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CASE STUDY

Resident-based learning model for sustainable resident participation in municipal solid waste management program

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ABSTRACT

BACKGROUND AND OBJECTIVES: Encouraging resident participation in the Municipal Solid Waste Management system still becomes a challenge for cities in developing countries. Previous studies showed that existing education strategies ineffective and insufficient to change resident behavior sustainably. Therefore, this study aimed to develop a resident-based learning model to encourage sustainable resident participation in waste management programs at the household level using the Community of Practice approach.

METHODS: This study was a conceptual model study using a case study as the research strategy. The case being analyzed was *Kawasan Bebas Sampah* (Zero Waste Area) program implemented in Bandung City, Indonesia. The primary data was collected through field observation on the 8 *Kawasan bebas sampah* and in-depth interviews with 63 key informants comprising 31 key actors in the educational programs and 32 informants as resident representatives, conducted from January 2020 – November 2020. Additional data from the quantitative method was gathered in April 2021, focusing on surveying resident's habits toward waste management as evidence of the program result.

FINDINGS: The findings showed that the education strategy implemented in Bandung City, Indonesia presented effective results, based on waste reduction rate reaching up to 0, 47% at the city level from 2019 to 2020. The survey provided evidence that the education program has succeeded in forming new habits for residents. Averagely 60% of respondents in each sample area have the habits and up to > 90% for the areas with more durable education program. Some critical points for education strategy implementations are identified. First, collaboration and supports from key stakeholders such as facilitators, local leaders, and educators become the enabler of the program. Second, key stakeholders need to identify knowledge and value needs before the program started. Third, the learning activities are conditioned to facilitate practice-based and dialogue-based learning through group and non-group learning activities. Fourth, local cadres are vital to sustaining the education program.

CONCLUSION: This study has succeeded in giving a new strategic approach to improve resident participation in municipal solid waste management. The resident-based learning model proposed in this study offered a more effective strategy for other cities in developing countries to improve the sustainable participation of residents in their waste management system. However, some adjustments may be required for residents with different characteristics. Future studies may focus on testing and refining the model to improve its applicability.

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INTRODUCTION

Household waste is to be the most dominant component of Municipal Solid Waste (MSW) in many developing countries (Esmaeilizadeh *et al.,* 2020; Jouhara *et al.,* 2017; Speier *et al.,* 2018;), which reached up to 55 – 85 % of MSW composition (Banerjee and Sarkhel, 2019). It indicated the crucial role of resident participation in the MSWM system (Kamaruddin *et al.,* 2017). Sustainable waste management at the household level remains a challenge due to high reliance on resident behavior (Jiang *et al.*, 2021; Moh and Manaf, 2017; Mukama *et al.,* 2016;), which has become the core problem in many cities in developing countries (Azevedo *et al.*, 2021; Banerjee and Sarkhel, 2019; Gundupalli *et al.,* 2017). Previous studies showed that education becomes one of the most critical factors to change resident behavior (Meng *et al.*, 2019; Liu *et al.*, 2019). However, existing education for residents in developing countries was considered ineffective and insufficient (Moh and Manaf, 2017; Wang *et al.*, 2018). Education cannot directly influence resident behavior toward waste management (Wang *et al.*, 2018). It is mediated by personal factor such as awareness (Chen and Gao, 2020; Lissah *et al.*, 2021; Pierini *et al.*, 2021), attitude (Lissah *et al.*, 2021; Liu *et al.*, 2019; Wang *et al.*, 2018), and moral norms (Wang *et al.*, 2018) to effectively nurture resident willingness to participate and change their behavior (Liu *et al.*, 2019; Meng *et al.*, 2019; Wang *et al.*, 2018). It is expected that the waste management behavior finally becomes their habit (Liao *et al.*, 2018; Moh and Manaf, 2017; Xu *et al.*, 2017). Education strategy should be improved to be more effective and impactful to promote personal factors (Chen and Gao, 2020; Pierini *et al.*, 2021; Wang *et al.*, 2018; Zheng *et al.*, 2020). This situation raises a question, what education strategy is more effective and impactful to nurture sustainable change on resident waste management behavior? Some studies offered several approaches for resident-based education improvements. Wang *et al.* (2018) recommended more informative and frequently shared information campaigns using posters and social media to reach more broadened communities, but Zheng (2020) found that media publicity has an insignificant impact and extensive publicity is not the solution. As indicated by Jiang *et al.* (2021), publicity was to be a communication channel to strengthen willingness. So, it may become a supporting system, instead of being the primary education approach. Pierini *et al.* (2021) proposed a relatively new strategy for resident-based waste management education through the citizen science concept while Pei (2019) and Zheng *et al.* (2020) advocated neighborhood ties, community attachment, and social connections, which highly rely on community empowerment for effective education. Chikowore (2020) added active community involvement as a behavioral change driver for sustainable waste management practice. It is expected that education can build new habits (Liao *et al.*, 2018; Xu *et al.*, 2017). In Knowledge Management (KM), intensive interaction and community engagement for educational purposes can be facilitated by a Community of Practice (CoP). The CoP concept was firstly introduced by Wenger *et al.* (2002), who contended that CoP becomes the source of learning and knowledge sharing for a particular community. A CoP is underpinned by the notion of social learning theory emphasizing informal learning groups with intensive interaction to deal with shared problems of the members (Denscombe, 2008; Stein, 2005). CoP is developed based on knowledge domain, comprising community identity determined by shared problems among members (Dessne and Byström, 2015; Madsen and Noe, 2012) and the community objectives (Middlemiss and Parrish, 2010; Reed *et al.,* 2014). So, CoP can be implemented in various domain, including waste management. Both shared problems and community objectives influence knowledge and value being shared, improved, and maintained by the communities (Li *et al.,* 2009; Madsen and Noe, 2012). The main goal of the learning activity is to prevent knowledge gap among members, so that the shared knowledge should be transferred to all the members and improve their practice (Li *et al.,* 2009). CoP enables social learning in two forms: collective learning and individual learning (Madsen and Noe, 2012; Tran *et al.,* 2018). The learning group in CoP can be formed naturally or intentionally to reach specific group objectives (Wenger *et al.,* 2002). As the learning interaction is conducted intensively (Stein, 2005), the members become experts on their problemd (Ghazali *et al.,* 2017). In the learning process, personal elements play a vital role, especially the leaders. Wenger *et al.* (2002) and Reed *et al.* (2014) indicated collaborative leadership for CoP success, meaning that the leadership should be

distributed to the whole community with different roles. Some roles are such as community coordinators, boundary spanners, thought leaders, knowledge experts, administrators, pioneers, and others (Wenger *et al.*, 2002). Community coordinators and thought leaders are central for successful CoP (Wenger *et al.*, 2002). Managerial element is related to regulations and norms required to encourage participation in the learning process (Abou-Setta, 2015). Participation level can vary from being the core group, active members, and legitimate peripheral participants (Wenger *et al.*, 2002). Other support systems are technology and infrastructure, required to facilitate more intensive knowledge sharing and practice (Li *et al.*, 2009; Middlemiss and Parrish, 2010; Stein, 2005). The previous studies about CoP implementation showed that the CoP framework is implementable for resident-based learning activities. CoP has been implemented in farming household communities in Vietnam (Tran *et al.*, 2018), an agricultural community in Denmark (Madsen and Noe, 2012), and resident-based waste management education program in Indonesia (Sunarti *et al.*, 2020). Tran *et al.* (2018) found that social learning facilitated by bonding and bridging relationship provided by CoP approach contributed significant effect to households' learning system. The study conducted by Madsen and Noe, (2012) showed that knowledge creation and knowledge implementation in the learning activities are important for CoP success. On the other hand, acquiring the relevant knowledge is vital to nurture the expected personal factors in waste management (Janmaimool and Denpaiboon, 2016) and impementating the waste management in the daily basis also crucial to nurture waste management habits (Xu *et al.*, 2017). Thus, applying CoP as the baseline concept of resident-based education can be an effective and sufficient way to nurture residents' personal factors and improve their behavior. Besides, resident-based education using CoP facilitates neighborhood engagement (Pei, 2019), social connections among community members (Zheng *et al.*, 2020), active community involvement (Chikowore, 2020) and direct practice as a part of learning system (Madsen and Noe, 2012). Thus, this study was aimed to investigate resident-based education program which implement CoP platforms. Based on study finding of Sunarti *et al.* (2020), A resident-based education program implemented in Bandung City, West Java, Indonesia, *Kawasan Bebas Sampah* (KBS/ Zero Waste Area), can be considered as CoP. However, this study investigated only one KBS location while there were 8 KBSs available. Thus, this study aimed to complete the previous study by investigating more broadened KBS areas to get comprehensive understanding about its education strategy. The second objective of this study was to investigate the effects of the education strategy for the resident waste management habits. Finally, the third objective was to develop resident-based education model to allow other cities in developing countries implementing similar strategy to improve household participation in the waste management program. The primary contribution of this study is to give more detailed picture of resident-based education strategy using CoP approach to improve resident participation in waste management effectively. The study was conducted in Bandung City, West Java, Indonesia from January - November 2020. Additional data from quantitative method was gathered in April 2021.

