International Journal on Emerging Technologies **10**(4): 374-379(2019)

ISSN No. (Print): 0975-8364
ISSN No. (Online): 2249-3255

Designing a Decision Support Framework for Municipal Solid Waste Management

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(Received 05 September 2019, Revised 09 November 2019, Accepted 19 November 2019)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Our government has been introduce Swachh Bharat Abhiyan or Swachh Bharat Mission in the country for the period 2014 to 2019. Main aim to this clean roads, streets and construction sites of India's urban areas, towns, urban and provincial zones. Sustainable Waste management is a major challenge for a long time in India. The rate of producing solid waste in India changing rapidly as the population grows. Now, these days working on the extent of waste segmentation changes, the conformation of the waste generated evolves and the technologies available to collect and process waste improve very rapidly. Many new technologies have been proposed for dealing with sustainable solid waste management. And for the support of the existing technologies, a DSS plays a very imperative role. It can help the decision-makers to take correct decisions or help to improve the efficiency of the decision-making process. A good solid waste management framework, it must include all disturbing factors including pollution generation, land use, energy use, financial costs, labor needs, monitoring, recycling rates, etc. To improve the efficiency of the municipal solid waste management decision-making process, an integrated decision support system (DSS) must be worked on the multi-attribute, geographical nature and monitoring of solid waste systems. DSS helps in operations, planning, and administration and helps to make correct decisions. In this research, propose a new incorporated DSS framework designed for municipal solid waste management.

Keywords: Data mining, Decision support system, Decision tree**,** Municipal solid waste management.

Abbreviations: DSS: Decision Support System; SBA: Swachh Bharat Abhiyan; MSW: Municipal Solid Waste management; SWM: Solid Waste Management; MLAs: Machine Learning Algorithms.

I. INTRODUCTION

For accomplish the dream of our father of nation Mahatma Gandhi, our honorable prime minister Shri Narendra Modi has been launched Swachh Bharat Abhiyan in the country for the period 2014 to 2019. The aim of this project to clean roads, streets and manufacture sites of India's urban areas. The main aim of Swachh Bharat is to aware of Indians for cleanness, improve the efficiency of cleanness, reducing open excretion through the construction of household-owned and community-owned toilets and develop a supportable waste management system for urban and rural areas [1]. The population of India is at second position in the world with a population of more than 1.3 billion, representing about 18% of the world's human population. Its urban population of major cities is raised at a rate of 32.8% during the last 10 to 20 years is 377 million, which is greater than the total population of many other small countries. SWM is one such type of service where India has a huge gap to fill. A MSW treatment and disposal framework or systems is very helpful not only for human beings but also environmentally [2]. The current SWM services are not capable to deals with current situations, it is inefficient, incur heavy expenditure and are so low as to be a potential threat to the public health and environmental quality [3].

The improper waste handling treatment work causes many serious factors like negative effects on public health, increase the percentage of harmful components in air, soil and water, it is also responsible for unequal climate changing and affects directly the nature and life of human being [4]. The main objective of this research to provide an integrated framework that can be help to increase the efficiency of decision making process for sustainable solid waste management. The main application area of this framework are urban and rural waste management sites and set up an advanced integrated system for waste management. The advantage of this DSS is helps to reduce decision making efforts. It also reduced geographical and technical difficulties.

II. LITERATURE WORK

This section of the paper describes the earlier work done by the various researchers in the field of solid waste management using decision support systems. Moore and Chang defined the DSS as "A DSS is a fully computer-technology based system, performing analytical and decision-making activities, concentrated on future planning and used at unplanned and uneven timestamps" [7,8].

Also, two other researchers, Sprague and Carlson define DSS as "DSS is a cooperating system that helps

decision-makers to resolve specific problem like economic problems through the particular data and models". A useful DSS is capable of classifying and examine a large quantity data in a very little time span[9]. The DSS model helps the decision makers to increase their business growth and overall throughput. At presently various data mining algorithms, tools, and other advanced analytical techniques are available. These techniques play very essential role for taking right decisions and it is very helpful for designing a useful DSS [10]. For classification of raw data, perform clustering and other various operations, the data mining algorithms play very useful in these cases. This paper proposed an integrated advanced N-DSS model for handling the MSWM problem. This DSS model should be integrated with geographical information systems to improve collection, processing, transportation and disposal processes. The basic architecture of a DSS is shown below. The working of this DSS was very simple, firstly it will take the data sets on inventory or in any particular database. After that these data set applies in some mathematical models or some analytical tools [11]. After analyzing the data, some useful patterns will find out. And on the based on that pattern the decision makers will take their decisions.

