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Impact of Knowledge of Waste Recycling for Socio Ecological Improvement of Kalyani and Jalpaiguri Municipal Areas of West Bengal, India

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Authors' contributions

This work was carried out in collaboration with all authors. Author AG wrote the first draft of the manuscript, collected data and did the 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 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. 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. knowledge of waste recycling (y_2) 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

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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 education, impact of waste management and recycling on health, water and micro flora and fauna have recorded the distinct contribution, for Jalpaiguri expenditure, volume of waste generation from household, impact of waste management on soil have 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 knowledge of waste recycling will reduce 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. 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 [4]. 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 [5]. 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 [6]. 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 [7]. Civil construction is responsible for the excessive consumption of natural resources and the generation of the largest share of solid urban waste [8]. 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 [9]. 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 [10]. 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 [11]. Among the challenges are proper waste-collection management, treatment, and disposal, with an emphasis on sustainable management. Every year in India we are producing 133760 tons 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 25,884 tons 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. 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 [12]. 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 [13]. 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 [14]. 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 [15].

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.

1.1 Need of the Study

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 [16]. 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 Limitation of the Study

The research was conducted at Jalpaiguri municipality and Kalyani municipality under Jalpaiguri and Nadia district of West Bengal, India. Being a student of PhD and its vast course and credit framework the time available for collection of data from study area is less. Two municipalities situated at two different parts of West Bengal i.e. Jalpaiguri municipality from the northern part of Bengal and Kalyani municipality from southern part of Bengal. So, it is not possible to visit the research area routinely and gather data from there regularly. It also sometimes happens that due to their pre occupation peoples are not willing to co-operate or providing any time for discussion. At municipality due to their hard work sometimes they cannot be able to give me enough time for the study.

2.9 Proper Description of Variables

2.9.1 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.

2.9.2 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 15 etc.

2.9.3 Total number of the family member(X_3)

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

2.9.4 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.

2.9.5 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.

2.9.6 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.

2.9.7 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.

2.9.8 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.

2.10 Water Consumption per Day(X_9)

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

2.10.1 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.

2.10.2 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.

2.10.3 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.

2.10.4 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.

2.10.5 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.

2.10.6 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.

2.10.7 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.

2.11 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.

2.11.1 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.

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

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

2.11.3 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.

2.11.4 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.

2.11.5 Knowledge of waste recycling (Y_2)

Knowledge of waste recycling has been classified into three different categories. Questions were asked and scores were given on 10 point scale after normalization.

3. RESULTS AND DISCUSSION

3.1 Coefficient of Correlation (r): Knowledge of Waste Recycling (y_2) vs. 21 Independent Variables (x_1-x_{21}) (Kalyani Municipal Area)

Result describes the coefficient of correlation between knowledge of Waste recycling (y_2) 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), impact of waste management on health(x_{11}), impact of waste management on livestock(x_{13}), impact of waste management on soil(x_{15}), impact of waste management on micro flora and fauna(x_{16}) exposure to media(x_{17}) and perception on environmental impact of waste management(x_{20}) have gone positively to influence knowledge of waste recycling. Similarly the following variables household land(x_5), total bio diversity(x_{10}), participation on waste recycling programmer(x_{19}), waste management at household level with value addition by percentage(x_{21b}), have got a negative impact on knowledge of waste recycling.

High education level on an average Kalyani citizen and its unique pro ecological values in the mind sets of the citizens have invited the scope for better waste management. Higher education leads to greater knowledge about different waste recycling processes. Kalyani has been found to have a traditional environmental consciousness and response to ecological services. As a high education level they are well aware about the impact of waste management on health, soil, livestock and micro flora and fauna. So, these variables are directly correlated with knowledge of waste recycling.

3.2 Multiple Regression Analysis: Knowledge of Waste Recycling (y_2) vs. 21 Independent Variables (x_1-x_{21}) (Kalyani Municipal Area)

Result 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 68.80 per cent it is conclude that with the combination of 21 variables 68.80 per cent of variance in the analysis has been explained.

