

The Influences of Internal Recycling Competencies and External Environmental Conditions on Urban Residents' Waste Classification and Recycling Behaviours: Based on the Mediating Effects of Classification and Recycling Intentions

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Waste classification and recycling behaviours of urban residents are important for waste recovery, reduction, and decontamination. Because residents' waste classification and recycling behaviours are influenced by several factors, this study developed a new waste classification and recycling influencing factor model. Based on 424 questionnaires collected from Shanghai residents, the influences of internal recycling competencies (i.e., waste classification skills and habits) and external environmental conditions (i.e., classification facilities and systems, reward and penalty measures for classification, and failure to safeguard classification achievements) on residents' classification and recycling behaviours were empirically tested. It was found that residents' classification and recycling skills and habits as well as government reward and penalty measures for classification had a significant positive effect on the residents' classification and recycling behaviours (0.159, $p < 0.01$; 0.241, $p < 0.01$ and 0.141, $p < 0.01$), and the failure to safeguard classification achievements had a significant negative influence on their classification and recycling behaviours (-0.106, $p < 0.05$). Residents' classification and recycling intentions were found to have a partial mediating effect on the relationship between waste classification skills and classification and recycling behaviours (0.572, $p < 0.01$); and a complete mediating effect on that between reward and penalty measures for classification and classification and recycling behaviours (0.577, $p < 0.01$). This research contributes to previous research by offering a new waste classification and recycling influencing factor model with a new and comprehensive empirical research result.

1. Introduction

While China's rapid economic and social development has significantly raised living standards, it has also resulted in a commensurate rise in urban household waste for consecutive years. The huge amount of waste has exerted tremendous pressure on social environments (Pham Phu et al., 2020). Recent data indicate that the proportion of wet waste in household food waste is over 50%. Such waste turns into organic fertilizer after fermentation, so if such a resource can be reused, it would reduce soil and underground water pollution and add greatly to social wealth (Zou et al., 2019). Waste classification is closely linked to whether waste decontamination, reduction, and recovery can be achieved (Sabki et al., 2019).

Research on the source separation of waste has gradually extended from the technical dimension to the personal psychological dimension, with the aim of finding the inherent law to guide residents to actively participate in household waste management activities. Most of the related studies conduct from the perspective of either individual socioeconomic variables or external stakeholders. For example, Botetzagias et al. (2015) found that gender, age, and education level significantly affect residents' waste classification and recycling intentions and that income has no influence on such intentions; Wang and Yang (2013) found that

environmental protection behaviours are by no means simply individual behaviours, but are also influenced by surrounding stakeholders and the classification and recycling atmosphere in communities.

Research on the classification and recycling of residential waste has achieved certain results, but the research on the influencing factors in waste classification still has the following inadequacies: (1) Past studies examine the direct influencing factors of waste classification and recycling behaviours from a single dimension and lack an examination of both internal recycling competencies and external environmental conditions dimensions. (2) Most studies have failed to consider the path through which internal and external factors act on waste classification and recycling behaviour by affecting residents' waste classification and recycling intentions. (3) Regarding the measurement of samples, as most studies measured variables using a single item, there could easily be bias in the results. The following questions arise: what then are the internal and external factors affecting residents' waste classification and recycling behaviour?; which factors exert influence on classification and recycling behaviours through affecting classification and recycling intentions? Based on these questions, a new residents' classification and recycling behaviour influencing factor model was constructed to investigate how internal recycling competencies (i.e., waste classification skills and habit) and external environmental conditions (i.e., classification facilities and systems, reward and penalty measures for classification, and safeguarding classification achievements) exert an influence on classification and recycling behaviours through affecting classification and recycling intentions.

2. Theoretical foundation and research hypotheses

2.1 Internal recycling competences and classification and recycling behaviour

Waste classification skills refer to the ability to identify common household waste and waste classification bins. In general, people are unwilling to accept demands that are more difficult. If they can accurately identify common household waste, waste classification becomes relatively simple, and they will be more inclined to classify waste. This paper puts forward the following hypothesis:

H1a: Residents' waste classification skills have a significant positive effect on their classification and recycling behaviours.

