



**Doctoral School of
International Relations
and Political Science**

THESES OF THE DISSERTATION

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**Zero Waste Indicators –
Waste prevention in the European Union**

Supervisor:

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Professor

Budapest 2024

**Department of Sustainability Management and
Environmental Economics**

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Content

1. Background of the research, and problem statement	4
2. Applied methodology.....	6
3. Results of the dissertation	8
Main references.....	23
Own list of publications	24

1. Background of the research, and problem statement

The physical manifestation of global economic activity is the international flow of materials, and the residual is the waste showing how effective humans are in using natural resources. The waste of material is becoming threatening, especially when it comes to critical raw materials, but the unsustainable management of waste even at the most developed countries puts an alert. The European Union (EU) as one of the major waste generator has made steps to increase its efficiency in material use, and has put waste prevention on top of its priority list. The waste regulation of the EU relies on the so-called Lansink Ladder forming the basis of the concept of waste hierarchy (or pyramid) (Figure 1) by ranking various waste management tools based on the environmental burden caused by them, and is an absolute basic paradigm in waste management. This concept sets the environmental scientific background for policy priorities (Hultman et al., 2012), i.e., shifting waste management from landfilling and waste incineration (and recovery) towards recycling, reuse, and most importantly waste prevention.

Figure 1 - The waste hierarchy (pyramid)



Source: European Commission, 2018

Nonetheless, the official statistics shows opposite trends to priorities in the EU, municipal solid waste generation per capita is consistently increasing. This is the waste generated by households and legal entities with wastes similar to household waste (e.g. offices,

service providers). To reduce the gap between policy goals and reality, policy-makers need a clear view on the effectiveness of waste prevention actions, monitoring is crucial. There are no waste prevention indicators available, only proxy indicators are applied (e.g. waste generated per mass unit, GDP, capita, per unit of GVA). These cannot distinguish between the effect of waste prevention policies, behaviour changes, and the economic and social processes that have an indirect effect on waste generation through consumption and production. An economic recession may lead to a decrease in municipal waste generation, but this is not a long-term positive outcome. Waste prevention is a conflicting topic, as it confronts current consumption patterns, political and economic goals. Economic growth implies growing production and consumption, whereas waste prevention is about the rationalisation of those: sticking to the very needs of human, and if necessary, reducing consumption and production. To the point that waste reduction brings savings to producers and households the concept is internalised, but holding back and/or rationalising consumption with less material use is critical. A shift in paradigm, the re-thinking of consumption and production strategies (Cecere et al., 2014) is required.

Waste prevention appeared in the EU legislation more than 40 years ago in the Waste Framework Directive of 1975. Albeit it was of top priority since 1998, the thorough elaboration of the policy measures were missing for more than two decades, only lists of measures and best practices are available.

This dissertation attempts to set out the monitoring framework of waste prevention in the European Union for better planning, implementation and accountability of the environmental policy. It is prepared as a contribution to boost waste prevention activities and networks, to support the shift in paradigm in production and consumption. The research questions rising are:

- Main question: “How can waste prevention be monitored in the European Union?”

- Supporting question 1: Which social, economic, and environmental factors affect the waste prevention?
- Supporting question 2: How does waste prevention appear in the EU and Member States policies?
- Supporting question 3: Which are the commonly used waste prevention indicators?
- Supporting question 4: Are there other, more appropriate indicators for the measurement of waste prevention?

Given the descriptive characteristic of the main question, and supporting questions 2 and 3, null hypotheses were only set up for supporting questions 1 and 4. The variables examined were based on the systematic review of the Eurostat indicator database, listed in chapter on ‘Result of the dissertation’ together with the verification of rejection of H_0 .

