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MODELLING SCENARIOS OF DEVELOPMENT FOR UKRAINEIN THE CONTEXT OF EU CIRCULAR ECONOMY, COMPOSITE INDICATORS, FUZZY SET THEORY

COST - FoodWaStop
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Presentation structure

1. Sustainability and Circular Economy via SDGs;

2. Composite Indicators to study CE Phenomenon;

3. CE Modelling for Ukraine, Fuzzy set theory.

Sustainable Development Goals and UN Agenda 2030

1 NO POVERTY — Porre fine ad ogni forma di **povertà** nel mondo

2 ZERO HUNGER — Porre fine alla **fame**, raggiungere la sicurezza alimentare, migliorare la nutrizione e promuovere un'agricoltura sostenibile

3 GOOD HEALTH AND WELL-BEING — Assicurare la **salute** e il benessere per tutti e per tutte le età

4 QUALITY EDUCATION — Fornire un'**educazione** di qualità, equa ed inclusiva, e opportunità di apprendimento per tutti

5 GENDER EQUALITY — Raggiungere l'**uguaglianza di genere**, per l'empowerment di tutte le donne e le ragazze

6 CLEAN WATER AND SANITATION — Garantire a tutti la disponibilità e la gestione sostenibile dell'**acqua** e delle strutture igienico sanitarie

7 AFFORDABLE AND CLEAN ENERGY — Assicurare a tutti l'accesso a sistemi di **energia** economici, affidabili, sostenibili e moderni

8 DECENT WORK AND ECONOMIC GROWTH — Incentivare una **crescita economica** duratura, inclusiva e sostenibile, un'occupazione ed un lavoro dignitoso per tutti

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE — Costruire un'infrastruttura resiliente, promuovere l'**innovazione** ed una industrializzazione equa, responsabile e sostenibile

10 REDUCED INEQUALITIES — Ridurre le **disuguaglianze** all'interno e fra le Nazioni

11 SUSTAINABLE CITIES AND COMMUNITIES — Rendere le città e gli **insediamenti umani** inclusivi, sicuri, duraturi e sostenibili

12 RESPONSIBLE CONSUMPTION AND PRODUCTION — Garantire modelli sostenibili di **produzione e consumo**

13 CLIMATE ACTION — Adottare misure urgenti per combattere il **cambiamento climatico** e le sue conseguenze

14 LIFE BELOW WATER — Conservare e utilizzare in modo durevole gli oceani, i mari e le **risorse marine** per uno sviluppo sostenibile

15 LIFE ON LAND — Favorire l'**ecosistema terrestre** e la biodiversità, gestire le foreste, contrastare il degrado del terreno

16 PEACE, JUSTICE AND STRONG INSTITUTIONS — Promuovere società pacifiche, offrire l'accesso alla **giustizia** per tutti e creare organismi responsabili e inclusivi

17 PARTNERSHIPS FOR THE GOALS — Rafforzare i mezzi di attuazione e rinnovare il **partenariato** mondiale per lo sviluppo sostenibile

THE GLOBAL GOALS — Per informazioni complete sugli SDGs e i loro target, visita il sito: **www.globalgoals.org**

