

HOW TO IMPROVE WASTE MANAGING ON THE ISLANDS - CASE STUDY OF THE ISLAND OF LOŠINJ

EMIL BURRIĆ, MIRJANA KOVAČIĆ & MATEA HORVAT

University of Rijeka, Faculty of Maritime Studies, Rijeka/Primorje-Gorski Kotar County, Croatia.

E-mail: emil.burri@gmail.com, mirjana051@gmail.com, kapitanovic.matea@gmail.com

Abstract The development, implementation and organization of a comprehensive waste managing system on the Adriatic islands is an important economic and political issue. It is an extremely powerful factor in the quality of life. The waste managing system on the islands is characterized by complexity and cannot be classified as a classic utility service, taking into account primarily the limited space. Environmental protection is dependent on waste managing. In Croatia, the specificity of the problem is the strong seasonality as a consequence of the growth of the tourism sector. There are organizational problems due to non-compliance with the waste management strategy and plan at the state level. The authors research obstacles, analyses specifics, and waste managing solutions on islands. The purpose of this paper is to define all processes and stakeholders in waste managing, to determine and to analyse the existing situation. The aim of this paper is to propose solutions in order to achieve the most efficient and effective waste disposal. A special goal of the paper is to determine the economic and environmental benefits of waste recycling on the example of the island of Lošinj, in relation to the current model of transport to the County Main Recycling Plant.

Keywords:

waste managing, environmental protection, tourism, island of Lošinj.

1 Introduction

The main goal of waste management is to reduce the production of waste at the place of its occurrence. The tendency is to realize the model of reuse of already used 'waste' by taking into consideration the material and if possible the type of waste and energy used. In modern times the habits of people, and primarily consumers are radically different. The reality is that food products, devices, materials and other things are written off and discarded from use even in the case when they are realistically still usable. As a definitive step forward for society, Croatia has passed the Law on Sustainable Waste Management, which states that measures to prevent or reduce the harmful effects of waste on human health and the environment by reducing waste generated and / or production and regulate waste management without use of risky procedures for human health and the environment, with the use of valuable waste properties (OG 94/13, 73/17, 14/19, 98/19).

In Croatia, a strategic goal of waste management has been determined through the Integrated Waste Management System (IWMS). The IWMS model (Avoidance-Evaluation-Disposal) is designed as a system of waste collection and then transport to a pre-planned location. Considering the management system, it was noticed that the priority is selection for the purpose of recycling, while the remaining waste that is no longer usable is processed using mechanical and biological treatment.

The subject of this paper is to analyze the current state and impact on the environment. The purpose of this paper is to try to define waste management in order to achieve the goals of rationalization and optimization of waste transport costs. The aim of the paper is to harmonize with the summary is to explore the possibilities of improvement through new technologies such as heat treatment within the field of waste collection and reflections on the reduction of transport costs. The methodological framework and procedure were tested on the waste management system on the example of the island of Lošinj.

2 Review of previous research

The waste collection and management system has been the subject of global research for decades. A review and analysis of the available literature reveals a diverse and meaningful range of professional and scientific papers, legal acts, which articulate opinions and attitudes regarding waste management on the islands. The focus is on increasing the efficiency of waste management, reducing the use of space resources and transport costs, and insisting on environmental standards. There is talk of optimizing the most economical routes for waste collection, determining the location of transshipment stations, i.e. landfills and limited space on the islands. In many studies, the authors observe the development of a so-called circular economy that generates waste management, among other things.

There is multiple research done on waste management on islands in Croatia. The authors (Kovačić, Kerčević & Burić, 2021) state that the possibilities of the circular economy and the importance of green investments in Croatia can give a significant boost to the Croatian economy. The authors (Erdelez et al, 2006) talk about an integrated approach to the management of municipal waste collection systems on the example of the island of Brač. They state that in order to achieve the optimization of the waste collection system, the management system is divided into three very clear levels of management and optimization:

1. strategic level: optimization of the waste collection system by choosing waste management technologies
2. tactical level: optimization of the waste collection system by choosing the locations of transshipment stations
3. operational level: optimization of the waste collection system by choosing the “route” of waste collection and transportation.

