Chapter 20

New business and marketing concepts for cross-sector valorization of food waste

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20.1 Introduction

In this modern time, society contributes more effort toward the impact of manufacturing, marketing, and purchasing products based on communal, moral, and ecological aspects along with the economic perspective. Commercialization of recovered products from waste has more environmental benefits, with unique characteristics and steady costs (Brown et al., 2011). As per the report of the International Energy Agency (IEA), the global trade value of biobased recovered chemicals reached 9% that of synthetic chemicals in 2012 with a market value of US$252 billion. In addition, the implementation of appropriate technology for the biorefinery process is required to withstand the competitive business sector. This competition enables the providence of high-quality recovered products with manufactured assurance to meet consumer requirements (Miandad et al., 2017). Hence, the adoption of cheaper methodology using fewer stages in the recovery process with appropriate performance and better product yield should enable profit during commercialization. The most significant fact in implementing recovered products on a large scale is consumer acceptance, which is an indication of product failure or success. This depends on the storage life, color, healthiness, formulation of the product, and source of the raw materials used. A raw material source has a major responsibility in the biorefinery process. In this framework, food waste (FW) is a better option, as it is an economical, renewable, and excellent feedstock to generate recovered products such as biochemicals, biomaterials, and bioenergy sustainably.

The global population increment and urbanization have exacerbated FW generation in the form of liquids and solids (Kavitha et al., 2017). The burden of disposal has instigated a recovery process that is an ultimate strategy in FW management. Consumer's awareness of environmental issues and strict legislation limits for industries in FW dumping promote the development of eco-safe management options. The valorization of FW alters its composition to beneficial products with better characteristics to gain market value. Nowadays, the beverages and meat-processing industries utilize phenols and dietary fiber extracted from olive mill wastewater (Caporaso et al., 2017). About 27 million tonnes of waste from fish-processing industries are used to recover products in for the cosmetic and pharmaceutical sectors (Ben Rebah and Miled, 2012). Hence, vast scientific knowledge is required to overcome innovation issues and prevent unsuitable products prior to commercialization on a large scale in accordance with the strict regulations for product safety.

During the innovation of business and marketing of recovered products, certain barriers such as investment cost, product knowledge, multidisciplinary skills, communication skills for marketing, research efforts, regulation limitations, and policies need to be tackled. An outline to the chapter is given in Fig. 20.1. This chapter describes the commercialization and patented applications in FW biorefineries including policy implications and marketability of products. The necessity for good marketing and formulation of these strategies to attain better value are well elaborated and various business models for implementing product recovery from FW are discussed. The contracts and public interest in the sustainable development of FW biorefineries are also detailed.

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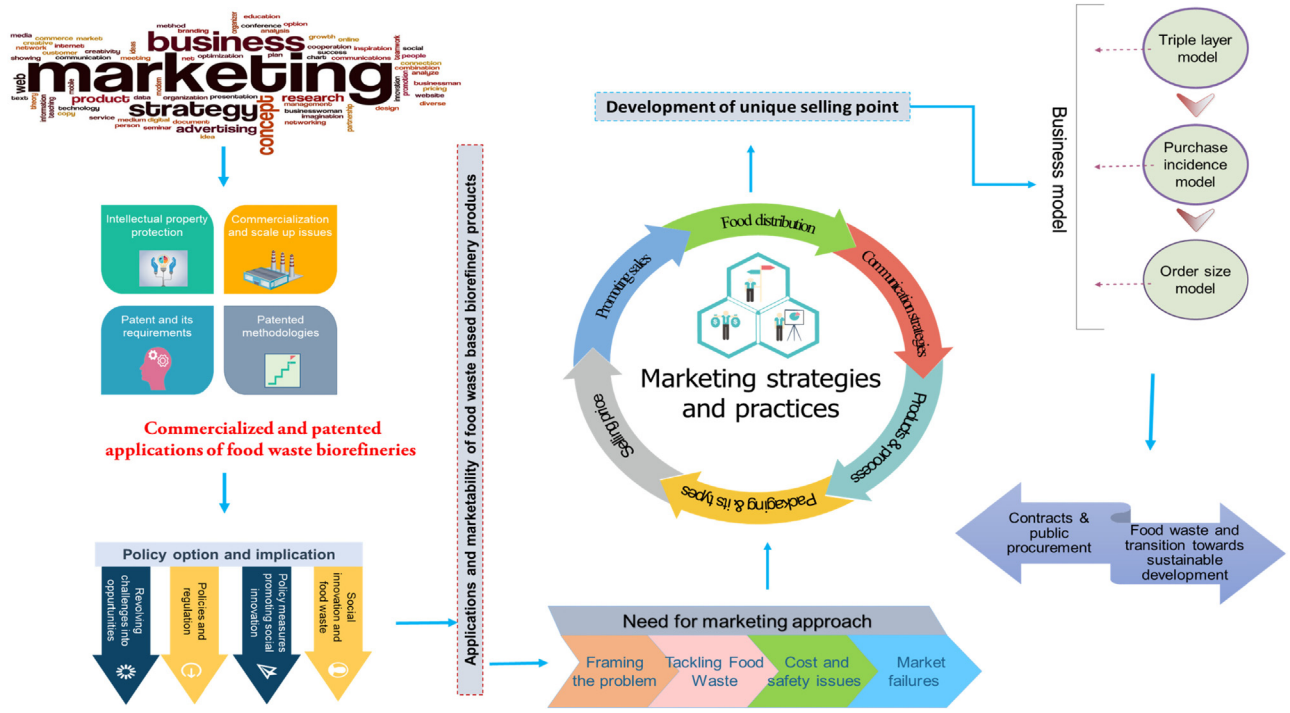

FIGURE 20.1 Overview of the business and marketing concept in food waste biorefineries.

20.2 Commercialized and patented applications of food waste biorefineries

Commercialization plays a significant role in achieving good social, environmental, and economic impacts of recovered bioproducts in FW biorefineries. The major objective of FW biorefinery commercialization is to extend the innovative patent idea from laboratory research to a large scale with similar productivity and product quality. Fundamental, methodical, and biological issues must be solved for profitable and successful large-scale operation after detailed study and research. Proper planning for successful implementation of the product with suitable capacities is necessary, with adequate knowledge of commercial and industrial strategic issues (Banu et al., 2018). These tactics assist in the sustainable development of innovative marketing companies.

