5,0	3,8	3,8	2,5	3,8	2,5	3,8	2,5	-1,3	56,5
DISKOMINFO	1,2	1,2	-0,6	-0,6	-0,6	-0,6	-0,6	1,2	2,4	-0,6	1,8	2,4	2,4	-0,6	-0,6	1,8	-0,6	-0,6	-0,6	21,1
DPMPPA	1,8	1,8	-0,9	0,9	0,9	1,8	1,8	1,8	1,8	1,8	-0,9	0,9	2,6	1,8	1,8	0,9	0,9	0,9	-0,9	26,4
POLPP	-1,2	2,4	-1,2	2,4	-1,2	-1,2	-1,2	2,4	1,2	-1,2	2,4	1,2	3,7	3,7	1,2	2,4	2,4	1,2	-1,2	35,5
BPBD	2,3	2,3	-0,8	-0,8	3,0	1,5	-0,8	-2,3	-3,0	1,5	3,0	1,5	0,8	-0,8	1,5	1,5	-0,8	-0,8	-0,8	29,5
KEC.TANSAR	-1,4	-1,4	-2,8	-2,1	-2,8	-2,1	-1,4	-0,7	-1,4	-1,4	0,7	0,7	-1,4	-0,7	-0,7	-0,7	-1,4	-1,4	-2,1	26,9
KEC.BOSEL	-0,8	-2,3	-1,6	-0,8	-0,8	0,8	0,8	0,8	-0,8	0,8	-0,8	0,8	1,6	0,8	0,8	-0,8	-0,8	-0,8	-0,8	18,0
OPERATOR	0,5	0,9	0,9	0,5	0,5	0,5	1,4	0,9	1,4	1,4	0,9	-0,5	1,4	0,9	1,4	0,9	1,4	0,9	-0,5	17,3
FKS	1,3	0,6	1,9	0,6	-0,6	-1,3	-0,6	1,3	1,3	0,6	1,3	0,6	0,6	1,3	0,6	-0,6	1,3	-0,6	-1,9	18,9
AKSANSI	-2,0	-1,0	1,0	1,0	1,0	-1,0	1,0	-1,0	-1,0	1,0	1,0	-1,0	-1,0	-1,0	-1,0	-1,0	-1,0	-1,0	4,0	23,0
PT	3,4	-1,7	-1,7	3,4	-1,7	-1,7	-1,7	3,4	1,7	1,7	1,7	3,4	3,4	5,2	3,4	3,4	3,4	1,7	1,7	49,8
MEDIA	-1,5	4,6	-1,5	-1,5	-1,5	1,5	-1,5	4,6	3,1	1,5	1,5	-1,5	4,6	-4,6	-1,5	-1,5	-3,1	-3,1	-1,5	46,0
LKM	-1,3	2,5	-1,3	-1,3	-1,3	-1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	-1,3	-1,3	-1,3	1,3	25,3
PUSAHA	3,0	3,0	3,0	1,5	4,4	4,4	3,0	3,0	3,0	3,0	4,4	1,5	4,4	1,5	4,4	1,5	3,0	1,5	1,5	54,7
Number of agreements	33,1	39,3	21,1	20,6	15,2	19,9	23,4	39,1	31,4	35,4	41,1	33,7	44,8	32,9	31,0	22,4	26,7	14,8	11,7	
Number of disagreements	-8,5	-6,8	-13,2	-9,9	-18,5	-16,7	-8,8	-4,9	-6,2	-3,2	-2,0	-3,3	-2,4	-7,7	-3,8	-9,6	-10,9	-12,9	-20,5	
Degree of mobilisation	41,6	46,1	34,3	30,5	33,7	36,5	32,2	44,0	37,6	38,6	43,1	37,0	47,2	40,5	34,8	32,0	37,7	27,7	32,2	



(**a**) (**b**)

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Figure 13. a) Actor relations matrix and third-order goals; b) actor mobilization to achieve third-order goals.

