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ECONOMIC AND ECOLOGICAL ASSESSMENT OF PACKAGING WASTE IN SLOVENIA

EKONOMSKA IN EKOLOŠKA UPRAVIČENOST RAVNANJA Z ODPADNO EMBALAŽO V SLOVENIJI

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The existing regime of waste packaging treatment in Slovenia has several disadvantages and also some advantages relative to regimes prevalent in developed countries. The main disadvantage is the absence of economic incentives for proper handling of waste packaging, particularly as they pertain to individuals and households. As a consequence, an unnecessarily large amount of waste packaging is thrown away into the natural surroundings. Another weakness is an insufficient waste packaging record, particularly in relation to the waste composition. It is especially important that waste is separated according to the type of material (plastic, metal, glass, paper, etc.). The beforehand use of materials is irrelevant from a technological point of view. A relatively large amount of waste packaging is recycled in Slovenia, but this amount is still below the EU average. A very small amount of waste is also incinerated in Slovenia, in accordance with Directive 2008/98/EC guidelines.

Keywords: packaging waste, separation, processing, recycling, incineration

Obstoječi koncept ravnanja z odpadno embalažo v Sloveniji ima več pomanjkljivosti, a tudi nekaj prednosti glede na koncepte v razvitih državah. Glavna pomanjkljivost je odsotnost ekonomskih spodbud za ustrezno ravnanje z odpadno embalažo, ki bi veljalo tudi za državljane. Zaradi tega odvržemo v naravno okolje relativno veliko količino odpadne embalaže. Poleg tega je velika slabost pomanjkljiva evidenca odpadne embalaže glede na sestavo odpadkov. Pomembno je predvsem to, da so odpadki ločeni glede na vrsto materiala (plastika, kovine, steklo, papir, itd.). Predhodna raba materialov je s tehnološkega vidika nepomembna. V Sloveniji recikliramo relativno velik delež odpadne embalaže, vendar je to še vedno pod povprečjem Evropske unije. Zelo majhno količino odpadkov pa namenimo za toplotno izrabo, kar je v skladu z usmeritvami Direktive 2008/98/EC o odpadkih.

Ključne besede: odpadna embalaža, ločevanje, obdelava, reciklaža, toplotna izraba

1 INTRODUCTION

Several policy mechanisms exist to stimulate proper waste management. They can be divided into two main content strands:

- threats of sanctions, if the prescribed way of acting is not taken into account,
- financial incentives, if the prescribed manner of behaviour is taken into account.

In the European Union, threats of sanctions, if the prescribed treatment of waste is not taken into account, are listed in Directive 2008/98/EC,[1] the Environmental Protection Act[2] and its implementing regulations, the Penal Code[3] and various municipal regulations. Public utility operators collecting and disposing of municipal waste also have prescribed penalties for those who do not comply with the relevant regulations.[4]

Financial incentives may vary. The main incentive for proper waste management is possible if waste has an appropriate market value. In that case, waste does not pose a problem that causes the costs but becomes a market item that can be sold. For certain types of waste, it is not necessary to raise market prices artificially, as the materials themselves already have a high enough market price (copper, aluminium, iron, zinc, paper, etc.). For many types of waste, the price of basic materials is relatively low (plastics, textiles, glass, etc.), and therefore it needs to be raised appropriately to encourage the population to behave in accordance with a state's policy goals. With a policy-prescribed price for waste recycling, the market value of waste could be raised and encourage the desired behaviour. These recycling costs are mainly paid for in the form of surcharges included in the purchases of new products. This is very relevant in the case of packaging, electronics, household appliances, cars, and the like. Now, these wastes do not have an adequate price and the poorly eco-conscious population prefers to leave that in the natural environment. With the annual campaigns of waste disposal from the natural environment, the situation is significantly improved, but the same effect is not achieved as would be achieved through economic incentives.