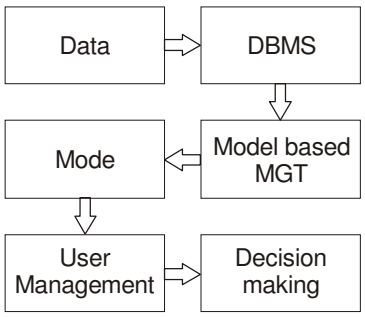

Fig. 1. A Basic architecture of a decision support system.

Some important characteristics of a well design DSS:
– The DSS must be user friendly and working should be easy. It is able to easily understand the unstructured problems because this decision –makers generally faced this types situations [12].
– The DSS must be works on an incorporated environments. The design of DSS must be consist of various advanced tools and techniques for easily access the information.
– The function of DSS must be simple for end users.
– The DSS should be highlights the adoptability and springiness when the conditions has been changed every time.
An advanced useful DSS focus on all important components of the problem and cover all parameters. A well designed DSS is based on advanced machine learning, AI and knowledge based system. To use for classify the data and resolved the problems. And increase decision process accuracy [13].
A well- design WMS model must be resolve the problems on:
– The must be focus on decrease of communicable diseases.
– The model must be capable to handle environmental pollution problem such as air, water and soil pollution.
– To determine new recycling techniques of harmful waste.
– The model should be helpful to save out environmental resources.
To implement the waste management policies effectively an integrated, adaptable and co-operated model is very necessary [14].

III. USES OF DATA MINING IN DSS

The data mining plays an essential role in accurate decision making process. The administrator need valuable information for correct decision making. These tools where used, when a large quantity of data is available and through general techniques the analysis is not done correctly. In this type of situations DM techniques are very helpful to overcome the problems. We have various data mining techniques for data analysis and predict results [15].
All of this complete process when data accessed form data warehouses, process the data sets for analysis purpose, transform the data, analyze the data and in final step the predict some useful pattern in the datasets. The complete process in known as data mining process.
The generated useful pattern are very helpful as a sample, as advise, as a suggestion for administrators. In current scenario, the organizations spend a lot of money in advanced technologies for enhancing their business activities. Through analytical tools, they can analyze their expenders, sells growth on a particular product and other various activities. In these type situations the DSS should be very helpful for organizations [16,17].
Through the DSS, the analysts predict the useful information. The managers keep all generated facts in front of experts or main decision makers. After details review and discussion, the administrator take the decisions, they can make new strategies for company [18, 19].
The data mining techniques co-operated with other general and advanced analytical technologies and AI & MI algorithms. It also provide the results in a visualized form Graphs [20]. The client or end- user easily understand the output of the model with these types' facilities. Through visualization, decision tree, the administrators easily understand the facts and on the basis of all these things. The decision makers take their decisions. In the Fig. 2, it is show the basic working process of data mining process and knowledge extraction process [21].