20.2.1 Intellectual property protection

Implementation of unique ideas in developing FW biorefineries is a crucial step to attaining better progress in the business sector with good market value for the recovered product. The term "intellectual property production (IPP)" is the fundamental method of protecting innovative facts to avoid the distortion of scientific and business strategies. Hence, intellectual property (IP) is considered a major feature during the commercialization of FW biorefineries. It is important to understand the fundamental rules and laws to safeguard the IP rights prior to the commencement of operations for industries or companies. Proper documentation of rules, costs, and expected investment, etc. are needed for the IPP application. It is a precautionary step to avoid the interference of third parties which may restrict business operations. Industries must take proper cautionary steps to guard their IP by filing patent applications, proper cataloging of trademarks and copyrights, along with additional suitable steps to protect trade secrets. About 147 members of the World Trade Organization have signed up to protect the IP of the work of individuals within member countries. There are four main types of IPP:

- Copyright protection;
- Patent protection;
- Trade protection;
- Design protection.

Copyright protection is the protection of creative and factual ideas that promote artistic and literary creation in recovered products. They can be registered once the work is published or voluntary registration can be done which prevents disputes about ownership. This copyright law is valid for 70 years after registration, even after the author's/creator's death. After the article publication, copyright is transferred to the author who holds the copyright for 25 years (James and Jennifer, 2014). In the United States, copyrights are valid for 28 years and can be renewed regularly, and it is an offense if the work is revealed to the public without the knowledge of the author. Economic rights and moral rights are protected in copyright by the World Intellectual Property Organization (WIPO). The economic right is the claim for revenue for using the work, and the author can prohibit or authorize the public utilization and translation of their work. Moral rights are the personal rights to protect from offensive worthless profit and the right to obstruct work modification to secure work fame. The WIPO committee on development of IP has an official agenda in implementing the guidelines, and considering queries and recommendations with respect to copyrights. Patent production protects novel methodological facets of the recovered product. It can be achieved by filing the innovative ideas at the patent office, which is the most common protection model. The longevity of a patent filing is 20 years (Williams, 2017). It can be filed at national, international, as well as regional levels. In trade protection, the trade identity is safeguarded to gain the market value by securing the information of business details such as investor details, dealers signs and business ideas. Design protection represents the registration of a product design or shape for marketing that protects the visual appearance of the product. Hence, IPP is an important pivotal phase that should be used to achieve successful marketing of new products recovered from FW biorefineries.

20.2.2 Commercialization and scale-up issues

Commercialization of recovered bioproducts at a large scale has several problems including (1) lab-scale research, (2) difficulties faced by biobased recovered product production at the pilot scale and large scale, (3) intellectual property protection (IPP), and (4) proper development of the precise application. Startup and basic optimization of the biorefinery process can also hamper timely product recovery (De Bhowmick et al., 2019). Another major challenge is handling of huge quantities of FW for large-scale production. In addition, it is essential to monitor for microbial contamination prior to processing, as this may drastically affect the biorefinery process and promote failure of the derived final product. This necessitates proper storage facilities, and critical scale-up parameters such as extraction processes and reactor working volume are required. It is not practical for all the physical or chemical parameters to be maintained constantly during scale-up, and it is important to predict crucial parameters which disturb the execution of effective scale-up. On implementing the bioproduct extraction techniques, economic benefits and establishment of recovered product in the market are the major factors to be considered. During the scale-up process, the functional characteristics and quality of the recovered product should not be altered, and they must satisfy the consumer's need (Pham and El Halwagi, 2011). This is difficult due to the existence of complicated recovery procedures, along with recapturing techniques. Crucial limitations such as time and heavier handling can affect the functional quality of the product. High process cost is attributable to high food formulations of recovered biorefinery products on a large scale compared to lab-scale production. Scale-up and commercialization problems should be resolved to enable the full range of cost-effective biobased product recovery from FW.

20.2.3 Patents and their requirements

An IP right granted for an innovative invention which can be used for industrial applications with a creative step is called a patent. The patent provides legal rights to restrict the manufacture, sale, use, and trade-in of recovered products. The patent holder can file a charge when infringement of patent occurs, since patent rights come under civil law. Patents encourage research growth by providing details of innovative, nonobvious biobased recovered products with industrial applicability and enable the right to earn capital during patent implementation (Giugni and Giugni, 2010). Patent offices/servers under process include the United States Patent and Trademark Office (USPTO) (http://www.uspto.gov/), Controller General of Patent Designs and Trademarks (http://www.ipindia.nic.in/), and Google Patents (http://www.google.com/patents). Based on the USPTO, there are three types of patents: utility patents, design patents, and plant patents. Utility patents include novel methods in the extraction processes, techniques, and manufacturing processes, and are granted for 20 years from the date of filing the patent application. Design patents cover the product's quality and characteristics with a firm depiction of the product nature. This design patent has 14 years longevity and can be used to stop sale and product manufacture by unauthorized persons (WIPO, 2019). Industrial plant are provided with innovated equipment and innovated design to recover products in the FW biorefinery process. Major requirements

to obtain patents include for patentable subject matter innovation (new products, processes, business methods, and materials), novelty (no publication before filing for patent), inventive innovation (certainty of new product), and utility innovation (novel industrial applicability). Patents are granted on technical criteria and are not based on commercial or market criteria.

20.2.4 Patented methodologies

There are various patented methodologies for biobased recovered products for the existing market, as shown in Table 20.1. Through the patent application, the recovered product is verified and matched with the patented process during each novel innovation. The exact innovation details about the production method are kept secure. Certain commercialized bioproducts from food and vegetable waste are now discussed in detail. A dietary supplement, albumin powder, was extracted from soy protein wastewater. This dietary supplement has analogous properties to whey protein. Lycopene was a highly marketed pigment in the business sector and can be extracted from tomato waste, which is utilized in restaurants to color meat and as a substitute for carmine. The Food and Drug Administration (FDA) confirmed the presence of lycopene in tomato by-products. In addition, the Food and Safety Inspection Service uses this lycopene pigment at a concentration of 50−100 mg/kg as a color agent in various food products. Hence, this biobased recovered pigment has good market value during commercialization. Apple pomace is a by-product of the apple-processing industry and this pomace is used to extract hemicellulose by a solvent extraction process using an alkaline solution. In addition, pectin is also extracted from pomace using acid. Both hemicellulose and pectin are employed in foodstuffs and sweet products as a substitute for flour, fat, or sugar. This recovered product has the ability to preserve liquid, which enhances the suspensions and oxidative immovability. Furthermore, phenolic compounds are extracted from peel and pulp mixture by a sequential extraction process which is disrupted by ultrafiltration. Olive mill waste is exploited to yield sustainable hydroxytyrosol using chromatographic columns filled with two resins: nonactivated ionic and XAD-type nonionic. Solvent extraction using acid is performed to treat olive mill wastewater to convert oleuropein to hydroxytyrosol. This recovered product retains antiradical properties associated with vitamins E and C, which inhibits lipid oxidation in fish and is used as a food preservative in bakery products to increase longevity. A polyphenol antioxidant, Hidrox, extracted from olive waste has antiinflammatory and antimicrobial potency. Salmon fish oil is extracted from salmon fish by patented a hydrolysis and mechanical extraction process. Spent grounded coffee is used to extract aroma using patented methodology.

