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Stakeholder dynamics and sustainable waste management in peri-urban settings: a case study of actor interactions in Indonesia

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This study investigates stakeholder dynamics within the TPS3R (Reduce, Reuse, Recycle Waste Processing Site) waste management program in Tulungagung Regency, East Java, Indonesia. TPS3R, a community-driven waste management initiative, aims to mitigate waste generation's environmental and health impacts by promoting waste segregation, recycling, and circular economy practices. Tulungagung Regency was chosen for its representative peri-urban characteristics, including rapid urbanization and the coexistence of urban and rural attributes. The study employs the MACTOR (Matrix of Alliances and Conflicts: Tactics, Objectives, and Recommendations) methodology to analyze interactions among 15 key stakeholders, encompassing government officials, local community members, and environmental advocates. Findings highlight that effective program implementation relies on strengthened leadership collaboration, resolving political tensions, and increasing community participation. While existing studies often focus on urban or rural settings, this research addresses a notable gap by exploring stakeholder dynamics in peri-urban areas, emphasizing the unique challenges and opportunities of such settings. Evidence from literature and primary data underscores the importance of integrating high-level leadership and grassroots participation for sustainable waste management. This study contributes to the field by presenting an original, localized examination of peri-urban stakeholder interactions, offering actionable recommendations to enhance the success of similar initiatives globally.

KEYWORDS

actor, stakeholder, sustainable waste management, peri-urban area, Waste Processing Site

1 Introduction

Improper handling and disposal of waste lead to significant environmental, health, and economic problems, particularly in developing countries (Ferronato and Torretta, 2019). In many regions, inadequate waste management infrastructure and practices result in the accumulation of waste (Dehghani et al., 2021), environmental pollution (Vinti and Vaccari, 2022) and the spread of infectious diseases (Krystosik et al., 2020). These challenges are further exacerbated by limited financial resources, insufficient technological advancements, and lack of public awareness and participation (Fulazzaky, 2014; Kaza et al., 2018; Yukalang et al., 2017). Traditional waste disposal methods, such as landfilling and open dumping, are not sustainable solutions as they occupy valuable land, produce harmful greenhouse gases, and contaminate natural resources (Mor and Ravindra, 2023). There is an urgent need to develop and implement effective waste management strategies that can minimize environmental impact, promote

public health, and enhance the overall quality of life in these communities.

Peri-urban areas in developing countries are transitional zones blending rural and urban characteristics, with mixed agricultural, residential, and industrial activities (Adam and Dadi, 2024). They reflect a coexistence of traditional lifestyles and urban influences, offering access to urban services while facing significant infrastructural gaps (Rajendran et al., 2024; Sareen and Haque, 2024). Rapid urbanization and population growth exacerbate challenges like inadequate waste management and resource pressure, making these dynamic regions both opportunities for innovation and focal points for urban expansion challenges. Despite significant advancements in waste management practices globally, there remains a notable gap in addressing the unique challenges faced by peri-urban areas in developing countries, particularly in Indonesia. Existing literature highlights the detrimental impacts of improper waste handling and disposal, such as environmental pollution, health risks, and economic burdens (Ferronato and Torretta, 2019; Yukalang et al., 2017). However, most studies focus on urban settings, overlooking the distinct needs and constraints of peri-urban communities (Fatimah et al., 2024; Iskandar, 2022; Utomo et al., 2023). A study on waste management in peri-urban in Indonesia is important because it has unique characteristics in accepting new innovations in their environment (Hudalah, 2010; Rochman et al., 2020; Sumardjo et al., 2022). While TPS3R (Reduce, Reuse, Recycle Waste Processing Sites) have been introduced in Indonesia to address these issues, there is a significant research gap in understanding the effectiveness of these initiatives in peri-urban settings, where comprehensive data on stakeholder dynamics is scarce.

This study addresses this gap by focusing on Tulungagung Regency, one of the regions not recorded in the Ministry of Environment and Forestry (KLHK) data, to enhance data accessibility and analyze the dynamics of stakeholder interactions in sustainable waste management. Waste collected at TPS3R has the potential to be transformed into economically valuable products by applying Circular Economy principles (Iskandar, 2022). The concept of a circular economy includes ideas of reuse, repair, remanufacturing, and recycling of products, materials, and components (Munaro et al., 2020). The novelty of this study lies in its focus on the unique characteristics of peri-urban communities in Indonesia and their interaction with new innovations in waste management. Unlike previous studies that primarily address urban settings or general waste management practices, this research delves into the specific dynamics and relationships among stakeholders in a peri-urban Indonesian context. This localized approach not only enriches the existing body of knowledge but also addresses the critical need for sustainable waste management solutions that consider the distinctive acceptance patterns and collaborative dynamics of peri-urban populations.

The study on stakeholder dynamics within the TPS3R waste management program in Tulungagung Regency is critical, as peri-urban areas in Indonesia face escalating challenges related to waste generation due to rapid urbanization and population growth (Adrianto, 2022; Legates and Hudalah, 2014). The program, which promotes waste segregation and recycling, has the potential to reduce pressure on landfills and foster sustainable practices, yet its effectiveness depends on strong stakeholder collaboration (MacDonald et al., 2022). By using the MACTOR method to analyze

stakeholder relationships, the study provides insights into how local governments, environmental groups, and communities can work together to overcome conflicts and enhance the program's impact, which is essential for improving waste management outcomes across Indonesia.

2 Context (setting and population)

2.1 Study area

Samar Village in Tulungagung Regency, East Java, serves as a significant peri-urban area for Tulungagung City, the regency's urban hub. Located at the transitional interface where urban influences blend with rural landscapes, Samar Village exhibits characteristics like mixed land use, increased accessibility to urban services, and ongoing infrastructural development. The village's peri-urban status makes it a strategic location for studying dynamic socio-economic conditions and their impact on emerging systems like waste management.

The recent establishment of a TPS3R (Reduce, Reuse, Recycle Waste Processing Site) in Samar Village highlights its importance as a pilot area for implementing sustainable waste management practices. Peri-urban zones face unique challenges, including inconsistent infrastructure and the dual pressures of urban demands and rural traditions (Sahana et al., 2023). Understanding community responses and institutional collaboration in such settings is vital. The insights gained from this study can guide similar initiatives in other transitional regions, addressing environmental concerns and the increasing demands of urban sprawl while fostering sustainable development.

2.2 Demographic description of Samar Village

Samar Village, located in Pagerwojo District within Tulungagung Regency, exemplifies a peri-urban area due to its strategic position and interplay between rural and urban characteristics. The location of Samar Village is illustrated in Figure 1.

Tulungagung Regency is a rapidly developing region in East Java, with a mix of urbanized centers and surrounding districts that maintain strong agricultural and rural traditions. Pagerwojo District, where Samar Village is situated, lies on the outskirts of Tulungagung's urban core, serving as a transitional zone that connects rural highland areas to more urbanized regions. The village's land use reflects this dynamic, with residential clusters covering 57.07 hectares and substantial agricultural and forested areas comprising over 600 hectares. This mix demonstrates how the village serves both as a settlement hub and as a source of agricultural and natural resources for the broader region. The TPS3R waste management initiative in Samar Village, which processes cow manure into organic fertilizer, further bridges the gap between rural agricultural practices and modern waste management systems—an indicator of peri-urban integration. Additionally, the location of Samar Village at the foot of Mount Wilis, surrounded by fertile land and connected to the broader Tulungagung region, enhances its peri-urban nature. This proximity allows residents to maintain traditional agricultural and livestock farming while engaging with

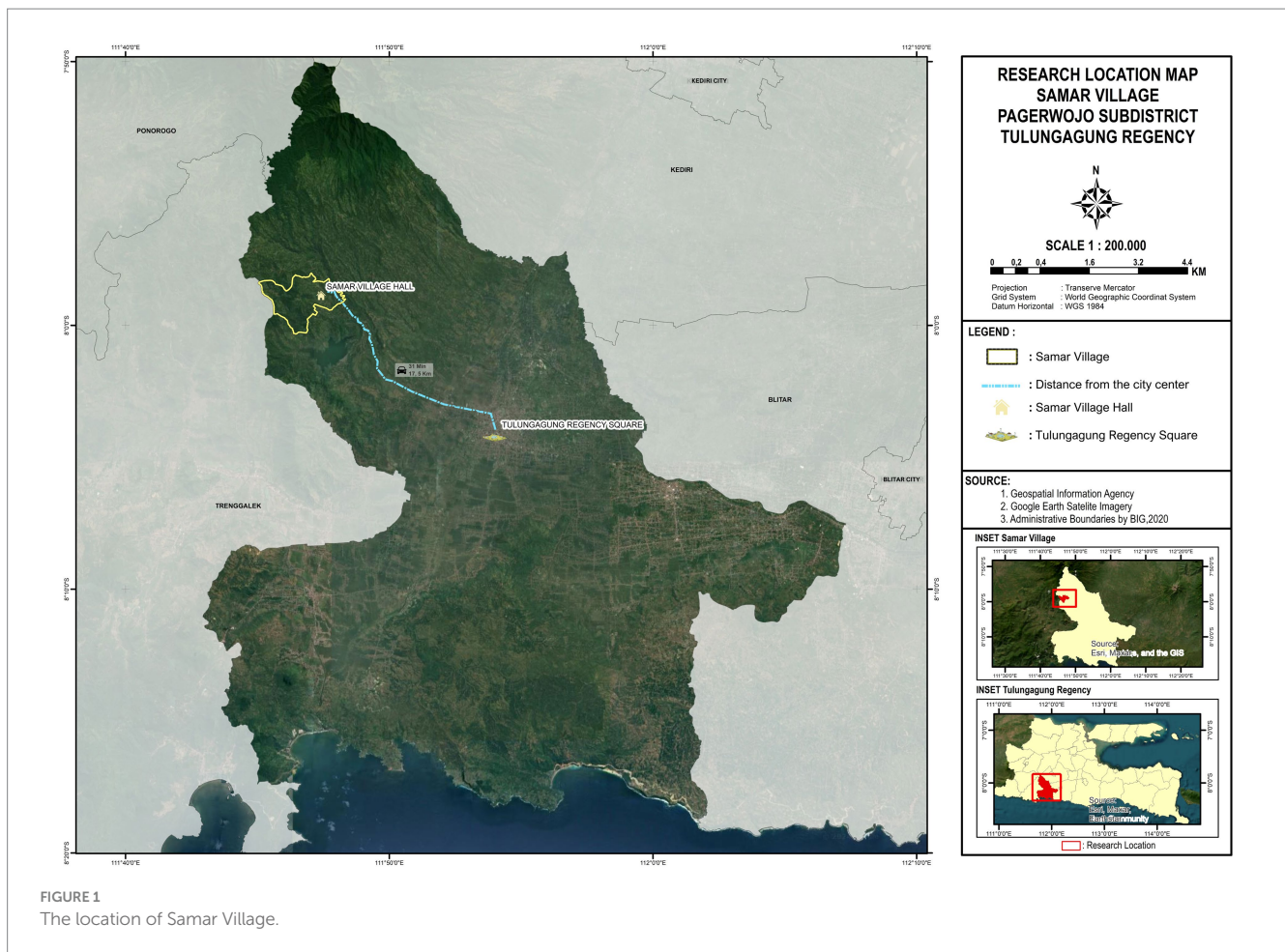


FIGURE 1
The location of Samar Village.

