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THE STATUS OF SOLID WASTE (BULK DEBRIS) AND ITS MANAGEMENT IN JODHPUR CITY: A GEOGRAPHICAL ANALYSIS

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ABSTRACT:

KEYWORDS:

INTRODUCTION:

Any material that is not useful and has lost its economic value in the eyes of its beholder can be termed as waste (WTERT 2011). Although this waste may be a good resource/raw material for many other valuable things. It might be the source of currency/income for others. Like other matter, waste can be distinguished into three types i.e. solid, liquid and gaseous on the basis of physical state. On the basis of the source solid wastes are categorized into municipal wastes, hazardous wastes, medical wastes and radioactive wastes. Solid waste may include any or all of these components such as garbage, refuse, sludge other discarded material from a water supply treatment plan, domestic, industrial, commercial, mining and agriculture operations and from community activities (James 1997). Although solid waste has been discussed at many forums previously, however people were sensitize by its concept when the World Health Organization (WHO) defined solid waste "as the waste arising out of man’s activities which is not free-flowing" in 1971. Cointreau 1982, elaborate the definition of solid waste as “organic and inorganic waste materials produced by households, commercial, institutional and industrial activities, which have lost their value in the eyes of the first owner"

Types of waste Solid waste is classified mainly into four different types depending on its nature as shown below

- Municipal solid waste: Waste generated from residential and commercial premises in the municipal or notified area which also includes plastic waste generated from indiscriminate use and disposal of plastic into the physical environment
- Industrial waste: Waste material produced during an industrial activity. This type of waste can be either hazardous or non-hazardous in nature
- E-waste: It refers to the disposal of broken or obsolete electronic components and materials
- Biomedical waste: Any waste which is generated during the diagnosis, treatment or immunization of human beings or animals or in research activities pertaining thereto or in the production or testing of biological

Municipal Solid Waste Municipal Solid Waste (MSW) mainly consists of household waste, construction and demolition debris. With the increasing population and rising urbanization, the amount of municipal solid waste is increasing rapidly. Safe and cost-effective management of MSW is a significant environmental challenge and it is emerging as a menace global problem. The MSW (Management and Handling) Rules (2000) by the Central Pollution Control Board India defines solid waste as commercial and residential wastes generated either in solid or semi-solid form, excluding industrial hazardous wastes but including treated biomedical wastes. The composition of municipal solid waste changes significantly with time from municipality to municipality MSW is categorized into three types: Residential or household waste which arises from domestic areas from individual houses; commercial wastes and/or institutional wastes which arise from individually larger sources of MSW like hotels, office buildings, schools, etc.; municipal services wastes which arise from area sources like streets, parks, etc. MSW usually contains food wastes, paper, cardboard, plastics, textiles, glass, metals, wood, street sweepings, landscape and tree trimmings, general wastes from parks, beaches, and other recreational areas (Annepu 2012). Sometimes other household wastes like batteries and consumer electronics also get mixed up with MSW. UNDP 2011 has categorized MSW into 4 types on the basis of source of generation

Municipal solid waste on the basis of Source of generation

Sources	Typical waste generators	Types of solid waste
Residential	Single and multifamily Dwellings	Food wastes, paper, cardboard, plastics, textiles, glass, metals, ashes, special wastes (bulky items, consumer electronics, batteries, oil, tires) and household hazardous wastes
Commercial	Stores, hotels, restaurants, markets, office buildings	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes
Institutional	Schools, government center, hospitals, prisons	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes
Municipal Services	Street cleaning, landscaping, parks, beaches, recreational areas	Street sweepings, landscape and tree trimmings, general wastes from parks, beaches, and other

Source: United Nations Environment Programme 2011

Solid waste disposal and wastewater are significant sources of methane (CH_4). They are estimated to contribute to about one-fifth of global anthropogenic methane emissions (EPA 2006). Methane is one of the major constituent of the greenhouse gasses and, is responsible for the global warming. Economic prosperity contributes to the higher percentage of the urban population which ultimately leads to the larger production of solid waste (Hoornweg and Laura 1999).

The waste management hierarchy is a nationally and internationally accepted guide for prioritising waste management practices with the objective of achieving optimal environmental outcomes. It explains the preferred order of waste management practices, from the most to the least preferred. It is also one of the guiding principles of the Zero Waste.

The highest priority, avoid and reduce the generation of waste encourages the community, industry and government to reduce the amount of virgin materials extracted and used. The goal is to maximise efficiency and avoid unnecessary consumption through behaviours such as: selecting items with the least packaging or that require the fewest resources to produce, avoiding disposable goods or single-use materials, buying products that are recycled, recyclable, repairable, refillable, re-usable or biodegradable and using leftover food rather than throwing it away. Where avoiding and reducing waste is not possible, the next most preferred option is to re-use the materials without further processing. For example, many household and industrial items can be repaired, re-used, sold or donated to charities. Re-use (without further processing) and recycling (processing waste materials to make the same or different products) keeps materials in the productive economy and benefits the environment by decreasing the need for new materials and waste absorption.

The second priority, resource recovery, maximises options for re-use, recycling, reprocessing and energy recovery. Where further recycling is not feasible, it may be possible to recover the energy from the material and feed that back into the economy where this is acceptable to the community. Some materials may be inappropriate to re-use, recycle or recover for energy and instead require treatment to stabilise them and minimise their environmental or health impacts. Finally, the waste hierarchy recognises that some types of waste, such as hazardous chemicals or asbestos, cannot be safely recycled and direct treatment or disposal is the most appropriate management option.