Goal 12. Responsible consumption and production

SDG 12
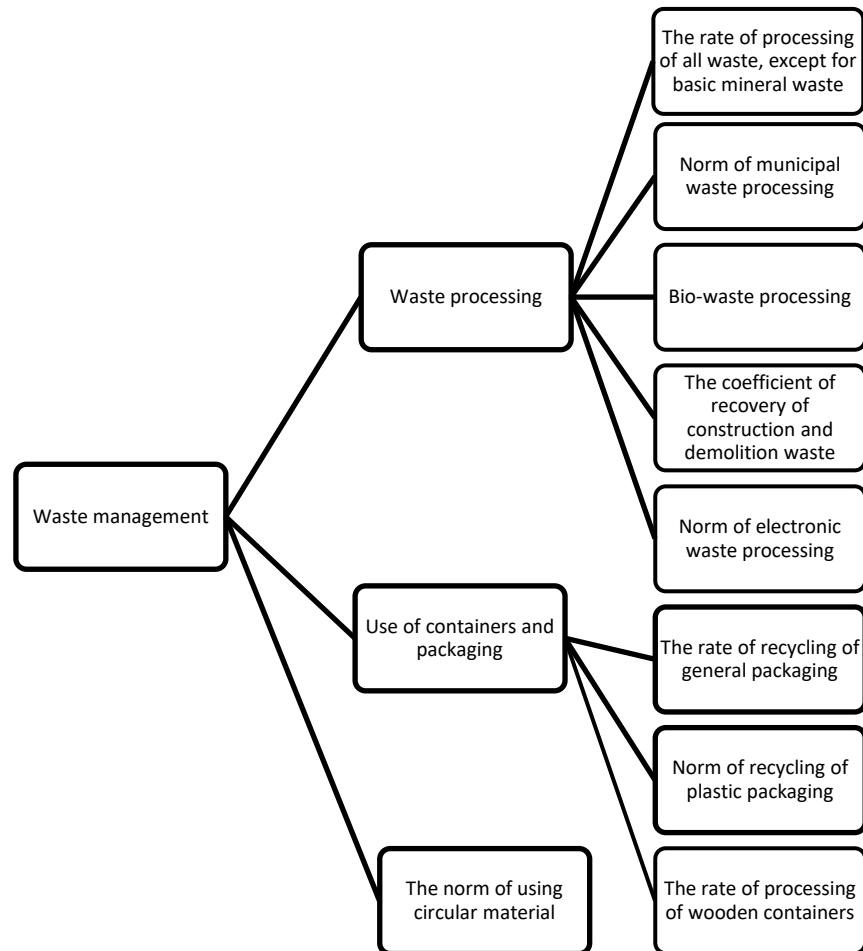 **calls for the sustainable production and consumption of goods and services.**
Countries have demonstrated it's possible to achieve economic growth without depleting natural resources: on average, countries have increased their natural capital by 26.8 percent since the mid-1990s.
Yet, for many countries, growth continues to come at the expense of natural resources.

**The UN has defined 11 _targets_ and 13 _indicators_ for SDG 12. Targets specify the goals
and indicators represent the metrics by which the world aims to track whether these targets are achieved.**

Countries with a sustainable consumption and production national action plan, 2022

This metric measures whether countries have implemented policies as part of a sustainable consumption and production plan. This does not measure the quality or ambition of these plans, only whether a country has one.

