

# Underground Storage of Recyclable Waste - a Viable Alternative for the Pleasant Aspect of the Urban Environment

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**Abstract:** Urban waste management is a particular issue, especially in big cities. One of the parameters that have a significant influence on urban waste management is the current or future urban environment, in the medium or long term. Due to the cities' expansion, the problem of recyclable waste has become more and more important and noticeable. The amount of recyclable waste continues to grow daily and, for that reason, the space occupied by the recycling bins has been exponentially increasing. There are multiple options that can contribute to the reduction of waste. This paper aims to highlight the role and importance of waste composting by the population and the significant necessity of finding a viable way of storing this recyclable waste. Another important issue underlined through this study is the reduction of the number of trash cans by building underground storage. This reduction will lead to an improved look of the city. By using this method, a part of the traditional bins will disappear and the risk of throwing garbage on the ground will be reduced.

The number of waste recycling bins is very small and indeed insufficient for the needs of the population. For that reason, finding a solution that can satisfy the majority of the population is necessary. The underground platforms are an innovative alternative for the traditional platforms represented by pens inside which containers/bins are placed. In addition to the urban and architectural comfort, which is at the highest possible point in underground platforms, other advantages of the underground platforms are the visual impact and the efficient usage of the space. Furthermore, under normal operating conditions the span of the plastic containers is 10 years, fact that leads to increased costs. It is also important to mention that investments in underground platforms are not very high and are recovered in a few years, and the change of environment is, in this case, undoubtedly essential.

**Keywords:** plastic containers, architectural comfort, underground platforms, waste composting

## 1. INTRODUCTION

One of the parameters that most often influence the management of urban waste is the urban environment that exists in the medium or long term. This does not only influence the relocation of existing garbage containers (considering the minimum spacing between buildings, the release of sidewalks, accessibility, etc.), but also the periodicity and costs

of the collection service (use of lateral or posterior loading vessels, bell-type containers, compactors, etc.), the citizens' perception (if we think of cases where the garbage trucks involved in emptying the garbage containers interrupt the circulation), accessibility and level of use by citizens etc. In the case of underground platforms, the containers are placed in a concrete vault embedded in the basement, protected by the action of the sun, water and partially temperature variations. Their life span can also increase beyond producer-guaranteed indicators [1].

Waste management through underground infrastructure is, of course, an important development that allows efficient and cost-effective approach to some of the most important needs of modern society. This paper aims to present the solutions provided by such an infrastructure, to identify the operational characteristics and the benefits of this collection method, as well as to provide information on the costs of these works compared to the costs of traditional waste collection systems. The lifetime of these waste collectors is important compared to the traditional life of the waste collectors. They have a much shorter operating time. Those presented in the paper will highlight future issues in order to analyse, present and increase the efficiency of the underground system for waste collection and recycling.



Figure 1. Organic islands for waste disposal in Brasov

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Figure 2. Waste disposal platforms in Brasov

## 2. THE NEED AND OPPORTUNITY OF UNDERGROUND COLLECTION

In order to place the possible containment systems of underground recyclable wastes, the designated areas should be established by taking into account the following criteria:

- the access for the utilizers should be made easy, there should be no physical obstacles for delimitation;
- the persons with walking difficulties should have the possibility to get closer even by car and to be able to dispose of waste;
- these garbage cans should be placed in (relative) proximity to residential areas and manned commercial activities so that the wastes could be collected without excessive physical effort;
- waste containment should be positioned close to places of public interest in order to stimulate the citizens to collect waste even on their way to stores, schools, city hall, etc.

According to the annual reports of the National agency for Environment Protection, out of the total contained quantity of domestic waste, only 1% was recycled in 2009, 5% in 2010 and 12% in 2011, 14% until 2018. Compared to the European average of 28%, at present Romania recycles only 5% of the produced waste, while the remaining waste goes to the landfill, as shown in the latest study conducted by Eurostat. The recycling target of 50% by 2020 is difficult to reach, as the representatives of the Ministry of Environment state, and due to this reason, a landfill fee was established by government decree in 2017, of 80 lei/stored ton, which should go up to 120 lei / ton starting with 2018 [1], [2].

At present, the Environment Fund Administration collects a contribution of 100 lei / ton owed by UAT, if they do not reach the annual objective of 15 % reduction of waste quantity eliminated through storing, from municipal and assailable waste collected through public sanitation service.

Selective waste collection is not organized well. There is no infrastructure, and unfortunately there is the same old system of waste collection preserved inside the blocks, which implies throwing the waste in the skips that are a source of infection. All these represent a barrier in implementing selective waste collection, which would eliminate the waste recycling fee.

Furthermore, they should also take into account densely populated areas, the possibility to attend to these more populated areas by placing compactor containers. The presence of numerous garbage cans and Euro containers for waste suggests the possibility

to make collecting services efficient through adequate logistics for waste transport. Hence, this objective would be reached by on-site waste compaction. Now comes the immense role of the population which is morally obliged to compost each plastic recipient and cardboard, since this considerably decreases the volume of recyclable waste. To exemplify, a study was conducted on a block of 100 flats, then this study was extended to an entire neighbourhood, then to a city. The study is shown in table 1.