In 2012, the author (Grofelnik, 2012) conducted research in the form of a case study of the approach to the analysis of the situation and the possibilities of evaluating the municipal solid waste management system on the islands of Cres and Lošinj. The paper analyzes the concept of waste disposal strategy through transport to the central county landfill and provides an overview of the cost-effectiveness and environmental impact of possible industrial incineration of municipal waste on the islands of Cres and Lošinj. The author (Kalambura, 2006) points out that the problems in waste management in Croatia are particularly pronounced, and

inadequate waste management endangers the components of the environment, human health and has adverse effects on the landscape and spatial activities.

In accordance with the 'Comprehensive Waste Management System' (2015), it is necessary to follow the models of developed countries where waste is used as raw material and energy source and move from a linear model to a circular one. It is a model in which a product that is no longer needed or used is reused, recycled or otherwise used. Waste management is extremely important in environmental and economic terms. It is actually a matter of rational management of valuable raw materials and resources that are the property of all people.

Directive 2006/12 / EZ of the European Parliament and of the Council of 5 April 2006 (2006) on waste establishes a legislative framework for Community waste management. It defines key concepts such as waste, recovery and disposal and introduces basic requirements for waste management, in particular the obligation for an institution or undertaking to carry out waste management procedures to be licensed or registered, and the obligation for Member States to draw up waste management plans. The Directive also sets out basic principles, such as the obligation to manage waste in a way that does not adversely affect the environment or human health, to encourage the application of the waste hierarchy and, in line with the polluter pays principle, to require that waste disposal costs be borne by the waste, previous owners or producers of the products from which the waste was generated.

3 Development and characteristics of waste management on island

The development and characteristics of waste management on the islands are characterized by the attempt to create a quality, stable, organized and economically efficient concept of waste management on the islands in accordance with the basic principles of sustainable development, ecosystem protection and natural environment. Also, there is constant action in the direction of improving the waste collection system on the islands. Waste management on the islands can also be defined in more detail as care for the environment. The specificity of waste transport on the islands is the fact that waste must be transported to the regional landfill by ferry that is special for this purpose due to the impossibility of transporting waste trucks together with passengers, especially in the tourist season. Waste management

is defined by the Ordinance on waste management (2020), which prescribes, among other things, the conditions for waste management, content, method of management, and the content of the decision on entry in the Register, recovery procedures, and details of the financial guarantee. The author Damjanić (2014) states that an ecologically based system of municipal waste disposal has been applied on the island of Krk. This is the first example of a whole, completely environmentally friendly waste management system in Croatia. The island of Krk should become a waste-free island in the near future. Based on this belief, a multi-year project was started in 2005, so an industrial plant for sorting, pressing and packaging of metal, plastic and paper waste was built, as well as a spacious composting plant where all collected biological waste is converted into humus and returned to green island surfaces.

Waste on the islands and on the mainland is traditionally treated as a factor of pollution. Landfills on the island can cause air contamination and limited water resources. The most useful option is to reduce the amount of waste generated, and in situations where this is not possible, it is necessary to create the possibility of reuse and recycling. Occasionally, waste on the islands, especially in the karst area, comes into contact with the sea, which distorts the tourist image of Croatia. The characteristics of waste management on the islands indicate that responsible and prudent waste management can make a major contribution to economic growth and job creation. It is worth noting that the occurrence of waste on the islands is a product of human activity. Since the islands have very limited spatial resources, the tendency of waste disposal and management on the islands is increasingly the model of the so-called 'circular economy'. The authors (Vlachogianni, et al, 2018) emphasize the need to recognize the fact that marine litter is not just a matter of waste management. One of the root causes of land and sea waste accumulation is the linear use of resources from their production, to short-term, one-time use, to final disposal. In this regard, the recently adopted EU Plastics Strategy should accelerate efforts in the plastic circular economy and lead to a drastic reduction in the use and impact of disposable plastic items. Interestingly, the development and characteristics of waste management on the islands are characterized by functionality in the sense that it does not endanger human health, without the use of procedures or methods that could harm the environment. It is extremely important to reduce the risk in order to avoid an increased risk of pollution of the sea and the coastal

zone, water, soil and air. When managing waste on islands, it is important to prevent endangerment of flora and fauna.

