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A Structural Scale for the Factors of Waste Sensors and Transducers Recycling Based on Consumer Satisfaction

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Abstract: This article first introduced the research results of both domestic and foreign scholars on the factors of waste sensors and transducers recycling, and in consideration of the four main bodies in waste sensors and transducers recycling, 14 influencing indicators of waste sensors and transducers recycling are extracted. Then this paper designed a questionnaire according to the 15 indicators of waste home appliance recycling, and put it on a research website. After verification of reliability and validity of the questionnaire, this paper analyzed the influencing factors of waste sensors and transducers recycling by using SPSS 13.0. Finally this article used factor analysis method to identify the representative factors. Two factors are concluded: Factor 1 mainly represents laws and regulations of government, governmental subsidy, governmental technology support, governmental market guidance, governmental monitor and control, recycling knowledge publication by government, social responsibilities of producers and recyclers, technique disposition ability of producers and recyclers, recyclers' service, therefore it could be summarized as government and enterprise disposition capability; while Factor 2 mainly represents consumers' benefit from recycling, convenience of consumers' recycling, mental satisfaction of consumers from recycling, consumers' recycling knowledge, social recycling environment, and thus they could be summarized as consumer incentive factor. This paper would provide some references for the analysis and research on influencing factors of waste sensors and transducers recycling.

Keywords: Sensors and transducers, Waste sensors and transducers recycling, Recycling factors, Data analysis.

1. Introduction

In recent years, transducers and sensors technique developed quickly with the improvements of information technology and computer science. According to Wikipedia, a transducer is a device that converts a signal in one form of energy to another form of energy. Energy types include (but are not limited to) electrical, mechanical, electromagnetic (including light), chemical, acoustic or thermal energy. While the term transducer commonly implies the use of a sensor/detector, any device which converts energy can be considered a transducer. Transducers are widely used in measuring instruments. In addition, a sensor is used to detect a parameter in one form and report it in another form of energy, often an electrical signal. For example, a pressure sensor might detect pressure (a mechanical form of energy) and convert it to electricity for display at a remote gauge.

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Sensors and transducers are widely used in many industries now. However, the recycling of them is becoming more and more important as the quantity is increasing plus the pressure of environmental protection. This paper designed a questionnaire after literature review process, by which we got a specific data of what factors influence sensors and transducers recycling satisfaction most from the view of consumers. Furthermore, we would also use factor reduction method to conclude a scale for the evaluation of waste sensors and transducers evaluation.

2. Literature Review and Design

Resource recycling is a necessary part of its life circle, especially for sensors and transducers. Although there are little influential literatures about the recycling of waste sensors and transducers now, we still could got some illustration from the recycling of other waste appliances, for there are many common factors that would influence the recycling. A. Michael Knemeyer, Thomas G. Ponzurick, etc. (2002) pointed out that the factors affecting the waste computer recovery include external and internal ones. External factors include competition and regulatory factors, internal factors include the identification and purchasing factors, specifically including input, regulations, output and competition, the input is the possibility of supply of product suppliers, regulations refers to the government and other external organizations' supervising, output is the market demand of the refurbished computer, competition is the ability to compete with other departments; external factors refer to strategic factors and operational factors, strategic factors refer to the cost of the equipment, the cost of workers and the costs of new warehouse, operational factors include cost-benefit analysis, transportation, warehousing, supply management, packaging and refurbishment and recycling, etc. [1]. Richard Ciocci, Michael Pecht (2006) investigated the electronic industry 's response on environmental legislation, that environmental legislation, energy consumption, environmental design, process all the activities have impact on e-business [2]. Felix T.S. Chan, Hing Kai Chan (2008) investigated the mobile phone enterprise. The survey showed that the loyalty of customers and the operating costs were the major factors of cell phone recycle [3]. G.T.S. Ho, K. L Choy, etc. (2012) pointed out that the factors impacting the returned logistics implementing were financial factors, human resources, fixed assets and the corporate partnership with other departments, etc. [4]. In China, Wang Geng (2002) aiming at the elimination of a large number of waste household appliances, extended service time, second-hand market turmoil status quo, discusses the legislative issues of the waste appliances recycling [5]. Du Gang (2005) pointed out that besides the key technology applied in waste home appliances recycling, facilities planning and layout of the recycling plant are also crucial factors [6]. Zhou Liping (2006) pointed out the importance of the technology used in household appliances recycling, demolition technology in the recycling system and evaluated its demolition processing path on the basis of economic indicators, pointing out the factors affecting waste home appliances recycling include the cost of related raw materials, the price of waste home appliances, the revenue, the technical and financial support of government for the production companies and recycling/processing enterprise, etc. [7]. Wang Yaping (2010) who has studied the key technologies used in household appliances recycling demolition, hold the idea that removal treatment technology, sustainable development of enterprises, social resources, efficient use of energy and environmental protection all affect the recovery of waste household appliances [8].

