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Keeping Waste Low through Management: The Socio-ecological Interpretation

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Authors' contributions

This work was carried out in collaboration among all authors. Author AG wrote the first draft of the manuscript, collected data and done statistical analysis. Author DP helped in collection of data and preparation of manuscript. Authors AB and SKA helped in interpretation and supervised the work. All authors read and approved the final manuscript.

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ABSTRACT

Waste is a ceaselessly developing issue at worldwide and territorial just as at neighborhood levels. Due to vigorous globalization and product proliferation in recent years, more waste has been produced by the soaring manufacturing activities. The social ecology of waste recycling implies the structural, functional and managerial intervention of waste generation process. The present study takes a look into the approach, process and impact of ongoing waste management process, followed by the both kalyani and jalpaiguri municipalities. A set of agro-ecological, socio-economic and techno managerial factors have been developed by selecting two sets of operating variables. 21 independent variables and one dependent variable i.e. waste reduction methods (y_4) were selected for the research. Total one fifty respondents, seventy five from each municipal area have been selected by systematic random sampling. A basket of multivariate analytic techniques have been carried out to isolate and interpret the variables. Throughout the study it has been observed that in terms of variable behavior and responses there has been stark differences between jalapaiguri and kalyani where as some few variables like income, impact of waste management and recycling on water and micro flora and fauna have recorded the distinct contribution, for jalpaiguri volume of waste generation from household, water consumption per day have gone in the determinant way.

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But in both municipal areas perception of environmental impact of waste management have recorded equal contribution. So it can be said that improper waste management leads to ecological damage and waste reduction methods will reduce waste generation, improper waste disposal and save our environment and ecology.

Keywords: Waste management; waste recycling; ecological services; social ecology.

1. INTRODUCTION

Waste is for the most part an urban wonder, and is commonly an urban Issue. Today, over half of the World's populace lives in the urban areas and the pace of urbanization is expanding rapidly. The production of municipal solid waste represents one of the greatest challenges currently faced by waste managers all around the world [1]. Due to the increase in the world's population and most of it moving to urban cities, there is increased demand for food, and this has resulted in the production of large amounts of agricultural wastes, both at farmer, municipality and city levels [2].Solid Waste age is the side-effect of the Urbanization. Waste is a great concern of urban life in every city of the world. Developed cities of world are using modern disposal and recycling technologies as well as state of the art equipments and ensuring their dwelling neat and tidy [3]. Management of solid waste may be defined as that discipline associated with the control of generation, storage, collection, transfer and transport, processing, and disposal of solid wastes in a manner that is in accord with the best principles of public health, economics, engineering, conservation, aesthetics, and other environmental considerations. Solid Waste generation is the by-product of the Urbanization. It is highly related with Economic growth, degree of industrialization and consumption pattern. With the increase of urban population of the cities and towns all other activities associated with population also increases resulting in more and more generation of Municipal Solid Waste. And in the absence of technology and efficient and effective methods of disposing refuse worsen the quality of Air of the urban centers which have detrimental impacts on human health. Açaí (*Euterpe oleracea* Mart.) is a fruit from forests typical of South American countries, such as Brazil. The fruit is harvested from palm trees and later processed to produce several food and aesthetic products that bear considerable health benefits. The processing of açaí generates substantial amounts of waste, such as natural fibres, which are generally disposed of in landfills [4]. The world paper industry produces a great amount of industrial solid waste that undergoes a treatment process that can be primary, secondary, or tertiary, in order to adapt the waste for correct disposal [5]. The pulp and paper industry traditionally generates large amounts of wastes at different stages of its production process, such as primary sludge that is extremely wet [6]. Electronic waste or E-waste is one of the main sources of harmful toxic pollutants (polyvinyl chlorides, polychlorinated biphenyls, lead and mercury). E-waste also represents a potent source of valuable metals such as gold, silver, palladium, and copper [7]. Due to the growing concerns about the increasing release of consumer products to the environment, especially for defective electronic products, the management of the closed-loop supply chain (CLSC) is emerging. To do this, a chain consisting of a manufacturer, a retailer, and a collector is offered in a manufacturer-led Stackelberg game [8]. Civil construction is responsible for the excessive consumption of natural resources and the generation of the largest share of solid urban waste [9]. The production process of ceramic roof tiles requires a large consumption of natural raw material, such as clay, and energy consumption in the sintering process [10]. Environmental contamination due to solid waste mismanagement is a global issue. Open dumping and open burning are the main implemented waste treatment and final disposal systems, mainly visible in low-income countries [11]. Solid Waste generation is the by-product of the Urbanization. It is highly related with Economic growth, degree of industrialization and consumption pattern. With the increase of urban population of the cities and towns all other activities associated with population also increases resulting in more and more generation of Municipal Solid Waste. And in the absence of technology and efficient and effective methods of disposing refuse worsen the quality of Air of the urban centers which have detrimental impacts on human health.