Directive 2008/98/EC[1] commits the EU states to apply a waste hierarchy, to take actions to promote options that together provide the least environmental impact. The EU states in applying the extended responsibility of the producer, take into account the technical feasibility and economic reasonability as well as the

overall environmental and social impacts and effects on human health, while respecting the need to ensure the proper functioning of the internal market.

The current Slovenian concept of packaging waste management[5–7] is not designed to encourage the consumer to collect waste packaging because it would be appropriately rewarded. The consumer should handle the packaging properly only because of the high ecological consciousness and fear of various penalties that fails to comply the prescribed treatment procedure. The process of changing the old packaging waste management concept started with the "Rules on the Management of Packaging and Waste Packaging".[7] This has led to an interruption of the direct contact between waste collectors and consumers, since packaging waste has no more market value for consumers. It became impossible for the consumer to collect waste packaging and be awarded by authorized collectors.

2 RESEARCH OF PACKAGING WASTE MANAGEMENT TREND IN SLOVENIA

The hierarchical scale in Directive 2008/98/EC on waste[1] has the following order: avoidance of formation, preparation for reuse, recycling, other processing, e.g., energy recovery and finally disposal. Trends in packaging waste management in Slovenia and the European Union in the period from 2005 to 2015 are reviewed. A lot of waste packaging is heat utilized,[8] which is less suitable than recycling[1] from a hierarchical scale. This is a consequence of the current situation when the new directive was passed.[1] In Germany, Austria, France and some other developed countries in 2008, large incinerators there were set up, most of which were also intended for energy use. **Figure 1** shows that the share of recycled municipal waste in Slovenia increased gradually from 2005.[9] A similar trend could be detected also previously. However, Slovenia had lagged behind the EU average for around 10 %, except in the year 2015.

In the continuation the share of types packaging materials will be analysed. **Figure 2** shows that the share of total amount of collected glass packaging significantly increased in Slovenia between 2005 and 2015.[10] As there was no other type of processing, the line of processing presents a trend of recycling. This means that the bottles and glasses are no longer washed, but the glass is melted and then produced the new glass packaging. Such a trend is less suitable from the point of view of consumed energy.[11] For the melting waste glass packaging, much more energy is consumed than for the washing and drying returnable glass packaging. Also, it could be detected that in the years 2014 and 2015 about 15 % of collected glass amount was sent abroad. We cannot explain the reduction in the amount of collected glass in the year 2016 unless we estimate that the data has not yet been updated by the Statistical Office in Slovenia.

The preparation of packaging for re-use is higher on a recycling scale. Some beer bottles, mineral-water bottles and similar glass packaging are returned to the process of preparation for reuse (washing and drying the packaging). It is clear that glass packaging is not included in the record of waste glass packaging. We consider this to be one of the weaknesses of the existing packaging waste management concept. Obviously, only packaging waste that is found in a container for waste glass packaging is recorded as waste packaging.

The increase of the share of recycled glass packaging is not caused by the relevant policy of waste glass treatment management, but by companies interest in recycling waste glass. Waste glass is mainly used in glassware in its production. The two largest Slovenian glassworks Steklarna Hrastnik and Steklarna Rogaška, have been working very well in the recent period. A lot of glass is also used in the production of mineral wool, which production takes place in Škofja Loka at the Knauf Isolation d.o.o. Waste glass is also used in some other products (ceramics, construction materials, enamels, etc.)

