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Analysis of Barrier Factors for Collaboration in Handling Used Cell Phones for Second-hand Market Actors to Implement e-waste Management

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Abstract

Waste management is an activity to manage residues, by-products, and used items. Handling used cell phones is one form of waste management activity. In developing countries, used cell phones are mostly handled by informal actors, where second-hand market actors for cell phones act as collection points. Some of these activities often affect the environment and the actors' health due to a lack of adequate technology. Hence, a collaboration between informal and formal actors is necessary to handle the used cell phones and reduce the adverse effects. However, several obstacles faced by informal actors can hinder such collaboration. This study explores the inhibiting factors for the collaboration between the informal and formal actors in handling used cell phones. The respondents were 424 informal actors in five areas of the Special Region of Yogyakarta (DIY Province), Indonesia. The results showed that the unavailability of infrastructure and insufficient organization significantly hindered collaboration in the Yogyakarta municipal area. As for the areas of Gunungkidul, Bantul, Kulonprogo, and Sleman regions, there were no significant factors hindering the collaboration. The results of this study can contribute for stakeholders' consideration related to e-waste handling, primarily used cell phones in Indonesia; thus, the management of used cell phones is safe for the environment and provide economic benefits for the informal actors.

Keywords: Collaboration Intention; Barrier Factors; Waste Management; Used Cell Phone.

1. Introduction

Waste management is a company strategy to prevent waste, especially electronic waste (e-waste). It is important as the increase in e-waste sharply rises every year, especially for developing countries with an e-waste generation rate of around 5% [1]. Managing e-waste properly is challenging. Poor e-waste management will impact the environment and human health [2]. One form of waste management activity is managing used cell phones. In developing countries, informal actors dominate the management of used cell phones, with the second-hand cell phone market as the central collection point. They provide a valuable "front line" service to the majority of the population and are economically influential in developing countries [3]. Katusiimeh et al. (2013) [4] defined the informal sector as an unregistered, unregulated, or simple activity carried out by individuals or families, or community-formed companies, which carry out activities for value addition on a small scale with minimal capital input. The informal sector is out of the state's control [5]. In addition, its existence is generally neglected by academics and regulators [6].

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Generally, there are three main activities in managing e-waste: recycling, exporting, and landfilling. Alblooshi et al. (2022) [7] developed an analytical hierarchy process to evaluate and prioritize alternatives for e-waste processing systems in the United Arab Emirates. The result showed recycling had the highest priority compared to other systems. Moreover, Rasheed (2022) [1] presented that approximately 80% of the impact on natural resources is reduced by the efficient recycling of e-waste in Pakistan using the cumulative exergy extraction method from the natural environment. Next, Liang (2021) [8] investigated consumer attitudes in reusing and recycling the e-waste in selected villages in Thailand, Vietnam, Japan, and China, reporting some differences in waste management among those countries.

Many countries face some challenges in e-waste management. In South Central Mindanao, Philippines, Dayaday & Galleto (2022) [9] evaluated the e-waste management in higher education institutions (HEIs) and found that the main challenges in managing e-waste are the lack of awareness, e-waste disposal facilities, priorities, audit resolution and procedure, and the unavailability of legislation or laws among HEIs. Similarly, in Dubai, Attia et al. (2021) [10] revealed that households' awareness and disposal behaviour of e-waste were low.

Interestingly, in Brazil, de Oliveira (2022) [11] survey showed more than 96% of respondents had basic knowledge of e-waste management, but only 9% of households dispose of the e-waste properly. It means the infrastructure plays an essential role in e-waste management. In addition, in India, even though a regulation for e-waste management has existed since 2012, the informal actors played more roles than recycling companies. Therefore, in 2018, the regulation was modified so that e-waste collection goals were set for brand manufacturers with the intention of diverting e-waste to legally recognized recyclers and dismantlers [12]. In addition, Kahhat et al., (2022) [13] proposed the integration of the formal and informal actors to minimize the environmental impacts while maximizing the social and economic traits of the current system in Mexicali, Mexico.

Activities in the second-hand market (informal actors) are mainly related to the buying and selling of used mobile phones and services. Previous research revealed that the second-hand market actors may store, dispose, burn, or sell the remaining mobile phone components. Second hand market actors aim to obtain economic benefits because these activities are their livelihoods. However, some of these activities can negatively impact the environment. Specifically, the process of taking precious metals from used cell phones without adequate equipment and technology can pollute the environment and endanger the health of the actors.

Ideally, handling a used cell phone requires high skills and technology, which can be done by formal actors, the Original Equipment Manufacturing (OEM) with remanufacturing activities. Informal and formal actors should collaborate in managing used cell phones to reduce activities harmful to the environment and health. This collaboration is an ideal embodiment, especially in developing countries where informal actors can get the economic benefits while preserving the environment. The collaborative activities support environmental sustainability.

In Indonesia, the collaboration between formal and informal actors has not yet been established in handling used cell phones. However, in some areas, a community of second-hand market actors strengthens their relationship by conducting regular meetings. Several factors can prevent informal actors from realizing the collaboration in handling used cell phones. Therefore, this study aims to explore the factors hindering the intentions of informal actors in realizing such collaboration. The respondents of this study were the second-hand market actors for mobile phones in the Special Region of Yogyakarta (DIY Province) in Indonesia. The following are the research objectives.

- To explore the value of each inhibiting factor on the collaboration intention of informal actors in handling used cell phones.
- To examine the influence of the inhibiting factors on the collaboration intention of informal actors in handling used cell phones.
- To determine the value of the inhibiting factors in forming the collaboration intentions of informal actors in handling used cell phones.

2. Literature Review and Hypotheses Development

This section describes the inhibiting factors influencing collaboration intentions for informal actors. This study involved two internal factors (insufficient organization and financial limitation) and four external factors (unavailability of regulation, infrastructure, information, and growth of informal recyclers). Initially, these factors were obtained from a literature review on the factors hindering the company's environmentally friendly activities, such as reverse logistics. Furthermore, field validation was carried out by discussing it with several respondents in each research area. The factors considered in this study are explained as follows.

2.1. Insufficient Organization

The insufficient organization factor is generally described as the inability of the company's organization to carry out an activity caused by the unavailability of the resources needed to carry out these activities. This factor can be the lack of human resources, inadequate organizational structure, slow decision-making, lack of concern for owners or managers, and difficulty allocating resources.

Some authors mentioned insufficient organizational factors as a barrier to green activities, such as classifying the insufficient organization factor as a management obstacle to carrying out RL activities in the Chinese manufacturing industry [14]. Bouzon et al. (2018) [15] studied the barriers to reverse logistics activities based on a multi-stakeholder perspective, so that there are obstacles from an organizational perspective. Another study examined the preliminary findings of barriers to green manufacturing practices [16] and barriers and difficulty factors to energy efficiency [17]. A study conducted in India examined the critical barriers to implementing e-waste management and insufficient organization, including lack of technology and knowledge [18]. Meanwhile, Meath et al. (2016) [19] mentioned the barriers to the adoption of energy savings, such as lack of time/staff commitments and a lack of staff with the skills to initiate change. Nordin et al. (2014) [20] investigated the barriers to sustainable manufacturing practices, especially in developing countries, namely Malaysia, and found several barriers that could be classified as insufficient organizational factors. Trianni et al. (2014) [21] categorized barriers to energy efficiency practices, one of which is organizationally based on empirical investigation in primary metals manufacturing in a province in Italy. In this research, insufficient organization means the organizational inability of informal actors to collaborate to handle used cellphones with formal actors.

Furthermore, Luo & Qi (2020) [22] stated that insufficient organization is one of the barriers to transforming the landscape for conservation planning in the Pearl River Delta. Yeni & Teoman (2022) [23] also presented the insufficient organization of the farmers in the green transition of Turkey's agriculture. Next, Hren et al. (2021) [24] stated that insufficient organization could reduce the quality of ecotourism in Ukraine. Based on the review, the following hypothesis is developed.

H1: *Insufficient organization negatively influences the collaboration intention.*

2.2. Financial Limitation

Financial limitation factor is related to the limited financial support to carry out certain activities within a company. This financial limitation can also result in difficulties in obtaining investment or capital and funding sources. previous studies have discussed financial limitations as one of the obstacles to environmentally friendly activities in a company, including Bouzon et al. (2018) [15] who termed it a lack of initial capital. Meanwhile, Ghazilla et al. (2015) [16] mentioned difficulties in acquiring financial capital and limited financial resources. Then, Henriques & Catarino (2016) [17] stated several forms: lack of capital, budget funding, restricted access to capital markets and investments, and insufficient capacity to develop bankable projects with finances. Other studies used different terms, including: a lack of funds [25, 26], cost prohibitive [19], increment in overall cost and high-cost requirement [20], economic barriers, especially capital availability [21], high investment and cost [27], and financial pressure [28].

In addition, Mell (2020) [29] argued that in maintaining the green infrastructure, financial limitation is the most critical influence on the liveability and quality of urban environments in the United Kingdom. In the automobile industry, Ravi and Shankar (2017) [30] developed interpretive structural modelling to analyse the interaction among the major variables of reverse logistics and found that financial limitation was the biggest inhibitors faced by top management to implement a reverse logistics program.

