

# Urban Mining Service Design: Roadmap for Recycling Industry Transformation

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**Abstract**—Current recycling industry must facing emerging challenges especially for rapid growth of public-welfare and environmental protection concepts. Although various participants have different ideas for improving our living environment, but these participants from society could become the most useful collaborator for improving the recycling industry. In this paper, an innovative recycling service application is proposed that highlights sharing the value for better utilization within the recycling industry. The new recycling service model is grounded from the service innovation ideas that emphasis on the prosocial behaviors and the massive participations of the entire society member. We introduce the service as well as its design concepts, followed by analyzing the challenges for promotion public-welfare service. In this paper, we concentrate on discovering what is the internal key factors that influence their decision and how the psychologically factors from the recycling service participants could encourage all urban participants to share their love and passion to improve their living environment and their spiritual satisfaction. Several critical service development issues are generated from multiple case studies, which provide the cues for future urban mining service design and supporting information system development.

**Index Terms**—urban mining, recycling ecosystem, ICT-enabled service design

## I. INTRODUCTION TO URBAN MINING

The recycling industries in Taiwan are facing the emerging challenges to balance between environmental protection and industrial development. With the intensive growth of various industries, unwanted or undesired waste material also growth rapidly. The same issue also comes to our living space. Handling our living waste becomes the important power that raised the recycling service industry. The term “Urban Mining” refers to transform the trash to treasure. Urban mining is planned to find solutions for transfer various materials in garbage to useful resources. Usually, the recycling industry

involves both public and private sectors to form an ecosystem to enable recycling service that brings values to the ecosystem. Traditional recycling industry usually focus on the utility issue that how to transfer trash to treasure and improve its performance. The general idea is to maximize the economical benefits for the company. However, many issues such as labor oppress and exploit usually happened in current ecosystem, which is awaiting for better solution to solve the unbalanced service design. In practices, current recycling ecosystem exist many conflict for collecting the recyclable resources. We could like to know, if the economically value distribution is the only solution to guide the future development of recycling industry? If there is a better solution that could reorganize the benefits within the recycling ecosystem, what would be the core issues for transforming current recycling service into the new era?

The human decision involves complex factors and context information to decide their behaviors. Exploring the core incentives for encouraging participants to contribute to public welfare is an important issue for operating current recycling industry. Although innovative recycling service model could facilitates various collaborations between participants. The service design also reshapes the value distributions for better utilization. But this transformation involves the benefits for all participants. To understand how each role within the recycling ecosystem think about the urban mining service innovation, we utilize in-depth interview to explore the challenge issues between recycling ecosystem members. How participants’ internal thoughts about recycling ecosystem transformation could be the critical issues for developing and managing this service innovation. Since the proposed innovative service model for recycling industry enables participants to share their love and passion to the environmental protection as well as public welfare. In the following sections, we would like to understand the existing challenges from current recycling ecosystem member’s perspectives.

The remaining paragraphs are organized as follows. In section 2, we introduce the context of current recycling industry and highlight how the proposed service innovation could enhance the fairness for current recycling industry. In section 3, we investigate multiple

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case studies to explore the challenges for each role within the recycling ecosystem. The thesis-and-antithesis analysis of these challenges regarding these issues is planned in section 4. Finally, discussion and conclusion remarks are organized in section 5.

## II. CURRENT URBAN MINING SERVICE DESIGN

### A. Taiwan's Current Recycling Industry

Urban mining service is one of the emerging recycling industry that focus on the recyclable items such as Electronic waste (i.e. Old PC, CRT monitors, PCB.) or other production waste that contains valuable materials. The operation of urban mining service is similar to current recycling ecosystem that requires different level's participants that collaborate together to accomplish certain goal.

Current recycling ecosystem contains four types of participant roles, including scavengers, small and medium size of collecting and processing company, and the recycling manufacturing company. According to Yang [3], there exist four types of relationship within Taiwan's recycle ecosystem. The relationships between recycling ecosystem are illustrated in Figure 1. Dependent relationships are the major links that exist between various layers within the ecosystem. The bottom layer is the scavengers, which is one of the major channels to collecting various recyclable wastes. Scavengers provide their collections to those collecting and processing companies, and these companies act as the source for providing classified recycle materials to recycled manufacturing company. There exist mutualism relationships between scavengers and small & medium size of collecting and processing companies. Scavengers are the alternative channels for these companies to get recycled items. Although scavengers may not get fair profit owing to the unstable volume of recycled items, but these collecting & processing company are the major channel for scavenger to redeem the recycled items to cash. Sometimes the scavengers and the collecting and processing companies are dependent on each other, and exists the mutualism relationship owing to the economic scale limitation. However, exploitive relationship do exists between the top of the pyramid with their lower layers. Since recycled manufacturing company usually control the profit allotment. To diminish the exploitive relationship, collecting and processing company could collaborate with each other. The collaborative alliance may have greater bargain power to deal with the recycled manufacturing company. Complementary relationship exists between different size of collecting and processing companies. Small and medium size of collecting and processing companies will treat others as both competitors and collaborators. Since all these collecting and processing companies collect various recycled materials, they may have their major specialties and exclusive channel with the upper layer companies to gain extra profits. Recycled items are usually trade between these companies to pursue greater utilities.