It can be seen from **Figure 3** that the share of recycled metal packaging increased gradually in the period 2005–2016.[10] It can be seen that significant share of metal packaging is processed. It means that there is no metal packaging postponed in the natural environment. Postponed metal packaging of used tins could cause an ecological problem. When corrosion process begins, some of the problematic metals (Zn, Ni, Cr, Sn, etc.) are

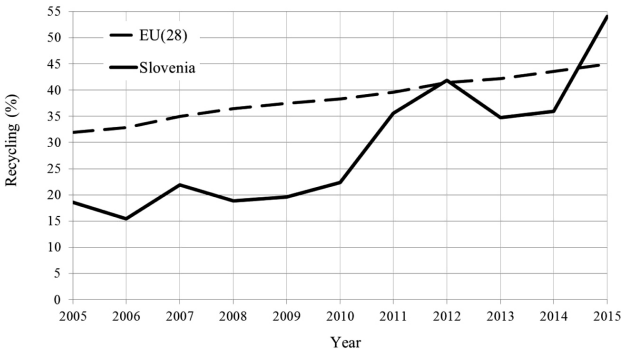

Figure 1: Recycling of municipal waste in the European Union and Slovenia in the period 2005–2015 (Eurostat, 2018)[9]

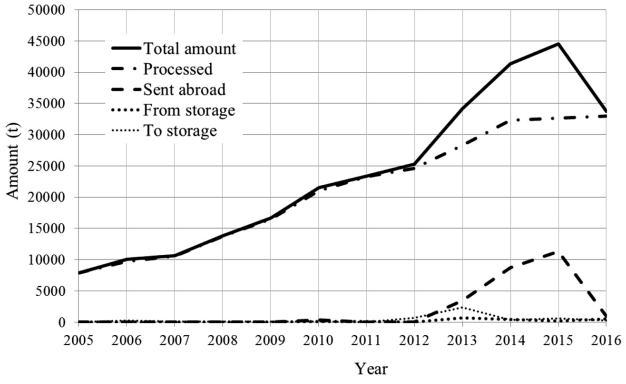

Figure 2: Management of waste glass packaging in Slovenia (SURS, 2018)[10]

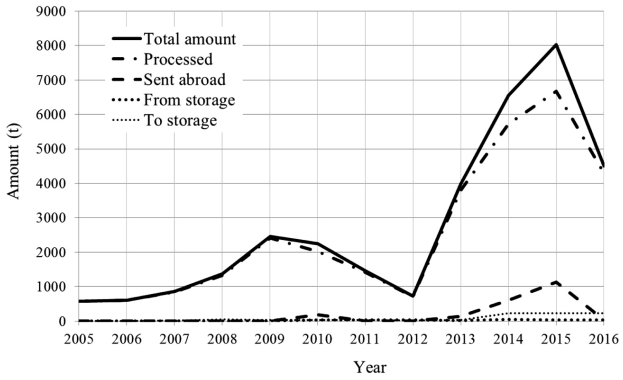

Figure 3: Management of waste metal packaging in Slovenia (SURS, 2018)[10]

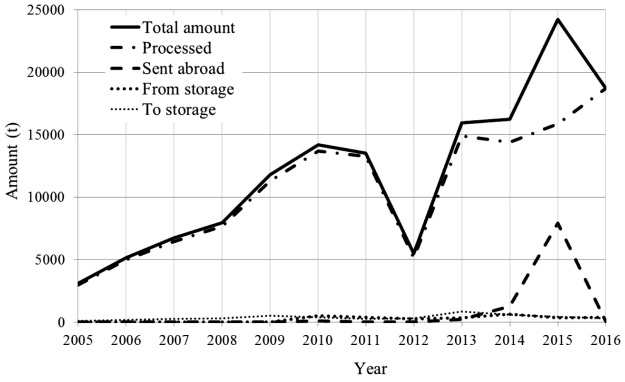

Figure 5: Management of waste plastic packaging in Slovenia (SURS, 2016)[10]

deposited in the natural environment. From the zincified tinplate, zinc excretion begins very quickly. Other stainless-steel sheets, most of the alloying metals (Ni, Cr, Mn, Co, etc.) are problematic, while only iron does not present a major problem for environmental pollution.

There are suitable industrial plants in Slovenia that can recycle waste metal packaging. Recycling of metal packaging usually means the use of metallic waste in metallurgical production. New steel sheet can be made from molten steel or aluminium that can be used further for tin production. In the case of waste metal packaging, the preparation for re-use is not possible.