Actor mobilization to achieve third-order goals is presented in Figure 13b, where the sequence of obstacles or lack of activities that support the achievement of goals according to the actors, successively from the largest value is BATURAN (the existence of implementing regulations as derivatives of regional regulations regarding the provision of incentives, disincentives, rewards and sanctions, meaning that there are still many regulations that need to be finalized which can become the legal basis for implementing incentives, disincentives, rewards and sanctions), TRUANG, namely the availability of spatial plans based on domestic wastewater management in informal self-help housing for the medium and long term, TKENDALI (control/supervision of buildings and environment based on domestic wastewater management in informal self-help settlements), DBANGUN (easy access to financing for the construction of domestic wastewater infrastructure), BDANA (increased adequacy of funds to manage domestic wastewater in informal self-help housing), BASET (increased security of land assets and domestic wastewater treatment infrastructure), DOM (easy access to operation and maintenance financing in the form of non-financial assistance), BIJAK (there are policies that support easy implementation of domestic wastewater management plans in informal self-help housing), TBANGUN (increased construction of domestic wastewater treatment infrastructure that meets technical requirements in informal self-help settlements), SAHAM, namely the community is increasingly understanding how to properly manage domestic wastewater, LDAMPEM (increasing government assistance to the community in managing domestic wastewater in informal self-help housing), SBUDAYA (the realization of culture and habits of clean and healthy living (free of open defecation), TSEDOT (increased accessibility of fecal sludge disposal), TPELIHARA (i.e. increased maintenance of domestic wastewater treatment infrastructure), LMITRA (increased partnerships between stakeholders in water management domestic waste), INSTITUTIONS (increasing the role of community institutions in managing domestic wastewater that can accommodate various aspects of management, TMONEV (reducing water and soil pollution due to domestic wastewater), LKAPEM (increasing government capacity (regional apparatus organizations) in managing domestic wastewater which can accommodate various aspects of management), SLONGSOR (preventing disasters in the form of landslides or subsidence due to the flow of domestic wastewater into the ground).

Based on the value of actor ambivalence, four actors have a high level of ambivalence, namely KEC BOSEL, BPBD, MEDIA, and DLH (Figure 14). Recommendations for these actors are

- South Bogor Sub-District (KEC BOSEL): Increase the capacity of officials at the sub-district office both in theory and in practice to properly manage community-based domestic wastewater and provide a sufficient budget to carry out activities according to the scope of their duties and functions.
- Regional Disaster Management Agency (BPBD): Improving disaster studies caused by unmanaged domestic wastewater, especially ways to mitigate it.
- Media: Improving cooperation, campaigning, and massively disseminating the proper ways of managing domestic wastewater.
- Department of the Environment (DLH): Increasing the budget for inspection of water quality standards originating from domestic waste and increasing the budget for campaigns for proper domestic wastewater management and environmental law enforcement.

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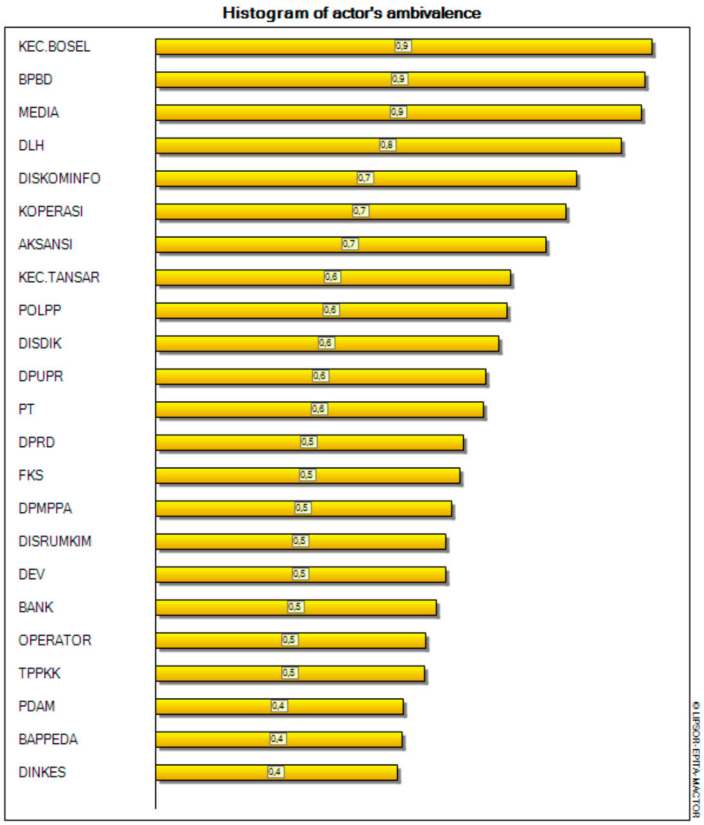

Figure 14. Actor ambivalence.