20.3 Policy options and their implications

In order to stimulate the innovation of the biorefinery concept in FW, policies have been formulated which address the challenges in FW, prohibition of excess waste production, diminishing of FW at source, effectual recovered product distribution, and recovered product trading schemes. A short description of the most significant policy options in FW biorefineries is given next.

20.3.1 Social innovation and food waste

This policy options focus on fulfilling the social needs in a more efficient manner than the current solution. Research interest and awareness of using biobased products should be boosted through the educational system by proper funding from R&D activities (Issa et al., 2019). Paramount assets include the knowledge provided through the education system (e.g., college and university degrees). Also, educational programs with industrial sectors enhance the education system with long-lasting policies. Proper training has been provided to develop the unemployed employees by providing innovative ideas to provide quality bioproducts for societial concern and also trained to promote the products in the market in order to augment the professional skill and social policies. The core intention of this policy option is to develop scientific knowledge and empirical evidence to encourage innovative technologies.

20.3.2 Policy measures promoting social innovation

In order to gain experience for a project to be launched on a large scale, a proper detailed investigation is required at the demo scale/lab scale. This develops the project experience and gains consumer interest, investor interest, and raw material supplier's interest regarding the final output (bioproduct) of the project and initiates the opportunities for deriving new business. A pilot-scale study may avoid the technical obstacles encountered during implementation. Incentives

TABLE 20.1 Patented methodologies for commercial-scale implementation of various food waste biorefinery products and their market applications.

S. no.	Food waste	Recovered bioproducts	Patented methodologies	Applicant/company	Market application	Patent application number	Reference
1	Apple pomace	Dietary fiber	Solvent extraction	Yantai Andre Pectin Co. Ltd (China)	Dietary supplements	CN2008/1139768	Anming et al. (2010)
2	Pomegranate peel and seed	Ellagic acid and punicalagin	Solvent extraction	Xi'an App Chem-Bi(Tech) Co., Ltd (China)	Antioxidant in food industry and cosmetics	WO/1999/030724	Guangyu and Xiaoyan (2011)
3	Chicken feathers	Keratin	Washing, grinding, perforated rotating spiral drum, skimming, compounding	Eastern Bioplastics LLC	Polypropylene packaging, as a sorbent of hydrocarbons	US2012/08182551	Meyerhoeffer and Showalter (2012)
4	Olive mill waste	Medoliva (hydroxytyrosol, tyrosol, caffeic acid, and *p*-coumaric acid)	Ultrafiltration, ion exchange resin adsorption, solvent elution, spray drying	Polyhealth (Larissa, Greece)	Food supplements and antioxidants, cosmetics, personal care products	GR2010/1006660	Petrotos et al. (2010)
5	Spent coffee grounds	Bioactive silverskin extract	Subcritical Extraction	Consejo Superior de Investigaciones Cientificas/ CIAL (Madrid, Spain)	Cosmetics, nutrition, and health	WO 2013/004873	Del Castillo et al. (2013)
6	Tomato processing waste	Lycopene	Conventional extraction process	BIOLYCO Srl.	Therapeutics value	US20100055261A1	Lavecchia and Zuorro (2010)
7	Grape seed	Polyphenols and pigments	Pulse electric field and high-voltage electric discharge process	Universite Technologie De Compiègne-UTC (Compiègne, France)	Food supplements and additives	PCT/EP2011/ 070597	Boussetta et al. (2013)
8	Olive pomace	Polyphenols and oil	Conventional extraction	University of Porto	Cosmetic purpose and food additives	WO/2017/212450	Oliveira et al. (2017)
9	Tamarind seed	Polysaccharide	Solvent extraction	Indena SpA	Active pharmaceutical constituent	EP2575973 A1	Giori et al. (2013)
10	Pomegranate peel	Polyphenols	Conventional extraction	Liker; Harley, 2014		US2014/0056930 A1	Liker (2014)
11	Plant food waste	Phytochemicals	Centrifugation	Minister of Agriculture and Agri-Food, Canada	Functional food ingredients	US07943190	Mazza and Cacace (2011)
12	Food waste	Methane	Anaerobic digestion plant	Emerson Electric Co.	Storage	WO2015199887A1	Michael and David (2015)

(*Continued*)

TABLE 20.1 (Continued)

S. no.	Food waste	Recovered bioproducts	Patented methodologies	Applicant/company	Market application	Patent application number	Reference
13	Cranberry and pomegranate extract powders	Antibacterial agents	Thermal extraction	Mackler, Ari (POM Wonderful LLC)., 2014	POMcran capsules (25−5000 mg)	US2014/0010871 A1	Mackler (2014)
14	Spent coffee grounds	Aroma	Solvent extraction	University of Minho. CEB—Center of Biological Engineering (Braga, Portugal)	Distilled beverage	PT 105346	Mussatto et al. (2013)
15	Mango peel	Pectin, polyphenols	Acid hydrolysis	Taboada, Evelyn., Francis Dave Siacor., 2013	Gelling agent, stabilizing agent in fruit juices, preservatives	WO2013141723 A1	Taboada and Siacor (2013)
16	Coffee silverskin	Bioactive silverskin extract	Centrifugation extraction	Ito En, Ltd, (Tokyo, Japan)	Paper industry	US 7,927,460	Sato and Morikawa (2011)
17	Citrus peel	Dietary fiber, flavorant, oil	Solvent and enzymatic extraction	Del Monte Foods Inc	Nutritional supplement, food additive	US20130064947 A1	Nafisi-Movaghar et al. (2013)
18	Kitchen waste	Lactic acid	Fermentation process	Massachusetts Institute of Technology	Acid regulator, preservatives and flavoring agent	US20160355849A1	Gregory et al. (2016)
19	Plant materials	Phytochemicals	Pulsed electric field	–	Food additives	US Patent 8147879	Ngadi et al. (2012)
20	Food waste	Lactic acid	Biofield generator to ferment food waste	TSNT GLOBAL CO., Ltd, Daegu	Flavor compound	US20180016196A1	Choi (2016)

