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Solid Waste Management for Circular Economy towards Sustainable Development of India

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Abstract

In the modern world, solid waste management has strategic ramifications. The need to balance environmental protection with economic growth is driving attention towards the non-linear economy's potential. The management of solid and liquid wastes should focus on methods that treat, recycle, and reduce wastes by treating them like resources. This Research article‘s objective is to examine circular economy and ecological protection for sustainable environmental livelihood and its theoretical and practical waste management is concerns from the standpoint of cross-disciplinary eco-economic collaboration, using the concepts of the circular economy.

Key words: - circular economy, solid waste, recycle, reduce, ecological, discipline, control, management, sustainable.

Introduction

Solid Waste Management is the discipline associated with the control of generation, storage, collection, transport or transfer, processing, and disposal of solid waste materials in a way that best addresses the range of public health, conservation, economics, aesthetic, engineering, and other environmental considerations. In 2016, this ministry released the −Solid Wastage Management (SWM) Rules, which were replaced by the Municipal Solid Waste (Management and Handling) Rules, 2000 of which had been in place for 16 years. India generates 62 million tonnes of waste each year. About 43 million tonnes (70%) are collected, of which about 12 million are treated, and 31 million tonnes are dumped in landfill sites. Waste management gains strategic implications in contemporary world. Until recently, the evolution of industrial activity was studied in terms of linear system of consumption of resources that was common for all countries‖ **(T. & Bachamanda, 2007)** and implied the following: collection and extraction of resources → manufacturing the product → handing over the product to consumer → disposal of the product. −However, the need to combine economic development with environmental safety urged to focus on capacities of non-linear flowchart, implying −reusability‖ concept of economy. In accordance with the objectives of circular economy, waste management should redirect its efforts to reduction, recycling and treatment techniques in favor of all stakeholders (government bodies, citizens, experts, business, entities). The waste treatment practice undergoes transformation from simple collection and sorting procedure to generation of sustainable systems, in terms of which the wastes‖**(Deus, Bezerra, & Battistelle, 2018)** are considered as potential resources.

−Circular economy is a sustainable development initiative targeting reduction of straight-line relationship of social systems of production and consumption. It features utilization of material cycles, renewable and cascaded energy flows to a linear system. CE encourages development of high value material cycles along with more conventional treatment and develops system approaches to collaboration of manufacturers, consumers and other agents of society within sustainable‖ **(Mandpe, Paliya, Vidyadhar, Patel, Tyagi, & Kumar, 2023)** development dimension. Circular economy describes economical system based on business models, which replace the −end of life‖ concept of by reduction, reuse, recycling of materials in production processes or in their distribution and consumption. −It functions on microscale level (products, companies, consumers), meso-level (eco-industrial parks) and macroscale level (city, region, nation, global level) in order to achieve sustainable development, which implies development‖**(Natalia, 2023)** of high quality environment, economic prosperity and social equity, for the benefit of current and next generations.

−Basic principles of −3R‖ circular economy: 1. Reduce 2. Reuse 3. Recycle The state government bodies will face the need to refer to principles of circular economy for achievement of required extent of eco-economical sustainability‖ **(Rajput, Prasad, & Chopra, 2009)** and competitive power at global level more often.

Review of Research Studies

Liu & Bai (2014) conducted an awareness study about circular economy in China. China being one of the prominent developer and follower of circular economy, they lag some empirical data involving

awareness and behaviour of firms involved in circular economy. The authors developed a questionnaire which contained multiple choice questions based on awareness and behaviour towards circular economy implementation. An interview method was also followed for the collection of data. During the interview, 3 barriers were frequently identified as structural, cultural and contextual factors. Suggestions for the improvement of the behavioural approach to improving and implementing the circular economy in China were made. Bin et al. (2017) conducted a survey about the awareness levels of public population in 6 urban districts of China and found them to be rather poor. The data and information used in this research were collected through distribution of questionnaires randomly in 6 urban districts and interviewing 600 respondents. The results indicated the limited awareness and a poor understanding of the residents about the CE program. Tisserant et al. (2017) have explained, detailed and comprehensive accounts of waste generation and treatment form the quantitative basis of designing and assessing policy instruments for a circular economy (CE). The research has presented a harmonized multiregional solid waste practice, covering 48 world regions, 11 types of solid waste, and 12 waste treatment processes for the year 2007. The account is part of the physical layer of exobase, a multiregional supply, and use table. Exobase was used to build a waste input output model of economy to quantify solid waste footprint of national consumption.

