

Intellectual output 3. Educational support content targeting instructors

Learning sheets for HERA activities

Towards a recycling circular economy

Topic: waste management, recycling, circular economy, nature based solutions, sustainability

Introduction

Waste management includes the activities and actions required to manage waste from its inception to its final disposal. This includes the collection, transport, treatment, and disposal of waste together with monitoring and regulating the waste management process.

Waste management deals with all types of waste, including industrial, biological, and household. In some cases waste can pose a threat to human health. Waste is produced by human activity, for example, the extraction and processing of raw materials. Waste management aims to reduce the adverse effects of waste on human health, the environment, or aesthetics.

Waste management practices are not uniform. Countries, including developed and developing nations, regions, including urban and rural areas, and residential and industrial sectors can all take different approaches.

Solid waste management is the biggest challenge for authorities of both small and large cities in developing countries. This is mainly due to the increasing generation of solid waste and the burden posed on the municipal budget in relation to its management. In addition to high cost solid waste management is associated with lack of understanding over different factors that affect the entire handling system.

Population increase, rapid urbanization, booming economy, and the rise in the standard of living in developing countries have greatly accelerated the rate, amount, and quality of municipal solid waste generation.



Figure 1. The recycling scenario challenges students to manage waste in an environmentally friendly manner.

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This learning scenario is inspired on the processes currently being implemented in most countries towards the creation of an increasingly circular economy, where inputs are recovered at the end of the product life cycles. It is an alternative to the prevailing linear economy model, in which the final destination of the products is not managed in any way other than transfer to landfill. The process of recovering the inputs used to generate new products requires a global change in vision and involvement throughout society. In addition it is also needed the investment of a significant amount of resources to design, create, and maintain infrastructures that allow the recovery of the inputs used in the products once they reach the end of their use (or their useful life), reintroducing them into the production processes of those same products, other related products, or reusing them in various ways. This game scenario transfers the recycling and circular economy problem in a simplified way to young students to sensitize them, on the one hand, and to contribute to their training for decision-making in environments of high complexity, uncertainty and social impact.

Context



Figure 2. Students work with a city with basic infrastructures to add waste management services.

The game is situated in the context of a city intended to develop a new recycling program. A selective collection system based on two different types of residues will be implemented distinguishing among: organic waste, and the rest of garbage. Of course, there is the option of waste that may be discarded directly to the landfill. The goal of the team is to minimize the amount of garbage that goes to the landfill.

Four roles are foreseen that students will play simultaneously, each one with its own objectives to fulfill, which is based on approaching the theoretical limit as closely as possible.

The four roles are:

Role 1: Garbage manager

The garbage manager is public representative responsible for the management of garbage in the local public administration. Her objective should be to minimize the garbage sent to landfill. He can build or destroy public recycling infrastructures such as areas where garbage



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containers can be located around the city but has to manage a limited budget. If not enough garbage collectors are available a public health problem can appear.

Role 2: Recycling manager

The recycling manager is a representative of a recycling consortium whose objective is to maximize the results of the consortium. This can create and destroy the consortium recycling infrastructures that are actually recycling plants for different types of waste and take decisions on the number of garbage trucks to deploy and their routes. The consortium also sells recycled products to final consumers, particularly organic and organic compost or compost to local producers of organic products. The activity depends on the amount of garbage collected in an appropriate way and the potential consumers of recycled products.

Role 3: The city mayor

The city mayor aims to maximize the health and happiness of citizens, especially in this case by promoting recycling through communication campaigns. This role decides the budget that will be invested in recycling in the municipality and will be able to build and destroy public infrastructures such as roads and power plants and also allocate space for local ecological markets.

Role 4: Consumer and recycling association representative

The consumer and recycling association representative must ensure that local producers have the maximum possible benefits. The person undertaking the role will be able to create and destroy ecological gardens and farms that can be sold in local markets.

The following picture demonstrates the activities of each role and the interaction between them.

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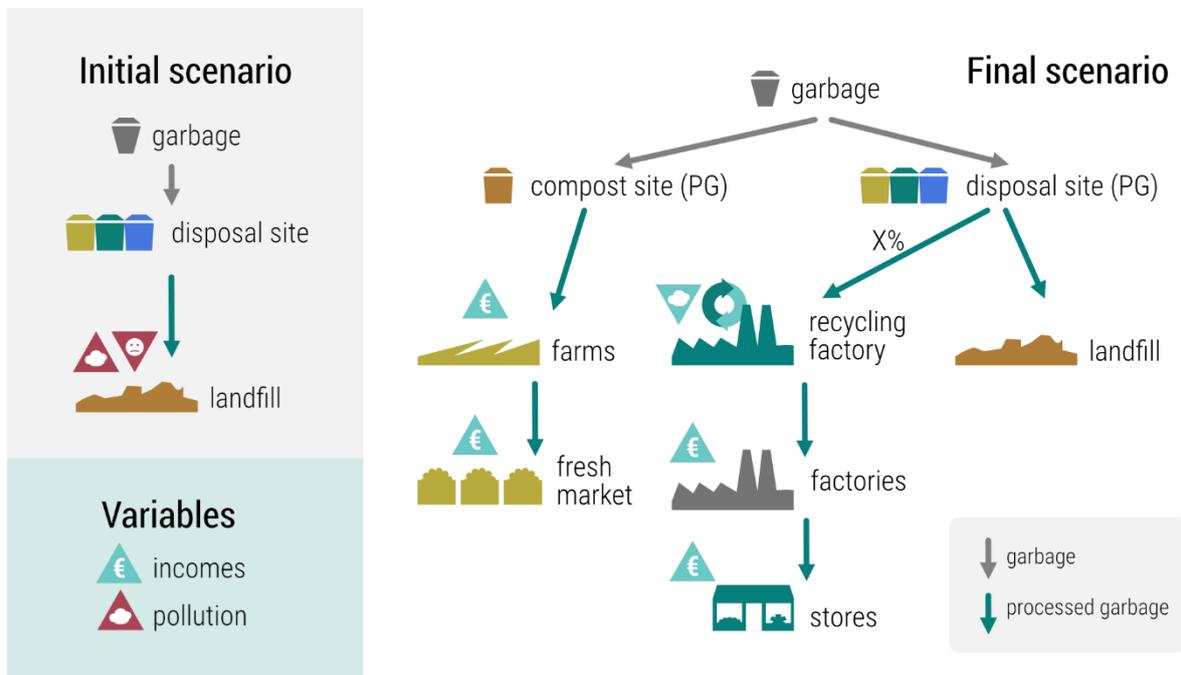


