

Waste Management Using a Multilevel Distributed System and Data Mining

Marcel DĂNILESCU

Research and Development institute for Aquatic Ecology, Fishing and Aquaculture
Viorel ARITON, Laura DĂNILESCU
“Danubius” University, Galați România

Administration is conducted through the control of events and management of problems in the territory. Economical growth and nowadays technologies lead to difficult problems related to environmental protection against pollution and to people safety against various direct threats from air soil, food. In this respect, an increasing importance get the collection of information and its processing and interpretation just to understand and discover threats and potential disturbance of the environment and health. The paper proposes a multi-level system for the administrative bodies involved in environment matters at local regional and national levels, which may collect and scrutiny data on waste generation, spread and reuse/elimination, and provide sound instruments to assist decision makers of the corresponding levels, using Data Mining and Business Intelligence.

Keywords: Management, environment, information system, business intelligence, data mining.

1 Introduction

The nowadays industry took new challenges to humankind, while threats on environment and health have to be solved in systematic ways and through sound policies. Recently, in Italy (Napoli), poor implication and means of the local authorities on environmental matters (regarding the urban garbage) generated difficult problems which lack of solution may lead to an ecological disaster. It is not only urban waste a problem but so many uncontrolled waste which is polluting the world may suffocate us.

The main difficulty of such problems is the lack of information regarding source and destination, cause and effects of waste produced in the modern society. Then, it is of greatest importance to discover and understand the various relations and phenomenological correlations in the field, just to act in a efficient way to solve the problems.

Romania is facing the world's environmental problems more acute because of the transition time it passes, when chaotic economical grow and fall generate both waste and pollution. So, this problem is hence of greatest importance to get a proper and quick solution.

Besides the poor waste recovery or elimina-

tion, Romania suffer of the lack of a sound policy in this respect – partly due to the dynamic capitalist society and partly due to few information existing in the field (regarding sources and destination of the waste, causes and effects of waste deposit and circulation). The paper reflects an attempt to solve the waste management problems through a multilevel system for collecting and processing data on waste regarding the various dimensions in concern: source-destination, type-threat, reuse-elimination, fail-profit, knowledge-experience. The ambitious aim is sustained through the integrated approach of the system including all administrative levels concerning the waste and also modern instruments offered by the Information technology – as Multidimensional Data Bases, Data Mining and Business Intelligence.

2. Waste management at various levels in a multidimensional approach

The waste management from the source to the reuse/eliminating destination is by itself a multidimensional problem while involving various locations of the sources and destinations, various types of waste - regarding the danger upon people and environment, procedures to follow for depositing and recycling.

The waste source (generator) and the destination (re-user/eliminator) are almost always decoupled in the real life - while they are usually different entities with their own economic and administration plans and with their own organization. So, source and destination entities are mostly oriented to their own local interests and have poor interaction or coherent common policies. As a consequence, many problems appear at macro levels (e.g. region or country level) concerning the relations between source and destination as regarding waste grade of danger, the way and time it is transferred between locations, intermediary depositing matters and many other problems regarding environmental policies and people health. In Romania, the institutional structure acting between source and destination consist of LEPA (Local Environmental Pollution Agency), REPA (Regional Environmental Pollution Agency) and NEPA (National Environmental Pollution Agency). They are concerned with strategic problems and the current management of the environmental, safety and healthy problems. However, they have poor control or possibilities regarding an effective management, due to complex and huge amount of information and knowledge concerning the waste sources and destinations, relations, causes and effects, measures of various quantitative and qualitative matters or synthetic interpretations on them.

The paper presents an attempt to solve the main problems as concerns the waste management, using a multilevel system which may gather and relate all the information on the waste production and re-use, also information on the multidimensional aspects of the waste itself (safety, reuse procedure, etc.). The system is meant not only for collecting but also for pre-processing data on where and how the waste is generated and reused/eliminated, but also to offer to discover hidden correlations between data (through data mining), to perform analysis and sound interpretations on events and phenomena coming from the real life (through AI techniques). The multidimensional management aspects involved (e.g. safety problems, quan-

titative and qualitative aspects at any moment, synchronization between sources and destinations, etc.) may have the aid of Business Intelligence instruments provided.