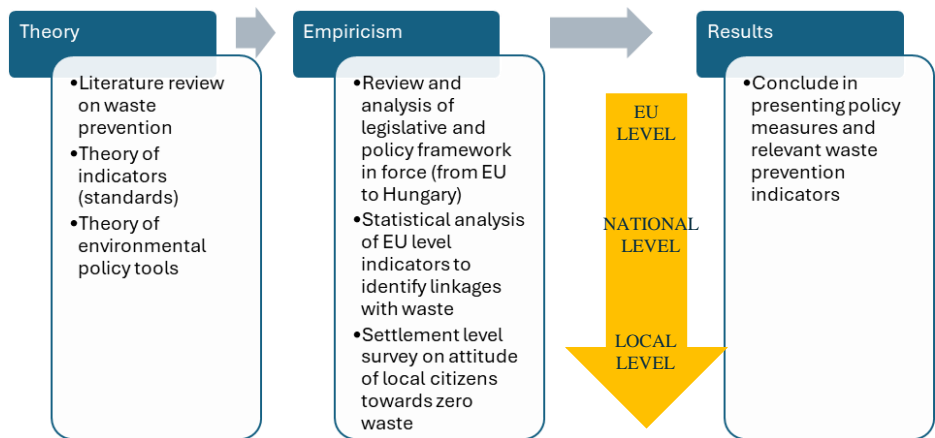
2. Applied methodology

The literature review focused on the theories existing in the field of waste prevention indicators, and also covered the topic of theory of indicators, particularly the types of indicators and the standards to be applied, and the theory of environmental policies.

The chosen methodology to understand the current situation of waste prevention in the EU is to track waste prevention policies of the European Union all the way through policy papers and legislations from the union level to Member States’ national level (Figure 2) choosing Hungarian legislation as an example. This is to be done by documentary analysis of relevant policy papers and legislation. Principles of waste prevention and management are dominantly set by the European Union. Member States are obliged to implement the priorities of the Waste Framework Directive, but the measures are chosen freely, based on local characteristics. The level of settlements is interesting, because local governments are close enough to households, have local knowledge, and also possess the policy tools to incentivise local citizen action. Local authorities, the municipalities, and communities, have a

key role – especially when it comes to principles of subsidiarity – to play in supporting changes towards sustainable development. They are responsible for infrastructure development, public procurement and waste management, as well as education, social welfare and physical planning. The chosen sample settlement is Zsámbék in the agglomeration of Budapest for the analysis of point of intervention, where Zero Waste Workshop served as detecting the interests and development preferences of main stakeholders – the mayor, the local government representatives, local public institutions’ and NGO representatives. Furthermore, a citizen survey has given the appropriate answers on the general level of awareness of local citizens and their attitudes towards individual zero waste actions and community level programmes. How goals of the EU legislation appear at the local level is revealed.

Figure 1 – The structure of the dissertation



To get a clear view on waste prevention monitoring is needed. It is not enough to understand policy, but the research also analyses the currently applied waste prevention indicators.

3. Results of the dissertation

Theoretical findings

- **Waste prevention, especially its monitoring is on the periphery of scientific literature of waste. Recycling and recovery are often intentionally included in the term waste prevention, which is misleading.**

Findings of the literature review confirm that waste prevention is most often mentioned as an important goal in waste management, but not discussed in details. Even within the modest waste prevention literature monitoring is the least addressed topic. The notion of waste prevention is often used as synonym for waste reduction and minimisation (Zorpas et al., 2013). This misleading usage stems from the aspirations to include preparation for reuse and particularly recycling in the term prevention, but in these cases waste is already generated. Waste prevention was found to be closely related to the terms zero waste, circular economy, material use and sustainable development related expressions.

- **Two schools are identified in waste prevention monitoring: theory-based school and data-driven school.**

Based on the literature review two schools were identified in this research regarding measurement. The first school's ('Theory-based School') priority is theory, and builds calculated and/or composite indicators based on how the waste prevention should be ideally measured (Waste Hierarchy Index, Pires et al., 2019, Annual Product Demand - APD, Tasaki et al., 2006, Mass Prevented Waste, Matsuda et al., 2018, Zero Waste Index, Zaman, 2013, Progress in waste reduction, Fernández-Brana et al., 2019, MIPS F Schmidt-Bleek, 1992, Food Loss Index, FAO, 2018, Food Waste Index, 2018, UNEP). Although the theoretical problem is well-addressed, data availability is often crucial problem. The second school is the 'Data-driven School' usually creating indicator sets based on (partly or entirely) available indicators to better describe the phenomena of waste prevention (Yano et al.,

2016, Due et al., 2023, Zaman, 2014, Resource Efficiency Scoreboard 2020, Circular Economy Monitoring Framework, 2018). These are closer to become applied in practice, however their weakness is that they are often not addressing the measurement of key policy instruments, or the ideal level in terms of subsidiarity.