With more serious levels of environmental pollution and waste classification pilot sites in place, knowledge of waste classification and recycling has gradually spread among residents, resulting in a wider spread of waste classification habits. Once a habit is formed, it has a lasting effect. The cultivation of waste classification habits among residents will have a lasting influence on their own waste classification and recycling behaviours. The following hypothesis proposes:

H1b: Residents' waste classification habits have a significant positive effect on their classification and recycling behaviours.

2.2 External environmental conditions and classification and recycling behaviours

Waste classification facilities are the foundation that allows residents to begin their classification and recycling activities. The number of facilities and how easily the classification signs can be comprehended affect residents' waste classification and recycling intentions and behaviours. Bolderdijk et al. (2018) held that the implementation of government-led environmental policies and systems is an important force in commencing effective waste classification in cities. This leads to the following hypothesis:

H2a: Perfect waste classification facilities and systems have a significant positive effect on residents' classification and recycling behaviours.

Waste classification and recycling activities will provide extra time and space costs. Economic and emotional rewards will increase residents' enthusiasm for participating in waste classification and recycling. Levying extra fees on those who do not classify waste or recycle properly will have positive effects on residents' classification and recycling behaviours. This paper proposes the following hypotheses:

H2b: Necessary reward and penalty measures for residents' waste classification have a significant positive effect on their classification and recycling behaviours.

The classification achievements that residents become aware of are derived primarily from the classification and recycling behaviours of groups of neighbours and the waste-disposal behaviour of environmental sanitation workers after they collect waste. The negative classification and recycling behaviours among neighbours has unfavourable effects on residents' classification and recycling. Otherwise, environmental sanitation organizations mixing classified waste and transporting it will hurt the classification enthusiasm of residents inclined to classify waste and recycle. The hypothesis puts forward:

H2c: Failure to safeguard residents' waste classification achievements has a significant negative effect on their classification and recycling behaviours.

2.3 Mediating effects of classification and recycling intentions

The theory of planned behaviour states that personal attitudes, subjective norms, and perceived behavioural control affect the behavioural intentions of individuals, whose ultimate behaviours are shaped through influencing their behavioural intentions. Residents with greater internal recycling competencies, driven by their classification and recycling intentions, engage more in classification and recycling. In light of the above, this paper proposes the following hypotheses:

H3a: Classification and recycling intentions mediate the effects of waste classification skills on classification and recycling behaviours.

H3b: Classification and recycling intentions mediate the effects of waste classification habit on classification and recycling behaviours.

Whether residents adopt a certain behaviour depends on the strength of social pressure they feel in relation to it. With the increasing level of damage to the environment, now the government calls for waste classification, and residents gradually understand their individual classification and recycling habits can have a major impact, encouraging them to engage more actively in waste classification and recycling. Classification and recycling intentions play a bridging role in the relationship between the external environmental conditions and residents' waste classification and recycling behaviours. This paper proposes the following hypothesis:

H3c: Classification and recycling intentions mediate the effects of classification facilities and system on classification and recycling behaviours.

H3d: Classification and recycling intentions mediate the effects of reward and penalty measures on classification and recycling behaviours.

H3e: Classification and recycling intentions mediate the effects of failure to safeguard classification achievements on classification and recycling behaviours.

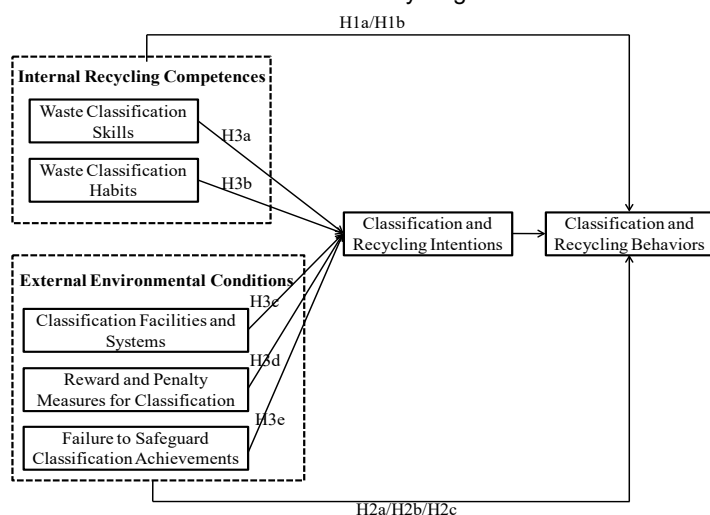


Figure 1: A conceptual model and research hypothesis

3. Research samples and measurement of variables

This study used a questionnaire survey to collect data through both online and offline means. The subjects were Shanghai residents and the period lasted from March to May 2019. 424 valid ones were collected at last.