In this study, it is the financial limitation of informal actors to carry out environmentally friendly activities in general and in particular to collaborate in handling used cell phones. Thus, the research hypothesis for this factor is as follows.

H2: *Financial limitation negatively influences the collaboration intention.*

2.3. Unavailability of Regulation

Unavailability of regulation is an internal factor of the company. It describes the unavailability of rules, policies, and laws to regulate certain aspects. This unavailability can occur because the regulation is not a priority in certain countries. Several authors mentioned the unavailability of regulation as one of the obstacles in carrying out environmental-related activities, including Abdulrahman et al. (2014) [14] stating the lack of supportive policies and enforceable laws. Meanwhile, Bouzon et al. (2018) [15] mentioned a lack of specific laws or a lack of supportive policies. Then, Ghazilla et al. (2015) [16] also found that the lack of government regulations and policies is an inhibiting factor for collaboration in green manufacturing practices, including the lack of environmental enforcement and support and guidance from the authorities. Furthermore, Kumar & Dixit (2018) [26] and Kumar & Dixit (2018) [25] also cited the lack of policies and regulations. In more detail, Kumar & Dixit (2018) [25] included delays in law enforcement, lack of adequate systematic monitoring and auditing, and lack of policies and regulations that address the environment. Furthermore, Nordin et al. (2014) [20] mentioned a lack of government regulation in sustainable manufacturing practices.

Mollers (2022) [31] presented that an insufficient regulation problem would mislead the investor (greenwashing). In addition, Abanina et al. (2021) [32] stated that insufficient regulation is one of the aspects that play role on social and environmental policy in achieving sustainable development goals in Russia. Furthermore, in the Iranian construction sector, Fathalizadeh et al. (2021) [33] found that insufficient regulation is one of the barriers preventing sustainable project management.

In this research, the particular rules regarding e-waste management in Indonesia are not available. The existing rules are limited to handling toxic and hazardous waste in general. Thus, the absence of special rules regarding handling e-waste that binds formal and informal actors, and consumers can hinder collaboration intentions. Thus, the hypothesis is as follows.

H3: *The unavailability of regulation negatively influences the collaboration intention.*

2.4. Unavailability of Infrastructure

Generally, the unavailability of infrastructure can be interpreted as the absence of facilities and infrastructure to support the implementation of specific activities. Unavailability of infrastructure can be the unavailability of storage facilities, modes of transportation, and mechanism for collaboration between partners.

Previous studies have discussed this factor as an obstacle to activities related to the environment. Ghazilla et al. (2015) [16] stated that lack of additional infrastructure is one of the obstacles in green manufacturing practice. Kumar and Dixit (2018) [26] also proposed inadequate infrastructure as one of the barriers for adoption e-waste management in India. Next, Kumar and Dixit (2018) [25] proposed unavailability of infrastructure as one of the barriers to implement waste of electrical and electronic equipment management. In addition, Trianni et al. (2014) [21] presented information technology as one of the barriers for energy efficiency practices in primary metals manufacturing SMEs in Northern Italy province. Furthermore, Zhang & Wang (2014) [28] identified that the lack of infrastructure and mechanism for recycling concrete aggregates are the main barriers that impedes the inter-firm collaborations on carbon emission reduction.

In India, Kar et al. (2022) [34] argued that lack of infrastructure is one of the challenges of hydrogen adoption in the domestic market for renewable resources. Meanwhile, in Dhaka City, Bangladesh, insufficient infrastructure is also one of the limitations on utilizing green spaces [35]. In Turkey, Korkmaz and Ceylan (2021) [36] proposed smart environmental application to solve one of the environmental problems in parallel with the increasing population, i.e. insufficient infrastructure.

In this study, infrastructure unavailability is considered an external factor. It means that stakeholders have not provided technology, facilities, tools, and infrastructure for handling used cell phones, hindering informal actors from collaborating with formal parties. The hypotheses developed is as follows.

H4: *the unavailability of infrastructure negatively influences the collaboration intention.*

2.5. Unavailability of Information

The unavailability of information means the absence of adequate information to disseminate information about some issues. It can hinder positive activities. Some previous studies have discussed this factor as an obstacle to environmentally friendly activities [17, 21, 37].

The unavailability of information includes some categories: lack of information, cost of obtaining information, and accuracy of information [17]. The unavailability of the information is complicated, unintegrated, or unreliable [21]. While Kotska et al. (2013) [37] defined unavailability of information as less relevant or insufficient information. Horvatinčić et al (2016) [38] reported that insufficient information was the highest barrier for renewable energy in food production. In China, Zhou (2019) [39] also found insufficient information as one of the problems of the green bond market. Makul et al. (2021) [40] argued that the lack of information on longevity and sustainability as a serious problem concerning recycled concrete aggregates production. Insufficient information is one of the barriers to promoting green products [41].

In this study, the unavailability of information factor is related to the proper handling of used cell phones, procedures for implementing collaboration, the availability of regulations, benefits, the dangers of cell phone waste, the possibility of cooperation in a safely used cell phone business, and availability of suppliers of used cell phones. The unavailability of this information can prevent informal actors from collaborating with formal parties in handling used cell phones. The following is developed the hypothesis.

H5: *the unavailability of information negatively influences the collaboration intention.*

2.6. The Growth of Informal Recycler

Informal recyclers in this study are unofficial or unlicensed parties who process used cell phone components to extract the precious metal content in them. The process is unsafe for them and the environment, given the harmful ingredients in mobile phone components because of the inadequate technology for the recycling process.

The increasing number of informal recyclers is one of the most important hurdles for e-waste management in the developing countries. The improper e-waste recycling leads to environmental implications and fitness risk for employees

directly concerned in recycling activities [26]. In addition, the backyard recycling operation, a process for recycling used cell phones without a waste handling permit (toxic and hazardous materials), conducted by informal recyclers also contributes to inhibitor factors as it interferes with worker's health. The growth of used cell phone recyclers conducting the unsafe process of handling cell phones can hinder the collaboration between the informal and formal parties aimed at environmental safety. Thus, the proposed hypothesis is as follows.

H6: *the growth of informal recycler negatively influences the collaboration intention.*

Based on the factors hindering the intention of second-hand market actors to collaborate with the formal actors in e-waste management, this study proposed the conceptual model (Figure 1).

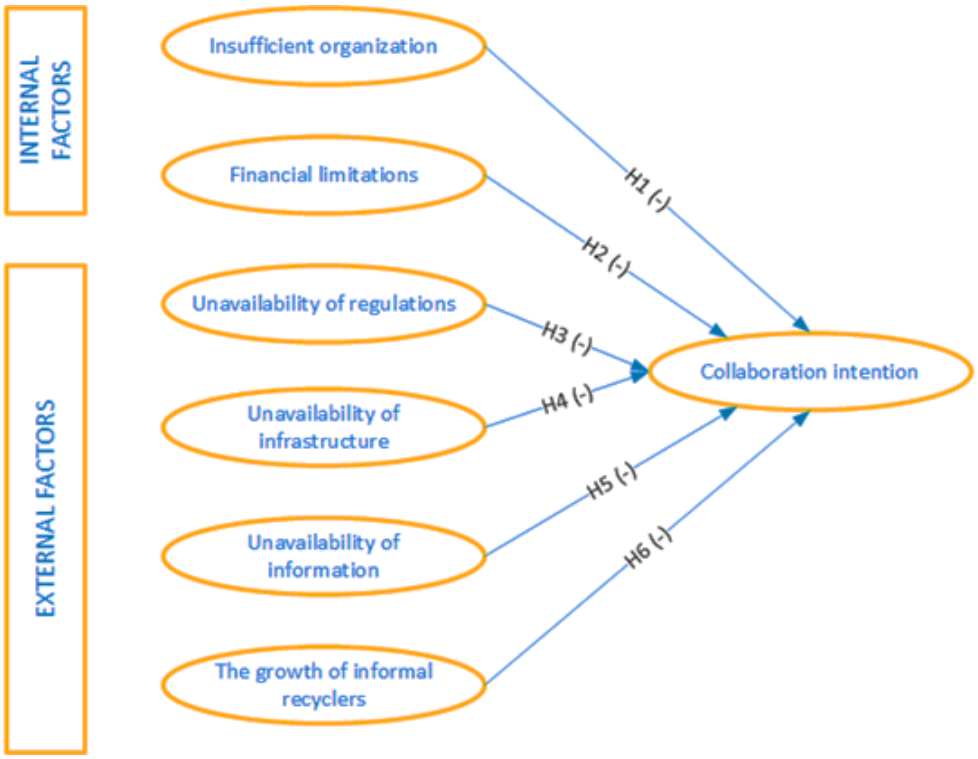

Figure 1. Conceptual model

3. Research Methodology

3.1. The Research Object

Most mobile phone consumers in Indonesia are not aware of the sustainable actions they should take with their used phones. In addition, the government has no special regulations related to e-waste, so the formal actors who must have a take-back program to reduce e-waste do not conduct the program correctly. This phenomenon makes the informal actors selling and buying activities and repairing used cell phones benefitting from the recycling economy. The collaboration between formal and informal actors is crucial because handling the used cell phones requires high technology to minimize the environmental impacts. Therefore, this research aims to measure the influence of barrier factors towards intentions to collaborate between informal and formal actors.