MATERIALS AND METHODS

Study area description

Bandung City is one of the cities in Indonesia that has a concern to handle MSW problems through resident participation encouragement. The local government of Bandung city has launched a program called 'KBS' (*Kawasan Bebas Sampah*/Zero Waste City) aimed to campaign 3R (Reduce, Reuse and Recycle) at *Kelurahan* (sub-district) level (Sunarti *et al.*, 2020). The KBS program was the follow up of Bandung City Local Regulation No.9/2018 about Waste Management, where the resident must separate their organic waste at home. The KBS program was handled by DLHK (*Dinas Lingkungan Hidup dan Kebersihan*/ Service Office of Environment and Cleanliness) in collaboration with a local-owned enterprise, PD. Kebersihan. The DLHK placed their officers in the KBS areas who were responsible to educate the residents and other stakeholders, supervise the waste management activity, handle the organic waste recycling process at the communal level and organize separated waste transfer from the communal to the city level. *PD. Kebersihan* was responsible to pick up the separated waste from the area and handle the waste management system at the city level. The location of the study is presented in Fig. 1.



Fig. 1: Geographic location of the study area in Bandung City, West Java, Indonesia

The KBS program was initiated in 2015 by local NGOs at the 'RW' (*Rukun Warga/*community association) level. There were started from one RW and then expanded after a year. In 2019, the program was officially started as government's program and reaching more expansive areas (*kelurahan* level). It was chosen 8 *Kelurahans* to be KBS models named KBS Sukaluyu, KBS Cihaurgeulis, KBS Neglasari, KBS Kebon Pisang, KBS Babakan Sari, KBS Kujangsari, and KBS Gempolsari. There was no exact data about how many households living in the KBS areas. Public statistics mostly provided number of group family. One household sometimes contains 2 – 4 families with only one waste disposal system. Each KBS commonly consists of 1,000 – 9,500 families. In total, the family groups living in all KBS areas were approximately 34,877 families. Assumed that each household contain 3 families, the total households were about 11, 625 households, spreading into 8 – 12 RWs/KBS. The whole residents in KBS areas were supposed to be exposed by the education program. Due to limited time, personal resources, and local leader problems, some RWs within KBSs did not get proper education. Before the program was started, all chosen areas implemented Collect – Transfer – Dispose system, similar with the municipal waste management system implemented in other cities in Indonesia. With the new system, the program's primary goal is to encourage residents' involvement, especially on waste separation. If the chosen areas have spaces, the organic recycling centers are built within the area to enable the waste collector recycling the organic waste. The residents were also allowed to utilize the recycling tools if they want to. If there is no space available, the separated waste will be transferred to a recycling center at the city level. The recycling center was built within an RW/several RWs, so waste collectors quickly put the separated waste into recycling tools. The government provided a transfer system to put the separated waste from the KBS to the recycling center at the city level. The waste management system in KBS areas is presented in Fig. 2.

Study design and data collection

The study's unit of analysis was the KBS program for residentials in Bandung City, which comprised 8 KBSs areas. This study was a conceptual model study using case study as research strategy. There were employed multiple methods to gather the data for better understanding toward cases (Yin, 2014). This study's main method was qualitative, conducted from

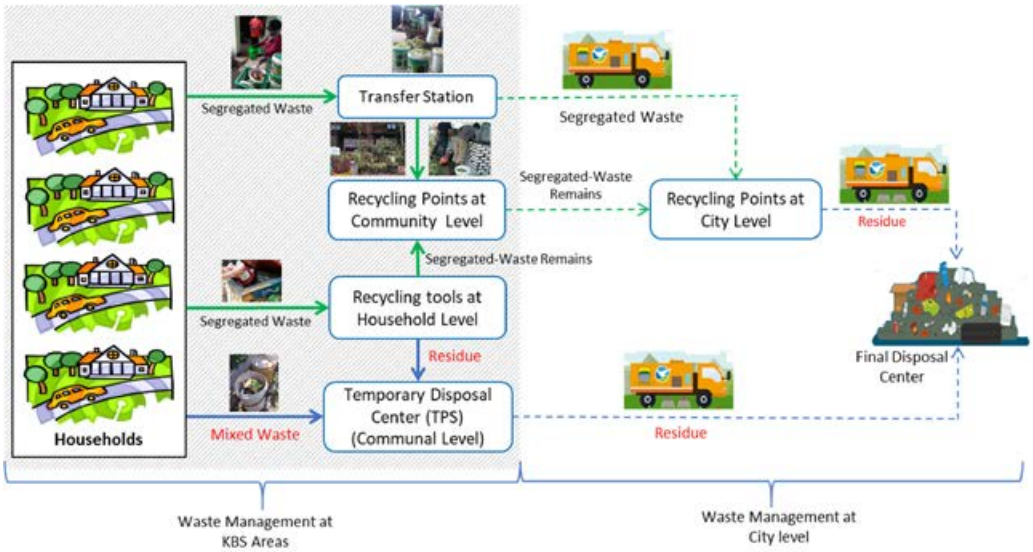


Fig. 2: Waste Management system in KBS areas

Table 1: Key Informants of the study

No	Data Collection	Position	Number of Informants for every KBS								
			Suka luyu	Cihaur geulis	Negla sari	Kebon Pisang	Suka miskin	Babakan Sari	Kujang Sari	Gempol Sari	Number of Participants
1	Interviews	Mentor	1	1	-	1	1	1	1	1	63
2		Supervisor	2	2	2	2	2	1	1	1	
3		Local leaders	2	1	3	1	-	1	2	1	
4		Residents	3	3	3	3	3	3	3	3	
5	Survey	Residents	40	103	71	60	89	70	27	30	490

January 2020 – November 2020. The quantitative data collection was gathered afterwards in April 2021 to get evidence about the effect of KBS program. It used abductive approach, as the data collection was applied to examine a phenomenon, recognize patterns and themes, locate the finding into a conceptual framework to modify existing theory which was subsequently tested through additional data collection (Saunders, 2019). The primary techniques to gather the data were in-depth interviews and field observation. It was added a survey about habits about waste management as education strategy evidence. For qualitative data analysis, the content analyzed and synthesized was from the verbatim version of the interviews and field observation. The data was then triangulated and synthesized to build the resident-based education model. Therefore, this study can be considered as a conceptual model study (Jaakkola, 2020) using a directed Qualitative Content Analysis (QCA) approach (Assarroudi *et al.,* 2018). Data triangulation was conducted to improve the internal validity of the qualitative research. There were five types of data triangulation for internal validity in qualitative research: data source, method, researcher, theory, and data type triangulation (Miles *et al.,* 2014). For this study, the triangulation was based on the data

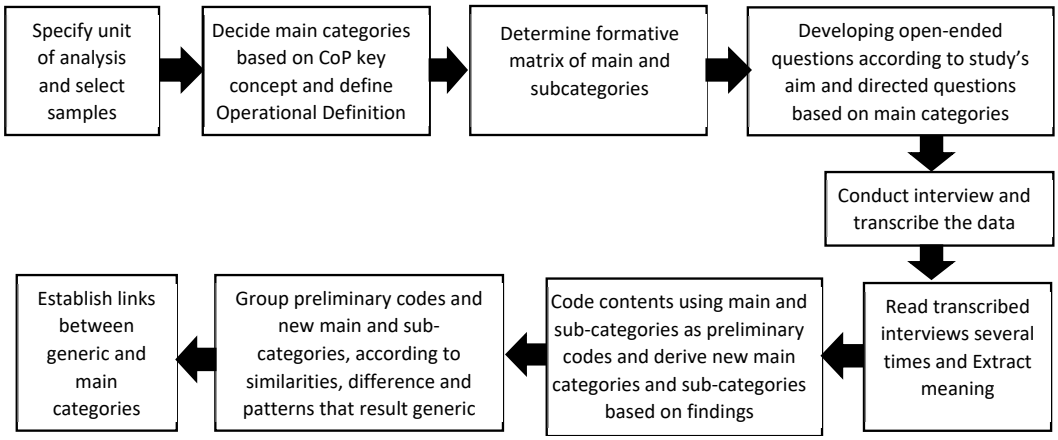


Fig. 3: Qualitative data analysis process using Directed QCA (Assarroudi *et al.*, 2018; Miles *et al.*, 2014)

source and method variation. The data source for qualitative method was from different persons with various roles, interviewed at different times and from different places. The data collection methods were from in-depth interviews, observation, and documents. For qualitative data, it was chosen 63 key informants consisting of 31 key actors in the educational programs and 32 informants as resident representatives. The sample selection technique was purposive sampling for the key actors in the educational programs and random sampling for the resident representatives. The informant selection from the key actors was based on the following criteria: 1) involve actively in the KBS activity for a considerable time, 2) have an essential role in the KBS activity, formally or informally. Therefore, the key actors from each KBS can be different because of the selection criteria consideration. The data collection was ended when the data gathered has been saturated. The survey respondents involved 490 residents as representatives of each KBS area which got sufficient educational exposure. The respondents were chosen using purposive-random sampling in which it was chosen residents who have been exposed by the education program. The key informants of the study are presented in Table 1.

Data analysis

According to Jaakkola (2020), a conceptual model study develops a model by identifying the existing elements or variables and then establishing the causal linkages of the elements. Main data was from qualitative method while quantitative data became the evidence to support the qualitative findings. The main elements were identified based on generic categories resulted from the qualitative data analysis process. CoP main concepts become the preliminary codes as the initial categories/sub-categories. The data analysis process was started as the interview recordings were transcribed to get the verbatim version. The Directed QCA (Qualitative Content Analysis) approach was applied to code the verbatim data using A Computer-Assisted qualitative data software (CAQDAS) named NVIVO 12. While Miles *et al.* (2014) provided six classic steps of qualitative data analysis, Assarroudi *et al.* (2018) introduced 16 steps of directed QCA comprising three main phases: the preparation phase, the organization phase, and reporting phase to increase the trustworthiness of directed QCA approach. In this study, it is combined the two versions by grouping some steps altogether. The learning model in this study was developed by determining the input, process, and output elements leading to resident participation improvement in the MSWM program based on the findings. The whole process of research methodology was presented in Fig. 3.