The collection efficiency of solid waste is below 75% in Jodhpur as with most of the small to medium cities in India. Population wise, Jodhpur is the second biggest city of Rajasthan with population as per 2001 census as 856034. In last ten decades, there is ten-fold increase in population. In 2011, the population of the Jodhpur was 1.03 million reporting an annual growth rate of 2.05 percent. The recently constituted two Jodhpur Municipal Corporation comprises around 82 percent of the total urban population of Jodhpur district. The Municipal Corporation covers an area of 78.6sq kms with a density of 13438 persons per sq kms. Jodhpur experienced phenomenal growth in the decade 1971-1981 with growth rate as high as 59.42% while 21% during 2001-2011. The city is densely populated within the walled city limits. As these areas have reached saturation levels, development has started at a phenomenon scale on the outskirts of the walled city. In the recent years Jodhpur has increasingly became the important industrial centre.

The Rajasthan State Industrial Development and Investment Corporation Limited (RIICO) has developed industrial areas in the district. Jodhpur is the third most industrialized district in Rajasthan. Jodhpur district accounts for 6 per cent of the net domestic product from the Mining & Manufacturing Sector of the state. This has increased the problem of solid waste management in the city. Despite the degradation of valuable land resources and creation of long term environmental and human health problems, uncontrolled open dumping is still . Poor collection and inadequate transportation are the main reason for the accumulation of MSW. The management of the MSW is in the critical phases which desperately need an immediate and concrete action in this regard.

People participation is also an integral part of making any management plan successful. The increased participation of the people has the tendency to make waste management more effective. Any rule will be of no use until and unless there is no participation of the people. The effective participation of people in waste management has both practical and policy implications. The maximum participation of the people is required in disposing the garbage at the proper place. This also involves a separate collection of recyclable or organic materials from other waste. The rationale for community participation in MSW management is a very important issue since the people are affected directly and indirectly if the waste is not well managed.

STUDY AREA:

Jodhpur is the second largest city in Rajasthan and also the gateway to the beautiful sand dunes of the the Great Indian Thar Desert. Jodhpur "The Sun City" was founded by Rao Jodha, a chief of the Rathore clan, in 1459. It is named after him only. Jodhpur in Rajasthan, India was previously known as Marwar. Jodhpur is the second largest city in Rajasthan. It is divided into two parts - the old city and the new city. The old city is separated by a10 km long wall surrounding it. Also it has eight Gates leading out of it. The new city is outside the walled city.Jodhpur is a very popular tourist destination. The landscape is scenic and mesmerizing. Jodhpur city has many beautiful palaces and forts such as Mehrangarh Fort, Jaswant Thada, Umaid Bhavan Palace and Rai ka Bag Palace. Other charms of Jodhpur include Government museum and it's beautiful Umed garden. The city is known as the "Sun City" because of its bright and sunny weather throughout the year. The charm of the pre-historic times of Jodhpur city is wonderfully embedded in the art, architecture, and infrastructure of this city. Jodhpur is a blissful experience to those tourists that love to experience the royalty and take a look back at the princely era of India.

Jodhpur district is among the largest districts in the state of Rajasthan. This district comes under the arid zone of the Rajasthan state. It covers 11.60 percent of the total area of the arid zone of the state. Some of the areas of the great Thar Desert in India also comes within the district. The general slope of the terrain is towards west. It is centrally situated in the western region of the state, and covers a total geographical area of 22850 Sq. Km. Jodhpur district lies between 26 degrees 0 minutes and 27 degrees 37 minutes north latitude and 72 degrees 55 minutes and 73 degrees 52 minutes east longitude. It is bounded by Nagaur in the east, Jaisalmer in the west, Bikaner in the north and Barmer and Pali in the South. The total length of the district from north to south is about 197 Km and from east to west it is about 208 Km. The district of Jodhpur lies at a height of 250-300 metres above sea level.

There is no perennial river in the district. However, there are important rivers in the district viz. Luni River `and Mithri River though their base is saline water. Main sources of irrigation besides rainwater are dug-wells and tube-wells. The highest-irrigated area in the district is in Bilara Tehsil followed by Bhoplgarh and Osian tehsil.

The soil of the district is classified mainly as sandy and loamy. Bajra (pearl millet) is the major crop in the Kharif season. Jodhpur has excellent ground water in many parts of the district. In Rabi, wheat, pulses and a variety of spices like Cumin (jeera), Coriander(dhania) and red chilli are also grown. Jodhpur is well known for its red chilli, onion and garlic. It is one of the major production centres for Guar. The major and important minerals of the district are sandstone and limestone. Fawn and red coloured sandstone of the district is very popular and found in abundance. Besides this, building stones, stone-slabs and flagstones are mined in the district on a regular basis. Minerals like quartz and clays of various colours and dolomite are also available in the district.

On account of the arid climate, a rather negligible percentage of the total reporting area for the land use in the district is covered by forests. Due to sandy soil only scrub and thorny bushes of vegetation are found in the forest areas of the district. The main species of trees are Kumat, Kair, Khejri, Babul, Bir, Jal khara, Pilu etc. Fruit bearing trees are pomegranates and guavas. The fauna of the district includes jackal, Jungle Cat, Indian Fox, Black Buck, Chinkara, common Hare, etc. The birds commonly found are Baya, koyal, parrot, Vulture, Jungle Crow, bulbul, House Sparrow, Kite, Sand Grouse, Common quail, grey partridge, little egrit, etc.

The lithological formations of the region classified as upper and lower Vindhyans in the east and Marwar in the west, have been recorded as consisting of a thick series of sedimentary rocks comprising sandstone, limestone and shales. Igneous activity preceded the deposition of these rocks in western Rajasthan in the form of a thick pile of lava, mostly of an acidic nature. These lava and its plutonic equivalent have been noted in the form of granite bosses and sills in Jalor, Siwana, Mokalsar and Jodhpur areas and designated as Erinpura granite and Malani Igneous Suite .

Mehrangarh Fort section in Jodhpur exposes the best Jodhpur Malani Suite contact. This erosional contact is between the underlying youngest Igneous suite of rocks of Precambrian age and overlying oldest sedimentary sequence of late Proterozoic to Eocene age. Its geological significance led to it being declared a National Geological Monument.