medium-scale industries and benefiting from Tulungagung's growing urban markets. Consequently, Samar Village represents a vital link between Tulungagung's urban expansion and the preservation of its rural highland economy, reinforcing its classification as a peri-urban area.

2.3 The objective of TPS3R in Samar Village

The objectives of establishing TPS3R (Reduce, Reuse, Recycle Waste Processing Site) in Samar Village include improving community health and well-being, enhancing environmental cleanliness, and protecting river water quality from waste. Additionally, TPS3R aims to produce and market organic fertilizer, create vegetable plant seeds, and engage in maggot cultivation for use in catfish farming. These objectives are designed to address local waste management challenges while promoting sustainable agricultural practices and contributing to the overall development of the village.

Operationally, the eight objectives of TPS3R in Samar Village and their alignment with the UN Sustainable Development Goals (UN SDGs) are outlined as follows:

- Objective 1: Improving community health and well-being (SDG 3: Good Health and Well-being)

- Objective 2: Enhancing environmental cleanliness (SDG 11: Sustainable Cities and Communities and SDG 6: Clean Water and Sanitation)
- Objective 3: Protecting River water quality from waste (SDG 6: Clean Water and Sanitation)
- Objective 4: Producing organic fertilizer (SDG 12: Responsible Consumption and Production)
- Objective 5: Marketing organic fertilizer (SDG 8: Decent Work and Economic Growth)
- Objective 6: Producing vegetable plant seeds (SDG 2: Zero Hunger and SDG 12: Responsible Consumption and Production)
- Objective 7: Maggot cultivation (SDG 15: Life on Land and SDG 12: Responsible Consumption and Production)
- Objective 8: Utilizing maggots for catfish farming (SDG 2: Zero Hunger and SDG 12: Responsible Consumption and Production)

The eight objectives of TPS3R are interrelated, focusing on sustainable waste management and community development. Objectives like producing organic fertilizer (Objective 4) and marketing it (Objective 5) form an economic loop, while maggot cultivation (Objective 7) supports catfish farming (Objective 8), linking waste reduction with food security. Environmental goals, such as enhancing cleanliness (Objective 2) and protecting river water (Objective 3), are complementary. The numerical sequence reflects thematic grouping

TABLE 1 The description of key informants.

No.	Code	Role and position
1	HP	TPS3R Manager
2	RA	Village Head of Samar
3	MM	Former Village Head, the initiator of TPS3R establishment in Samar Village
4	SK	Head of <i>Lembaga Masyarakat Desa Hutan</i> – LMDH (Forest Village Community Institution)
5	SL	TPS3R member
6	KS	TPS3R member
7	AN	TPS3R member
8	SP	TPS3R member
9	TK	Resident living near TPS3R. This resident is a livestock farmer living about 200 meters from TPS3R and uses TPS3R for household waste disposal.
10	IS	Resident living near TPS3R. This resident is a livestock farmer living about 220 meters from TPS3R.
11	MR	Resident living near TPS3R. This resident is a farmer living about 230 meters from TPS3R.
12	SKRN	Prospective political opponent of the village head
13	YD	Tulungagung Environmental Agency representative who concerns in providing waste processing equipment
14	SR	Tulungagung Environmental Agency representative
15	NR	Public Works and Public Housing Ministry representative

rather than priority. The choice of eight objectives aligns with Samar Village's specific needs and available resources, balancing scope and practicality without overextending program capacity.

3 Data collection and data analysis

3.1 Data collection

In this study, both primary and secondary data were utilized to provide a comprehensive analysis of stakeholder dynamics within the TPS3R waste management program. The secondary data were sourced from various publications, reports, and reputable documents from Samar Village related to the TPS3R, including: the leaflet of Samar TPS3R business brochure, the Samar TPS3R report on the use of CSR Grant Funds from the Ministry of Public Works and Housing (PUPR) Indonesia, and the profile of Pagerwojo District. The Samar TPS3R Business Brochure provides detailed insights into the operational framework and services offered by the waste management program. Additionally, the Samar TPS3R Report on the Use of CSR Grant Funds from the Ministry of Public Works and Housing (PUPR) Indonesia was instrumental in understanding the financial underpinnings and external support mechanisms that facilitated the program's establishment and growth. The Profile of Pagerwojo District offered a broader contextual background, detailing demographic, geographic, and socio-economic characteristics of the area, which are essential for analyzing the peri-urban setting where the TPS3R operates. These sources were integrated into the analysis to provide a comprehensive understanding of the program's foundation, its operational challenges, and its role within the local socio-economic framework.

Primary data collection involved conducting separate in-depth interviews and Focus Group Discussions (FGDs) with 15 key informants representing diverse roles in the TPS3R program, as detailed in Table 1. The in-depth interviews were conducted by visiting each of the 15 respondents individually at their respective residences.

Data collection through these interviews took place from April to May 2024. The Focus Group Discussion (FGD) was held in May 2024 at the Samar Village Hall. The purpose of the in-depth interviews was to gather individual insights and specific experiences, while FGDs facilitated collaborative discussions to explore shared challenges, alignments, and conflicts among stakeholders.

The selection of the 15 key informants was guided by their direct involvement, influence, or proximity to the TPS3R program, based on several criteria. These included relevance to TPS3R objectives, with individuals actively participating in or benefiting from the program, such as the TPS3R manager, members, and nearby residents. A diversity of roles was considered to ensure a mix of stakeholders, including community leaders, government officials, environmental agency representatives, and political figures, to capture varying perspectives. Geographical proximity was also a factor, with residents living near TPS3R facilities selected to understand the local impact. Additionally, informants with decision-making power or influence, such as village heads or representatives from public works and environmental agencies, were included for their strategic roles in policymaking or program implementation.

Each of these informants provided unique perspectives on the operational, social, and political dynamics influencing the waste management program. The qualitative data gathered from these interviews and FGDs were then integrated into the MACTOR analysis, where they were quantified to assess stakeholder objectives, alliances, and conflicts. The qualitative insights informed the identification of strategic objectives, as well as the creation of the matrix of alliances and conflicts, which allowed for a deeper understanding of stakeholder interactions.

3.2 Data analysis

To understand the dynamics of stakeholder interactions in executing TPS3R waste management practices, the study employed the Matrix of Alliances and Conflicts: Tactics, Objectives, and

Recommendations (MACTOR) analysis tool. The MACTOR will identify the actors/stakeholders involved in the efforts to establish TPS3R waste management system. Once the actors are identified, they can be grouped based on their respective roles, allowing us to determine whether they are main actors, key actors, or supporting actors. Additionally, the MACTOR analysis in this study will be used to explain the relationships or interactions among the actors.

Steps involved in the MACTOR Analysis include the following:

1. Identification of Actors: The 15 actors were identified and categorized based on their roles and influence in waste management in Samar Village.
2. Collection of Strategic Objectives: focuses on understanding the goals and aims behind the establishment of TPS3R. This involves identifying the specific objectives that the various stakeholders have in mind when supporting or participating in the TPS3R initiative.
3. Matrix Construction: An alliance and conflict matrix were constructed to analyze the relationships and interactions between the actors.
4. Evaluation of Influences: The matrix was used to evaluate the influences and dependencies among actors, identifying potential conflicts and coalitions.

5. Recommendation Formulation: Based on the analysis, recommendations were formulated to enhance stakeholder collaboration and improve waste management practices.

Generally, the MACTOR analysis follows the framework developed by Godet (1991) in Figure 2.