From **Figure 4** it can be seen that in the years 2014 and 2015 approximately 80 % of all paper and cardboard packaging[10] were recycled. In the year 2016 this share was changed and already all the collected paper and cardboard packaging was processed. That is good as the share of paper and cardboard packaging incinerated for the thermal utilization is negligible.

In our opinion, handling with waste paper and cardboard packaging is in accordance with the guidelines of the waste directive. Most of this waste is recycled, which is good. A very low amount of it is thermal exploited. A large amount of paper packaging (about 30 %) was sent abroad in the years 2014 and 2015.

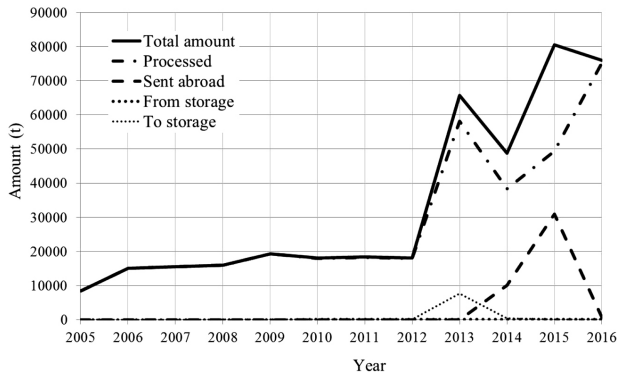

Figure 4: Management of waste paper and cardboard packaging in Slovenia (SURS, 2018)[10]

Figure 5 shows that in the period 2004–2013 the total quantity of processed plastic packaging increased in Slovenia, mainly in the period from 2008 to 2010.[10] Over the recent period, the amount of processed plastic packaging waste already exceeds the total collected quantity. This means that the waste plastic packaging was processed into new polymer products in Slovenia. Plastic processing companies have obviously found an economic opportunity in this area. For example, Plasta d.o.o., imports waste PE and PP foil from abroad, which is then processed into new foils. There are even more processors of waste plastic packaging. This is a good example of the proper handling of waste plastic packaging when it is already collected. This type of behaviour is significantly more relevant than in some developed European countries, where a large amount of waste plastic is burned in order to generate thermal and electrical energy.

Figure 6 shows that Slovenia collects a relatively small amount of plastic waste. In 2005, according to these data, only about 17.5 kg per capita of plastic packaging waste was collected, while Austria collected more than 27 kg per capita and Italy almost 39 kg plastic packaging per capita.[9] However, this data does not show the real state. Obviously, Slovenia separated waste plastic packaging from plastic waste. In terms of size and economic development, Slovenia can produce about five times less plastic waste than Austria, but not so small amount as reported in Eurostat.[9] This indicates a lack of

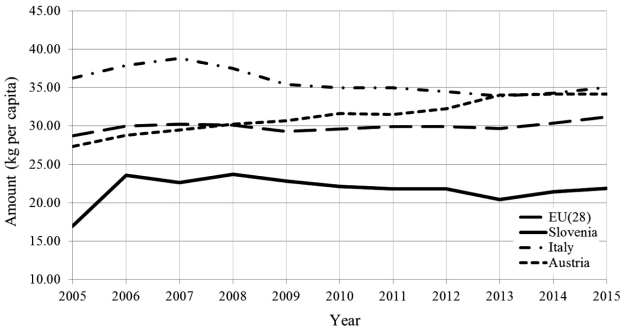

Figure 6: Amount of plastic waste per capita in the period 2005–2015 in EU (28 countries), Slovenia, Italy, and Austria (Eurostat, 2018)[9]