The district has ample stores of mineral wealth. The sand used in construction is found in abundance in Jodhpur Tehsil. Apart from this sandstone, ‘Chhitar Stone’ and Brown Stone are also found in rich quantity. Chhitar stone is being used mainly for the construction of roofs. Stone slabs, which are being used for the construction of buildings, are found near Jodhpur City and Balesar.

Some mines of marble stone dolomite are found in Phalodi

Tehsil. The mineral and the stone used for Emery Stone is found in Bhopalgarh. White clay is found near Pipar City, which is being used as a paste to join two stones. There are 156 quarries of lime stone. The limestone is being used in lime, cement, rubber, steel and chemical works. Apart from this quarries of Jasper are also found in the district

The climate of Jodhpur is generally hot and arid but with a rainy season from late June to September. Although the average rainfall is around 360 millimetres (14 inch), it is extraordinarily variable. The temperature varies from 49 degrees in summer to 1 degree in winter. The Sandstorm (andhi) is a spectacle for people from other regions of India. The rainy days are limited to a maximum of 15 in a year. Temperatures are extreme throughout the period from March to October, except when monsoonal rain produces thick clouds to lower it slightly. During these periods of heavy rain, however, the generally low humidity rises and this adds to the normal discomfort from the heat.

Only 6948 hectares of the total reported area of land use in the district was covered with forests in 1999-2000. The forest area is available around the hills and is classified as any scrub thorn forest. Due to the sandy soil and dry climate of the district, only shrub and thorny bushes of vegetation are found in the forest areas of the district. The main species of trees are Vilayati Khejri (Prosopis - juliflora) and Kumat.

Balsamand Jheel is located in the north of Jodhpur City. Kailana Tank and Ummed Sagar are notable water reservoirs. There are two natural springs in the district namely the Beri Ganga and Ban Ganga. Besides, some of the important Tanks are Soorpura and Golejor bandhs, Pichiyak (Jaswant Sagar) and Birai Tank, which are maintained by the irrigation department.

Jodhpur district has a well distributed network of exploratory wells (119) and ground water monitoring stations (507) in the district owned by RGWD (92 and 481 respectively) and CGWB (27 and 26 respectively). The exploratory wells have formed the basis for delineation of subsurface aquifer distribution scenario in three dimensions. Benchmarking and optimization studies suggest that ground water level monitoring network is sufficiently distributed for appropriate monitoring but for water quality 29 additional wells in different blocks are recommended to be added to existing network for optimum monitoring of the aquifers.

Depth to water level shows large variation ranging from less than 10m below ground level to about 110m below ground level. Most of the alluvial part of Luni block and adjoining parts falling within Bilara, Luni and Mandor blocks the ground water occurs at shallow depths ranging from less than 10 – 50m. There is also a shallow water zone in North around Bap the depth to water level is low, reaching about 30m. Otherwise, in general, in the central and northern parts the ground water occurs at deeper levels i.e., beyond 50m and reaching even upto 110m in major part of Osian bloc, Northern part of Bawari block, major part of Phalodi and eastern and southwestern parts of Bap block.

Agricultural activities in the district are mainly dependent on the rains. Kharif is the main crop of the district. Rabi crop is mainly cultivated in Bilara, Bhopalgarh and Osian Tehsils only. Bajra, Moong, Moth, Sesamum (Til), Jowar and Cotton to some extent are the main crops of Kharif whereas wheat, Barley, Gram, Mustard, Raida, Taramira etc are the main crops of Rabi in the district. Only 15 per cent of the cultivable land is sowed due to scarcity of irrigational facilities.

Jodhpur district has a total of 7 Tehsils and a total area of 22,850 sq km. There are 7 towns and 1,838 villages in this district. As per census Jodhpur District has a population of 3,687,165 in 2011 out of which 1,923,928 are male and 1,763,237 are female. Population of Jodhpur District in 2019/2020 is 4,140,093. Literate people are 2,031,532 out of 1,265,753 are male and 765,779 are female. People living in Jodhpur District depend on multiple skills, total workers are 1,489,741 out of which men are 965,103 and women are 524,638. Total 398,287 Cultivators are depended on agriculture farming out of 253,197 are cultivated by men and 145,090 are women. 103,001 people works in agricultural land as labor, men are 62,642 and 40,359 are women. Jodhpur District sex ratio is 916 females per 1000 of males. Out of total population of 4,092,754 in the district, 1,264,614 are in urban area and 2,422,551 are in rural area. 234,790 households are in urban, 414,223 are in rural area. 873,192 literate people are in urban, 1,158,340 are in rural area. Next Jodhpur District Census will be in 2021

Most of the population does not store the waste at source and instead dispose the waste into the municipal bins, streets, open spaces, drains, etc as and when waste is generated. Segregation of recyclable waste is not practiced. Most of the recyclable material is disposed of along with domestic and trade waste. Therefore, recyclable waste is generally found mixed with garbage on the streets, into the municipal bins and at the dumpsites from where part of this waste is picked up by the rag pickers.

There is no system of door-to-door collection of waste except in few housing societies earlier in year 2008 M/s Kanak Resource Management, Jodhpur was given a tender for the door- to-door collection but the groups worked only for one year and stopped to do it further due to some financial crisis. Street sweeping is thus the only method of primary collection of waste. There has been a significant increase in the generation of municipal solid waste in Jodhpur over the last few decades. The daily estimated generation of municipal solid waste in Jodhpur city is about 300 to 350 MT/Day, which is collected through street sweepings and from communal waste storage sites.