⊞ Table   🌐 Map

World ▼

No data   No plan   Has a plan

▶   2019   2022

Modelling of CE Scenarios for Ukraine, CE Waste management

Global Indicator Framework structure

Goal	Number of Targets	Number of Indicators
SDG 1	7	14
SDG 2	8	13
SDG 3	13	27
SDG 4	10	11
SDG 5	9	14
SDG 6	8	11
SDG 7	5	6
SDG 8	12	17
SDG 9	8	12
SDG 10	10	11
SDG 11	10	15
SDG 12	11	8
SDG 13	5	8
SDG 14	10	10
SDG 15	12	12
SDG 16	12	23
SDG 17	19	25
Total	169	237
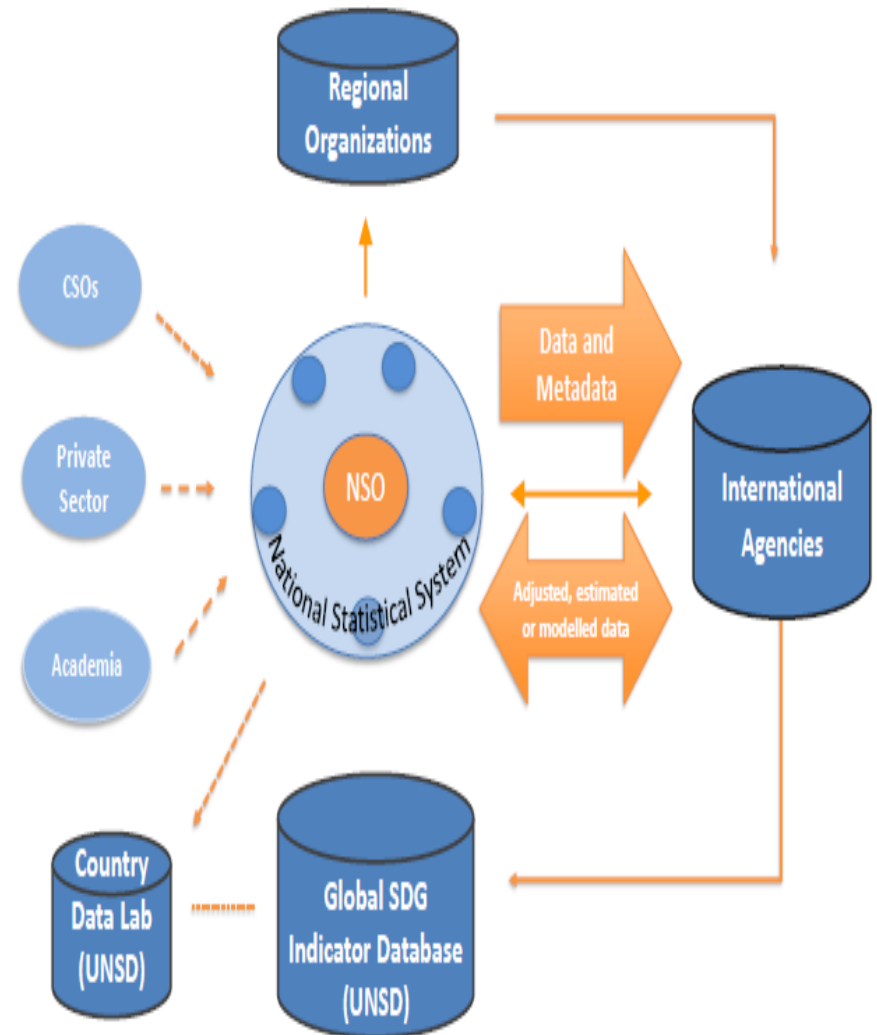
Composed Indicators in Social Research

Composite Indicator (CI) is " mathematical combination of single indicators that represent different dimensions of a concept, the description of which is the objective of analysis" (Saisana et al, 2002)

The methodological approaches used to build a CI are:

- *Methods of aggregation:* in this case, after a transformation to homogenize the various elementary indicators, it is defined an <u>appropriate system of weights</u> on which the compute of a CI is based;

- *Multiple linear regression analysis, Fuzzy Model based modelling* in this way as weights are used the regression coefficients and it is possible to investigate the linkages between a large number of indicators and a single output indicator.

CE Indicators features

- **Structure complexity and communicate information (information-structuring challenge);**

- **Operationalization of Sustainability/ (interpretation challenge, global overview on partial information);**

- **Social learning (interpretation and influence challenge);**

- **Demonstrate accountability and benchmarking (influence challenge therefore useful for policymakers, scientistists);**

- **Identification of knowledge and data gaps (information-structuring challenge).**

Fuzzy logic tools

| Fuzzy Inference System	Advantages
Mamdani	• Intuitive • Well-suited to human input • More interpretable rule base • Have widespread acceptance
Sugeno	• Computationally efficient • Work well with linear techniques, such as PID control • Work well with optimization and adaptive techniques • Guarantee output surface continuity • Well-suited to mathematical analysis

Mamdani Fuzzy Inference

A method to create a control system by synthesizing a set of linguistic control rules obtained from experienced human operators.

In a Mamdani system, the output of each rule is a fuzzy set.

Mamdani systems have more intuitive and easier to understand rule bases, they are well-suited to expert system applications where the rules are created from human expert knowledge, such as medical diagnostics. The inference process of a Mamdani system is described in **Fuzzy Inference Process** and summarized in the following figure.

