

Building a public awareness on solid waste segregation at source. A management scenario in Craiova city, Romania

Nicoleta Bumbac, Oana M. Rosca, Philippe Dondon, and Cornelia A. Bulucea

Abstract—This paper is focusing on solid waste segregation at source as the main component of an integrated waste management system. Within the framework of Industrial Ecology the solid waste must be seen as secondary resources that should become through recycling processes the raw materials for distinct manufacturing organizations. Aiming to build a public awareness on this important issue the paper encompasses a management scenario for solid waste segregation at source within an area of Craiova city in Romania. There are estimated the types and quantities of solid waste collected separately in order to be further recycled. It is carried out a questionnaire with respect to the public willingness for implementing a sustainable waste management mainly based on the separate collection of solid waste at source.

Keywords— environmental stewardship, industrial ecology, integrated waste management, selective collection.

I. INTRODUCTION

FOLLOWING the notion that so far the Nature generated ordered structures highlighting no-waste processes of life forms, within the framework of Industrial Ecology an approach of anthropogenic activities according to the pattern of the ecosystems is aimed [1-6].

Nowadays manufacturing processes of products involve utilization of raw materials from various sources. Rapid increase in volume and types of solid and hazardous waste as a result of continuous economic growth, urbanization and industrialization is rising concerns, becoming a key problem for local, national and international authorities and citizens as well, in order to ensure an effective and sustainable management of waste [6-9].

Within the framework of Industrial Ecology the solid waste must be seen as secondary resources that should become through recycling processes the raw materials for distinct manufacturing organization. One could highlight that solid waste is mainly composed of organic materials and recyclables

like glass, paper, metals and plastics [6-9]. Still, despite the key role of waste management systems for becoming a circular economy, a continuous and consistent reporting of waste treatment capacities on a European level is lacking [6-7].

In line with the previous idea it is highly increasing the awareness that recycling of segregated solid waste can and should become a key component of any integrated waste management system. One could recall that recycling is the process in which used or abandoned materials from anthropogenic activities are converted into new products. Items that can be recycled include; glass, paper, plastics and various metals, still there are many other recyclable types of waste [6-9]. The process of recycling involves either a selected waste collection or a waste segregation after collection, followed by the processing of the recyclable waste and finally manufacturing products from the waste thus processed [6-7].

One could highlight that waste recycling reduces the demand on raw materials. It also reduces waste disposal by landfill or by incineration, hence helps reduce pollution and global warming [1-9]. It might be noted that recycling belongs to recommended techniques of Cleaner Production, under the vision of Sustainable Development. In line with the same idea, recycling also prevents pollution caused by reducing the need to collect raw materials. If used materials are not recycled then new products are made through the use of genuine raw materials through methods such as mining and forestry [6-9]. So, recycling saves energy, since energy is required to extract raw materials as well as refine, transport and construct, and recycling also helps in the conservation of natural resources and habitats [1-9]. Consequently, one of the promising developments in an integrated solid waste management system should doubtless be related to the waste components' recycling starting from a segregated waste collection.

This paper focuses on an overview of recycling options for managing solid waste, based on the segregated collection of solid waste at source. Identifying the process elements represents an important issue that one should consider when planning for an integrated solid waste management.

II. DEFINING INTEGRATED WASTE MANAGEMENT SYSTEM

Rapid increase in volume and types of solid and hazardous waste as a result of continuous economic growth, urbanization

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and industrialization is rising concerns, becoming a key problem for local, national and international authorities and citizens as well, in order to ensure an effective and sustainable management of waste [6-9].

Following the idea that waste generation increases with population expansion and economic development it is widely accepted that improperly managed solid waste poses a risk to human health and the environment. For instance, uncontrolled dumping and improper waste handling causes a variety of problems, including contaminating water, attracting insects and rodents, and increasing flooding due to blocked drainage canals or gullies. Improper waste management also increases greenhouse gas (GHG) emissions, which contribute to climate change [6-9]. Planning for and implementing a comprehensive program for waste collection, transport, and disposal—along with activities to prevent or recycle waste—could maintain under control these problems.