Table 1. Comparing the resulting paper volume from a family of 4 people before and after composting

Nr. of people	Type of packaging	Nr. boxes / month	Volume in the initial state (m <sup>3</sup> )	Volume final state (m <sup>3</sup> )	V <sub>i</sub> -V <sub>f</sub> (m <sup>3</sup> )	Total initial state volume (m <sup>3</sup> )	Total final state volume (m <sup>3</sup> )	Economics through composting (m <sup>3</sup> )
4	large cardboard boxes	2	2x90x50x20 =0.18	2x90x70x5 =0.063	0.117	0.4	0.15	0.25
4	medium cardboard boxes	5	5x40x25x15 =0.075	5x40x25x5 =0.025	0.05			
4	small cardboard boxes	7	7x25x15x10 =0.02625	7x25x20x3 =0.0105	0.0105			
4	boxes of milk	15	15x25x10x10 =0.0375	15x15x10x5 =0.01125	0.002625			
4	Others	Altele	0.05	0.016	0.033			

Underground platforms are aimed at selective collection of municipal and assailable (domestic) waste, on 4 fractions maximum. A platform has 4 insertion recipients which can be aimed at established waste fractions, according to local Sanitation Regulations.

## 3. URBAN COMFORT

### a) Eliminating odours

By using underground platforms, unpleasant smell is eliminated due to:

- quasi-hermetic enclosure
- due to the fact that the platforms include concrete or granite finishings of surface metallic plaque, these do not display high temperature in scorching periods either, which limits waste fermentation and gas emission implicitly.
- Significant limitation of insects; the enclosed space is not accessible to insects; it almost eliminates their presence at collecting points.

### b) Eliminating the presence of rodents and stray animals

Due to the fact that the place is hermetically enclosed, regardless of size, the animals do not have access to waste, which eliminates their presence at collecting points.

### c) Eliminating the connection to sewerage

According to the legislation in force, the collecting points for waste must have a washing system, drainpipes for water collection, drain trap, connected to the sewerage network of the locality. For classical collecting points, there are: significant spending on designing, approving and executing the necessary works to connect the platform to sewerage (road undercrossing, breaking and rebuilding the roadway, etc.); spending for interventions in the case of damage to sewerage; impossibility to place collecting points due to refusal of approval in areas that do not have sewerage network within reasonable reach [3].

In the case of underground platforms, these do not necessitate connection to sewerage since the concrete tank in the underground is a waterproof space that does not allow water infiltration and exfiltration in the walls/floor; The underground enclosure is waterproof in what regards meteoric waters, being equipped with a system for sealing at contact surface with the underground metallic platform.

d) Eliminating vandalism and theft Underground platforms, (metallic or plastic) containers cannot be vandalized, destroyed or stolen, since only the sanitation operator and relevant authorities have access to them. This way, it is no longer necessary to replace containers in case of damage; the useful life of these containers is much longer, metallic or plastic container producers guarantee a 10-year useful life in normal operating conditions, useful life span that can exceed the indicators guaranteed by the producers. In the case of underground platforms, increasing the lifespan of the investment is the result of the replaced in the build-in concrete tank in the underground, which is protected from sun exposure, is protected for water and therefore for temperature oscillations.

e) Space efficiency. The efficiency of the use of the spaces, the visual impact, besides the urban and architectural comfort, is the highest in the underground platforms. Underground platforms do not obstructs traffic routes, their overhead being extremely low volumetric. It does not obstruct the visibility and can be located even in parking lots.

g) Location optimization

In the case of classical platforms, because of the lack of legal requirements (sewerage, minimum distances), space, urbanism but also respect for the inhabitants and their comfort, the location conditions determine the inefficient placement of waste collection points. It is also necessary to have several points to cover the area, but unfortunately the number of these points is too low, leaving the area uncovered. Thus, this waste is thrown down days, weeks or months, without anyone getting involved in collecting them.

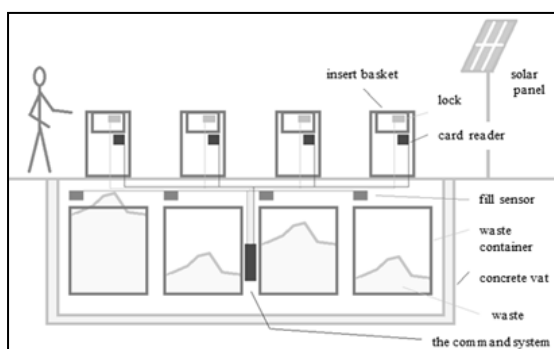


Figure 3. Underground storage platforms

h) Limiting additional arrangements

Underground points can be installed anywhere, including in the road, and do not require a separately built concrete platform or access alley for operation. Underground points can be built just above the already arranged alley or even on its surface (if space permits). Additional arrangements are not excluded,

but are significantly limited by a careful selection of locations. Underground points do not require fences, which degrade slightly and have a negative visual impact.

i) Reduced investment due to the location of underground containers

Underground platforms use standard containers of 1100 liters, without lid, which are accessible to purchase in no time. Existing operators hold such containers and the replacement (if necessary) is an easy activity that does not involve very high costs, and their replacement is easy. All other underground technical variants use atypical containers of large size (ex: 3000 litres) or special typologies with much higher costs that cannot be accessible within the short term required by the legislation.