Findings of the empirical research

- **Waste prevention appears in the preambles of policy papers and legislation as a priority principle, rather than a policy to be implemented.**

As regards to the documentary analysis of EU level legislation and policy papers, the strong business approach tends to avoid any structural change in production and consumption to lower the level of waste generation. The only extent to which waste prevention is considered, is the passive form: as long as the resource use reduction leads to cost savings waste prevention is welcome. When it needs additional efforts and investment (active form), it is neglected. Binding regulation (directives) and quantitative targets are motivating, mandatory recycling rates with infringement procedure set as sanction are good examples for effective measures.

- **Regional characteristic is that CEE countries run low-tech waste management vs. more developed EU Member States operating high-tech (over)capacities with higher level of public awareness in prevention.**

At the regional level there are relevant differences between the original EU countries and the Members States of the CEE region. The statistics of CEE deteriorate, but also enhance the performance of the EU15. As a positive contribution, the amount of waste produced per capita is lower than that of the advanced countries (due to lower production and consumption levels). On the other hand, the waste management is dominated by landfilling and lower levels of recycling are typical, and no organised form of reuse or waste prevention is existing. As opposite, the more developed Member States strongly rely on waste incineration with significant overcapacities, and perform

higher levels of recycling (Gentil et al., 2011), with reuse networks running business for many years, and the awareness raising in waste prevention also has track record of many years in these countries.

Concerning the sample country, Hungary, the main issue is that waste prevention as a cross-sectoral topic in policies has no truly responsible authority. Measures of the National Waste Management Plan to date are rarely implemented. The top priority to be addressed is re-enabling the self governance of local governments in the field of waste, they should also be incentivised to call local communities for action. The level of households' awareness also needs to be boosted, particularly because the people's willingness to take individual responsibility in the solution of waste problems leads to prevention, and makes implementation of waste management policies more cost-effective for the state.

- **National Waste Prevention Programmes and EU policy papers apply debatable proxy indicators for waste prevention.**

National Waste Prevention Programmes or rather plans of all 27 Member States were analysed revealing that either absolute, or relative indicators (to GDP, GVA, per capita) are set which are meant to be intensity indicators showing how decoupling takes an effect. Almost all waste prevention plans focus on the mandatory targets set by the EU on recycling (and reuse) of separately collected waste, on phasing out single-use plastic products and the reduction of food waste. Reuse is also in the spotlight, as an implementing regulation from the EU has been adopted on mandatory reporting of textiles, furniture, electronic and electrical items and construction materials.

Policy papers on waste prevention indicators most importantly refer to resource productivity (GDP/ Domestic Material Consumption) as a decoupling indicator, and a proxy to measure the effective use of material within an economy. It was demonstrated in the research that it does not have any correlation with the amount of waste generated in the Member States. Some of the most resource efficient countries turned out to be the most significant municipal waste generators. Besides other

indicators another similar approach also focuses on material use, this is the economy-wide material flows accounts which statistics are compiled every year by Member States. These indicators show the material flows between the economy and the environment including the inflow, the intermediate use, and the outflow. This system of indicators could be used as proxy, however it needs enhancement by including the footprint of imported goods and materials evergrowing in countries of the EU, and by more consistency with waste statistics. Recycling rate is also often applied as proxy indicator proven to be misleading, according to the current research.

- **Null hypotheses on demographic and consumption related independent variables were rejected. No connection between municipal waste generation and the disposable income, the raw material consumption and the recycling rate could be verified.**

As part of the top-down approach the next task was proving or rejecting the causality among the dependent variable, municipal waste generation per capita and the independent variables. Independent variables related to supporting question 1 are median age of population, average household size, classification of functions of government (COFOG): education (government expenditure), mean consumption expenditure by degree of urbanisation: cities, real gross disposal income of households, consumption footprint and Gini-coefficient are named as potential driver of waste generation. For supporting question 4 classification of individual consumption by purpose (COICOP), raw material consumption and the recycling rate were set as independent variables. Recycling is observed mainly to analyse the statistical relation to waste generation, as the recycling rate is very often applied as a proxy indicator to waste prevention. For regression analysis the sample size of the 27 EU Member States was fairly small, for this reason 4 small models were built up following the material use – consumption logic, and for identifying demographic characteristics having effect on waste generation. Based on multiple regression analysis the null hypothesis, H_0 for the independent variables were

mainly rejected among the independent variables except for real gross disposable income of households, raw material consumption and recycling. In these cases causal relationship could not be verified.