The use of the MACTOR method in this study is particularly well-suited for analyzing the complex stakeholder dynamics within the TPS3R waste management program because it allows for a detailed examination of alliances, conflicts, and the strategic objectives of various actors involved in the program. The MACTOR framework facilitates the mapping of relationships and dependencies, which is essential for understanding how different stakeholders' goals align or conflict with each other (Fetoui et al., 2023; Mohamed et al., 2021). By incorporating qualitative data through in-depth interviews and focus group discussions, the study captures nuanced perspectives that are crucial for building the matrix of alliances and conflicts. This qualitative approach is necessary for identifying the underlying social, political, and institutional factors that influence stakeholder interactions, which are often overlooked in purely quantitative analyses. The combination of qualitative data and the MACTOR method provides a robust approach by quantifying the qualitative insights gathered from interviews and focus groups. This

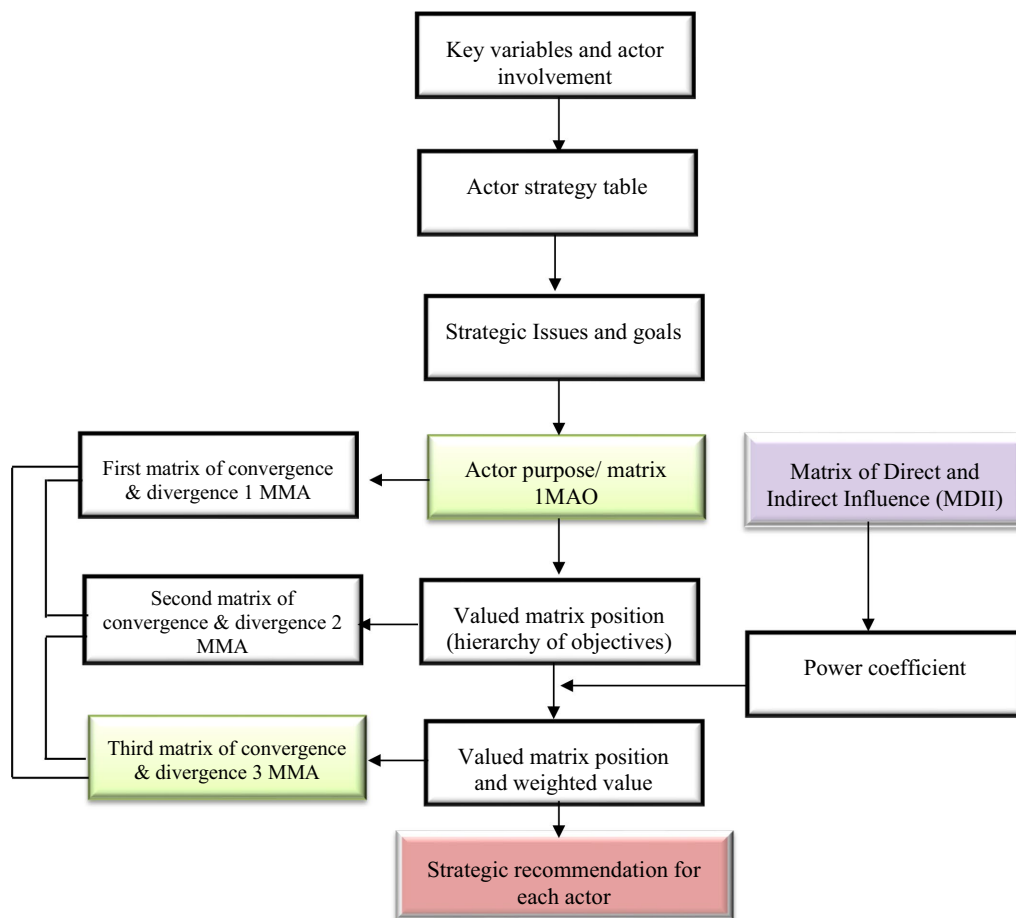


FIGURE 2 Analysis framework using MACTOR.

quantification is crucial because it translates subjective perceptions into measurable factors, enabling a clearer understanding of the dynamics that drive stakeholder behavior.

4 Results and discussion

4.1 Matrix construction and evaluation of influences

In the MACTOR method, the Matrix of Direct Influences (MDI) and the Matrix of Valued Positions Actor-Objective (2MAO) serve as essential input data matrices.

4.1.1 The Matrix of Direct Influences

The Matrix of Direct Influences (MDI), often referred to as Actor X Actor, is derived from the table of strategies employed by the various actors. This matrix illustrates the direct interactions and influences that each actor exerts on others within the network. By mapping these direct influences, the MDI provides a comprehensive view of how different actors impact one another through their actions, decisions, and strategies. To input scores into the Matrix of Direct Influences (MDI) in the MACTOR method, the process begins by identifying all relevant actors involved in the system under study. Once actors are defined, the relationships and influence dynamics among them are analyzed through stakeholder mapping, expert interviews, or structured surveys. Experts or stakeholders assess the degree to which each actor influences another, assigning scores based on a predefined scale (e.g., 0–4, where 0 indicates no influence and 4 indicates dominant influence). The MDI of TPS3R Samar Village Actors can be seen in Table 2.

Table 2 captures the nature of interactions, such as financial, operational, or regulatory influences among the actors. For example, the influence of HP (the row actor) on MM (the column actor) is

scored as 2, indicating that HP exerts a moderate level of influence on MM's actions or strategies. Similarly, the matrix reveals that YD has a score of 2 in influencing NR, signifying that YD also has a moderate impact on NR's decisions or behaviors.

4.1.2 Valued Position Matrix

The Valued Position Matrix (2MAO), also known as Actor X Objective, offers detailed insights into how each actor perceives and prioritizes different objectives. This matrix captures the stance of each actor toward each objective, categorizing their positions as supportive, opposed, neutral, or indifferent. Additionally, it highlights the relative importance or hierarchy of these objectives for each actor. By mapping these values, the 2MAO provides a clearer understanding of how actors align their goals and preferences with the broader objectives, allowing for a better assessment of their strategic priorities and potential areas of agreement or conflict. The details of it are shown in Table 3.

The scores in Table 3 reflect the likelihood of an actor achieving specific objectives, with varying degrees of impact. A “0” suggests that the objective is unlikely to be achieved. A rating of “–1” or “1” indicates that the objective either threatens or is crucial for the actor's operational procedures, such as management processes. A “–2” or “2” means that the objective could either endanger or be essential for the success of the actor's projects. Similarly, a “–3” or “3” points to an objective that could compromise the actor's mission or is vital for its accomplishment. Finally, a “–4” or “4” signifies that the objective either jeopardizes or is critical for the very existence of the actor.

For example, Actor HP demonstrates a clear and consistent alignment with most of the objectives presented in the Valued Position Matrix (2MAO). The matrix reveals that HP frequently assigns the number “4,” which suggests strong support or a positive stance, to most of the objectives. This alignment is a strong indicator that HP is highly in favor of these goals and plays a key role in driving or endorsing the strategies associated with them. However, there are

TABLE 2 Matrix of Direct Influences (MDI) for actors at TPS3R Samar Village.

MDI	HP	RA	MM	SK	SL	KS	AN	SP	TK	IS	MR	SKRN	YD	SR	NR
HP	0	4	3	4	1	2	2	2	2	2	2	3	4	4	3
RA	4	0	4	4	4	4	4	4	2	3	3	4	4	4	4
MM	2	2	0	3	3	3	3	3	2	2	2	1	1	1	2
SK	4	4	4	0	4	4	4	4	2	3	3	4	4	4	4
SL	1	2	3	4	0	4	4	4	2	2	2	2	2	2	2
KS	1	2	3	4	4	0	4	4	2	1	1	2	2	2	2
AN	1	2	3	4	4	4	0	4	2	1	1	2	2	2	2
SP	1	2	3	4	4	4	4	0	2	1	1	2	2	2	3
TK	2	3	2	3	1	1	1	1	0	1	1	3	3	3	3
IS	2	3	2	3	1	1	1	1	1	0	1	3	3	3	3
MR	2	2	2	3	1	1	1	1	1	1	0	3	3	2	3
SKRN	0	3	0	1	0	0	0	0	2	2	2	0	0	0	0
YD	3	4	1	4	1	1	1	1	1	1	1	1	0	2	2
SR	3	4	1	4	1	1	1	1	1	1	1	1	2	0	2
NR	2	4	1	3	1	1	1	1	2	2	2	1	2	2	0

TABLE 3 The Valued Position Matrix (2MAO) for TPS3R actors in Samar Village.

2MAO	O1	O2	O3	O4	O5	O6	O7	O8
HP	4	4	4	4	4	4	3	3
RA	4	4	4	4	4	4	2	4
MM	3	4	3	3	3	3	2	2
SK	3	3	4	4	4	4	2	2
SL	1	1	1	1	1	2	1	1
KS	1	1	1	1	1	2	2	2
AN	3	3	1	3	3	3	1	1
SP	1	1	1	1	1	2	0	0
TK	1	2	2	2	2	2	0	0
IS	1	2	2	2	2	2	0	0
MR	1	2	2	2	2	2	0	0
SKRN	-1	-1	-1	-1	-1	-1	-1	-1
YD	3	3	3	3	3	3	2	2
SR	3	3	3	3	3	3	2	2
NR	3	3	1	1	1	1	1	1

occasional variations, such as a “3” for certain objectives, which may point to a slightly more neutral or moderate support, but overall, HP’s responses suggest a very supportive position. This makes HP a critical player in ensuring the success of initiatives that align with these objectives. Furthermore, Actor MR’s responses across the objectives in the Valued Position Matrix show a more varied and less consistent pattern of support. MR provides a mix of “1” and “2” ratings, which could suggest a neutral or indifferent stance on some objectives and a mildly opposed or less enthusiastic position on others. This indicates that MR does not uniformly support the goals outlined in the matrix, and their support may be conditional or require further persuasion. This variability points to the need for more targeted engagement or negotiation to solidify MR’s commitment to certain objectives. Understanding MR’s mixed responses can help identify areas where additional efforts might be needed to align their perspective with the overall goals.

4.1.3 Matrix of Direct and Indirect Influences

The Matrix of Direct and Indirect Influences (MDII) evaluates both direct and second-order indirect effects between actors. It provides a comprehensive view of how actors can influence each other directly or through intermediaries, which can limit the options for others. Unlike the MDI matrix, the MDII uses a different scale for its calculations. Nevertheless, MDII values effectively reflect the importance of these direct and indirect interactions. Two key metrics are derived from this matrix: (1) the degree of influence each actor has (Ii), calculated by summing rows and (2) the degree of dependence each actor experiences (Di), determined by summing columns. The MDII is illustrated in Table 4. Values reflect both Direct Influences (Di) and Indirect Influences (Ii) between actors, with higher values indicating greater influence one actor has over another.