3.1 Measurement of variables

Independent Variables: The measurement scale for internal recycling competencies was derived primarily from survey questions developed by Pakpour et al. (2014) and constructed a scale consisting of five survey questions, with answers on a 5-point Likert scale. The five questions were about the residents' degree of knowledge of waste classification, ability to identify waste bins, time availability, waste classification habit, and possession of classification tools. The measurement scale for the dimension of external environmental conditions relied mainly on the question items developed by Chung and Poon (1999). A scale with seven survey question items was formed, using a 7-point Likert scale. The selection of a 7-point scale was intended to reduce common method biases in the questionnaires. The seven survey question items covered the reasonableness of the number of waste bins available, installation of waste classification bins, implementation

of the classification system, penalty measures, implementation of rewards, neighbors' classification situation, and the backend classification process.

Mediating and Dependent Variables: The mediating variable was classification and recycling intentions. The scale items developed by Tonglet et al. (2004), which contained two items: residents' intention to accept the waste classification system and their intention to participate actively in waste classification. The dependent variable was classification and recycling behaviours, which developed by Ghani et al. (2013). For this variable, respondents indicated their subjective ratings on the item "I can usually do waste classification"; in addition, a reverse item, "I rarely perform waste classification" was included to identify and exclude invalid questionnaires. 5-point Likert scales were used for these variables.

Control Variables: The control variables included the respondents' gender, age, education level, nature of their residence (i.e., owned or rented) and personal monthly income.

3.2 Reliability and validity tests and test for common method biases

The overall alpha coefficient of the scale was 0.830. The removed alpha value of any indicator was lower than the overall alpha value (0.830), which means that all indicators must be preserved. The scale had good internal consistency and relatively good overall reliability. The correlation coefficient between waste classification skills and habits was 0.529, smaller than the internal consistency of these two variables measurements (0.762, 0.731), which is an indicator of good validity; the correlation coefficient between the three variables of classification facilities and system, reward and penalty measures for classification, and failure to safeguard classification achievements (-0.362, 0.480, -0.364) was far smaller than the internal consistency coefficient for each variable (0.788, 0.727, 0.723), also indicating validity.

The eigenvalue of the common factor with the greatest explanatory power was 4.142, which explained 34.516 % of the total variance. The problem of common factor biases were relatively small and could be ignored.

4. Empirical analysis

The correlation coefficient for each variable was smaller than 0.6, so the problem of multicollinearity did not exist. Control variables, which are not the focus of this research, are omitted in the following data analysis.

The regression results are provided in Table 1. Residents' waste classification skills had a significant positive effect on such behaviours ($\alpha = 0.159$; $p < 0.01$) and H1a is valid. Waste classification habits had a significant positive effect on such behaviours ($\alpha = 0.241$; $p < 0.01$), and H1b was confirmed. Classification facilities and systems had no significant effect on such behaviours, so H2a was not confirmed. Reward and penalty measures for classification had a significant positive effect on such behaviours ($\alpha = 0.141$; $p < 0.01$), so H2b is valid. H2c was confirmed because failure to safeguard classification achievements had a significant negative effect on classification and recycling behaviours ($\alpha = -0.106$; $p < 0.05$).

Table 1: Effects of internal and external factors on classification and recycling behaviours

	Variables	Classification and recycling behaviours
Internal Recycling	Waste classification skills	0.159***
Competences	Waste classification habits	0.241***
External Environmental	Classification facilities and systems	0.018
Conditions	Reward and penalty measures for classification	0.141***
	Failure to safeguard classification achievements	-0.106**
	R ²	0.195
	Adjusted R ²	0.145
	F value	3.867***

Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

To test the mediating effect of classification and recycling intentions between internal recycling competencies and classification and recycling behaviours, this research performed a test based on Baron and Kenny (1986) criteria. First, Table 1 shows that waste classification skills and habits were significantly positively correlated with classification and recycling behaviours, satisfying the first condition of the mediator test. Second, a test was performed on the significant correlation between the independent variables and the mediating variable. A regression analysis was conducted on the relationship between waste classification skills and habits and classification and recycling intentions; the results are shown in Table 2. Waste classification skills and such intentions were significantly positively correlated ($\alpha = 0.077$; $p < 0.05$), meeting the conditions of the mediator

test. The relationship between waste classification habit and such intentions was not significant, and so the test for a mediating effect was ended at this point; classification and recycling intentions had no mediating effect between waste classification habit and such behaviours, and so H3b could not be verified. Third, when tested the simultaneous regression of the independent and mediating variables, the effect of the mediating variable was significant. As Table 3 shows, after bringing in the mediating variable of classification and recycling intentions, the effect of waste classification and recycling skills on such behaviours decreased from 0.101 ($p < 0.05$) to 0.067 ($p < 0.1$), and the significance of classification and recycling intentions was 0.572 ($p < 0.01$), indicating that these intentions had a partial mediating effect between classification and recycling skills and such behaviours. H3a was verified.

A similar research process performed to test the mediating effect of classification and recycling intentions between external environmental conditions and classification and recycling behaviour. First, as indicated in Table 1, the effect of classification facilities and systems, on such behaviours was not significant, which failed to satisfy the first condition of mediating effect, and H3c was not confirmed. Both reward and penalty measures for classification and safeguarding classification achievements were significantly correlated with such behaviours. Second, a regression analysis was performed on the relationship between reward and penalty measures for classification and safeguarding classification achievements and such intentions; the results are shown in Table 2. The relationship between failure to safeguard classification achievements and such intentions was not significant, so the test for a mediating effect was ended at this point. It concluded that such intentions had no mediating effect between failure to safeguard classification achievements and such behaviours, so H3e could not be verified. Reward and penalty measures for classification did have a significant positive effect on such intentions ($\alpha = 0.103$; $p < 0.01$). Third, as shown in Table 3, after bringing in the mediating variable of such intentions, the effect of reward and penalty measures for classification on such behaviours changed from 0.075 ($p < 0.1$) to insignificant, and the significance of such intention was 0.577 ($p < 0.01$), indicating that such intentions had a complete mediating effect between reward and penalty measures for classification and such behaviours. H3d was verified.

Table 2: Effects of internal and external factors on waste classification and recycling intentions

	Variables	Classification and recycling intentions
Internal Recycling	Waste classification skills	0.077**
Competences	Waste classification habits	0.047
External Environmental	Classification facilities and systems	-0.036
Conditions	Reward and penalty measures for classification	0.103***
	Failure to safeguard classification achievements	0.042
	R ²	0.132
	Adjusted R ²	0.078
	F value	2.422***

Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 3: Test of the mediating effect of waste classification and recycling intentions

Variables	Dependent Variables	Dependent Variables	Dependent Variables	Dependent Variables
Independent variables				
Waste classification skills	0.101**	0.067*		
Reward and penalty measures for classification			0.075*	0.029
Mediating variable				
Classification and recycling intentions		0.572***		0.577***
R ²	0.129	0.277	0.124	0.272
Adjusted R ²	0.084	0.237	0.078	0.232
F value	2.835***	6.970***	2.702***	6.824***

Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

5. Conclusions

This study started from the perspectives of internal recycling competences and the external environmental conditions that affect residents' waste classification and made a comprehensive analysis of the mediating effects of residents' waste classification and recycling intentions between the factors influencing classification and recycling and such behaviours. Research conclusions are as follows: (1) Waste classification skills and habit have a significant positive effect on classification and recycling behaviours. (2) Government reward and penalty measures for classification have a significant positive effect on such behaviours. Failure to safeguard residents' classification achievements has a significant negative effect on such behaviours. Classification facilities and systems have no significant effect on such behaviours, which might be owing to the improved waste classification facilities in Shanghai so that their breakthrough effect is not significant. (3) Residents' waste classification and recycling intentions have a partial mediating effect on the relationship between their waste classification skills and such behaviours; and their such intention has a complete mediating effect on the relationship between reward and penalty measures for waste classification and such behaviours. Starting in 2019, all Chinese cities at the prefectural level and above initiated waste classification work. In this context, residents' source separation of household waste is an important link that affects such work. Based on these results, this paper makes several theoretical and management contributions.

This study is still inadequate regarding a few aspects, which can be improved through follow-up research. First, in the future, the sampling district should be enlarged to increase the generalizability of the research results. Second, further research can be conducted on the changes in the influencing factors in classification and recycling behaviors in different stages of development.

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