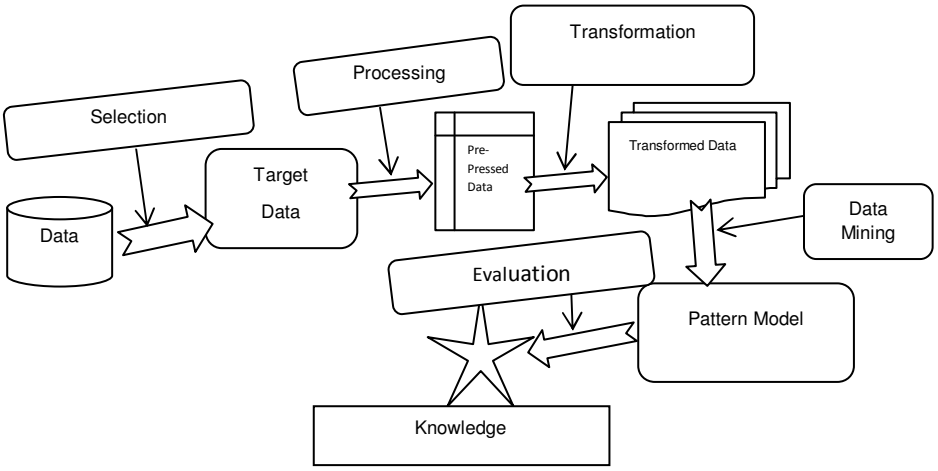

Fig. 2. Data mining process model.

IV. PROPOSED METHODOLOGY

Recently the researchers develop various advanced analytical tool that can very significance for enhancing the business process and this types of decisions taken by the administrators is very supportive to their business growth. A well design DSS is very useful for taking the correct decisions to resolve specific problems. For development of an effective DSS, it is necessary. It will cover all important factors of related input data sets or particular issues. It is very important that the DSS must be works on incorporated other relevant fields. In this paper the proposed advanced N-DSS has been specially designed for resolving the problem of SWM in our country. My main objective to design this model to provide a data mining based advanced N-DSS for resolving this problem. For analysis of data, I also develop a supportive framework. This framework collects the data through different – different modules and sub modules. Ones the data is gathered, the second phase of this model is activated. This model co-operated with various data mining algorithms or tools. This framework consist of advanced machine learning & AI based supportive tools for generating best outcomes. With the help of these outcomes the administrators take correct decision easily.

V. ADVANCED DECISION SUPPORT SYSTEM – FRAMEWORK BASED ON DATA MINING TECHNIQUES

We proposed an integrated decision support framework that can be based on past working case studies data and data mining techniques. The previous decision support system of MSWM does not cover all affecting factors. They had focused only on some specific areas like waste collection and waste disposal. Most of the cities in India do not have a centralized co-operative MSW to overcome this problem. An integrated decision support system is required for this. Our framework accomplishes all these types of requirements. It is can be to cover all important fields of municipal solid waste management shown in the Fig. 3. In the first face there are the main module is presented which is control of all the operations of the sub module and provide the facility to store all sub modules data in a centralized database.

We can see the framework consists of the sub-modules like a sub module for collection of waste, another one for transportation, one for classification disposal of waste via an integrated approach. One sum module is presented for the study and testing of air, water and soil pollutions. All data of sum modules is stored in a centralized database. If the decision-makers are faced with some problems of any sub modules related are, they can apply Data mining techniques on related datasets and get some useful knowledge. The generated result is discussed between the expert committee. And taken the useful decision based on analyzing datasets. The advanced DSS framework is shown in the Fig. 3.

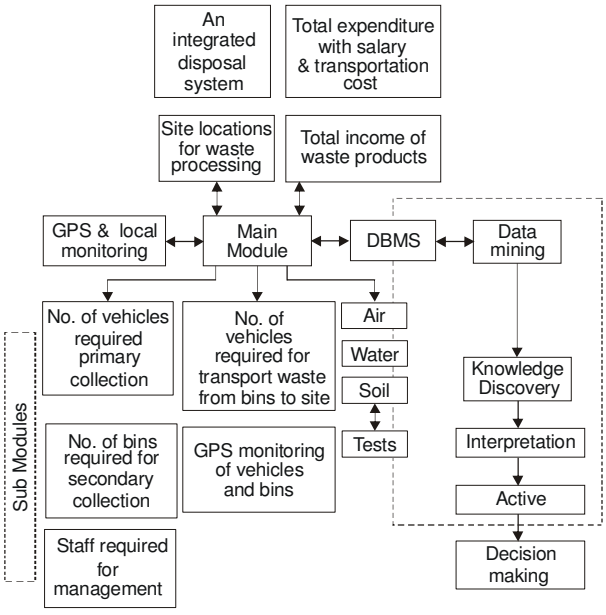

Fig. 3. Proposed advanced N-DSS Framework.