4.1.4 Direct influence

The top five actors with the highest direct influences (Di) are SK (407), RA (379), NR (354), YD (341), and SKRN and RN, both with a

score of 338. Actors with moderate influence include MM (327), and HP, KS, AN, and SP, all with a score of 317. Those with the lowest influence are SL (308), TK (287), MR (285), and IS (284). These findings provide a clear hierarchy of influence among the actors involved in the TPS3R working system. The actors with the highest direct influences are SK (TPS3R senior member, 407), RA (Village Head, 379), NR (Public Works and Public Housing Ministry Representative, 354), YD (Tulungagung Environmental Agency representative, 341), and SKRN (Prospective Political Opponent of the Village Head, 338). SK, RA, NR and YD are actors with important roles in the waste management program due to their leadership positions, policy-making capabilities, and potential to shape the community’s waste management strategies. Their high scores reflect their critical impact on the program’s direction and operational effectiveness.

The LMDH actor, represented by SK, received the highest score for Direct Influence (DI) in the TPS3R program due to the alignment of LMDH’s objectives with those of TPS3R. Specifically, LMDH’s goals of protecting river water quality, producing and marketing organic fertilizer, and producing vegetable plant seeds closely match TPS3R’s aims. This alignment means that LMDH’s existing initiatives directly support and enhance TPS3R’s efforts. As a result, SK’s role in both organizations amplifies their impact, justifying the high DI score and underscoring the importance of aligning partners on a shared purpose. As stated by Brown et al. (2021), this alignment is crucial for building a shared understanding of key concepts, a common vision, and joint goals, all of which are essential for achieving sustainable environmental outcomes.

A notable finding in this study is that SKRN, the Prospective Political Opponent of the Village Head, ranks among the actors with the highest direct influence in the TPS3R establishment despite whispering negative stigma about the program can be argued from several perspectives. SKRN’s high direct influence in the TPS3R establishment, even while whispering negative stigma, can be attributed to their strategic manipulation of public perception

TABLE 4 The Matrix of Direct and Indirect Influences (MDII) for TPS3R in Samar Village.

MDII	HP	RA	MM	SK	SL	KS	AN	SP	TK	IS	MR	SKRN	YD	SR	NR	li
HP	28	37	27	36	24	24	24	24	23	22	22	28	30	30	30	381
RA	28	40	32	47	30	31	31	31	24	23	23	31	33	32	34	430
MM	21	26	28	30	24	25	25	25	23	21	21	25	25	25	26	342
SK	28	40	32	47	30	31	31	31	24	23	23	31	33	32	34	423
SL	24	29	28	35	28	28	28	28	23	21	21	25	26	26	28	370
KS	22	27	26	33	28	28	28	28	23	21	21	23	24	24	26	354
AN	22	27	26	33	28	28	28	28	23	21	21	23	24	24	26	354
SP	22	28	26	34	28	28	28	28	23	21	21	23	24	24	26	356
TK	24	28	19	26	18	19	19	19	20	22	22	21	22	22	23	304
IS	24	28	19	26	18	19	19	19	20	22	22	21	22	22	23	302
MR	22	26	18	24	17	18	18	18	20	21	21	20	21	20	22	285
SKRN	10	10	10	10	7	7	7	7	7	8	8	10	10	10	10	121
YD	23	24	21	24	19	20	20	20	18	20	20	22	23	23	23	297
SR	23	24	21	24	19	20	20	20	18	20	20	22	23	23	23	297
NR	24	25	22	25	18	19	19	19	18	20	20	23	24	24	24	300
Di	317	379	327	407	308	317	317	317	287	284	285	338	341	338	354	4,916

(Chen et al., 2022), adept political maneuvering (Arterton, 2023), ability to mobilize opposition (Sommer et al., 2023), and the multifaceted nature of influence that includes both supportive and critical roles (Sovacool et al., 2022). This dynamic underscores the importance of addressing criticisms constructively and engaging with all stakeholders to foster a more robust and inclusive program (Cuppen, 2012).

Actors with moderate influence include MM (Former Village Head and Initiator, 327), HP (TPS3R Manager, 317), KS (TPS3R Member, 317), AN (TPS3R Member, 317), and SP (TPS3R Member, 317). These individuals, while not at the top of the hierarchy, still hold significant sway in the program. HP, KS, AN and SP's role is crucial as they are directly responsible for overseeing the routine activities of TPS3R. This finding aligns with Bhatnagar and Aggarwal's (2020) study which found that employees who are given the chance to align their work with environmental objectives, as SK does, tend to engage more deeply in eco-initiatives. According to Bhatnagar and Aggarwal (2020), this engagement not only boosts their psychological capital—comprising optimism, resilience, self-efficacy, and hope—but also reduces feelings of alienation. Their direct involvement in the day-to-day activities of TPS3R positions them at the heart of the program's operational success. Unlike formal leaders who may focus on broader strategic goals, SK's role ensures continuous and hands-on management of routine activities, which is essential for the program's smooth functioning and adherence to its environmental goals. This daily engagement fosters a strong sense of purpose within SK and creates a meaningful work for this person. Meaningful work is defined as work that is personally significant and worthwhile. It embodies the personal importance of one of the most prominent social activities, occupying a substantial portion of adults' waking hours and serving as a primary context for individuals to pursue their life aspirations (Lysova et al., 2019).

Those with the lowest influence are SL (TPS3R Member, 308), TK (Resident living near TPS3R, 287), MR (Resident living near TPS3R,

285), and IS (Resident living near TPS3R, 284). Although their direct influence is lower, these actors are still integral to the program's ecosystem. Their roles as residents and members reflect the grassroots level of the program, highlighting the importance of community participation and local engagement in the success of TPS3R.

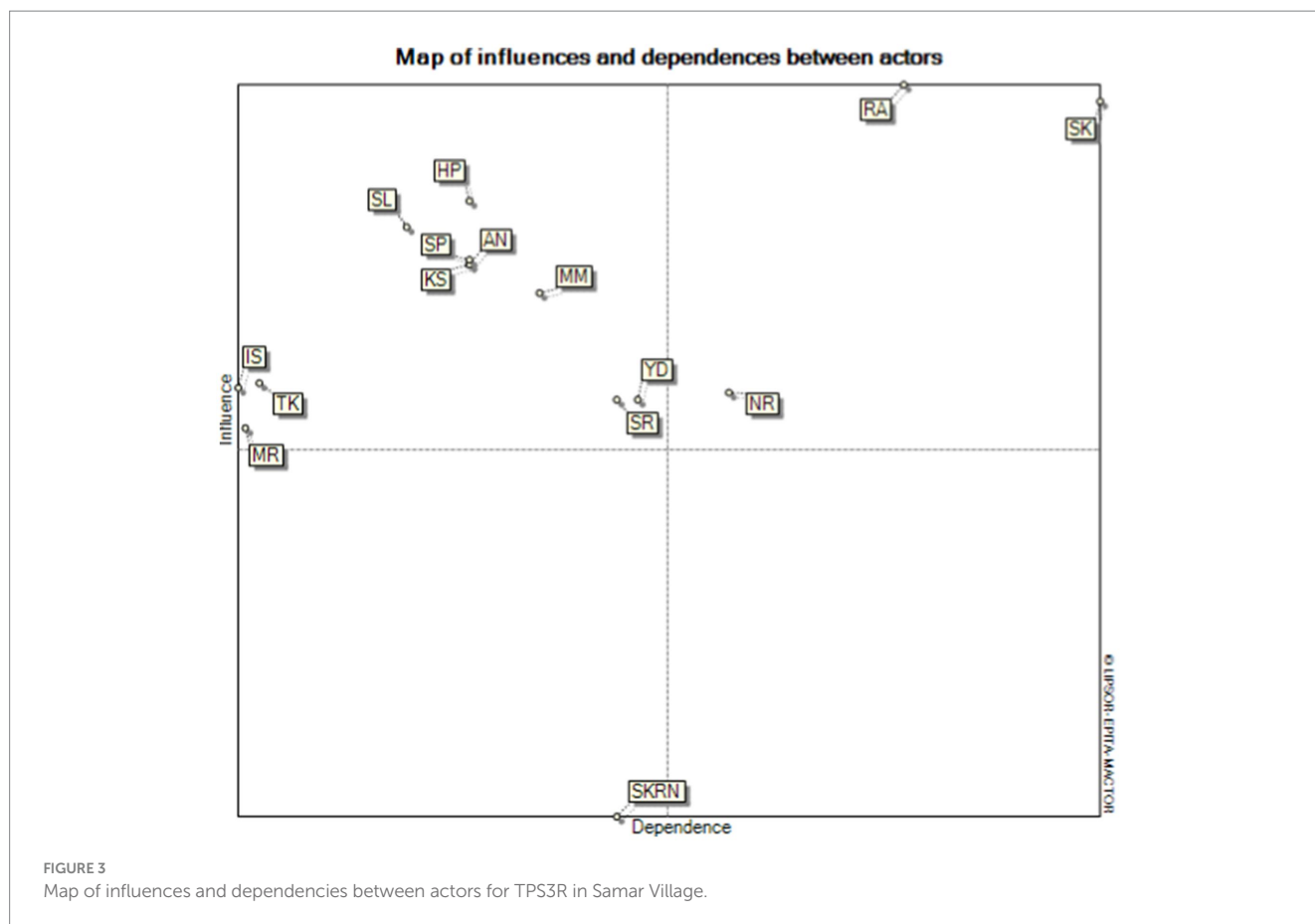
These findings underscore the multi-level structure of influence within the TPS3R program, illustrating the importance of both high-level leadership and grassroots involvement in achieving sustainable waste management practices.

4.1.5 Indirect influence

Actors with the highest indirect influences are RA (Village Head, 430), SK (Head of LMDH, 423), HP (TPS3R Manager, 381), SL (TPS3R Member, 370), and SP (TPS3R Member, 356). These individuals wield significant indirect influence due to their pivotal roles in policymaking, community leadership, and operational management. According to Ekpenyong (2022), level of mobilization and participation in leadership programs in peri-urban communities depends on the extent of their access to various communication channels, including social, conventional, and traditional media. Their high scores indicate their capacity to affect the program through indirect channels, such as mobilizing community support, advocating for resources, and shaping public perception.

