

*Article*

**Sustainability of Sugarcane Bagasse as Natural Fibre Composite Products in YIWU Communities:  
A Conceptual Framework**

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**Abstract:** Global warming, white pollution, ecological degradation and other environmental and resource issues have become the focus of attention in all areas of society today, and sustainable development is no longer a slogan. Design practitioners are committed to developing new visions and approaches. The application of materials is an important part of realising a circular economy. Sugar cane is the world's number one sugar crop and the second largest bioenergy crop, while bagasse is one of the most produced agricultural wastes in the world. This study is located in the hometown of brown sugar in China - Yiwu City, Zhejiang Province. The research objective is to develop the design and application of bagasse fibre composites in the brown sugar industry of Yiwu using waste bagasse materials as a starting point. The aim is to use design to drive the circular flow of waste resources, extend the economic chain of the brown sugar industry, and help build a local ecological civilisation and sustainable economic development. The researcher used theoretical framework, qualitative research and data analysis as research methods. In this study, the theoretical framework of sustainable development of the brown sugar industry in Yiwu is proposed, and the circular path diagram of the brown sugar industry ecological park. With theory guiding practice, and successfully developed bagasse paper material and bagasse bioplastic material and applied them in the field of lamps and brown sugar product packaging.

**Keywords:** bagasse materials; communities; sustainable design; brown sugar industry; product design

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## **Introduction**

Sustainable Development (SD) and Circular Economy (CE) are of increasing concern to society (Geissdoerfer et al., 2017), and the concept of sustainable development has emerged in the context of environmental issues. In order to advance sustainable development and achieve peace and prosperity for people and the planet now and in the future, all Members of the United Nations proposed 17 sustainable development goals and 169 targets in 2015 (UN News Centre, 2015). The SDGs focus on people and the planet, covering all aspects of life, including energy, natural resources, urbanisation, equitable living and community cooperation (Sachs et al., 2019). Sustainable communities are a vision of a better future (Roseland, 2000). In order to achieve the creation of sustainable communities, countries must change consumption and production patterns to facilitate the development of community-based industries through regenerative systems that promote the reuse and recycling of materials (Sachs et al., 2019). Sustainable communities are a vision of a better future (Roseland, 2000). In order to achieve the creation of sustainable communities, countries must change consumption and production patterns to facilitate the development of community-based industries through regenerative systems that promote the reuse and recycling of materials (Sachs et al., 2019).

Yiwu City, Zhejiang Province, China, is known as the "Township of Brown Sugar". Brown sugar is one of the "three treasures" of Yiwu's traditional agriculture, and it is also the main economic income of farmers in the local sugar cane growing areas. But there are pitfalls to the "sweet business". Yiwu Municipal People's Government 2023 report takes Yiting Town, Yiwu City, Zhejiang Province, China, as an example, Yiting Town, as the main producing area of brown sugar in Yiwu, has a sugarcane planting area of 4,500 acres. Every year, it is able to harvest a total output of sugar cane of over 30,000 tones, a total output of brown sugar of over 3,000 tones, and a total output value of the brown sugar industry of over 100 million yuan (City Agricultural District, n.d.). However, there are worries behind the "sweet business". Based on the ratio of bagasse production to sugarcane production of about (24% to 27%) (Bezerra & Ragauskas, 2016), Yiwu produces about 720-810 tonnes of bagasse per year.

The Yiwu brown sugar industry is a typical linear economic model of planting, extracting, producing, selling and discarding. Due to the limitation of bagasse conversion and utilisation technology, there is currently no way for small and medium-sized brown sugar factories in Yiwu to deal with bagasse for the time being, and bagasse is used as biofuel or compost (Liu et al., 2017). Yiwu is an economically developed city, city residents and rural residents of the righteousness of a wider gap between rich and poor. The Yiwu brown sugar industry is concentrated in villages and towns, the high cost of agriculture, agricultural work hard mechanisation is low and other reasons, the local young generation is more inclined to go out to work rather than stay in the countryside. Yiwu ancient brown sugar production process is facing the predicament of no successor.