Adams et al. (2017) applied circular economy in construction practices where large amount of waste is generated and little waste is recycled. The authors conducted an industry wide survey related to circular economy awareness, challenges, and enablers. They concluded that the circular economy concept was least informed to clients, designers and subcontractors which forms the key challenge for implementation. Hossain & Mahfuja (2021) have provided an in-house model and implementation of circular economy in a developing country like Bangladesh. The researchers have performed a qualitative study basing the factors Like Extensive Lifespans, And Excess Availability Of Apparatus And Supplementary Materials.

Research Gap

The present study is based on sustainable development and circular economy and explains how solid waste management is related to circular economy. The researcher identified the research gap as the majority of the study is related to only solid waste management and how it is collected. But no previous studies have been done on the relationship between the circular economy and solid waste that aids to achieve SD through the circular economy. Therefore, the current study was conducted to fill this gap.

Objectives of the Study

1. To study the concept of circular economy and its impact on sustainability
2. To study the present scenario of Solid Waste Management in India
3. To analyse the linkages between solid waste management, circular economy and sustainable development in India.

Research Methodology

The present analytical and descriptive research study is totally based on secondary data sources. And the secondary data we have reviewed and collected from various research documents along with CPCB and State Pollution Control Boards‘ (SPCBs) annual reports. To confirm the problems related to waste management in India, which is already presented in above sections, the current study method has been divided into section.

Percentage of data availability and their Assessment

Current study is mostly based on open source data availability. CPCB and all SPCB websites were accessed for their annual reports on waste management in their administrative areas. Count of total annual reports ―accessible‖ on CPCB website between 2005 and 2020 was found, as majority of the waste generation data recording was done in this period. Further, the count of annual reports of the total which ―actually‖ provided waste generation data was identified. Percentage of data availability was measured as the ratio of number of annual reports ―actually‖ providing the waste generation data to the total number of annual reports ―accessible‖ to public from 2005 to December 2020. Similar methodology was followed in case of various SPCBs.

Results and Discussions

Environment plays important role in development of economy as well as human beings, but the Indian economy faces more challenges and more difficulties to achieve sustainable development goals.―Sustainable development that meets the needs of present without compromising the ability of future generation. Environment faces the so many problems like climate change,pollution,co2 emission, GHG, Waste, externalities etc. but try to improve our environmental adverse change with the help of

circular economy and three ‗r' principle (reuse, recycle, reproduce) most of the developed country implement the three ‗R' principle and achieve sustainability .In the present study, the researcher proposes the implementation of circular economy in the developing country like India so as to achieve the sustainable development andenvironmental as well as nature stability .The main objective of the study is to check and analysethe status of circular economy for sustainable development in India‖ **(Minko, Vanya, & Blagoeva, 2023)**