The quantity of waste generally collected and transported to the waste processing site is only about 100 MT/Day, which is about 35% of the waste generated in the city. Remaining solid waste not being transported is the main concern of all visible solid waste pollution in Jodhpur city. Jodhpur, being a heritage and tourist city, there are many hotels and restaurants in the city. Arrangements of primary collection of waste from hotels and restaurants are not yet made. These establishments, therefore, dispose of their waste on the nearby open space or into the municipal bins. Adequate storage facilities were not provided in the main vegetable, fruits and fish markets. The market waste is thrown in open space leading to unhygienic conditions and unbearable odour. Near the waste processing site, Keru village, a private operator is transporting & incinerating the waste to common biomedical waste treatment facility, where prope disposal of waste is being done as per the guidelines. Some pathology labs, small nursing homes, dental clinics, clinics and dispensaries were disposing their waste along with municipal solid waste.

NEED FOR THE STUDY:

During last decades there has been exponential rise in the population resulting in accelerated urbanization which has brought to the fore the Jodhpur city. The solid waste generated in the region is disposed off mainly by open dumping in and around the Jodhpur city. Such open dumping creates health hazards as they are sources for objectionable smoke and odour and breeding grounds for flies and mosquitoes. Open dumping of solid waste along roads also poses pollution threat in all environmental medium, like air, water and land, and affects the living beings. To minimize the problems related with waste disposal, there is a need to identify suitable landfill site for proper disposal of solid waste. The proper disposal of municipal solid waste is not only absolutely necessary for the preservation and improvement of public health but it has an immense potential for resource recovery.

The solid wastes generated by households, commercial establishments and medical centres but the way how they are handling disposal of these wastes need extensive study. The uncontrolled and unscientific dumping of such wastes has brought about a rising number of incidents of hazards to human health. More serious risk to human health is envisaged due to contamination of surface and ground water. The problem of Municipal Solid Waste Management (MSWM) is also prevailing throughout the urban environment of Jodhpur city and need to improve at the large scale. Hence, there is a need for a study to evaluate available technologies of waste disposal and also to study base line environmental conditions of the dumpsites, characteristics and composition of solid waste. Further no detailed spatial study on the issue has been done till now for the Jodhpur city. The latest tools and techniques of Geography will be highly helpful not only in addressing the management stress but also in speeding up of the recycling process and hence this study.

LITERATURE REVIEW:

GENERAL: Anderson (1968) first proposed the economic optimization in planning of solid waste management. Since then, most of waste related planning models have been focused on cost minimization in system analysis. Recently, considerable research efforts have been directed towards the development of economic-based optimization models for MSW flow/allocation from source to treatment facilities, such as waste recycling stations, incinerators, landfills and disposal facilities (Lin et al., 2006). Tchobanoglous et al. (1993) pointed out that the continuous increasing size of urban population makes it progressively more complex and difficult to manage the waste. Apart from the technical issue, MSWM is also strongly influenced by political, legal, socio-cultural, environmental and economic factors.

These factors have interrelationships that are usually complex in waste management systems (Abu Qdais, 2007; Kum et al., 2005). All these issues need to be addressed to reach a sustainable municipal solid waste management solution. Dayal (1994) studied on solid wastes, its sources and probable implications on management, while Malviya et al. (2002) have studied on solid waste assessment and management in Indore city of India. This section brief about the importance of solid waste characterization, method of handling, solid waste management procedures and occupational health issues. A brief review of the literature associated with municipal solid waste, waste management practices, zero-waste concepts, occupationally related and non-related health issues of solid waste workers is presented below.

SOURCES OF WASTE GENERATION:

Hui-Zhen et al. (2015), stated in their research that daily human activities were classified into three groups: maintenance activities (meeting basic needs, MA); subsistence activities (providing the financial support, SA); and leisure activities (social and recreational pursuits, LA). The author described various aspects related to waste generation such as volume of retail sales of consumer goods, residents groups, time spent on different activities by residents and discussed in detail about waste generation rate during festivals, weekdays and weekends.

CHARACTERISTICS OF MSW:

Lorena De Medina et al. (2013), studied on physical and chemical characteristics of municipal solid waste, stated that based on the characteristics of MSW, a decision can be taken for further processing. Based on their study results of specific heat and ashes, incineration will be a good choice for the final treatment of MSW, but due to the high cost of this technique, it is not recommended for semi-rural and rural localities. However, the results of humidity, organic matter, pH and sulphur present in the MSW from this locality suggests that it has optimum values for biological treatment such as vermi- composting method, not only because it exploits the weather conditions of the region (optimum to develop this technique) but also because the high levels of organic matter found favour this practice which is an appropriate procedure for waste recovery.

CHARACTERIZATION FOR MSW MANAGEMENT:

Ajayakumar Varma carried out a study in Kerala region for the basic data required for proper planning and effective MSW management such as assessment of quantity of waste generation and different sources of waste generation. This study also gives the details of physical composition of MSW such as paper, plastic, metals, glass, rubber and leather, compostable organics, other textiles, inerts and onsite hazards which is important for deciding the prime management action, namely the reduction, reuse, and recycling of waste. It also described the chemical characteristics of waste such as moisture content, low calorific value and high nutrient content which are the main factors for the conversion of waste into manure (http://www.seas.columbia.edu).

SEASONAL STUDY ON MSW:

Suad Mahdi Gleawa (2012) studied the seasonal variation in Hilla municipal solid waste composition. He stated that there is no significant variation in moisture content of solid wastes through winter, spring and summer seasons, but autumn has the lowest moisture content and highest calorific value. He also stated that waste contains high percentage of organic matter (food wastes) during all seasons of the year. A baseline study of MSW in the state of Kuwait was carried out by Rawa Al-Jarallah & Esra Aleisa (2014) with the objectives to conduct an upto-date characterization of the MSW generated in Kuwait, investigate whether any significant change has occurred, and conduct a statistical analysis to detect sources of variations resulting from seasons and governorates.