Based on the map of the net distances between goals, the goals that tend to diverge are BATURAN (there are implementing regulations as derivatives of regional regulations regarding the provision of incentives, disincentives, awards and sanctions, meaning that there are still many regulations that need to be finalized which can become a legal umbrella in the implementation of incentives, disincentives, awards and sanctions), TRUANG (availability of spatial plans based on domestic wastewater management in informal self-supporting housing for the medium and long term), TKENDALI (control/supervision of buildings and environment based on domestic wastewater management in informal self-help settlements), DOM (easy access to operation and maintenance financing in the form of non-financial assistance), and BIJAK (the existence of policies that support the ease of implementation of domestic wastewater management plans in informal self-help housing), can mean that these goals will be achieved with more effort by all actors (Figure 15). The stronger the relationship between goals, the higher the convergence of actors' opinions about these goals.

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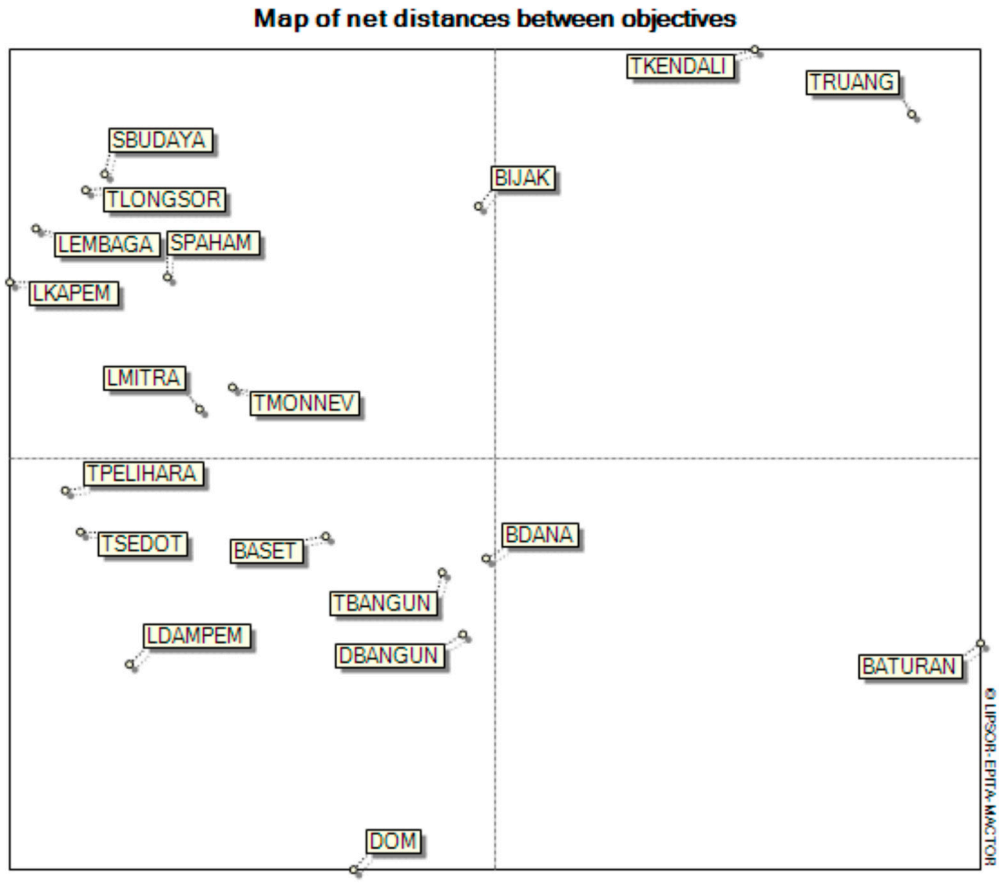

Figure 15. Map of the net distance between goals.

In general, managing domestic wastewater in informal self-help housing requires capacity building of actors who directly interact with the community. These actors include KEC TANSAR, KEC BOSEL, and AKSANSI. Based on MACTOR analysis, the three actors tend to have a high divergence of goals. Based on the 3MAO matrix, it can be seen that there are still constrained or the absence of activities to achieve the goals, such as DBANGUN, TRUANG, DOM, BATURAN, SBUDAYA, and SPAHAM. Actors from OPD with high goal divergence are DLH and BPBD. Therefore it is necessary to increase the capacity of these actors to support the goals, especially TLONGSOR.

The role of DPRD as an actor is competitive and has high influence but low dependency among actors. Based on the 2MAO matrix, obstacles/difficulties in achieving goals according to DPRD on DOM and BDANA. The DPRD must make budget policies based on the community's needs; therefore, community suggestions are needed to achieve these goals. Therefore, the goals of SPAHAM and SBUDAYA must not be an obstacle anymore. Awareness and culture of proper domestic wastewater management will increase community ideas/suggestions for DPRD.