The output of each rule is a fuzzy set derived from the output membership function and the implication method of the FIS. These output fuzzy sets are combined into a single fuzzy set using the aggregation method
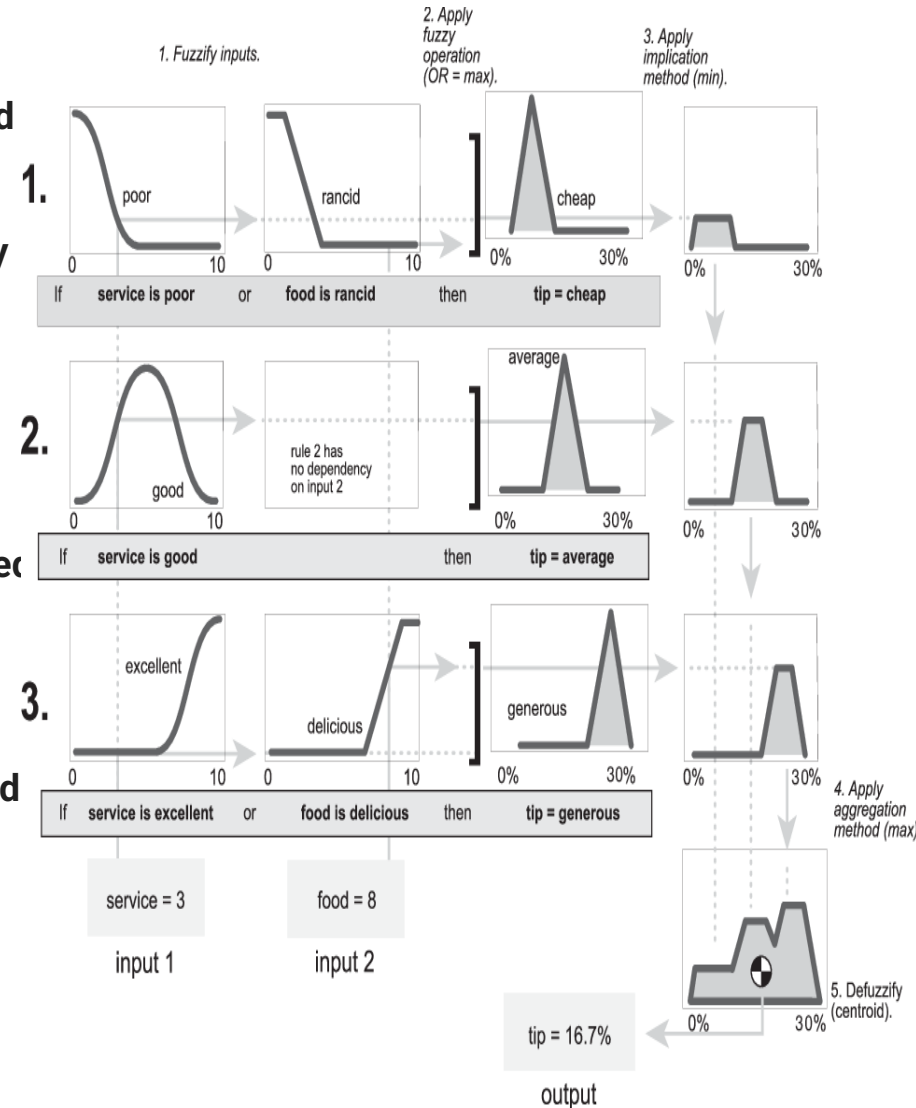
The CIs building

The construction of CIs usually involves the following steps:

- elementary indicators selection;
- treatment of the missing data;
- elementary indicators normalization;
- defining a suitable weighting systems;
- choosing an aggregation function of elementary indicators;
- validating a composite indicator

A Composite Indicator (CI) can be used to:

- Summarise multi-dimensional issues;
- to reduce the size of a set of elementary indicators;
- to build and interpret a ranking of countries on complex issues;
- in order to address public policies and attracting enterprises and citizen's interest.