This study reveals that the daily average MSW for the last 5 years was 1.01 Kg/person and also gives the details of components present in the waste and the quantity variation of these components during season to season. Prayong Keeratiurai (2012), in his research, studied the management of solid wastes of municipal sub-districts in the Lower Northeast, Thailand Nakhonchaiburin group. This study aimed to determine the proportion of different types of the solid wastes at the present time and to offer the right choices for solid waste management. It states that season was one of the factor that influence the amount of solid waste but the season had low impact on the composition of the solid wastes. Gidarakos et al. (2005) in their study on municipal solid waste composition determination supported the integrated solid waste management system, and mentioned that there is a strong correlation between certain social activities and solid waste composition and quantity. During high-season months (months with increased number of tourists) not only increased MSW quantities produced, but also MSW composition is accordingly altered.

The author carried out a research project "Seasonality of Municipal Waste Generation and Composition and Corresponding Fluctuations of various Environmental Indicators for Waste Management and Treatment Facilities", from the study, they found that economic development and geographical latitude (which corresponds to different climate conditions) play the major role in the waste generation statistics (Gintaras Denafasa, 2014). Kamran et al. (2015), carried out a study to characterize and to quantify the MSW generated from three different income groups of ST, Lahore, during four different seasons of the year and among three different socio-economic levels (income groups).

They stated that, for planning a sustainable integrated municipal solid waste management (IMSWM), quality and quantity of MSW is essential which helpful in minimizing the human health risks associated with waste management. Their study found that the food waste was 84% of total MSW with 72.21% moisture content and had a low heating value of 5,642 J/g. Seasonal variations in MSW are only significant for food waste, other organic and plastic. The results also show that there is positive correlation between the economic status and MSW generation.

MUNICIPAL SOLID WASTE MANAGEMENT:

Banar et al. (2008) studied and determined the Municipal Solid Waste (MSW) management strategy for Eskisehir city, Turkey, using Life Cycle Assessment (LCA) methodology. They emphasized that an effective management system is needed since the generated MSW is dumped in an unregulated dumping site and recommend to develop five different scenarios: collection and transportation of waste, a material recovery facility (MRF), recycling, composting, incineration and landfilling processes as an alternate to the current waste management system. He stated that composting scenario is the more environmentally preferable alternative, where the recovery of biologically degradable fraction and organic fraction (77%) from the MF is transported to the composting facility and the residue (8.24%) is sent to the landfill. Naresh Kumar & Sudha Goel (2009) carried out a study on MSW characterization and proposed a management plan for Kharagpur, West Bengal, India. In their study, it was revealed that 45 metric tonnes/day of solid waste generated remains uncollected which was dumped in open land and natural and engineered drains, thus blocking the flow of storm water and contaminating groundwater. Other major issues are inappropriate bin locations and poorly designed community bins, collection vehicles that are in poor condition, inadequate labour for collection and transport of waste and lack of waste treatment and disposal facilities.

The authors suggested an integrated solid waste management plan for Kharagpur city through improvement in solid waste collection methods, replacing the stationary container system with the hauled container system, sitting of waste disposal sites and suitable methods of disposal. Tripathi et al. (2012) studied the physico-chemical properties and heavy metals in contaminated soils of municipal waste dumpsites at Allahabad, India. He stated that the level of heavy metal contamination is higher at dumpsites which may be a cause of concern for their surrounding environment and organisms and concluded that all the dumpsites are contaminated with heavy metals, thus open dumping of waste should be discouraged and proper monitoring and remediation plan is needed to reduce the chances of groundwater pollution from leaching of these contaminants. Kodwo Miezaha, (2015) conducted a study to generate a comprehensive data at the regional and national level for use in planning and implementation of relevant waste management activities in Ghana.

They found that organic fraction in the waste was the highest in the waste stream and ranged from 48% to 69%. Paper increased the percentage of biodegradables to 58-76% which could be used as raw material for biological conversion processes like composting, biogas and bioethanol refinery process. Also stated that, the success of any designed waste segregation system will depend largely on the active participation of the waste generators in the various communities and how they comply with the principles of sorting and separation of the waste.

ENVIRONMENTAL IMPACT:

Antti Niskanen et al. (2009) carried out environmental assessment of Ammassuo Landfill (Finland) by means of LCA modelling (EASEWASTE). In this study, the authors focused on the environmental impacts caused by the waste landfilling. The assessment criteria evaluate specific categories of impact, including standard impact categories, toxicityrelated impact categories and impact categorized as Spoiled Groundwater Resources (SGR). With respect to standard and toxicity-related impact categories, the LCA result shows that substantial impact potentials are estimated for Global Warming (GW), Ozone Depletion (OD), Human Toxicity via soil (HTs) and Ecotoxicity in water chronic (ETwc). The largest impact potential was found for SGR and amounted to 57.6 person equivalent per tonne of landfilled waste. He stated that LCA approach can be usefully applied to landfilling systems which is a powerful tool in identifying the contributions to the impact potentials from different parts of the analyzed vsystem or from the emission of single substances.

CREATING AWARENESS:

Rajesh et al. (2014) the author stated that with the increase in population there is an exponential increase in the MSW generation, hence it is necessary to reduce either by disposing it or recycling periodically. Conducting awareness programs about waste generation and its effects on human health and sustainability for the people, proper planning in industries may create a healthy environment both for the humans and animals to live.

REDUCE, RECYCLE AND REUSE:

Alice sharp et al. carried out a research which aims to study the current situation of MSW management system in Monagar, an urban town in eastern Bhutan, to identify appropriate integrated solid waste management system for various waste streams that will ultimately lead to a zero-waste city (http://www.ipcbee.com). The authors recommend two major aspects to minimize the waste generation in the town: one is reduce, raise awareness through educational campaigns, seminars, researches and academic involvement as a method for raising awareness and knowledge in SWM for the people of Monagar district.