Those with medium indirect influence include KS (TPS3R Member, 354), AN (TPS3R Member, 354), MM (Former Village Head and Initiator, 342), TK (Resident living near TPS3R, 304), and IS (Resident living near TPS3R, 302). These actors contribute significantly to the program, though their influence is somewhat less pronounced. Their roles involve active participation and support for TPS3R activities, reinforcing the program's objectives through consistent engagement and indirect contributions.

Actors with the lowest indirect influence are NR (Public Works and Public Housing, 300), YD (Tulungagung Environmental Agency,



297), SR (Tulungagung Environmental Agency, 297), MR (Resident living near TPS3R, 285), and SKRN (Prospective Political Opponent of the Village Head, 121). Although their indirect influence is limited, these actors still play essential roles. Their lower scores reflect a more peripheral involvement in day-to-day TPS3R activities but highlight their support functions and potential impact through specific interventions or policy support.

4.2 Map of influences and dependencies between actors

The map of influences and dependencies between actors is a graphical representation that illustrates the positions of actors in terms of their influences and dependencies (both direct and indirect: Di and Ii) on one another. These positions are automatically calculated using the MACTOR software and can be seen in Figure 3.

The map of influences and dependencies between actors, generated using the Mactor software, provides a detailed visualization of the power dynamics within the TPS3R (Waste Management Program) system. This graphic representation reveals the positions of various actors based on their calculated influences and dependencies, both direct and indirect. In the top-right quadrant of the map, we find RA (Village Head) and SK (Head of LMDH), who exhibit both high influence and high dependence. The Lembaga Masyarakat Desa Hutan (LMDH) plays a crucial role in village development in Indonesia, particularly in areas adjacent to state forests managed by Perhutani (Rosyadi, 2013). LMDH collaborates with local governments, including village heads, to manage forest resources sustainably

(Rustinsyah, 2015). Their efforts include planning, managing, maintaining, and producing forest resources while ensuring ecological conservation, economic improvement, and social relationship enhancement within the community. This collaboration is vital for maintaining forest sustainability and supporting local economic development, reflecting the integrated approach needed for peri-urban advancement. These key players are central to the TPS3R program, wielding significant power to affect other actors.

The top-left quadrant is populated by HP (TPS3R Manager), SL (TPS3R Member), SP (TPS3R Member), KS (TPS3R Member), AN (TPS3R Member), and MM (Former Village Head and Initiator). These actors have high influence but low dependence, indicating their strong ability to impact the program while being less influenced by others. Their pivotal roles in the implementation and sustainability of the program highlight their importance in maintaining operational effectiveness and fostering community engagement. In contrast, the bottom-left quadrant includes MR (Resident near TPS3R), IS (Resident near TPS3R), and TK (Resident near TPS3R), who exhibit both low influence and low dependence. These peripheral participants, while essential to grassroots support, do not significantly affect the program nor are they heavily affected by other actors. Their involvement is important for the overall acceptance of the TPS3R program within the community as Zurbrügg et al. (2012) stated that one of the key drivers determining the success or failure of a solid waste management project is social acceptance. The bottom-right quadrant features SKRN (Prospective Political Opponent of the Village Head), who has low influence but high dependence. This actor is significantly affected by the actions of others but has limited power to influence the program. SKRN's position suggests a need for reactive

strategies, closely monitoring and responding to the decisions and actions of more influential actors.

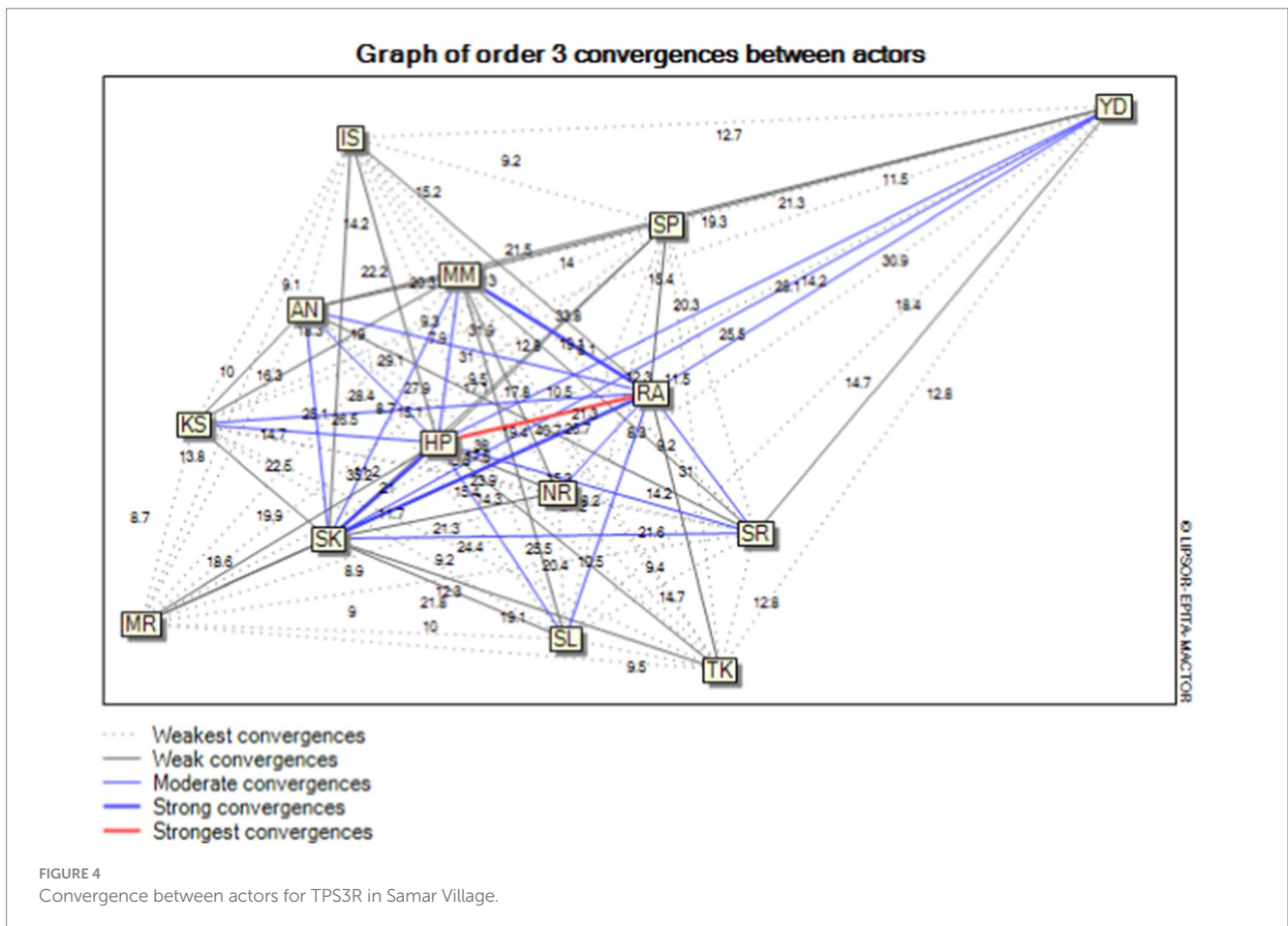
In the public sector, the concept of cooperation has evolved into collaboration with the rise of collaborative governance theories (Sudrajad et al., 2022). Occupying a central position on the map, with moderate influence and dependence, are YD (Tulungagung Environmental Agency representative), SR (Tulungagung Environmental Agency representative), and NR (Public Works and Public Housing representative). These supportive actors play intermediary roles in the TPS3R program, providing essential services and resources. In the context of the TPS3R (Waste Management Program) in Samar Village, Tulungagung, the support from environmental services and the Public Works and Public Housing Ministry has been instrumental. The environmental services have contributed significantly by providing a sorting machine, essential for efficiently separating different types of waste materials. This machinery streamlines the waste management process, ensuring that recyclable materials are effectively sorted from non-recyclables. Additionally, the Public Works and Public Housing Ministry has supported TPS3R by constructing the necessary buildings for the program's operational activities. This infrastructure development is crucial for housing the sorting machine, storing waste materials, and facilitating the daily operations of the waste management program.

Overall, the map of influences and dependencies within the TPS3R program highlights the complex interplay of power and support among various actors. Key influencers like RA and SK drive

the program's success, operational leaders such as HP and the TPS3R members ensure effective implementation, while supportive agencies and peripheral community members contribute to the program's sustainability and acceptance. This comprehensive network of influences is crucial for achieving sustainable waste management outcomes.

4.3 Convergence between actors

Figure 4 illustrates the convergences between actors and highlights their relative alignments. That is, the closer actors are to each other, the more their convergence is intense. Figure 3 depicts the graph of order 3 convergences between actors presents a detailed visualization of the relationships among various stakeholders in the TPS3R (Waste Management Program) based on the intensity of their convergences. The different colored lines on the graph, ranging from weakest to strongest, indicate the strength of these convergences. At the heart of the graph, we observe the most intense convergence between RA (Village Head) and HP (TPS3R Manager), represented by a red line. This aligns with the notion that a leader's role is to stimulate the creativity of employees and reward their innovative behavior (Kozioł-Nadolna, 2020). By fostering a collaborative environment, these actors can effectively drive the TPS3R program's success, encouraging innovation and engagement from all participants involved.



Blue lines denote strong convergences, notably between YD (Tulungagung Environmental Agency representative) and RA (Village Head), HP (TPS3R Manager), and SK (Head of LMDH). This indicates a substantial alignment and cooperative effort between the environmental agency and the program's leadership and management, essential for the program's success. RA also shows strong convergences with SK and SP (TPS3R Member), reflecting robust alignment and collaboration within the program's framework (Bingham et al., 2014; Matinheikki, 2019; Vangen and Huxham, 2003).