from well-famed biorefinery industries through joint ventures may minimize the investment risk (Rosales Calderon and Arantes, 2019). It supports innovated product development to replace inadequate products in the market. This enables profit, greater distribution of product, more affordable price of product to be decided, good promotion in the market, and also adds trade value. Setting up educational programs at a national/local scale about biobased product usage may assist in the development of innovative technologies. The absence of this may obstruct and hinder the development of innovative technologies due to poor understanding. Hence, proper information about different stakeholder requirements with technical details and their impact is necessary for effective commercialization of biobased products.

20.3.3 Policies and regulations

Advancement of opportunities to produce green products is done through firm environmental standards and regulations. The augmentation of goods and service prices result in product loss. It is intended to enhance stakeholders' expectancies by gathering successful stories about the innovative biorefinery sector. Some negative aspects of this policy include limited data, which may lead to misconception of methodological and commercial information. Japan's Food Waste Recycling Law was passed to encourage the recycling of FW by industries in order to enhance biobased product businesses. The Amendment of Municipal Solid Wastes (Management and Handling) Rule in 2013 and 2015 categorized FW into biodegradable coded containers by color at the source of generation. The National Environmental Agency (NEA) and Agri-Food and Veterinary Authority (AVA) of Singapore and Malaysia have conducted educational programs to reduce FW generation. China launched the Food Security Law in 2009 to regulate FW treatment.

20.3.4 Resolving challenges into opportunities

This policy option exists for areas to meet unnecessary issues that develop during orientation, including a lack of harmonization in national and local governance. This requires public investment and subsidies to establish a structure with proper facilities, such as communication systems, power requirements, and manufacturing unit systems. The decisive option to harmonize service procurement has to be guaranteed to develop a biorefinery. This depends on the FW suppliers, companies involved in collection, mechanical services, stocking and delivering biorefinery products, all aimed at minimizing the operational costs for resourcing innovate logistics systems (Philp, 2015). These are crucial activities in order to guarantee the procurement of services necessary for the development of a biorefinery and to achieve effective coordination. Direct grants for marketing biobased products may distort the market resulting in excess supply. If grants are provided based on quantity, marketability increases. Furthermore, fixing higher price for final products causes issues in transferring wealth to producers from consumers/taxpayers. This addresses the creation of marketability for biobased products along with regulatory challenges. The major limitation of this policy requirement of bioproducts shows no difference, but there is a major difference in cost and benefits of the products. This depends on the feedstock or production methods. Proper recognition needs to be provided by governments for these recovered biobased products with little environmental impact compared to petroleum-based products.

20.4 Applications and marketability of food waste-based biorefinery products

There has been a dynamic development of biobased recovered products from FW biorefineries, with a 20% annual growth rate. Most of these companies are still in their early developmental stage of marketing, as it is a time-consuming activity due to the multifaceted supply chain and operational process. The bioproducts derived from FW replaces the fossil fuel-based products which could make a huge impression in the present market on a large scale at low price and are considered to be valuable bio-refinery products. Thus, price and environmental impact play vital roles in the application and marketability of these products. This necessitates the prospect of innovating new bioproducts rather than replacing products to satisfy the market need without competing with current products. Though innovation of novel markets has challenges, it could enable a sustainable expansion of these products to new areas. The global marketing for bioplastic polymers is less than 1% as these polymers are used for food packaging only, however they are an innovative green product that was expected to attain 5% of the market by 2020. Biochemical and biomaterial sales in this market could reach 17% and 38%, respectively, of the total market by 2050 (Dusselier et al., 2015). The real marketability of biobased products is governed by industrial growth and policies that shift from a fossil fuel-based economy to a biobased economy.

Basic biobased recovered product has a market value in the range of €0.5−2/kg. Perfect innovative products could achieve a good market price. Each year, biomedicines have an 11% increment in the market. Nearly 50%−60%

medicines are produced by chemical synthesis using natural products as the source material (Straathof and Bampouli, 2017). About 120 medicines currently in the market are prepared from higher plants and 10%−25% of medicines that at least have one active compound from higher plants. A similar marketing approach was achieved for biocosmetics and bionutrients extracted from FW biorefineries.

20.4.1 Fruit and vegetable waste

There are some biobased recovered products that are produced on a commercial scale that have high marketability. Europe is a major producer of sugar beet, at 13 million tonnes/year. Sugar beet processing units create beet pulp as a waste product which is processed by a PULP2VALUE approach to extract a valuable compound—microcellulose fiber. This fiber has a high marketing value for manufacturing detergents, oils, paints, personal care substances, and coatings (Yang et al., 2018). One of the leading companies, Royal Cosun, has utilized the PULP2VALUE approach and developed a full-scale plant to produce bioproducts. This product has a market potential of 350 tonnes, with a value of 200 million euros. Another innovative research is Pro-Enrich, which utilizes rapeseed pressed cake, olive pomace, tomato, and citrus waste to generate bioproducts using research designed by the Danish Technological Institute (Denmark). The biobased recovered products generated include protein, polyphenols, pigments, and dietary fibers which are utilized as food additives, animal feed, cosmetics, and adhesives. Global Bioenergies in France has organized an OPTISOCHEM approach to extract isobutene from wheat straw. This extracted product has been used for producing high-value marketable products such as lubricants, flavor agents, fragrances, and sealants. The yield of this isobutene from wheat straw is 20% greater than from fossil fuel-based substances. Food grade protein powder (RuBisCO) is unique in nature as it is extracted from discarded vegetal processing industry waste in an industrial scale. This product has two to five times higher market value than the current artificial protein powder. Phenolic compounds and carotenoid pigment are extracted from paprika, red chili, red pepper, and capsicum species (Yammine et al., 2017). Carotenoid pigment has good market value as a coloring agent.