The second one is to turn organic waste into fertilizers through composting, which ensures the “reuse” of the waste materials; convert the unwanted materials into a useful product and energy. Sesha Sai Ratnamala Bommareddy & Asadi (2017) in their study recommend automated plastic separator by which the plastic content in the waste can be segregated and other biodegradable content will be discharged as slurry. The plastic contents may be sent to recycling units and slurry can be used as compost for agricultural purposes. The study by Rajeev Dahiya (2015) reveals that removal of recyclable fraction and composting of biodegradable components should be an integral part of the waste management policy to handle the increase of the solid waste with population growth. These measures will decrease the quantity of solid waste remaining for final disposal at landfill site.

The policy measures with multi-pronged approach of population control, and recycling and composting of solid waste will make a significant impact on sustainable development of the region. Pramada Valli & Sudhir Mathur (2011) state that large amount of solid wastes is contributed by domestic wastes which cause serious disposal problem. If they are not properly disposed, then those places become a home for rats, flies, bacteria, mosquitoes and a large number of vectors which have the potential of causing many human diseases. Also, the authors suggested that it is imperative for a large-scale utilization of MSW in the construction of roads. It was explored that road constructed using MSW combustor ash performed well even after three years. Mahdi Ikhlayel et al. (2016) states that municipal solid waste increased significantly due to rapid population growth and fast urbanization, change in lifestyles and consumption patterns. Major problems associated with MSWM are poor collection rates, open dumping, and improper recycling that pose environmental damages.

Their study revealed that the materials recycled could be increased by 33.5% if the waste separation was applied at the source of generation. The authors also state that CO2 and CH4 are mainly emitted from collection and landfill sites, and part of the pollution could be avoided through recycling. CH4, NOx, and CO were emitted during waste collection and landfilling. The other pollutants in air and water were mainly caused by landfill processes. The study indicated that the scenario included 28% of dry recyclable materials through MRF and solid waste landfills with energy recovery of the remainder reduced GHG emissions by 80%. It recovered 155% of the costs while the current cost recovery in the current system was 55.6%. A case study was made on MSW composition by Salah et al. at Amman city, Jordan. They stated that the MSW composition can vary according to the lifestyle and the activity existing in a region. People of highlifestyle areas buy more printings than the others; the plastic and corrugated waste are higher in commercial areas compared to other areas; the organic waste weight percentage in industrial area is the lowest in comparison with other categories.

They discussed the size of MSW, the larger is (>100mm) present at 65.8%, 34% of the waste has medium size

(20–200mm), and only 0.2% of the MSW has small size (<20mm). The author suggested to have waste containers with cover (Lid) to protect the waste from rain (lower moisture content is preferable), and to avoid dispersion of odour and reduce the attraction of insects and also recommended source-level segregation of waste. Research was conducted in the UK by Anne C. Wool ridge et al. (2006) to quantify the energy used by a reuse/recycling operation and whether this resulted in a net energy benefit using LCA tools. In their study, taking into account extraction of resources, manufacture of material, electricity generation, clothing collection, processing and distribution, and final disposal of wastes, it was demonstrated that for every kilogram of virgin cotton displaced by second-hand clothing approximately 65kWh is saved, and for every kilogram polyester around 90kWh is saved. They stated that when materials are recycled there is an environmental benefit as a result of avoiding the environmental burden associated with the manufacture of new products and the disposal of wastes. He concluded that the reuse of 1 tonne of polyester garment only uses 1.8% of the energy required for the manufacture of these goods from virgin materials and the ruse of 1 tonne of cotton clothing only uses 2.6% of the energy required to manufacture those from virgin materials. Gerardo Collaguazo et al. (2016) carried out a study on household wastes characterization from Bihor County, Romania for the purpose of identifying and quantifying the materials likely to be recovered energetically or economically.

The authors stated that, the economic activities and the lifestyle of the population determine the characteristics of the generated waste; therefore they vary depending on the area where the samples weretaken as well as on the season. Also, this characterization can be considered as reference for choosing the possible treatment process, so that methods such as composting, agricultural recovery, biodegradation in reactors-energetic recovery, the recycling of metals and glass or other recyclable materials (paper, cardboard, plastic) – economic recovery, etc. could be optimized. Gabriel et al. (2015), conducted a study to assess performance of municipal solid waste recycling program in a single facility waste treatment unit located in Depok, Indonesia with a aim to recover a meaningful amount of recyclable materials from waste flow to help to reduce the amount of residual waste to be disposed to a landfill. This will also help problems of raw materials scarcity, reduce municipal waste generation, and create jobs and financial incentives for recycling industry. One of key finding is to increase the percent of recyclable materials by encourage waste separation at source either encouraging it by economic incentives or increasing environmental awareness among the households.

WASTE TO ENERGY CONVERSION:

During the combustion of Municipal Solid Waste (MSW), energy is produced which can be used to generate electricity. Chalita Liamsanguan et al. studied and compared the conventional waste management system and waste incineration system where waste management as well as electricity production can be achieved. They stated that in case of incineration of waste with energy recovery system, a large portion of the waste has significant energy potential which can be utilized. They emphasized that incineration, of course, cannot play a role in electricity production as a main function, but electricity production from incineration as a benign waste management option provides approximately deNOx and dioxin removal process is added. Ankur et al. (2013), their study focused on the designing and development of anaerobic digester for generation of methane gas from kitchen waste. They discussed in detail about design of anaerobic digester, its working principle and process.

The anaerobic digester for the generation of methane gas by kitchen waste is the apparatus which can be used for the effective disposal of solid waste from kitchen and in the digester, the complete decomposition of waste takes place, this decomposition results in the generation of methane gas as the main product. Arthur Omari et al. (2014), have made a case study at Arusha, Tanzania about the thermal degradation behaviour of municipal solid waste which includes determination of its proximate analysis, ultimate analysis higher heating value and kinetics. They observed that municipal solid waste is less reactive to combustion as compared to coal and biomass, but its reactivity can be improved through pre-treating process so as to reduce non-combustible materials such as oxygen and ash content. Also stated that, pyrolysis and gasification can be used to convert MSW to liquid or gaseous fuel. In the proximate analysis, the waste contains more than 50% and 5% of carbon and hydrogen respectively which may contribute to high calorific value of Arusha municipal solid waste.