Based on the above analyses, we could summarize 15 indicators that influence waste sensors and transducers recycling satisfaction, which are shown in Table 1.

Table 1. Waste sensors and transducers recycling satisfaction factors.

Consumers	Government	Producers and recyclers
Consumers' benefit from recycling	Laws and regulations of government	Social responsibilities of producers and recyclers
Convenience of consumers' recycling	Governmental subsidy	Technique disposition ability of producers and recyclers
Mental satisfaction of consumers from recycling	Governmental technology support	Recyclers' service
Consumers' recycling knowledge	Governmental market guidance	
Consumers' recycling knowledge	Governmental market guidance	
Social recycling environment	Governmental monitor and control	
	Recycling knowledge publication by government	

Then, we designed a questionnaire with the 14 indicators. The scale we used is Likert 7 level, from strong dissatisfaction to strong satisfaction. We also added the information of age, gender, education background and residence to get a better analysis of the fillers. Besides, we also set an item to measure the entire satisfaction degree of waste sensors and transducers of fillers to evaluate the overall satisfaction degree.

3. Data Collection and Analyses

We put the questionnaire on a survey website to collect the opinions of sensors and transducers consumers. 134 valid questionnaires were collected in a month. Then, we put the data into SPSS 13.0 to make further analyses. First, reliability of the questionnaire should be judged. According to the run result of SPSS software, reliability statistics is shown in Table 2 as below.

According to Table 2, Cronbach's Alpha is equal to 0.960, far bigger than 0.7, which indicates that this questionnaire is with good reliability.

Item to total statistics is shown in Table 3 as below.

Table 2. Reliability Statistics.

Cronbach's Alpha	N of Items
0.960	14

Table 3. Item-Total Statistics.

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Consumers' benefit from recycling	44.4254	325.404	0.680	0.959
Convenience of consumers' recycling	44.5746	325.058	0.701	0.959
Mental satisfaction of consumers from recycling	43.9851	326.646	0.672	0.959
Consumers' recycling knowledge	44.5000	321.966	0.786	0.957
Social recycling environment	44.6866	316.232	0.824	0.956
Laws and regulations of government	44.5224	320.236	0.842	0.956
Governmental subsidy	44.6119	318.946	0.849	0.956
Governmental technology support	44.5597	318.278	0.808	0.956
Governmental market guidance	44.5000	318.643	0.835	0.956
Governmental monitor and control	44.7090	321.426	0.827	0.956
Recycling knowledge publication by government	44.4776	319.981	0.818	0.956
Social responsibilities of producers and recyclers	44.5672	319.977	0.769	0.957
Technique disposition ability of producers and recyclers	44.7612	323.777	0.781	0.957
Recyclers' service	44.3433	327.581	0.716	0.958

From Table 3 we could find that the corrected item-total correlation of all the 14 indicators are bigger than 0.6. What is more, Cronbach's Alpha if Item Deleted of the 14 indicators are all bigger than 0.95. Consequently, this questionnaire is with good validity.

Then, we analyzed the descriptive statistics of the 14 indicators, which is shown in table 4 as below.

Table 4. Descriptive Statistics.

	N	Minimum	Maximum	Mean	Std. Deviation
Consumers' benefit from recycling	134	1.00	7.00	3.5149	1.77169
Convenience of consumers' recycling	134	1.00	7.00	3.3657	1.73656
Mental satisfaction of consumers from recycling	134	1.00	7.00	3.9552	1.74229
Consumers' recycling knowledge	134	1.00	7.00	3.4403	1.67472
Social recycling environment	134	1.00	7.00	3.2537	1.79258
Laws and regulations of government	134	1.00	7.00	3.4179	1.62822
Governmental subsidy	134	1.00	7.00	3.3284	1.65786
Governmental technology support	134	1.00	7.00	3.3806	1.75488
Governmental market guidance	134	1.00	7.00	3.4403	1.69258
Governmental monitor and control	134	1.00	7.00	3.2313	1.61717
Recycling knowledge publication by government	134	1.00	7.00	3.4627	1.67985
Social responsibilities of producers and recyclers	134	1.00	7.00	3.3731	1.77566
Technique disposition ability of producers and recyclers	134	1.00	7.00	3.1791	1.62152
Recyclers' service	134	1.00	7.00	3.5970	1.61347
Valid N (list wise)	134				

According to Table 4 we could find that consumers are not satisfactory with the recycling of waste sensors and transducers. All the satisfaction index is between 3 and 4, while even if the medium satisfaction degree is equal to 4. This also signifies the importance of waste sensors and transducers recycling.