20.4.2 Coffee waste

Worldwide, coffee is a highly utilized food product and the by-products of coffee processing include coffee silverskin and spent coffee grounds as waste during the roasting and brewing processes. This waste has certain biobased compounds such as antioxidants, nutritious fiber, and biostarch which have numerous health benefits (Campos Vega et al., 2015). Coffee silver skin is one of the best functional food additives to improve health, and also can be used to manufacture paper. About 6 million tonnes of spent coffee waste are generated annually, this could be utilized to extract flavors for confectionery, biscuit, cereals, and pastry preparation. Another waste from the coffee bean processing industry is coffee cherry, which has a citrus, floral, or roasted fruit nature. This waste has wide applications in bread, cookies, brownies, pasta, sauces, etc. (Hughes et al., 2014) and wide scope in the food market. Extraction phenolic compounds from winery waste include grape marc and lees (Yammine et al., 2017). These techniques are also used to extricate the carotenoid pigment from paprika, red chili, red pepper, and capsicum species.

20.4.3 Dairy product waste

Natural nutrient-rich proteins are a major product recovered from dairy product waste. From the dairy product waste, lactose and aroma compound are extracted by an enzyme-assisted extraction process. The recovered lactose has potential applications in glucose-rich syrup production and sweetener preparation (Dutra et al., 2015). The European dairy industry makes use of this waste to generate whey protein using the AgriChemWhey approach, and also lactic acid, polylactic acid, minerals, etc., which enhance human nutrition and quality biobased fertilizers. This approach attracts an income of up to 325 million euros, with about 80,000 tonnes of lactic acid being exported.

20.4.4 Animal by-products

A tremendous quantity of waste is generated by the meat-processing industry with potential nutritive value which can be processed as food additives. The microbial-disintegrated waste of this industry forms a slurry which is processed as fertilizer. The meat industry generates a huge amount of wastes and by-products, which are a good source of nutrients and can be used as food ingredients and additives (Jayathilakan et al., 2011). The meat products processed by the air flotation skimming process form a sludge which has good nutritive value and is purchased for agricultural purposes as a

fertilizer (Hamawand et al., 2017). Chicken feathers have a high keratin content, which is used for packaging. In addition, omega-6-fatty acid, which can be extracted from chicken waste from the chicken-processing industry, has medicinal uses (Lasekan et al., 2013).

20.4.5 Seafood waste

The shells of crab and shrimp are used to extract a polymer-based compound, chitosan, by a solvent extraction process with alkali and chloroacetic acid treatment. This recovered chitosan is used as a thickener in vegetable oil and an antirancidity agent in meat (Muley et al., 2018). The fishery industry produces a huge quantity of waste and by-products that can have high fish oil contents. The omega-3 in this fish waste is used in foodstuffs and therapeutics. Greater attempts have been proposed to valorize fishery wastes and by-products (Lopes et al., 2015). The skin of fresh and burnt salmon fish is used to form gelatin and salmon oil as a result of fish protein hydrolysate. In addition, fish guts, skins, heads, and bones can be used as animal feed (Fan et al., 2017; Jayathilakan et al., 2011).

20.4.6 Emerging innovative marketing technologies

High-pressure processing (HPP) units have been utilized for preservation purposes in the past. Currently, HPP has gained significance in the extraction process for valorization techniques to recover valuable compounds. Other innovative technologies such as ultrasonication are used to obtain biopolymers (protein and carbohydrates) from soy waste. Also, pulse electric fields (PEFs) and high voltage electrical discharges act as potential treatment units to recover products from various FWs (Zuntar et al., 2019). The electroporation method extracts food products from meat, fish, and seafood by-products. Certain plant-derived vegetable wastes are utilized to recover biobased products. Phytochemical compounds are extracted by a subcritical water extraction process from plant-based FW; this compound is a rich source of antioxidants (Kumar et al., 2017).

20.5 Need for new marketing approaches

New marketing is one of the major requirements in the business field at present. The growing demand and search for new sustainable biobased products (with zero side effects) by consumers has promoted the development of a new marketing approach. Recently, the marketing trend has focused on eco-friendly products to overcome the various health issues and reduce the purchasing of chemical-based foods in the market. This motivates the innovation of various biorefinery products from FW (Perlatti et al., 2014). These biorefinery products reach the consumer through marketing. This makes the definition of marketing as follows: "marketing is the business action that supplies the exact biorefinery products and amenities from perfect producer to consumer at perfect place, time and price with proper service allocation to fulfill the customer's satisfaction." The marketing concept focuses the demands and necessities of consumers in terms of market data for developing strategies in order to fulfill consumer demand and organization goals. This boosts the development of a new market approach by proper collection of FW from source of generation and processing to recover the biobased product. This may easily tackle the problem of FW generation in quantity and quality. The marketing concept includes the following:

- Products in the form of belongings, services or thoughts are distinct based on consumer requirements which has been focused by the organization.
- Assimilation of entire organizational activities together with production and publicity to meet consumer demands.
- Attainment of longstanding organizational targets through official and reliable fulfillment of consumer demands.

20.5.1 Cost and safety issues of emerging technologies compared with conventional techniques

FW biorefineries process FW to biobased products by conventional techniques including physical processes: boiling and freezing, machine-driven, and electromechanical processes. About 29% of energy was utilized in the boiling process and 16% in freezing techniques. This motivates the development of innovative technologies to reduce the energy cost. This innovative technology also demands reduced operational costs (Sikarwar et al., 2017). Low thermal plasma treatment consumes less energy, at about $0.045/kg, but requires $636−9096/h to feed helium gas as input (operational cost) and $9−72/h for nitrogen as feed gas. Valorization of FW using a PEF extraction process consumes $9−72/h for a flow rate of 10 t/h and requires a lower energy input of 10 kJ/kg, which is sufficient to recover bioproducts from juices, sugar beet, apples, and chicory. The HPP-assisted extraction process consumes $0.107/L as operation costs

on processing 16,500,000 L/year of FW. However, the labor and capital costs are about 59% ($0.063/L) and 37% ($0.04/L) (Nizami et al., 2017). Innovative techniques also require more operational cost to produce biobased products, but have the advantage of reducing toxic compound generation. Consumers with knowledge of present biorefinery development would purchase biobased products with cost consideration but in knowledge of the environmental benefits. Consumer anxieties toward the regular usage of ideal product and processes enables the food manufacturers to develop innovative technologies in the production field. Hence, this approach has been used to develop new technology for FW biorefinery processes.