Wastes are the by-product of a process called “Modernization and Urbanization” with the generation of urban amenities and livelihood. Municipal solid waste management (MSWM) is an important environmental challenge and subject in urban planning [12]. The ecological impact of waste recycling certainty implies the structural functional and managerial nature and intervention of the waste generation process. Population growth associated with population migration to urban areas and industrial developments have led to consumption relations that result in environmental, social, and economic problems. With respect to the environment, a critical concern is the lack of control and the inadequate management of the solid waste generated in urban centers [13]. Among the challenges are proper waste-collection management, treatment, and disposal, with an emphasis on sustainable management. Every year in India we are producing 133760tons of wastes comprising of both bio degradable and non bio degradable materials. Out of this total waste generation 91,152 tons of wastes are collected and 25,884tons of wastes are treated for different purposes. Medical bio wastes drifted by Hospitals and private Nursing homes are also a serious concern. Medical care is vital for our life, health and wellbeing. But the waste generated from medical activities can be hazardous, toxic and even lethal because of their high potential for diseases transmission. Cooperatives of Recyclable Material Pickers (CRMP) should play a leading role in this regard, but they do not have adequate management to be economically, socially and environmentally sustainable, depending on assistance to maintain the activity [14]. The hazardous and toxic parts of waste from healthcare establishments comprising infectious, medical and radioactive material as well as sharps constitute a grave risks to mankind and the environment, if these are not properly treated / disposed or are allowed to be mixed with other municipal waste [15]. Composting of organic waste is a possible solution to the long-standing rubbish problem, limiting the amount of waste going to final disposal. Fertilization with composted waste could have positive agronomic and environmental effects if the doses are balanced against the N requirements of crops [16]. When wastes are properly recycled treated and managed it can add values and resources but incase it is not properly managed it contributes to pernicious pollution. The bio wastes and residues from agriculture field a well are transformed into bio resources in the form of organic manure and different bio products, available and amenable to mobilize sustainable agriculture. Not only agricultural waste fish waste can also be used in organic farming. The production and uses of fertilizers from fish and fish waste (FW) can be applicable for certified organic farming, with a focus on crop and horticultural plants. Fish industries generate a substantial amount of Fish waste. Depending on the level of processing or type of fish, 30–70% of the original fish is Fish waste. Circular economy and organic farming concepts were used to evaluate the potential of production of fertilizers from captured fish. Fertilizers produced from captured fish promote the recycling of nutrients from the sea and back to terrestrial environments [17]. A typical waste management system comprises collection, transportation, pre-treatment, processing, and final settlement of residues. The waste management system consists of the whole set of activities related to handling, treating, disposing or recycling the waste materials [18].

Kalyani Civil territory, that is 21 wards, was chosen for the investigation. In Kalyani town wastes the executives is a difficult issue and carefully need legislative concern. In kalyani civil territory around all out 52Mt wastes produces every day. This town has 9 vegetable markets and 8 fish markets. Roughly 6-8Mt of wastes produces structure vegetable markets and around 1Mt of wastes create structure fish showcase. Out of all out waste age, household wastes contribute 75%, wellbeing units contribute 2%, Markets contribute 10%, office and foundations contribute 3%, modern wastes contribute 2% and street clearing contributes 8% wastes and 60% of absolute wastes are bio degradable in nature. Kalyani district has acquainted a framework with gather collected solid waste from singular premises in two separate holders. Bio degradable wastes in green dustbin and non bio degradable waste in yellow dust bin. Collection of wastes is done through house to house collection and network canister collection. After collection, waste is moved to dumping ground. From collection to disposal to the damping ground the whole procedure confronting difficult issues. Unhygienic open dumping is pervasive in dumping ground that dirties the ecosystem. Jalpaiguri Municipality area that is 1to 25 wards were selected for the study. In Jalpaiguri town Waste Management is a serious problem and strictly need governmental concern. In west Bengal approximately total 12552 MT wastes per day. In jalpaiguri town approximately 52520 kg wastes produced every day. Out of total waste generation, 29490 kg wastes are bio degradable in nature and 23020 kg of waste are non biodegradable in nature.