RESULTS AND DISCUSSION

Personal elements and their roles

According to the interviews and field observation, stakeholders who have crucial roles in the KBS program were identified. All stakeholders involved and their roles in the KBS program are shown in Table 2.

There were 8 KBSs chosen based on their

Table 2: KBS Program stakeholders

Organization	Stakeholders	Roles in KBS Program	Status of the Roles
Government Party	DLHK	administrator, knowledge sharing and infrastructure facilitator	mandatory
	PD. Kebersihan	waste management operator at city level	supporting function
	mentors	official thought leader, knowledge expert	mandatory
	supervisors	supervising and monitoring the waste management activities, boundary spanner, knowledge expert	mandatory
Structural local leaders under *Kelurahan*	(Lurah/KASIE EKBANG)	field representative of *Kelurahan,* *f*acilitator, community organizer,	supporting function mandatory
	RW/RT Chiefs	facilitator, community organizer, pioneer	encouraged
	PKK members	community organizer, local cadre	voluntary
	karang taruna	voluntary educator, local cadre	voluntary
Local Residents	residents	Waste management operator at household level	encouraged
	waste Collector	Waste management operator at communal level	mandatory
NGOs	e.g. YPBB, GSSI	External (boundary spanner)	voluntary
Outsider	environmental communities, visiting Students	temporary knowledge experts voluntary educator	voluntary (only found in KBS Kebon Pisang)

achievement in various local championships conducted by local government for RW level. In 2019, the 8 KBSs had intensive guidance from DLHK as program organizer and owner. DLHK organized the program and collaborated with *PD. Kebersihan* to manage the waste further. For every KBS, DLHK provided a 'mentor' as a knowledge expert and a thought leader at the same time, accompanied by two 'supervisors' chosen from the residents. The mentors collaborated with the government representative in *Kelurahan* (Structural local leaders) including 'KASIE EKBANG' (*Kepala Seksi Ekonomi Pembangunan*/Economic Development Section Chief), 'PKK' (housemother organization), 'RW chiefs', 'RT chiefs' (*Rukun tetangga*/neighborhood/ the lower level of RW), and '*Karang Taruna*' (Youth Organization). They bridge the educators to the residents, organize the residents and also educate the residents. In some KBSs, there were also NGOs who support the program and other outsiders. Finally, the key actors who also become the target of education programs were residents and waste collectors. Residents should separate their waste at home, while waste collectors should be responsible for waste collection waste transfer and waste recycling at communal level. When the KBS first started, the structural local leaders (RT/RW chiefs, PKK chief) played a vital role in the community because mentors were outsider, so they need to be introduced and allowed to interact with the residents. Once the local structural leaders were not active in bridging the education mission by mentors, there will be no learning activities in the related RW areas. These unexposed areas were found in many RWs in KBS Kujangsari, KBS Gempolsari and small number of RWs in other KBSs. It showed that structural local leaders played a role as community organizers and boundary spanner at the same time (Wenger *et al.*, 2002). This finding confirmed the importance of active community involvement to be change driver in the community as suggested by Chikowore (2020) and existence of boundary spanners to bridge difference between multi stakeholders as suggested by Reed *et al.*, (2014). Wenger *et al.* (2002) also emphasized the importance of community organizers at initial process of CoP development. To help mentors educating the residents, there were supervisors, recruited from the residents interested in joining the program. The supervisors stay in the area to supervise waste management practice conducted by the residents and waste collectors. Unlike the mentors, supervisors and waste collectors were mainly

joined because of occupation instead of enthusiasm toward the program. Local government and mentors should prepare their readiness by organizing formal knowledge sharing activities with all supervisors and waste collectors before the program started. This event was mainly to encourage their motivation in doing their task and give them basic skills on waste management practice. However, the study found that some waste collectors did not do their job, causing abandoned recycling infrastructure in the area. Some informants stated that it can be because either waste collectors had not enough skills to utilize the tools, or they did not want to recycle the organic waste. It is also implied by 7 informants that waste collectors mixed their separated waste, causing residents' reluctance in separating waste anymore. This finding confirmed the importance of internal motivation (passion) to join the CoP for successful learning process as suggested by Abou-setta (2015). As waste collectors and supervisors were recruited, they should be educated intensively to nurture their internal motivation. The other personal element involved was local cadres who helped the educator team and local leaders educating a vast number of residents. Local cadres played a role as knowledge experts and community organizers at the same time. This requirement is crucial, especially for KBS that covers a wide area. Moreover, the leaders who were active typically has a limited territory (e.g., KBS Sukaluyu, KBS Kujangsari, KBS Kebon Pisang), and limited time length of service, causing their inability to reach other areas outside their territory and disable them to conduct sustainable learning activities. Thus, the program needs more leaders in a smaller group (such as within an RW) to work effectively. Local cadres' existence confirmed Wenger *et al.* (2002)'s suggestion about small groups to facilitate personal relationship among peripheral members. Thus, neighborhood ties, community engagement and social interaction as proposed by Pei (2019) and Zheng *et al.* (2020) can still be facilitated. However, local cadres were commonly chosen from the local organization members such as PKK, *Karang Taruna*. Some KBSs even obliged the organization members to be the cadres causing possibility of internal motivation absence on the local cadres as suggested by Abou-setta (2015). Improvement can be achieved by allowing any residents who have enthusiasm toward the domain to join. Thus, local cadres are chosen not due to their activeness in the local organization under the structural government body, but their enthusiasm toward the program. Moreover, they played as knowledge experts for the residents so that intensive knowledge sharing activities with primary educators are required. In 2020, DLHK only continued the guidance to 2 KBSs: KBS Sukamiskin and KBS Cihaurgeulis. The other KBSs can continue the program and PD. Kebersihan still handled the waste management at city level. Only *Lurah* at KBS Neglasari continued the program officially (sub-district level), while other KBSs mostly continued it independently without *kelurahan* guidance. As a result, only some RWs/RTs which stay active, if they have local leaders to organize them. This confirmed the vital role of community organizer as suggested by Wenger *et al.* (2002). However, most local leaders were from RW chiefs and or RT chiefs which have limited territory (RT or RW level). So, they cannot affect other RT/RWs outside their coverage, causing limited area to continue the program. The detailed information about leadership existence in each KBs is presented in Table 3.

Table 3: Leadership existence in every KBS

KBS	Facilitators	Community Organizers	Thought Leaders	Knowledge Experts	Boundary Spanners	Pioneers
KBS Sukaluyu	√	-	-	-	-	√
KBS Cihaurgeulis	√	√	√	√	√	√
KBS Neglasari	√	√	-	-	-	√
KBS Kebon Pisang	-	√	√	√	√	√
KBS Sukamiskin	√	√	√	√	√	√
KBS Babakan Sari	-	-	-	-	√	√
KBS Kujangsari	-	√	√	√	-	√
KBS Gempolsari	-	-	-	-	-	√

Knowledge domain

Knowledge domain consisted of community shared problems, program objectives, and knowledge and value in the learning activities. According to the interviews and field observation, it is found that the shared problems for all KBSs were similar. First, most residents' mindset was not pro to the waste separation. Second, the residents had low awareness and no willingness to separate their waste. As a result, the participation rate on waste separation at the household level was low. The programs' objectives were to encourage sustainable residents' participation in waste separation at home by changing their mindset toward waste management, giving separation skills for the residents, and recycling skills for waste collectors and local leaders. The local leaders are encouraged to educate their residents by being role models to initiate waste separation and recycling at their homes. To reach the objectives, educator team was mandated to educate residents, waste collectors and local leaders by disseminating several information, especially technical knowledge about organic waste separation. The educator team should also educate waste collectors and local leaders about recycling techniques of organic waste. Even though the main content of education was focused on technical knowledge, the educator team was permitted to implement other approaches to reach the objectives based on their initiatives. Therefore, it was found various other knowledge and value being shared as the educational contents. According to the observation and interviews, their decision to share specific additional knowledge and value were based on the educators' knowledge and value toward waste management and their consideration toward the residents' interest. For example, the educators who educate residents from low-income economic level will approach them by informing economic benefits

Table 4: The educational contents in the KBS

Type of knowledge and Value	KBS Sukaluyu	KBS Cihaurgeulis	KBS Neglasari	KBS Kebon Pisang	KBS Sukamiskin	KBS Babakan Sari	KBS Kujangsari	KBS Gempol Sari
1. Technical knowledge of waste segregation for residents, mainly for organic waste	√	√	√	√	√	√	√	√
2. Technical knowledge of organic waste recycling for waste collectors and local leaders	√	√	√	√	√	√	√	√
3. Practical tips to reduce and recycle organic waste		√	√					
4. Recycling technique of inorganic waste				√	√		√	√
5. Impacts of waste for environment and health	√	√	√			√		√
6. Benefits of organic waste for planting	√	√	√			√		
7. Economic benefits of inorganic waste				√	√		√	√
8. Local regulation about waste segregation	√	√			√			
9. Individual and social roles to environmental protection	√			√	√			
10. Social Religious value toward personal obligation to environment	√						√	
11. Cleanliness for aesthetics				√				

of waste. They also activate waste banks to facilitate valuable inorganic waste sale from the residents as found in KBS Kebon Pisang, KBS Sukamiskin, KBS Kujangsari, and KBS Gempolsari. Education in KBS Kebon Pisang were concerned about cleanliness for aesthetics because one of the RWs in the KBS has been famous for their Mural Art village. Some educators shared environmental values, religious obligations, and responsibility toward environmental protection and organic waste benefits because they were more into the contents. It showed educators' preference and their knowledge influence their decision to choose what content will be shared. The detailed information about knowledge and value being shared as the educational contents in KBSs is presented in Table 4.