It was noted that the development of waste management on the islands should go in the direction of a comprehensive waste management system at the state level. This way of development integrated the construction of a series of facilities whose structure would be so complex that waste management centers, transshipment stations and recycling companies would be absolutely in the function of waste collection. Such investments require significant financial outlays. It is recommended that funds be secured from available EU funds.

4 Waste management analysis on island

The analysis of waste management on the island of Lošinj (2020) was based on data and assumptions that each inhabitant of the island of Lošinj produces 1 kg of waste per day, which is the world average. Considering that the island of Lošinj has approximately 9,587 inhabitants, the total amount of waste is approx. 9.6 t of waste per day. At the annual level, that amount is 3,504 tons. Furthermore, each tourist night results in an additional 1 kg per night. According to the data of the Tourist Board of Mali Lošinj in 2020, the total number of overnight stays on Mali Lošinj is 1 310 991. Accordingly, the daily additional amount of waste is 1 310 991 kg or approx. 1,311 tons. It was found that the total amount of 'produced' waste at the annual level is 4,815 t. Official data for 2019 according to the 'Report on the implementation of the waste management plan of the Republic of Croatia in the Primorje-Gorski Kotar County' (2020) for Lošinj amounts to 4,453.57 tons.

We should start from the claim that waste collection, especially on islands, requires an exceptional amount of money. It was noticed on the example of the island of Lošinj that the Kalvarija landfill must have a lower impermeable sealing layer in order to protect the underground of the karst area where there is a lot of groundwater. A step forward for the island of Lošinj would be to reduce the total amount of waste and, which means introducing the principle of circular economy in the broader context.

Tourism has an exceptional impact on waste management on the islands. It was noted that an ecological step forward for society would be to establish harmony between tourism and waste management itself in such a way that mass tourism gives way to specialized branches of tourism depending on the comparative advantages of individual areas. For example, on the island of Lošinj, the choice of waste collection technology is crucial, then the organization of the transport system that mostly affects the costs, and thus the market assessment of the surrounding area of the island. The analysis established that the waste from the island of Lošinj is transported to the county center for waste management Marišćina. A step forward for the local community is that the Kalvarija landfill on the island of Lošinj is increasingly oriented towards recycling, since it is more expensive to transport waste over such a long distance. By focusing on recycling, it is possible to create new jobs, which would give additional impetus to the economic development of the island.

In the Strategic Study on the Impact of the Waste Management Plan of the Republic of Croatia for the period 2020-2022 on the environment (2017), an analysis of the current situation in the field of waste management was carried out taking into account the mentioned objectives (reduction of biodegradable municipal waste disposal, and the recovery rate of individual components of municipal waste and construction waste) and liabilities. The analysis showed that in order to establish a comprehensive, efficient and sustainable waste management system in the Republic of Croatia, it is necessary to intensify activities aimed at separate collection of municipal waste at the place of origin, encourage construction and equipping of recovery facilities and remediation of landfills and black spots. An indispensable part of the establishment of such a system is the implementation of organized measures and activities aimed at preventing waste.

In order to achieve the goals, a waste transfer station was built in Lošinj, which has been in operation since 2019. The design and implementation of the waste management system on the island of Lošinj should go in the direction of efficient fragmentation and separation of biowaste (food residues) and other collected waste. The issue of biowaste is especially pronounced in the midst of the tourist season. Therefore, it is important to make a feasibility study for the construction of a composting plant and determine the location, taking into account the surrounding gravitating islands.