The solid waste management system for jalpaiguri municipality has been prepared for improvement of the present solid waste management system of the town. Project has been developed and requires 12.2 acres of land. Jalpaiguri municipality already has 14 acres of land for this purpose. At present solid waste management programmer is going through ward committee of different wards with direct supervision of the sanitary department of jalpaiguri municipality. This scheme has implemented in 16 wards. Jalpaiguri municipality has introduced a system to collect accumulated solid waste from individual premises in two separate containers i.e. bio degradable wastes in green container and non bio degradable waste in yellow container. Collection of waste is done through house to house collection and community bin collection. After collection, waste is transferred to dumping ground. The function of entire system has been facing various problems such as non approval of vermi composting project, require number of vehicles, implements etc.

Municipalities have been facing problems to keep the management of their municipal solid waste (MSW) in financial balance. Increasing public awareness, stricter legislation and large generation of MSW have led to high costs concerning related services [19]. Both Jalpaiguri and Kalyani municipal areas have great ecological diversity. Jalpaiguri which is situated at the northern part of West Bengal, India is surrounded by beautiful Hills, Forests and rivers and Kalyani which is situated at southern part of West Bengal, India, is a very beautiful planned city, which is surrounded by lakes, trees and have diversified ecosystem. Both municipalities are trying to keep the cities clean. But the function of entire system has been facing various problems such as non approval of vermi composting project, require number of vehicles, implements etc. Unhygienic open dumping is also prevalent in both towns. Medicinal wastes require recycling facility. Recycling facility, incineration facility is not available in towns. Adequate fund is also required to run the solid waste management programmer under both Kalyani and Jalpaiguri Municipality as the system is a continuous process. Presently Jalpaiguri municipal authority has decided to engage private agency, NGO, and institution as recognized by the government to run the project of solid waste management because a sound waste management guarantees better stewardship for guaranteeing bio security and natural wellbeing and knowledge of waste recycling will reduce improper waste disposal and save the environment and ecological diversity of these towns. In this way, with the end goal of the investigation, a model has been developed for reasonable waste management so biological expectations can be followed out dovetailed to the working financial capacities.

The specific objective of the research was to isolate and identify the system variables characterizing and the management of waste recycling process and to estimate intra and inter level of interaction amongst and between the variables for respective, inductive and interactive contribution.

2. RESEARCH METHODOLOGY

2.1 Locale of Research

The present study was conducted in two districts namely Jalpaiguri district and Nadia district, West Bengal, India. In Jalpaiguri distrct, Jalpaiguri Municipal area and in Nadia district Kalyani Municipal area were selected for the study. The area had been selected for the study because of there is a large scope for collecting relevant data for the present study, acquaintance with the local people as well as local language, The closure familiarities of the researcher with area, people, officials and local dialects.

2.2 Pilot Study

Before taking up actual study, a pilot study was conducted to understand the areas, it people, institutions, communication and extension system and the knowledge, perception level and attitude towards waste management practices and its impact on ecology.

2.3 Sampling Design

The state, district, sub divisions were selected using non-probability sampling technique called purposive sampling and the respondents were selected using simple random sampling method. The two municipalities were selected purposively. Out of two municipalities total 150 respondents were selected, 75 respondents from each municipality from five respective locations (Vegetable market, Fish market, Hospital area, Railway stations, Ward area) were selected randomly for final data collection.

2.4 Preparation of Interview Schedule

On the basis of findings of pilot study a preliminary interview schedule was formed with the help of literature, and by the assistance of Chairman of Advisory Committee and subsequent discussion with the members of the advisory Committee.

2.5 Finalizing of Schedule after Pre-Testing

The draft schedule for collection of data, incorporating the tools and techniques of different variables were presented twice each time on respondents. The quantification was done for each and every variable after operationalized them. Before starting final data collection, entire schedule was pretested for elimination, addition and alternation with respondents of the study area.

2.6 Techniques of Field Data Collection

This was personally interviewed during puja vacation and summer vacation. The items were asked in Bengali as well as English version in a simple term so that the members could understand easily. The entries were done in the schedule by student investigator himself at the time of interview.

2.7 Variables and their Measurements

After reviewing various literature related to the field of study and consultation with the respected chairman of Advisory Committee and other experts, a list of variables was prepared. On the basis of selected variables, a schedule was formed. Analysis was done by SPSS V20.0 software and opstat.com.

2.8 Proper Description of Variables

2.8.1 Age(X_1)

In all societies, age is one of the most important determinants of social status and social role of the individual. Age of the head member of the family has only been considered for the purpose of the study.

2.8.2 Education(X_2)

Education is instrumental in building personality structure and helps in charging one's behavior in social life. In the present study qualification of the head member of family has been considered(i.e. if the person complete matriculation it denoted by 10 if he/she passed higher secondary if denoted by 12, if he/she completed graduation it denoted by 15etc.

2.8.3 Total number of the family member(X_3)

Total numbers of adult and minor member present in a family were considered for the study.