20.6 Business models

A business model illustrates the successful implementation of a business by considering the investment and financial details. Business models in FW valorization provide commercial prospects that contribute to sustainable business growth to generate new revenue and shift the attitudes of customers and businesses to protect the economy against product shortage and cost increments. Implementation of business models augments the production of biorefinery products and their marketability.

20.6.1 Triple-layered business model

This business model tool was used to explore an innovative and environmentally sustainable business. It explains the method of business development and the value of products created. It includes financial value in addition to the social and environmental values (Joyce and Paquin, 2016). This model enhances the sustainable development of organizations and society to produce good products with better market value. It allows the economic, environmental, and social validation of the model to develop creative user-friendly exploration of products for marketing. It offers a short outline to support visualization, statement, and teamwork throughout sustainable business model development (Lewandowski, 2016). The economic features of this business model to retail FW biorefinery product is illustrated in Fig. 20.2. Expenditures is described through funds such as distribution networks, brand, manufacturing factories, and patents, and activities such as marketing, manufacturing, and logistics. The social impact of the triple-layered business model considers the social value, employees, governance, business partner communities, scale of outreach, etc. The environment aspects of this model are required to assess the environmental benefits of the recovered product. Environmental benefits depend on the raw FW used and the quality of products obtained.

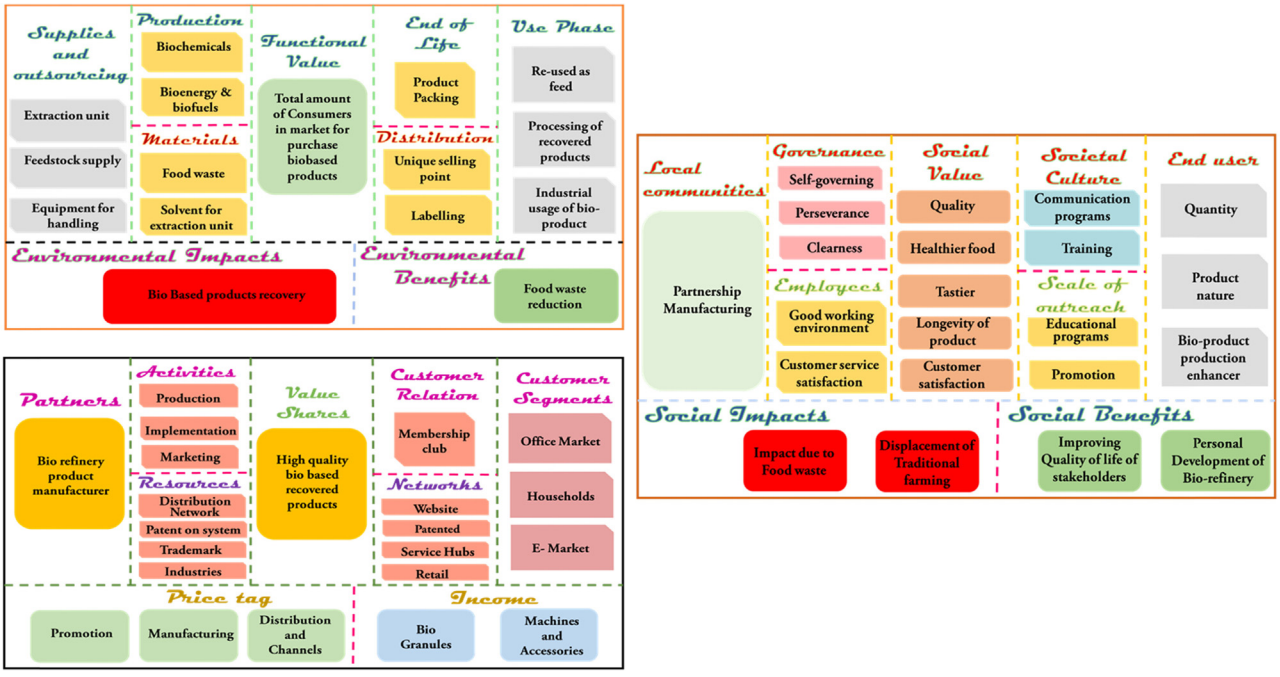

FIGURE 20.2 Triple layer model in social, economical, and environmental aspects.

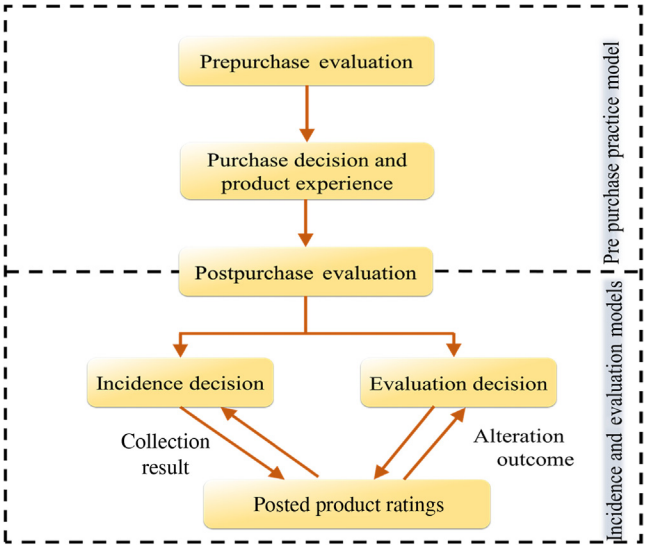

FIGURE 20.3 Flowchart representing the purchase incidence model.

20.6.2 Purchase incidence model

This model specifies the number of purchases that occur within a specific time. The sale of new product quantities is estimated in terms of customer percentage based on past documentation. This type of model was validated by cross-sectional data in accordance with marketing and services. However, it is difficult to deal with individual customers. The model investigates the reward program and events motivating the product purchase, retention, and revenue growth (Tafesse and Korneliussen, 2012). In this model, shareholder value maximization and investments made for marketing recovered products are properly evaluated. This intensifies the attractiveness to certain shareholders and significant analysts to focus alternative business strategies to intensify the growth, revenue, and profit as monitored by the manager (Verhoef et al., 2015). The opted-for techniques must be consistent with the ultimate marketing activities funds, which are calculated with respect to the expected effects on market capitalization. Fig. 20.3 presents a purchase incidence model.