Moderate convergences, indicated by thicker gray lines, reveal balanced levels of alignment and collaboration across different roles. RA maintains these moderate convergences with various actors such as NR (Public Works and Public Housing), SR (Tulungagung Environmental Agency), MM (Former Village Head and Initiator), KS (TPS3R Member), and AN (TPS3R Member). Similar moderate connections are seen between HP, SK, and other actors like AN, SP, and NR, showcasing a supportive network that is crucial for the program's implementation. Weaker convergences, depicted by thinner and dashed gray lines, are found between peripheral actors like MR (Resident near TPS3R), IS (Resident near TPS3R), and TK (Resident near TPS3R) and the more central figures. These weaker connections indicate less direct collaboration or shared goals, suggesting that while these peripheral actors are involved, they do not align as closely with the core leadership.

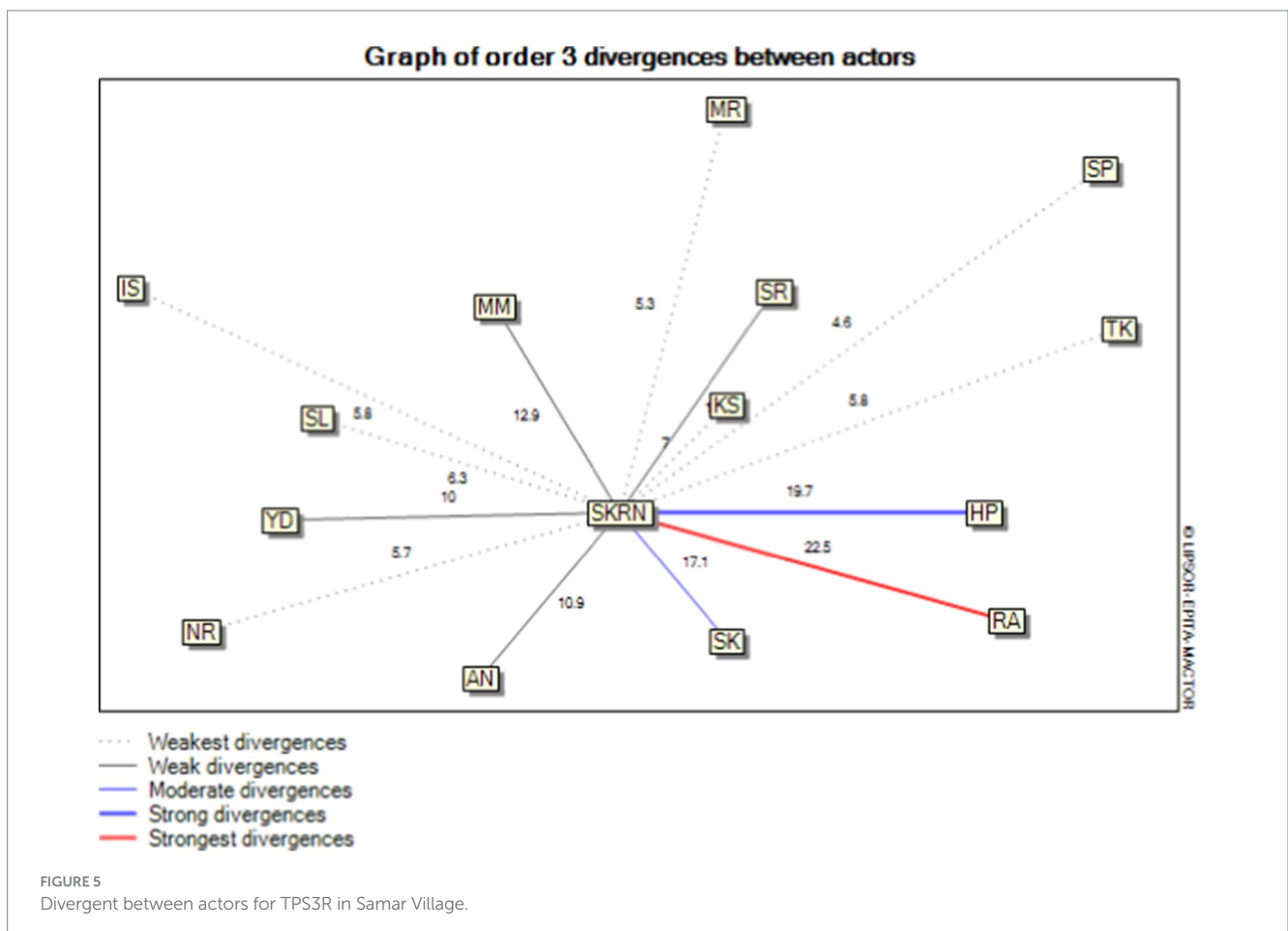
Overall, the graph highlights the central roles of RA, HP, and SK, who exhibit the strongest and most numerous convergences with

other actors, underscoring their pivotal roles in driving the program's success. Supportive roles are played by actors such as YD, NR, SR, and MM, who have strong to moderate convergences linking them to central figures, ensuring that the necessary resources and support are aligned with the program's goals. Community involvement is also significant, with actors like SP, KS, and AN showing notable convergence, reflecting the importance of engaging the local community in the TPS3R program. Meanwhile, residents like MR, IS, and TK, although displaying weaker convergences, represent the broader community's participation, which is essential for the grassroots support and local implementation of waste management practices.

4.4 Divergence between actors

The graph of divergences between actors maps the actors of order 3 with respect to their divergences is presented in Figure 5. It helps to identify potential alliances and conflicts.

In the realm of strongest divergences, marked by red lines, the graph reveals a significant discord between RA, the Village Head, and SKRN, a prospective political opponent. This deep red line suggests a profound clash in their objectives or methods, potentially indicative of a major conflict, given SKRN's adversarial political position. The strong divergences are illustrated with blue lines, showcasing notable differences between HP, the TPS3R Manager, and SKRN. This



indicates a substantial disparity in perspectives or actions between the TPS3R manager and the political opponent, which could lead to significant disagreements and friction. Moderate divergences are represented by thicker gray lines, such as the one connecting SK, the Head of LMDH, with SKRN. This indicates a level of disagreement or conflicting interests that, while present, are less severe compared to the more intense divergences denoted by blue and red lines. Weaker divergences are depicted by thin and dashed gray lines, showing less pronounced conflicts between SKRN and other actors like YD from the Tulungagung Environmental Agency, AN and SL, both TPS3R Members, NR from Public Works and Public Housing, and KS, another TPS3R Member. These thin lines suggest that while there are some differences in objectives or actions, they are not significant enough to create major conflicts. The weakest divergences, shown as minimal thin gray lines among actors such as SP, TK, IS, and MR—all residents near TPS3R—indicate a general alignment in their goals and actions. The minimal conflicts here suggest a relatively harmonious network with little to no disruption to the program.

Overall, the graph underscores SKRN's central role as a point of divergence within the TPS3R network. The most intense conflicts are observed between SKRN and key TPS3R leaders, RA and HP, highlighting potential areas of contention that could impact the program's progress. The intense conflicts between SKRN and key TPS3R leaders, RA and HP, can be understood through the lens of ideological clashes (Harel et al., 2020). On the intergroup level, differing ideologies between SKRN and the TPS3R leaders contribute to the preservation and escalation of these conflicts. SKRN's political opposition introduces significant ideological differences that create tension and hinder collaborative efforts. On the intragroup level, the moderate divergence between SK and SKRN highlights how internal ideological differences can induce conflicts that may need addressing to ensure the smooth operation of the TPS3R program. Ideology's role in these interactions underscores the complexities of managing and resolving conflicts within such initiatives. Conversely, the weaker divergences among other actors suggest a relatively cooperative environment with minimal conflict, facilitating a more harmonious working dynamic. This comprehensive view of divergences allows stakeholders to navigate the program's complexities, addressing conflicts proactively and fostering stronger alliances to achieve the program's goals effectively and sustainably.

4.5 Recommendation

To enhance stakeholder collaboration and improve waste management practices in the TPS3R, the following policy recommendations are proposed based on the analysis of direct and indirect influences, as well as convergence and divergence among actors:

4.5.1 Strengthen leadership collaboration

Given the high direct influence of key actors like RA (Village Head), SK (Head of LMDH), and HP (TPS3R Manager), it is crucial to formalize and enhance collaboration among these leaders. Establish regular joint meetings and strategic planning sessions to ensure alignment on program goals and strategies. This will help in leveraging their substantial influence to drive cohesive policy and operational decisions and address any potential conflicts early on. To effectively leverage the substantial influence of key actors, it is crucial to formalize and enhance collaboration among these leaders.

Recent literature underscores the significance of strategic partnerships and formalized collaboration in achieving impactful policy and operational outcomes. For instance, Hambrick and Wowak (2021) highlight that aligning key actors can drive substantial changes. Bryson et al. (2014) emphasize that collaborative governance, involving regular meetings and strategic planning, enhances public value and addresses operational challenges effectively. Park et al. (2021) argue that local governments can achieve better outcomes through deliberate collaborative strategies, including formalizing interactions among key stakeholders. Similarly, Van der Voet and Steijn (2021) discuss the need for structured management to achieve collaborative advantage, reinforcing the necessity of formal processes to ensure alignment and cohesion. Collectively, these sources validate the recommendation to formalize collaboration among influential leaders, emphasizing its role in driving cohesive policy decisions and addressing potential conflicts.