In line with previous ideas has been coined the concept of Integrated Solid Waste management (ISWM) as a comprehensive waste prevention, recycling, composting, and disposal program [8]. An effective ISWM system considers how to prevent, recycle, and manage solid waste in ways that most effectively protect human health and the environment [6-7,9]. ISWM involves evaluating local needs and conditions, and then selecting and combining the most appropriate waste management activities for those conditions. So, major ISWM activities are waste prevention, recycling and composting, and combustion and disposal in properly designed, constructed, and managed landfills as it is emphasized in Figure 1, according to [8]). Each of these activities requires careful planning, financing, collection, and transport, all of which are discussed in this and the other fact sheets.



Fig.1 Depicting ISWM system, according to EPA US [8]

The Integrated Solid Waste Management (ISWM) concept has to be adapted in correlation with the view that effective management schemes need the flexibility of design, adaptation, and systems which must meet the social, economic, and environmental conditions. These are likely to change over time and vary by location [6-8]. The ISWM systems should be organized on a large-scale since there must be taken into consideration the need for consistency in quality and quantity of recycled and/or recovered materials (as compost) and/or energy (through incineration), as well as the need to support a range of disposal options.

Waste management systems should take into consideration

institutional, social, financial, economic, technical, and environmental factors [6-8]. Based on these factors which vary from place to place, each community has the challenge of selecting the combination of waste management activities that best suits its needs.

One could note major features of ISWM as below [6-9]:

- Holistic approach to all waste streams, this way maximizing synergetic benefits in collection, recycling, treatment and disposal.
- Maximize the opportunities for secondary resources' recovery at all stages, from generation to final disposal of solid waste.
- Facilitate life cycle view of products and materials, thus promoting greater resource use efficiency.

The ISWM concept, as per definition, involves the entire life-cycle process from generation to disposal, of varied waste streams [6-9]. This issue not only involves different sources of waste generation but also includes diversities in terms of waste characteristics, involved stake-holders and the required technological know-how. In order to deal with this complex issue and to arrive at an optimal solution, a number of difficult choices shall have to be made. Prediction of waste generation and characterization is crucial for developing a robust waste management plan. However, these parameters being a function of several factors, the prediction has to be done following the scenario building approach. A plan for managing diverse streams needs a flexible approach involving varied organizations and stake-holders and generating alternatives based on participatory approach [6-9].

Because integrated solid waste management involves both short- and long-term choices, it is critical to set achievable goals. Segregation at source of solid waste is the key to any effective waste management system. In line with that idea this work aims to provide a scenario for a segregated collection of recyclable solid waste in order to transfer them as raw materials to other industrial actors.

III. A MANAGEMENT SCENARIO FOR SOLID WASTE SEGREGATION AT SOURCE IN CRAIOVA CITY

A. Necessity of Selective Waste Collection in Craiova City

The waste is part of a substance or a material resulting from a technological process of making a product unusable in the same process [10]. From its source one could highlight the types of waste as industrial (from the processing resources through different technologies) and metabolic (from biological processes, for example manure). In urban and rural ecosystems daily results huge amounts of waste, not only make space problems for aesthetic storage, but are also a source of pollution threatening human health. All waste degrade the environment, contaminate groundwater (storage method makes possible infiltration of rainwater, which causes pollutants and pathogens).

Domestic waste is solid waste collected from the households, institutions, companies, factories, consisting of food scraps, paper, plastic, fabric, glass, packaging, batteries

and more. Most of these wastes are not biodegradable, and aerobic and anaerobic degradation process by microorganisms is taking a long time. For example metal containers (cans) degrades in about 150-300 years; aluminum containers (beer cans or juice) disappear in 300-400 years; plastic (soda bottles, packaging) does not degrade; glass objects never disintegrating, they only suffer a process of attrition, so none of these wastes are never integrated in material circuit in nature [6-10].

Recycling is the recovery and processing of materials already used to enable their reuse. Waste recycling presents environmental benefits (removes environmental pollution) and economic (saving energy and raw materials) [6-9].

Waste that should recovered are: ferrous, nonferrous and precious metals, chemical waste (waste rubber), waste paper, glass, plastic [10].

In Romania the containers are labeled or marked in colors provided by law [10], to ensure identification of containers intended as follows:

- Yellow for plastic and metal waste;
- White / green for white / colored glass, respectively;
- Blue for paper and cardboard.



Fig.2 Labeling of containers for segregated waste collection

One could recall that storing waste is recognized as impact and risk generating to the environment and human health. The main forms of risk and impact caused by waste landfills from population and industry are related to changes in landscape and visual discomfort; the air and water pollution.