Accenture's analysis reveals that the developed countries like Germany, Australia and Sweden have ―a significantly higher per capita resource consumption as compared to countries like Bangladesh and Nigeria. For instance, in 2017 the world exhausted the entire ―budget‖ of natural resources available for the year on 2 August 2017 (a day referred to as Earth overshoot day)‖ **(Pal & Bhatia, 2022)** ―Research indicates that if the global economies continue to operate in the business-as- usual mode, then by 2030 the world would be over utilizing natural resources by a factor of three. Tremendous value can be potentially realized by eliminating these four types of waste through the adoption of circular business models. Accenture's research estimates the size of this new business opportunity to be around $4.5tn of GDP globally by 2030. According to FICCI research, around half-a-trillion dollars' worth of India's GDP value that could be protected through Circular Economy business models by 2030 in India and $4.5 trillion globally. This would entail eliminating the concept of waste altogether (i.e. eliminating waste not in the traditional sense of rubbish, but any underutilization of natural resources, products and assets). From business perspective, Circular Economy opportunity manifests itself in multiple forms depending on the industry context. Based on the priority resources identified above, in the following section we deep-dive into three industrial sectors – (i) Agriculture, Food and Beverage (ii) Metals and Mining, and (iii) Electronics and High Tech. India currently ranks 100out of 119 countries in the Global Hunger Index 2017, with ~25% of the world's undernourished people living in India. The challenge of hunger is further exacerbated by high food wastage, with almost 40% of the farm produce in India wasted annually. Unlike developed countries where food wastage is a challenge primarily at consumer and post-consumer stages, food wastage in India is spread across the value-chain. In fact, only 10% of the food loss in India canbe attributed to the consumption stages. Circular models entail adoption of new business models that can deliver transformative impact. With $500bn of India's GDP value at risk (by 2030), clearly the stakes are high. Delivering on this enormous opportunity would require an enabling ecosystem that encourages identification‖ **(Ivan & Peterkova, 2023)** and adoption of new business models.

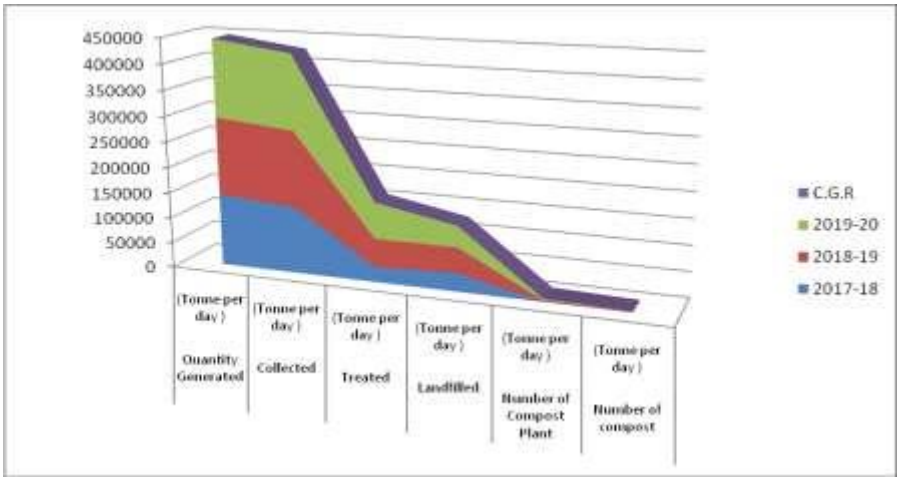
India's material requirements are projected to be nearly 15 billion tonnes by 2030 and little above 25 billion tonnes by 2050 under medium growth scenario. ―This means that India would nearly triple its demand on primary materials compared to 2010, particularly the demand of energy carriers, metals and non-metal minerals. Increased domestic resource extraction will exert increasing pressure on natural resources such as land, forest, air and water. Extraction per acre can be used as an proxy estimate‖ **(Kamble & Kamble, 2022)** of environmental pressure, which in India, is already thehighest in the world, at 1,579 tonnes per km2 land area compared to the global average of 454 tonnes per km2 (IGEP, 2013, in TERI).―According Maharashtra State Pollution Control Board (MPCB), the solid waste generated by Corporations in Maharashtra is 19050.11 MT/Day with share of 83.02 % while generation by ―A‖ class council is 1028.00 MT/Day with share of 4.48 %, ―B‖ class council generates 1276.92MT/Day with share of 5.53 %, ―C‖ class council generates 1051.96 MT/Day with share of 4.58 %, Nagar Panchayats generates 450.766 MT/Day with share of 1.96 % and Cantonment Boardscontribution is 96.5 MT/day with a share of 0.42 %. Percentage of solid waste treatment is increased from 53 % to 70.00 %. i.e 17.00 % as compared to last year Treatment percentage. Total 16037 MT/Day Solid Waste is treated/processed" **(Kamble & Kamble, 2022)** by ULBs by adopting waste treatment technologies achieving overall 70.00 % average treatment. The remaining solid wastes find its way for unscientific disposal/dumping. Overall average waste segregation is 74.46 % and overall solid waste transportation is 96.45 %.