- **The citizen survey revealed the lack of information in waste prevention, and the decisions made primarily based on economic benefits. Actions should address food waste, composting, reuse and the reduction of packaging.**

The bottom-up inductive approach of the research was based on an action research in the settlement of Zsámbék. The overall conclusion of the citizen survey is that there is openness to waste prevention activities, but knowledge is missing which underpins that the main barrier to prevention apart from consumerism is the lack of knowledge (Barr, 2007). For this reason recycling and waste treatment (waste yard) seems to be most attracting, which is of course substantial, but beyond that there is higher level of uncertainty. The flow of information should be facilitated by creating pro environmental channels, and by supporting the ones already existing, like the local NGO's social media channels, for example. The population of Hungary is traditionally very price sensitive, this is absolute primary in consumer decisions, and the crises and inflation of the recent times, have pushed the population even more towards that direction. The decoupling did not take place in the minds of majority of respondents although this is not a poor city: well-being seems to depend almost exclusively on financial decisions, and the environmental impact having a negative boomerang effect on the quality of life is not integrated in the thinking of the majority of respondents. On the occasion of any action, primarily the financial gain should be very much emphasized. In lot of cases waste prevention leads to financial saving – e.g. choosing second-hand or repairing items, home composting, reducing overconsumption, reducing packaging paid for. This could be a starting point for awareness raising. The workshop held for stakeholders underpinned the openness of the local government and the public institutions. According to the outcome of the workshop actions should address food waste, composting, reuse and the reduction

of packaging, also requiring monitoring to track progress at the city level. These indicators could then be aggregated at national level with the additional added value of contributing to mandatory reporting to the EU.

Main result: a new indicator system model and a new set of indicators for waste prevention in the European Union

The findings and answers given to the research questions led to a new set of indicators and a modified, causal indicator system.

- ***How can waste prevention be monitored in the European Union?***

The outcome is that the dual approach in waste prevention is unavoidable. As waste prevention matters on diverse, usually small scale actions difficult to standardise, it is not enough to set top-down targets, especially when monitoring to date is based on national or EU level aggregates, that frequently do not have settlement level disaggregations. Understandably, the European Union expects Members States to report in a standardised format, to be able to aggregate and put forward the outcomes of the joint efforts of the union. Comparability is also important as the single efforts of the Member States should also be recognised. Data collected already by the European Union was reviewed to make use of already existing data collection and find statistical relations among them and the municipal waste generation. Indicators had to be observed based on the needs of local governments and communities, the viable waste prevention actions had to be understood and translated into indicators for monitoring. National prevention programmes made enormous leaps forward in their details respective to the versions of 2013, but there is still lot to develop: a balance should be reached between using waste generation as exclusive monitoring tool, and the other extreme were dozens of indicators were introduced for waste streams having to cope with data availability problems.

Assigning reuse centres to waste management companies running waste yards or recycling centres seems reasonable, as not only this is a convenient solution for the clients, but these companies are already

reporting on waste generation and treatment. Giving licence to new reuse centres automatically requiring data provision is also viable, but it is hard to get data for example on the repair of goods by survey. This might be better covered by defining the repair NACE categories. In case of waste prevention not only repair (Due et al. 2023), but second-hand commerce and leasing related NACE groups, and classes may also be taken into account. In the official structural business statistics (SBS) value added, or net turnover data of these is available.

The development of indicators should serve the top-down expectation and bottom-up reality, and should reveal the causal effects, which would improve the forecasting ability. Indicators should not only be the basis for monitoring of performance, but should contribute to the EU, the national and local government level policy planning where forecasting is essential.

- ***Which social, economic, and environmental factors affect the waste prevention?***

Based on the regression and also the survey run in Zsámbék demographic characteristics having causal effect on waste prevention action was proved as explained above in details.

- ***How does waste prevention appear in the EU and Member States policies?***

The National Waste Prevention Programmes (NWPP) are mandatory since 2013, and developed in huge steps since the first programmes. The 2020 review shows that some programmes are explicitly detailed, and all of them are much more focused on the pre-waste phases like reuse, repair, bulk shopping, banning packaging, etc. Regarding the indicators countries either include only those already subject to mandatory reporting – probably to lower political risk –, or in the other extreme very detailed indicators in case of which data availability shall be an issue. Still, there are countries that remain without any targets and/or indicators, or only the binding EU recycling or plastic packaging reduction targets are set.