2.8.4 Total cost of energy per month(X_4)

Total cost of energy per month is an important parameter to access the economic status of a family in the society. Data was taken by dividing the cost of energy per month by family member.

2.8.5 Total household land(X_5)

Household land refers to a parcel of property jointly owned by all members of a particular family. In this study household land has been divided into two parts i.e. total covered area and green covered area. Data was taken by dividing total green area by total cover area.

2.8.6 Income(X_6)

The Monthly Income of a person is an important parameter to assess the economic status of the person in the society. In this study income has been classified into three categories i.e. service, business, and farmer and the income of the family head have been considered for the study and it is divided by family member.

2.8.7 Expenditure(X_7)

The expenses or disbursements made by a family purely for personal consumption during the reference period. Data was taken by dividing monthly expenditure by family member.

2.8.8 Total volume of waste generation from household per day(X_8)

Total amount of waste generation is an important parameter for the purpose of the study. Data was taken by dividing total volume of waste by family member.

2.8.9 Water consumption per day(X_9)

Data was collected by dividing total consumption of water per day by family member.

2.8.10 Total bio diversity(X_{10})

Biodiversity is the variety and variability of life on Earth. Biodiversity is typically a measure of variation at the genetic, species, and ecosystem level. In this study bio diversity measured the total area covered by the vegetable, flower, orchard and others. For the purpose of the study total bio diversity has divided by the family member.

2.8.11 Impact of wastes management and recycling on household(X_{11})

Data has been collected through 10 point scale. Question was asked to the respondents and they gave score out of 10 on the basis of their preferences.

2.8.12 Impact of wastes management and recycling on agriculture(X_{12})

Data has been collected through 10 point scale. Question was asked to the respondents and they gave score out of 10 on the basis of their preferences.

2.8.13 Impact of wastes management and recycling on livestock(X_{13})

Data has been collected through 10 point scale. Question was asked to the respondents and they gave score out of 10 on the basis of their preferences.

2.8.14 Impact of wastes management and recycling on water(X_{14})

Data has been collected through 10 point scale. Question was asked to the respondents and they gave score out of 10 on the basis of their preferences.

2.8.15 Impact of wastes management and recycling on soil(X_{15})

Data has been collected through 10 point scale. Question was asked to the respondents and they gave score out of 10 on the basis of their preferences.

2.8.16 Impact of wastes management and recycling on Micro flora and fauna(X_{16})

Data has been collected through 10 point scale. Question was asked to the respondents and they gave score out of 10 on the basis of their preferences.

2.8.17 Exposure to media(X_{17})

This variable has been classified in to four categories that are Radio, Television, Newspaper, Mobile phone and the ranking were done by adaptability of these media and total values has been divided by family member.

2.8.18 Training received regarding waste management(X_{18})

Training is teaching, or developing in oneself or others, any skills and knowledge or fitness that relate to specific useful competencies. Data collected on the basis of number of training received.

2.8.19 People's participation in waste recycling programmer(X_{19})

Data collected on the basis of number of people participated in waste recycling programme.

2.8.20 Perception on Environmental impact of waste management(X_{20})

Four types of question were asked to the respondents and scores have been given according to their preferences.

2.8.21 Waste management at Household level(X_{21})

Data has been collected on the basis of what percentage of household wastes can be utilized for compost making or for other uses.

2.8.22 Waste reduction methods (Y_4)

Waste reduction methods have been classified into three categories and data were collected on 10 point scale.

3. RESULTS AND DISCUSSION

3.1 Coefficient of Correlation (r): Waste Reduction Methods (y_4) vs. 21 Independent Variables (x_1-x_{21})

Table 1 presents the coefficient of correlation between waste reduction methods (y_4) and 21 independent variables(x_1-x_{21}). The variables education(x_2), total cost of energy(x_4), income(x_6), expenditure of family(x_7), water consumption per day(x_9), impact of waste management on health(x_{11}), impact of waste management on water(x_{14}) and perception on environmental impact of waste management(x_{20})have gone positively to influence waste reduction methods. Similarly the change in following variables household land(x_5),total bio diversity(x_{10}) , impact of waste management on micro flora and fauna(x_{16}), participation on waste recycling programmer (x_{19}) and waste management at household level with value addition by percentage (x_{21b}), have got negative impact on waste reduction methods.

3.2 Multiple Regression Analysis: Waste Reduction Methods (y_4) vs. 21 Independent Variables (x_1-x_{21})

Table 2 offers us the multiple regression analysis with full model to see what are the significant causal variables functionally impact on consequent variables. The R^2 value being 77.50 per cent it is to conclude that with the combination of 21 variables 77.50 per cent of the variance in the analysis has been explained.