In order to classify the 14 indicators, we used the popular data analysis method. When using data analysis method, one thing we should do first is to test the correlation of the items. KMO and Bartlett's Test results are shown in Table 5.

Table 5. KMO and Bartlett's Test.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.930
Bartlett's Test of Sphericity	Approx. Chi-Square	1935.061
	df	91
	Sig.	0.000

From Table 5 we could know that Kaiser-Meyer-Olkin Measure of Sampling Adequacy is equal to 0.930, far bigger than 0.5. Besides, the significance test of Bartlett's Test of Sphericity is equal to 0.000. All these information shows that the 13 items are fit for data analysis. Using principal components method and varirmax rotation, we could extract 2 factors, which are show in Table 6.

From Table 6 we could find that 75.931 % of the total variance is explained and 2 factors are extracted. As 75.931 % of the total variance is bigger than 70 %, this extraction is valid. Then we should take a look at the rotated component matrix, which are shown in Table 7 as below.

Table 6. Total Variance Explained.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.284	66.312	66.312	9.284	66.312	66.312	6.311	45.078	45.078
2	1.347	9.619	75.931	1.347	9.619	75.931	4.319	30.853	75.931
3	0.723	5.166	81.097						
4	0.539	3.850	84.947						
5	0.444	3.168	88.116						
6	0.326	2.329	90.445						
7	0.272	1.943	92.388						
8	0.213	1.524	93.912						
9	0.198	1.411	95.323						
10	0.172	1.226	96.549						
11	0.156	1.113	97.662						
12	0.144	1.027	98.690						
13	0.105	0.749	99.439						
14	0.079	0.561	100.000						
Extraction Method: Principal Component Analysis.									

Table 7. Rotated Component Matrix.

	Component	
	1	2
Consumers' benefit from recycling	0.328	0.745
Convenience of consumers' recycling	0.252	0.867
Mental satisfaction of consumers from recycling	0.214	0.871
Consumers' recycling knowledge	0.467	0.724
Social recycling environment	0.534	0.697
Laws and regulations of government	0.698	0.520
Governmental subsidy	0.759	0.455
Governmental technology support	0.696	0.477
Governmental market guidance	0.890	0.272
Governmental monitor and control	0.878	0.276
Recycling knowledge publication by government	0.876	0.265
Social responsibilities of producers and recyclers	0.722	0.382
Technique disposition ability of producers and recyclers	0.823	0.274
Recyclers' service	0.718	0.310
Extraction Method: Principal Component Analysis.		
a. Rotation converged in 3 iterations.		

From Table 7 we could find that Factor 1 mainly represents laws and regulations of government, governmental subsidy, governmental technology support, governmental market guidance, governmental monitor and control, recycling knowledge publication by government, social responsibilities of producers and recyclers, technique disposition ability of producers and recyclers, recyclers' service, therefore it could be summarized as government and enterprise disposition capability; while Factor 2 mainly represents consumers' benefit from recycling, convenience of consumers' recycling, mental satisfaction of consumers from recycling, consumers' recycling knowledge, social recycling environment, and thus they could be summarized as consumer incentive factor.

4. Conclusions

This paper followed a scientific research method and made some investigations on the recycling of waste sensors and transducers. With literature review, this paper designed a questionnaire and collected the corresponding data. The result of this paper shows that there are two kinds of factors that would influence the waste sensors and transducers recycling satisfaction. Factor 1 mainly represents laws and regulations of government, governmental subsidy, governmental technology support, governmental market guidance, governmental monitor and control, recycling knowledge publication by government, social responsibilities of producers and recyclers, technique disposition ability of producers and recyclers, recyclers' service, therefore it could be summarized as government and enterprise disposition capability; while Factor 2 mainly represents consumers' benefit from recycling, convenience of consumers' recycling, mental satisfaction of consumers from recycling, consumers' recycling knowledge, social recycling environment, and thus they could be summarized as consumer incentive factor.

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