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Research paper

Trends of recycling management in Taiwan during 1999 – 2021

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Abstract

Purpose: Recycling is the process of converting waste materials into new materials and objects. It can prevent the waste useful materials and reduce the environmental pollution.
Approach: Using rates of recycling materials information during 1999 – 2021. We approached the trend of resource and recycling management in Taiwan.
Results: The years was significantly correlated with the recycling fund ($r = 0.82$, $p<0.05$) recycling rate of waste electronic and electric appliances ($r = 0.92$, $p<0.05$), waste containers ($r = 0.88$, $p<0.05$), waste lubricating oil ($r = 0.87$, $p<0.05$), waste information technology equipment ($r = 0.73$, $p<0.05$), waste dry cell batteries ($r = 0.73$, $p<0.05$), waste tires ($r = 0.66$, $p<0.05$), waste lead-acid batteries ($r = 0.59$, $p<0.05$), and waste lighting sources ($r = 0.52$, $p<0.05$) separately.
Conclusion: The relations of raters of recycling materials and the years were higher than the relations of recycling materials and the recycling fund. This feedback system including participating people, cleaning teams, recycling enterprises, and the recycling fund has encouraged nationwide participation.

Keywords: *Recycling Materials; Recycling Funds; Feedback System.*

1. Introduction

Recycling is a key component of modern waste reduction (Liening et al. 2017). It promotes environmental sustainability by removing raw material input and redirecting waste output in the economic system (Geissdoerfer et al. 2017).
The Recycling Fund Management Board (RFMB) has responsible for handling recyclable wastes, the recycling fee and income, counseling and managing recycling enterprises since 1998 in Taiwan[Environmental Protection Administration, Executive Yuan, R.O.C. 2022]. The RFMB divided recyclable materials into 9 kinds, such as waste electronic and electric appliances, waste containers, waste lubricating oil, waste information technology equipment, waste dry cell batteries, waste tires, waste lead-acid batteries, waste lighting sources, and scrap moto vehicles.
In order to prevent the waste of potentially useful materials and pollution. The environmental management control of recycling practice needs to be evaluated importantly.

2. Methods

Using rates of recycling materials information during 1999 – 2021 from RFMB. This study investigated the changes of recycling rates of 9 kinds of recyclable materials, and evaluated the feedback system that prevented the waste pollution. The correlation in the various groups were studied by Spearman's correlation model. The level of significance was set at 0.05.

3. Results

The years was significantly correlated with the recycling fund ($r = 0.82$, $p<0.05$), recycling rate of waste electronic and electric appliances ($r = 0.92$, $p<0.05$), waste containers ($r = 0.88$, $p<0.05$), waste lubricating oil ($r = 0.87$, $p<0.05$), waste information technology equipment ($r = 0.73$, $p<0.05$), waste dry cell batteries ($r = 0.73$, $p<0.05$), waste tires ($r = 0.66$, $p<0.05$), waste lead-acid batteries ($r = 0.59$, $p<0.05$), and waste lighting sources ($r = 0.52$, $p<0.05$) separately.
The recycling fund was significantly correlated with recycling rate of waste information technology equipment ($r = 0.83$, $p<0.05$), waste containers ($r = 0.64$, $p<0.05$), waste lead-acid batteries ($r = 0.63$, $p<0.05$), waste electronic and electric appliances ($r = 0.56$, $p<0.05$), and waste dry cell batteries ($r = 0.55$, $p<0.05$), separately (table1).
The means of recycling rates of the 9 kinds of recyclable materials during 1999 – 2021 by year interval are seen in table2. The means of recycling rates of recyclable materials in 1999 – 2006 were lower than that in 2007 – 2014, or in 2015 – 2021 almost. The means of

recycling rates of recyclable materials in 2007 – 2014 were lower than that in 2015 – 2021 almost. The trends of recycling rates of recyclable materials increased with the year interval. However, the recycling rates of waste dry cell batteries was lower than 50 % during 1999 – 2021.

Table1: The Spearman's Correlation Coefficient between Recycling Rates of Recyclable Materials and Years, and Recycling Fund During 1999 – 2021

Recyclable material	years	Recycling fund
waste electronic and electric appliances	0.92*	0.64*
waste containers	0.88*	0.56*
waste lubricating oil	0.87*	0.08
waste information technology equipment	0.73*	0.83*
waste dry cell batteries	0.73*	0.55*
waste tires	0.66*	0.41
waste lead-acid batteries	0.59*	0.63*
waste lighting sources	0.52*	0.32
scrap motor vehicles	0.22	0.24

*$p < 0.05$.

Table2: Estimated Means of Recycling Rates (%) During 1999 – 2021

Recyclable material	1999 – 2006	2007 – 2014	2015 – 2021
waste electronic and electric appliances	41.5	65.4	60.3
waste containers	45.8	72.0	74.0
waste lubricating oil	4.7	54.8	-
waste information technology equipment	38.9	40.6	57.7
waste dry cell batteries	17.1	45.8	47.1
waste tires	78.6	83.7	92.1
waste lead-acid batteries	72.5	73.2	90.0
waste lighting sources	39.9	96.1	95.1
scrap motor vehicles	75.1	67.8	85.9

4. Discussion

In the past 23 years, the recycling rates of the recyclable materials have increased due to the 4-in-1 recycling program promoted by the EPA since 1997. The relations of raters of recycling materials and the years were higher than the relations of recycling materials and the recycling fund [Environmental Protection Administration, Executive Yuan, and R.O.C. 2022]. For the reasons, the recycling has encouraged nationwide participation.

Most of the means of recycling rates of the recyclable materials were over 50 % after 2014. It indicated that the recycling rates in Taiwan has reached the level of recycling rates in Europe [European environment agency.2021]. However, the recycling rates of waste dry cell batteries was lower than 50 % during 2015 – 2021. It should be more improved.

5. Conclusion

Recycling rates of recyclable materials could be increased by 4-in-1 recycling program. The recycling rates of waste dry cell batteries should be more improved.

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