3.3 Stepwise Regression Analysis: Waste Reduction Methods (y_4) vs. 21 Independent Variables

The Stepwise regression analysis suggests that four variables retained in the last step and have contributed 66.40 per cent of the total variance explained. Here, these four variables have explained approximately 85 per cent of the total variance. Income contributes to ecological prosperity. Improper waste management leads to water pollution and create adverse effects to micro flora fauna. The better perception on waste management and its impact on environmental health has got significant functional unit.

3.4 Path Analysis: Decomposition of Total Effect into Direct, Indirect and Residual Effect: Waste Reduction Methods (y_4) vs. Consequent Variables(x_1-x_{21})

In the Table 4 the path analysis decomposes the total effect into direct, indirect and residual effect of waste reduction methods (y_4) vs. 21 exogenous variables. The variable impact of waste management on water(x_{14}) exerts the highest total effect(r), and the variable, total bio diversity(x_{10}) records the highest direct effect and the variable total bio diversity(x_{10}) exerts the highest indirect effect on waste reduction methods (y_4). The variable total cost of energy per month(x_4) has routed highest indirect effect through as many as six exogenous variables. The path analysis depicts that 43.75 per cent variance of Waste reduction methods (y_4) cannot be explained.

3.5 Coefficient of Correlation (r): Waste Reduction Methods (y_4) vs. 21 Independent Variables (x_1-x_{21})

Table 5 presents the coefficient of correlation between waste reduction methods (y_4) and 21 independent variables(x_1-x_{21}). The variables education(x_2),total cost of energy(x_4), income(x_6), expenditure of family(x_7),water consumption per day(x_9),impact of waste management on health(x_{11}), exposure to media(x_{17}), perception on environmental impact of waste management(x_{20}) have gone positively to influence waste reduction methods. Similarly, the change in the following variables; age(x_1), family member(x_3), household land(x_5), total bio diversity(x_{10}) have got a negative impact on waste reduction methods.

3.6 Multiple Regression Analysis: Waste Reduction Methods (y_4) vs. 21 Independent Variables (x_1-x_{21})

Table 6 offers us the multiple regression analysis with full model to see what is the significant causal variables functionally impact on consequent variables. The R^2 value being 56 percent, it is to conclude that with the contribution of 21 variables 56 per cent of variance in the analysis has been explained.

3.7 Stepwise Regression Analysis: Waste Reduction Methods (y_4) vs. 21 Independent Variables

The Stepwise regression analysis suggests that three variables retained in the last step; and have contributed 47.10 per cent of the total variance explained. Here, these three variables have explained approximately 84.10 percent of the total variance explained. The revelation suggests volume of waste generation from household and water consumption per day both have some significant impact on waste reduction methods and it is also found that better perception on waste management on agriculture and its impact on environmental health has found significant functional impact.

Table 1. Coefficient of Correlation (r): waste reduction methods (y_4) vs. 21independent variables(x_1-x_{21}) (Kalyani municipal area)

Sl No.	Independent Variables	'r' Value	Remarks
1.	Age(x_1)	.019	
2.	Education(x_2)	.550	**
3.	Family member(x_3)	-.208	
4.	Total cost of energy(x_4)	.523	**
5.	Household land(x_5)	-.470	**
6.	Income(x_6)	.619	**
7.	Expenditure of family(x_7)	.490	**
8.	Volume of waste generation per household(x_8)	-.190	
9.	Water consumption per day(x_9)	.397	**
10.	Total bio diversity(x_{10})	-.319	**
11.	Impact of waste management on health(x_{11})	.233	*
12.	Impact of waste management on agriculture(x_{12})	.224	
13.	Impact of waste management on livestock(x_{13})	-.045	
14.	Impact of waste management on water(x_{14})	.633	**
15.	Impact of waste management on soil(x_{15})	-.044	
16.	Impact of waste management on micro flora and fauna(x_{16})	-.269	*
17.	Exposure to media(x_{17})	.199	
18.	Training received(x_{18})	-.016	
19.	Participation on waste recycling programmer (x_{19})	-.329	**
20.	Perception on environmental impact of waste management(x_{20})	.578	**
	Waste management at household level with value addition by percentage (x_{21a})	-.126	
	Waste management at household level with value addition by percentage (x_{21b})	-.241	*

*** Correlation is significant at the 0.01 level*Correlation is significant at the 0.05 level*

Table 2. Multiple Regression Analysis: waste reduction methods (y_4) vs. 21independent variables (x_1-x_{21}) (Kalyani municipal area)