5 Result and discussion

Waste management on the islands has not received much attention in the past. The problem of waste management is practically as old as human existence. Significant positive developments have been observed in recent times. The results of waste management were manifested primarily through reduced contamination of unsuitable relief and limited space on the islands. The implementation of laws and bylaws would improve and regulate the system of waste management and energy recovery. Graph 1 shows the percentages of separately collected waste by local self-government units, which shows that the best results were achieved on the island of Krk, where in 2020 68.36% of waste was collected separately. Thus, all JLSs on the island of Krk achieved the goal set by the Waste Management Plan of the Republic of Croatia in terms of separate waste collection (60% of separately collected waste), and even exceeded it. The islands of Cres and Lošinj also have high results in separate waste collection with 51.18%, the Municipality of Lopar with 44.94% and the City of Rab with 36.45%. Encouraging results were also shown by the local government of Gorski Kotar: the increase of separately collected quantities of waste is recorded in the area where the company Komunalac d.o.o. Delnice performs the service of municipal waste collection (7.53% was collected separately in 2019, and 27.90% in 2020), while in the area of the City of Vrbovsko in 2019 13.09% was collected separately, and 20.76% in 2020 .years.

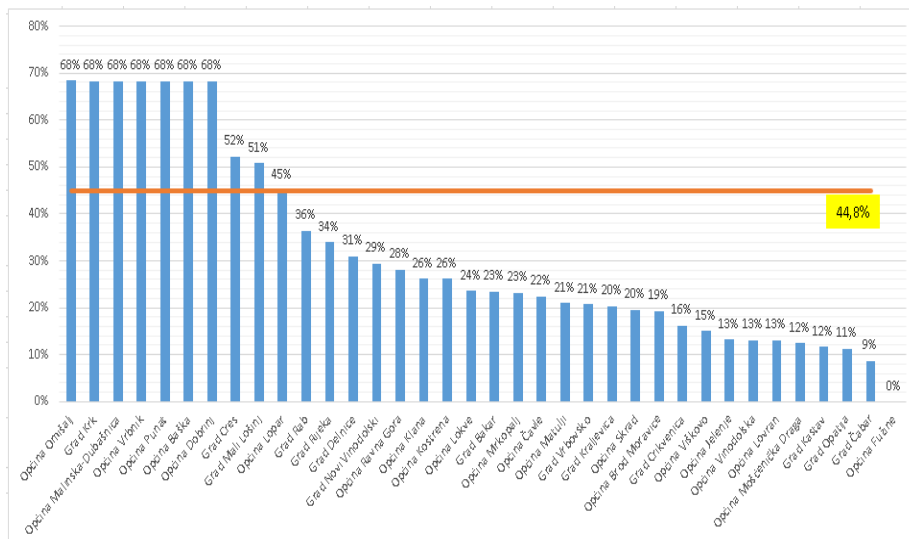


Figure 1: Graphic presentation of quantities of separately collected waste during 2020 by local self-government units in relation to the total amount of total separately collected waste

Source: Primorje-Gorski Kotar County (2021). Report on the implementation of the waste management plan of the Republic of Croatia in the Primorje-Gorski Kotar County for 2020

According to the author Miličić (2012), most of the municipal waste that is treated by the hygienization process, after treatment is mostly converted into a mass called organic fibers. This process reduces the volume of everything of organic origin, including paper and cardboard, and contains approximately 55% moisture. Such material can be used for composting or dried in the same plant at 13-15% moisture and preferably used as an alternative fuel. The dried material of such composition has, as already mentioned, a calorific value of 15.5 MJ / kg. Depending on the acceptability of the chemical composition, this dried material can be used as a good alternative fuel in the cement industry and thus save and reduce the consumption of fossil fuels.

Considering the economic orientation of the island of Lošinj on tourism, the analysis showed a great influence of the tertiary sector, especially tourism, on waste management, which is evident during the summer months. Efforts to abolish the Kalvarija recycling plant on the island of Lošinj would increase the ecologically extremely high air purity. The authors (Fundurulja, Mužinić, Pletikapić, 2000) state that official landfills should in principle be located in carefully selected locations, or

locations where environmental protection, aesthetic conditions, access and conditions of exploitation are taken care of. There are plans for the plant, and the technology of operation at the landfill is based on environmental protection, safety and increasing the usability of the landfill. For the purpose of better and more efficient waste management, back in 1997 the Ordinance on the conditions for waste management (OG 123/97) (1997) was adopted, which determines the conditions for technical and technological equipment of space, equipment and buildings for storage and treatment of waste, landfills, categories of landfills, technical conditions of construction, method of operation, closure of landfills, deadline for rehabilitation of existing landfills and professional equipment for waste management.