Since the underground platforms are fitted with standardized containers, the garbage trucks in service can lift these containers already provided with the necessary lifting system. In other variants, special machines with crane arms, extremely expensive and inefficiently operational in areas with trees, overhead power lines, etc. have to be purchased.

Underground platforms do not allow rodents to access the waste disposal chamber, which is hermetic for rodents. In the case of underground platforms for waste collection, it is not necessary to dispose of them and the space in their immediate vicinity. Lack of access to waste (as a closed enclosure) hinders access to insects and significantly reduces their presence around the platform, so it is not necessary to disinfect the space.

j) Low operating and maintenance costs

The average annual maintenance costs of an underground platform, according to the Operations Manual, amount to a maximum of 800 Lei/year, with the cost of degradation/vandalizing containers, disinfestation, disinfection, sweeping the site, etc. The operating costs are the same as those of the classical platforms, but can be significantly optimized if the underground platforms are equipped with SMART communication devices for filling degree and implicitly for the optimization of collection routes.

According to the Forecasted Cash Flow the investment in underground platforms is recovered at the beginning of the 5th operation, with the impact on the population tariff being at least (1-4 RON/person / year depending on the number of platforms and users of the service).

#### 4. TECHNICAL DESCRIPTION OF UNDERGROUND PLATFORMS

Underground waste collection platforms are an alternative to classic platforms, represented by pens in which containers / bins are placed (Fig. 3).

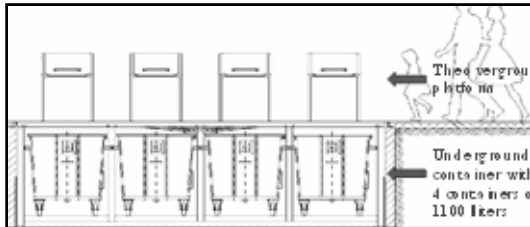


Figure 4. Underground waste collection platforms

## 5. THE LEGAL ADVANTAGES OF URBAN COMFORT

Underground platforms fully comply with applicable environmental and health legislation. In very frequent cases where space does not allow for compliance with the minimum distances imposed by legislation, both in block areas and in home areas, the underground platforms are the only applicable legal solution, can arrange special waste collection rooms / enclosures, which are not considered as collection platforms, including those on the ground floor of buildings fitted with ghene. The Euriteh underground points, which are in fact special collection rooms, do not assume the minimum distance of 10 meters to the windows of the dwellings.

The execution of the construction works and the installation of a platform after the construction of the site and the delivery of the materials last between 5 and 7 days. Running a platform requires the following components: execution of the excavation and the foundation bed, laying of the concrete tank, the upper support plate (on the surface of the tank), the inner metallic structure and the hydraulic installation, the lower support plate (inside the underground tank), the insertion baskets, the 1100 liter containers. 1100-liter containers must be made in accordance with EN 840-2-5-6, galvanized or plastic, without cover.

Advantages of urban comfort: Optimization of location, significant space efficiency, removal of smells, significant limitation of the presence of insects, elimination of the presence of stray animals and rodents, protecting the health of the population and animals.

Pre-collection/collection of municipal waste on underground platforms has many advantages, including: eliminating unpleasant smells, eliminating outbreaks of infection, eliminating dirt around waste disposal sites, accessing containers only to authorized persons, aesthetically improved appearance, emptying is easily accomplished by waste collection utility vehicles.

## CONCLUSIONS

The main advantages deriving from integrated waste collection systems

- Quality: due to the technologies and quality of selected materials

- Integrability: high efficiency in the selective collection of waste can be implemented in successive steps.

- Aesthetics: eye-catching, modern collection gates respect the urban footprint becoming a real piece of urban furniture.

- Hygiene: ensuring the collection of waste in the quantity and quality desired, is eliminated the problem of ugly odors for a long time.

- Comfort: Using the through the door-to-door collection system, is possible daily collection, 24 hours a day.

- Safety: underground ecological islands are safe and do not become restrictive barriers for children, the elderly or the disabled. Safety will also increase in circulation street.

- Easy to use: great user-friendliness, accessible to the elderly and to the elderly people with disabilities.

- Recovery: eliminates the dangers of vandalism and arson of the tested technologies.

Risks that may occur

- The weaknesses in the feasibility study can influence both the quality of the evaluations and the budget as part of the grant;

- Inappropriate use of containers by residents;

- Inappropriate response from the population regarding the awareness campaign.

- Uncontrolled increase in the prices of goods provided during the project implementation;

- Possible problems regarding the maintenance of the locations for the constructions envisaged in the project;

- Difficulties in the implementation of selective waste collection in households;

We appreciate that all these risks will be avoided and even eliminated through an efficient management of the project, as well as by the interest of all parties involved in the project.

## REFERENCES

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