Sl.No	Variables	Reg.Coef. B	S.E. B	Beta	t Value
1	Age (x_1)	-.001	.017	-.003	-.033
2	Education(x_2)	-.034	.043	-.165	-.781
3	Family member(x_3)	.302	.181	.286	1.670
4	Cost of energy per month (x_4)	.004	.002	.567	2.167
5	Household land (x_5)	-5.367	1.652	-.652	-3.249
6	Income (x_6)	5.668	.000	.406	1.431
7	Expenditure (x_7)	-7.665	.000	-.154	-.721
8	Volume of waste generation from household (x_8)	-.002	.001	-.524	-2.804
9	Water consumption per day (x_9)	-.038	.034	-.138	-1.119
10	Total bio diversity (x_{10})	.005	.002	1.019	3.118
11	Impact of waste management on Health (x_{11})	-.150	.074	-.181	-2.021
12	Impact of waste management on Agriculture (x_{12})	.014	.072	.015	.188
13	Impact of waste management on Livestock(x_{13})	.049	.092	.048	.533
14	Impact of waste management on Water(x_{14})	.138	.055	.232	2.491
15	Impact of waste management on Soil(x_{15})	.112	.073	.141	1.536
16	Impact of waste management on Micro flora and fauna(x_{16})	-.247	.098	-.292	-2.522
17	Exposure to Media(x_{17})	-.045	.114	-.035	-.400
18	Training received(x_{18})	.023	.081	.025	.291
19	Participation on waste recycling programmer (x_{19})	-.162	.120	-.148	-1.351
20	Perception on environmental impact of waste management(x_{20})	.375	.097	.374	3.860
21	Waste management at household level with value addition by percentage (x_{21a})	.001	.003	.035	.387
22	Waste management at household level with value addition by percentage (x_{21b})	.001	.008	.020	.187

R square: 77.50 per cent, The standard error of the estimate 55.77 per cent

Table 3. Stepwise Regression Analysis: waste reduction methods (y_4) vs. 21 independent variables (Kalyani municipal area)

Sl.No	Variables	Reg.coef.B	S.E. B	Beta	t value
1	Income (x_6)	5.726	.000	.410	4.972
2	Impact of waste management on Water(x_{14})	.163	.055	.274	2.967
3	Impact of waste management on Micro flora and fauna(x_{16})	-.201	.071	-.237	-2.819
4	Perception on environmental impact of waste management (x_{20})	.300	.086	.299	3.496

R square: 66.40 per cent, The standard error of the estimate 58.76 per cent

Table 4. Path Analysis: Decomposition of total effect into direct, indirect and residual effect: waste reduction methods (y_4) vs. consequent variables(x_1-x_{21}) (Kalyani municipal area)

Sl. No	Variables	Total Effect	Direct Effect	Indirect Effect	Highest Indirect Effect
1	Age (x_1)	0.019	-0.007	0.026	0.169(x_8)
2	Education(x_2)	0.550	-0.170	0.720	0.440(x_4)
3	Family member(x_3)	-0.208	0.286	-0.491	0.307(x_8)
4	Cost of energy per month (x_4)	0.523	0.567	-0.044	0.402(x_5)
5	Household land (x_5)	-0.470	-0.656	0.186	0.817(x_{10})
6	Income (x_6)	0.619	0.425	0.194	0.465(x_4)
7	Expenditure (x_7)	0.490	-0.169	0.659	0.495(x_4)
8	Volume of waste generation from household (x_8)	-0.190	-0.527	0.337	0.780(x_{10})
9	Water consumption per day (x_9)	0.397	-0.137	0.534	0.375(x_4)
10	Total bio diversity (x_{10})	-0.319	1.025	-1.344	0.103(x_2)
11	Impact of waste management on Health (x_{11})	0.233	-0.178	0.411	0.288(x_5)
12	Impact of waste management on Agriculture (x_{12})	0.224	0.014	0.210	0.110(x_4)
13	Impact of waste management on Livestock(x_{13})	-0.045	0.048	-0.090	0.084(x_{10})
14	Impact of waste management on Water(x_{14})	0.633	0.232	0.401	0.180(x_4)
15	Impact of waste management on Soil(x_{15})	-0.044	0.139	-0.183	0.040(x_8)
16	Impact of waste management on Micro flora and fauna(x_{16})	-0.269	-0.289	0.020	0.080(x_{15})
17	Exposure to Media(x_{17})	0.199	-0.036	0.235	0.199(x_5)
18	Training received(x_{18})	-0.016	0.023	-0.039	0.090(x_{10})
19	Participation on waste recycling(x_{19})	-0.329	-0.144	-0.185	0.156(x_3)
20	Perception on environmental impact of waste management(x_{20})	0.578	0.372	0.206	0.323(x_5)
21	Waste management at household level with value addition by percentage (x_{21a})	-0.126	0.034	-0.160	0.064(x_8)
22	Waste management at household level with value addition by percentage (x_{21b})	-0.241	0.019	-0.260	0.468(x_{10})