Air pollution with unpleasant smells and suspensions driven by wind is particularly evident in the current municipal deposits, in which is not practical coating of inert material.

Deposits not waterproof of municipal waste are often sources of groundwater pollution with nitrites, nitrates and other pollutants. The current practice of collecting transport / storage urban and rural waste enables the propagation and dissemination of pathogens and their vectors: insects, rats, crows, stray dogs.

A negative aspect is that many useful and recyclable are submitted to disposal together with those non-recyclable being mixed and contaminated chemically and biologically, their recovery being difficult [6-9].

B. Locating Area of Project Implementation

In order to build public awareness on the major importance of segregated waste collection in Craiova city, we address this environmental management scenario in an area of Craiova city.

Hence, this management scenario for a selective waste

collection is aimed to "Rainbow Childhood" kindergarten, Craiova, Dolj County, Romania, as shown in Fig.3.

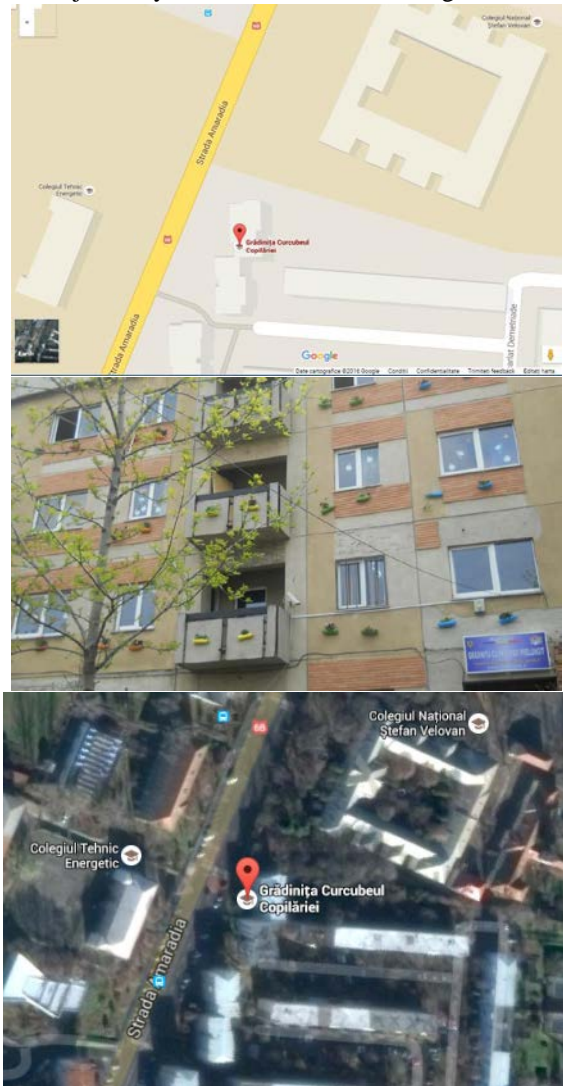


Figure 3 "Rainbow Childhood" kindergarten location

Prolonged "Rainbow Childhood" Kindergarten is a preschool institution with legal personality and is part of the national education system [11-12].

The kindergarten promotes public policies for implementing a new vision of education, training, research and development with the main dimensions improving the quality and effectiveness of education and training, facilitating universal access to education and training, opening the education and training the European professional space. The activities are carried on age levels consistent with the curriculum of educational activities in kindergarten [11-12]. Educational process is modern and quality, using modern methods and teaching strategies based on active learning game that encourages creativity and networking with others.

Classrooms are equipped with modern furniture and teaching materials attractive for children. Kindergarten yard has space for outdoor activities. Kindergarten consists of 8 groups with overtime structured as follows: two small groups, three medium groups, three large groups [11-12].

The little ones from "Rainbow Childhood" Kindergarten celebrate Earth Day [11-12]. Prolonged "Rainbow Childhood" Kindergarten held every April 22 environmental activity for celebrating the Earth Day, as greening and beautification of kindergarten, under the title "We save the earth by recycling". The action aims: raising public awareness of environmental problems; ownership rules for environmental education; promoting new activities; development of volunteer spirit; the development of competitive spirit; Effective attract children and teachers in organizing extracurricular activities character, active components in the personality development of the child; beautifying the exterior of the kindergarten from recyclable materials. So with the help and involvement of parents, children have recycled PET, which made pots of colorful flowers in which they have planted, each group having a different color from the rainbow.