Returning to the theory of environmental policies, waste prevention is the classic case of the re-structuring (preventive) environmental policy (Kerekes et al., 1996) aiming to transform production and consumption patterns. Forecasting in this set is crucial, this should be born in mind when selecting indicators, demographics and consumption data could give approximations on how much waste shall be produced.

Based on the NWPP review the most applied policy instrument of this environmental policy for MSW prevention is information campaigns, almost all countries have applied them. Setting up or supporting the running of reuse and repair centres are also priority, followed by green procurement, the ban on single-use plastic packaging together with tap water campaigns. Labelling of products as part of information actions is also emphasized as well as the establishment or running of food banks, together with tax reductions for donations. Organic waste reduction is targeted by home composting, and unsolicited mail reduction is also the case in some countries. The common use (rental, sharing) is rarely addressed in NWPPs, but this has a huge potential in waste reduction, this might be the next step of development for many countries. Collaborative consumption models are the best choice for shifting consumption. According to Karigl et al. (2022) “instruments should be legally binding, voluntary agreements should be disregarded, and tax incentives should be given (some countries already apply that), green procurement, and the formalisation of community engagements must take place among others”. The principle of subsidiarity (Zaman, 2017) has to be applied to perform community and household level actions, and measure them. So far 74% of EU Member States have increasing municipal waste generation since the adoption of NWPPs, so further steps should definitely be taken, as instruments so far used proved to be ineffective.

- ***Which are the commonly used waste prevention indicators?***

The most commonly used proxy indicators in policy are waste generation (per capita, per GDP, per unit of GVA), resource productivity, recycling rate. Other than proving that the latter two does

not have statistical relation to waste generation, the linking of waste generation to economic performance raises concerns as policymakers do not get a picture on why the waste is increasing or decreasing. It could change because of the economy's performance if no decoupling appears, and this is the case for municipal waste. The scientific literature presents few theoretical models discussed above, either in the form of composite indicators or in the form of indicators sets of systems, however, these often lack data.

Taking the DPSIR model (Smeets et al., 1999) as a widely used environmental indicator model as basis, major part of the indicators are descriptive pressure indicators featuring output of human activity. There is hardly any circular approach – in terms of the DPSIR models causal circularity including a feedback and adjustment system –, the few cases of 'drivers', i.e. demographic, material use and consumption data are above mentioned. For the 'state' indicator Lithuania and Denmark presents the only cases with the GHG emission of the waste sector. Few 'response' indicators occur on policies, incentives.

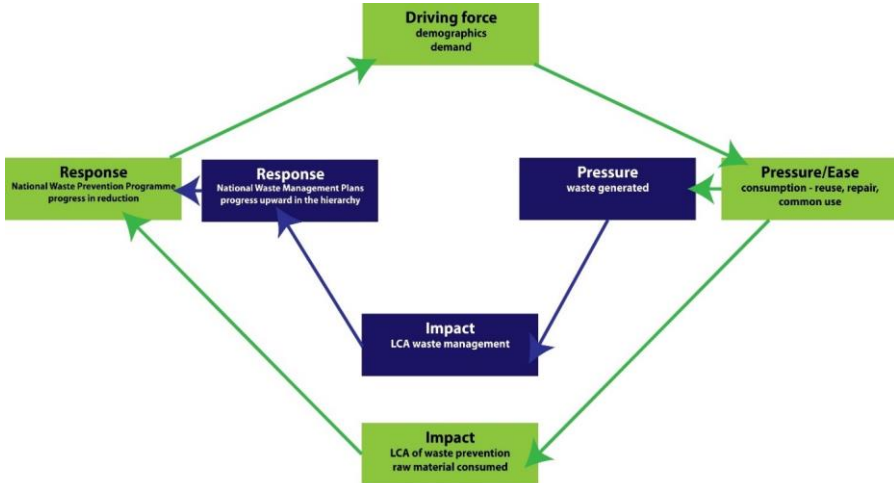
- ***Are there other, more appropriate indicators for the measurement of waste prevention?***