Previous studies showed that some of mentioned knowledge and value in Table 4 were crucial to encourage residents to participate in waste management. The knowledge about harmful impacts of waste to environment and health, was found only in 5 KBSs. According to previous studies, this knowledge was crucial to improve personal awareness toward waste management (Moh and Manaf, 2017) which had significant effect to waste separation and recycling behavior of residents in other countries such as China (Fan *et al.,* 2019; Meng *et al.*, 2019) and Singapore (Fan *et al.,* 2019). Sharing knowledge about waste management benefits was found in different places. KBSs which highlighted additional income from waste did not campaign benefits of organic waste for planting, and vice versa. It was probably because of educator consideration toward the residents' characteristic as suggested by Knickmeyer (2019) and Sunarti *et al.* (2021) who stated that educational approach should be adjusted to residents' typicality. Previous studies confirmed that economic profit became the powerful driver of waste management behavior (Chen and Gao, 2020), thought it may be more impactful for low-income residents (Sunarti *et al.*, 2021). The combination of awareness to waste management and perceived benefits will nurture strong motivation to participation (Wadehra and Mishra, 2018). Other educational contents being shared were about individual and social roles to environmental protection and social religious value toward personal obligation to environment, found in 4 KBSs. These two contents highlighted that knowledge about the individual and social responsibilities was associated with personal moral responsibility (Zebua and Suhardini, 2021; Wang *et al.*, 2020). Previous studies, such as Mukama (2016) and Liu *et al.* (2019) prove that personal moral responsibility and motivation had crucial effect to attitude toward waste management. Combination among awareness, personal moral responsibility and attitude was also proven to be influential to encourage willingness to participate in waste management in China (Meng *et al.*, 2019; Zhang *et al.*, 2019). In fact, personal moral responsibilities which were nurtured through social-religious value have affected sustainable waste management behavior of community members in Malaysia (Tiew *et al.,* 2015). As implied by Aboul-Enein (2017) and Zebua and Suhardini (2021), educating residents through a religious value approach is vital especially for the religious communities as Bandung City residents. Some educators in KBS Sukaluyu, KBS Cihaurgeulis and KBS Sukamiskin also socialized local regulation about waste separation obligation, while educators in other KBS areas stated that they did not want to encourage the residents through law enforcement because they want the residents to separate voluntarily. This consideration may be true, but past studies, for instance Xu *et al.* (2017) and Ma *et al.* (2018), found that regulation was influential for initial encouragement to improve their skill and form new habits. The importance of habituation for learning approach was also mentioned by 9 informants from 7 to build sustainable participation on waste separation. But habituation without enlightening them about the value are not strong enough to sustain the participation, as indicated by 5 of resident representatives, who stated that they only followed the rules. They intended to end the separation activity once the rules were not enforced anymore. Even though previous literature showed significant effects of educational contents being shared by educators initiatively, there was no obligation for the educators to share the whole. The primary educational contents they shared were about technical knowledge. It indicated no identification of knowledge needs being done before the KBS started. Wenger *et al.* (2002) stated that one of the basic strategies to enable the CoP to achieve its goals is by identifying knowledge needs at the first step based on the shared problems. Wenger's

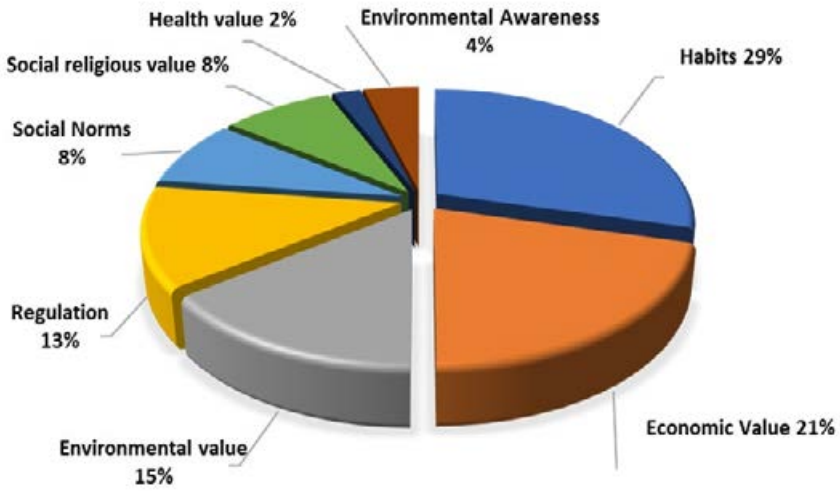


Fig. 4: The driving force of residents' participation in KBS program

statement was agreed by the study conducted by Janmaimool and Denpaiboon (2016) who indicated that knowledge relevance influence what personal factors will be nurtured. Thus, identifying knowledge and value needs should be done at first place. The findings from this study showed that the educational contents being shared by educators in the KBSs (Table 4) are vital to nurture waste management behavior. The crucial knowledge and value for waste management behavior improvement should be combined altogether to be effective (Sunarti *et al.*, 2021). To confirm the driving factors of resident behavior in KBS area, the informants from residents' representatives were asked to what factors causing them to keep participating in the waste management program for more than months. The result of driving factors is presented in Fig. 4.

The participants who have separated their waste for more than months mentioned at least 2 driving force that keep them participating in the waste separation program. For instance, a resident decided to participate in KBS program for an extended period because of three primary reasons: social value, regulation, and environmental awareness at the same time. Other resident representative stated that they stay participated because they get used to do it (habits) and they felt the benefits, especially for its cleanliness (environmental value). Beside the driving force resident participation, some insights about residents' rejection in participation were also identified. Some supervisors stated that the residents often complained about the separation because they have paid for the waste disposal. Other reasons were because they think that waste separation was supposed to be waste collectors' job. These findings indicated low personal responsibility toward environment and their low understanding to the consequence of their behavior to the environment. These findings may indicate that the residents have not got the required knowledge in the knowledge sharing activities.

Knowledge sharing activities

The immediate concern in the KBS program is to improve resident mindset and awareness to waste management, so they will be willing to participate and change their habits sustainably. There are some scheduled knowledge-sharing activities conducted in all KBS to reach the objectives. According to the study findings, there were some characteristics of learning activities found: 1) some activities were formal, given to all/specific stakeholders, without regular schedule (eventual), 2) some activities need certain requirement to join (informal membership), 3) activities with certain requirements have regular meeting schedule and specific activities conducted, 4) All activities have dialogue-based and/or practice-based learning. Based on the characteristics of knowledge sharing activities in the KBS areas, the activities were classified into two main forms: non-

Table 5: Profile of Non-group Learning Activities in KBS Program

Organizers	Type of Learning	Educational Contents	Freq of Learning	Targets	Knowledge Sharing
Mentors, Supervisors, Kelurahan, NGOs	Recycle Training for organic waste	- Technical knowledge about waste recycling (household composters) - Technical knowledge about waste separation - Background of the program (waste issues) - Regulation socialization	1 – 3 times/year	Local Leaders (RWs, RTs, PKK, Karang Taruna, *Kelurahan*)	Practice-based learning
Mentor and supervisors	1. Program Socialization in *Kelurahan*		1 – 3 times/year		Dialogue-based learning
	2. Program Socialization embedded in local leader meetings (RW meetings, RT meetings)		Eventual (according to meeting schedules)		Dialogue-based learning
Mentors, Supervisors, Kelurahan, NGOs	1. Recycle Training for organic waste	- Technical knowledge about waste recycling and waste separation - Background of the program (waste issues) - Regulation socialization	1 time before the program started and then being monitored in the field by the supervisors	Waste Collectors	Practice-based learning
	2. Socialization about technical skill of waste separation and waste issues in Bandung City				Practice-based learning
Mentor and Supervisors accompanied with PKK members	1. Door to Door Education (DTDE)	- Technical knowledge about waste separation - Impacts of waste for environment and health - Regulation socialization	1 – 3 times / household, each time took 10 – 15 minutes	Residents	Dialogue-based learning
	2. Socialization through community activities (*Senam Lansia*/ elderly Workout, *arisan, pengajian*, *Gerakan Pungut Sampah* (GPS)/Trash Pick Motion)	- Technical knowledge about waste separation - Program socialization	At least every month	Residents	Practice-based and dialogue-based learning

group and group learning activities. Non-group and group learning activities were presented in Table 5 and Table 6.