20.6.3 Order size model

This model predicts the optimal order quantity at a given time for a given cost and requires sufficient space for storage, which indicates the economic order quantity business model (EOQ model). As per the literature, there are certain limitations in the EOQ model concerning the modern standard management's role through an effective inventory control system (Zhou et al., 2016). Assumptions made within this model are maintaining constant demand and lead-time and that inventory is instantaneous. This can promote serious financial implications for the organization. Inefficient cost control causes excessive expenses through high storage costs, unwanted product, and a reduction in working capital. The manager should have control of the inventory method, as the private sector acquires its profit when the inventory is controlled. It is obvious to maintain product value that is economically desirable for the customer. The major issues are maintaining inventory value to the lowest cost feasible subsequently saving on working investment and storage costs (Shekarian et al., 2016). The following formula explains the order size model:

$$Q = (2AS)^{1/2}/I \tag{20.1}$$

where Q is the economic order quantity (units); A is the yearly demand for specific product for a specific time (units); S is the ordering cost for a single purchase order; and I is the carrying cost to hold 1 yearly unit inventory.

The order quantity model with function as the total cost is provided in Fig. 20.4. It was observed that when the Q value increases, orders to be placed decrease for each year. Thus, the supply cost is augmented due to the larger average inventory.

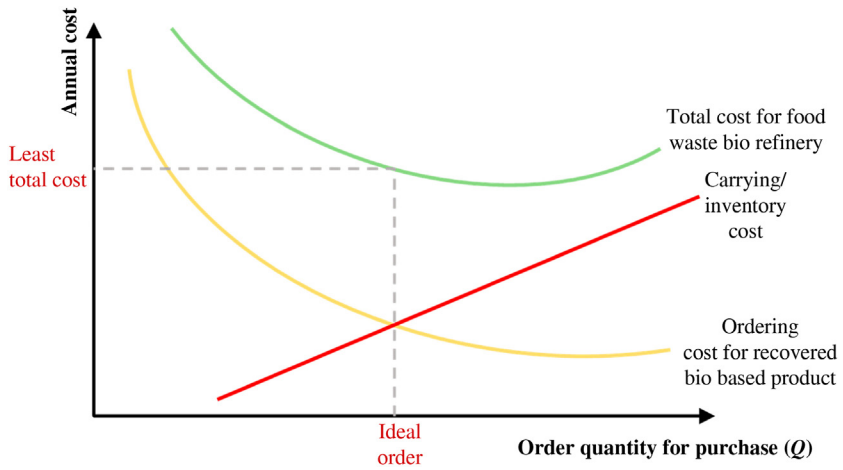

FIGURE 20.4 Order quantity model plot.

20.7 Marketing strategies and practices

This section illustrates the different strategies that are utilized to supply products to clients and customers of a business. It focuses on the efforts expended by the manufactures to produce the product for the marketing. There are various marketing strategies, namely: food distribution, communication, product and purchase, packing and its types, selling price, and promoting sales. These strategies act as a bridge between companies to collaborate with consumers. Practical implementation of this strategy creates knowledge about the product, awareness of product features, specifications, and benefits (Maniatis, 2016). Hence, these effective marketing strategies support the innovative product production in gaining an advantage over the competition.

20.7.1 Food distribution

FW occurs at each stage of food production and distribution. The national food industry and environment organizations are taking drastic steps to prevent these issues. The Feeding Network of America has launched a food biorefinery technique with the distribution of excess FW as food (Paritosh et al., 2017). This is an initial phase of the FW management process in which FW is collected from the source of generation prior to dumping. The collected FW is distributed to those with a shortage of food. Also, the remaining waste including raw vegetables and fruit, like peels, pericarp, decayed food products, etc., are collected and distributed as animal feed and biofertilizers for plant growth.

20.7.2 Communication strategy

It is the strategy of biorefinery organizations to reach the market goal by various means of communication and also to share information for political, psychological, or linguistic purpose (Van Dael et al., 2017). During this communication, caution should be taken to avoid incomplete unfinished messages and irrelevant discussions. This strategy can be promoted in seven ways:

- Nomination—This is the method of illustrating relevant clear and truthful information about the product;
- Restriction—Obligation of responses and reaction raised during communication;
- Optimal performance—Recognizing the perfect time to perform and communicate by analyzing when and how to speak;
- Subject control—This is a query section to forward the subject discussion. This also motivates listeners to contribute ideas;
- Subject shifting—This is a method of incorporating new innovative topics when there is a follow-through, so that new topics continue to be discussed. This can also be used to repair the communicative strategy;
- Repair—Overcoming communication breakdown to send more comprehensible messages;
- Termination—Making use of verbal and nonverbal gestures to end the communication.

20.7.3 Products and processes

The strategy for the product is the roadmap of the recovered product with complete manufacturing in the stipulated time to produce authentic products to achieve the market goal (Jayaram et al., 2013). The process strategy focuses on the process performed to fulfill the customer requirements and satisfaction throughout the product cycle.

20.7.4 Packaging and its types

Packing is the process, technology, and science of sealing or closing the product for sale, distribution, storage, and use. This significant strategy serves product identification and protection making it clean and convenient for the customer at the point of purchase (García Arca et al., 2014). Different types of packing include plastic packing (to pack industrial goods), aluminum packing (to pack animals feeds), cardboard backing (to pack groups of products for distribution), glass packing (to pack medicinal products), and foam packing (to pack animal-based products during shipping).

20.7.5 Selling price

Pricing for a new marketing approach must be attractive. It aims to gain the attention of consumers by offering a lower price on recovered product than the competitive, and by delivering the correct message to consumers to capture their attention at critical points of purchase in retail stores with attractive offers for biobased products. About 70% of consumers fall into this marketing strategy. This can be done by emphasizing price benefits and offers. This strategy is efficient for market competition.

20.7.6 Promoting sales

One of the top-most strategies in marketing is the creation of awareness and interest toward a product. This strategy mainly focuses on the consumer's perception of bioproducts rather than cost. Awareness of problem identification and its solution are required in this strategy (Espinoza et al., 2017). Attracting customer attention by digital advertisements such as blogs, content marketing in newspapers, video marketing, and social media marketing and infographics improve product marketability. Also, the direct selling of the biobased product to the doorstep by a virtual marketing technique is helpful. A social media management service promotes the new innovative product directly to consumers in a nonretail environment. Nowadays, this type of marketing strategy has high demand and helps facilitate the rapid growth of innovated biobased products.