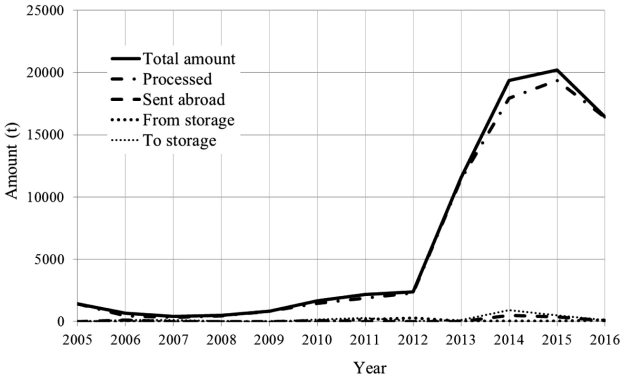

Figure 7: Management of waste wood packaging in Slovenia (SURS, 2018)[10]

a record of plastic waste that was not taken into account for waste plastic packaging.

Figure 7 shows the management of waste wood packaging in Slovenia from 2005 to 2015.[10] Already, the whole amount of collected wood packaging waste was processed. The officially recorded heat utilization of this waste is negligible. Since this waste has a lot of carbon, it should not be deposited in municipal landfills.[12] It could be processed into various products (chipboard, solid fuel, etc.).

3 DISCUSSION AND CONCLUSIONS

The existing waste-management concept in Slovenia has some major defects that cannot be eliminated without changing the entire concept. The first disadvantage is that waste packaging does not have an appropriate market value that would encourage citizens to behave more appropriately. If the waste bottles, plastic bottles, waste cans and tins, waste plastic bags, etc. had the appropriate value (for recycling) they would not be rejected by the inhabitants, but should be collected and handed in for an appropriate payment. Such a packaging waste-management system is known in some countries, such as Croatia, California, etc. A suitable price for packaging waste would stimulate the citizens to get involved in more appropriate waste management. With annual campaigns for removing wastes from the natural environment, the state of environmental pollution with packaging waste has considerably improved, but it does not eliminate it. It would be much easier to eliminate the pollution of the natural environment by packaging waste with the economic mechanism and the environmental awareness of citizens than with the threat of punishment. If the waste packaging (the same could be applied to the other wastes) would have an appropriate price, it would be picked up and receive a certain payment for it from the appropriate collectors. Non-ferrous waste cannot be found in the natural environment in Slovenia, because it has an appropriate market value. Waste metals (copper, aluminium, zinc, iron, etc.) can be delivered to the appropriate collectors and generate income. With waste packaging it is not like this. Even cans and tins could be handed in formerly, with other metal waste having to be collected separately as waste packaging now. From a technological point of view, it is unreasonable to collect waste regarding the type of its use (waste packaging), but it is much better to be collected regarding its composition. When recycling waste glass, it does not matter whether it is a window glass or a glass of food packaging. The same relates to plastics. When recycling waste PE, it is irrelevant from the recycling point of view whether it is a foil from a greenhouse or PE bags that were used as food packaging.

The existing concept of packaging waste management in Slovenia causes a considerable discrepancy with relevant records at the level of the European Union. That is most evident from **Figure 6** (Amount of plastic waste in the period 2005–2015 in EU). In Slovenia, the annual quantities of plastic waste are significantly lower than in comparable European countries. Obviously, in Slovenia waste plastic packaging is not taken into account in the total quantity of waste plastics. Distorted data could be found in some other types of packaging waste. For example, the record does not contain that part of the returned packaging such as bottles, cases, etc. At the level of SURS, ARSO, or some other database, there is no record of return packaging. The relationship between return and non-return packaging is an important indicator of compliance with Directive 2008/98 / EC guidelines. Re-use is higher than recycling on a hierarchical scale.[1] At least this should be recorded by the state, even though this way of management is not encouraged.

In recent years, several industrial facilities have been built where waste plastic packaging and other polymeric waste can be recycled.[11] This is an example of good practice in the field of waste management. The companies that process waste plastic packaging also import a significant amount of plastic. Slovenia is among the more successful countries of the European Union.[9]

The appropriate capacities for the recycling of glass and metal packaging[5] were already available before Slovenia gained its independence. Therefore, it is no wonder that a relatively large proportion of packaging waste is recycled in Slovenia.