Yiwu brown sugar products also face the impact of the brown sugar industry in China's Yunnan and Guangxi provinces. The local community has passed down the ancient method of brown sugar, brown sugar, and due to the local temperature in all seasons, the flower industry is flourishing. Therefore, the local brown sugar industry combined with flowers, for women's groups to launch the beauty of brown sugar products, brown sugar products in the packaging to reflect the local characteristics by the tourists' favourite. Yiwu brown sugar industry compared to a single industry chain, innovation is weak.

The Yiwu brown sugar industry has a long history, local characteristics and economic value, but in the production, process will produce a large amount of waste resources - bagasse. This resource is a renewable plant fibre material, which is natural, harmless and biodegradable. This study, guided by the theory of circular economy, explores the upgrading and utilisation of bagasse material in product design to extend the economic chain of the brown sugar industry while exploring the strategy of resource sharing and circular flow.

## Literature Review

### 1. China Yiwu Brown Sugar

Sugarcane is a versatile plant grown for sugar production (Sindhu et al., 2016), the second largest bioenergy crop in the world (Nguyen et al., 2022). The largest global sugarcane production is in Brazil, followed by India, and China (Table 1). Food and Agriculture Organization of the United Nations data for 2021 global sugarcane production is about 1.9 billion tonnes per year. Sugarcane production is expected to exceed 2.2 billion tones by 2026, with the supply of sugarcane being about 600 million tonnes (Khatri & Pandit, 2022). Brown sugar is no-centrifugal sugar (NCS) (Asikin et al., 2014) and NCS is the technical name used by the Food and Agriculture Organization of the United Nations (FAO) for a food product (Kiple & Ornelas, 2000). NCS unlike industrially refined sugar, retains most of the nutrients found in sugarcane except for the inclusion of molasses (Zhang, 2018) containing glucose and fructose, minerals, vitamins, organic acids, and amino acids favourable to the human body among other micronutrients (Jaffé, 2015). NCS has different extraction methods, forms and names in different countries such as jaggery (India), koku to (Japan), Gula Melaka (Malaysia), Jaggery (South Africa), and others (He, 2013).

Table 1. Top 5 global sugarcane producers

Area Code (M49)	Area	Element	Unit	Value
76	Brazil	Production	t	715659212
356	India	Production	t	405399000
159	China	Production	t	107258724
586	Pakistan	Production	t	88650593
764	Thailand	Production	t	66278506

Source: FAOSTAT (n.d.)

Yiwu City, Zhejiang Province, China is an economically developed city located in the southern region of China, close to Shanghai. Yiwu has China's largest commodities market, known as "the world's supermarket", and developed an import and export industry. According to China's CCTV financial "World Finance" reported: according to Hangzhou Customs statistics, just 2023 the first half of the year, Yiwu, Zhejiang Province, had a total import and export value of 268.97 billion yuan. In addition to the famous commodities market, Yiwu is also known as the "township of brown sugar". According to "Jia's Genealogy" of Yanli Village, Co-operation Township, Yiwu brown sugar has a history of nearly 400 years (Yiwu County Records Compilation Committee, 1987). The Yiwu ancient brown sugar production process is a local traditional folklore, one of the national intangible cultural heritages. Brown sugar is one of the "three treasures" of traditional agriculture in Yiwu, and it is also the main economic income of farmers in the local sugarcane planting area.

The people of Yanli Village, Fotang Town, Yiwu City, first planted sugarcane in Yiwu from Fujian Province (Jing, 2022). After the success of planting, the area continued to expand, and in 1946 the planting area reached more than 4,000 hectares, ranking the first in Zhejiang Province, and became the key sugar area of the province (Jing, 2022). Until today, Yiting Town is still the main production area of brown sugar in Yiwu, in which Xiantian Village has preserved the few sugar-pressing workshops and a full set of ancient sugar-pressing techniques. Now Yiwu brown sugar products are mainly powdered sugar, but in recent years, there are also sugar cubes and brown sugar snacks (Figure 1).