Table No. 1 All India Generation of Municipal Solid Waste

Year	Quantity Generated (Tonne per day)	Collected (Tonne per day)	Treated (Tonne per day)	Landfilled (Tonne per day)	Number of Compost Plant (Tonne per day)	Number of compost (Tonne per day)
2017-18	142870	129967	29650.4	35647	639	108
2018-19	152076	149748	55759.6	50161.3	2548	1684
2019-20	150847	146053	70973.2	40893.2	3121	0
C.G.R	**2.75**	**6.01**	**54.71**	**7.11**	**121.00**	**00.00**

Source: EPWRF India Time Series.

All India Generation of Municipal Solid Waste



Source- computed by the author in Excel.

The above table and graph depicted the information about the percentage of generated municipal solid waste in India. In the year 2017-18, the generation of solid waste is highest compared other years. But in year 2019-20 compare to the previous year it showing the decreasing trends in solid waste generation in India. The per-capita Solid Waste Generation has increased marginally from 118.7 gm/day in 2015-16 to 119.1 gm/day in 2020-21. Maximum quantity of per capita solid waste is generated in Delhi. Processing of solid waste has been improved significantly from 19% in 2015-16 to 50% in 2020-21. According to a World Bank Report, globally 2.01 billion tonnes of municipal solid waste is generated annually, of which at least 33% is not managed in an environmentally safe manner. Global per capita waste generation is 740 gm/day (average) but varies from 110 gm/day to 4.54 kg/day across countries. High Income countries contribute 34% to global waste generation despite having only 16% of the population.

Table No. 2. State Wise Overall Solid Waste Management Status of India

Sr. No.	State	The solid waste generated (TPD)	Collected (TPD)	Treated (TPD)	Land filled (TPD)
1.	Andhra Pradesh	6898	6829	1133	205
2.	Arunachal Pradesh	236.51	202.11	-	27.5
3.	Assam	1199	1091	41.4	0
4.	Bihar	4281.27	4013.55	-	-
5.	Chhattisgarh	1650	1650	1650	0
6.	Goa	226.87	218.87	197.47	22.0
7.	Gujarat	10373.79	10332	6946	3385.82
8.	Haryana	5352.12	5291.41	3123.9	2167.51
9.	Himachal Pradesh	346	332	221	111
10.	Jammu & Kashmir	1463.23	1437.28	547.5	376
11.	Jharkhand	2226.39	1851.65	758.26	1086.33
12.	Karnataka	11085	10198	6817	1250
13.	Kerala	3543	964.76	2550	-
14.	Madhya Pradesh	8022.5	7235.5	6472	763.5
15.	Maharashtra	22632.71	22584.4	15056.1	1355.36 (Unscientifically disposed= 6221.5)
16.	Manipur	282.3	190.3	108.6	81.7
17.	Meghalaya	107.01	93.02	9.64	83.4
18.	Mizoram	345.47	275.92	269.71	0
19.	Nagaland	330.49	285.49	122	7.5
20.	Odisha	2132.95	2097.14	1038.31	1034.33
21.	Punjab	4338.37	4278.86	1894.04	2384.82
22.	Rajasthan	6897.16	6720.476	1210.46	5082.16
23.	Sikkim	71.9	71.9	20.35	51.55
24.	Tamil Nadu	13422	12844	9430.35	2301.04
25.	Telangana	9965	9965	7530	991

26.	Tripura	333.9	317.69	214.06	12.9
27.	Uttarakhand	1458.46	1378.99	779.85	-
28.	Uttar Pradesh	14710	14292	5520	0
29.	West Bengal	13709	13356	667.6	202.23
30.	Andaman and Nicobar Islands	89	82	75	7
31.	Chandigarh	513	513	69	444
32.	DDDNH	267	267	237	14.5
33.	Delhi	10990	10990	5193.57	5533
34.	Lakshadweep	35	17.13	17.13	-
35.	Pondicherry	504.5 482	482	36	446
	TOTAL	**160038.9**	**152749.5**	**79956.3**	**29427.00**