According to Table 5, educational contents were dominated by technical knowledge of waste management. A minor portion has been given for sharing knowledge about waste impacts on the environment, social and personal obligation to environmental protection and other essential contents. Regulation socialization was conducted to encourage learning from habituation to enable the residents sensing the benefits as they experience it directly. Sensing the benefits may be limited when they were not informed about the value of the waste management activity through dialogue. Therefore, the perceived value driving resident participation was dominated by environmental value (cleanliness) and economic value which they felt directly (Fig. 4). Non-group learning activities tended to lack intensiveness and iterative cycle because most activities were held 1-3 times/year (eventual). Other knowledge sharing activities were also too short (e.g., DTDE), causing

Table 6: Profile of group learning activities existing in KBS areas

No	KBS	Learning Groups	Member of Group	Educational Contents	Activities	Freq.	Knowledge Sharing
1	KBS Sukaluyu	Weekly cleaning days (Friday Clean Day and Sunday Clean Day)	Local leaders (PKK, RW, RT), Supervisors, Mentor	Waste separation habituation, waste impacts to environment	1. Trash Pick activities 2. Workout together 3. *Botram* (potluck)	Weekly	Practice-based and Dialogue-Based learning
2	KBS Cihaurgeulis	RW Urban Farming	Local leaders (PKK, RW, RT), Supervisors, Mentor	Waste separation and organic recycling practice, economic benefits of organic waste	Planting vegetables, fruits, and Fish farming by using recycled organic waste (BSF larvae and compost)	Weekly	Practice-based and Dialogue-Based learning
3	KBS Neglasari	*Kelompok Berkebun/Gardening Group,* collaborated with other government department	Kelurahan, PKK, RW, RT, Karang Taruna, residents who are interested in gardening	Waste separation and organic recycling practice, economic benefits of organic waste	Planting vegetables, fruits, and fish farming and make sellable products	Weekly/bi-weekly	Practice-based and Dialogue-Based learning
		Trash Hero Kids program (Pasgeber (*Pasukan Gerakan Bersih*/Cleanup-Motion Troof)	NGOs, Students, Children	Waste separation habituation, waste impacts to environment, individual and social roles of environmental protection	1. Cleanup activities, 2. Habituation on waste separation, 3. Trash Pick activities	Eventual	Practice-based and Dialogue-Based learning
4	KBS Kebon Pisang	*Cibunut Berwarna* /Cibunut Colored	Karang Taruna, RW 7 Cibunut residents	Environmental Cleanliness campaign	1. Coloring RT area with the same specific color 2. Mural Art containing persuasive mesages for waste management campaign	Eventual	Practice-based and Dialogue-Based learning
		KSM *(Kelompok Swadaya Masyarakat*/Resident self-subsistent Group)	RW 7 members, active residents who are concern about environment	Educative tourism to campaign environmental cleanliness	Manage Mural Art Village for tourism destination	Monthly	Practice-based and Dialogue-Based learning
		Waste Bank for kids and housewives	Kids and active residents who are concern about environment	Inorganic waste separation practice, economic benefits of inorganic waste	buy-sale inorganic waste and save their point to get exchange to money every year		Practice-based and Dialogue-Based learning
5	KBS Sukamiskin	A learning group for each RW 1 day/week to learn about inorganic recycling waste (Soap, candle, handy crafts)	PKK and Housewives who are interested in learning in inorganic recycling	Inorganic recycling practice, economic benefits of inorganic waste	1. Learn about creating handy drafts made of inorganic waste 2. How to recycle organic and inorganic waste (Eco Enzyme, making soap from used oil, and so forth)	Weekly	Practice-based and Dialogue-Based learning
		RW Urban Farming	Local leaders (PKK, RW, RT), Mentors, Supervisors	Waste separation and organic recycling practice, economic benefits of organic waste	Planting vegetables, fruits, and Fish farming by using recycled organic waste (BSF larvae and compost)	Weekly	Practice-based and Dialogue-Based learning
6	KBS BabakanSari	GPS (*Gerakan Pungut Sampah/* Trash Pick Motion)	Residents based on RWs	Waste separation habituation, waste impacts to environment	Cleanup the home yard together every week in the morning	Weekly	Practice-based and Dialogue-Based learning
7	KBS Kujangsari	PPO (*Pilah Pilih Olah/Separating Recycling*) every Saturday in Waste Bank in 1 RW (buy-sell inorganic valuable waste)	Housewives who are willing to earn money from their inorganic waste	Inorganic separation and recycling practice, economic benefits of inorganic waste	Cleanup valuable inorganic waste, weight the waste, buy-sale inorganic waste and save their point to get exchange to money every year, Cooking together for bonding, making handy crafts from inorganic waste	Weekly	Practice-based and Dialogue-Based learning
8	KBS GempolSari	RW Urban Farming	Local leaders (PKK, RW, RT) at RW 9	Organic recycling practice	Planting vegetables, TOGA (Tanaman Obat keluarga/Herbal medicine for Family)	Eventual	Practice-based learning

little chance to share more knowledge, no possibility to have intensive interaction as typical activity in CoP (Tran *et al.*, 2018; Wenger *et al.*, 2002). Such learning activities also did not meet the requirements of expected education strategy as suggested by Chikowore (2020); Zheng *et al.* (2020) and Pei (2019). Meanwhile, group-based learning provided more intensive interaction with regular activities to allow bonding establishment as expected.

Table 6 presented some group-based joint activities conducted regularly. Weekly group activities allowed intensive and iterative learning processes, building bonding, community engagement and intensive communication among members which are impactful to encourage collective participation in waste management in other cities (Chen and Gao, 2020; Pei, 2019). Intensive and iterative learning activities enabled the members to sense their community identity (Li *et al.,* 2009; Madsen and Noe, 2012; Wenger *et al.,* 2002), nurture their sense of belonging, and build trust among members (Reed *et al.,* 2014) which are essential to enable effective knowledge sharing. Moreover, most activities combined practice-based and dialogue-based learning for habituation and sharing required knowledge and value which are suggested by previous study for CoP success (Tran *et al.*, 2018). In the learning group, the members are encouraged to learn by doing intensively enabling the members to sense the benefits of the waste management activities directly in the long term. According to the interview, 9 informants from 7 KBSs agreed that habituation is the best way to build new behavior for the residents related to waste management. The habituation is required to allow the residents to learn by doing, making the behavior familiar to them, and eventually building their new behavior by transforming the iterative practice into their new habits (Sunarti *et al.,* 2021). According to literature, habituation through learning by doing practice is significant in affecting waste management behavior (Ulhasanah and Goto, 2018) and has been proven in changing residents' behavior toward waste separation in many countries such as in China (Liao *et al.,* 2018; Xu *et al.,* 2017). Learning by doing was also suggested by Madsen and Noe (2012) for successful CoP based on their study about CoP in agricultural farmers. The group learning activities which were based on economic orientation such as Waste Banks and PPO are required but cannot stand independently without non-economic-oriented activities. Dependence on extrinsic benefits such as only expecting money is disfavored because earning money from waste may have some limitations, such as marketing and product quality, as indicated by some informants. Moreover, the income was relatively low, which encouraged only low-income residents as indicated by previous studies (Almasi *et al.*, 2019; Meng *et al.,* 2019). In fact, the obstacles faced often cause low interest for several low-income residents as well, as found in KBS Kebon Pisang, KBS Sukaluyu and KBS Neglasari. Once they found a better way to make money, they will leave the activity. It indicated the vital role of balanced motivation between intrinsic motivation and extrinsic motivation for sustainable participation (Chen and Gao, 2020; Sunarti *et al.,* 2021). Waste bank can be very useful when it becomes education approach for children as conducted in KBS Kebon Pisang. Through Trash Hero Kids and PASGEBER program, KBS Kebon Pisang has educated their youth since their childhood. This approach was positive for program sustainability because the children can be cadres in the future. Besides several positive impacts found in the group learning activities, some weaknesses were also identified. First, some learning groups are only accessible for local structural leaders (e.g., *Kelompok Berkebun* in KBS Neglasari and KSM in KBS Kebon Pisang). The learning groups were supposed to allow other members (including peripheral members) to join as they have enthusiasm toward the knowledge domain to regenerate more local cadres. Local cadres may not only from the structural organization under local leaders but also peripheral members who have readiness toward the domain. Second, the educational contents of the existing group learning activities were mostly still focused on technical knowledge of waste separation and waste recycling. More portions should be provided for other important contents such as waste impacts to environment and health, social and personal behavioral consequences that result responsibility to environmental conservation in dialogue-based learning activities. Less attention to fundamental knowledge being shared causes residents' mindset focusing solely on extrinsic factors they sense (e.g., to obey the rules, to meet social norms, expect economic benefits), which was not enough to encourage sustainable participation (Issock *et al.,* 2020; Lawrence *et al.,* 2020; Zhang *et al.,*

2019). Third, the group learning was varied between KBSs. Combining several types of group learnings in every KBS to cover diverse groups of residents can be beneficial, such as groups for kids, housewives, youth, and any other possible groups, according to the potency of the area.

Managerial elements

Managerial elements were related to regulation and norms to support mutual interactions and leadership with various roles to complement each other. Based on study findings, there is no obligation for the residents to involve in the joint activities even though waste separation practice is mandatory for all residents, according to the local regulation. The involvement in the community activities is only voluntary, while it is mandatory for local leaders and educators. Low enthusiasm and less perceived value toward the knowledge domain caused a few residents willing to join the learning activities. Therefore, non-group learning activities are still required to reach all residents for early campaign including for disseminating regulation about waste separation mandatory. Previous study found that dissemination of regulation was significant in encouraging participation in the waste management, if the participation mandatory (Liu *et al.*, 2019). When the regulation about waste management practice was not mandatory, regulation publicity was proven to be insignificant in encouraging participation (Meng *et al.*, 2019). As the mandatory for direct practice will encourage participation and habituation, the follow up should be involvement in the group learning activities to share knowledge and value more deeply and improve their practice. Social norms can be the tool to encourage their participation in the group learning activities. According to research findings, when residents within the same areas are close enough, they tend to feel shame when they were different from others. This cultural value was adopted by local cadres and educators when encouraging the residents in waste separation. This finding confirmed the study conducted by Chen and Gao (2020) who found that neighborhood influenced other people's decision-making to participate in the recycling activity of households in China. This social norm should also be utilized to encourage group-learning participation for more effective learning result.