Figure 1. Brown sugar powder, brown sugar cubes, brown sugar twists, brown sugar shortbread  
Source: Yiwu Xiaobao Brown Sugar (2023)

The success of Yiwu brown sugar industry is mainly attributed to the following reasons:

#### *Yiwu ancient brown sugar production process*

Yiwu adopts a purely handmade ancient method of sugar production, which has a whole set of strict procedures of peeling cane, squeezing cane, squeezing juice, filtering, fishing sugar foam, boiling sugar, scooping sugar, cooling, and cutting pieces (Figure 2). A unique chain of eight sugar pots are used to boil the sugar, lined up in sequence from large to small. The process of brown sugar processing is very tight, and each step of the process requires extremely skilled people with more than 5-10 years of experience in the craft of sugar making (Ye, 2020). This traditional practice maximises the nutritional value of the sugarcane.



Figure 2. Yiwu Brown Sugar Processing Flow  
Source: Wei (2021)

### *High-quality varieties, unique location*

Yiwu sugarcane varieties are dominated by Yue Sugar 54-474, a yellow-skinned sugarcane, which has been planted for more than 50 years (Wu et al., 2015). This is a variety bred in China for sugar production and fruit compatibility, featuring clear cane juice, high water content, high sweetness, high pressing performance, high sugar content, also high fibre content, and fair crunchiness (Yang & Pan, 2006). The brown sugar produced by Yue Sugar 54-474 has a special green colour, which is also known as Yiwu green, with a unique taste and a soft texture that resembles fine sand. Yiwu is located in Jinhua City, Zhejiang Province, which has a subtropical monsoon climate with abundant rainfall and more than 2100 h of sunshine. Especially after October, the temperature difference between day and night is more than 10°C, which is difficult to reach in the southern province of China (Wu et al., 2015). Therefore, although Yiwu is not the main sugarcane producing area in China, Yiwu's sugar production is higher than that of other sugarcane areas in the south.

### *Long history, government support and promotion*

During the Qianlong period of China's Qing Dynasty, Yiwu farmers went out in the winter and spring seasons each year to make sugar cakes and ginger candies from brown sugar cubes and brown sugar in exchange for chicken feathers (Yiwu County Records Compilation Committee, 1987). Later on, small items were added to the shelves of the candy seller, and the business grew. The source of the rise of small commodity market is "chicken feather for sugar", and the source of chicken feather for sugar is brown sugar. Therefore, Yiwu "small commodities" culture is an extension of brown sugar culture. Yiwu's commercial culture encompasses the extension of brown sugar culture, with a unique historical memory.

Local residents and the Yiwu government attach great importance to the brown sugar culture, with the help of the government to establish a linear economic model of "raw material planting, extraction, production, sale and disposal". In order to better protect the quality of Yiwu traditional brown sugar and promote the healthy development of Yiwu traditional brown sugar industry, two group standards, "Yiwu Brown Sugar" and "Yiwu Brown Sugar Processing Technical Regulations" were issued.

## 2. Current Status of Bagasse Applications

Sugarcane is the world's number one sugar crop and the second largest bioenergy crop, and sugarcane waste is one of the most produced agricultural wastes in the world (Nguyen et al., 2022). Sugar cane produces waste after sugar production and sugar cane trash (ST) includes bagasse (SB) sugar cane leaves (SL) (Chandel et al., 2012). Sugarcane trash is refined in biorefineries to produce useful products such as bagasse, molasses, filter sludge, spent molasses and vinegar residue. The traditional sugar industry uses spent molasses to produce alcohol. Cellulose and hemicellulose from SB and SL can be polymerised into simple sugar monomers such as glucose, xylose, etc (Liu et al., 2017).

Sugarcane bagasse (SB) is the residue from the juice of sugarcane, a by-product of the sugar industry, and an agricultural waste biomass obtained from the processing of sugarcane (Ajala et al., 2021). The bagasse-to-cane ratio obtained from cane sugar production is 24 to 27 per cent (Bezerra & Ragauskas, 2016), 46 to 48 percent water content of bagasse (Lin, 2020). Bagasse can be used for bioelectricity generation, feed production, cultivation substrates, biogas, paper making, panels, development of functional food additives,

chemical synthesis, high-performance adsorbent materials and bio composites (Liu et al., 2017). Due to the uniform distribution of bagasse fibres, it has also been used as a source of new edible mushroom cultivation material. Bagasse as a substrate has been successfully used in the field of soilless cultivation of flowers, mushrooms, wood and mycelium (Wang et al., 2010).