The ultimate analysis shows that average amount of nitrogen, sulfur, chlorine and phosphorus are small, these reduce emissions during combustion. The municipal solid waste shows exothermicity property at the devolatilization zone. The devolatization zone shows that the municipal solid waste can be easily ignited at temperature above 423K.Therefore municipal solid waste has a good potential to be used as a fuel. Michael Hoffmann et al. (2015), conducted a research in four countries: Lithuania, Russia, Georgia, and Ukraine to address the seasonality of waste composition. Their study shows, although food and yard waste contributed up to 37% of the weight of the energy-rich waste elements, these wastes contributes only 9% of the total energy share. The author stated that the efficient recovery of energy from these elements may only be possible using technologies that can exploit their energy without resorting to energyintensive drying procedures; hence, they may be better used in composting and the production of biogas. Further they states that the composition of waste depended on several factors, including geography, climate, season, and social context.

PUBLIC–PRIVATE PARTNERSHIP IN MSWM:

Nabukeera Madinah (2016) suggested that public–private partnership is an important process for improving and modernizing the urban waste management system. However, to institutionalize the active participation of other private service providers, regulations pertaining to SWM must be formulated with a view of promoting and enhancing partnerships between the city council and other private service providers. Dalvi Vikas et al. (2016) suggested to have public–private partnership in solid waste collection, segregation and disposal since the capacity to carry out this work by the municipality is difficult and also solid waste generation is increasing day by day. They emphasized that municipal corporation should adopt scientific methods in handling wastes where public– private partnership will play an effective and important role.

Avani Chopra & Kapoor (2016) emphasized that, in municipal solid waste management, involving private sector will result in an efficient and professional SMW system. The private sector is usually best in providing efficient service and is capable to infuse the latest technology by resorting to collaboration with leaders in the technology, while the public sector is best at doing the jobs of monitoring and enforcement. Therefore, a suitable combination of the private and the public sectors will be necessary to provide an efficient management system.

MSW- ZERO WASTE MANAGEMENT:

Atiq Uz Zaman & Steffen Lehmann (2011), stated that zero waste cities would recycle100% of their waste or recover all possible resources from waste streams and produce no harmful waste for our environment. The concept of "zero waste city" would tackle the issue like GHG emissions and the provision of potential specific solutions for emissions reduction and sustainable waste management. They stated that, zero waste is the 6th wave in waste management and the most holistic innovation of twenty first century for waste management systems for achieving a true sense of sustainable waste management systems which include a holistic approach of cradle-to-cradle closed-loop design systems, sustainable resource consumption and resource recovery from waste. They emphasized the importance of zero waste city principles and the waste hierarchy, i.e. avoid, minimization and recovery, behavior change and sustainable consumption practice, extended producer and consumer responsibility, resource and product stewardship, achieving total recycling of waste and legislation for zero landfill and incineration. Mohammed Saleh Al. Ansari (2012) stated that Landfills are a significant source of greenhouse gases, which contribute to the process of global warming. In the region covered by the Gulf Co-operation Council (GCC), changes in consumption patterns have led to an excessive dump of Municipal Solid Waste (MSW). Thus, it is clearly an important time to reevaluate conventional waste management protocols in order to establish methods that not only deal with increased demand but also minimize greenhouse gas emissions and improve efficiency of resource management. Global warming is driven by increase in greenhouse gases (GHGs) predominantly water vapour, nitrous oxide, carbon dioxide (CO2), and methane (CH4) in the Earth‟s atmosphere.

This has led to major environmental changes worldwide. Landfills are a significant source of greenhouse gases, which contribute to the process of global warming. In the region covered by the Gulf Co-operation Council (GCC), changes in consumption patterns have led to an excessive dump of municipal solid waste (MSW). Thus, it is clearly an important time to re-evaluate conventional waste management protocols in order to establish methods that not only deal with increased demand but also minimize greenhouse gas emissions and improve efficiency of resource management. Atiq Uz Zaman (2012), stated that waste management social business would be an opportunity for the corporate world to implement the strategy of extended producer responsibility in more successful way and developed a business model where the producers can contribute more significantly in the social development process, promote value creation, ensure the product stewardship and equity within the society.

This can improve the current waste management problems in our society, provide jobs to local people and can save our global finite resource. The conceptualized social business model can endorse closed-loop resource flow in the circular society and it can maximize resource utilization through recycling and reusing so-called "solid waste" and prevent environmental depletion. Queena K Qian et al. (2013), proposed a holistic methodological framework for designing a SWM system for a zero-waste low carbon residential precinct. Based on an extensive literature review on waste management of system approach, the methodological framework for understanding the overall process of the zero waste management by combining system characteristics as well as the cost/ benefit impact with the attitudes and requirements of a specific stakeholder group (i.e., the city planner, government, and/or households) and highlights the dynamic interrelationships of the sustainable SWM practices, supplemented with the cost/benefit factors into the System Dynamics process.

The system-oriented research framework serves the decision-makers to draw the forward-looking and preventative insights and reach a scientific understanding of the carbon and cost consequences relating to various sustainable SWM scenarios. The framework provides an inventory of leverage points that helps policy-makers design waste policies and allocate resources effectively, with minimum environmental impact and optimum social benefits. It also helps planning professionals and business stakeholders better understand the costs and benefits of different scenarios for achieving a zero waste residential precinct. Karthik Rajendran et al. (2013), describes about the Boras model on "a Zero Waste City in Sweden", they emphasizes on ''reduce, recycle and recover energy'' before dumping. They stated that before1996 more than 40% of waste was landfilled in Sweden and today it has approached to zero landfill. The author stated that the city has developed a sustainable waste management mechanism by reducing landfill, recovering fuel from the waste and recycling in collaboration with University of Boras, local municipality and other private partners. In Boras, the household waste is sorted in 30 different fractions, which is either recycled or converted to electricity, fuel or heat.