C. Establishing Target Groups and Estimating Types and Amount of Recyclable Waste

Prolonged "Rainbow Childhood" Kindergarten is made up of the following categories of waste producers:

- ❖ 135 preschoolers
- ❖ 17 teachers
- ❖ 12 persons as auxiliary staff

Further, at the same location the types and amount of generated recyclable and household waste are depicted in Table 1 as below. One should note that in Table 1 there are included the waste code according to the European Waste Catalogue [13-15]. The European Waste Catalogue (acronym EWC) refers to a set list of wastes that are derived from both households and businesses inside the European Union. The EWC is used to derive a code (six numbers in 3 sets of 2) that adequately describes the waste being transported, handled or treated [13-15].

Table 1

Waste code in European Catalogue	Waste type	Amount (kg/month)
Recyclable waste		
20 01 01	Paper / Board	3
15 01 02	Plastic	5
03 03 01	Wood	2
20 01 02	Glass	3
16 06 04	Batteries	2
20 01 36	Electronics	10
Household waste		
20 01 25	Fats	2
20 01 29	Detergents	3
Total		30

IV. QUESTIONNAIRE ON A SEGREGATED WASTE COLLECTION

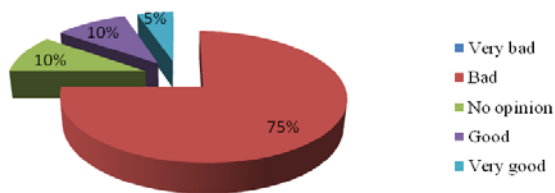
The purpose of this questionnaire is to evaluate the amount of waste generated by pre-school and kindergarten teachers and ancillary staff of "Rainbow Childhood". By applying this questionnaire we aim to find out if the kindergarten staff is responsive in terms of implementing a program of selective waste collection.

The addressed questions are listed as below:

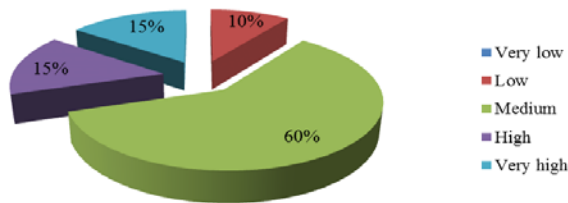
1. What do you think about the effectiveness of the current system of waste management?
2. What do you think is the degree to which the current waste management system provides adequate protection to the environment?
3. For a more efficient waste management have you agree with sorting your waste (organic materials, glass, paper, metal, plastic, textile)?
4. Do you consider the implementation of an integrated waste management (collection, sorting, composting and containment) will help to improve the environment?
5. In your institution it was introduced a system of selective collection of waste?
6. Which of the following categories of waste are generated within your institution?
7. Do you think that sanitation service in the area will be more effective with the implementation of a system of selective collection of waste?
8. How would you rate the institutions involved in the implementation of selective waste collection?
9. How do you evaluate the quality of selective collection of electrical and electronic waste equipment?
10. Do you know what happens to waste after being raised from storage?
11. Do you agree that sanitation service taxing to be made according to the quantity of waste selected?

Further there are presented the questionnaire results.

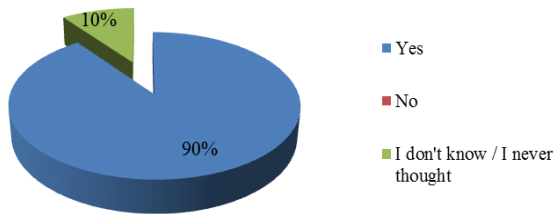
1. What do you think about the effectiveness of the current system of waste management?



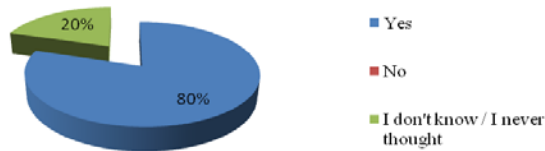
2. What do you think is the degree to which the current waste management system provides adequate protection to the environment?



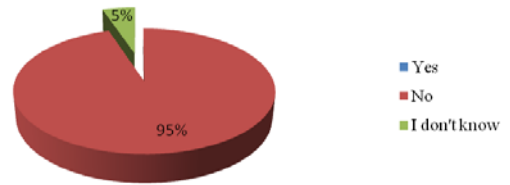
3. For a more efficient waste management have you agree with sorting your waste (organic materials, glass, paper, metal, plastic, textile)?



