An Opportunity for the Entrepreneurs in Waste Management

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1 Introduction

Waste management is becoming the top priority for all researchers throughout the world. The problem of waste management has become crucial for a healthy environment. One of the most pressing problems facing our planet today, plastic trash poses serious risks to biodiversity worldwide [1, 2]. Eventually, single-use plastic degrades into microscopic particles known as microplastics, which contaminate marine environments worldwide. India's economy is one of the fastest-growing in the globe. Nonetheless, accelerated industrialization, urbanization, and an expanding population lead to a variety of environmental issues, one of which is rising plastic waste. The dearth of sufficient infrastructure for the treatment and dispersal of plastic waste in India has exacerbated the severity of the problem [3].

Entrepreneurs play a very important role in the waste management sector as they design innovative and sustainable ideas for society to overcome this problem. Increasingly, it is acknowledged that the economic, environmental, and social challenges of sustainability deliver enormous possibilities for innovation and enterprise. Entrepreneurship can promote both social well-being and an ecologically sustainable economy. Entrepreneurship is widely acknowledged as a driver of economic development [4]. Different forms of entrepreneurship in various nations have also

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2 Challenges for Entrepreneurs in Waste Management

Waste management is an ongoing challenge for the modern global community. Waste management problems can't be addressed without first identifying and eliminating sources of waste [11]. The number of operations which produce waste and wastewater is constantly expanding in modern civilizations. Assessing the need for collection and the best treatment methods requires a thorough awareness of the many sources of waste, which is a prerequisite for successful management at both the local and global levels [12]. However certain sources are well identified for waste production some of them are from households, industries, hospitals, river and lakes. Household is a major contributor to waste mainly through kitchen and washrooms. As a matter of fact, human needs at least several liters of water every day to meet necessities including drinking water for survival, cleanliness, sanitation, and food preparation. A lot of waste gets generated through these activities [13].

The current challenges include removing toxins from wastewater, reducing solid waste, and inventing novel methods to recycle these waste products. Several chemical wastes need to be disposed of properly. Nowadays several advanced processes were utilized to remove waste materials such as solid waste, pesticides, dyes, organic matter, and nutrients particularly from wastewater. Currently, a survey of the literature on wastewater reveals an abundance of research on membrane bioreactor (MBR) to enhance treatment efficiency. With MBR and other treatment procedures, sediment production is a significant issue that requires specialized management. Consequently, current wastewater research also focuses on minimizing sediment production and enhancing their management [14]. Figure 2 illustrates various types of challenges mainly due to unbalanced administration and political activities.

There are a number of other obstacles that must be overcome in order to effectively manage waste, and they vary depending on the geographical context, the financial status of a country, waste classifications, and the regional infrastructure. Some of the challenges are the rise in urbanization that leads to a waste disposal problem, the absence of a suitable infrastructure for waste collection and disposal, the absence of hazardous waste collection facilities, the insufficiency of economic encouragement, and the lack of public awareness [15].

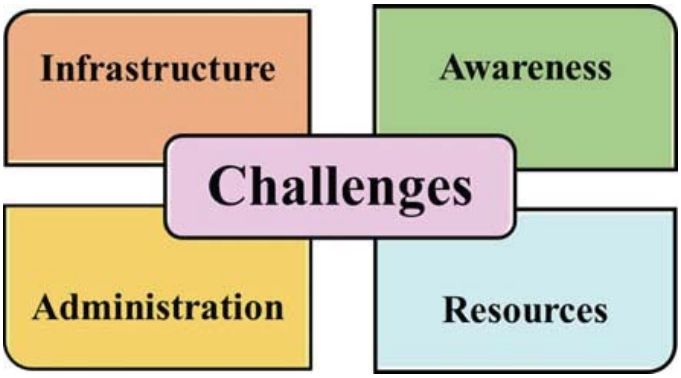

Fig. 2 A visual illustration of the numerous challenges inherent in waste management

3 Opportunities for Entrepreneurs in Waste Management

Entrepreneurs in waste management have opportunity to make profitable business out of it and innovate new ideas for sustainable development of environment. Sustainable entrepreneurship correlates business and innovative thoughts for the betterment of the socio-economic conditions of any country and environmental aspects [16]. However, sustainable entrepreneurs face challenges in changing the society. Therefore, they need assistance of government and NGOs to support or improve conciliation, progressive political initiatives, amenities and social norms that foster more sustainable lives [17]. Figure 3 depicts variety of opportunities for entrepreneurs in waste management, various firms produce productive products with innovative ideas.

There are several key business opportunities in waste management for entrepreneurs which are outlined below.