Infrastructure elements

There were two primary facilities required in waste management: organic waste bins and recycling facilities. According to the field observation, some KBS programs provided an organic waste bin for each house for the residents who have separated their waste (e.g., KBS Cihaurgeulis, KBS Neglasari). KBS Sukamiskin provided big-sized bins that cover several houses. Most residents' representatives implied that they did not depend on waste bins to decide whether they want to separate or not. As presented in Fig. 4, most driving forces of their behavior beside habits were related to perceived value such as economic, environmental, social-religious, and health value. There were only 2 residents who stated that they would be more motivated to separate their waste if they get specific bins. It indicated that waste bins were not the primary driving force of the behavior. Instead, it may become the support system to moderate the separation behavior. Educators informed that residents did not have to provide brand-new waste bins for separation. They can use anything, such as secondhand buckets for the bins. In terms of recycling facilities, all informants stated no problems because DLHK provided all the required facilities for the recycling process including vehicles to carry the waste. Some recycling facilities were placed at recycling points at the communal level, while others were placed between housings. Some recycling facilities have different products, according to residents' interests and or personal resource recycling skills. When the RWs or RTs had no space to put the facilities in the KBS areas, the separated waste will be handled by the government to be recycled further at the city level. The existing recycling facilities are presented in Table 7.

Commonly, all the KBSs (except KBSs guided by DLHK) relied on waste collectors to manage the recycling process unless the areas had local experts as found in KBS Kebon Pisang. The role of waste collectors was crucial if there were recycling facilities available in the area. However, most informants agreed that recycling facilities did not become the primary facilities they should have. Residents who sense the internal benefits, such as social-religious, environmental, and health value, implied that it does not matter if they cannot get concrete benefits from their separation activity; they will continue the separation activity

Table 7: Recycling facilities, the placement, and the end products

No	Recycling facilities	Placement	Middle Products	End products/utilization
1	Bata Terawang (Aerob Composter)	Recycling Point	compost	Vegetables, flowers
2	BSF (Black Soldier Fliers)	Recycling Point	Animal feed	Fish
3	Biopore/Loseda (organic waste holes)	Between housings	Compost directly to land	
4	Takakura (portable Composter)	Household	compost	Vegetables, flowers
5	Biodigester	Recycling Point	Gas	Electricity
6	Waste Bank	Recycling Point	Earn money	
7	Windrow	Recycling Point	compost	Vegetables, flowers
8	hydroponic	Recycling Point	Vegetables	

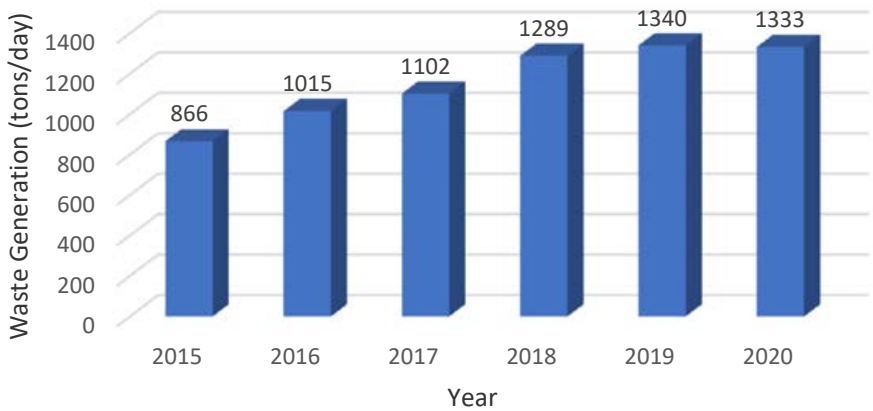


Fig. 5: Waste generation at Bandung City which was relatively decreased after education implementation (Source: *PD. Kebersihan* Archives)

because they have got the benefits directly. In contrast, residents who were mainly motivated by economic benefits for the activity will expect recycling products or money from selling/utilizing the inorganic recycling products. Different finding was found by the study conducted by Meng *et al.* (2019) and Trihadiningrum *et al.* (2017) who found that accessibility to separation and availability of recycling facilities were significant factors of waste management activities of residents in China and Indonesia. However, it was supported by previous study conducted by Lawrence (2020) who found that strong intrinsic motivation was enough to keep long-term participation of residents in Trinidad-Tobago without external driver. Thus, recycling facilities in KBSs are optional if it is feasible, and it is suitable as residents' expectation. The primary point is that the education should improve residents' intrinsic and extrinsic perceived value of waste management to avoid dependency on facilities. When the intrinsic perceived value was higher, residents tend to be more effortless in supporting the program. In terms of technology utilization, there was no found technological involvement, except *Whatsapp* group. The group was utilized merely for information dissemination among local leaders. According to the interviews with the local leaders, most members were

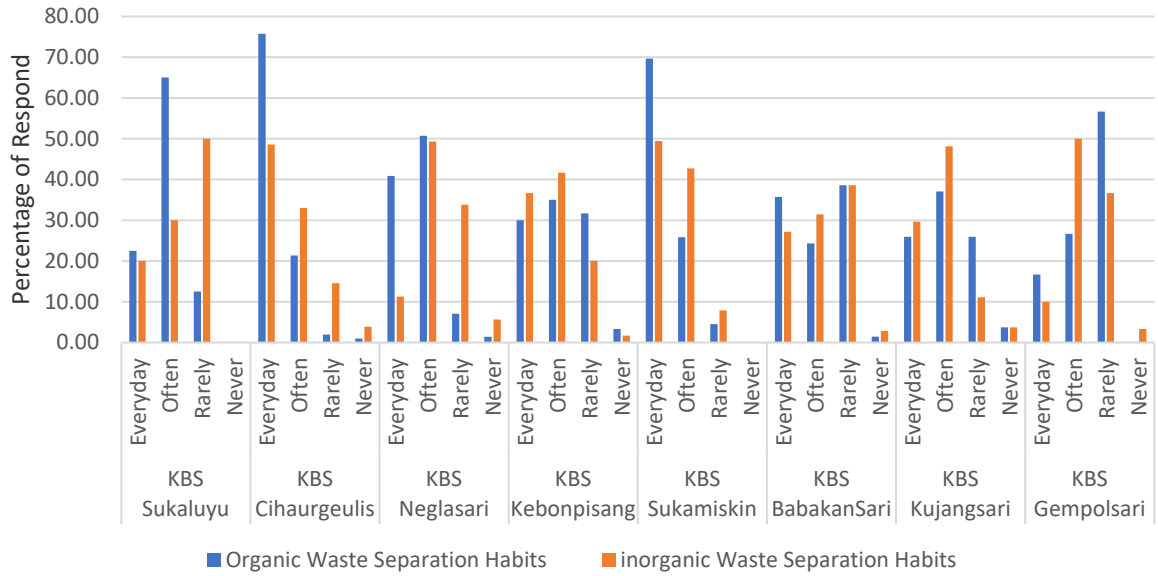


Fig. 6: Waste separation habits of residents in KBS area

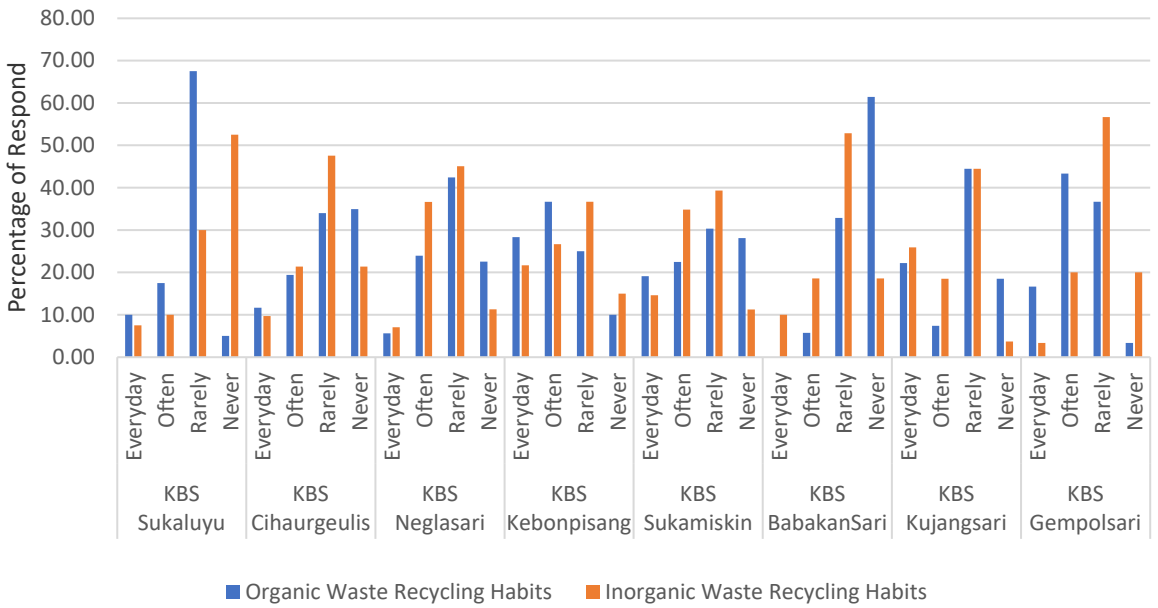


Fig. 7: Waste recycling habits of residents in KBS area

passive in knowledge sharing in the platform. Instead, face-to-face and direct interaction are more dominant and more required because they live in the same areas. There were also no knowledge repositories found as the storage for the activity documentation, regulations of the communities required to be easily retrieved anytime to support knowledge sharing (Koeglreiter *et al.,* 2006). Knowledge repositories are required, especially for educators, to enable knowledge retrieval and performance re-evaluation for improvement. Thus, knowledge repositories can be crucial for the core members.