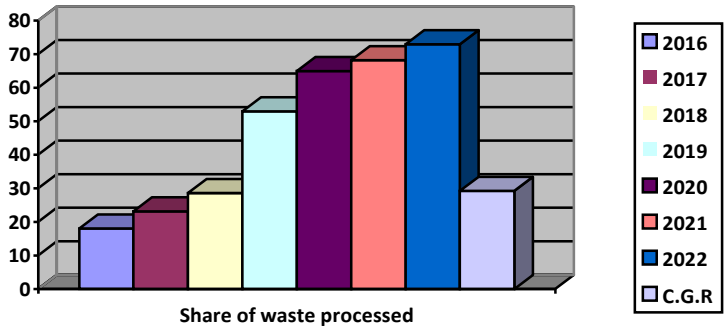
Source: Annual Report on Solid Waste Management (2020-21), CPCB, Delhi .

The above table and graph showing the overall statistical details about the management of total quantity of Solid waste generated in the country. It shows 160038.9 TPD of which 152749.5 TPD of waste is collected at a collection efficiency of 95.4%. 79956.3 TPD (50 %) of waste is treated and 29427.2 (18.4%) TPD is landfilled. 50655.4 TPD which is 31.7 % of the total waste generated remains un-accounted. The information of the state-wise details of solid waste management is given in the above it is also demonstrated the Trend in solid waste processing and their percentage of solid waste treated in different States/UTs is illustrated in Figure above. It is also observed that the maximum percentage of solid waste treated is in Chhattisgarh (100 %) followed by DDDNH (88.76), Goa (87.04 %), Andaman and Nicobar Islands (84.7 %) & Madhya Pradesh (80.67 %) in that order to the percentage of solid waste treated is increasing day by day which is understanding with helping of the above graph and table. and it also beneficial for circular economy and sustainable environmental livelihood development of India.

Table No. 3. Status of share of waste processed in India FY2016-2022

Year	Share of waste processed
2016	17.97
2017	23.14
2018	28.57
2019	53
2020	65
2021	68.18
2022	73
C.G.R	**29.27**

Status of share of waste processed in India FY 2016-2022



The above table and graph demonstrated that the status of increasing shear of waste processing in the FY year 2016 to 2022 in those particular years the shear of waste management is increasing rapidly and the ratio of waste processing in the year 2016 -2022 is also growing. In the year 2016, it is mention in above table and graph the percentage of waste processing is 17.97 % and in FY year in 2022 it is a 73% there is a huge and major increase in the share of waste processing will be observed and it also indicates a positive impact on the environment as well as on society as hole. It will helping out that if the increase in

waste processing or management of waste its turns into a circular economy and simultaneously achieves the goal of sustainable development.

Conclusions and Policy Suggestions

In today's scenario, effective and sustainable management of waste has become extremely challenging in different economies due to the varying proportions and composition of waste. The Concept of Circular Economy and its configuration with Solid Waste Management and SDGs provides novel insights and approaches. The Circular Economy approach can be considered best suited for its implication in the Indian waste management scenario. The work attempts to understand the concept of Circular Economy adoption in Solid Waste Management sector in the Indian context by considering several legislative frameworks and initiatives taken by the Government of India. Further, the current waste management practices, waste management inadequacy, and inferring the Circular Economy as a solution for successful waste management practices are also discussed. The current article also provides the cradle-to-cradle approach in Circular Economy, its various goals, and the recovery of energy and resources from the discarded materials by employing the Circular Economy approach. It is expected that the national solid waste compliances, enacted legislation, key initiatives taken by the Government of India, and the influence of industry and legal framework on Circular Economy will facilitate the Indian Solid Waste Management sector transition towards Circular Economy -based practices. However, before the inception of Circular Economy in the Indian waste management sector, analyzing its feasibility by considering the available waste processing facilities and thorough economic evaluation for sustainable development of India is of a paramount importance. lastly the researcher has to suggested one major suggestion for reducing that problem of solid waste if the government adopt a strict recycling policy on solid waste or any waste related issue to recycling or creates awareness about the importance of recycling or reuse in public then we are achieve the sustainable development in our country.

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