The municipality also provides white and black bags for every household for free. All compostable waste is collected in black bags, while other waste goes in white bags for combustion. The black bags and other organic flows are sent to biological treatment for production of biogas. More than 3 million m3 biogas is produced every year, which is enough to run the buses in the city, garbage collecting trucks and around 300 CNG vehicles in the city. The white bags and other industrial waste are sent to two 20 MW combustion plants, where 960MWh heat and electricity is produced every day. This public, private partnership model has made Boras a zero waste city. William Hogland et al. (2014), conducted a research in order to raise concerns and awareness about the importance of establishing a new model of waste management schemes and discussed about waste handling principles.

The producer responsibility referred to a system where producers must ensure that waste from their companies is collected and recycled in the best available way. The eco-efficiency concept referred to an environmentoriented policy that aims to prevent and reduce the negative impact products have on the environment and on human health throughout its entire life cycle. Rajamanikam et al. (2014), made a research to develop a proper waste management plan for achieving the goal of “Zero Waste Campus” at Pondicherry Engineering College (PEC). Their main aim of the study was to examine how far solid waste generation and compositional analysis in residential sector support the design of policies on waste reduction practices and implement sustainable waste management system in campuses.

The composition analysis shows the solid waste stream from the staff quarters in PEC was consisted of 65% of compostable, 26% of potentially recyclable materials, 4 % of reusable or divertible products and 5% of waste materials which were not recyclable due to toxicity, composite-nature, contaminations and the absence local recycling industries. The results also indicated that the household solid waste generation and composition varies according to the household income, and highest average daily per capita waste generation rate was by middle income households at 1.982 ± 0.837 kg/household/day while the low income household produced 1.685 ± 0.713 kg/household/day and the high income household produced 1.612 ± 0.585 kg/household/day, which were similar.

Abhilash Rajendra & Ramu (2014), their research aims to assess the present status of municipal solid waste management and to suggest measures to improve them for Mysore city, India. Author emphasized the importance of MSW management and stated that selection of the system for the collection, transportation, recycling, treatment, and disposal can determine the number of recycling bins needed, the day people must place their garbage at the curb, the truck routes through residential streets, and the cost of waste services to households. It must be ensured that MSW management is environmentally safe and follows sustainable disposal. Thus, MSW management can be a significant issue for municipalities. The waste collection, transport and transfer methods depend on the specific site, waste generated, distribution road network, work force, vehicles, treatment methods, etc.

The issue of waste is not only because of the increasing quantities but also largely because of an inadequate management system. Aparna Nayak (2016), stated that the involvement of industries and government is prerequisite in eliminating waste from the beginning because they are presented with more advantages than individuals. Without their role zero waste will not be possible. Industry has control over product and packaging design, manufacturing processes, and material selection. Governments have the ability to form policy and provide subsidies for better product manufacturing, design and the ability to develop and adopt inclusive waste management strategies which can eliminate waste rather than just manage it. Also discussed in detail about Cradle-to-cradle / Cradle-to-grave, Cradle-to-cradle functioning.

The author emphasized about the two categories in the cradle to cradle model, used in industrial or commercial processes that are "technical" or "biological" nutrients. Technical nutrients are strictly limited to non-toxic, non-harmful synthetic materials that have no negative effects on the natural environment; they can be used in continuous cycles as the same product without losing their integrity or quality. In this manner these materials can be used over and over again instead of being "down cycled" into lesser products, ultimately becoming waste. Biological Nutrients are organic materials that, once used, can be disposed of in any natural environment and decompose into the soil, providing food for small life forms without affecting the natural environment.

OBJECTIVE:

- To Study demography & population growth in Jodhpur city.
- To Study the present solid waste management in Jodhpur city.
- To Study Geographical tools used in solid waste managed system.
- To Study future planning of solid waste management system in Jodhpur city.

SIGNIFICANCE OF THE STUDY:

It is expected that the research results will provide useful information and decision support for solid waste managers and decision-makers and planners when they are conducting long-term planning of waste management activities and formulating related policies/regulations. The research findings would also be of immense help to the executive officers of municipalities, chief functionaries of

NGOs and environmentalists for better management of Municipal Solid Waste. The findings will also benefit those who want to take up solid waste management activities like recycling, vermicomposting and garbage management etc. as entrepreneurial units. Thus, maximized environmental and economic benefits may be achieved. The study will provide baseline data for consultancy services to Government and Nongovernmental agencies on issues related to waste management, sanitation, hygienic and environmental protection.

METHODOLOGY:

- The present study would be carried out through primary sources such as personal interview ,field work , site photography ,well as with the help of secondary sources, such as Govt. / N.G.O. / Print & Mass media ,reports, literature, pamphlets, monogram etc.
- The present study will adopt historical, descriptive and analytical methods. As far as the present study is concerned, both primary and secondary data will be utilized. The primary data will be collected by administering a questionnaire schedule issued to the respondents. Further, the details regarding solid waste management will be collected from the records of Jodhpur Municipal Corporation, State Pollution Control Board, the Central Pollution Control Board and other related sources. Besides, personal interviews will also be conducted with the officials concerned to collect the necessary data on the solid waste management. For collecting the secondary data, the various books, journals, periodicals will be used and some information will be collected from the authentic websites.

HYPOTHESIS:

- There is correlation between solid waste management system & population.
- The present solid waste management (SWM) is affectively management in Jodhpur City.
- Geography tool are helpful in mapping & future planning of solid waste management system.

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