Table 1. Coefficient of Correlation (r): Knowledge of Waste recycling (y_2) vs. 21 independent variables (x_1-x_{21}) (Kalyani municipal area)

Sl no.	Independent variables	'r' Value	Remarks
1	Age(x_1)	-.054	
2	Education(x_2)	.570	**
3	Family member(x_3)	-.221	
4	Total cost of energy(x_4)	.485	**
5	Household land(x_5)	-.495	**
6	Income(x_6)	.555	**
7	Expenditure of family(x_7)	.542	**
8	Volume of waste generation per household(x_8)	-.148	
9	Water consumption per day(x_9)	.166	
10	Total bio diversity(x_{10})	-.396	**
11	Impact of waste management on health(x_{11})	.456	**
12	Impact of waste management on agriculture(x_{12})	.101	
13	Impact of waste management on livestock(x_{13})	.267	*
14	Impact of waste management on water(x_{14})	-.039	
15	Impact of waste management on soil(x_{15})	.290	*
16	Impact of waste management on micro flora and fauna(x_{16})	.395	**
17	Exposure to media(x_{17})	.239	*
18	Training received(x_{18})	-.142	
19	Participation on waste recycling programmer (x_{19})	-.236	*
20	Perception on environmental impact of waste management(x_{20})	.561	**
21	Waste management at household level with value addition by percentage (x_{21a})	-.142	
22	Waste management at household level with value addition by percentage (x_{21b})	-.345	**

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

3.3 Stepwise Regression Analysis: Knowledge of Waste Recycling (y_2) vs. 21 Independent Variables (Kalyani Municipal Area)

The Stepwise regression analysis suggests that five variables retained in the last step and has contributed 58.80 per cent of the total variance explained. Here, these five variables have explained approximately 85 per cent of total variance explained.

Education contributes to ecological awareness and cleanliness. Improper waste management leads to serious health hazard and contamination of water bodies. Better perception of waste management and its impact on environmental health has found significant functional consequences.

3.4 Path Analysis: Decomposition of Total Effect into Direct, Indirect and Residual Effect: Knowledge of Waste Recycling (y_2) vs. Consequent Variables(x_1-x_{21}) (Kalyani Municipal Area)

The path analysis decomposes the total effect into direct, indirect and residual effect of Knowledge of waste recycling (y_2) vs. 21 exogenous variables. The variable education(x_2) exerts the highest total effect(r) and the variable, perception on environmental impact of waste management(x_{20}) records the highest direct effect and the variable expenditure (x_7) exerts the highest indirect effect on knowledge of waste recycling (y_2). The variable education(x_2), total bio diversity(x_{10}), impact of waste management on water(x_{14}), participation on waste recycling(x_{19}), perception on environmental impact of waste management(x_{20}), has associative effect or good companionship effect for influencing other variables. The path analysis depicts that 31.32 per cent variance of knowledge of waste recycling (y_2) cannot be explained.

3.5 Coefficient of Correlation (r): Knowledge of Waste Recycling (y_2) vs. 21 Independent Variables (x_1-x_{21}) (Jalpaiguri Municipal Area)

Result describes the coefficient of correlation between knowledge of waste recycling (y_2) 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}) and perception on environmental impact of waste management(x_{20}) have gone positively to influence knowledge of waste recycling. Similarly, the change in the following variables age(x_1), family member(x_3), household land(x_5), total bio diversity(x_{10}) ,participation on waste recycling programmer (x_{19}) and waste management at household level with value addition by percentage (x_{21a}) have got a negative impact on knowledge of waste recycling.

Education is instrumental in building personality structure and helps in charging one's behavior in social life. High education level on an average Jalpaiguri citizen and its unique pro ecological values in the mind sets of the citizens have invited the scope for better waste management. As a high education level they are well aware about the impact of waste management on health and its effect on environment. So it can be said that improper waste management leads to ecological damage and knowledge of waste recycling will reduce improper waste disposal and save our environment and ecology and knowledge can be obtained through education. So, these variables are directly correlated with knowledge of waste recycling.

3.6 Multiple Regression Analysis: Knowledge of Waste Recycling (y_2) vs. 21 Independent Variables (x_1-x_{21}) (Jalpaiguri Municipal Area)

Result 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 being 56.60 per cent conclude that with the combination of 21 variables 56.60 per cent of variance in the analysis has been explained.

3.7 Stepwise Regression Analysis: Knowledge of Waste Recycling (y_2) vs. 21 Independent Variable (Jalpaiguri Municipal Area)

The Stepwise regression analysis suggests that four variables retained in the last step and has contributed 50.70 per cent of the total variance explained. Here, these four variables have explained approximately 89 per cent of the total variance explained.