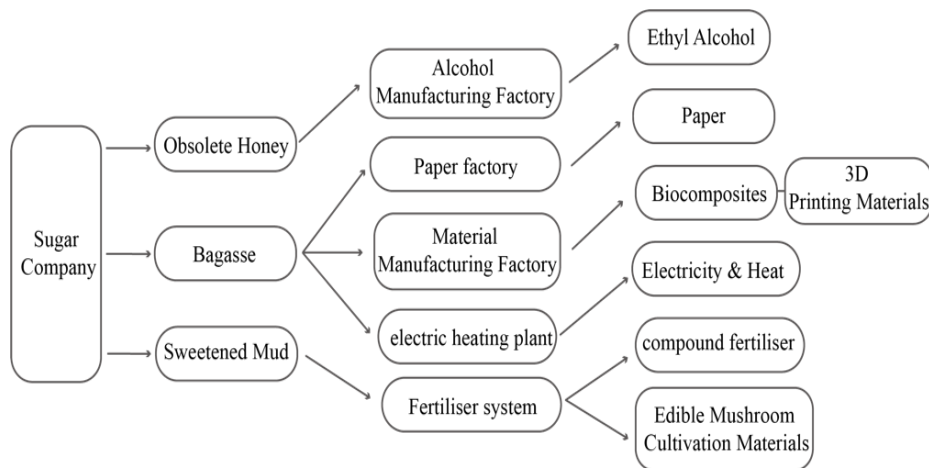


Figure 3. Main utilisation of sugar by-products  
 Source: Summarised on the basis of Liu et al. (2017); Singh et al. (2021)

The most direct and fastest way to utilise bagasse is to burn it to generate electricity, being used for bioelectricity (Singh et al., 2021). Another important use of bagasse is the production of pulp and paper. Now bagasse pulp is mainly used in the food packaging and disposable tableware industry. Bagasse has also been used as a reinforcing material to produce bio composites such as sheets, veneers and films (Mahmud et al., 2023). Bagasse can also be converted into a sustainable fibre for clothing and textiles (Jalalah et al., 2022). Can be effectively utilised to produce 3D printed food packaging (Nida et al., 2022). Bagasse has a high cellulose and hemicellulose content, which makes it an ideal raw material for making high-density panels (Liu et al., 2017). At the same time, bagasse raw materials are relatively concentrated, low transport costs, and bagasse as a reinforcing material in the composite material can be used directly without secondary processing (Singh et al., 2021). These advantages in the transport process, the production process to the enterprise to bring direct economic benefits to enterprises. At present, high-density sheets are the most direct and effective way to use bagasse in China (Liu et al., 2017).

Table 2. Overview of plant fibre application areas

Fields	Applications
Physical processing applications	Fuel energy (about 80%) power generation fuel
	Pulp and paper (about 19%)
	Production of composite materials
	Production of high density fibreboard
Chemical processing applications	Tableware, disposable products
	Production of ethanol Production of xylan
Bioprocessing applications	Preparation of activated carbon and capacitors
	Making livestock feed Tea production

Source: Lin (2020); Zheng et al. (2011)



Due to the high degree of lignification of bagasse, the digestibility of bagasse as animal feed is only 20 to 25 per cent, which is also not significant in the field of soilless culture (Liu et al., 2017). Bagasse fibre has no significant advantage over other fruit fibres; sugarcane fibre is short, less brittle and tough and has the lowest tensile strength (Hajiha & Sain, 2015). As can be seen through the collation of line and Zhen scholars (Table 2), no more than 20 percent of sugarcane bagasse is now being reused at a high value in China.

### 3. Theoretical Framework

The framework of this study (Figure 4) is based on the theoretical framework of circular economy (Geissdoerfer et al., 2020). The sustainable development framework of the brown sugar industry in Yiwu focuses on the flow of biomass materials in a circular economy. Taking bagasse, a waste product in the brown sugar industry, as a starting point, it explores the recycling and utilisation of bagasse materials to extend the brown sugar industry chain, realise the circular flow of resources and promote local economic development.