3.1 Innovations for Recycling Waste

In the world of business, waste appears as a liability with no economic worth and is typically disposed of in landfills, which incur enormous surveillance, transportation, and ecological expenses. There is a need of appropriate innovative techniques for recycling different varieties of waste in ecosystem. Utilizing waste as a resource through recycling and urban mining could be a viable substitute to the current method of disposal. Fermentation or incineration are two methods for using waste

Fig. 3 Schematic representation of variety opportunities in waste management

Fig. 4 Innovative recycling of waste materials

3.2 Energy Production Technologies from Waste Materials

Waste-to-energy technologies offer an intriguing strategy to both waste management and sustainable energy production. These revolutionary innovations leverage the energy potential of a variety of waste materials, including organic waste, remnants from agriculture, and non-recyclable plastics [38]. Harnessing waste products for the production of H_2 is a great alternative as it promotes a circular economy in which recycling waste serves to turn into energy [39]. Bundhoo et al. investigated dark fermentation process using bacteria, glycolysis, and pyruvate degradation for production of H_2 gas. According to the bio-hydrogen production shown in the previous research, the projected global bio-hydrogen potential is found to be greatest for unprocessed rice straw, measured at 58,002 Mm^3/year, and then for unprocessed wheat straw at 34,680 Mm^3/year [40]. Abo-Hashesh et al. studied photo fermentation method for generation of H_2 gas with highest percentage yield. The thorough study of a single-stage method for the reduction of glucose to hydrogen by photo fermentation by *Rhodobacter capsulatus* has been initiated. The generation of roughly 3 mol of H_2 per mole of glucose has been achieved, resulting in a yield of 25% [41]. Lignocellulosic biofuels can be extracted from inexpensive, plentiful, and renewable non-edible biomass, such as crop residues, agricultural waste, and forestry leftovers [42, 43]. Since inedible biomass is employed, the principal benefit of producing lignocellulosic biofuels is that it reduces the direct food versus fuel antagonism complications [44]. Pyrolysis is a technique for conversion of waste products into valuable fuel such as biomass, biochar, syngas, and bio-oil. Cellulose decomposition results in the production of levoglucosan through rapid pyrolysis; this levoglucosan then endures dehydration to produce hydroxymethyl furfural, which breakdown into liquid and gaseous byproducts such as bio-oil and syngas. Figure 5 demonstrates the mechanism of photodegradation of toxic elements into non-toxic products by utilizing nanocomposites and also shows production of Hydrogen gas.

Table 1 Comparative study for removal methods of waste materials

Basis	Adsorption	Photodegradation	Coagulation	Flocculation	Biological methods
Working principle	Catalyst acts as adsorbent and pollutants as adsorbate which adhere at adsorbent surface	Removal of contaminants with UV light. Radicals' breakdown contaminants into harmless particles	Aggregation of particles with use of coagulants	Formation of larger particles with continuous mixing	Breaking down of larger particles into smaller ones with use of microorganisms
Efficiency	High efficiency with choice of adsorbent	Its efficiency is quite high depending on type of catalyst used	It depends on the choice of coagulant	Effective in removal of solid waste	Effective in removal of organic waste
Applicability	Effective in reducing toxicity of dyes, organic matter, and pesticides	Better activity for removal of organic pollutants	Efficiently eliminates suspended particles and heavy metals	It helps in separating colloidal particles and suspended particles	Effective in breaking of organic contaminants with microorganisms
Expenditure	Adsorbent functioning cost	UV reactor apparatus and chemicals cost	Coagulants cost and sludge disposal cost is there	Cost for blending apparatus and chemicals	Microorganisms functioning and maintenance cost
Sensitivity	Highly applicable but only vary with choice of adsorbent	Applicable to organic contaminants	Sensitive towards some types of water	Applicable to wide range	Suitable for many organic waste kinds
Environmental impact	Less energy consumption for adsorbent regeneration	Requires energy and light for UV reactor functioning	Sludge disposal issue may arise	Blending may require high energy	Though ecologically favorable, may create extra sludge

3.3 Composting Solutions

New innovative technologies are implemented for recycling processes such as composting and vermicomposting in industrial sectors. These two processes lead to growth and development of opportunities for entrepreneurs. Ghorbani et al. study illustrates the vermicomposting utilizing *Eisenia fetida* earthworms which converts waste to productive fertilizers for enhancement of soil fertility [46]. The Indigenous

The citizens of Bengaluru city, India led initiatives like SwachaGraha for initiating composting revolution. The campaign acquired momentum as people realized the evident advantages of home composting. Experts such as N. S. Ramakanth and Vani Murthy disseminated information about composting to a broad spectrum of Bengaluru households. Till now there are lot of compost santhe have been established in the city. This is a form of organization in which experts and entrepreneurs encourage the public about domestic composting [48].