Table 2. Multiple regression analysis: Knowledge of waste recycling (y_2) vs. 21 independent variables (x_1-x_{21}) (Kalyani municipal area)

Sl. no	Variables	Reg.Coef.B	S.E. B	Beta	t Value
1	Age (x_1)	-.018	.020	-.103	-.922
2	Education(x_2)	.067	.052	.320	1.283
3	Family member(x_3)	-.185	.217	-.173	.854
4	Cost of energy per month (x_4)	.000	.002	.068	.221
5	Household land (x_5)	-2.785	1.976	-.333	-1.409
6	Income (x_6)	3.839	.000	.271	.810
7	Expenditure (x_7)	-3.907	.000	-.077	.307
8	Volume of waste generation from household (x_8)	.000	.001	-.090	-.409
9	Water consumption per day (x_9)	-.072	.040	-.258	-1.778
10	Total bio diversity (x_{10})	.001	.002	.260	.675
11	Impact of waste management on Health (x_{11})	.183	.089	.217	2.058
12	Impact of waste management on Agriculture (x_{12})	-.054	.087	-.060	-.625
13	Impact of waste management on Livestock(X_{13})	.170	.109	.164	1.555
14	Impact of waste management on Water(x_{14})	-.180	.066	-.299	-2.720
15	Impact of waste management on Soil(x_{15})	.109	.087	.134	1.246
16	Impact of waste management on Micro flora and fauna(x_{16})	-.013	.117	-.016	-.115
17	Exposure to Media(x_{17})	-.059	.136	-.045	-.437
18	Training received(x_{18})	-.131	.096	-.140	-1.362
19	Participation on waste recycling programmer (x_{19})	.170	.143	.153	1.188
20	Perception on environmental impact of waste management(x_{20})	.356	.116	.350	3.059
21	Waste management at household level with value addition by percentage (x_{21a})	.001	.004	.023	.211
22.	Waste management at household level with value addition by percentage (x_{21b})	.012	.009	.175	1.365

R square: 68.80 per cent, The standard error of the estimate 66.73 per cent

Table 3. Stepwise regression analysis: Knowledge of waste recycling (y_2) vs. 21 independent variables (Kalyani municipal area)

Sl. no	Variables	Reg.coef.B	S.E. B	Beta	t value
1	Education(x_2)	.086	.019	.411	4.462
2	Impact of waste management on Health (x_{11})	.153	.076	.181	2.001
3	Impact of waste management on Water(x_{14})	-.157	.062	-.259	-2.523
4	Impact of waste management on Micro flora and fauna(x_{16})	.146	.081	.170	1.813
5	Perception on environmental impact of waste management(x_{20})	.352	.109	.346	3.230

R square: 58.80 per cent, The standard error of the estimate 66.48 per cent

Table 4. Path analysis: Decomposition of total effect into direct, indirect and residual effect: Knowledge of waste recycling (y_2) 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)	-0.054	-0.103	0.049	0.054(x_9)
2	Education(x_2)	0.570	0.325	0.245	0.234(x_6)
3	Family member(x_3)	-0.221	-0.167	-0.054	0.082(x_{19})
4	Cost of energy per month (x_4)	0.485	0.071	0.414	0.252(x_2)
5	Household land (x_5)	-0.495	-0.337	-0.158	0.217(x_{10})
6	Income (x_6)	0.555	0.261	0.294	0.291(x_2)
7	Expenditure (x_7)	0.542	-0.072	0.614	0.258(x_2)
8	Volume of waste generation from household (x_8)	-0.148	-0.096	-0.052	0.207(x_{10})
9	Water consumption per day (x_9)	0.166	-0.257	0.423	0.138(x_6)
10	Total bio diversity (x_{10})	-0.396	0.272	-0.668	0.061(x_{14})
11	Impact of waste management on Health (x_{11})	0.456	0.217	0.239	0.180(x_{20})
12	Impact of waste management on Agriculture (x_{12})	0.101	-0.061	0.162	0.090(x_{20})
13	Impact of waste management on Livestock(x_{13})	0.267	0.163	0.104	0.046(x_{14})
14	Impact of waste management on Water(x_{14})	-0.039	-0.297	0.258	0.137(x_{20})
15	Impact of waste management on Soil(x_{15})	0.290	0.133	0.157	0.078(x_{14})
16	Impact of waste management on Micro flora and fauna(x_{16})	0.395	-0.014	0.409	0.130(x_{16})
17	Exposure to Media(x_{17})	0.239	-0.045	0.284	0.102(x_5)
18	Training received(x_{18})	-0.142	-0.141	-0.001	0.049(x_{19})
19	Participation on waste recycling(x_{19})	-0.236	0.151	-0.387	0.124(x_9)
20	Perception on environmental impact of waste management(x_{20})	0.561	0.351	0.210	0.166(x_5)
21	Waste management at household level with value addition by percentage (X_{21a})	-0.142	0.022	-0.164	0.037(x_{19})
22.	Waste management at household level with value addition by percentage (X_{21b})	-0.345	0.174	-0.519	0.124(x_{10})