While the waste problems are so complex, the bulk of data should be analyzed periodically and the information system should issue reports and even new knowledge on current and prospective situations – just to come to an action (e.g. preventing a danger, regulating the flow of waste) or to sustain various policies at regional and national levels on safety improvement or on economical matters regarding the waste. Business Intelligence and Data Mining approaches may lead to sound analyses and to new knowledge on the long/short terms and on each or between dimensions.

Knowledge on the local, regional or national waste management matters refers to:

1. Information and management of sources of waste with types, quantities, properties, danger degree (for environment and peoples' safety).
2. Information and management of factors involved in deposit activities, valorization and elimination of waste.
3. Influence of various categories of waste on the environment (pollution).
4. Ways of reuse of the various categories of waste, and the economic effects (recovery).
5. Ways of waste processing in the aim of their elimination or deposit (elimination/ deposit).
6. Support for the decision policy at different levels, by means of reports on the various dimensions regarding the waste management, in the aim of environment preservation and improvement of the quality of life; reports on long medium and short terms for current and prospective situation at regional and national levels.
7. Support for creation of an effective circuit from source to transport, then re-use or elimination of waste.

The interaction model proposed refers to three levels of data collection / store / processing, represented by specific bodies: LEPA (Local Environmental Pollution Agency), REPA (Regional Environmental

Pollution Agency) and NEPA (National Environmental Pollution Agency) – as presented in Fig. 1. All of them are involved in the management and decision activities in some measure and with specific tasks. Also, there are different levels of accessibility to data and reports according to the specific level and concerning specific strategic matters. In this respect, the “intelligent part” of the system (modules corresponding to Business Intelligence and Artificial Intelligence) will help in discover hidden correlations and store in associative memories (as artificial neural networks) the knowledge obtained

from experience. Those modules have an important role in the decision processes for the various levels of waste management. The operational level is the one where data collection is meant; it includes not only LEPA but also companies and administrative organizations. Data is structured according to geographical location, waste quantity and type, transport, ecological deposits. The tactical level refers to small geographical zones which may contribute to the general waste policy of upper level. At this level it is produced the medium term policy and context analyses based on fresh data.

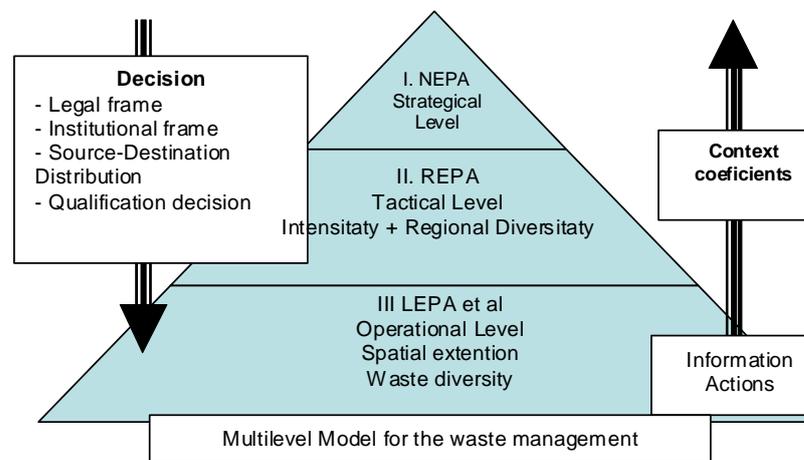


Fig.1. The three distribution levels of data and processing required by the waste management

The strategic level is the macro level and refers to management problems at national level. The complexity of the problems, the need for accurate data and the synthetic coefficients involved in decision making - are main characteristics of the level.