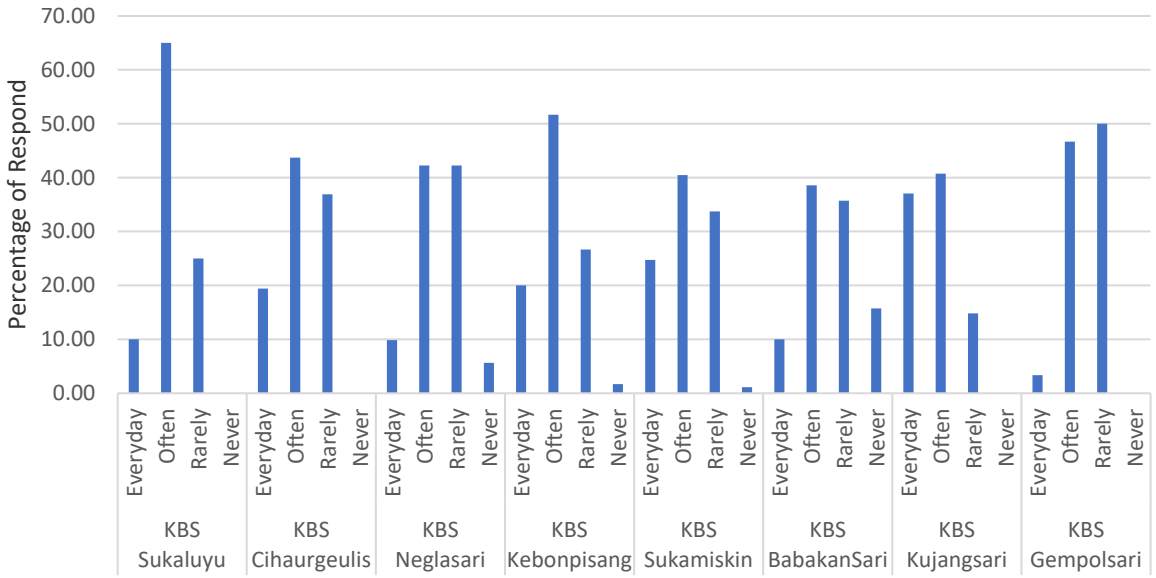


Fig. 8: Waste reduction habits of residents in KBS area

Resident waste management behavior after education strategy Implementation

The effects of the resident-based education using CoP approach was gathered through secondary documents from the governments and survey to get information about resident waste management behavior. The information become the evidence to show the effectiveness of the resident-based education to improve resident changing behavior effectively. The profile of waste generation at city level from 2015 to 2020 is presented in Fig. 5.

Waste generation showed in Fig. 5 indicated waste reduction from 2019 to 2020 up to 0,47 % after slowing down from 2018 to 2019. Further evidence is given related to waste management habits of respondents who become resident representatives within KBS areas as presented in Fig. 6.

Data from the survey as presented in Fig. 6 showed that some KBSs presented high percentage of waste separation habits, averagely more than 60%. KBS Cihaurgeulis and KBS Sukamiskin showed higher percentage than other KBSs (>90%) because the two KBSs still get guidance from the government so that they get sufficient, intensive, and regular education with infrastructure supports. However most other KBSs (except KBS Gempolsari) which had no official guidance from government still showed relatively positive habits. Organic separation habits in all KBSs are higher than inorganic waste separation habits because the program focused mainly on organic waste separation. Inorganic waste separation was allowed and facilitated but not the main campaign, similar with recycling activities. The data of recycling habits of residents in KBS areas was presented in Fig. 7.

Recycling habits (Fig. 7) were relatively low for both organic and inorganic waste, except KBS Gempolsari. This was because the program' key objectives focusing on waste separation. The recycling process was mainly handled by waste collectors or *PD. Kebersihan*. KBS Gempolsari showed quite higher percentage on organic waste recycle because the local leader encouraged residents to dispose their vegetable waste on recycling tools he provided around their neighborhood. The resident representatives implied that they get used to dispose vegetables in the recycling points without thinking about waste management. It indicated that they did not know the value of their activity, proven from the low percentage of the separation habits which are supposed to be higher as well. The local leaders played as a pioneer and community organizer but there is no thought leader available so there were no learning activities once DLHK ended the

guidance. This finding confirmed the vital role of two key leaders' existence for effective CoP: community organizers and thought leaders, as indicated by Wenger *et al.* (2002). The thought leader is needed to facilitate proper knowledge and value sharing. Another waste management activity being surveyed was waste reduction habits as presented in Fig. 8.

Even though waste reduction is not the main campaign in the KBS program, most KBS areas showed higher percentage of waste reduction habits. KBS Sukaluyu showing higher percentage of waste reduction can be due to their long experience in waste management. All informants from KBS Sukaluyu stated that their area was the pilot for KBS program since 2015, initiated by an NGO named YPBB. This finding confirmed the requirement of long-term education as suggested by Azevedo *et al.* (2021) who indicated that one of weaknesses of waste management in developing countries was the absence of regular agenda of public campaigns. CoP approach meets this requirement because CoP suggested long-term and regular learning activities (Wenger *et al.,* 2002). The findings about waste management behavior of residents in KBSs become the evidence that the educational strategy was effective and powerful in changing resident behavior sustainably. The percentage can be higher if all required educational contents got sufficient portions and the education is lengthened (not only one year) to allow intensive interaction. A longer period of education enables the educators to nurture more local cadres from the learning activities, add personal elements and nurture key leaders. A long-term education also provides more chance for the educators to share important educational contents sufficiently. If these requirements are met, zero waste area can be achieved.

Resident-based learning model development

According to the analysis to critical elements of KBS program using CoP approach, it was generated generic codes which were developed through grouping the codes based on their similarities, differences, and roles in the input-process-output and support system. The main and sub-main elements were grouped and result new main categories. To determine the causal links among categories, the roles of each new main elements are determined. Based on the discussion section, it was found that some key stakeholders' support become the input because they played a vital role in initiating the program. The key stakeholders refer to government support as facilitator, and educators (mentors and supervisors), local leaders and waste collector who should be ready in the beginning. The readiness for facilitators included providing supporting elements such as infrastructures to support learning, educators, and operational support. The facilitators may also need 3rd parties such as NGOs and environmental communities to help conducting learning activities for educators and local leaders' readiness. The readiness for educators and local leaders included ownership of knowledge and value being shared which were changing their personal factors to encourage their waste management behavior. Those referred to understand personal responsibility, environmental awareness, perceived value of waste management activity, attitude, willingness to participate and waste management behavior. They also need to have waste management skills to enable practice. Waste management readiness can be called waste management literacy, rooted from environmental literacy concept introduced by Roth (1992). Environmental literacy comprises four dimensions: knowledge, skills, affect and behavior (Coyle, 2005; Roth, 1992; Scholz, 2011). In the waste management context, the value is added as part of knowledge, consisting of economic, environmental, social, and religious value, which are vital to encourage waste management behavior. Environmental literacy involved behavior as the observable form of the learning result. To build the resident-based learning model using CoP approach, this study referred to the basic model of CoP proposed by (Scarso *et al.,* 2009). Because knowledge domain contains community shared problems, community objectives, knowledge, and value needs for the educational contents, it is placed to be CoP baseline. The core process is the learning activities which should be conducted both group and non-group using two learning approaches: practice-based learning and dialogue-based learning. The group learning is mainly separated into two major groups: groups for key stakeholders and local cadre development from residents. Since residentials commonly contain thousand households, it requires subgroup division, based on residents' characteristics. The group can be based on interest on certain waste management option, age group or profession, such

Table 8: Content synthesis process for model development

No	Preliminary Codes	Sub-preliminary Codes	New main categories	Group of codes	Generic Categories	Roles
1	Personal Resources	• Leaders	• Supports from leaders and waste collectors to the program initiation • Facilitator	• Key stakeholders' support	• Facilitator readiness • Educators' waste management literacy	Input
		• Leaders with various roles	• Community Coordinators • Thought leader • Knowledge expert • Boundary spanner • Pioneer	• Facilitator • Community coordinators/organizers • Thought leader • Knowledge expert • Local cadres • Pioneers	• Local leaders' waste management literacy	
		• Local Cadres	• Knowledge expert readiness to support education program sustainability	• Local cadres' learning system	• Local cadres' learning system • Local cadres' waste management literacy	Group-learning activities (Main Process)
		• Waste Collectors as operator and education target	• Waste Collector readiness to support program initiation	• Waste collectors' learning system	• Waste collectors' learning system • Waste collectors' waste management literacy	Group-learning activities (Initial phase Process)
		• Residents as education target	• Resident readiness for sustainable program	• Residents' learning system	• Residents' learning system	Group and non-group learning activities (Main Process)
					• Residents' waste management literacy	Output
2	Knowledge Domain	• The shared problems of the CoP that determines the community identity	• Negative residents' mindset to waste separation • Residents' Low willingness to waste separation • Low participation rate on waste separation	• Problems to be solved by learning	Knowledge and value needs	Learning Baseline
		• The objectives of the CoP	• Sustainable residents' participation in waste separation at home	• Residents' waste management literacy	Residents' waste management literacy	Output