The respondents of this research were the informal actors of the second-hand market in the Special Region of Yogyakarta. This research focused on five regions: Gunungkidul region, Bantul region, Kulonprogo region, Sleman region, and Yogyakarta municipality.

3.2. Measurement

This subsection presents the measurement barrier factors for collaboration intention. The questionnaire was distributed on a Likert scale of 1 to 5. The survey was conducted from September to October 2018. There are six barrier factors for collaboration in handling used cell phones for the second-hand market. They were grouped into internal and external barriers. The internal factors include (1) insufficient organization and (2) financial limitation, and the external factors include (3) unavailability of regulation, (4) unavailability of infrastructure, (5) unavailability of information, and (6) the growth of informal recyclers. The factors are adapted from previous studies as follows [14–27, 37].

- Insufficient organization was adapted;
- Financial limitation was adapted;

- Unavailability of regulations was adapted;
- Unavailability of infrastructure was adapted;
- Unavailability of information was adapted;
- The growth of informal recyclers was adapted.

3.3. Research Stages

The stages of the research included:

- Distributing the initial questionnaire to the respondents;
- Conducting the validity and reliability test of the initial questionnaire using the SPSS software version 16;
- Distributing the formal questionnaire to the respondents;
- Conducting a classic assumption test for data in each district/city using the SPSS software version 16;
- Performing regression analysis for data in each district/city using the SPSS software version 16;
- Conducting confirmatory factor analysis (CFA) using AMOS 25 for data in all areas of DIY Province;
- Developing Structural Equation Modelling (SEM) development using AMOS 25 software for data in all areas of DIY Province and conducting Confirmatory Factor Analysis (CFA) used AMOS 25.

4. Results and Discussion

4.1. Demographic Characteristics

The questionnaire was administered to 424 respondents from September to October 2018. The respondents were the second-hand market actors (including buying and selling, cell phone service, or cannibalization) in Yogyakarta province, including Bantul (75 responses), Sleman (160 responses); Yogyakarta municipality (90 responses); Gunungkidul (50 responses) and Kulonprogo (49 responses). Our previous research [42] presents the characteristics of the respondents, including age, gender, household member, income, education level, marital status, position at work, and treatment of used components. Most respondents (62%) were male, and, on average, 67% of them were between the ages of 20 and 30. It is interesting to note that out of the total respondents, 75 percent had senior high school or higher as their level of education. In addition, the majority of respondents were single and employees. Over 49% of respondents saved the used parts. The respondents also frequently fixed those parts for resale and reuse them on other damaged cell phones as the explanation.

4.2. The Location of Second-Hand Market Actors

The locations of second-hand cell phone market actors as research objects in each research area covering the districts of Gunungkidul, Bantul, Kulonprogo, Sleman, and Yogyakarta City, are shown in Figures 2.

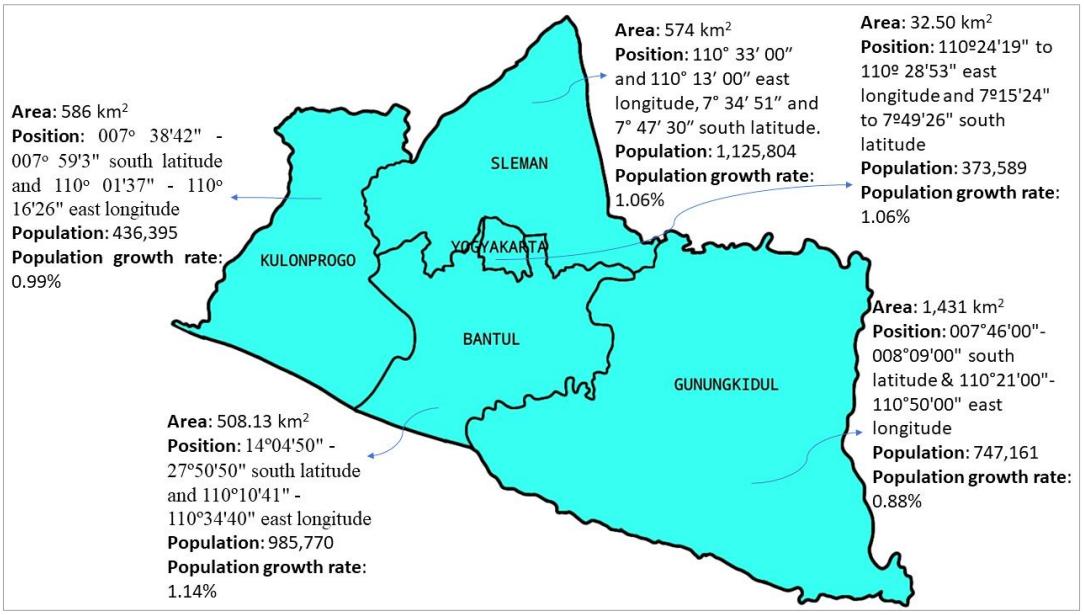

Figure 2. The details of research area

4.3. Regression Analysis Result

This section presents the results of regression analysis of the barrier factors on the collaboration in handling the used cell phones between second hand market and formal actors. The reliability and validity tests were performed on the questionnaires distributed to each region before applying the regression analysis. There were 30 respondents used for Kulonprogo, Gunung Kidul, and Yogyakarta municipality. For Bantul, 35 respondents were used, with special note for the sixth factor, the growth of informal recyclers, using 40 respondents. In Sleman, 100 respondents were participated, except for the first factor, insufficient organization, involving 30 respondents.

A reliability test was performed to measure the consistency of the questionnaire. A survey is reliable if the responses are consistent over time. The validity tests were intended to demonstrate the extent to which the questionnaire items used in this research measure what they were intended to measure. Validity tests are employed to measure whether the questionnaire item is valid or not. It is conducted by comparing the total Pearson correlation to the R table values. If the Pearson correlation is greater than the R table value, the questionnaire item is deemed valid. Reliability and validity tests were performed using SPSS and shown in detail in Appendix I. Table 1 displays the results of the reliability and validity tests in each research area.

Table 1. The results summary of the reliability and validity tests

The result of reliability and validity test for Gunungkidul Region		
Variable	**The value of Cronbach α**	**The range value of Correlated item –Total Correlation**
Collaboration intention	0.941	0.788 - 0.916
Insufficient organization	0.849	0.683 - 0.816
Financial limitations	0.843	0.537 - 0.874
Unavailability of regulation	0.888	0.817 - 0.872
Unavailability of Infrastructure	0.857	0.760 - 0.905
Unavailability of information	0.832	0.661 - 0.863
The growth of informal recycler	0.830	0.814 - 0.893
The result of reliability and validity test for Bantul Region		
Variable	**The value of Cronbach α**	**The range value of Correlated item –Total Correlation**
Collaboration intention	0.852	0.571 - 0.813
Insufficient organization	0.601	0.558 - 0.639
Financial limitations	0.681	0.620 - 0.697
Unavailability of regulation	0.663	0.637 - 0.839
Unavailability of Infrastructure	0.727	0.620 - 0.819
Unavailability of information	0.757	0.493 - 0.811
The growth of informal recycler	0.606	0.814 - 0.895
The result of reliability and validity test for Kulonprogo Region		
Variable	**The value of Cronbach α**	**The range value of Correlated item –Total Correlation**
Collaboration intention	0.851	0.444 - 0.778
Insufficient organization	0.756	0.549 - 0.755
Financial limitations	0.746	0.524 - 0.759
Unavailability of regulation	0.807	0.726 - 0.878
Unavailability of Infrastructure	0.777	0.573 - 0.874
Unavailability of information	0.847	0.637 - 0.905
The growth of informal recycler	0.845	0.806 - 0.934
The result of reliability and validity test for Sleman Region		
Variable	**The value of Cronbach α**	**The range value of Correlated item –Total Correlation**
Collaboration intention	0.852	0.379 - 0.569
Insufficient organization	0.542	0.449 - 0.774
Financial limitations	0.601	0.388 - 0.752
Unavailability of regulation	0.644	0.611 - 0.797
Unavailability of Infrastructure	0.713	0.616 - 0.841
Unavailability of information	0.680	0.600 - 0.718
The growth of informal recycler	0.613	0.659 - 0.877

The result of reliability and validity test for Yogyakarta Municipality		
Variable	**The value of Cronbach α**	**The range value of Correlated item –Total Correlation**
Collaboration intention	0.931	0.838 - 0.922
Insufficient organization	0.920	0.704 - 0.927
Financial limitations	0.811	0.594 - 0.858
Unavailability of regulation	0.906	0.817 - 0.925
Unavailability of Infrastructure	0.831	0.785 - 0.858
Unavailability of information	0.960	0.870 - 0.973
The growth of informal recycler	0.733	0.785 - 0.821

4.3.1. Gunungkidul Region

The respondents in Gunung Kidul were 50 informal actors, and their responses about the cooperation intention and value for each of the surveyed factors are shown in Table 2. Informal actors in the Gunung Kidul area had a cooperative intention of 3.46, meaning that the actors in Gunung Kidul were neutral and most agreed with the willingness to cooperate.