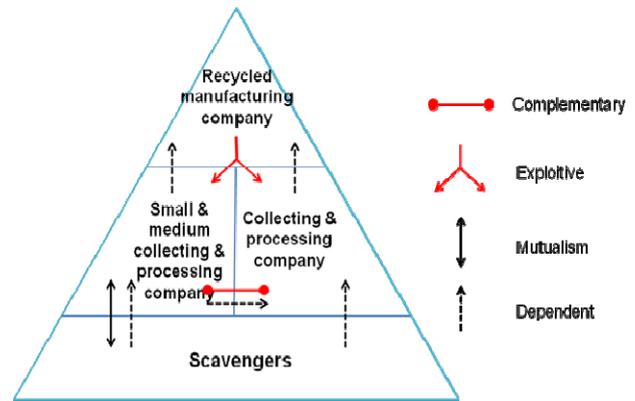


Figure 1. Roles & Relationships within Recycling Ecosystem, [3].

### B. Innovative Urban Mining Service Design

We proposed a public welfare-driven recycling service model for urban mining service. This innovative urban mining service is designed based on reorganize the value distribution for the recycling ecosystem.

We will use a case scenario to illustrate the difference between traditional model and the public welfare-driven recycling service model. Reframing service value network of the recycling ecosystem could have some changes for different roles within the service model. Let's set the recycling price for unclean & mixed recycling items as 100 dollars per kilograms. Normally, the traditional scavengers will collect these recycled items and sell it to the collecting & processing company and receive around 80 to 100 dollars per kilograms. Usually the scavengers will accumulate the recycled items for huge volumes to bargain for higher price. Otherwise, the scavengers must be forced to accept the lower price as they need the instant cash incomes.

The key concept of this service innovation is to encourage residents to clean and classify their waste and recycled items correctly so as to be rewarded with higher price for scavengers. Community will authorize the specific scavengers to maintain their waste storage place to trade the privilege to collect the recycled items. Since collecting & processing company can reduce the handling fee to process these recycled items, they usually will offer higher price for collecting these high quality recycled items, says 20% in addition to normal price. The recycled items can be collected with 120 dollars per kilograms, which brings extra 20 dollars per kilograms as the profit within the ecosystem. The ecosystems could share the profit to the eco-scavengers as well as the public welfare associations in 80/20 rules. The eco-scavengers could be rewarded with the 16 dollars per kilograms, and the public welfare association could receive 4 dollars donations for each kilogram's recycled items.

The minimal required conduction for the upper layer companies to support the urban mining service project is their benefit should be at least stays in the same level of the current recycling model. In our proposed recycling service model, the eco-scavengers could have 116 dollars cash income for each kilogram of recycled items. The community residents could have better living quality as eco-scavengers will maintain their living space without

additional charges. The collecting & processing company will reduce the handling fee and transportation fee to collect the recycled items stored in the communities. Moreover, the higher layer roles within the ecosystem (recycling manufacturing company and collecting & processing company) will be rewarded with the service imagery that they are the good enterprise that contribute for the society. Public welfare associations will receive more donations than before. The whole society will help each other with kindness and love to make the recycling industry becomes a new ecosystem that contribute themselves with merely no cost to make the world better.

### III. RESEARCH METHOD

In order to understand what people think about the proposed urban mining service design, this study adopts multiple case design [9] to explore the different viewpoints. Several typical cases were conducted for representing and helping us to understand similar matters of urban mining service participants. This study selects the typical roles within the recycling industry, including the community resident, recycling company manager, and scavengers. The case studies were based on in-depth interviews, observation, and documentation, triangulation technique was used for collecting data for analysis [1, 2]. Instead of using survey tools, interview method is more flexible. Researcher usually uses specific terms and language in survey questionnaire to ask the questions from researcher’s viewpoint. However, interview method provides the opportunity for subjects to disclosure their viewpoints.

This study adopted a qualitative research approach. The in-depth interviews were conducted with Taiwan’s recycling industry operators, owners, and local community residents in Miao-Li County to comprehend the current situations and problems of urban mining service operation. There were eight subjects interviewed within the urban mining ecosystem. Table 1 lists the interview subjects and the categories they belonging.

