Research on the Recycling Model of Waste Mobile Phone Based on System Dynamics

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Abstract. Mobile phone replacement is accelerating, the waste of mobile phone will not only cause a lot of waste of resources, after the simple landfill, the heavy metal infiltration into the soil, rivers and groundwater, but also soil and water pollution, bring serious harm to the animals and plants in contact with the soil and water. Efficient and standardized recycling of increasingly used mobile phones has become an urgent social problem to be solved. The emergence and continuous improvement of "Internte plus" recycling mode of used mobile phones make it possible to solve this problem. On the various influence factors of recovery efficiency, and their relations on the basis of the analysis of building "Internte plus" old cell phone recycling model of system dynamics model, using Vensim software to draw causal loop diagram and in view of the old cell phone recycling price, information security and logistics cost effect on the recovery mode efficiency is analyzed. Research shows that information security is the most important factor affecting the efficiency of "Internte plus" waste mobile phone recycling model.

1. Introduction

With the prosperity of the global electronic communication industry, the consumption of electronic information products, mainly mobile phones, is increasing day by day, and the replacement speed is obviously accelerating, leading to a surge in the number of used mobile phones. China's e-waste pollution is so widespread that the recycling rate is negligible.

While enjoying social development and technological progress, people have also produced a lot of old mobile phones. As the world's largest consumer of mobile phones, the number of mobile users in the world is 7.74 billion in 2017, and China's mobile phone penetration rate is consistent with global growth rate, with an estimated 800 million mobile phones in China in 2017. The development of the mobile phone's function and technology, which causes the mobile phone to be updated for 18 months, and the fact that a lot of the old phones and their parts are illegally entered our country every year, and are processed in the small business of the wrong rules. The recycling of plastic, precious metals and rare metals, which have a recirculation value, "urban mining" is more successful than the original mining, and the improper disposal of the post-abandoned treatment can cause great environmental pressure and waste of resources. In our country, we have not yet formed a reasonable scientific recycling system for recycling, so it is necessary to build the reverse supply chain of the old phone, choose the right recycling mode and use it in practice, which will produce good environmental and economic benefits.
2. Literature review
Domestic and foreign researches on recycling and reverse supply chain of used mobile phones mainly include: Ongondo Williams (2011) [2] studied the information, products and incentive mechanism of voluntary mobile phone network recycling in the UK, evaluated the mechanism, and put forward relevant Suggestions on improving recycling management of used mobile phones. Georges (2014) [3] used system dynamics to study the competitive transition inertia of recycling and remanufacturing supply chains. Diouf (2015) [4] et al studied the method of using mobile phone batteries to generate electricity. Lai (2012) [5] studied the recycling of precious metals in waste mobile phones. Saeed (2013) [6] used system dynamics to study the optimization model of e-waste recycling and treatment.

Guo bin et al. (2013) used the consumption and use model to calculate the waste mobile phone production volume in China from 2005 to 2011. The results showed that the waste mobile phone production volume in China was huge and showed a rapid growth trend year by year. Zheng xiujun et al. (2014) proposed the recycling model of waste mobile phones in China based on the current situation of recycling waste mobile phones in China, the European Union and Japan, and based on the basic characteristics of low input, low consumption, low emissions and high efficiency of recycling economy. YIN et al and SARATH et al pointed out that consumer recycling behavior is the key to affect the recycling efficiency of waste mobile phones. On this basis, this study USES the system dynamics method to analyze the impact of the recovery price of waste mobile phones, information security and recovery logistics cost on the efficiency of "Internte plus" waste mobile phone recovery model, and puts forward effective countermeasures for the improvement of the efficiency of this model.

3. Model Building
"Internte plus" old cell phone recycling mode on the one hand, by the structural elements of model itself (such as price, logistics cost and recycling subsidies, etc.), on the other hand the traditional model of discarded mobile phones (such as the individual recycler quantity, price, etc.), in addition to the total consumer mobile phones change frequency, waste such as environmental factors. According to relevant research results, the building factors of the system dynamics model of "Internte plus" waste mobile phone recycling mode can be determined, as shown in table 1.