An indicator set may be a convenient form, rather than a composite index to reduce risks from methodology, to avoid over-aggregation causing information loss, and to diversify among the various drivers and impact areas. The basic framework chosen is the widely used DPSIR framework (Smeets et al., 1999) which structures indicators in a causal framework, but is applied in a modified form. The main issue with this framework is that focusing on avoidance, phase P (pressure) could be rather E (ease), leading to DESIR in the future. This could only happen, if standardised data collection on waste prevention activities could take place. Another problem faced with DPSIR was that in case of waste generation the 'State' of environment is hard to describe, and even if we can quantify the GHG emission or the soil or other damages caused by waste management operations those are just one, smaller portion of the waste's environmental effect. The main

problem – especially in the context of waste prevention – goes back to the roots, it is the depletion of natural resources. The real ‘Pressure’ put on the environment is consumption. The state includes indicators causing change in the state of the environment, that is the e.g. quality of soil by landfills, quality of air at incinerators, but if we approach from the natural resource and consumption, it becomes clear, that the state could be best described by the raw material consumed, i.e. missing from the natural resources. The impact is the consequence of change in state such as the environmental, health, social and economic impacts. Waste management operations could cause illness, but also the loss of biodiversity, as well as exploiting the natural resources. Response includes political indicators referring to the waste prevention programmes, and this is where the local level should step in besides providing data on prevention action. It is fine to present national level data to the European Union, but for being able to follow-up on the National Waste Prevention Programmes it is crucial to measure at settlement level. The aggregation of settlement level data leads to robust, reliable national data with its diversified source.

The new model of DPSIR including waste prevention is demonstrated in Figure 3. Keeping the causal framework, the model becomes combined. The ‘Driving force’ is based on demographic indicators. These indicators define the demand that ultimately triggers consumption. The consumption in terms of waste prevention is the real pressure, and also ‘easing’ factors step in the model by including reuse, repair and common use performance. Home composting is arguable, the author accepts the concept that it belongs to prevention as it does not leave the doors of the homes. At the same time, there is an official estimation method regulated by the European Commission which permits to make the calculation of home composting, even though estimated, and add it to the recycling performance of the country. Obviously, double-count should be avoided.

Figure 2 – The new indicator system for waste and prevention based on DPSIR model



Source: own compilation based on Smeets et al., 1999

The DPSIR framework is simplified by integrating ‘State’ into ‘Impact’. The ‘State’ according to Smeets et al. includes indicators related to state of the environment caused by emission, in other words immission. Immission by definition is the aggregate level of pollutants in the environment, a general state of the environment following ‘pressure’. Even though it is one of the most important indicators in environmental protection, it is difficult to distinguish the effects one-by-one that cause a general state of the environment at the indicator level. There are indicators describing the state of the environment, but in today’s statistical datasets it is not realistic to establish the connection between the ‘pressuriser’ and the general state. At the same time, the impact is crucial to understand the effect of a specific human activity, and also from the impact one can indirectly conclude on the state of environment. The indicators proposed having causal effect on municipal waste are the following (Table 1) based on the literature review, the policy and legislative analysis, the regression model and the survey run.

Table 1 - Proposed indicators for prevention of municipal waste

Headline indicator	General Indicator	Source/Methodology	
	Municipal waste generation (<i>kg per capita</i>)	official statistics	
	Performance Indicators		
	Waste intensity of raw material consumption per capita (MSW/RMC)	official statistics	
Waste intensity of total individual consumption per capita (MSW/COICOP Total)	official statistics		
Dimensions	DPSIR/DESIR Indicator		Based on
Driver	Median age of population	official statistics, negative relation	by regression
	Average household size	official statistics, negative relation	by regression
	Government spending on education - COFOG (classification of functions of government): Education (<i>% of GDP</i>)	official statistics positive relation	by regression
	Gini-coefficient	official statistics, negative relation	by regression
Pressure	Total individual consumption - COICOP (classification of individual consumption by purpose) total per capita (<i>chain-linked volume (2015), million EUR</i>)	official statistics, positive relation	by regression, by literature (Coggins, 2001)
	Mean consumption expenditure by degree of urbanisation (<i>purchasing power standard (PPS) per household</i>)	official statistics, positive relation	by regression

