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Reverse Logistics in Clothing Recycling: A Case Study in Chengdu

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***Abstract*—**Clothing recycling bin is a traditional way to collect textile waste in many areas. In the clothing recycling business, the transportation cost normally takes over 50% of total costs. This case gives a good way to reduce transportation cost by reverse logistics system. In this reverse logistics system, there are offline strategic alliance partners, such as transport firms, convenience stores, laundries, and post office which are integrated onto the mobile APP. Offline strategic alliance partners provide the service of textile waste collection, and transportation by their vacant vehicles return journey from convenience stores, laundries and post offices to sorting centers. The results of the case study provide the strategic alliance with a valuable and light - asset business model by using the logistics of offline memberships. The company in this case just focuses on textile waste sorting, reuse, recycling etc. The research method of this paper is a case study of a clothing recycling company in Chengdu by field research and interview; the analysis is based on the theory of the reverse logistics system.

***Keywords*—**Closed-loop recycles system, clothing recycling, end-of-life clothing, sharing economy, strategic alliance, reverse logistics.

I. Introduction

CLOTHING recycling can be divided by two ways, which are online and offline. Offline clothing recycling is the traditional way; the citizen can drop off in recycle bins or donate to Charity communities. Online recycling is normally to fill in a donation application online and then the transportation company's door-to–door service collects. In whatever ways of recycling, the transportation expenditure from collection spot to sorting center takes a larger portion of the total cost in clothing recycling due to geographic dispersion.

Reverse logistics can be defined by two kinds in terms of items; reverse logistics for the product returns process and for disposal of end-of-life products to reused, recycling, and recovery process. Returns reverse logistics refers to the process of the customers returns of products to the suppliers [1]. Reverse logistics in end-of-life products recycling refers to collecting from the customers, through the logistics activities in the supply chain, including sorting, reused and recovery materials back to the original supplier as raw materials in new product manufacturing [2]; it also known as "environmental logistics". The purpose is to classify and utilize end-of-life products, restore their full or partial value again, and reduce the adverse impact on the environment.

In the closed-loop clothing recycling system, there are the following phases: Collecting, transportation, sorting, then reused, or remanufacturing, or recycled fiber as raw materials, which is back to the new clothing manufacturing process. It starts from fabric, clothing design, manufacturing, and transportation to retail stores for selling, and customers buying and wearing, years-later disposal to recycling process.

Under a sharing economy, reverse logistics can be arranged on internet platforms to solve the lack of scale of returns trip, and increase the likelihood of transportation operating at full capacity [3]. Reverse logistics plays an important role in transitioning under a circular economy [4].

Reverse logistics in clothing recycling become more environmentally efficiency to lower transportation cost by using the same trucks as for deliveries in the return trip [5].

Mr. R (the registered trademark) is a company dealing with reused clothing collecting, sorting, reselling and recovery in the Chengdu area. Chengdu is a large city in China with over 16,045 thousand population in 2017. Mr. R's Reverse Logistics System is based on mobile APP (Abbr. SAAS software) which it has developed. The APP aggregates strategic alliance partners on the platform by sharing their deliveries capacity to lower transportation costs [6].

The aim of the paper is twofold. First, it analyses the closed-loop clothing recycling system and the main costs. Second, it presents Mr. R's Reverse Logistics System in clothing recycling with its strategic alliance. In the last section, concluding remarks are given with a study of the sharing economy, strategic alliance and Mr. R's light asset business model.

The research method of this paper is qualitative content analysis in a case study of Mr. R's Reverse Logistics System. The data in the paper are provided by the Mr. R Company. Besides, field research and interview method are conducted.

II. Case Study and Methods

A. Closed-Loop Clothing Recycling System

Fig. 1 illustrates that under a closed-loop clothing recycling system, there are three ways to utilize end-of-life clothing, these are reuse, remanufacture and recycling after collecting, transportation, sorting. Reuse clothing can be donated or resold in thrift shops. Remanufacture is when the used clothing is made into rags for cleaning machines. Recycled clothing can be used as raw materials to spin and weave fiber for fabric which can then be used to make into new clothing, as result to be closed-loop in terms of zero-to-landfill and therefore is better for the environment.