In this framework, we used the SPSS modeler tools for data analysis, which provides a huge range of different – different algorithms for data analysis. We collect the waste management data form municipal offices and government sites.

Table 1: Chemical properties of waste Products.

Component	Percent By Weight (Dry Basis)					
Organic	**Carbon**	**Hydrogen**	**Oxygen**	**Nitrogen**	**Sulfur**	**Ash**
Food wastes	48	6.4	37.6	2.6	0.4	5
Paper 6.0	43.5	6	44	0.3	0.2	6
Cardboard	44	5.9	44.6	0.3	0.2	5
Plastics	60	7.2	22.8	—	—	10
Textiles	55	6.6	31.2	4.6	0.15	2.5
Rubber	78	10	0	2	0	10
Leather	60	8	11.6	10	0.4	10
Yard wastes	49.5	6	42.7	0.2	0.1	1.5
Glass	0.5	0.1	0.4	<0.1	0	98.9
Metals	4.5	0.6	4.3	<0.1	0	90.5
Dirt, ash, etc.	26.3	3	2	0.5	0.2	68

VI. DATASETS

We collect the data from central government web sites(www.mygov.in). This site has a data repository which includes all area's database. Other data I was collected on municipal offices deal with solid waste management. These datasets are directly applied to analysis tools and generate the result.

VII. DATA ANALYSIS

IBM SPSS Modeler is the most well-known data analysis tools that gives the facility to create prescient models utilizing business skill and send them into business activities to improve basic leadership. Planned an industry-standard CRISP-DM model, SPSS Modeler gives bolsters the whole data mining process from raw information to well business results. It offers an assortment of displaying techniques taken from AI, man-made brainpower, and insights. The transferring of informational collection in SPSS modeler is appeared in the Fig. 4.

Perform the C5.0 classification algorithm: C5.0 analytical algorithm is an advanced machine learning algorithm based on decision trees. After applying the algorithm on the data set, the decision tree has generated on the basis of important parameter of input data sets and a specific group of training cases. The generated tree can be used to establish some successive test cases in a specific manner. C5.0 is an advanced type of a well-known and mostly used C4.5 classifier and it has contain numerous essential advantages over its predecessor. The generated rules of C5.0 are more accurate and the time used to generate them is lower. In C5.0 several new techniques were introduced for generating decision tree. Uploaded data set process sets in the SPSS modeler shown in the Fig. 4. We have applied three different-different data mining algorithms on these data sets such as k- means, regression analysis and K5.0 to generating a decision tree.

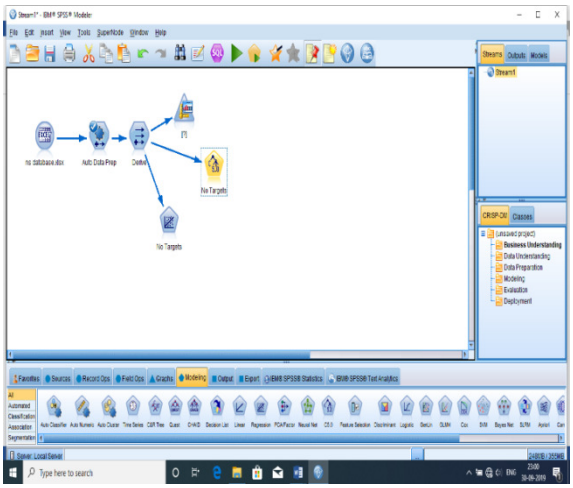

Fig. 4. Data analysis in SPSS.

VIII. RESULTS

This decision tree has shown the organic compound analysis after apply the data sets in K5.0 classification algorithms. Every waste material has contained the organic materials in some specific amount which affects the environment directly. In this Fig. 5, the decision tree showed the classification of organic compounds of percentage-wise n various types of waste.

This decision tree showed the distribution of three organic elements carbon, sulfur, and nitrogen of different types of waste. If the value of sulphur is less than 0.19, it can find out on the glass, if the value is greater than the 0.5, it can find out on rubber. All the classification we can see in the Fig. 6. With the help of decision tree, we can predict the following results on the basic of transformation.