| Type                        | Variable                                                                 |
|-----------------------------|--------------------------------------------------------------------------|
| "Internte plus" recycling   | The number of "Internte plus" recycling sites                           |
|                             | "Internte plus" recycling price                                          |
|                             | The number of "Internte plus" recycled mobile phones                     |
|                             | Average logistics cost invested by "Internte plus" recyclers             |
|                             | Average cost of information security invested by "Internte plus" recyclers|
|                             | The price gap between "Internte plus" recyclers and individual recyclers  |
|                             | The recycling price of each used mobile phone after disassembly          |
|                             | Other factors influence the recovery price of "Internte plus"            |
|                             | The average number of old mobile phones recycled per site per year        |
| Traditional individual recovery | Number of individual recyclers                                           |
|                             | Individual recovery price                                                |
|                             | The number of discarded mobile phones recycled by individuals            |
|                             | The average unit of individual recyclers recycled the number of used     |
|                             | mobile phones every year                                                 |
| Other factors               | The number of mobile phones that consumers are using in their homes      |
|                             | The number of new phones consumers buy                                   |
|                             | Mobile phone replacement speed                                           |
|                             | The number of used mobile phones in consumers' homes                     |
|                             | The average life of a cell phone                                          |
Based on the above analysis, the causal loop diagram of the system dynamics model of "Internetes plus" waste mobile phone recycling mode is constructed. The causal loop diagram is used to describe the feedback relationship between variables. The positive sign at the arrow indicates that the variable pointed by the arrow will increase with the increase of the arrowhead source variable, while the negative sign indicates that the variable pointed by the arrow will decrease with the increase of the arrowhead source variable. Vensim, a system dynamics simulation software, can be used to draw the causal circuit diagram of "Internetes plus" waste mobile phone recovery mode, and the result is shown in figure 1.

Figure 1. Causal loop diagram of "Internetes plus" waste mobile phone recycling mode.

4. The qualitative analysis
According to figure 1, in the vensim software, the "Internetes plus" recovery, traditional personal recovery, other factors are mainly affected by the factors, and the feedback loop analysis is carried out in the above 3 categories, including the key feedback loop:

1. the number of "Internetes plus" recycling waste mobile phones →+ the price of individual recycling →+ the difference between the price of individual recycling and "Internetes plus" recycling →+ the average number of waste mobile phones recycled by each website every year →+ the number of "Internetes plus" recycling waste mobile phones. The feedback loop indicates that the higher the quantity of "Internetes plus" recycling waste mobile phones, the higher the individual recycling price, and the larger the difference between individual recycling and "Internetes plus" recycling price, resulting in an increase in the quantity of "Internetes plus" recycling waste mobile phones.

2. the number of people who recycle used mobile phones is the number of people who are investing in the information security of the "Internetes plus" recycler, and the number of used mobile phones that each site is recycled every year is a number of "Internetes plus" recycling of used phones - the number of people who recycle the used phones. The feedback ring indicates that the number of people who recycle the old phones, the "Internet plus" recycling chamber of commerce, will increase the cost of information security, attract more consumers to invest in used mobile phones to improve
the recycling rate, and the amount of people who recycle the waste mobile phones will be reduced when the number of used phones must be.

(3) the quantity of waste mobile phones recovered by individuals $\rightarrow+$ the average logistics cost invested by "Internte plus" recyclers $\rightarrow+$ the average quantity of waste mobile phones recovered by each website every year $\rightarrow+$ the quantity of waste mobile phones recovered by "Internte plus" $\rightarrow$ the number of discarded mobile phones recycled by individuals. The feedback loop indicates that the more waste mobile phones are recycled by individuals, the more logistics costs will be invested by "Internte plus" recyclers to increase the amount of recycling, and the number of waste mobile phones will be correspondingly reduced.

The causal loop diagram includes not only positive and negative feedback loops, but also variables that do not participate in the formation of the feedback loop, which together with other variables form a causal chain. For example, the average service life of mobile phones $\rightarrow -$mobile phone replacement rate $\rightarrow+$ the number of waste mobile phones in consumers' homes, indicating that the longer the average service life of mobile phones is, the lower the replacement rate of mobile phones is, and the fewer consumers have used mobile phones.

5. Conclusion

According to relevant research, in the process of "Internet plus" recycling mode of recycling, consumers are considering recycling price, information security and logistics cost 3 factors. The effect of 3 factors on mode operation efficiency is discussed.

In the process of "Internet plus" recycling mode, the recycling price of used mobile phones is mainly influenced by the market average price of mobile phone manufacturing materials, the performance of old mobile phones and the subsidy of recovery. At present, the state has no subsidies, but with the standardization of recycling, the implementation of the recovery fund and the implementation of the subsidy policy will be the future development trend.

In mobile phone information security, consumers worried about old cell phone information leakage resulting in their old cell phone recycling pattern recognition degree is low, therefore, the development is used to eliminate information technology should be promote discarded mobile phones so as to achieve the main factors of green ecological consumption, therefore, "Internte plus" recyclers should increase investment in mobile phone information security, establish a good reputation and reputation, won the consumer trust.

As the logistics cost invested by "Internte plus" recyclers keeps increasing, the logistics cost borne by consumers will decrease, which stimulates the desire of consumers to take the initiative to recycle waste mobile phones, resulting in an increasing trend of mobile phone recycling volume of "Internte plus" recyclers. It is suggested that "Internte plus" recyclers cooperate with logistics companies or take door-to-door pick-up to reduce the logistics cost of mobile phone recycling while reducing or reducing the logistics cost of consumers, so as to improve the efficiency of "Internte plus" waste mobile phone recycling mode.

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