B. The Costs in Clothing Recycling

Fig. 2 illustrates that there are three main costs in clothing

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recycling, that is collecting, transportation and sorting. Among them, the transportation cost accounts for the largest proportion, which is more than 50-60%, including the investment of transport vehicles, the wages of drivers, fuel, vehicles repairing, etc. The labor cost of personnel sorting accounts for about 40%, including the wages of workers and social insurances expenses. Collecting is based on donation, bins making and locating are the main expenses.

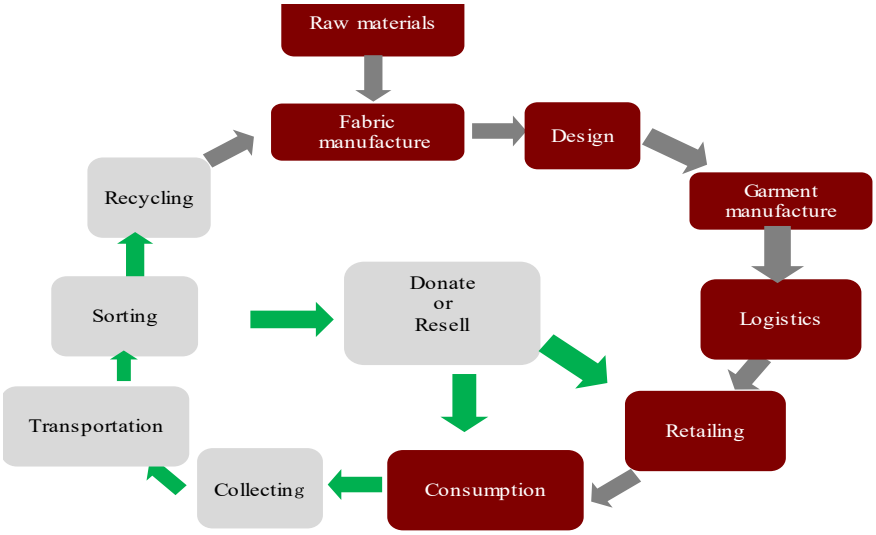

Fig. 1 Closed-loop clothing recycling system

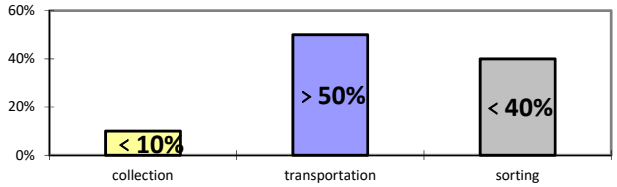

Fig. 2 Three major costs in clothing recycling

C. Mr. R's Reverse Logistics System

The cost of clothing recycling directly affects the price of recycled fibers. Normally the price of regenerated fibers is 30% higher than that of native fiber. Therefore, clothing recycling is based on donation or free in most countries in order to lower the cost of recycled fibers.

In order to reduce the transportation cost of the recycling business, the Mr. R Company adopts strategic alliances with offline partners, including convenience shops, laundries, post offices, and expresses stations etc.

Fig. 3 illustrates that Mr. R's Reverse Logistics System with strategic alliance partners consists of two main parts. One part is the alliance partners who are responsible for collecting and transporting. They also provide clothing collection services that are convenient for residents in their area. After collection, they deliver the collected clothing back to their warehouses. The alliance members utilize their return trip trucks' idle space to provide transportation from the collecting points to Mr. R sorting center, and thus can lead to reduction in the overall logistics costs.