Figure 3. Scenario initial and final states.

There are some dependencies among the different roles. The number of recycling points will determine the action of the person in charge of the consortium that will operate the recycling plants and which will therefore be conditioned by the distance to the collection points. Local producers of organic products will also be conditioned by the distance to the collection points.

The location of the ecological gardens and farms will determine the action of the mayor because he must presumably decide that the places where the markets are held are close to those production spaces and also to the final customers, who will be the inhabitants of the city. The municipality's recycling budget affects all 4 roles that have to balance their expenses.



Figure 4. The starting city includes rich amenities, such as cultural services in the form of museums and sports facilities.

Learning goals

Upon completion of the activities students will:

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- Understand the connections between environmental, social and economic aspects of everyday life.
- Have experienced how to achieve cooperation between different parties with different goals and needs.
- Built competence in taking an integrative approach in managing the waste in a city.
- Have created the conditions necessary for navigating the challenges modern society and environmental changes pose for the public and private sector.



Figure 5. The starting city further includes industrial infrastructure, such as organic and commerce farms.

Prerequisites

Students need a basic understanding of recycling and waste management principles.

Audience

The activity targets general audiences in engineering and economics, challenging students to explore alternatives in waste management that help preserve the environment and promote quality of life.

Core concepts

- **Recycling points.** To simplify, the installation of containers will be carried out at recycling points that will be placed in the different points. Each container has cost and a certain capacity both in volume and weight. There are two main types of waste that initially go to the landfill:
 - Organic waste, which must be deposited in the compost container.
 - General waste, which must be deposited in recycling plants.
- **Recycling plants.** They have a cost and a certain capacity to process waste of a certain type. Therefore, there should be a plant for each type of waste. They will be operated by the consortium of companies that the municipality has chosen for it.

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- **Ecological farms.** Managed by farmers or ecological concerned citizens, they will have a cost and a production capacity of ecological products. These products will have a unit cost related to the management of the fertilizer transport, and their transport to local markets. The kind of land and the availability of natural water supplies could be considered in the calculation of production costs.
- **Markets and stores.** They will be held in places decided by the industry and commerce representative with the approval of the city mayor. They have a cost, but will also involve benefits if they become a place where producers and consumers can meet and take advantage of the recycling program.

Class activity

1. The teacher presents the problem to the class and introduces the scenario and game.

2. The students discuss in order to understand the problem and define possible solutions. They further discuss in order to understand the parameters that define success, such as achieving reducing pollution as much as possible with an overall objective of achieving zero-waste, taking into account city plans



Figure 6. The starting city includes educational organizations in the form of schools and universities.

that may limit the locations on which students may install waste management buildings, the available budget, and more. They further discuss the limitations set in the scenario such as restricted budgets, availability of locations for installing recycling installations and how these influence the capacity of proposed waste management building, diverse waste management techniques and related costs, and more.

3. The students are encouraged to come up with as many ideas as possible through brainstorming. Techniques of design thinking may be used to promote innovative thinking, brainstorming, sharing are building upon each other's ideas, and thinking from the perspective of city inhabitants in terms of designing an environmentally sound solution to waste management.

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4. The students are asked to jointly decide on the ideas to implement from the pool of suggestions that they came up with taking into account restrictions, such as city plans and budget. The teacher forms groups and gives students their roles in the game.
5. The students play the game according to their roles striving to achieve individual and group objectives that may be conflicting. For example, they may need to share a common budget.
6. The students discuss the game results and their roles; the teacher gives feedback.

Description of the scenario

The overall objective of the scenario is to ensure the appropriate management of the waste produced in a city. Waste cannot be managed effectively by the city government acting alone; all parties have to work together in order to manage garbage sustainably.

This can be achieved through planning for a sustainable recycling system. The choice of solution will be determined by the local characteristics of the site including its size, population, and distances.

Students must understand that **the key is to reduce the amount of waste going to landfill**. To achieve this, students need to introduce traditional and alternative waste management services.

Assessment methods

This is an open-ended learning activity in which no single correct solution exists. Rather, the activity aims to raise awareness among students on the importance of effective waste management and recycling and to build their knowledge on related methodologies and strategies.

Students discuss their roles and the outcomes of their activity and decide by using self- and peer assessment methodologies the degree with which they have achieved their goal of developing a zero-waste economy in their city.