According to a research study in ICAR-Central institute for Research on Cotton Technology (CIRCOT), Mumbai, cotton stalk is transformed into valuable byproducts such as cellulose and lignin. A granular board may be produced from it, and as it has a high calorific value, it can also be used to make charcoal granules for use in renewable energy production. Cotton stalk has several uses, including making bio-enriched compost and for cultivation of mushrooms. These innovative opportunities are generating new additional income sources for farmers and opened up entrepreneurism chances for the development of rural-based companies, and provided new job opportunities for the rural young ones [49].

4 Construct Eco-Friendly Buildings for Waste Management

The construction industry contributes to the economic expansion. It is one of the greatest economic sectors in Europe, it accounts for roughly 10% of the country's GDP and generates 18 million opportunities (European Committee for Standardization—CEN, 2017). In the last decade, it has contributed 8% of India's gross domestic product [50]. However, construction industries are the biggest consumers for various natural resources, such as coal tar, carbon substituents generated from waste materials [51].

According to NRAI (National Restaurants Association of India) report 2020, the restaurant business is rapidly growing and is significant asset in green Eco-friendly construction of buildings. Government agencies need restaurant firms to uphold their Corporate Social Responsibility (CSR), particularly in the form of environmentally friendly efforts, in order to support green initiatives in this sector [52]. It can be beneficial to use programs like MBKM (Merdeka Belajar Kampus Merdeka) to encourage green entrepreneurial enterprises among Indonesian students [53]. Figure 7 schematically represents enhancement of efficiencies of various factors with the construction of Eco-Friendly or sustainable buildings.

The Leadership in Energy and Environmental Design (LEED) accreditation was created by the U.S. Green Building Council. This grading system evaluates environmentally friendly buildings, efficient use of water, energy and the environment, assets and supplies, and interior sustainability. The following is a list of the top companies that are currently promoting sustainable green building that are among the top 10 organizations on Newsweek's 2011 list of greenest companies:

5 Successful Case Studies of Entrepreneurs in Waste Management

Keshav et al. overviewed lignocellulosic ethanol production from cotton stalk. According to a report of 2018, India secured first rank in production of 6.3 metric tons of cotton stalk [54]. Then the cotton stalk was converted to ethanol via sequential pretreatment, saccharification, and fermentation methods [55]. Approximately 84% of the world's fuel ethanol is produced in the United States and Brazil, both are major producers of bioethanol from maize and sugarcane [54].

China has developed a Yitong system to gather crop straw and animal residues for conversion into energy and some other valuable byproducts such as fertilizers and fuels [56].

Feng et al. have discussed the production of biogas using agricultural residues, animal slurry, and grass silage via anaerobic digestion [57].

Raimondo et al. examined the significance of citrus waste valorization, specifically focusing on the production of pectin yield. This pectin yield was afterwards used for the generation of biogas and biomass [58]. The Indian Oil Corporation Limited (IOCL), the country's largest oil marketer, just inaugurated a plant in Panipat to produce ethanol from agricultural stalks using a fermentation process. Other major ethanol producers in the nation are the Institute of Chemical Technology (ICT) in Mumbai and Praj Industries. In addition, Praj has its own demonstration services in Maharashtra with a 1 million L/year efficiency and an absence of liquid dispose [59].

The Full Circle Coin (FCC) is a blockchain platform which aims to generate waste reduction rates. The mission of FCC is to raise public awareness, enlighten people, and to develop an industry for recyclable materials. They facilitate entire source tracking from the moment of extraction through the end product and data collecting, which boosts business efficacy. Consumers receive FCC in return for recyclables when they are handled. A "good recycling mall" is an online shopping platform where FCCs may be used to make purchases like as those found in a grocery store, clothing store, or even a home interchange. rLoop intends to provide all a platform to establish creative approaches for both the economy and society. Subsequently delivers a blockchain-based platform with the objective of enhancing innovative participation from stakeholders. To strengthen the ecological validation of innovation, the business model was implemented [60].