  …….however CIs may send misleading or non-robust policy messages if they are poorly constructed or misinterpreted;

Fuzzy clustering of countries for the composite indicator - Waste recycling, which accumulates the impact of 5 input indicators of the circular economy, 2020
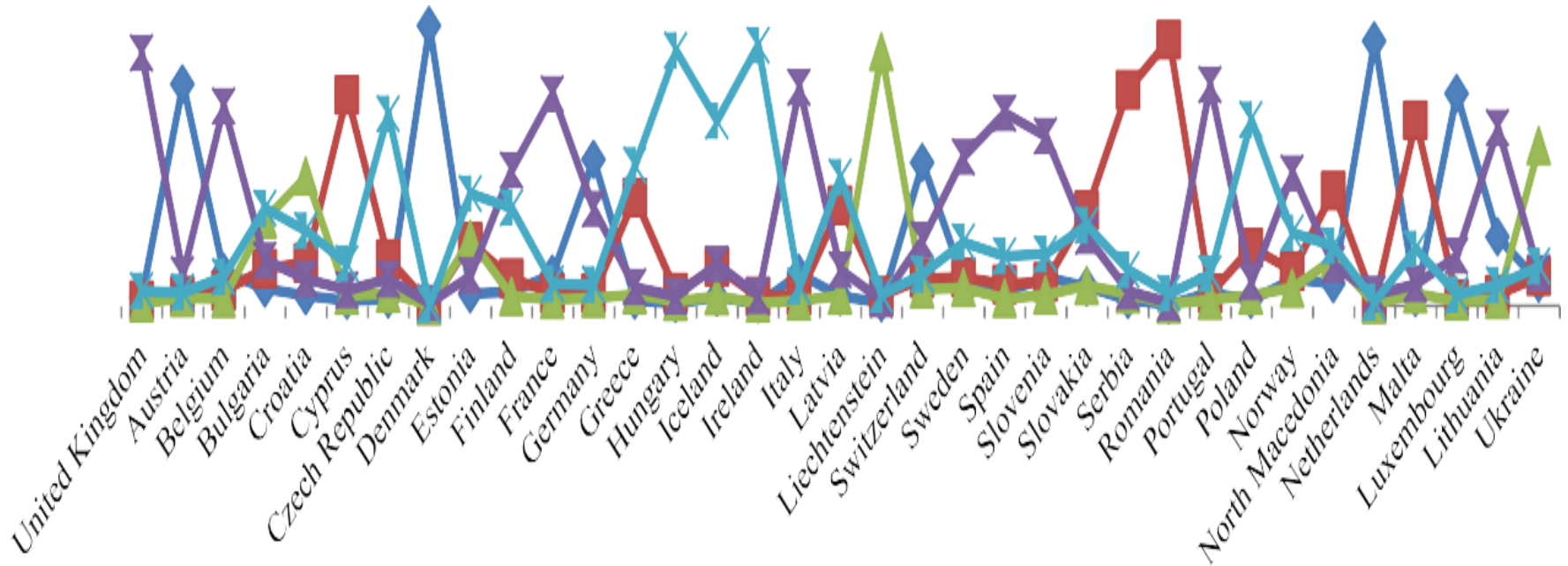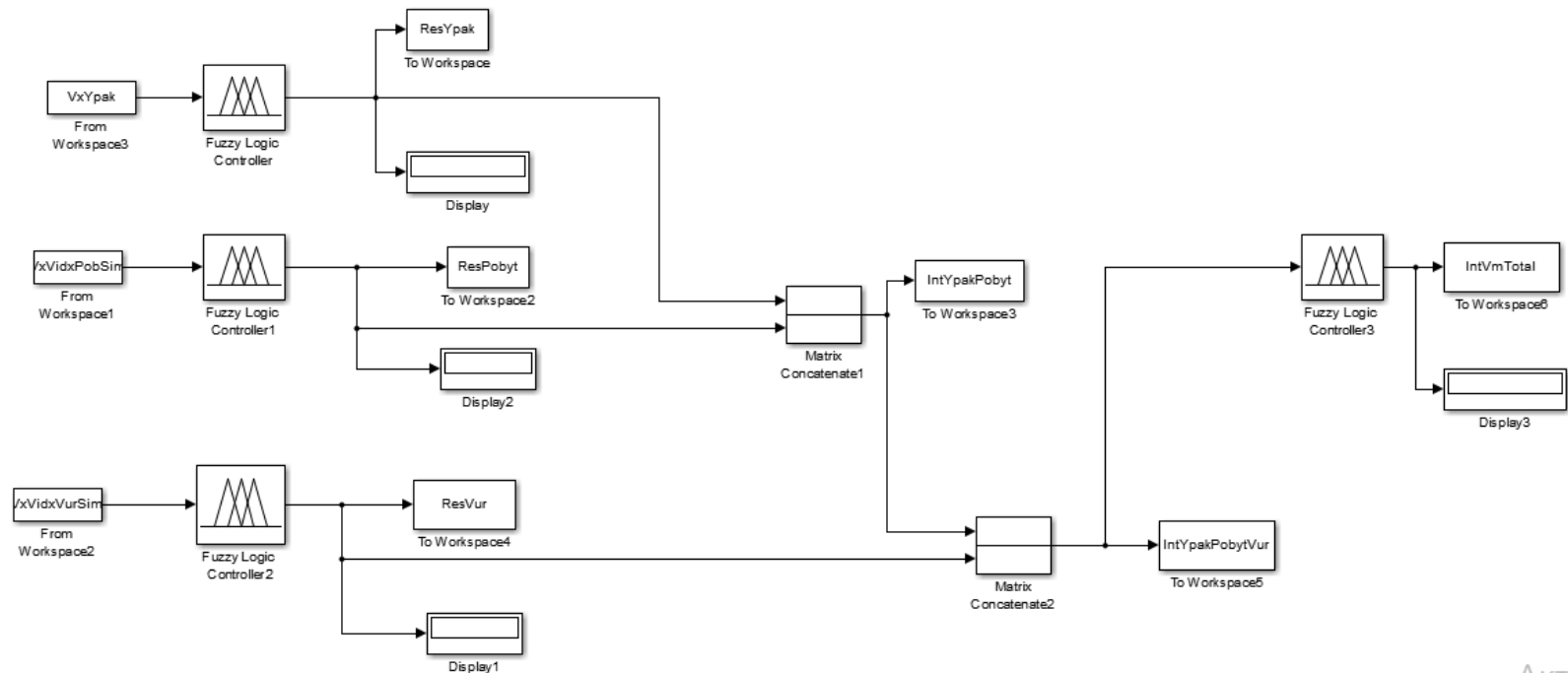
Ranking of countries by the level of development of the circular economy as a whole in the section, identified by a set of composite indicators