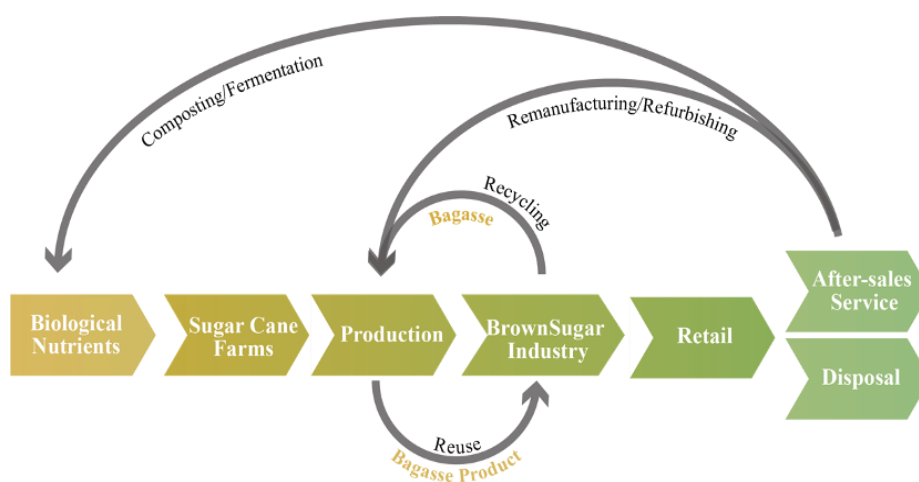


Figure 4. Sustainable Development Framework of Yiwu Brown Sugar Industry  
Source: The authors build on the circular economy, Geissdoerfer et al. (2020)

## 2. Methodology

### 1. Research design

This study focuses on bagasse, a waste resource in the brown sugar industry in Yiwu, China. It explores the recycling path of bagasse material in the brown sugar industry, which has positive significance for the diversification of local agriculture. Data collection was conducted using qualitative research, where the purpose of the study was to observe and visit in order to obtain experience, information rather than corroboration of data (Vishnevsky & Beanlands, 2004). Qualitative research is an effective method of collecting data that cannot be assessed statistically or otherwise (Corbin & Strauss, 1990). The methodology involves several steps, one of which is data collection, mainly through interviews and observations (Creswell, 2009). Data collection for this study consisted of observations and semi-structured interviews, with written descriptions and video recordings to document the information gained from the observations in order to effectively supplement or corroborate the study (Carroll et al., 2008). Semi-structured interviews were used, where open-ended questions were asked of the interviewee in a face-to-face format to obtain valuable data related to the topic (Charmaz & Belgrave, 2012).

### 2. Data Collection

Data collection consisted of observations and semi-structured interviews. Information obtained from observation was documented through written descriptions and video recordings to effectively supplement or corroborate the study (Carroll et al., 2008). Semi-structured interviews were used, where open-ended questions were asked of the interviewees in a face-to-face format to obtain valuable data related to the topic (Charmaz

& Belgrave, 2012). The government of Yiwu City in China has granted the geographical indication "Yiwu Brown Sugar" to 34 local brown sugar enterprises, 17 of which are located in Yiting Town.

Table 3. List of field visits

Name of Brown Sugar Factory	Address
Yiwu Xilou Village Brown Sugar Factory	Xilou Village, Yiting Town
Yiwu Xiaobao Brown Sugar Factory	Baozhai Village, Yiting Town
Yiwu Cane Family Brown Sugar Factory	Xilou Village, Yiting Town
Yiwu Liucun Sugar Processing Factory	Yiting Township, Liu Village

Source: Author

As mentioned earlier, Yiting Town is the origin of the brown sugar culture in Yiwu, with the largest area of sugarcane cultivation, and retains the traditional ancient brown sugar production process. The data collection location of this study is located in Yiting Town, Yiwu City, through the screening of online data and offline visits to 17 brown sugar enterprises, sorting out a representative 4 brown sugar factories (Table 3) for further in-depth interviews.

### 3. Data Analysis

The interview data were analysed by means of thematic analysis by firstly converting the audio recordings into textual organisations and reading all the data sentence by sentence. Secondly the data was organised and prepared for analysis and finally the data was hand coded based on themes. The researcher used open coding method to identify different concepts and themes (Charmaz & Belgrave, 2012).