4.5.2 Address political tensions

The strong divergences between RA (Village Head) and SKRN (Prospective Political Opponent) suggest significant political and strategic disagreements. To address the political and strategic disagreements between RA and SKRN, it is essential to initiate dialogue sessions and involve neutral mediators. Structured dialogue can effectively manage and resolve conflicts between opposing stakeholders. According to a study by Cuppen (2012), dialogue involves the expression of a wide range of perspectives and the challenging of claims and ideas grounded in these differing viewpoints. By leveraging three key properties of diversity—variety, balance, and disparity—the methodological implications of constructive conflict can be addressed as a central design issue. This approach underscores the importance of structured dialogue in fostering mutual understanding and resolving disagreements effectively. Meanwhile, Peltola et al. (2023) emphasize that involving neutral mediators in discussions helps create a more balanced and constructive environment, which is crucial for mitigating the risk of conflicts negatively impacting program effectiveness. Researchers can act as neutral mediators in dialogues between political opponents. By applying their expertise and impartiality, they can facilitate constructive discussions, bridge divides, and promote effective conflict resolution. However, it is important to justify this role, as many researchers come from academic backgrounds and may lack practical social experience. Nonetheless, their analytical expertise, evidence-based approach, and objective perspective can equip them to navigate complex stakeholder dynamics and facilitate balanced discussions.

4.5.3 Enhance community engagement

Despite their lower direct influence, actors such as SL, TK, MR, and IS are essential for grassroots support. Developing targeted outreach programs to engage these residents more effectively is crucial (Christens et al., 2021). Community workshops, feedback sessions, and participatory decision-making processes can empower residents and integrate their perspectives into the program. Grassroots initiatives are crucial in peri-urban contexts because they empower local communities to lead decision-making processes that reflect their unique strengths, resources, and realities (Westoby et al., 2021). By focusing on locally led decision-making, these initiatives harness local institutions, social networks, indigenous knowledge, and coping mechanisms to address community-specific vulnerabilities and inequalities. Utilizing local metrics for success and prioritizing local agendas ensures that the efforts are meaningful and sustainable,

particularly when supported by external agencies. This approach enables communities to determine their own futures and ensures that limited resources are used effectively, leading to more resilient and adaptive peri-urban communities. Utilizing local metrics for success and prioritizing local agendas ensures that the efforts are meaningful and sustainable (Szetey et al., 2021), particularly when supported by external agencies. This approach enables communities to determine their own futures and ensures that limited resources are used effectively, leading to more resilient and adaptive peri-urban communities. Such initiatives ensure that community members feel heard and involved, which can build broader support and proactively address local concerns.

4.5.4 Strengthen supportive agencies' roles

Actors with moderate indirect influence, such as YD (Tulungagung Environmental Agency) and NR (Public Works and Public Housing), play critical supportive roles in the success of any program. Enhancing their involvement by formalizing their roles in program implementation and evaluation can lead to more effective outcomes. Formalization ensures that these agencies have clear, defined responsibilities and channels for providing input, resources, and support, which aligns their contributions with the program's objectives (Ponte et al., 2021). Effective program implementation requires a comprehensive understanding of program foundations, clear implementation systems, and continuous program monitoring (Duerden and Witt, 2012). The policy recommendation also highlights the importance of evaluation processes. By establishing formal roles, YD and NR can contribute systematically to these areas, ensuring that their input is consistent and aligned with program goals. Integrating these agencies into the formal structure of program evaluation enhances accountability and transparency. This structured involvement allows for systematic data collection and analysis, which are crucial for assessing program performance and making necessary adjustments (Cornwall and Aghajanian, 2017). By creating clear channels for these agencies to participate, programs can leverage their expertise and resources more effectively, leading to improved program outcomes and sustainability.

4.5.5 Monitor and adapt

One of the most challenging aspects of innovation implementation is securing high levels of commitment and acceptance from key stakeholders. Postema et al. (2012) suggest that significant progress can be made by thoroughly understanding the indicators of stakeholder influence and acceptance during the phases of innovation implementation and adoption. Establish a monitoring system to regularly assess the dynamics of influence, convergence, and divergence among stakeholders (Ahmed et al., 2022). Regular reviews and assessments can identify potential conflicts or areas of divergence early, allowing for proactive management and resolution. This ongoing evaluation helps maintain effective collaboration, ensuring that the program adapts to changing dynamics and continues to progress toward its goals. By implementing these recommendations, the TPS3R program can enhance stakeholder collaboration, address conflicts, and improve waste management practices, leading to more effective and sustainable outcomes.

5 Conclusion

The examination of stakeholder dynamics within the TPS3R (Waste Management Program) in Tulungagung Regency provides

valuable insights into the specific challenges faced in peri-urban areas, where rapid population growth, limited infrastructure, and the mix of rural and urban characteristics complicate waste management efforts. The study emphasizes that addressing local political tensions, fostering stronger leadership collaboration, and boosting community engagement are particularly crucial in these settings. Unlike urban areas with more established systems, peri-urban regions require more tailored solutions, where both high-level leadership and grassroots involvement are necessary for overcoming socio-political barriers and ensuring sustainable waste management. However, the study has its limitations. It offers a snapshot of stakeholder dynamics at one point in time, potentially overlooking how these relationships evolve in a constantly changing peri-urban environment. Additionally, while the research incorporates quantitative analysis, it may miss important qualitative factors such as trust and communication, which play a significant role in local governance and program effectiveness, especially in areas with diverse stakeholder groups.

Future research could benefit from longitudinal studies to track these evolving dynamics over time, offering deeper insights into the factors that drive long-term success. Qualitative methods, such as ethnographic research and interviews, could better capture the intangible elements like trust, communication, and the local governance challenges unique to peri-urban settings. Finally, considering external influences such as political shifts or regional development changes could help explain how broader forces impact waste management programs in these areas.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by Komisi Etik Penelitian Universitas Negeri Malang. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

ImM: Writing – original draft, Writing – review & editing, Conceptualization, Data curation, Investigation, Methodology. SF: Data curation, Investigation, Writing – original draft, Writing – review & editing, Resources. FR: Writing – original draft, Writing – review & editing, Formal analysis, Funding acquisition, Methodology. SS: Formal analysis, Writing – original draft, Writing – review & editing, Supervision, Validation. InM: Writing – original draft, Writing – review & editing, Project administration, Software, Visualization.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

- Adam, A. G., and Dadi, T. T. (2024). Perspectives for smooth bridging of dichotomized urban–rural land development in the peri-urban areas of Ethiopia: toward a continuum approach. *Reg. Sci. Policy Pract.* 16:12733. doi: 10.1111/rsp3.12733
- Adrianto, D. W. (2022). *Peri-urbanisation and the emergence of integrated spatial planning and governance managing the growth of Peri-urban areas in the secondary City-regions of Indonesia*. University of Manchester. Available online at: <https://www.proquest.com/openview/84cf86bc622496397c144e3cc20fccc/1?cbl=2026366&diss=y&pq-origsite=gscholar> (Accessed on September 12, 2024).
- Ahmed, Z., Eryilmaz, E., and Alzahrani, A. I. (2022). IS diffusion: A dynamic control and stakeholder perspective. *Information & management* 59:103572. doi: 10.1016/j.im.2021.103572
- Arterton, F. C. (2023). *Strategy in politics: plotting victory in a democracy*. Oxford, England: Oxford University Press.
- Bhatnagar, J., and Aggarwal, P. (2020). Meaningful work as a mediator between perceived organizational support for environment and employee eco-initiatives, psychological capital and alienation. *Employee Relations: The International Journal* 42, 1487–1511. doi: 10.1108/ER-04-2019-0187
- Bingham, L. B., O'Leary, R., and Carlson, C. (2014). Frameshifting: Lateral thinking for collaborative public management. In *Big ideas in collaborative public management* (pp. 13–26). Routledge, London. Editor: Lisa Blomgren Bingham, Rosemary O'Leary.
- Brown, P., Von Daniels, C., Bocken, N. M. P., and Balkenende, A. R. (2021). A process model for collaboration in circular oriented innovation. *J. Clean. Prod.* 286:125499. doi: 10.1016/j.jclepro.2020.125499
- Bryson, J. M., Crosby, B. C., and Bloomberg, L. (2014). Public value governance: Moving beyond traditional public administration and the new public management. *Public administration review* 74, 445–456. doi: 10.1111/puar.12238
- Chen, L., Chen, J., and Xia, C. (2022). Social network behavior and public opinion manipulation. *J. Inf. Secur. Appl.* 64:103060. doi: 10.1016/j.jisa.2021.103060
- Christens, B. D., Gupta, J., and Speer, P. W. (2021). Community organizing: Studying the development and exercise of grassroots power. *Journal of Community Psychology* 49, 3001–3016. doi: 10.1002/jcop.22700
- Cornwall, A., and Aghajanian, A. (2017). How to find out what's really going on: Understanding impact through participatory process evaluation. *World Development* 99, 173–185. doi: 10.1016/j.worlddev.2017.07.010
- Cuppen, E. (2012). Diversity and constructive conflict in stakeholder dialogue: considerations for design and methods. *Policy. Sci.* 45, 23–46. doi: 10.1007/s11077-011-9141-7
- Dehghani, M. H., Omrani, G. A., and Karri, R. R. (2021). "Solid waste—sources, toxicity, and their consequences to human health" in *Soft computing techniques in solid waste and wastewater management*. eds. R. R. Karri, G. Ravindran and M. H. Dehghani. (Amsterdam, Netherlands: Elsevier), 205–213.
- Duerden, M. D., and Witt, P. A. (2012). Assessing program implementation: What it is, why it's important, and how to do it. *The Journal of Extension* 50:5. doi: 10.34068/joe.50.01.05
- Ekpenyong, M.-M. D. (2022). Community leaders' access to channels of communication: the Nigerian experience. *Int. J. Afr. Lang. Media Stud.* 2, 71–84.
- Fatimah, A., Assomadi, A. F., Febrianto, A., and Hermana, J. (2024). Efforts to reduce carbon emissions from TPS3R and Rumah Kompos facilities: case study in Surabaya. *IOP Conf. Ser. Earth Environ. Sci.* 1307:012011. doi: 10.1088/1755-1315/1307/1/012011
- Ferronato, N., and Torretta, V. (2019). Waste mismanagement in developing countries: a review of global issues. *Int. J. Environ. Res. Public Health* 16, 16:1060. doi: 10.3390/ijerph16061060

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Fetoui, M., Idoudi, Z., Rudiger, U., Sacko, I., Tebourbi, O., Dione, M., et al. (2023). *Stakeholder analysis: prospects for effective and sustainable implementation of innovation packages, achieving Initiative's immediate results and outcomes in Mali*. The Consortium of International Agricultural Research Centers.