Residual effect: 31.32 per cent

Table 5. Coefficient of Correlation (r): Knowledge of waste recycling (y_2) vs. 21 independent variables (x_1-x_{21}) (Jalpaiguri municipal area)

Sl. no	Independent variables	'r' Value	Remarks
1	Age(x_1)	-.412	**
2	Education(x_2)	.451	**
3	Family member(x_3)	-.392	**
4	Total cost of energy(x_4)	.350	**
5	Household land(x_5)	-.455	**
6	Income(x_6)	.403	**
7	Expenditure of family(x_7)	.512	**
8	Volume of waste generation per household(x_8)	-.082	
9	Water consumption per day(x_9)	.356	**
10	Total bio diversity(x_{10})	-.400	**
11	Impact of waste management on health(x_{11})	.298	**
12	Impact of waste management on agriculture(x_{12})	-.110	
13	Impact of waste management on livestock(x_{13})	.112	
14	Impact of waste management on water(x_{14})	-.130	
15	Impact of waste management on soil(x_{15})	.071	
16	Impact of waste management on micro flora and fauna (x_{16})	.194	
17	Exposure to media(x_{17})	.338	**
18	Training received(x_{18})	.068	
19	Participation on waste recycling programmer (x_{19})	-.358	**
20	Perception on environmental impact of waste management (x_{20})	.569	**
21	Waste management at household level with value addition by percentage (x_{21a})	-.263	*
22	Waste management at household level with value addition by percentage (x_{21b})	.134	

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

Expenditure, volume of waste generation from household and impact of waste management on soil have got significant functional impact on knowledge of waste recycling. The better perception on waste management and its impact on environmental health have got significant functional consequences.

3.8 Path Analysis: Decomposition of Total Effect into Direct, Indirect and Residual Effect: Knowledge of Waste Recycling (y_2) vs. Consequent Variables(x_1-x_{21}) (Jalpaiguri Municipal Area)

The path analysis decomposes the total effect into direct, indirect and residual effect of Knowledge of waste recycling (y_2) vs. 21 exogenous variables. The variable perception on environmental impact of waste management(x_{20}) exerts the highest total effect(r) and the variable, perception on environmental impact of waste management(x_{20}) records the highest direct effect and the variable education(x_2) exerts the highest indirect effect on knowledge of waste recycling (y_2). The variables, expenditure(x_7), perception on environmental impact of waste management(x_{20}), have associative effect or good companionship effect for influencing other variables. The path analysis depicts that 43.39 percent variance of knowledge of waste recycling (y_2) cannot be explained.

It is found from the result that perception on environmental impact of waste management has recorded direct effect on knowledge of waste recycling. Improper waste management can damage our environment and ecological diversity. Knowledge of waste recycling can reduce amount of improper waste disposal and save our environment and ecology.

Table 6. Multiple regression analysis: Knowledge of waste recycling (y_2) vs. 21 independent variables (x_1-x_{21}) (Jalpaiguri municipal area)