Waste bagasse is up valued and utilised in the industry to meet the diversification of the local community's economy at the same time as it relates to the UN Sustainable Development Goals Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation and Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable (UN News Centre, 2015). This study obtained data analyses by mapping the product outcomes in the UN Sustainable Development Goals (SDGs). The analysis summarised six sets of associated vocabulary in the SDGs (Table 4), which were used to guide the establishment of a sustainability programme for bagasse as a natural fibre composite product for the Yiwu community.

Table 4. Related topics

Processes	Infrastructures	Technological innovations	Material cycles	Industrial value	Natural culture
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Source: Author

### 4. Material Experiment

Materials with their own personality (Ashby & Johnson, 2003), Physic-chemical properties of materials such as strength, elasticity, thermal conductivity etc. this is used to differentiate materials (Karana, 2010). Materials also have sensory properties, and it is common to use subjective sensory terms such as fluffy, hard, and soft to describe how they feel. It is difficult for design-related staff to translate descriptive vocabulary into experience and accurately translate it into product applications through words and pictures. In this study, knowledge related to bagasse material properties was acquired through material experiments, which is the process of transforming acquired knowledge into created knowledge (Rognoli & Levi, 2004).

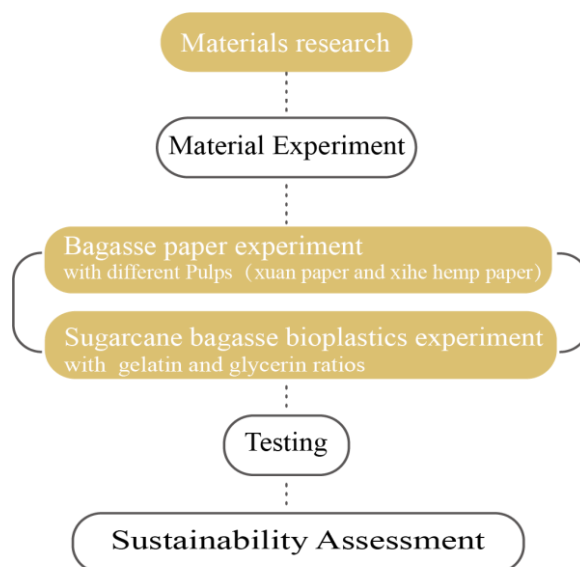


Figure 5. Material experiment flow chart  
Source: Author

Bagasse material is a stem fibre of plant fibres and due to limitations in material properties (Hajiha & Sain, 2015) is mainly used in daily necessities for making pulp and as a reinforcing fibre applied in the field of panels. During the material experience, it was discovered that bagasse has a unique aesthetic of short fibres, which was used to create a flowchart for the material experiment (Figure 5). The material experiment relies on the product design laboratory of Zhejiang Normal University in China, and now the material experiment is based on handmade DIY production (Fox, 2014). The materials experiments focused on the proportion of matrix (binder) and the embodiment of bagasse fibres in materials synthesis. The main substrates of the materials are rice paper, gelatine, glycerine, and vegetable starch. The purpose of the experiment is to explore the many possibilities of the materials in terms of the way they are moulded and the forms in which they are used. In the process, samples of bagasse material are accumulated to help other design-related staff visualise the material and better develop bagasse products.

### The Findings

This researcher has the following findings from the fieldwork:

- i. Most of the brown sugar industry in Yiwu is a joint-stock reform business model with the support of village and town party committees and governments. Villages, streets and communities are used as units for sugarcane cultivation, brown sugar production and brown sugar sales of integrated brown sugar factories.
- ii. Yiwu grows sugarcane from March to November and matures in November-January, and farmers in Yiwu concentrate on harvesting sugarcane and making brown sugar in November-January every year. Sugarcane planting, harvesting and transporting are done with semi-mechanised machines, and the brown sugar production process requires 8 craftsmen to work with each other for manual boiling. The brown sugar production factory concentrates on producing brown sugar for 3 months, and the brown sugar factory is semi-rested for 9 months.
- iii. Local villagers are sugar cane growers as well as brown sugar producers and sellers, with 70 percent of villagers directly or indirectly involved in the production, processing and sale of brown sugar. The village is dominated by the elderly and women, with relatively few young labourers. The brown sugar industry is a major source of economic income for farmers in the area.
- iv. Yiwu government and brown sugar enterprises have awareness of bagasse recycling and treatment, there is no unified standardised bagasse recycling policy, and now it is mainly piled up ( Figure 6), lacking the method of turning waste into treasure.