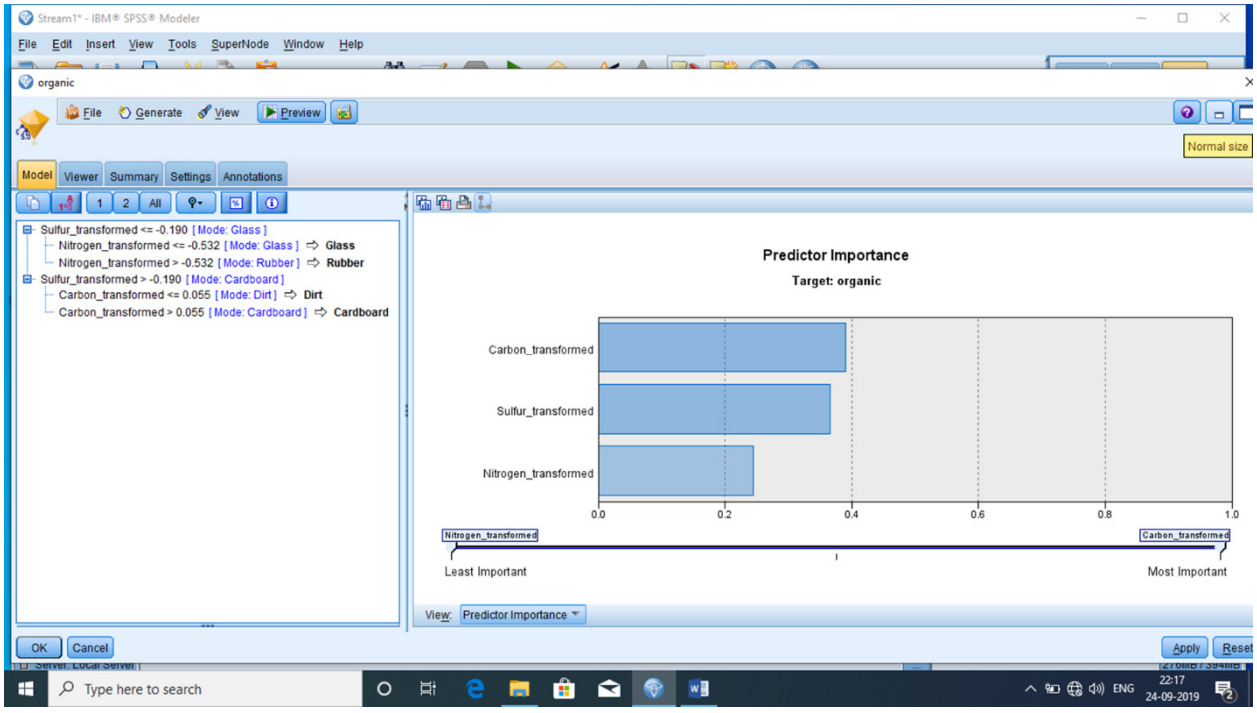

Fig. 5. Results prediction in C5.0 classifier.