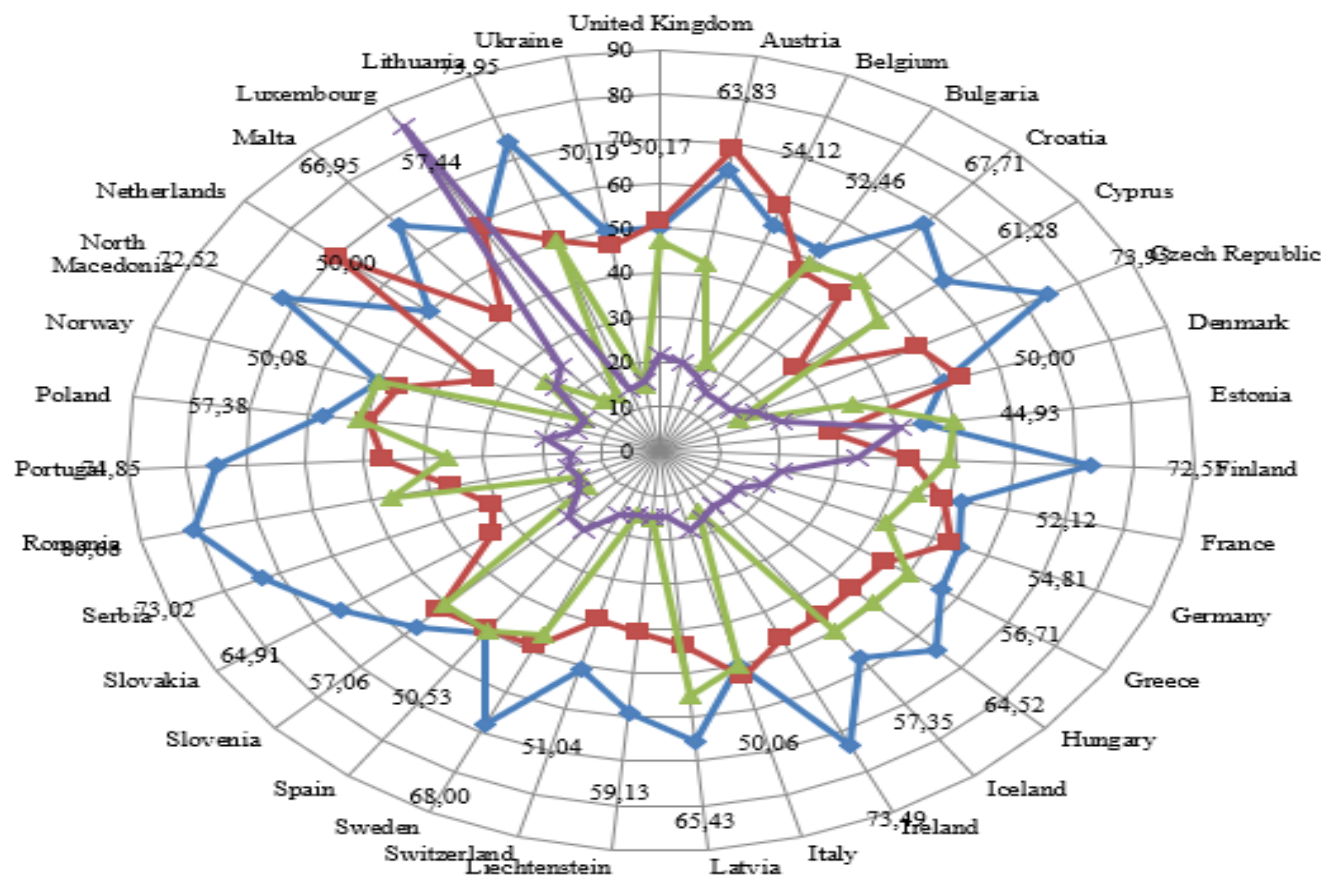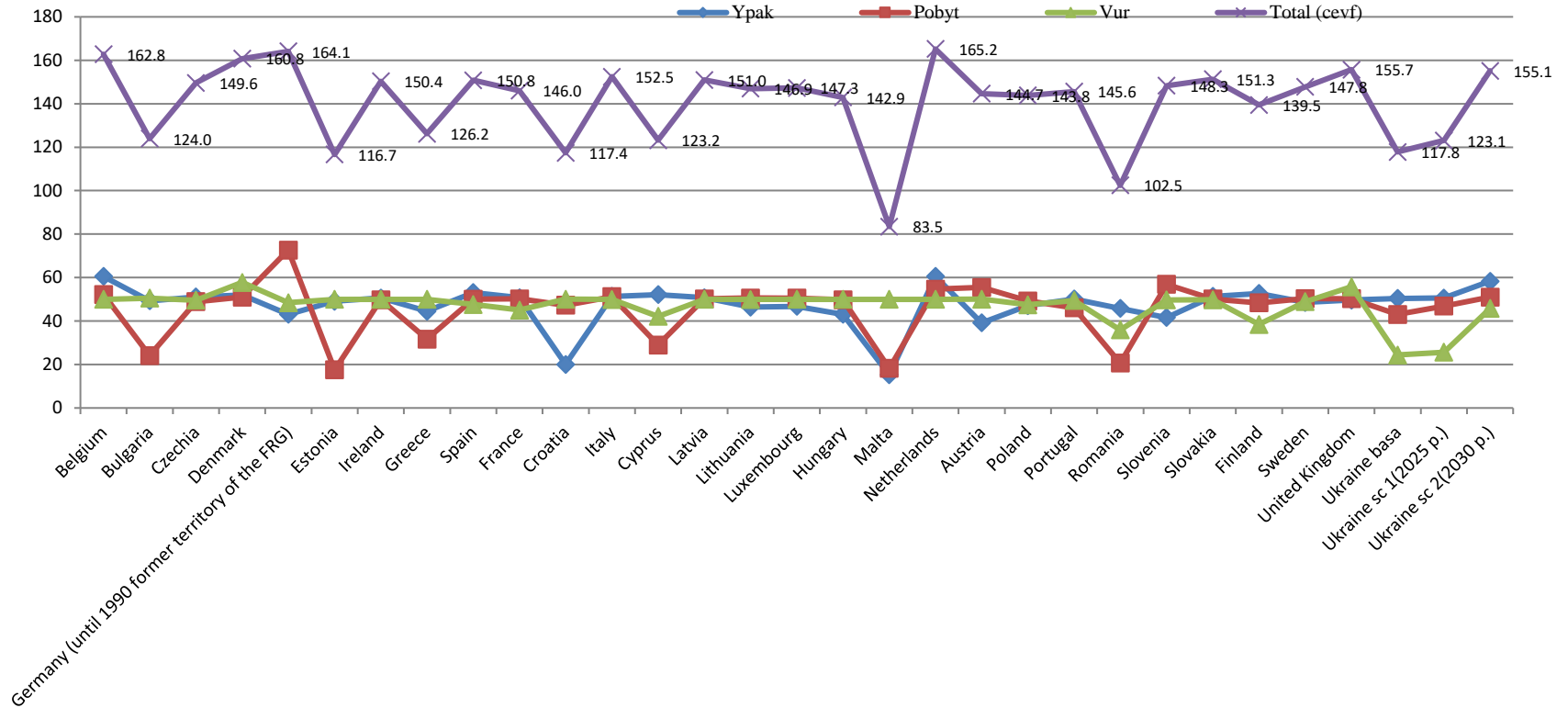
Simulation model for calculating the dynamics of the entire system of composite indicators identified by the information model, according to the circular economy section of Waste Management