Residual effect: 43.75 per cent

Table 5. Coefficient of Correlation (r): waste reduction methods (y_4) vs. 21independent variables (x_1-x_{21}) (Jalpaiguri municipal area)

Sl No.	Independent Variables	'r' Value	Remarks
1.	Age(x_1)	-.318	**
2.	Education(x_2)	.318	**
3.	Family member(x_3)	-.320	**
4.	Total cost of energy(x_4)	.305	**
5.	Household land(x_5)	-.381	**
6.	Income(x_6)	.384	**
7.	Expenditure of family(x_7)	.376	**
8.	Volume of waste generation per household(x_8)	.052	
9.	Water consumption per day(x_9)	.507	**
10.	Total bio diversity(x_{10})	-.319	**
11.	Impact of waste management on health(x_{11})	.304	**
12.	Impact of waste management on agriculture(x_{12})	-.040	
13.	Impact of waste management on livestock(x_{13})	.093	
14.	Impact of waste management on water(x_{14})	-.001	
15.	Impact of waste management on soil(x_{15})	.051	
16.	Impact of waste management on micro flora and fauna(x_{16})	.100	
17.	Exposure to media(x_{17})	.339	**
18.	Training received(x_{18})	.021	
19.	Participation on waste recycling programmer (x_{19})	-.131	
20.	Perception on environmental impact of waste management(x_{20})	.605	**
21.	Waste management at household level with value addition by percentage (x_{21a})	-.165	
22.	Waste management at household level with value addition by percentage (x_{21b})	.180	

*** Correlation is significant at the 0.01 level, *Correlation is significant at the 0.05 level*

Table 6. Multiple Regression Analysis: waste reduction methods (y_4) vs. 21independent variables (x_1-x_{21}) (Jalpaiguri municipal area)

Sl. No	Variables	Reg. Coef. B	S.E. B	Beta	t Value
1	Age (x_1)	-.011	.011	-.155	-.958
2	Education(x_2)	-.040	.045	-.189	-.902
3	Family member(x_3)	.039	.208	.054	.190
4	Cost of energy per month (x_4)	8.046	.001	.019	.136
5	Household land (x_5)	-1.251	1.434	-.243	-.873
6	Income (x_6)	4.584	.000	.325	1.274
7	Expenditure (x_7)	-6.302	.000	-.139	-.561
8	Volume of waste generation from household (x_8)	-.001	.000	-.232	-1.792
9	Water consumption per day (x_9)	.045	.021	.352	2.124
10	Total bio diversity (x_{10})	.001	.001	.184	.742
11	Impact of waste management on Health (x_{11})	.048	.073	.080	.662
12	Impact of waste management on Agriculture (x_{12})	-.049	.087	-.070	-.558
13	Impact of waste management on Livestock(x_{13})	.023	.075	.039	.304
14	Impact of waste management on Water(x_{14})	.038	.077	.060	.488
15	Impact of waste management on Soil(x_{15})	.145	.088	.198	1.648
16	Impact of waste management on Micro flora and fauna(x_{16})	-.017	.087	-.026	-.194
17	Exposure to Media(x_{17})	.152	.133	.142	1.147
18	Training received(x_{18})	.015	.073	.024	.203
19	Participation on waste recycling programmer (x_{19})	.077	.112	.124	.684
20	Perception on environmental impact of waste management(x_{20})	.403	.140	.422	2.872
21	Waste management at household level with value addition by percentage (x_{21a})	.001	.003	.030	.203
22	Waste management at household level with value addition by percentage (x_{21b})	-.002	.004	-.063	-.555

R square: 56 percent, The standard error of the estimate 57.86 percent

Table 7. Stepwise Regression Analysis: Waste reduction methods (y_4) vs. 21independent variables (Jalpaiguri municipal area)

Sl.No	Variables	Reg.coef.B	S.E. B	Beta	t value
1	Volume of waste generation from household (x_8)	-.001	.000	-.206	.033
2	Water consumption per day (x_9)	.049	.013	.379	.001
3	Perception on environmental impact of waste management(x_{20})	.456	.092	.479	.000

R square: 47.10 percent, The standard error of the estimate 54.31 percent

Table 8. Path Analysis: Decomposition of Total Effect into Direct, Indirect and Residual Effect: waste reduction methods (y_4) vs. consequent variables(x_1-x_{21}) (Jalpaiguri municipal area)

