



Research on the Current Situation of Recycling and Application of Discarded Fishing Nets and Pollution Countermeasures

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Abstract

The marine ecosystem has been severely damaged by the increasing amount of plastic waste dumped in the ocean in recent years. In this paper, the current situation of the recycling and application of waste fishing nets among them is investigated. Methods and opinions for the development of waste fishing nets for garment production are provided, taking into account the current development of environmentally friendly fabrics and the development trend of environmentalism and veganism in society to promote the recycling of waste fishing nets and reduce environmental pollution.

Keywords: Environmentalism; Veganism; Discarded fishing nets; Garment industry

Introduction

Since the 21st century, sustainable development has become a common pursuit of all humanity based on the background of global climate change, energy shortage and problems such as water and air pollution [1]. It is necessary to plan the development of the global economy from the height of the harmonious coexistence of man and nature [2]. For this reason, environmental protection is the responsibility of every country, every industrial enterprise, and even every individual.

As the economy grows and social attitudes change, the pursuit of high-quality life increases so does the consumption of clothing products and related natural resources. At the same time, the related enterprises have produced a large amount of wastewater, waste gas and waste residue at the expense of the environment to pursue efficient production speed and novel new material products. Coupled with the increasing amount of used clothing

being eliminated worldwide every year, producing healthy and environmentally friendly clothing products is now the trend of the textile and clothing industry [3].

In recent years, marine ecosystems have been severely damaged by the increasing amount of plastic waste dumped in the oceans, which has caused great concern worldwide [4]. In particular, lost or abandoned fishing nets account for approximately 10% of global marine waste [5]. Fishing nets are usually made of non-biodegradable materials, so entangled nets are difficult to cut or separate. They will cause marine pollution and seriously affect the ecological environment for the survival of marine flora and fauna. This has become a killer threat to marine life, from tiny coral reefs to large whales and even divers, who are inevitably entangled in used fishing nets [6]. Therefore, the recycling and reuse of used fishing nets is essential to protect the ecological environment and animals of the sea and to achieve the reuse of resources.

Considering the material of used fishing nets, recycling used fishing nets for garment production is in line with the green development concept of harmonious coexistence between human beings and nature.

Pollution in the Textile Industry and the Plight of Discarded Fishing Nets

Pollution in the textile industry

When removing impurities from natural fibres such as silk and raw linen, chemical or biological degradation is often used, during which wastewater and emissions are generated. The raw material of synthetic fibres is also treated by adding various oils to the spinning process to keep it soft and smooth. Moreover, the oligomers leached from the fibres place a significant burden on the soil and groundwater [7]. In addition to the noise pollution caused by the large equipment in textile mills (up to 100 decibels or more), carbon disulphide and hydrogen sulphide added to synthetic fibres are released during the sorting and washing of raw wool. The boilers used for weaving also emit large amounts of exhaust gases such as soot and nitrous oxide, which seriously pollute the atmosphere [8]. Dyestuffs and dyeing additives enter rivers and lakes with the wastewater, seriously affecting the living environment of aquatic plants and animals. The treatment and disposal of printing and dyeing wastewater are still very tough [9]. In addition, with the rise of the fast fashion industry worldwide, the population places excessive emphasis on fashion and trends, leading to the rapid replacement of the clothing. According to rough statistics, about 26 million tons of clothing are discarded in China every year. A large proportion of the discarded old clothes are disposed of in landfills or incinerated, which also significantly impacts the environment [3].

Environmental damage and recycling dilemma of discarded fishing nets

In Europe, fishing gear such as abandoned or lost nets is the most common debris on the coast, accounting for 27% of the total amount of litter [9]. Fishing nets are usually intact for only a short period. They are worn out in the ocean during use, resulting in approximately 640,000 tons of fishing gear being discarded each year [10]. These discarded fishing nets not only cause serious harm to living marine flora and fauna but also decompose over time to produce microplastics that will cause significant economic and social harm [11]. In order to eliminate the problems posed by used fishing nets, there are already some methods to recycle and reuse fishing nets around the world.