Ease	Reuse rate (tonnes or if GVA-based: million EUR)	data from reuse centres and/or online platforms NACE retail of second-hand goods	by regulation, by survey
	Repair rate (million EUR)	NACE repair sector, GVA and survey	by survey, by literature (Due et al., 2023)
	Common use (million EUR)	NACE rental sector, GVA and survey	by literature (Due et al., 2023), own development
	Home composting (kg/household/year)	settlement survey	by literature (Zorpas et al., 2013, Cox et al., 2010), survey
	Other individual and community waste prevention actions: <ul style="list-style-type: none"> • number of households reached • number of households taken action • changes in municipal waste generation (before-after) (%) 	survey and collection round or local MSW data compared to the outcome of the survey	by literature (Zorpas et al., 2013, Cox et al., 2010)
(State)/Impact	Raw material consumption (tons per capita)	official statistics	by literature (Due et al., 2023, Zaman, 2014) and correlation
	Consumption footprint per inhabitant	official statistics, positive relation	by regression
	LCA waste prevention: <ul style="list-style-type: none"> - environmental emission of waste prevention actions (WMP) - environmental impact of waste prevention actions: Global Warming potential, Water Depletion, Metal Depletion, Human Toxicity 	calculations to be made for typical cases – estimation based on that	by literature (Cleary, 2010, Hutner et al., 2018)

Response	National waste prevention programme: <ul style="list-style-type: none"> - availability of quantitative targets Y/N - availability of relevant indicators (recycling excl.) Y/N - is there dedicated budget to the programme Y/N - rate of progress in MSW per capita reduction (%) 	official programmes, country factsheets and statistics	by literature (Due et al., 2023, Karigl et al., 2022, Wilts et al., 2015)
	Rate of settlement level with implemented waste prevention programmes to total number of settlements	administrative data collection	survey

Source: own compilation

All indicators should meet requirements of statistical standards presented in the chapter on theory of indicators. The final performance can still be best measured by the municipal waste generation per capita, however, the additional indicator set gives insight into the details of policy effectiveness. The two performance indicators are extremely important in assessing the overall outcome of consumption and production related policy actions. These three headline indicators give a good view on how effectively the closing, and shrinking of the loop of circular economy is happening. It provides a process-oriented approach from raw material use to consumption linked to waste at the end of the process.

The level of disaggregation is important to be able to involve local governments. Demographic data is fairly available at settlement level, but for a better forecast on waste generation household at least consumption data would be also useful in every country. The indicators of the ‘Ease’ phase are substantial to get feedback on local community and household actions. The State/Impact phase could hardly be monitored directly at settlement level for cost-effectiveness reasons, but estimations could take place.

The Commission decision laying down the rules of reuse is currently inexecutable for countries where reuse centres do not exist. Getting mass data on reused product categories by household surveys is not a solution. The survey among citizens of Zsámbék proved the hardship in estimation, so other data sources should be identified. The physical infrastructure should be first established for collecting items for reuse, repair and rental besides recycling then data collection can be built on that. The other option requires much deeper change: classifications of official business statistics should be adapted to such demands, and reused goods should be distinguished in PRODCOM¹ similarly to the secondary raw materials. Home composting is now included in recycling data reporting to the EU based on an estimation formula. Home composting should be excluded from recycling, and should get an independent indicator as one of the most important household actions of waste prevention. Other local actions (reducing packaging waste, nappies campaigns, single use cutlery avoidance at events, short supply chain based shopping, etc.) could be collected via surveys. Indicators for important waste streams may also be included (e.g. food waste, e-goods, furniture, etc.).

The findings of the research focus on monitoring, the least discussed topic within the scientific literature of waste prevention. Monitoring is the very basis of evidence-based policy, and also gives feedback to the policymakers and the public. To some extent, it has a binding effect, as the public control, the watchdog activity relies on these data. Individual, community and society level models and incentives should be defined to achieve a green economy, and the present concept of economic growth should be challenged. Waste prevention is shaking the foundations of today's social and economic settings. An improved and accountable waste prevention policy could push towards this shift in paradigm in consumption and production.

¹ PRODUCTION COMMUNAUTAIRE' (Community Production). Prodcom data cover the economic activities of mining and quarrying, manufacturing, and materials recovery, which refer to the sections B, C, and E of the 'Statistical classification of economic activities in the EU' (NACE).

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