The establishment of the Federal Environmental Protection Agency (FEPA) in Nigeria in 1988 highlighted as a significant turning point in solid waste management. In 1999, the FEPA united with additional significant agencies of government to establish the Federal Ministry of the Environment. The aforementioned ministry is responsible for issuing guidelines on how to address important environmental issues, such as solid refuse management. Nonetheless, the majority of the responsibility for enacting laws, implementing them, and enforcing them with state governments. The policy statement acknowledged that policies for waste management at the local level must be consistent with the regional culture, land usage, socioeconomic basis, weather variables, and organizational frameworks. The federal government's

Universal Basic Education (UBE) initiative to boost the prevalence of literacy of Nigerians for paper and pulp waste management. The variety of pulp and paper goods often referred to as tissue or toilet paper continues to be of substantial demand and utilization in Nigeria because of vital role in hygienic practices [61].

Stuti Haldar has focused on case study of Renewable Energy Management in Gujarat, India. There were 200 firms till 2017 according to a database Gujarat Energy Development Agency (GEDA), which is a state regulatory body for managing Renewable Energy. The Ministry of New and Renewable Energy (MNRE) initiated the Jawaharlal Nehru National Solar Mission (JNNSM) in 2010, and since then, various small-scale businesses have been opened [62].

Abdullah Al-Dhabi and Arasu have observed the biosorption of heavy metals like lead from hazardous waste materials. Algal biomass was used for removal of >98.5% lead metal from hazardous waste in 10 min [63].

Abu-Ghazala et al. experimented on removal of hazardous waste by utilizing white brick waste powder as a catalyst for generation of biodiesel via transesterification method of waste cooking oil. It results in conversion of 92.7% of biodiesel and catalyst is reused up to 6 cycles [64].

Li et al. discussed the removal of sulfates and nitrate from flue gas in wastewater with heat crystallization technique. They have gathered 59 g/L sulfate, 13.1 g/L nitrate and 16.4 g/L chloride [65].

6 Alliances and Future Perspectives

Entrepreneurship training, an entrepreneurial attitude, and innovation foster youthful talent and encourage people to initiate their own ventures [66]. According to the social cognitive theory, learning about entrepreneurship raises one's sense of esteem. It gives people the chance to engage in entrepreneurial activities, including opportunity identification, determining the viability of a company idea, and strategy execution [67]. Porter and Kramer state that this harmonious connection between the company and its customers is certainly beneficial since it enables businesses to achieve their mutual objectives and benefit society [68]. Some of alliances are stated below:

- With the tagline "Forests are your business," WWF launched a project with the forestry sector in the 1990s with the intention of attaining environmental sustainability. In order to promote the import and export of exclusively viable timber, an alliance between firms and forest sectors was built up. Subsequently, they added the Forest Stewardship Council's FSC certificate, this developed by applying UNCED's Rio Declaration in 1992 and ensures that the labelled wood has been manufactured sustainably [69].
- Eco Asia is a bilateral agreement started in 1991 between East Asia and other Asian parts, a Northeast Asian Conference on Environmental Cooperation (NEAC) was held in 1992, the North-West Pacific Action Plan (NOWPAP) was established

in 1994. All of the aforementioned conferences were held to spread awareness among society [70].

- ARC (Alliance of Religious and Conservation) is an international secular NGO that assists the world's foremost beliefs to formulate environmental policies in accordance with their fundamental guidelines, principles, and processes. ARC GPN and Bhumi Project initiated The Green Temple program in 2014 to establish an association of sustainable temples in India. The Green Temple program will connect international green places for devotion, promote the exchange of knowledge and experience between temples in India and beyond, motivate Hindu Temples to join up government policies, NGOs and other private parties to preserve their worship premises [71].

7 Conclusion

The findings presented in this chapter demonstrate the crucial significance of entrepreneurs in the advancement of sustainable waste management and the growth of a circular economy. Government partnerships and non-governmental organizations (NGOs) provide assistance for the development and implementation of emerging breakthrough technologies, which in turn aid entrepreneurs in their economic endeavors. One of the significant conclusions drawn from this discourse is the rising concern and apprehension about ecological issues. There is a growing emphasis among consumers, companies, and governments on the importance of sustainable practices, leading to a willingness to endorse and invest in revolutionary waste management technologies. Entrepreneurs that capitalize on this opportunity have the potential to access a swiftly growing market, fueled by the increasing demand for environmentally sustainable goods and services. On top of that, the waste management business is being reinvented by innovation breakthroughs. Entrepreneurs are provided with state-of-the-art equipment, such as intelligent recycling cans, waste surveillance equipment, and modern energy production innovations, which have the potential to augment operational efficiency and financial gains. By adopting these technological advancements, businesses may differentiate themselves from their competition and explore novel avenues for generating cash. Several successful case studies were highlighted, demonstrating the potential for improved prospects for sustainable development across several industries. The objective of this chapter was to promote awareness among youngsters in our society about the potential for entrepreneurial endeavors in the field of waste management, which is now a significant problem.

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