While all the information is collected just on the place in which the respective process take place (generation - transport - reuse/elimination) a great quantity of data is easily collected in the multilevel system. The bulk of data correspond to real cases that occur during time and those cases become source of knowledge for past and future events that have to be managed by beneficiary bodies. Thus the system should be able to perform sound correlation and reports on various cases, causes and effects, good and bad actions taken during time. The existing new knowledge refers to data on waste generated manipulated and reused, and new

knowledge refers to correlation discovered between quantities and qualities of waste generated and transferred or reused, on critical or dangerous situations discovered after automated correlations through data mining, recognition of patterns of data (on quantities and qualities) that is proven from past experience as showing specific situations (e.g. dangerous or unsafe) but no or poor explanation exists.

3. Architecture of the multilevel system

Exploiting the law, it is supposed that all organizations (enterprises, mayoralties, local administrations, hospitals, slaughter-houses, chemical and biological factories, labs etc.) must have a “Waste registration book”. This book must reflect the incidence of activities in waste field. Periodically same organizations must report their recordings to the LEPA (Local Environmental Pollutions Agen-

cy), in a statistical program coordinated by NEPA (National Environmental Pollution Agency).

As seen in Fig.2 in the next picture, the records registered by organization are trans-

mitted to the LEPA by scripts (official letter) or electronic (emails, direct links, ftp, recording by web browser etc.), and constitutes databases records.

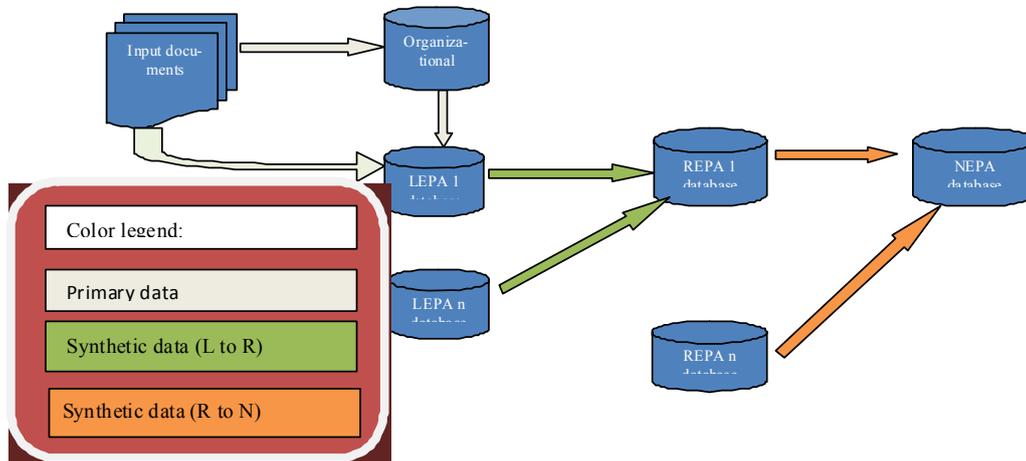


Fig.2. Primary information data flow

Dataflow begin from primary data (organizational data), collected by the organization employees, involved with environmental activities. LEPA will collect all data in a database, and will validate the data. This is the first step of data collection.

The main goal of database is to reflect the entire request about waste categories, quality, and operations, so on. Database design reflects the laws and the requests of some statistics of NEPA about waste categories and qualities see Fig 3.