The interview can be unfolded into two parts: the first part focuses on the current recycling industry situation including its operation issues, competition challenges, and misunderstandings, etc. The second part is related to the overall impact for adopting the service imagery that using public-welfare donation as the incentives to encourage residents participate and contribute to the urban mining service. Based on the observation and interview results, the urban mining service development challenges can be classified into some major issues.

One may wonder how we avoid the subjectivity of the results of the case study. According to Patton [6], owing to the characteristics of qualitative research, this study applies the “purpose sampling method” that selects the subjects that can provide maximum information for our research question. In this study, since we emphasis the opinions of how Taiwan’s recycling industry participants thinks about the urban mining service, the non-probability sampling method is applied that could help us comprehend the research question deeply.

TABLE I.  
INTERVIEW SUBJECTS AND CATEGORIES

Identity	Role	Gender	Age
Subject A	Recycling company owner	Male	50
Subject B	Recycling company operator	Female	42
Subject C	Recycling company manager	Male	61
Subject D	Community chair	Male	40
Subject E	Resident committee secretary	Male	35
Subject F	Community resident	Male	47
Subject G	Scavenger	Female	70
Subject H	Government cleaning squad captain	Male	43

In this study, we followed the guideline of Grounded theory in social science research [7, 8] to formulate hypothesis based on conceptual ideas. How the urban mining service design may be generated from actual data that contains both inductive and deductive thinking. We applied triangulation methods in this research to improve the reliability as well as the explanatory power to its reality. The interviewee selected in this study contains various roles and its different relationships within the recycling industry. Therefore, different viewpoints from various participants can be understood to examine the research outcomes of urban mining ecosystem.

### IV. CHALLENGES OF URBAN MINING SERVICE DESIGN AND DEVELOPMENTS

To design a sustainable urban mining service, there are many development issues should be considered. According to Larry Keeley [5], service innovation could be unfolded into four categories: process, offering, delivery and finance [4]. The following proposition developments are based on the finance, delivery, offering, and processing perspective of recycling industry.

**A. Proposition 1: Transparent information of urban mining service could impact the current recycling service design and its development.**

The recycling industry contains various unrevealed information including their techniques and private channel for collecting recyclable items. Enabled with the special skills, the recycling manufacturing company could gain more benefits than other competitors on particular kinds of recycled items. However, the prices of resource items are determined by its volume and cleaning degree. Different levels of preprocessing recycled resources highly influence their recycling prices. However, since the revenue of a recycling company is related to their tax problem, recycling company owners

may refuse to public their actual financial information to others. This also means in current urban mining industry, there is gray area that their actual incomes are hidden.

***“You must be kidding! We surely DON’T want to reveal these operation information to others, especially our benefits and collection volume. This is how it works and we do care about our revenue”***

***“I know these items can redeem a little money. But I won’t do that. ....Well, we do not care about that who took these dumped items as long as they do not mess up our living environment.”***

***“Actually, the dumped recycled items are not just trash. These recyclables items are valuable (Items can redeem cash) .You knows the scavengers will seriously fight for these items? If they know where the dumped items are, they will hurry to collect them.”***

The financial information within the current urban mining service is unrevealed. We can see the community residents sometimes ignore the hidden value of recycled items as residents do not pursue the tiny value. However, we found that the value of recycled resources is more valuable than we expected. Unfortunately, the dominators of recycling ecosystem may not want to share the value to others as well as the society as they think this is their vested interest. The revenue distribution within the recycling ecosystem is unbalanced.

***“The redeem price for last year are relatively stable than before. But the redeem price of all recyclable materials are determined by upstream factories. We (scavengers & collecting company) do not have enough bargain power for this.”***

***“The residents usually do not clean their dumped recyclable items. The redeem price can be lower for those unclean and mixed items. I must clean the collected items again before selling to collecting company for more reward.”***

Some issues raised in current recycling ecosystem. First, the waste classifications from residents are not executed appropriately. Second, even the clean and well classified recyclable items do worth more money, but residents are too lazy to do waste classification. Also, the twisted relationships could be the major barriers for transforming current recycling industry into sustainable urban mining service as the ecosystem are unbalanced and have exploitive relationships. Although the special techniques could bring the recycling manufacturing company a lot of fortune, but should citizens and government allow them to obtain absolute profits without fulfill some social responsibility? As the recycled items are collected from community residents with low cost, the cost for gathering the resources is tiny while the revenue is incredible huge. The revenue should not be oligopoly by some recycling manufacturing companies. Instead,

some of the revenue should be shared to the society as well as the whole recycling ecosystem.