Table 2. Results of descriptive analysis of respondents' answers in Gunungkidul Regency

Factor	Collaboration intention	Insufficient organization	Financial limitations	Unavailability of regulation	Unavailability of infrastructure	Unavailability of information	The growth of informal recyclers
Average	3.46	4	3.7	3.7	3.54	3.64	3.53

Testing the classical assumptions before performing regression analysis is important. It aims to ensure that the regression equation obtained is reliable in terms of estimation, impartiality, and consistency. Before analysing the data, this classical assumption test was run as a precondition test. The classic assumption tests employed in this research included the heteroscedasticity, multicollinearity, and normality tests. The summary of classical assumption tests is displayed in Table 3. The classical assumption test results for each region are presented in Appendix II. The results showed that all classic assumption tests were satisfied for the Gunungkidul region.

Table 3. The summary of classical assumption test for Gunungkidul Regency

The result of normality test	The result of multicollinearity test	The result of heteroscedasticity test
1. Residual data plot spread around the diagonal line	1. Tolerance value for all variables is greater than 0.1, insufficient organization (0.465), financial limitations (0.356), unavailability of regulation (0.293), unavailability of Infrastructure (0.269), unavailability of information (0.208), and the growth of informal recycler (0.388).	The points are scattered randomly above and below the number 0 (zero) on the Y axis and does not form a certain pattern.
2. Kolmogorov-Smirnov statistical test has a significance level greater than 0.05 namely 0.091	2. The Variance Inflation Factor (VIF) value for all variables is less than 10 consisted of: insufficient organization (2.150), financial limitations (2.808), unavailability of regulation (3.408), unavailability of Infrastructure (3.712), unavailability of information (4.800), and the growth of informal recycler (2.579).	

The regression outcome of the inhibiting factors on the collaboration intentions of informal actors in the second-hand cell phone market in the Gunungkidul region is shown in Table 4. For this region, the growth of the informal recyclers was the dominant barrier factor compared to others.

Table 4. The regression result for Gunungkidul Region

Coefficients [a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	1.088	0.560	-	1.943	0.059
	Insufficient organization	0.135	0.198	0.125	0.683	0.498
	Financial limitations	0.334	0.202	0.345	1.650	0.106
	Unavailability of regulation	0.123	0.217	0.130	0.567	0.574
	Unavailability of Infrastructure	0-.010	0.235	-0.010	-0.041	0.968
	Unavailability of information	0.271	0.298	0.248	0.909	0.368
	The growth of informal recycler	-0.207	0.178	-0.233	-1.162	0.252

a. Dependent Variable: Collaboration Intentions

The growth of the informal recycler (b= -0.207) and the unavailability of infrastructure (b=-0.010) were the most essential barrier factors for collaboration intention, but those barrier factors did not significantly affect the collaboration intention (p>0.05). The results of coefficient determination (R^2) of 0.332 (refer to Table 5) indicate that all predictors (independent variables) of collaboration can account for 33.2% in collaboration intention, while 66.8 % is influenced by other factors.

Table 5. The R^2 result for the inhibiting factors of collaboration intention for Gunungkidul Region

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.576 [a]	0.332	0.238	0.69486

4.3.2. Bantul Region

The responses in the Bantul region were from 75 informal actors. Table 6 summarises the mean of collaboration intention and each barrier factor of respondents' collaboration intention. The summary of classical assumption tests is displayed in Table 3. The classical assumption test results for each region are presented in Appendix II. The findings indicate that informal actors in Bantul Regency have the intention to collaborate (M=3.87), meaning that they tend to agree to intend to collaborate.

Table 6. Results of descriptive analysis of respondents' answers in Bantul Regency

Factor	Collaboration intention	Insufficient organization	Financial limitations	Unavailability of regulation	Unavailability of infrastructure	Unavailability of information	The growth of informal recyclers
Average	3.87	3.9	4	4.1	4	4	3.9

The summary of classical assumption tests for the Bantul region is displayed in Table 7 and the classical assumption test results for each region are presented in Appendix II. The results demonstrate that it is satisfied for all test types.

Table 7. The summary of classical assumption test for Bantul Regency

The result of normality test	The result of multicollinearity test	The result of heteroscedasticity test
1. Residual data plot spread around the diagonal line	1. Tolerance value for all variables is greater than 0.1, insufficient organization (0.902), financial limitations (0.927), unavailability of regulation (0.818), unavailability of Infrastructure (0.783), unavailability of information (0.853), and the growth of informal recycler (0.929).	The points are scattered randomly above and below the number 0 (zero) on the Y axis and does not form a certain pattern.
2. Kolmogorov-Smirnov statistical test has a significance level greater than 0.05 namely 0.80	2. The Variance Inflation Factor (VIF) value for all variables is less than 10 consisted of: insufficient organization (1.109), financial limitations (1.079), unavailability of regulation (1.222), unavailability of Infrastructure (1.278), unavailability of information (1.172), and the growth of informal recycler (1.076).	

Table 8 displays the regression results of the barrier factors on the collaboration intentions of informal actors in the second-hand cell phone market in the Bantul area. Interestingly, in the Bantul region, there was no negative influence for collaboration intentions, meaning that informal actors in Bantul did not feel that the six inhibiting factors negatively influence their intention to collaborate.

Table 8. The regression result for Bantul Region

Coefficients [a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.145	0.917	-	1.248	0.216
	Insufficient organization	0.179	0.139	0.151	1.286	0.203
	Financial limitations	0.100	0.136	0.085	0.735	0.465
	Unavailability of regulation	0.056	0.143	0.048	.393	0.695
	Unavailability of Infrastructure	0.227	0.120	0.239	1.898	0.062
	Unavailability of information	0.004	0.151	0.003	0.028	0.978
	The growth of informal recycler	0.123	0.112	0.126	1.092	0.279

a. Dependent Variable: Collaboration Intention

The coefficient determination (R^2) of 0.160 (see Table 9) show that all predictors (independent variables) of collaboration account for 16% of the variation in collaboration intention, while the remaining 84% is impacted by other factor not considered in this research.

Table 9. The R^2 result for the inhibiting factors of collaboration intention for Bantul Region

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.400 [a]	0.160	0.086	0.45085

4.3.3. Kulonprogo Region

The respondents in the Kulonprogo region were 49 informal actors. The mean for each barrier factor of collaboration intention and the intention value are displayed in Table 10. The mean of intention is 3.783, showing that informal actors tend to agree to interact with formal actors in the Kulonprogo Region in managing used cell phones.

Table 10. Results of descriptive analysis of respondents' answers in Kulonprogo Regency

Factor	Collaboration intention	Insufficient organization	Financial limitations	Unavailability of regulation	Unavailability of infrastructure	Unavailability of information	The growth of informal recyclers
Average	3.783	3.9	3.9	4.12	4.1	4.2	3.9

The results of the classical assumption test are displayed in Appendix II. The summary of classical assumption tests for Kulonprogo region is displayed in Table 11, indicating that all classical assumption tests are were satisfied for the Kulonprogo area.

Table 11. The summary of classical assumption test for Kulonprogo Regency

The result of normality test	The result of multicollinearity test	The result of heteroscedasticity test
1. Residual data plot spread around the diagonal line	1. Tolerance value for all variables is greater than 0.1, insufficient organization (0.475), financial limitations (0.532), unavailability of regulation (0.351), unavailability of Infrastructure (0.334), unavailability of information (0.327), and the growth of informal recycler (0.524).	The points are scattered randomly above and below the number 0 (zero) on the Y axis and does not form a certain pattern
2. Kolmogorov-Smirnov statistical test has a significance level greater than 0.05 namely 0.114	2. The Variance Inflation Factor (VIF) value for all variables is less than 10 consisted of: insufficient organization (2.107), financial limitations (1.881), unavailability of regulation (2.851), unavailability of Infrastructure (2.993), unavailability of information (3.060), and the growth of informal recycler (1.907).	

Table 12 presents the regression results of the factors preventing informal actors in the Kulonprogo region from collaborating with formal actors in handling used cell phones for the second-hand market. It is clear that financial limitation is the most influential factor.

Table 12. The regression result for Kulonprogo Region

Coefficients [a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.271	0.822		1.545	0.130
	Insufficient organization	0.462	0.218	0.396	2.122	0.040
	Financial limitations	-0.146	0.203	-0.127	-0.719	0.476
	Unavailability of regulation	0.018	0.258	0.015	0.070	0.945
	Unavailability of Infrastructure	0.137	0.231	0.133	0.594	0.556
	Unavailability of information	0.048	0.321	0.034	0.150	0.882
	The growth of informal recycler	0.116	0.143	0.142	0.807	0.424

a. Dependent Variable: Collaboration Intentions

One barrier factor affecting collaboration intentions in the Kulonprogo region is financial limitation (b= -0.146) but it is not significant. The R^2 of 0.290 (as presented in Table 13) indicates that all predictors (independent variables) of collaboration accounts for 29 % in barrier factors of collaboration intentions, while 71 % is influenced by other factors.