In practice, however, it is not easy to recycle fishing nets, which are made from different plastic fibres [12]. Because of the stringent requirements for the toughness and elasticity of fishing nets, they need to be manufactured from high-quality polymers, mainly polyester, polyamide, polyethylene and polypropylene [13]. Their availability and ease of utilization differentiate the recycling of fishing nets. Fishing nets like those made of polyamide are

chemically recycled by depolymerization, converting polyamide nets into recycled material used in garment manufacturing or developing yarns for new products [14]. For example, the gauze material produced by Zhongliang Co., Ltd. is made from recycled fishing nets. The polyamide material from the discarded nets is recycled, undergoes a deep cleaning and drying process, and is then remanufactured into fibre masterbatches and drawn into yarn. Other environmentally friendly materials can be added to increase the elastic texture, and the prepared product meets the GRS global recycling standard certification. Fishing nets made from polyethylene and polypropylene are of a lower value as they are often used to produce trawl nets, which suffer from severe wear during use and need to be thoroughly cleaned if recycled, thus increasing the cost of the process, so most research has focused on the use of these nets as reinforcing fibres for construction applications [15].

Although some improvements have been made in the reuse of waste fishing nets, the processes involved in this process are complex and may also generate some new pollution. The existing literature and patented inventions for the recycling of waste fishing nets are also lacking, so research on waste fishing nets has to continue [16-19].

Responses to Pollution and New Trends in Environmental Protection

Trends in the development of environmentally friendly fabrics

Since the 1980s, the pursuit of environmentally friendly and safe clothing fabrics has been slowly emerging in the industry. It has now developed into a new trend and goal to be pursued worldwide [2]. In 1986, the British company Courtaulds was the first to use natural fibres to make environmentally friendly fabrics, using high-tech means to extract fibres with minor irritation to human skin to weave. After that, more natural and environmentally friendly fibres jumped into the public eye, such as the absorbent bamboo fibre and the unique coffee yarn series of underwear fibres extracted from corn protein [20]. In the research of environmentally friendly dyes, Itochu Shosha in Japan has developed green tea dyeing technology. Furthermore, China has invented resin-based formic acid-free dyeing agents and the use of organic photochromic materials for garment production, which can change the color of clothing after a simple physical process of light [20].

The production of fabrics or clothing from recycled waste has also been widely investigated. For example, Young et al. took advantage of common waste resources in daily life and made new fabrics from used fishing nets to produce clothes, thus up-cycling waste fishing nets. The use of waste tents and plastic stools has been transformed into clothes, shoes and bags, etc. [21].

In addition, with the continuous development of the polyester fibre industry, polyester has brought convenience to people's lives and brought many pollution problems. Turning these polyester wastes into resources that human beings can use has been a hot

spot of research in countries around the world. At present, the polyester raw materials are recycled from waste polyester bottles, polyester fishing nets and other polyester fibres by physical, chemical and physical-chemical spinning methods, after which they are processed into garments [22]. For example, 3M in the USA used PET bottles to develop a thermal fabric containing 50% recycled polyester fibres. Meanwhile, Dyersburg Fabrics and Wellman in the USA use fibres made from recycled polyester bottles to make suede fabrics and have developed fabrics for people to use outdoors and clothes to wear when playing sports. The uniforms provided by Nike and Adidas for the nine national teams at the 2010 World Cup in South Africa were made from recycled polyester bottles [23]. Many factories in Italy can automatically sort and recycle clear and colored polyester bottles and produce high purity materials suitable for high-quality fibres. The Japanese company Nemoto Sangyo uses waste polyester bottles to produce a variety of carpets and garments [23].

The popularity of veganism

With growing environmental awareness around the world, veganism is gaining much traction as a healthy lifestyle emerging at the moment. The original intention of vegan-ism is to reject animals as commodities, avoid as much as possible the consumption of all products containing animal ingredients, and protect the planet. According to a survey, China's per capita consumption of meat products reached 29.2kg in 2020. This high total consumption is closely related to the rapid development of China's livestock industry, but inevitably, the process of livestock farming causes harm to the environment [24]. For example, the methane and nitrogen produced by livestock farms reduce the quality of the air, and the microorganisms and insect eggs contained in livestock manure, as well as the antibiotics, fertilizers, and other medicines applied during the farming process, can be discharged into rivers causing pollution of the soil and water environment, among other things, threatening the health of the public [24].