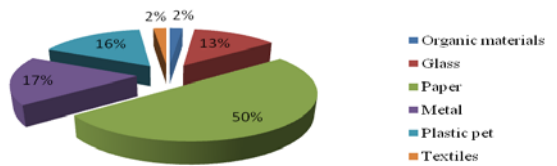
4. Do you consider the implementation of an integrated waste management (collection, sorting, composting and containment) will help to improve the environment?



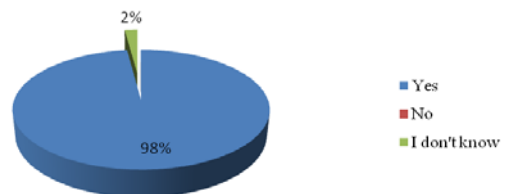
5. In your institution it was introduced a system of selective collection of waste?



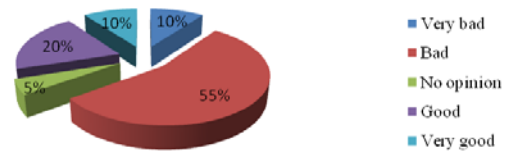
6. Which of the following categories of waste are generated within your institution?



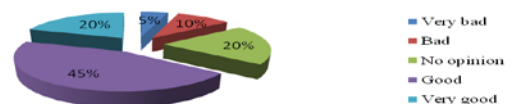
7. Do you think that sanitation service in the area will be more effective with the implementation of a system of selective collection of waste?



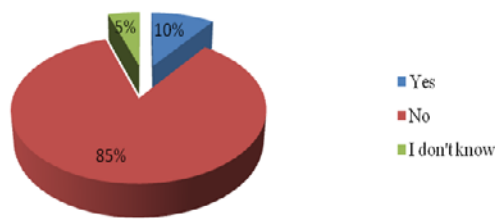
8. How would you rate the institutions involved in the implementation of selective waste collection?



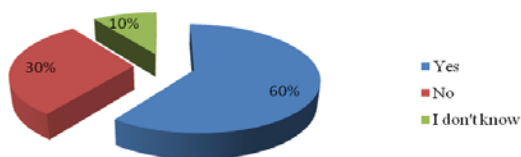
9. How do you evaluate the quality of selective collection of electrical and electronic waste equipment?



10. Do you know what happens to waste after being raised from storage?



11. You agree that sanitation service taxing to be made according to the quantity of waste selected?



Further will be presented the interpretation of the Questionnaire.

V. QUESTIONNAIRE INTERPRETATION AND CONCLUSION

The questionnaire aims to highlight awareness of the target group on the idea of selective waste collection, its degree of openness to ideas promoted by the two students working on this paper versus educational trends from individual members of the initiative group, as well as the development of participatory spirit in the community.

The results show that the interviewed persons are just a little above the average interested in natural environmental issues and everything that goes beyond the narrow space, everyday action. Thus, while 10% have a good opinion about the effectiveness of the current waste management system, there are 75% who feel bad about this system. Moreover, 60% of respondents believe that the degree to which the current waste management system ensures adequate protection of the environment is medium. Instead 15% believe that the system has a high or very high degree.

Although the kindergarten lacks a system of selective collection of waste, most of the staff surveyed believes that waste sorting would be more efficient and implementing an integrated collection of waste management (collection, sorting, composting and containment) will contribute improve environmental quality.

In the institution where the questionnaire was applied, the waste generated by pre-school and school staff are diverse:

50% paper, 17% metal, 13% glass, 2% plastic and textiles. So 98% believe that sanitation service will be more effective with the implementation of a system of selective collection of waste.

The conclusions are as follow:

- Kindergarten lacks a system of selective waste collection and staff should agree to implement such a system.

- The project will have to use the best strategies so that this selective collection system to be successfully implemented within the institution.

- By implementing this system of selective collection environment will be protected.

- In addition, it is clear that the children (from this kindergarten, but also from other kindergartens) are most easily attracted to the idea of selective waste collection and them must lead them to become our allies in disseminating information and changing attitudes among adult members of the community.

On a broader front one could conclude that in Craiova city as in all cities of Europe the segregated solid waste collection could and should represent the main technique applied within a sustainable integrated waste management system.

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