Table 13. The R^2 result for the inhibiting factors of collaboration intention for Kulonprogo Region

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.539 [a]	0.290	0.189	0.49581

4.3.4. Sleman Region

In Sleman Regency, 160 informal actors responded. Table 14 presents the mean of the responses to the seven factors under investigation and the mean of their intentions to collaborate. The informal actors' intentions for collaborating are the highest compared to other regions (M=4.008), proving their sincere desire for collaborating with formal actors.

Table 14. Results of descriptive analysis of respondents' answers in Sleman Regio

Factor	Collaboration intention	Insufficient organization	Financial limitations	Unavailability of regulation	Unavailability of infrastructure	Unavailability of information	The growth of informal recyclers
Average	4.008	4	4	4	4	4	3.8

The results of classical assumptions conducted before performing regression analysis are displayed in Appendix II. The summary of the tests for Sleman region is displayed in Table 15, showing that it is satisfied for all tests.

Table 15. The summary of classical assumption test for Sleman Regency

The result of normality test	The result of multicollinearity test	The result of heteroscedasticity test
1. Residual data plot spread around the diagonal line	1. Tolerance value for all variables is greater than 0.1, insufficient organization (0.783), financial limitations (0.732), unavailability of regulation (0.737), unavailability of Infrastructure (0.648), unavailability of information (0.720), and the growth of informal recycler (0.795).	The points are scattered randomly above and below the number 0 (zero) on the Y axis and does not form a certain pattern
2. Kolmogorov-Smirnov statistical test has a significance level greater than 0.05 namely 0.052	2. The Variance Inflation Factor (VIF) value for all variables is less than 10 consisted of: insufficient organization (1.277), financial limitations (1.367), unavailability of regulation (1.356), unavailability of Infrastructure (1.544), unavailability of information (1.389), and the growth of informal recycler (1.258).	

Table 16 presents the regression result of the barrier factors on informal actors from collaborating with formal actors in handling used cell phones for the second-hand market in the Sleman region.

Table 16. The regression results for Sleman Region

Coefficients [a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.047	0.431	-	4.748	0.000
	Insufficient organization	0.028	0.093	0.025	0.304	0.761
	Financial limitations	0.094	0.086	0.095	1.094	0.276
	Unavailability of regulation	0.119	0.087	0.117	1.357	0.177
	Unavailability of infrastructure	0.088	0.081	0.101	1.095	0.275
	Unavailability of information	0.248	0.082	0.264	3.019	0.003
	The growth of informal recycler	-0.098	0.063	-0.130	-1.561	0.120

a. Dependent Variable: Collaboration Intention

The growth of informal recycler is the most important barrier factor compared to others (b=-0.098) but it is not significant. Table 17 shows all predictors (independent variables) of collaboration account for 16.1% of the variation in collaboration intention (R^2 = 0.161), the remaining 83.9% is impacted by factors.

Table 17. The R^2 result for the inhibiting factors of collaboration intention for Sleman Region

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.401[a]	0.161	0.128	0.38411

4.3.5. Yogyakarta Municipality

Ninety informal actors living in the Yogyakarta municipality responded. Table 18 shows the mean of each barrier factor for collaboration intention (M=3.60). This result indicates that Yogyakarta's informal actors have neutral or close to agreeable levels of intention for collaborating.

Table 18. Results of descriptive analysis of respondents' answers in Yogyakarta Municipality

Factor	Collaboration intention	Insufficient organization	Financial limitations	Unavailability of regulation	Unavailability of infrastructure	Unavailability of information	The growth of informal recyclers
Average	3.6	3.58	3.74	3.96	4	3.86	3.7

The classic assumption test for regression analysis shown in Appendix II. It demonstrates that all test types are satisfied for the Yogyakarta Municipality, allowing regression analysis to proceed. The summary of classical assumption tests for Yogyakarta Municipality is displayed in Table 19.

Table 19. The summary of classical assumption test for Yogyakarta Municipality

The result of normality test	The result of multicollinearity test	The result of heteroscedasticity test
1. Residual data plot spread around the diagonal line	1. Tolerance value for all variables is greater than 0.1, insufficient organization (0.835), financial limitations (0.710), unavailability of regulation (0.334), unavailability of Infrastructure (0.452), unavailability of information (0.651), and the growth of informal recycler (0.839).	The points are scattered randomly above and below the number 0 (zero) on the Y axis and does not form a certain pattern.
2. Kolmogorov-Smirnov statistical test has a significance level greater than 0.05 namely 1.290	2. The Variance Inflation Factor (VIF) value for all variables is less than 10 consisted of: insufficient organization (1.198), financial limitations (1.408), unavailability of regulation (2.991), unavailability of Infrastructure (2.212), unavailability of information (1.536), and the growth of informal recycler (1.192).	

The regression results of the barrier factors on informal actors from collaborating with formal actors in handling used cell phones for the second-hand market in the Yogyakarta municipality is shown in Table 20. It is clear that the unavailability of infrastructure is the most important, inhibiting collaboration intentions (b=-0.715, p=0.002). The results support H4. The second factor with a negative effect is the unavailability of regulation (b=-0.347) but it is not significant.

Table 20. The regression result for Yogyakarta Municipality

Coefficients [a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.418	0.653	-	5.235	0.000
	Insufficient organization	0.036	0.182	0.027	0.198	0.844
	Financial limitations	0.130	0.155	0.114	0.834	0.409
	Unavailability of regulation	-0.347	0.238	-0.248	-1.460	0.151
	Unavailability of Infrastructure	-0.715	0.218	-0.471	-3.280	.002
	Unavailability of information	0.901	0.290	0.494	3.106	0.003
	The growth of informal recycler	0.044	0.121	0.049	0.366	0.716

a. Dependent Variable: Collaboration Intention

The coefficient determination (R^2) in Table 21 indicates that 93.7% of collaboration intention is explained by other factors not considered in this study.

Table 21. The R^2 result for the inhibiting factors of collaboration intention for Yogyakarta Municipality

Model				
1	0.252 [a]	0.063	- 0.004	1.979

4.3.6. The Special Region of Yogyakarta (DIY) Province

The Special Region of Yogyakarta (DIY) Province consists of some regions: Gunung Kidul, Bantul, Kulonprogo, Sleman, and Yogyakarta Municipality. There were 424 informal actors in this province who responded. The analysis at the provincial level was done using SEM (Structural Equation Modelling), with CFA must be done before the structural model was developed. CFA was carried out on inhibiting factors as exogenous variables. CFA examines whether all questionnaire items can be used. There is no general rule for determining the cut-off value for the loading factor [16]. In this study, the factor loading was set to at least 0.5. The CFA results show the fit model (p=0.486, χ^2=243,091, GFI=0.954, AGFI=0.929, and RMSEA=0.001). The factor loading of eight items were less than 0.5, so they must be removed from the questionnaire. They include three items from the insufficient organization factor, three items from the financial limitation factor, an item from the lack of regulation factor, and an item from the lack of infrastructure factor.

The mean of collaboration intention is 3.744, as presented in Table 22, indicating that this province's informal actors had neutral or close to agreeable levels of collaboration intention. Furthermore, based on the mean of respondents' answers to the inhibiting factors of collaboration, the unavailability of information factor was the highest (M=4.2).

Table 22. Results of descriptive analysis of respondents' answers in DIY Province

Factor	Collaboration intention	Insufficient organization	Financial limitations	Unavailability of regulation	Unavailability of infrastructure	Unavailability of information	The growth of informal recyclers
Average	3.744	3.88	3.87	3.98	4.1	4.2	3.9

The results of the structural model are shown in Table 23. Structural model fit was obtained (p= 0.063, χ^2=206.669, GFI = 0.956, AGFI = 0.926, and RMSEA = 0.021). The structural model shows that a significant factor hindering collaboration in the DIY province is the insufficient organization factor (b= -0.241, p=0.071), meaning that H1 is supported.

Table 23. Structural model result for Special Region of Yogyakarta Province

			Estimate	S.E.	C.R.	P	Label
Collaboration intention	←	Insufficient organization	-0.241	0.134	-1.806	0.071	par_18
Collaboration intention	←	Financial limitations	-0.126	0.086	-1.466	0.143	par_19
Collaboration intention	←	Unavailability of regulation	0.075	0.256	0.293	0.769	par_20
Collaboration intention	←	Unavailability of Infrastructure	0.005	0.274	0.019	0.985	par_21
Collaboration intention	←	Unavailability of information	-0.281	0.318	-0.883	0.377	par_22
Collaboration intention	←	The growth of informal recycler	0.035	0.121	0.290	0.772	par_23

The coefficient of determination (R^2=0.141), as shown in Table 24 indicates that the six inhibiting factors considered in this study explains the collaboration intentions by 14.1%. Other factors form 85.9% of collaboration intentions.