Figure 6. Status of bagasse dumps  
Source: Author

### 1. The Countermeasures

#### *Circular Business Model-Brown Sugar Industry Ecological Park*

A business model is a conceptual tool to help understand how an organisation conducts business and can be used for analysis, comparison and performance evaluation, management, communication and innovation (Osterwalder et al., 2005). "Closing the loop" in business model innovation refers to capturing value in what is considered "waste" in a linear business model (Wells & Seitz, 2005). One type of circular economy business model promotes reuse and longevity through repair, remanufacturing, upgrading and retrofitting. Another category is to complete the circular flow of resources by turning waste resources into new resources through recycled materials (Walter R., 2016).

This study builds a circular business model and proposes the concept of brown sugar industry eco-park. The circular flow of resources is realised around sugarcane farms, brown sugar production factories and brown sugar selling shops (Figure 7).

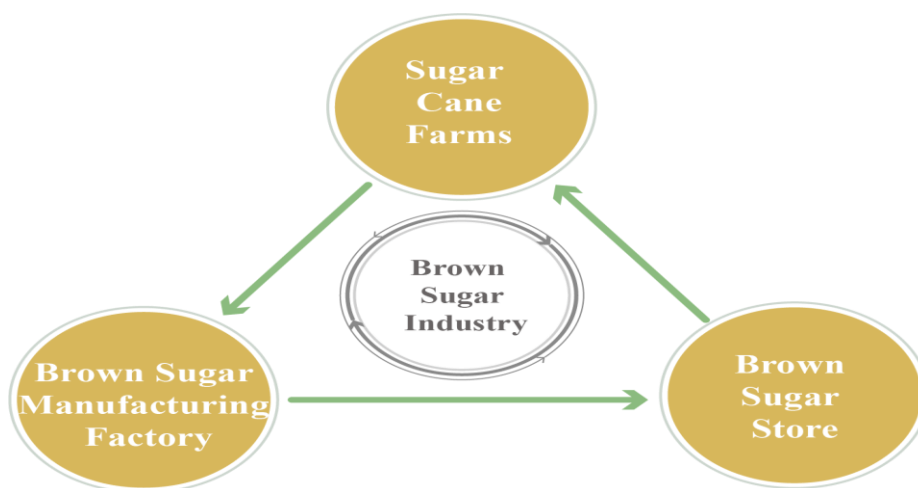


Figure 7. Three pillars of brown sugar industry ecological park  
Source: Author

This study focusses on the waste resource bagasse in the manufacturing line of the brown sugar industry, the brown sugar making factory space, and the natural resource - the sugarcane farm. Firstly, bagasse is recycled and transformed into bagasse packaging materials and bagasse products. Secondly, research and experience activities are carried out for children, experiencing nature in bagasse farms, and organising visits to Yiwu ancient brown sugar craft during the time of brown sugar production (November, December and

January) to understand the culture of Yiwu brown sugar. During the time when the brown sugar production factory is closed (February-October), an experience space will be created, together with bagasse paper-making experience kits, bagasse bioplastic experience kits, and brown sugar edible toy kits, to cultivate hands-on skills while fostering the concept of environmental protection through the sustainable use of materials. At the same time, these bagasse products, experience kits and toy kits can be sold in the sales outlets. Achieve 3 space sharing and mutual benefit (Figure8).