Fulazzaky, M. A. (2014). Challenges of integrated water resources management in Indonesia. *Water (Switzerland)* 6, 2000–2020. doi: 10.3390/w6072000

Godet, M. (1991). Actors' moves and strategies: the mactor method: an air transport case study. *Futures* 23, 605–622. doi: 10.1016/0016-3287(91)90082-D

Hambrick, D. C., and Wowak, A. J. (2021). CEO sociopolitical activism: A stakeholder alignment model. *Academy of Management Review* 46, 33–59. doi: 10.5465/amr.2018.0084

Harel, T. O., Maoz, I., and Halperin, E. (2020). A conflict within a conflict: Intragroup ideological polarization and intergroup intractable conflict. *Current Opinion in Behavioral Sciences* 34, 52–57. doi: 10.1016/j.cobeha.2019.11.013

Hudalah, D. (2010). *Peri-urban planning in Indonesia: contexts, approaches and institutional capacity*. Netherlands: University of Groningen.

Iskandar, I. (2022). Waste management sites-reduce, reuse, and recycle (3Rs) construction study in Sekanak area, Palembang City. *Int. J. Eng. Appl. Sci. Technol.* 7. Available1111111111111111 online at: <http://www.ijeast.com> (Accessed on September 12, 2024).

Kaza, S., Yao, L., Bhada-Tata, P., and Van Woerden, F. (2018). *What a waste 2.0: A global snapshot of solid waste management to 2050*. Washington, DC.: World Bank Publications.

Kozioł-Nadolna, K. (2020). The role of a leader in stimulating innovation in an organization. *Administrative Sciences* 10:59. doi: 10.3390/admsci10030059

Krystosik, A., Njoroge, G., Odhiambo, L., Forsyth, J. E., Mutuku, F., and LaBeaud, A. D. (2020). Solid wastes provide breeding sites, burrows, and food for biological disease vectors, and urban zoonotic reservoirs: a call to action for solutions-based research. *Front. Public Health* 7:405. doi: 10.3389/fpubh.2019.00405

Legates, R., and Hudalah, D. (2014). Peri-urban planning for developing east asia: learning from Chengdu, China and Yogyakarta/kartamantul, Indonesia. *J. Urban Aff.* 36, 334–353. doi: 10.1111/juaaf.12106

Lysova, E. I., Allan, B. A., Dik, B. J., Duffy, R. D., and Steger, M. F. (2019). Fostering meaningful work in organizations: A multi-level review and integration. *Journal of vocational behavior* 110, 374–389. doi: 10.1016/j.jvb.2018.07.004

MacDonald, A., Clarke, A., and Huang, L. (2022). "Multi-stakeholder partnerships for sustainability: designing decision-making processes for partnership capacity" in *Business and the ethical implications of technology*. eds. M. Kirsten; S. Katie and S. Jeffery (Switzerland: Springer), 103–120.

Matinheikki, J. (2019). *Creating value through inter-organizational collaboration: A collective action perspective*. Finlandia: Aalto University <https://urn.fi/URN:ISBN:978-952-60-8534-0>.

Mohamed, B.-D., El Mahrab, B., Moroşanu, G. A., Elhassnaoui, I., Moumen, A., El Mezouary, L., et al. (2021). *Stakeholders' interactions in water management system: Insights from a MACTOR analysis in the R'Dom sub-basin, Morocco*. Springer.

Mor, S., and Ravindra, K. (2023). Municipal solid waste landfills in lower-and middle-income countries: environmental impacts, challenges and sustainable management practices. *Process Saf. Environ. Prot.* 174, 510–530. doi: 10.1016/j.psep.2023.04.014

Munaro, M. R., Tavares, S. F., and Bragança, L. (2020). Towards circular and more sustainable buildings: A systematic literature review on the circular economy in the built environment. *Journal of cleaner production* 260:121134. doi: 10.1016/j.jclepro.2020.121134

- Park, A. Y., Krause, R. M., and Hawkins, C. V. (2021). Institutional mechanisms for local sustainability collaboration: Assessing the duality of formal and informal mechanisms in promoting collaborative processes. *Journal of Public Administration Research and Theory* 31, 434–450. doi: 10.1093/jopart/muaa036
- Peltola, T., Saarela, S. R., Kotilainen, J. M., Litmanen, T., Lukkarinen, J., Pölonen, I., et al. (2023). Researcher roles in collaborative governance interventions. *Science and Public Policy* 50, 871–880. doi: 10.1093/scipol/scad034
- Ponte, S., Noe, C., and Mwamfupe, A. (2021). Private and public authority interactions and the functional quality of sustainability governance: Lessons from conservation and development initiatives in Tanzania. *Regulation & Governance* 15, 1270–1285. doi: 10.1111/rego.12303
- Postema, T., Groen, A., and Krabbendam, K. (2012). A model to evaluate stakeholder dynamics during innovation implementation. *International Journal of Innovation Management* 16:1250025. doi: 10.1142/S136391961200385X
- Rajendran, L. P., Raúl, L., Chen, M., Guerrero Andrade, J. C., Akhtar, R., Mngumi, L. E., et al. (2024). The “peri-urban turn”: a systems thinking approach for a paradigm shift in reconceptualising urban-rural futures in the global south. *Habitat Int.* 146:103041. doi: 10.1016/j.habitatint.2024.103041
- Rochman, G. P., Odah, Chofyan, I., and Sakti, F. (2020). Understanding the smart society in rural development. *IOP Conf. Ser. Earth Environ. Sci.* 447:012016. doi: 10.1088/1755-1315/447/1/012016
- Rosyadi, S. (2013). Good governance practices by local organization in forest resource management. *J. Adm. Sci. Organ.* 19, 28–33. doi: 10.20476/jbb.v19i1.1876
- Rustinsyah (2015). A pattern for partnership between LMDH and Perhutani to enhance local community prosperity and preserve the forest: a case study at RPH Besowo, Kediri regency, Indonesia. *Chin. J. Popul. Resour. Environ.* 13, 265–271. doi: 10.1080/10042857.2015.1059595
- Sahana, M., Ravetz, J., Patel, P. P., Dadashpoor, H., and Follmann, A. (2023). Where is the Peri-urban? A systematic review of Peri-urban research and approaches for its identification and demarcation worldwide. *Remote Sens.* 15:1316. doi: 10.3390/rs15051316
- Sareen, S., and Haque, M. (2024). Analyzing barriers in peri-urban land development for informed policymaking. *Int. J. Hum. Cap. Urban Manag.* 9, 489–508. doi: 10.22034/IJHCUM.2024.03.09
- Somer, M., McCoy, J. L., and Luke, R. E. (2023). “Pernicious polarization, autocratization and opposition strategies” in *Resilience of democracy* (London: Routledge), 61–80.
- Sovacool, B. K., Hess, D. J., Cantoni, R., Lee, D., Brisbois, M. C., Walnum, H. J., et al. (2022). Conflicted transitions: exploring the actors, tactics, and outcomes of social opposition against energy infrastructure. *Glob. Environ. Chang.* 73:102473. doi: 10.1016/j.gloenvcha.2022.102473
- Sudrajat, E., Domai, T., Makmur, M., and Kumalasari, I. (2022). Exploring the waste management policy in developing country: lesson and challenges from Kediri regency, Indonesia. *JLAP* 8, 304–312. doi: 10.21776/ub.jiap.2022.008.03.7
- Sumardjo, Firmansyah, A., Dharmawan, L., Kriswatriyono, A., and Wulandari, Y. P. (2022). Environmental management system toward sustainable development goals Achievement Base on community empowerment in Peri-urban. *IOP Conf. Ser. Earth Environ. Sci.* 950:012067. doi: 10.1088/1755-1315/950/1/012067
- Szetye, K., Moallemi, E. A., Ashton, E., Butcher, M., Sprunt, B., and Bryan, B. A. (2021). Co-creating local socioeconomic pathways for achieving the sustainable development goals. *Sustainability science* 16, 1251–1268. doi: 10.1007/s11625-021-00921-2
- Utomo, M. M. B., Pieter, L. A. G., Kusumawati, D., and Putra, H. P. (2023). *From waste to managed waste facility and compost for farming: the role of women movement in urban villages in Bali, Indonesia*. The Consortium of International Agricultural Research Centers.
- Van der Voet, J., and Steijn, B. (2021). Team innovation through collaboration: How visionary leadership spurs innovation via team cohesion. *Public Management Review* 23, 1275–1294. doi: 10.1080/14719037.2020.1743344
- Vangen, S., and Huxham, C. (2003). Nurturing collaborative relations: Building trust in interorganizational collaboration. *The Journal of applied behavioral science* 39, 5–31. doi: 10.1177/0021886303039001001
- Vinti, G., and Vaccari, M. (2022). Solid waste Management in Rural Communities of developing countries: an overview of challenges and opportunities. *Clean Technol.* 4, 1138–1151. doi: 10.3390/cleantechnol4040069
- Westoby, R., Clissold, R., McNamara, K. E., Ahmed, I., Resurrección, B. P., Fernando, N., et al. (2021). Locally led adaptation: drivers for appropriate grassroots initiatives. *Local Environment* 26, 313–319. doi: 10.1080/13549839.2021.1884669
- Yukalang, N., Clarke, B., and Ross, K. (2017). Barriers to effective municipal solid waste management in a rapidly urbanizing area in Thailand. *Int. J. Environ. Res. Public Health* 14:1013. doi: 10.3390/ijerph14091013
- Zurbrügg, C., Gfrerer, M., Ashadi, H., Brenner, W., and Küper, D. (2012). Determinants of sustainability in solid waste management—the Gianyar waste recovery project in Indonesia. *Waste Manag.* 32, 2126–2133. doi: 10.1016/j.wasman.2012.01.011