The role of MEDIA as an actor with a high level of competitiveness must be able to cooperate with DISKOMINFO as an actor with a relatively low level of competitiveness and a high level of objective divergence, to jointly assist the government in organizing communication and informatics to achieve domestic wastewater management goals in informal self-help housing. Collaboration between BANK and LKM, where each of these actors has a relatively high competitive value, to provide affordable financing for the community.

The actors' opinions for achieving goals greatly influence the results of the MACTOR analysis, and good results are influenced by the ease of achieving goals by actors and vice versa. MACTOR analysis shows which actors have difficulties/obstacles and the level of obstacles in achieving goals so that which actors can be identified and what goals are having problems achieving them. A list of

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actors and problems, obstacles, difficulties, and lack of activity for each goal, obtained from the 1MAO matrix and the results of interviews with actors, is presented in Table 1.

Table 1. List of problems, obstacles, difficulties, and lack of activity towards achieving goals according to actors.

Goals	Problems, obstacles, difficulties, and lack of activity towards achieving goals according to actors
Social aspects	
SPAHAM	Minimum information/don't understand about domestic wastewater management, one of the reasons is the absence of concrete examples of correct ways to manage domestic wastewater, whereas until now, many people still practice open defecation.
SBUDAYA	Open defecation has become a habit for several reasons, including no sanctions for the community and no land for laying septic tanks; the government's budget is limited and not yet a priority.
Financial aspects	
DBANGUN	There are still limited funding institutions that can serve the construction of domestic wastewater infrastructure facilities; the construction of domestic wastewater infrastructure facilities has not yet become a development priority/lack of funding from the government; the community has also not prioritized its development, limited CSR from private companies.
DOM	There are no incentives/rewards, and no assistance with tools for the operation and maintenance of domestic wastewater infrastructure facilities.
Technical aspects	
TRUANG	There are no specific rules for organizing informal self-help housing, and it is impossible to plan for informal self-help housing.
TKENDALI	There is no supervision and control of space in informal self-supporting housing, it is impossible to control the construction of informal self-help housing, and there are no planning documents as a guide in controlling.
TBANGUN	The cost of constructing domestic wastewater infrastructure is not affordable by the community, and due to limited land.
TPELIHARA	Topographical obstacles for draining fecal sludge (sharp slope, very narrow access), lots of community sanitation that is not maintained, because KSM/KPP is inactive/non-existent.
TSEDOT	KSM/KPP has never/rarely desorbed desludging, KSM/KPP is not active, there are several locations where desludging cannot/is very difficult, and the cost is expensive.
TMONEV	There has never been/rarely been monitoring of the performance of domestic wastewater management by the government.
TLONGSOR	There are no mitigation activities for locations that have the potential for landslides due to the flow of domestic wastewater into the ground, as a result of managed domestic wastewater, there is no construction control (domestic wastewater infrastructure) in landslide-prone locations.
Institutional aspects	

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LEMBAGA	Social capital is lacking in several informal self-help housing locations, existing institutions still lack knowledge about proper domestic wastewater management.
LKAPEM	The government budget is limited and not a priority and the existing government capacity is still lacking in knowledge about domestic wastewater management, not the duties and functions of the OPD (because it is not written in the Mayor's of Bogor Regulation regarding the main tasks and functions), there are still many government officials who do not understand management methods domestic wastewater.
LDAMPEM	There is no/rarely any assistance from the government, many government officials themselves do not understand aspects of domestic wastewater management, not in the main duties and functions of OPD.
LMITRA	The existing partnerships are not continuous, there is a lack of determination from fellow partners to manage domestic wastewater better.
Policy aspects	
BIJAK	There are still policies that impede (indirectly) the management of domestic wastewater in informal self-help housing, and there is no planning for domestic wastewater management that is integrated between sectors.
BASET	The community is still not willing to relinquish their land even though a communal WWTP has been built. The ownership of land that has been built by an WWTP is unclear because it is handed over to KSM/KPP where KSM/KPP is not yet a legal entity, while Regional Government only has its assets listed, but not owned.
BDANA	The government's budget is very lacking, community suggestions are very lacking, and are not a priority (budget policies have not prioritized domestic wastewater management).
BATURAN	There are no implementing regulations, so it cannot be implemented regarding the provision of incentives, disincentives, sanctions and rewards. There is fear of social unrest because there are still many who practice open defecation.