Veganism is not simply restricted in terms of diet only, but shows this concept in all aspects of life, such as our choice of clothes, rejecting clothing made from animal leather, and in the manufacturing of cars choosing not to use seats made from

animal leather. In recent years, veganism has swept the fashion world, combining beauty with environmental health, such as the vegan make-up brand HausLab, created by Lady Gaga, and Stella McCartney, who has teamed up with sports giant Adidas to launch a 100% recycled fabric hoodie and a bio-fibre tennis skirt. Adidas has also developed a plant-based leather material to make shoes, for example, and the leather alternative is made from mycelium, which is part of a fungus [25]. Although veganism has gained some traction, it has only caught on in a small way and it will take a long time before it is generally accepted and becomes a common national lifestyle.

Current examples of sustainable brand product design in the clothing industry

In addition to veganism, novel designs that allow for the regeneration of used clothing into fashion can also be profitable and environmentally friendly. For example, the Re-clothing Bank, founded by designer Zhang Na in 2011, is excellent [26]. They accept donations of second-hand clothes from the whole community, sorting the used clothes they receive and either sterilizing them for donation, reselling them directly, or designing them to be 'reborn' [26]. Currently, the Recycled Clothes Bank's 'reborn' designs consist of three collections, divided into basic, ready-to-wear and couture, depending on the customer's needs. The basic collection is based on standardized patterns designed by the team to be produced in bulk. The ready-to-wear collection is based on designer Zhang Na's idea of restructuring the dismantled clothes into fashionable ready-to-wear pieces. For the Haute Couture collection, unique designs are selectively made for clients because of the amount of workforce and resources involved [26].

Rombaut, a menswear and footwear brand founded by a Belgian designer, is also an internationally renowned ecologically conscious fashion brand, producing each of their products with considerable sophistication, hand-dyeing and sewing with strictly biodegradable raw materials, embodying simplicity and eco-friendliness throughout the process [27], as shown in Figure 1, where Rombaut uses discarded fishing nets to develop new fabrics for garments and footwear.



Figure 1: Products made from recycled material from discarded fishing nets [27].

In addition, the Guangzhou cotton and linen clothing company "INMAN", the British recycled fashion brand "Junky Styling", the Italian recycled lingerie brand "Intimissimi" and the Japanese company UNIQLO, which has set up a large-scale collection of its clothing. All of these brands have made great strides in recycling

used clothing. They promote themselves by holding fashion shows, press conferences, or using the media and celebrities to make their ideas understood and call for more people to participate in the "recycling of clothes" campaign. These brands are making a profit and contributing to the environmental sector at the same time [3].

Current status of recycling and reuse of discarded fishing nets

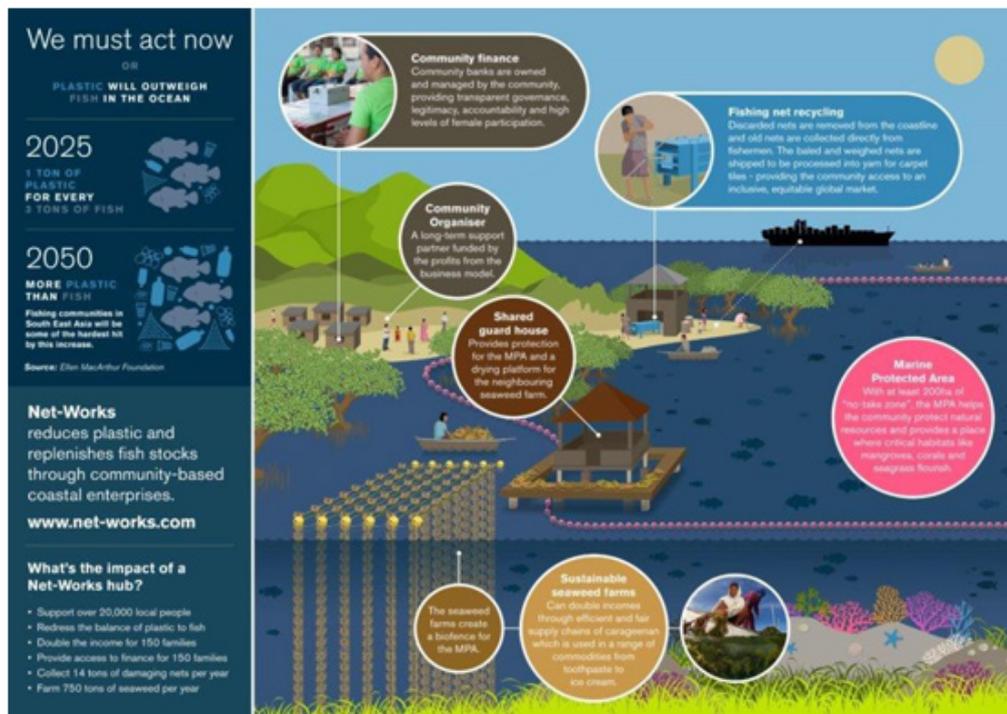


Figure 2: Net-Works business model for recycling discarded fishing nets [28].