Scenarios for Waste Management for Ukraine in the context of EU countries 2025, 2030

Ypak - level of recycling of packaging and containers, Pobyt - level of household waste recycling, Vur - level of recycling of all waste (minus household waste) and Total - integrated assessment of countries as a whole by section. It should be noted that the metrics of composite indicators for all other European countries were calculated according to Eurostat data for 2020.

Conclusions:

- The above logic is a holistic method of studying the level of development of countries' circular economy:

  a) by defining fuzzy clusters of the whole set of studied countries and ;
  b) by calculating for each of them integrated estimates in terms of the whole set of composite indicators defined by the information model structure for them and performing ranking.

Consequently, such integrated estimates for the whole set of composite indicators make it possible to identify horizontal relationships between composite indicators, which are not clearly defined in the information model.

Mamdani's fuzzy inference knowledge base (when calculating integrated estimates) is structural components in the form of simulators from the simulation model, which allows predicting different scenarios of the circular economy for a particular country.

For countries with limited financial resources, which includes Ukraine at the current stage of its development, it is appropriate to identify the individual growth points that would stimulate the accelerated development of the circular economy identified in the above mentioned information model.

The growth points can be given only on the basis of simulation models, the relationships between influencing factors and indicators or composite indicators are defined in the system of indicators of the circular economy.

Grazie per l'attenzione!