In order to generate the energy to change society, the ecological balance of the current recycling system must be re-planning. Allocate appropriate revenues to the society and the recycling ecosystem is vital, government could regulate information more transparent in urban mining service. Appropriate information transparency will improve current monopoly interest situations.

***B. Proposition 2: Emphasis on the kindness and public-welfare concepts of residents could facilitate shaping the value network for urban mining service.***

Is there any solution that could bring more revenue to the ecosystem without unreasonably harm their vested interest? What could be done for making urban mining service better than current recycling ecosystem? One of the solution concepts is the kindness of humanity. We do have kindness in our heart. The kindness could be the incentives to facilitate the transformation of urban mining service design. Residents just clean and properly classified the waste could increase the value of recycled collections, which could bring extra profits to the recycling ecosystem, especially the scavengers in lower layer.

***“We can’t force our residents to conduct correct waste classification..... But without correct waste classification, the cleaning squad will not receive the garbage.”***

***“If he (scavengers) can clean up our garbage room, then it’s what he earned.”***

Expectations of a sustainable recycling ecosystem may be various. From the resident’s viewpoint, they would care about their living environment more. But people do have compassion and care for the economically disadvantaged populations. Vulnerable scavengers are relatively hard to collect more recyclable items for improving their incomes as they are alone and unable to compete with the collecting & process companies. There exist some unbalanced competitions of gathering these recyclable resources.

***“Scavengers will fight for these items; all these items are treated as money or valuables. But the old and skinny scavengers are less competitive than others; they must cruise frequently to collect more recyclable items. ...they attach great importance to this money.”***

***“Sometimes we allow these scavengers to collect the recyclable items in our community. Usually they (scavengers) are old and poor, we can’t decline their request.”***

***“Our committees will sell these recycled resources in order to get feedback funds....but in our community, the resident committee annually donate 33% feedback funds to charity organizations.”***

Although the kindness of humanity may drives resident committees to accept the vulnerable scavengers to collect the recyclable items from their community, but residents also care about if their benevolent actions could keep the environment clean and tidy. Sometimes, community residents will care about the security issue more than the charity behaviors.

***“Some scavengers collect what they want and just leave. However, after they collect these items, sometimes the storage place is dirty and mess. It bothers me.”***

***“We must guarantee the community’s security. If we can’t tell who the trustworthy scavenger is, bad person may enter our living environment. It is quite dangerous.”***

For the sustained and healthy development of the recycling ecosystem, there is indeed room for improving the ecological structure of urban mining service. However, appropriate measures must be complete, including the emphasis on residents must proper classify the garbage; a balanced and fairness rule for allocating recyclables to vulnerable scavengers; establishing a collaborative management system with the urban mining service to keep the community safety.

## V. DISCUSSION AND CONCLUSION REMARKS

Emerging urban mining service is one of the recycling industries in green ecosystem. There are many complex organizational relationships in the current industrial ecology. However, transformations within this emerging industry require various supports including the government, members of recycling ecosystem, the whole society, and residents. In this paper, an innovative recycling service application is proposed that highlights sharing the value for better utilization within the recycling industry. The new recycling service model is grounded from the service innovation ideas that emphasis on the prosocial behaviors and the massive participations of the entire society member. To sum up, the barrier of urban mining service design and development could be unfolded into five challenges:

- A. *The urban mining service design must guarantees all members remain profitable.*
- B. *Promote the social status of scavengers and treat them as collaborators instead of disposable employee.*
- C. *Encouraging prosocial behaviors and massive participations within the urban mining service.*
- D. *Highlights the kindness of humanity and public-welfare concepts as the incentives for residents.*
- E. *Shaping the value network of urban mining ecosystem and keep reasonable revenue allocation.*

In order to conquer the mentioned challenges, information communication technologies (ICT) should be involved for improving current urban service designs. Mobile application enables various location-based service designs to support rapid recycling service responses. With the lightweight mobile devices, the resident’s communities could tightly integrate with the urban mining ecosystem. Scavengers could be treated as the collaborators, which guarantee appropriate living standards and training for handling the recycling materials. Moreover, the social participations become the most important resources. With proper waste classification by residents, more feedback funds could be earned to helping the economical vulnerable populations.

For future research directions, a suitable urban mining e-service could be implemented addressing the mentioned challenges. Scenario-based e-service implementation could facilitating generate innovative ideas for improving urban mining service design. Moreover, various mobile applications for supporting the urban mining ecosystem should be developed to support each role within the ecosystem. The urban mining e-service design would consider its performance evaluations, and its service quality measurements.

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