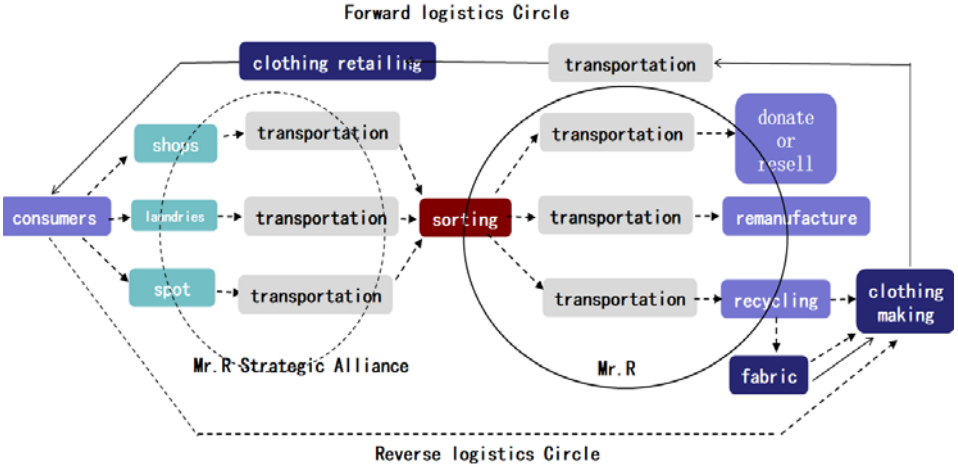

Fig. 3 Mr. R and its Strategic Alliance

In the closed-loop clothing recycling system, the Mr. R Company only do business starting from the sorting to recycle phase. After sorting, end-of-life clothing can be utilized in three ways; one is to donate or resell, another is to remanufacture to rags, and the rest can be recycled for fiber to make into new fabric.

III. Results and Discussions

A. Sharing Trucks' Idle Space to Lower Cost

Convenience stores, laundries, post offices, and express stations have their own logistics transportation systems, mostly they are a one-way trip, and the return trip might be empty. Through strategic alliance, Mr. R takes advantage of the existing logistics capacity to undertake clothing recycling transportation. In this way, the Mr. R Company might save on vehicles' investment and drivers hiring. The Mr. R Company is currently only responsible for the transportation from the sorting center to reuse, remanufacture, and recovery sectors with only two vehicles and two drivers. The transportation cost accounts for only 5% of the company's total annual expense, which is far lower than that of its counterparts.

B. Environmental Significance

The environmental significance of sharing alliance members' logistics is more than just the economic ones. Maximizing return journeys of idle spaces could also results to reduced numbers of vehicles in the streets and therefore carbon emissions, which is better for the environment.

Fig. 4 shows how alliance members such as convenience stores, express stations and laundries, which are chain operations or franchises with centralized warehouses in Chengdu, use reverse logistics. For example, the express parcel delivery service is mostly a one-way operation, and under the alliance, express stations around the city are used as a collection point for old clothes, which are then transported to the central warehouse on the return trips. After accumulating to fill a transportation vehicle, they are taken from the centralize warehouse to Mr. R sorting center. The scale economy can be reached for both. The convenience stores and laundries also follow this collection method.

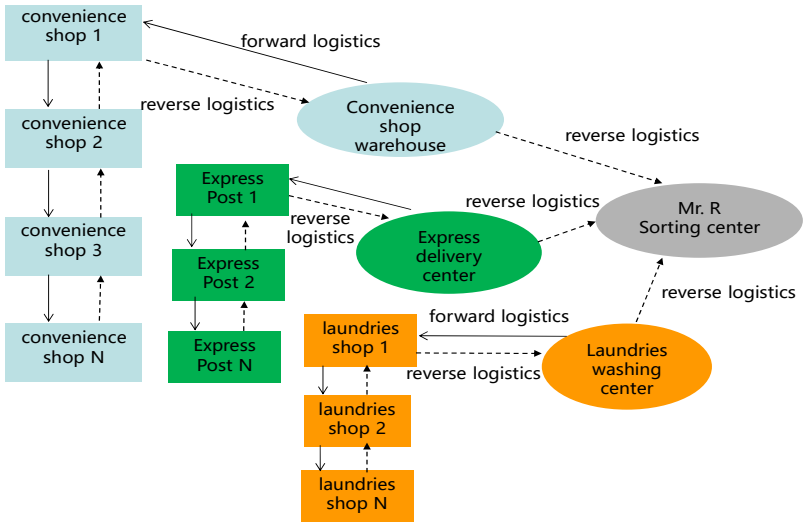

Fig. 4 Reverse logistics centralizes the decentralized shops in Chengdu

C. Convenience to Put in End-of-Life Clothing

In Mr. R's Reverse Logistics System, there are over 240 convenience stores, 80 laundries, 260 express stations and 45 post offices; this amounts to a total of about 625 alliance members in Chengdu and covering more than 200 communities. This system provides convenience for locals who want to dispose of end-of-life clothing whenever and wherever. The annual collection of recycled clothing is over 3000 tons. Alliance members receive 0.2 Yuan per kg of recycled clothes delivered to Mr. R each month. By employing this system, Mr. R saves on the investment of the placement of and pick up from collection bins around the city.