Continued Table 8: Content synthesis process for model development

No	Preliminary Codes	Sub-preliminary Codes	New main categories	Group of codes	Generic Categories	Roles
		• Educational contents	• Technical knowledge of waste management • Impacts of waste for environment and health • Economic, environmental, social, and religious value of waste management • Individual and social roles to environmental protection • Local regulation about waste management	• Waste management skills • Environmental awareness • Personal responsibility • Perceived value of waste management activity • Attitude • Personal responsibility • Willingness to participate • Personal responsibility • Waste management skills • Habituation	• Knowledge and Value needs • Waste management literacy	Learning Baseline
3	Knowledge Sharing activities	• Knowledge sharing activities to enable knowledge flow	• Group learning • Non-group Learning	• Type of learning activities	• Habituation • Learning process • Local cadre development	
			• Practice-based learning • Dialogue-based learning	• Learning approach		Learning Process
		• Mechanism of bonding, intensive interaction, community engagement	• Group Learning to nurture local cadres • Effective knowledge sharing • Practice-based learning • Dialogue-based learning	• Core process • Learning approach		
4	Managerial Element	• Identified regulation and norms that support joint interactions	• Waste Separation practice through law enforcement • Social norms of joint activities	• Regulations and Norms • Habituation	• Knowledge toward regulations and norms • Practice-based learning	Supportive System
5	Infrastructure	• Social Media for knowledge repositories	• Knowledge sharing support	• Technology for Knowledge repositories	• Technology for Knowledge repositories	Supportive System
		• Waste bins for waste separation practice • Recycling tool facilities • Recycling product utilization facilities	• Practice-based learning • Encourage willingness to participate • Encourage attitude	• Practice-based learning • Waste management literacy	• Learning process	Learning process
				• Waste Separation facilities • Waste Recycling facilities	• Waste management facilities	Supportive System

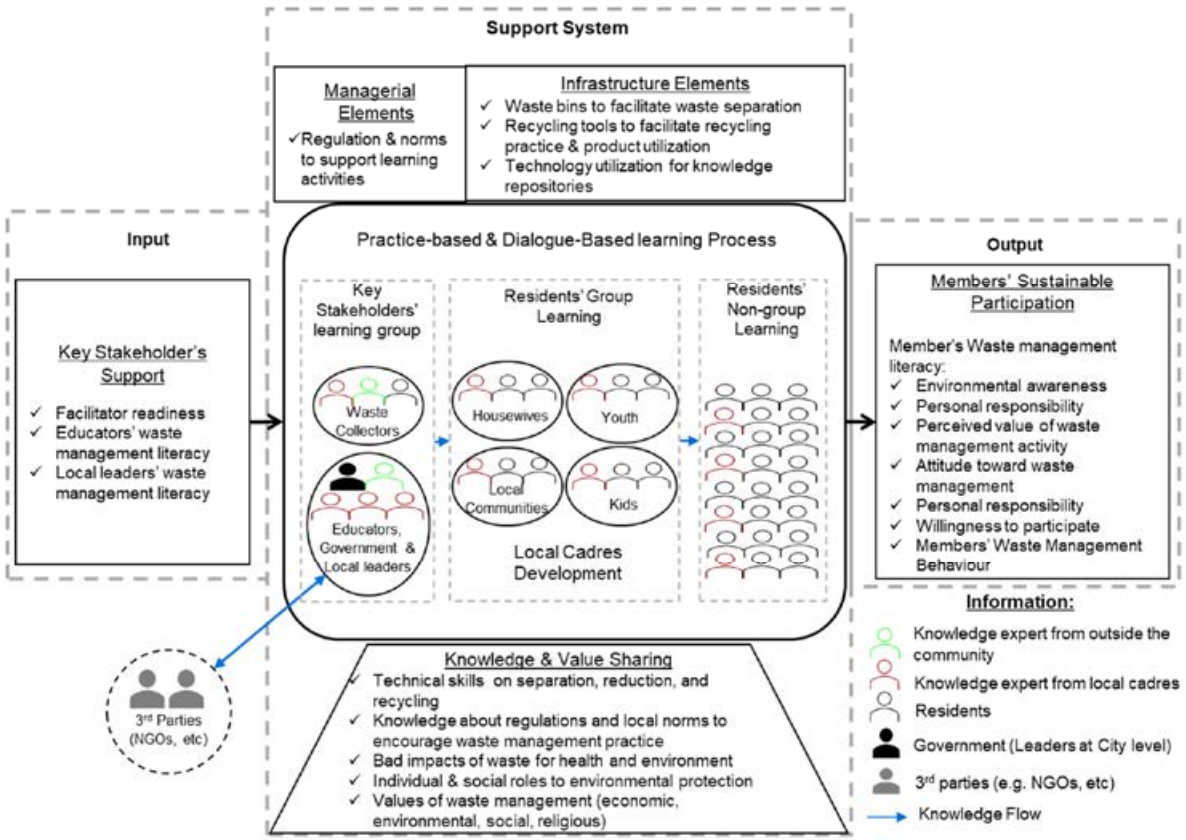


Fig. 9: The proposed design of resident-based learning model for waste management participation

as kids, youth, housewives or local communities. The output of the learning process in the CoP is represented by residents' waste management literacy. The whole process of model building through coding categories is presented in Table 8.

According to the model development process through content synthesis as presented in Table 8, the proposed model of resident-based learning can be presented as Fig. 9.

CONCLUSION

Resident participation in MSWM system is vital to ensure its effectiveness because residentials are considered the most dominant waste producers in MSWM. It requires education to encourage sustainable participation from the residents. Previous studies have failed to provide effective and impactful learning strategy to promote personal factors that eventually nurture their sustainable behavior. This study offered a new learning strategy by developing a resident-based learning model using CoP approach. Using case study on resident-based education implemented in Bandung City, Indonesia, this study gave a feasible and implementable resident-based learning model for other cities in the developing countries which faced the same problems. This study was successful in conceptualizing the resident-based education model. The local government, policy makers or other facilitators who were struggling in campaigning household participation in their waste management system can implement this educational strategy. This study provided some key findings. First, the educational strategy is feasible and implementable when there are facilitators and local leaders collaborated to provide educators, operators, and support systems. Second, facilitators and local leaders need to identify the main problems of the

residents related to waste management practice before the program started to determine the learning main objectives. Second, key stakeholders together with educators should identify knowledge and value needs based on their residents' characteristics to reach residents' waste management literacy. Third, support systems are required to facilitate and support practice-based and dialogue-based learning for effective resident learning activities. Fourth, local cadres are vital to sustain the waste management program. Fifth, educational strategy using CoP approach highlighted a long-term small group learning to facilitate intensive interaction and engagement among members for impactful learning outcomes. This study provides essential insights to understand how to build a resident-based educational program as a learning activities platform for residentials to result sustainable participation in the MSWM process. There are some limitations which need improvement for further research. First, the proposed model was still hypothesis. It needs further studies to test the relationship among elements in the model. Second, the findings were highly based on cultural characteristics of Bandung city, Indonesia. Other cities with different culture may need some adjustments to implement the model. Third, samples for quantitative data were chosen purposively based on their history being exposed by the learning program. So, the survey finding may not represent the entire residents in Bandung city and Indonesia. Future research can focus on investigating other type of resident-based learning programs which meet CoP characteristics for comparison.

AUTHOR CONTRIBUTIONS

A. Ghazali conducted the literature review, research design, analyzed and interpreted the data, and developed the model, J.H. Tjakraatmadja analyzed and interpreted the data, developed the model, review the manuscript. Sunarti conducted the literature review, collected, analyzed the data, and prepared the manuscript text, Eka Yunita Dian Pratiwi collected and analyzed the data.

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CONFLICT OF INTEREST

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors.

ABBREVIATIONS

3R	Reduce, reuse, recycle
BSF	Black soldier fly
CoP	Community of practice
CAQDAS	Computer assisted qualitative data software
DLHK	*Dinas Lingkungan Hidup dan Kebersihan*
DTDE	Door to door education
GPS	*Gerakan pungut sampah*
GSSI	*Generasi semangat selalu ikhlas*
K3	*Kebersihan, ketertiban, keindahan*
KANG PISMAN	*Kurangi pisahkan manfaatkan*
KASIE EKBANG	*Kepala seksi ekonomi pembangunan*
KBS	*Kawasan bebas sampah*
KM	Knowledge management
KSM	*Kelompok swadaya masyarakat*
MSWM	Municipal solid waste management
MSW	Municipal solid waste
NGO	Non-government organization
NVIVO	A qualitative data analysis software provided by QSR International
PASGEBER	*Pasukan gerakan bersih*
PD Kebersihan	*Kebersihan perusahaan daerah kebersihan*
PKK	*Pemberdayaan dan Kesejahteraan Keluarga*

PPO	*Pilah pilih olah*
P3MI-ITB	*Penelitian, Pengabdian kepada Masyarakat dan Inovasi Institut Teknologi Bandung*
QCA	Directed content analysis
QGIS	Quantum Geographic Information System
RT	*Rukun tetangga/hamlet*
RW	*Rukun warga/ community association*
TOGA	*Tanaman obat keluarga*
YPBB	*Yayasan Pengelolaan Biosains dan Bioteknologi*

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