Slovenia is among the best in the European Union for the treatment of waste paper and cardboard packaging. Most of this waste is recycled. In the light of the guidelines for the waste directive,[1] it is also important that very little of this waste is thermally utilized. Thermal utilization is lower on the hierarchical scale than recycling.

In the case of waste wood packaging, the treatment is significantly worse than for waste paper and cardboard. The main reason for this is the poorly developed wood processing industry that could recycle such types of waste. Prior to the independence of Slovenia, the wood processing industry was well developed, but during the

time of ownership transformation that industry mostly collapsed.

In Slovenia there is no recycling of textile packaging (bags, covers, etc.) and other waste textiles. Mostly this type of waste is mixed together with other waste (mixed municipal, construction, industrial, etc.), although 20 years ago recycling facilities for textile waste[13] existed. In recent times, there has been an attempt to increase the proportion of the re-use of textile waste.

The presented analysis showed that a rather large amount of glass, metal, paper and cardboard and plastic waste packaging was sent abroad from Slovenia in the period from 2014. Also, we cannot explain the decrease for all types of packaging in the year 2016. However, the reason could be incomplete data from the Statistical Office in Slovenia for the last year.

4 REFERENCES

[1] European Commission, Directive 2008/98/EC on waste and repealing certain Directives, Official Journal of the European Union, L 312/3

[2] Republika Slovenija (2006), Zakon o varstvu okolja (Uradni list RS, št. 39/06 – uradno prečiščeno besedilo, 49/06 – ZMetD, 66/06 – odl. US, 33/07 – ZPNačrt, 57/08 – ZFO-1A, 70/08, 108/09, 108/09 – ZPNačrt-A, 48/12, 57/12, 92/13, 56/15, 102/15 in 30/16)

[3] Republika Slovenija (2008), Kazenski zakonik (Uradni list RS, št. 95/04 – uradno prečiščeno besedilo in 55/08 – KZ-1)

[4] Republika Slovenija (2017), Uredba o obvezni občinski gospodarski javni službi zbiranja komunalnih odpadkov (Uradni list RS, 6t. 33/2017)

[5] Republika Slovenija (2013), Operativni program ravnanja s komunalnimi odpadki, št. 35402-2/2013/7

[6] Republika Slovenija (2011), Pravilnikom o ravnanju z embalažo in odpadno embalažo (Uradni list RS, št. 104/00, 12/02, 41/04 – ZVO-1 in 84/06)

[7] Republika Slovenija (2015), Uredba o ravnanju z embalažo in odpadno embalažo (Uradni list RS, št. 84/06, 106/06, 110/07, 67/11, 68/11 – popr., 18/14, 57/15, 103/15 in 2/16 – popr.)

[8] Gesellschaft für Verpackungsmarktforschung mbH (GVM), Mainz, Stand 03/2016

[9] Eurostat, http://ec.europa.eu/eurostat/data/database, (accessed February, 2018)

[10] Statistični urad Republike Slovenije, http://pxweb.stat.si/pxweb/Database/Okolje/27_okolje/02_Odpadki/01_27061_odvoz_odpadkov/01_27061_odvoz_odpadkov.asp (accessed February, 2018)

[11] Umwelt Bundes Amt: Integrierte Vermeidung und Verminderung der Umweltscmutzung (IVU), Merkblatt über die besten verfügbaren Techniken für bfallbehandlungsanlagen, German Federal Environmental Agency, August 2006

[12] Republika Slovenija (2016), Uredba o odlagališčih odpadkov (Uradni list RS, št. 10/14, 54/15 in 36/16)

[13] M. Krzyk, J. Panjan, D. Drev, Postupci recikliranja tekstilnog odpada = Procedures of textile waste recycling = Recyclingverfahren von textilen Abfällen, Tekstil, 63 (**2014**), 306–313