D. Mr. R Input and Output

Table I illustrates how under Mr. R's Reverse Logistics System, the company and its alliance members cooperate in different sectors and take advantage of their respective benefits to create a win-win situation for all partners. Alliance members have the advantages of offline shops location, idle return trip and warehouse, while Mr. R is focused only on the business of used clothing; the sorting to reuse, remanufacture and recycling sectors.

Table II provides a breakdown of expenses of the Mr. R Company in the sorting sector, in which sorting workers wages and warehouse rental account for 30% and 8%, respectively. Fig. 2 shows the percentage of three main expenses generally associated with clothing recycling. In the collection sector, Mr. R Company needs to pay for package bags (containers) which accounts for only 2% of overall expenses, which is far below that of the averages shown in Fig. 2 (normally this expense is 10%), while in the transportation sector, it pays alliance members' fees (0.2 Yuan per kg recycled clothes) which

accounts for 15% (normally this expense is above 50%).

Table III illustrates the benefits for member cooperation under the strategic alliance. From the alliance member's point of view, they receive additional revenue from Mr. R for providing collection services, while utilizing their return trip transportation. From the Mr. R Company point of view, it uses the light-asset business model to lower their colleting and transportation costs. In this way, Mr. R is focused only on the sorting and recycling sectors.

TABLE I
COOPERATING SECTORS BETWEEN ALLIANCE MEMBERS AND MR. R.

Input	Alliance members	Mr. R
Collecting	√	
Package containers		√
Transportation	√	
Warehouse	√	
Sorting		√
Reuse		√
Remanufacture		√
Recycling		√

TABLE II
MR. R COMPANY ALL EXPENSES AS A PERCENTAGE

Expense	Accounted for
Sorting workers' wages	30%
Sorting warehouse rental	8%
Transportation from sorting to reuse, etc.	5%
Package bags	2%
Pay for alliance members' fee	15%
R&D	5%
Supervisions wages	30%
Utilities and others	5%

TABLE III
OUTPUT FOR BOTH UPON ALLIANCE

Output	Alliance members	Mr. R
Collecting	Pay from Mr. R by weight of collecting	
Transportation	pay from Mr. R by weight of transportation in return trip	
Reuse		Selling income
Remanufacture		Selling income
Recycling		Selling income

IV. CONCLUSIONS

In contrast to traditional clothing recycling companies, under the sharing economy, companies are characterized by network-based business models. The primary value of these sharing platforms lies in the use of software to match the idle transportation capacities, warehouses, and labor. For example, the express postmen can pick up end-of-life clothing on their return trip after making their deliveries. Laundry staff can collect old clothes when they are not busy. Every day, goods are delivered from centralized distribution centers to each convenience store within a network, and under reverse logistics, the transportation trucks can collect deposited recycled clothing from the stores along their route and deliver to the main warehouse on their return trip.

The strategic alliance members are chain or franchise operations. These partners can increase their revenue by providing reverse logistics services to Mr. R Company, while lowering the collection and transportation cost for the used clothing recycler. As a result, both sides will reach an economy scale. This case shows that it is easy to utilize the available return capacity of trucks in the same city, such as Chengdu.

Comparing with the traditional clothing recycling company, this case provides a new business model. As an IT company, Mr. R conducts its clothing cycling business using a light asset business model under a sharing economy. Firstly, Mr. R developed a mobile APP, which is its core competence. Table II shows that its R&D expense is about 5% of total revenues, while wages account for 30%. Secondly, Mr. R builds strategic alliances to share the membership's advantages, such as transportation capacity and convenient location instead of doing so by itself. In this way, Mr. R lowers its investment in the collection and transportation sectors. The strategic alliance provides complementary advantages for both side and allows them to reach an economy scale. Thus, this business model is worth promoting.

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