Waste management is not only an economic activity that employs today's and future generations, but it should also be perceived as a pursuit of the highest possible quality and safety of life.

6 Suggestions and measures

Pursuant to the Law on Sustainable Municipal Waste Management (OG 94/13, 73/17, 14/19, 98/19) and the Croatian Waste Management Plan, all municipal waste landfills in Croatia must be closed, i.e. they should have been closed. The case of the island of Lošinj is specific since the Kalvarija recycling plant is still in operation. Over time, due to the growth of mass tourism, the expansion of Kalvarija would be required, and due to the specificity and scarcity of space on the island, this is impossible. In order to avoid disturbing the ecosystem and damaging the tourist image of the island of Lošinj, it is necessary to gradually close the recycling plant of Kalvarija. The analysis established that it is first of all necessary to rehabilitate the recycling plant. EU Structural and Investment Funds should be used as a source of funding. After closing, mixed municipal waste would be transported to the Marišćina County Main Recycling Plant (ŽGCO). Residual waste, glass, paper, other 'paper' products such as cardboard, etc., furniture and other bulky waste would be sorted and recycled, after which it would also be transported from the island to the competent institutions.

The SWOT analysis table explains and identifies strengths, weaknesses, opportunities and threats that will contribute to the strategic thinking of waste management on the islands.

Table 1: Strengths and weaknesses contribution to strategic thinking of waste management

STRENGTHS	WEAKNESSES
<ul style="list-style-type: none"> ● Regulated legislative framework 	<ul style="list-style-type: none"> ● Risk of waste disposal due to karst soil
<ul style="list-style-type: none"> ● Extremely professional and competent workforce 	<ul style="list-style-type: none"> ● Unsatisfactory condition of transport infrastructure in some parts of the island and insufficient quality maintenance of local roads and paths
<ul style="list-style-type: none"> ● Favorable geographical location 	<ul style="list-style-type: none"> ● Poorly developed waste management system, especially on the islands
<ul style="list-style-type: none"> ● Existence of capacity (cement plant) for incineration of treated waste 	<ul style="list-style-type: none"> ● Inadequate and insufficient equipment of most waste management facilities
OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> ● Possibility of EU funding structural and investment funds 	<ul style="list-style-type: none"> ● Outflow of competent and highly educated staff, especially after joining the EU
<ul style="list-style-type: none"> ● Opportunity to develop and use new waste treatment technologies 	<ul style="list-style-type: none"> ● Degradation of existing composting plants, recycling yards and in general waste management centers due to lack of funds for regular maintenance
<ul style="list-style-type: none"> ● Strengthening human resources and strategic networking at regional and local level for the purpose of more efficient waste management 	<ul style="list-style-type: none"> ● Inertia and disorganization for the new national waste management system
<ul style="list-style-type: none"> ● Opportunities for new employment and minimizing demographic collapse 	<ul style="list-style-type: none"> ● Difficulty working due to the pandemic, COVID-19

A transshipment station and recycling plants have been built in the town of Mali Lošinj, and the construction of a sorting plant and composting plant and other supporting infrastructure are under consideration and preparation. This is important for the local island community, and for society as a whole, since all waste will be removed from the island for further disposal.

7 Conclusion

Waste management on the islands and the integrated waste management system must be in accordance with the Waste Management Strategy of the Republic of Croatia, which was adopted in 2005. In Croatia, mechanical biological treatment of waste i.e. the so-called MBO is mainly used. Croatia is one of the countries with a rather weak and problematic policy, so the EU is trying to increase efficiency in waste management with its legislation and tax policy.

In waste management, the emphasis should be primarily on waste sorting, and then on the faster and more efficient separation of biowaste from other waste. Biowaste should be processed into compost in the island compost whose location is acceptable to the local population and is not an obstacle to sustainable tourism development of the island. The compost produced in this way, which does not develop unpleasant odors, would be used on the island itself for agricultural or gardening purposes. The analysis confirmed the need to separate biodegradable waste, which is extremely important for the local community and in order to prevent possible damage to the ecosystem, which is closely related to the sustainable development of the tertiary sector, especially tourism.

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