Policy Recommendations Supporting Achievement of Actor's Goals

Policy recommendations that support the achievement of actors are based on problems, obstacles, difficulties, lack of activity towards achieving goals according to actors. Recommendations are grouped into five aspects with the following results:

a. Social aspects
   - Intensive triggering, with improved triggering materials, expanded triggering targets, expanded triggering media,
   - Conduct awareness campaigns for the environment,
   - Using existing educational institutions (formal or informal) to promote proper management of domestic wastewater,
   - Dissemination of Regional Regulation No. 4 of 2018 Concerning Domestic Wastewater Management, in which the regional regulation contains sanctions for people who do not treat domestic wastewater,
   - Disseminate Law No. 32 of 2009 concerning Environmental Protection and Management, wherein the law requires everyone who generates waste to process it,
   - Increasing community participation in domestic wastewater management.

b. Financial aspects
   - Making a community-based domestic wastewater management plan in each kelurahan with government assistance, including planning sources of financing (from the community itself, CSR, government, loans, etc.) so that the community knows/understands the importance of financing, providing input on ways obtaining financing, facilitating the public to gain access to financing,
   - Bringing microfinance institutions closer to communities that need loans for the procurement of domestic wastewater infrastructure,
   - Dissemination of ways to get the Company's CSR.

c. Technical aspects
   - Dissemination of methods for treating fecal sludge properly, especially how to operate and maintain domestic wastewater infrastructure, including the disposal/absorption of fecal sludge
   - Making plans for the management of domestic wastewater in each sub-district based on the community with assistance from the government, so that the decision on the type of domestic wastewater treatment is carried out by the community itself by considering the advantages and disadvantages of each wastewater treatment system (looking for forms / ways of building that are agreed upon by the community), agreement on ways to mobilize materials, tools and labor,
   - Government assistance in construction, operation and maintenance
   - Dissemination of the need for building and environmental management in support of sustainable domestic wastewater management,
   - Socialization of the need for supervision of buildings that will be and are being built to support the arrangement of buildings and the environment based on domestic wastewater management,
   - Conducting training on the construction of proper pre-sanitation facilities for local residents,
   - Adding BPBD tasks and functions to create mitigation strategies for domestic wastewater infrastructure facilities that have the potential to cause landslides
   - Creating appropriate technology in locations with limited land

d. Institutional aspects
   - Disseminating/explaining to the public that managing domestic wastewater involves various aspects (social, technical, financial, institutional, policy) and various activities ((socialization, triggering, planning, development, operation, and maintenance), thus a combination of existing institutions is needed, and therefore the need to increase the role of existing institutions in the community to be able to manage domestic wastewater, strengthen the institutional capacity of managers and users,
   - Strengthening community institutional cooperation internally in the sub-district with government facilitation as a basis for cooperation with other institutions,
   - Increase the capacity of government officials both in the region, as well as in other Regional Apparatus Organizations regarding the management of domestic wastewater, and as parties who assist the community,
   - The recommendation to overcome this difficulty is to provide an understanding that domestic wastewater management includes various aspects.

e. Policy aspects
   - Provide sufficient funding for the Kelurahan
   - Positioning sanitation management as a development priority
   - Increase the portion of the government's budget for domestic wastewater management
   - Made clear rules on how sanctions can be implemented through a Mayor's Regulation as a derivative of No. 4 of 2018 concerning Domestic Wastewater Management
   - Planning for the construction of domestic wastewater infrastructure (especially communal WWTP) must include proper land administration planning and an explanation of the consequences of the function of the land used by the communal WWTP

- Give awards to people who have managed domestic wastewater properly, for example, holding a competition for managing communal WWTPs, etc
- Making rules in the form of guardianship and instructions for implementing control/supervision of buildings and the environment based on domestic wastewater management in community-based informal self-help housing.
- Providing incentives to communal WWTP land owners, Making clear rules on communal WWTP land ownership.
- Recommendations for overcoming this difficulty are establishing guardianships with an explanation of the conditions under which sanctions can be applied and creating implementing regulations as derivatives of regional regulations regarding granting incentives, disincentives, awards, and sanctions.

5. Conclusions

Knowledge and understanding of the correct management of domestic wastewater are the basis for achieving the actors' goals. In an implementation, social capital is needed to increase community participation by providing incentives that can affect the management of domestic wastewater, both directly and indirectly; therefore, it is necessary to increase the capacity of actors to assist the community in managing domestic wastewater.

Ease of implementation at the community level must be based on community-based planning with government assistance so that the community itself carries out the decision on the type of domestic wastewater management by considering the advantages and disadvantages of each wastewater management system (looking for forms/ways to build the agreed by the community and availability of land), agreement on ways to mobilize materials, tools, and labor, as well as sources of financing.

Conflicts of Interest: The authors declare no conflict of interest.

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