Net-Works, a philanthropic team formed by internationally renowned carpet manufacturer Interface and the Zoological Society of London, has been promoting a co-prosperity business model for recycling discarded fishing nets in the Philippines since 2014, as shown in Figure 2. They help poor local fishers to collect broken nets, which are then supplied to Interface as raw material for the nylon used to make carpets. The project aims to reduce the ecological damage caused by discarded nets and provide economic support to low-income families in the Filipino fishing community. Similarly, the team plans to travel to Cameroon, West Africa, to promote this co-prosperity business model to support the local economic fashion community [28].

The Philippine government then calls on fishers to collect used fishing nets, which the fishermen sell and recycle abroad. This approach protects the ecosystem and expands the local income stream. In China and Pakistan, some divers volunteer to clean up the nets in the ocean. Related companies collect the salvaged nets and reprocess the good quality nets into new fishing gear or remanufacture them into plastic pellets for other products.

As shown in Figure 3, the raw material for MARINYLON™ net recycled gauze is waste fishing nets, which are sorted by material

and the recyclable parts (e.g., nylon) are subjected to a rigorous deep cleaning and drying process before being remanufactured into fibre masterbatches and drawn into yarn [29]. Recycled nylon yarns can be combined with other environmentally friendly materials, for example with recycled PET yarns to create a two-tone effect. Elastic yarns can also be added to increase the elastic feel of the fabric or to make it more breathable by using variations in the fabric's structure. Even with yarns made from recycled nylon raw materials, the physical properties of these fabrics can be very outstanding [29].



Figure 3: MARINYLON™ gauze material made from recycled fishing nets [29].

Strategies & Implications

Adopting positive psychological cues and marketing approaches

The public can know a brand to a large extent without the success of brand marketing. The essence of a brand is to induce consumers to produce a perceptually matching to-tem with the help of psychological suggestions. The key to the success of brand marketing lies in whether it can produce psychological resonance in the mind of consumers and thus generate consumer behavior [30]. Therefore, when a brand wants to suggest and guide consumers with the help of a particular element of the brand, consumers will subconsciously make a preconception. If this preconception matches the psychological suggestion of the company, this will resonate with the consumers, which in turn will create the emotion of wanting to buy [31]. For example, manufacturing a car will put more weight on the door, which will make the consumer think that it is a safe psychological perception.

Reclothing Bank has built a strong brand image through charity and philanthropy, offering jobs to laid-off workers and donating a portion of its profits to more needy organizations. INMAN uses the influence of public figures to promote the concept of environmental protection and gain public recognition, while at the same time making their brand's concept of turning waste into treasure and old into new reach everyone's mind, thus promoting the sales of their products. Junky Styling in the UK uses its products as examples and organizes training sessions and seminars to teach people how to transform their old clothes. This allows people to learn the skills and better understand the concept of environmental protection and energy-saving that the brand implies and makes the brand image more deeply rooted in consumers' hearts [30].

Conclusion

Through the research of literature and information on the current situation of the use of waste fishing nets, the development and application of environmentally friendly fabrics, as well as the research of some sustainable brands, in this paper, the pursuit of discarded fishing nets is illustrated that can be developed sustainably from three aspects including global trends, industry pollution and environmentalism. There are still many problems for the actual industrial reuse of discarded fishing nets in large quantities. Research into the reuse of fibres from discarded fishing nets is still lacking. The associated processes involved are complex, leading to high costs and difficulties in balancing profitability and socially responsible management of companies. Although environmentalism and veganism are becoming popular internationally, they are still niche. Combined with the weak product design capabilities compared to other clothing brands, especially fast fashion brands that place a tremendous burden on the environment, further research is needed to determine whether the general public can proactively accept these niche eco-friendly products. The recycling methods, reuse methods, related product design, and marketing strategies for discarded fishing nets need to

be further researched and developed by the companies involved to contribute to the protection of the planet while making a profit.

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Conflict of Interest

Authors declare no conflict of interest.

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