20.8 Developing unique selling points

This is the method of maintaining uniqueness in the product among equivalent bioproducts to make the product more valuable during marketing (Ramcilovic and Pülzl, 2018). The unique selling point is created based on consumer need and their satisfaction, current trends and competition, and continuous monitoring of new competitors. Some options that develop unique selling points are given below.

20.8.1 Date labeling

Based on the European Food Information to Consumer law, the recovered product requires date marks to indicate the threshold for the product's safety. This labeling is aimed at sharing information about the duration of food quality without spoilage, along with manufacturing and packing date labeling.

20.8.2 Retailer options

This is a method of making product available to the customer using different modes of operation, such as placing products in shopping mall, website, and vending machines. It focuses in selling the product.

20.8.3 Mobile applications

This is a method of advertising the product using a mobile app to the customer. The mobile app marketing business is performed throughout the world, with the best-known examples being Amazon, Flipkart, and Snapdeal Through a

mobile app, recovered products are promoted by creating a blog and using social media such as Facebook and WhatsApp to share details of innovated products in the market(Kannan and Hongshuang "Alice" Li, 2017). The Snapdeal app has a separate category called "BIO Daily needs" for selling recovered products. Shopify Inc., a Canadian multinational e-commerce company, has online stores to sell these products.

20.9 Contracts and public procurement of biorefinery products

Public procurement is acquisition by governments and state-owned enterprises of goods, services, and works including for biobased recovered products. The procurement of green biobased recovered products is a complex task due to various environmental aspects (Sherwood et al., 2016). A charitable method to acquire environmental performance certification is ecolabeling. This method of labeling biobased recovered products is in practice throughout the world. This ecolabel assists in product marketability and enables consumers to choose a product with a low environmental impact. This symbol is reliable, enabling producers to demonstrate to the consumer the authenticity of their product. The government has trade constraints to seal foreign products, termed mandatory labels. Voluntary ecolabeling is the labeling of government-sponsored products that are funded and supervised by the private sector. However, there remains a lack of proper recognition for biobased recovered products in the business sector. These green public procurement schemes have secure environmental sustainability requirements. The procurement expert assures ecolabeling with proper selection criteria to identify products and producers and to verify environmental claims. The government passes tenders for contracts to analyze the innovative processes for launching on a large scale. Contracting authorities must consider the total cost incurred on the product recovery project. Recently, 13 innovative contracts have been undertaken in the Netherlands with a total cost of 125 euros to promote the development of a biobased economy (Keegan et al., 2013).

20.10 Food waste and the transition toward sustainable development

To have a better transition of FW in the direction of sustainable growth, high-quality experimentation and campaigning are required, as detailed in Fig. 20.5. This helps to achieve more innovative techniques to produce biobased products with lower energy consumption, minimum resource inputs, and using renewable energy sources wherever possible (Jurgilevich et al., 2016). In addition, this ensures that all those involved in the FW biorefinery process work in a nontoxic and sanitized working environment with adequate social welfare and training activities.

20.10.1 Food waste dynamics

This is the method of assessing the current FW in the ecosystem and the challenges to manage it. It also explains the regulation, waste to be sorted before treatment, treated FW, and its mass reduction, which play an important role in

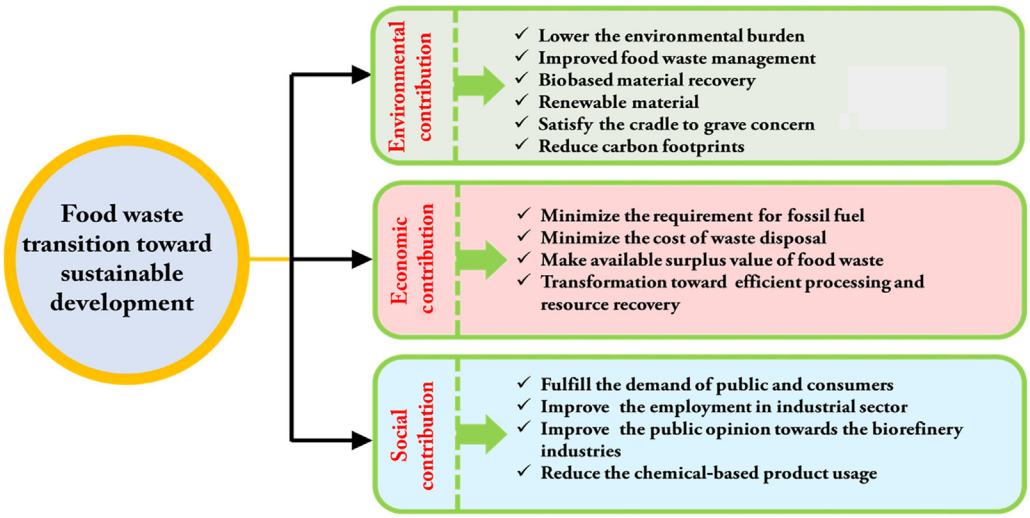

FIGURE 20.5 Food waste biorefinery sustainable development.

determining the FW quality to adopt a proper volarization process (Ingrao et al., 2018). Through dynamic study of FW, policy options are formulated with proper volarization strategies to produce environment-sustainable biobased products.

20.10.2 Multilevel perspective framework

Industrial development and population expansion expel a large quantity of FW to the environment. These sustainable tools promote augmentation of food volarization, which contributes efficient processing of the unit. Recently, innovation of biobased industries has shifted the existing producing system to FW loss biorefineries. Reframing of innovative models could enhance the profitable techniques of volarization in the future. A proper business model should be considered to manage the various methods of FW processing and must be considered to have a major impact on the sustainability of FW management.

20.11 Conclusions

The major commercialization aspects of FW valorization are to improve and innovate the recovery technologies that promote product flexibility and alternative techniques. Although the methodologies of product innovation are cost-effective with easy scale-up technique, crude products may still be found. Proper monitoring of recovered product prior to marketing to achieve better marketability is therefore necessary. The need for beneficial biobased products is increasing daily. Policies and regulations have been tightened to generate high-quality health-promoting biobased products. A broad discussion of the large-scale implementation of biobased biorefineries should motivate research into innovative licensed biobased foods. Tax reductions also assist in the high generation of marketing techniques.

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