Table 24. Squared Multiple Correlations

	Estimate
Collaboration intention	0.141

4.4. Discussion

The descriptive analysis at each region and province levels showed that informal actors have the intention to collaborate with formal actors in handling used cell phones. This result is promising because it indicates that there is a possibility for both actors to collaborate.

This study presents six barriers factors for collaboration in handling used cell phones for second-hand market actors, grouped into internal and external barriers. The internal factors are insufficient organization and financial limitation, while the external factors include the unavailability of regulation, unavailability of infrastructure, unavailability of information, and the growth of informal recyclers.

The average of each inhibiting factor in each region and at the provincial level is above 3.5 and some are above 4.0. This result implies that the respondents tend to agree that the factors considered in this study are close to being able to inhibit collaborative intentions for handling used cell phones. In Gunungkidul Region, respondents admitted that the main inhibiting factor was insufficient organization (M=4.0). They agree that insufficient organization is the barrier factor for the collaborative intention to handle used cell phones. They feel that their internal organizational capabilities have not been able to support the collaborative activities. It is in line with the findings of Luo & Qi's (2020) [22] research in Pearl River Delta, Yeni & Teoman's (2022) [23] research in green transition of Turkey's agriculture, and Hren et al.'s (2021) [24] research in Ukraine ecotourism.

Meanwhile, in Bantul Region, the factor with the highest average score is the unavailability of the regulation (M=4.1). This finding shows that respondents agree that the unavailability of regulations that specifically regulate the management of used cell phones will hinder their intention to collaborate with formal actors. This barrier factor was also mentioned in green washing [31], sustainable development goals in Russia [32], and in Iranian construction sector [33]. Furthermore, in the Kulonprogo Region, the unavailability of information factor received the highest approval as an obstacle to the collaboration intentions of 4.2. With this value, it means that the respondents significantly agree that the unavailability of information regarding the mechanisms, benefits, and rules for managing used cell phones will hinder their desire to collaborate in handling used cell phones. This result also occurred in the use of renewable energy in food production [38], in the green market in China [39], in the production of recycled concrete aggregates [40], and in the promotion of green products [41].

Meanwhile, in Sleman Regency, five inhibiting factors: insufficient organization, financial limitation, unavailability of regulation, unavailability of infrastructure, and unavailability of information, were the obstacles to collaboration intentions (M>4.0). The respondents in Sleman Region really agreed that the five factors considered in this study can hinder their collaboration intentions. The financial limitation factor was also reported by previous researchers. Mell (2020) [29] also presented as the inhibitor in maintaining the green infrastructure in the United Kingdom, Ravi and Shankar (2017) [30] and Bouzon et al. (2018) [15] in implementing a reverse logistics program, Kumar and Dixit (2018) [25] in implementing WEEE management, Kumar & Dixit (2018) [26] in conducting e-waste management practices in India.

The analysis results reveal that among the inhibiting factors in the city of Yogyakarta, the unavailability of regulation is the highest (M = 3.96). Similarly, in Bantul Region, the unavailability of regulations, policies, and laws for handling used cell phones can prevent informal actors from collaborating.

The overall results at DIY Province show that the inhibiting factor with the highest mean is the unavailability of information (M = 4.2). This result is similar to Kulonprogo Region. Generally, the mean of external factors in the Special Region of Yogyakarta Province is higher internal factors. This finding indicates that second-hand mobile phone market actors in the DIY Province feel that external factors hinder collaboration intentions more than their perceived internal factors. These results can be used as a consideration for policy makers in the DIY Province to provide support for realizing the collaboration in e-waste management between informal and formal actors.

In addition, the results of the regression analysis, an analysis of the level of influence of inhibiting factors on collaboration intentions, show that the city of Yogyakarta and DIY Province have factors with a negative and significant effect on collaboration intentions. For the city of Yogyakarta, the unavailability of infrastructure significantly influences the collaboration intentions (b= -0.751, p=0.002), supporting H4. These results need to be the attention of policy makers regarding the environment in those regions. It is necessary to provide supporting facilities and infrastructure to encourage collaborative activities in handling used cell phones between informal and formal actors.

This study shows that the unavailability of infrastructure is a significant inhibiting factor affecting collaboration intentions. It is in line with the results of the Zhang & Wang (2014) [28] study, which revealed that the lack of infrastructure and mechanisms were the main barriers to collaborations on carbon emission reduction. Meanwhile, Kumar & Dixit (2018) [25, 26] found that the inadequate infrastructure factor was not the most dominant factor inhibiting the adoption of e-waste management in India.

In addition, data from all DIY Province show that the insufficient organization factor has a significant influence on the collaboration intention (b=0.241, p=0.071), supporting H1. This result indicated that the internal organizations of informal actors have not been able to support the intention of collaboration with formal actors in managing used cell phones. Informal actors usually have small and micro businesses, without an adequate organizational structure. More often, the owner also doubles as labour, so they do not have adequate resources to conduct collaborative activities with formal actors.

The results of the regression analysis in the DIY Province should be the concern for formal actors to provide managerial assistance to informal actors. Thus, collaborative activities are not hindered by the inability of the informal parties to work internally. In addition, assistance from formal parties can be a manifestation of corporate social responsibility.

The results also showed that insufficient organization is a significant inhibiting factor affecting collaboration intentions, in line with the results of research by Ghazilla et al. (2015) [16]. In his initial study on green manufacturing practices in Malaysian SMEs, it was found that the top critical barrier is a weak organizational structure. However, this results in contrast to Trianni et al. (2014) [21], showing that enterprises believe that external drivers are more important than internal ones. Insufficient organization is an internal factor. On the other hand, the results of Kumar and Dixit (2018) [25] and Kumar and Dixit (2018) [26] showed the insufficient organization in knowledge and technology barriers were the low-level obstacle. To strengthen the organization's ability to implement environmental activities, a workforce should be prepared with adequate skills [43].

Furthermore, the results of the analysis of the coefficient of determination (R^2) in each research area and the analysis at the provincial level reveal that the coefficient of determination is below 0.5. The ability of the inhibiting factors in this study to explain collaboration intentions does not reach 50%. Interestingly, the illegal e-waste recycling market in Brazil was also one of the barriers to implementing the e-waste reverse logistics system [44], so that the actions among stakeholders are similar to those in the Special Region of Yogyakarta Province.

Many other factors outside of this research may shape the collaborative intention of the informal actors. Hence, next research should include those factors. Furthermore, this research can be developed for other regions in Indonesia to generate more comprehensive results with a wider scope of analysis.

Generally, the study's findings can serve as a starting point for discussion among interested parties who may be handling e-waste, primarily smartphones in Indonesia, to minimize the bad impact of informal actors handling e-waste [45]. These findings can be used by the government to establish guidelines, disseminate knowledge, offer aid, and provide financing for the responsible disposal of used cell phones. The findings of this study can be used by formal actors, such as mobile phone manufacturers, to devise and advertise a program to accept used cell phones from consumers as a corporate social responsibility. If this measure is taken, the management of used cell phones by informal actors will not negatively impact health or the environment while remaining as income generators for these individuals.

5. Conclusion

The descriptive analysis of informal actors' responses shows that they intend to collaborate with formal actors in handling used cell phones (M = 3.744). The mean for each inhibiting factor indicates that informal actors tend to agree that these factors can hinder their intention to collaborate in handling used cell phones. The highest values of inhibiting factor for each region are insufficient organizations in Gunungkidul region, unavailability of regulation in Bantul region and Yogyakarta municipality, and unavailability of information in Kulonprogo region and DIY Province. For the Sleman region, all inhibiting factors are considered obstacles to collaboration intentions, except for the growth of informal recyclers.

The inhibiting factors significantly affecting the collaboration intentions are the unavailability of infrastructure in the Yogyakarta municipality and the insufficient organization in the analysis of all informal actors in the DIY Province. These results support H1 and H4. Meanwhile, the results of the regression analysis in other regions show no significant influence. Thus, the hypotheses of H2, H3, H5, and H6 are not supported in this research.

The analyses of the coefficients of determination in all research areas show that the ability of the inhibiting factors to explain collaboration intentions does not reach 50%, meaning there are other factors outside the study. The findings of this study can be taken into account by legislators in deciding how to treat e-waste, particularly used cell phones. Through partnerships with informal actors, formal actors can also use the study's findings to promote the initiative to take used smartphones from customers as corporate social responsibility.

6. Declarations

6.1. Author Contributions

Conceptualization, S.M.B. and I.Y.P.; methodology, S.M.B.; formal analysis, S.M.B; data curation, S.M.B.; writing—original draft preparation, S.M.B. and H.M.A.; writing—review and editing, S.M.B., I.Y.P., and H.M.A.; visualization, H.M.A.; supervision, I.Y.P; funding acquisition, S.M.B. All authors have read and agreed to the published version of the manuscript.

6.2. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

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6.5. Conflicts of Interest

The authors declare no conflict of interest.