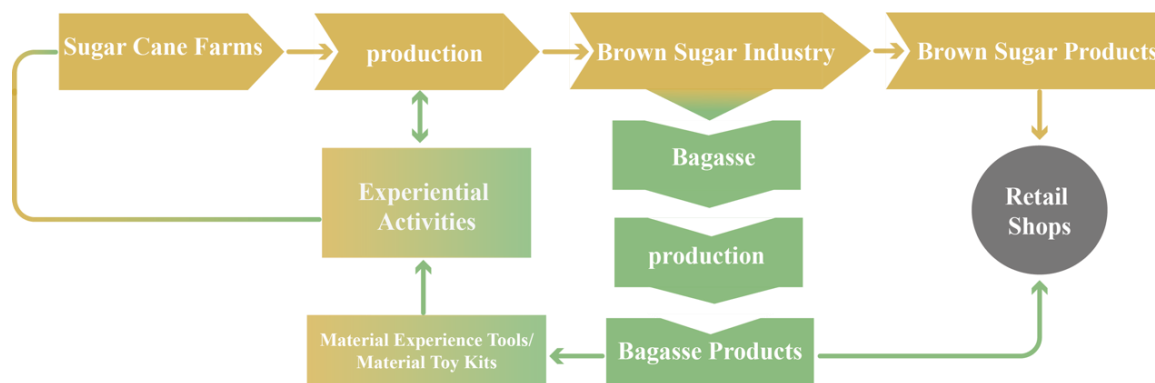


Figure 8. Circulation path diagram of brown sugar industry ecological park  
Source: Author

*Establishment of a Database of Bagasse Material Samples*

Establishment of online and offline material sample database, online material database helps to publicise and promote brown sugar corporate culture and material sustainability concept. The establishment of offline material sample database helps consumers, enterprises and designers to build a good interaction. On the one hand, it helps consumers to understand where bagasse materials come from and how they are made. On the other hand, it helps designers to drive design projects based on the material properties. Samples of bagasse paper, bagasse bioplastics and bagasse composites are already available (Figure 9). After the matrix (binder) ratio is stabilised, more series of material samples will be launched in collaboration with the factory.



Figure 9. Bagasse material samples  
Source: Author

### *Application of Bagasse in Design*

Bagasse paper material and bioplastic samples have the characteristics of light transmittance, softness and thinness, presenting the unique paper texture and bagasse short and soft fibre aesthetics under the light source. This study applies this material to lamps and lighting products under light and natural light to reflect the unique aesthetics of bagasse fibre (Figure 10).



Figure 10. Bagasse material in the design of lamps and lanterns application  
Source: Author

Bagasse bioplastic has certain hardness, bending and biodegradable properties, which was used to launch the brown sugar product packaging design (Figure 11). The application of bagasse materials in design is thus developed to guide the subsequent diversification of commercially available products.



Figure 11. Design application of bagasse material in brown sugar packaging  
Source: Author

### **Discussion**

We are living in a non-sustainable "take-make-waste" model, which is based on a linear economic model that creates many environmental problems (Antikainen & Valkokari, 2016). In the past, the selection and use of materials was only a part of the design process, but now more and more attention is being paid to material-centred sustainable design exploration. The upgraded use of waste bagasse resources in the brown sugar industry enhances the value of sugarcane agricultural by-products on the one hand and solves the problem of bagasse dumping on the other. The application of bagasse materials in product design promotes the circular flow of waste resources and achieves the goal of extending the economic chain of the brown sugar industry. In this regard, this study has positive practical guiding significance. However, the production of bagasse products means that the brown sugar industry needs to open a new manufacturing line, which will generate more economic inputs and resource emissions. Whether or not this beautiful plan can achieve a win-win



situation for society, the environment and the economy require the co-operation of the government, the enterprises and the designers. The method of recycling waste resources in the industry needs to be further verified to see if it can contribute to the sustainable development of the industry.

## Conclusion

Bagasse material can meet the technical requirements for mass production in industrial systems, and the upcycling process of waste bagasse material can be realised as an example to promote the reuse of other biomass wastes for agricultural diversification. This is of great importance to increase the added value of agriculture and the economic income of local farmers. The reuse of bagasse materials in the brown sugar industry fulfils the diversification of the community economy, which is conducive to gaining the attention and heritage of the younger generation. The brown sugar industry eco-park realises the flow of bagasse waste, the sharing of unused space, and the dissemination of traditional brown sugar culture and sustainable concepts, reflecting the concept of industrial republic.

The bagasse material in this study still has room for progress in the field of material application, in the form of material expression, and in the way of interaction with consumers. The material experiments and products should be constructed in a more perfect way to reflect its commercial value, especially in the cultural attributes given to the products, the relevance and inheritance of the local corporate culture and history, which need to be explored more. In the subsequent development, we will consider promoting the circular economy initiative of the whole Yiwu brown sugar industry and registering the initiative in the knowledge platform of the United Nations Sustainable Development Group (UNSDG).

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**Conflicts of Interest:** The authors declare no conflict of interest.

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