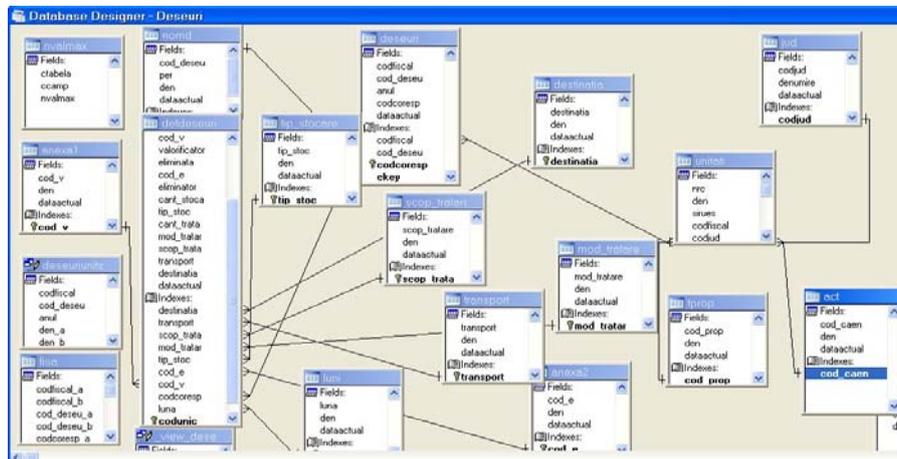


Fig.3. Database design

The first synthesis of database is send to REPA which also collect important synthesis data from all LEPA around, constructing their databases and synthesis which are necessary for NEPA databases. As the result, the Business Intelligence tasks of REPA are to observe, predict and assist decisions which result from middle term plans.

NEPA will filter the results of all REPA's side, and according to them in the view of national laws and international treaties, in the aim of assisting the managing decisions for long term plans.

4. Conclusion

In the effort to organize the information

meant for the waste management, the natural structure comes to be the one just created for the responsible bodies in Romania: LEPA REPA, NEPA. So, the data is organized on the pyramid suited for those bodies, based on “data warehouse” at regional level and with the benefit of the Business Intelligence modules just for ease data interpretation and correlation discovery (data mining, process mining).

The elements for data analysis and for assessing economical processes involved in the transport/store and reuse/elimination

processes take into account various scenarios obtained during the past as experience. This is an important acquisition that may be exploited while artificial intelligence means provided. So, patterns of such situations are stored and recognized in a non-deterministic way by Artificial Neural Networks (multilayer perceptron).

The multilevel system is in a pilot phase (only for the local and regional levels and for main tasks) and it can be extended to cover all levels existing in the structure of responsible bodies in Romania.

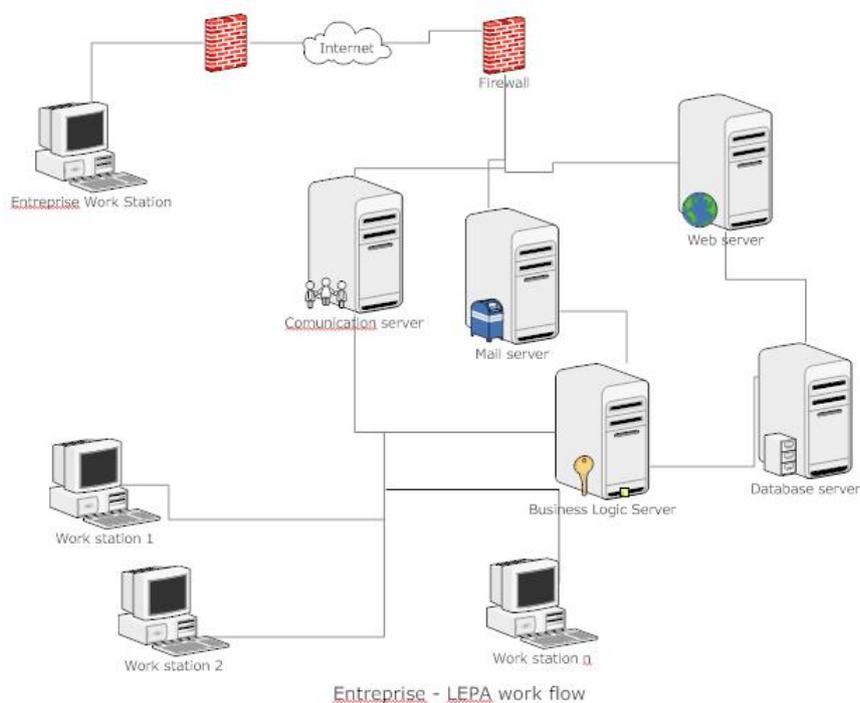


Fig.4. The communication and hardware requests for LEPA, REPA and NEPA

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