Sl. No	Variables	Total Effect	Direct Effect	Indirect Effect	Highest Indirect Effect
1	Age (x_1)	-0.318	-0.156	-0.162	0.122(x_{20})
2	Education(x_2)	0.318	-0.192	0.510	0.243(x_6)
3	Family member(x_3)	-0.320	0.057	-0.377	0.121(x_2)
4	Cost of energy per month (x_4)	0.305	0.020	0.285	0.184(x_6)
5	Household land (x_5)	-0.381	-0.245	-0.136	0.160(x_{10})
6	Income (x_6)	0.384	0.325	0.059	0.159(x_9)
7	Expenditure (x_7)	0.376	-0.136	0.512	0.275(x_6)
8	Volume of waste generation from household (x_8)	0.052	-0.232	0.284	0.147(x_9)
9	Water consumption per day (x_9)	0.507	0.353	0.154	0.188(x_{20})
10	Total bio diversity (x_{10})	-0.319	0.185	-0.504	0.100(x_2)
11	Impact of waste management on Health (x_{11})	0.304	0.079	0.225	0.150(x_9)
12	Impact of waste management on Agriculture (x_{12})	-0.040	-0.071	0.031	0.057(x_2)
13	Impact of waste management on Livestock(x_{13})	0.093	0.039	0.054	0.108(x_{20})
14	Impact of waste management on Water(x_{14})	-0.001	0.060	-0.061	0.073(x_6)
15	Impact of waste management on Soil(x_{15})	0.051	0.199	-0.148	0.030(x_7)
16	Impact of waste management on Micro flora and fauna(x_{16})	0.100	-0.025	0.125	0.143(x_{20})
17	Exposure to Media(x_{17})	0.339	0.142	0.197	0.139(x_{20})
18	Training received(x_{18})	0.021	0.024	-0.003	0.046(x_6)
19	Participation on waste recycling(x_{19})	-0.131	0.125	-0.256	0.113(x_2)
20	Perception on environmental impact of waste management(x_{20})	0.605	0.421	0.184	0.158(x_5)
21	Waste management at household level with value addition by percentage (x_{21a})	-0.165	0.031	-0.196	0.108(x_8)
22	Waste management at household level with value addition by percentage (x_{21b})	0.180	-0.063	0.243	0.148(x_9)

Residual effect: 43.94 percent

3.8 Path Analysis: Decomposition of Total Effect into Direct, Indirect and Residual Effect: Waste Reduction Methods (y_4) vs. Consequent Variables(x_1-x_{21})

In the Table 8 the path analysis decomposes the total effect into direct, indirect and residual effect of waste reduction methods (y_4) vs. 21 exogenous variables. The variable perception on environmental impact of waste management(x_{20}) exerts the highest total effect (r) and highest direct effect and the variable expenditure(x_7) exerts the highest indirect effect on waste reduction methods (y_4).The variables, income(x_6), perception on environmental impact of waste management(x_{20}), have associative effects or good companionship effect for influencing other variables. The path analysis depicts that 43.97 percent variance of waste reduction methods (y_4) cannot be explained.

4. CONCLUSION

The entire study has created an array of platforms to elucidate the effect of such transformation as it is happening in both Kalyani and Jalpaiguri municipal area. The study has been elucidated with the following observations. The recycling and management of municipal waste has got economic, ecological and management dimensions, and Jalpaiguri as well as Kalyani are no exception to it. The surrounding ecology of any municipality is the primary recipient of waste generated by the life and livelihood of the citizen of respective municipalities. The huge disposal of urban wastes are offering serious threat and concern to the ecological health including human and livestock health if the waste generated are not managed or recycled. Two municipalities Jalpaiguri from the northern part of Bengal and Kalyani surrounded by new alluvial agro ecosystem are considered for the study. A total of 150 respondents have been selected, 75 from each of Kalyani and Jalpaiguri by following cluster random sampling to frame up the total number of eligible respondents.

Throughout the entire study it has been observed that in terms of variable behavior and responses there have been stark differences between Jalpaiguri and Kalyani. In Kalyani some variables like income, impact of waste management and recycling on water and micro flora and fauna have recorded the distinct contribution. Kalyani has been found to have a traditional environmental consciousness and response to ecological services. These variables have come out strong determinant in characterizing the consequent variable waste reduction methods. For Jalpaiguri, volume of waste generation from household, water consumption per day has gone in the determinant way. But in both municipal areas perception of environmental impact of waste management have recorded equal contribution. So it can be said that improper waste management leads to ecological damage and waste reduction methods will reduce waste generation per day improper waste disposal and save our environment and ecology.

CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the author(s).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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