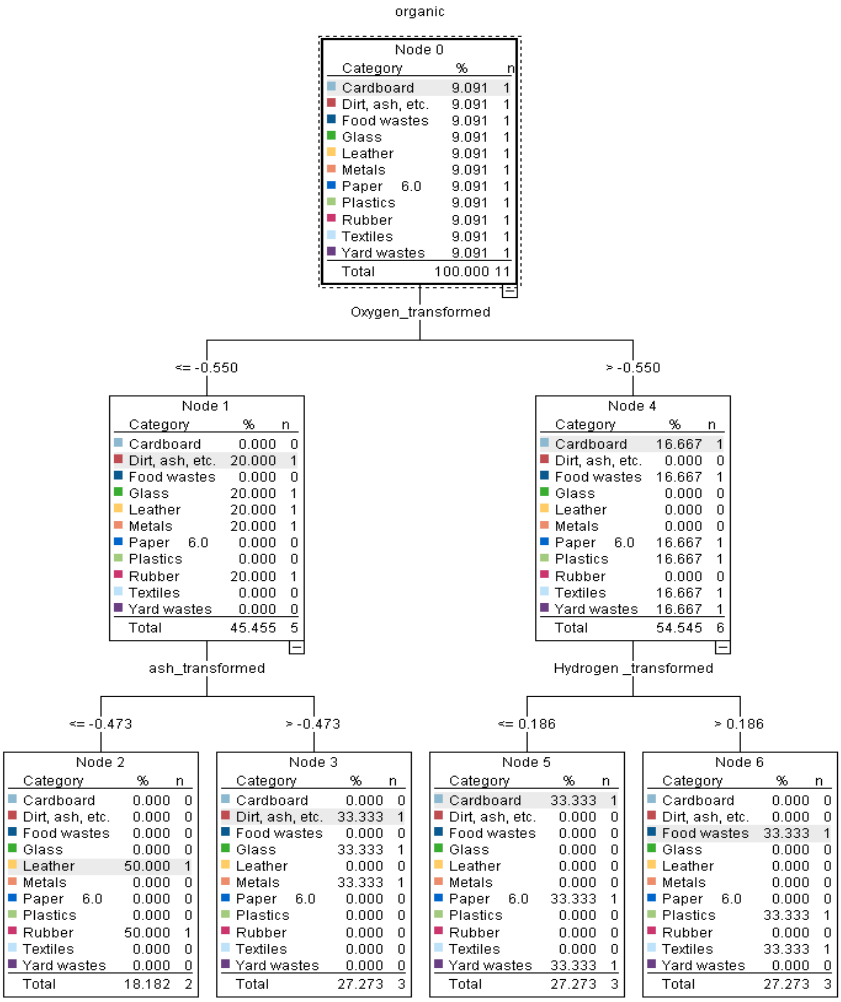

Fig. 6. Decision tress.

If the value of oxygen transformation is less than or equal to -0.55, it will be found on dirt, ash, glass, leather, metal and rubber waste types, if the value of oxygen transformation is greater than the > -0.550, it will be found on cardboard, food waste, plastic, paper, textile, yard waste type waste product. Other transformation results we can also see the decision tree.

Oxygen_transformed<= -0.550 [Mode: Dirt, ash, etc.]
ash_transformed<= -0.473 [Mode: Leather] => Leather
ash_transformed> -0.473 [Mode: Dir, t, ash, etc.] => Dirt, ash, etc.
Oxygen_transformed> -0.550 [Mode: Cardboard]
Hydrogen _transformed <= 0.186 [Mode: Cardboard] => Cardboard
Hydrogen _transformed > 0.186 [Mode: Food wastes] => Food wastes

IX. CONCLUSION

For increase the proficiency of decision-making process, it is very necessary to capable work of all relevant factors. An incorporated supportive DSS plays an important role, it can be very helpful for improving the effectiveness of the decision making process. The proposed DSS model will be able to cover all important components of MSW managing framework. This framework help administrator to take accurate decisions for sustainable WMS task on the basis of analyzed data sets. Since this information can be distributed over a large geographic region. The SPSS modeler and other relevant analytical tools have been compromise a variation of modeling methods taken from advanced algorithms. Every methods specially designed and used for resolve specific problems.

X. FUTURE WORK

This prototype framework will be directly applying on any urban and rural area of our country. For increasing the efficiency of this framework, we will use GIS techniques with this DSS, that can be made this DSS is very advanced and powerful tools. It can provide data analysis on 3D and 4D visualization techniques. It will be able to visualize as systems that can monitor and deliver progressively smart decisions in a unpredictable and ambiguous environment.

ACKNOWLEDGEMENTS

We would like to thank the unspecified referees of the paper for their valuable recommendations and constructive comments which helped us in refining the quality of the paper.

Conflict of Interest. The authors declare that there are no conflicts of interest regarding the publication of this paper.

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How to cite this article: Sharma, Narendra, Litoriya, Ratnesh, Sharma, Deepika, and Singh, Harsh Pratap (2019). Designing a Decision Support Framework for Municipal Solid Waste Management. *International Journal on Emerging Technologies*, *10*(4): 374–379.