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Appendix I

The results of the reliability and validity test of the research questionnaire:

		Gunungkidul Region[1]	Bantul Region[2]	Kulonprogo Region[3]	Sleman Region[4]	Yogyakarta Municipality[5]
	Collaboration intention	**Cronbach α 0.941**	**Cronbach α 0.852**	**Cronbach α 0.851**	**Cronbach α 0.852**	**Cronbach α 0.931**
		Correlated item –Total Correlation				
1	You intend to take part in the collaborative activity.	0.788	0.808	0.730	0.379	0.838
2	You will try to participate in the collaborative activity.	0.825	0.571	0.662	0.489	0.871
3	You plan to take part in the collaborative activity.	0.880	0.678	0.778	0.569	0.906
4	You are willing to participate in the collaborative activity.	0.916	0.813	0.676	0.434	0.922
5	You wish to participate in the collaborative activity.	0.789	0.660	0.444	0.471	0.913
	Insufficient organization	**Cronbach α 0.849**	**Cronbach α 0.601**	**Cronbach α 0.756**	**Cronbach α 0.542**	**Cronbach α 0.920**
		Correlated item –Total Correlation				
1	There is a perception that environmental conservation activities are outside the company's responsibility.	0.816	0.608	0.752	0.449	0.704
2	Lack of internal capacity to develop and implement environmental conservation activities.	0.749	0.558	0.609	0.774	0.927
3	Limited resources affect the organization's ability to adopt environmental conservation practices.	0.815	0.632	0.549	0.717	0.843
4	Lack of flexibility to switch from current practices to new practices that support environmental preservation.	0.765	0.639	0.741	0.668	0.838
5	Lack of awareness of business opportunities in implementing environmental conservation programs.	0.724	0.500	0.694	0.472	0.871
6	Lack of management commitment in environmental conservation activities	0.683	0.575	0.755	0.556	0.926
	Financial limitations	**Cronbach α 0.843**	**Cronbach α 0.681**	**Cronbach α 0.746**	**Cronbach α 0.601**	**Cronbach α 0.811**
		Correlated item –Total Correlation				
1	Limited internal financial resources for environmental conservation activities.	0.830	0.666	0.746	0.388	0.823
2	Difficulty in obtaining capital to initiate environmental conservation activities.	0.874	0.692	0.750	0.586	0.858
3	Return on investment in the implementation of environmental conservation activities takes a long time, while bank loan payments are short-term.	0.846	0.695	0.746	0.635	0.836
4	Lack of financial support from the government to start environmental conservation activities.	0.838	0.697	0.524	0.752	0.675
5	Reduced benefits when implementing environmental conservation activities.	0.537	0.620	0.759	0.693	0.594
	Unavailability of regulation	**Cronbach α 0.888**	**Cronbach α 0.663**	**Cronbach α 0.807**	**Cronbach α 0.644**	**Cronbach α 0.906**
		Correlated item –Total Correlation				
1	There are no specific rules and policies for collaborative handling of used mobile phones.	0.874	0.683	0.878	0.611	0.915
2	There is no support and guidance from the authorities for collaborative handling of used cell phones.	0.910	0.659	0.840	0.708	0.925
3	Lack of training or consultation provided by the government for collaborative handling of used mobile phones.	0.872	0.637	0.760	0.797	0.918
4	The absence of financial incentives and government policies in the application of collaborative handling of used cell phones.	0.817	0.839	0.726	0.657	0.817
	Unavailability of Infrastructure	**Cronbach α 0.857**	**Cronbach α 0.727**	**Cronbach α 0.777**	**Cronbach α 0.713**	**Cronbach α 0.831**
		Correlated item –Total Correlation				
1	There is no infrastructure available to support collaboration in handling used mobile phones.	0.760	0.730	0.573	0.616	0.858
2	There is no technology available to support collaboration in handling used cell phones.	0.869	0.819	0.874	0.720	0.785
3	There is no planning and forecasting mechanism for the rate of return of used cell phones.	0.905	0.620	0.753	0.841	0.837
4	There is no coordination or collaboration mechanism between partners for handling used cell phones.	0.826	0.785	0.863	0.741	0.813

	Unavailability of information	**Cronbach α 0.832**	**Cronbach α 0.757**	**Cronbach α 0.847**	**Cronbach α 0.680**	**Cronbach α 0.960**
		Correlated item –Total Correlation				
1	There is no information on the procedure for implementing collaborative handling of used cell phones.	0.863	0.493	0.637	0.629	0.923
2	There is no precise information available about the benefits of collaborative handling of used cell phones.	0.661	0.743	0.905	0.705	0.973
3	There is no information available about the rules for implementing collaboration in handling used mobile phones.	0.851	0.724	0.883	0.662	0.951
4	Information on the availability of sources of supply of used mobile phones is not yet available.	0.711	0.757	0.788	0.718	0.870
5	There is no information available regarding the demand for products resulting from the handling of used cell phones.	0.807	0.811	0.742	0.600	0.936
	The growth of informal recyclers	**Cronbach α 0.830**	**Cronbach α 0.606**	**Cronbach α 0.845**	**Cronbach α 0.613**	**Cronbach α 0.733**
		Correlated item –Total Correlation				
1	The growth of informal recyclers who process used cell phones.	0.893	0.893	0.806	0.659	0.785
2	There is a recycling process for used cell phones that do not have a permit to handle B3 waste (toxic and hazardous materials).	0.895	0.895	0.934	0.751	0.821
3	There is competition between the formal and informal sectors in handling used cell phones.	0.814	0.814	0.895	0.877	0.818

Note:

1. Validity test for the area of Yogyakarta City, Gunungkidul Regency, Kulonprogo Regency, and Sleman Regency (especially for the first factor, namely insufficient organization) using answers from 30 respondents. The validity test uses a 95% confidence level (α=5%) with degrees of freedom (df)=n-2, which means 30-2=28. Based on the level of confidence and degrees of freedom, the R table value is 0.3061, so the questionnaire item is said to be valid if the calculated r value is greater than r table and is positive.

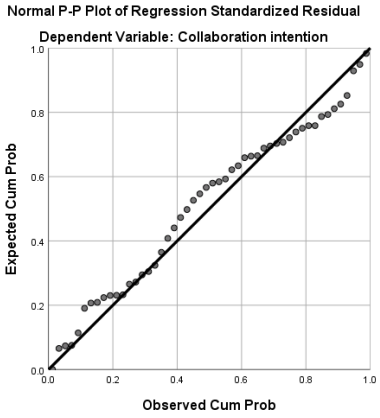
2. The validity test for the Bantul Regency area uses answers from 35 respondents. The validity test uses a 95% confidence level (α=5%) with degrees of freedom (df)=n-2, which means 35-2=33. Based on the level of confidence and degrees of freedom, the R table value is 0.2826, so the questionnaire item is said to be valid if the calculated r value is more than r table and is positive. With a note, specifically for the sixth factor, namely the growth of informal recyclers uses answers from 40 respondents. The validity test uses a 95% confidence level (α=5%) with degrees of freedom (df)=n-2, which means 40-2=38. Based on the level of confidence and degrees of freedom, the R table value is 0.2638, so the questionnaire item is said to be valid if the calculated r value is more than r table and is positive.

3. Validity test for the area of Sleman Regency using answers from 100 respondents. The validity test uses a 95% confidence level (α=5%) with degrees of freedom (df)=n-2, which means 100-2=98. Based on the level of confidence and degrees of freedom, the R table value is 0.1966, so the questionnaire item is said to be valid if the calculated r value is greater than r table and is positive. Especially for the first factor already written on the first note.

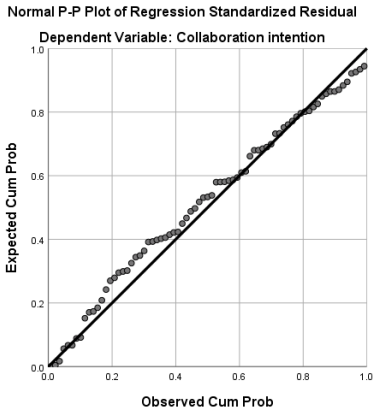
Appendix II. Classical Assumption Test Results

Normality Test Results

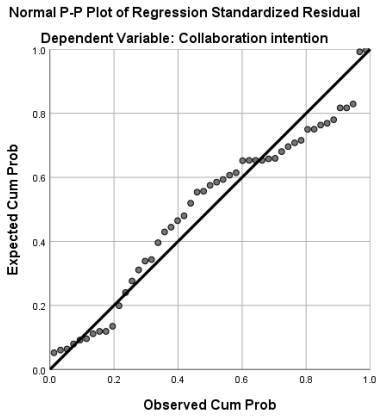
The results of the normality test are displayed in the form of a plot of residual data, which is shown in Figure A.1 and the results of the Kolmogorov-Smirnov test in Table A.1. From Figure A.1 it can be seen that the data plot is spread around the diagonal line, which means the model fulfill the assumption of normality. Moreover, from Table A.1 it is shown that the value of the Kolmogorov-Smirnov statistical test in the five research areas has a significance level greater than 0.05, so that the regression model in all regions meets the normality test.