Sl. no	Variables	Reg.Coef. B	S.E. B	Beta	t Value
1	Age(x_1)	-.006	.013	-.070	-.433
2	Education(x_2)	-.032	.053	-.126	-.605
3	Family member(x_3)	-.026	.244	-.030	-.105
4	Cost of energy per month(x_4)	.000	.001	.094	.679
5	Household land(x_5)	-.042	1.683	-.007	-.025
6	Income(x_6)	-4.910	.000	-.029	-.116
7	Expenditure(x_7)	.000	.000	.327	1.329
8	Volume of waste generation from household(x_8)	-.001	.000	-.267	-2.080
9	Water consumption per day(x_9)	.004	.025	.025	.151
10	Total bio diversity(x_{10})	2.758	.001	.006	.025
11	Impact of waste management on Health(x_{11})	.111	.086	.157	1.297
12	Impact of waste management on Agriculture(x_{12})	-.027	.102	-.033	-.262
13	Impact of waste management on Livestock(x_{13})	.086	.088	.125	.981
14	Impact of waste management on Water(x_{14})	-.079	.090	-.107	-.869
15	Impact of waste management on Soil(x_{15})	.124	.103	.144	1.200
16	Impact of waste management on Micro flora and fauna(x_{16})	-.001	.103	-.002	-.012
17	Exposure to Media(x_{17})	.047	.156	.037	.298
18	Training received(x_{18})	.032	.085	.044	.379
19	Participation on waste recycling programmer (x_{19})	-.050	.132	-.068	-.381
20	Perception on environmental impact of waste management(x_{20})	.468	.165	.415	2.841
21	Waste management at household level with value addition by percentage (x_{21a})	5.417	.003	.003	.017
	Waste management at household level with value addition by percentage (x_{21b})	.000	.004	-.005	-.041

R square: 56.60 percent, The standard error of the estimate 67.93 percent

Table 7. Stepwise regression analysis: Knowledge of waste recycling (y_2) vs. 21 independent variable (Jalpaiguri municipal area)

Sl. no	Variables	Reg.coef.B	S.E. B	Beta	t value
1	Expenditure(x_7)	.000	.000	.490	4.245
2	Volume of waste generation from household(x_8)	.001	.000	-.187	-2.151
3	Impact of waste management on Soil(x_{15})	-.171	.075	.197	2.279
4	Perception on environmental impact of waste management(x_{20})	.551	.103	.388	5.360

R square: 50.70 per cent, The standard error of the estimate 62.42 per cent

Table 8. Path analysis: Decomposition of total effect into direct, indirect and residual effect: knowledge of waste recycling (y_2) 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)	-0.412	-0.070	-0.342	0.074(x_2)
2	Education(x_2)	0.451	-0.124	0.575	0.254(x_7)
3	Family member(x_3)	-0.392	-0.028	-0.364	0.078(x_2)
4	Cost of energy per month(x_4)	0.350	0.095	0.255	0.167(x_7)
5	Household land(x_5)	-0.455	-0.012	-0.443	0.071(x_2)
6	Income(x_6)	0.403	-0.030	0.433	0.275(x_7)
7	Expenditure(x_7)	0.512	0.326	0.186	0.134(x_{20})
8	Volume of waste generation from household(x_8)	-0.082	-0.267	0.185	0.086(x_{20})
9	Water consumption per day(x_9)	0.356	0.027	0.329	0.185(x_{20})
10	Total bio diversity(x_{10})	-0.400	0.011	-0.411	0.065(x_2)
11	Impact of waste management on Health(x_{11})	0.298	0.156	0.142	0.097(x_7)
12	Impact of waste management on Agriculture(x_{12})	-0.110	-0.034	-0.076	0.048(x_{11})
13	Impact of waste management on Livestock(x_{13})	0.112	0.126	-0.014	0.106(x_{20})
14	Impact of waste management on Water(x_{14})	-0.130	-0.106	-0.024	0.035(x_7)
15	Impact of waste management on Soil(x_{15})	0.071	0.144	-0.073	0.027(x_{13})
16	Impact of waste management on Micro flora and fauna(x_{16})	0.194	-0.001	0.195	0.140(x_{20})
17	Exposure to Media(x_{17})	0.338	0.037	0.301	0.137(x_{20})
18	Training received(x_{18})	0.068	0.044	0.024	0.057(x_7)
19	Participation on waste recycling(x_{19})	-0.358	-0.068	-0.290	0.073(x_2)
20	Perception on environmental impact of waste management(x_{20})	0.569	0.414	0.155	0.105(x_7)
21	Waste management at household level with value addition by percentage(x_{21a})	-0.263	0.003	-0.266	0.070(x_2)
	Waste management at household level with value addition by percentage(x_{21b})	0.134	-0.005	0.139	0.109(x_{20})

Residual effect: 43.39 per cent

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 has been stark differences between Jalpaiguri and Kalyani where as some few variables like education, impact of waste management and recycling on health, 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 knowledge of waste recycling. For Jalpaiguri, expenditure, volume of waste generation from household, impact of waste management on soil 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 knowledge of waste recycling will reduce improper waste disposal and save our environment and ecology.

CONSENT

As per international standard or university standard, respondents' 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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