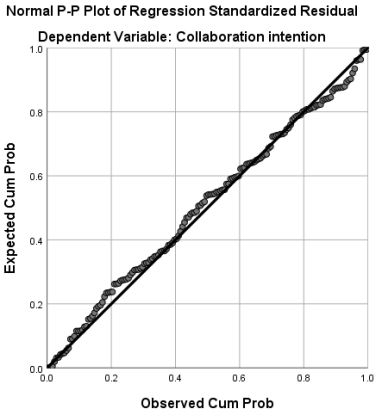
(a) Gunungkidul Regency



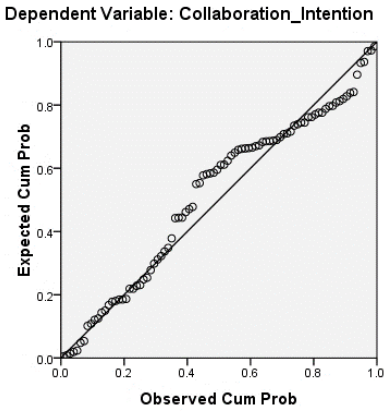
(b) Bantul Regency



(c) Kulonprogo Regency



(d) Sleman Regency



(e) Yogyakarta City

Figure A.1. Result of residual data plot from each region

Table A.1. Result of Kolmogorov-Smirnov test

One-Sample Kolmogorov-Smirnov Test

	Unstandardized Residual
Kolmogorov-Smirnov Z	0.091
Asymp. Sig. (2-tailed)	0.200

a. Test distribution is Normal; b. Calculated form data

(a) Gunungkidul Regency

One-Sample Kolmogorov-Smirnov Test

	Unstandardized Residual
Kolmogorov-Smirnov Z	0.800
Asymp. Sig. (2-tailed)	0.200

a. Test distribution is Normal; b. Calculated form data

(b) Bantul Regency

One-Sample Kolmogorov-Smirnov Test

	Unstandardized Residual
Kolmogorov-Smirnov Z	0.114
Asymp. Sig. (2-tailed)	0.139

a. Test distribution is Normal; b. Calculated form data

(c) Kulonprogo Regency

One-Sample Kolmogorov-Smirnov Test

	Unstandardized Residual
Kolmogorov-Smirnov Z	0.052
Asymp. Sig. (2-tailed)	0.200

a. Test distribution is Normal; b. Calculated form data

(d) Sleman Regency

One-Sample Kolmogorov-Smirnov Test

	Unstandardized Residual
Kolmogorov-Smirnov Z	1.290
Asymp. Sig. (2-tailed)	0.072

a. Test distribution is Normal; b. Calculated form data

(e) Yogyakarta City

Multicollinearity Test Results

The results of the multicollinearity test are presented in Table A.2. From the figure, it can be seen that the tolerance value for all variables is greater than 0.1 and the Variance Inflation Factor (VIF) value for all variables is less than 10, in all research areas. Thus, it can be concluded that there is no multicollinearity between the independent variables.

Table A.2. Result of multicollinearity test

(a) Gunungkidul Regency

Variable	Collinearity Statistics	
	Tolerance	VIF
Insufficient organization	0.465	2.150
Financial Limitations	0.356	2.808
Unavailability of Regulation	0.293	3.408
Unavailability of Infrastructure	0.269	3.712
Unavailability of Information	0.208	4.800
The Growth of Informal Recycler	0.388	2.579

(b) Bantul Regency

Variable	Collinearity Statistics	
	Tolerance	VIF
Insufficient organization	0.902	1.109
Financial Limitations	0.927	1.079
Unavailability of Regulation	0.818	1.222
Unavailability of Infrastructure	0.783	1.278
Unavailability of Information	0.853	1.172
The Growth of Informal Recycler	0.929	1.076

(c) Kulonprogo Regency

Variable	Collinearity Statistics	
	Tolerance	VIF
Insufficient organization	0.475	1.198
Financial Limitations	0.532	2.107
Unavailability of Regulation	0.351	2.851
Unavailability of Infrastructure	0.334	2.993
Unavailability of Information	0.327	3.060
The Growth of Informal Recycler	0.524	1.907

(d) Sleman Regency

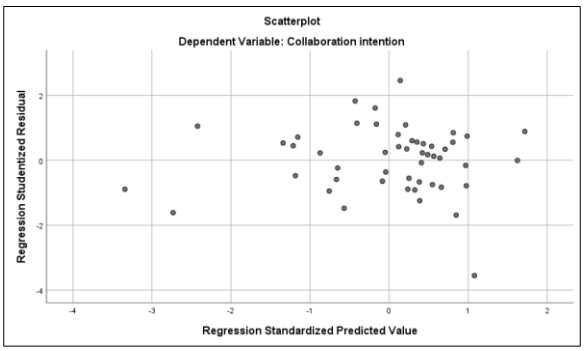
Variable	Collinearity Statistics	
	Tolerance	VIF
Insufficient organization	0.783	1.277
Financial Limitations	0.732	1.367
Unavailability of Regulation	0.737	1.356
Unavailability of Infrastructure	0.648	1.544
Unavailability of Information	0.720	1.389
The Growth of Informal Recycler	0.795	1.258

(e) Yogyakarta City

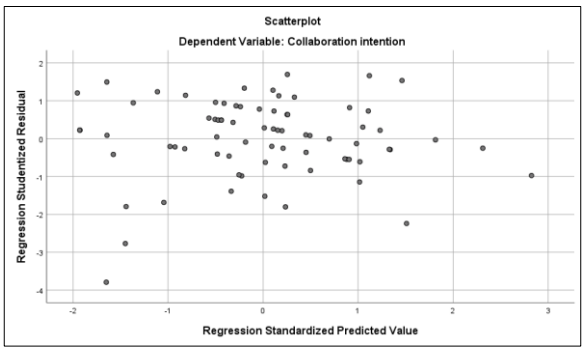
Variable	Collinearity Statistics	
	Tolerance	VIF
Insufficient organization	0.835	1.198
Financial Limitations	0.710	1.408
Unavailability of Regulation	0.334	2.991
Unavailability of Infrastructure	0.452	2.212
Unavailability of Information	0.651	1.536
The Growth of Informal Recycler	0.839	1.192

Heteroscedasticity Test Results

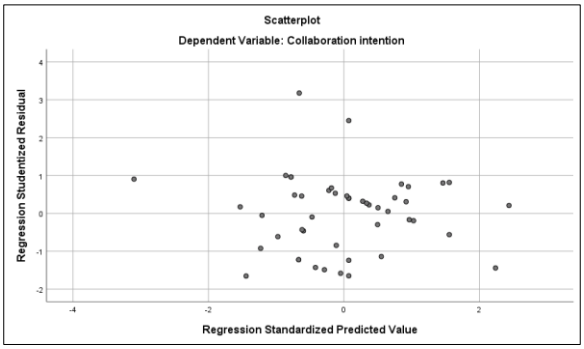
In this study, the heteroscedasticity test was carried out using the Park test. The results of the heteroscedasticity test are displayed in the form of a scatterplot which is presented in Figure A.2. From the figure, it can be seen that the points are scattered randomly above and below the number 0 (zero) on the Y axis and does not form a certain pattern. This means that there is no heteroscedasticity in the regression model.



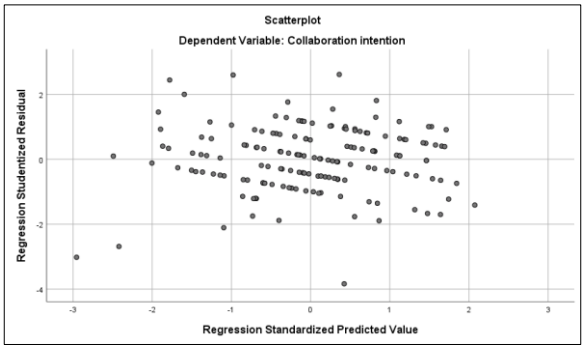
(a) Gunungkidul Regency



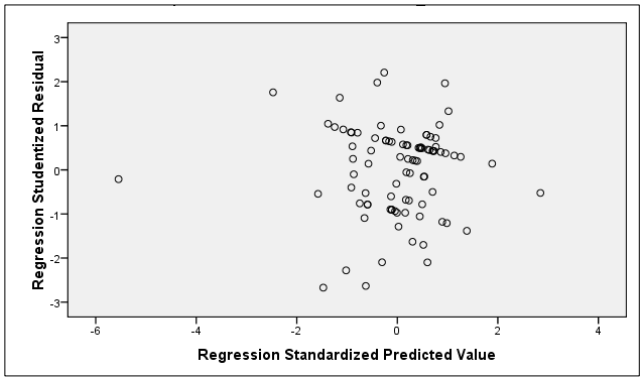
(b) Bantul Regency



(c) Kulonprogo Regency



(d) Sleman Regency



(e) Yogyakarta City

Figure A.2. Result of heteroscedasticity test