Sustainability

- Millennium Development Goals (MDGs) - Sustainable Development Goals (SDGs)
- In Industry 4.0
- How industry 4.0 can help to achieve SDGs?
- Indicators and Performance Metrics

Smart-Edu4.0

Erasmus project

Co-funded by the
Erasmus+ Programme
of the European Union

Sustainability

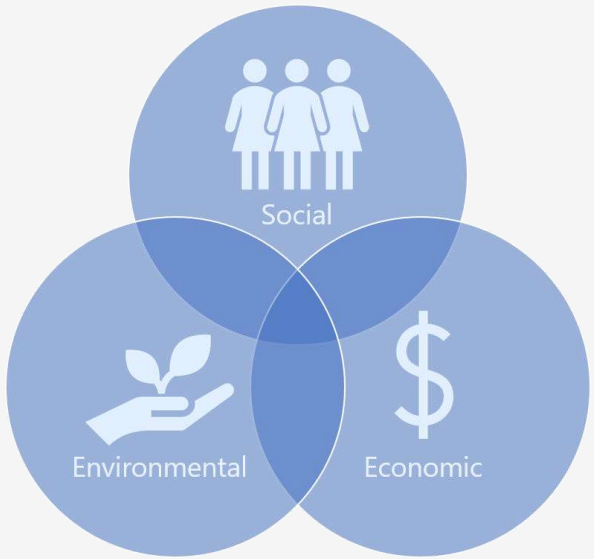
"Sustainable Development is development that meets the needs of the present, without compromising the ability of future generations to meet their own needs."

https://www.kindpng.com/imgv/ibbhwmo_sustainability-norron-sustainable-and-smart-cities-hd-png

the most common definition from the **UN Brundtland Commission, 1987**

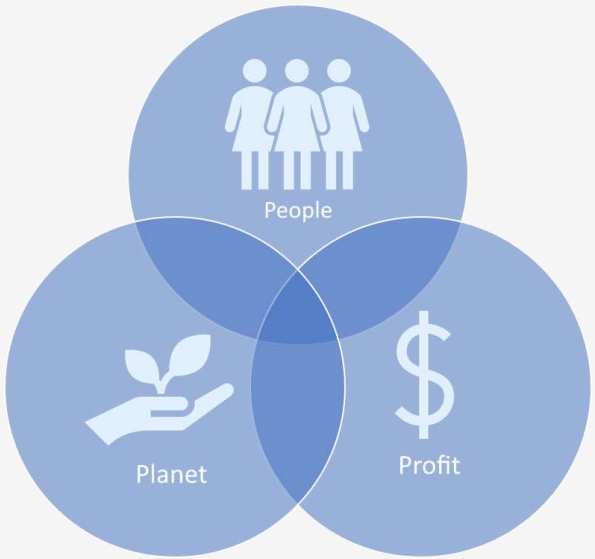
Triple Bottom Line

In the literature, sustainability consists of the three pillars: **social, environmental** and **economic** which constitute the **Triple Bottom Line (TBL).**



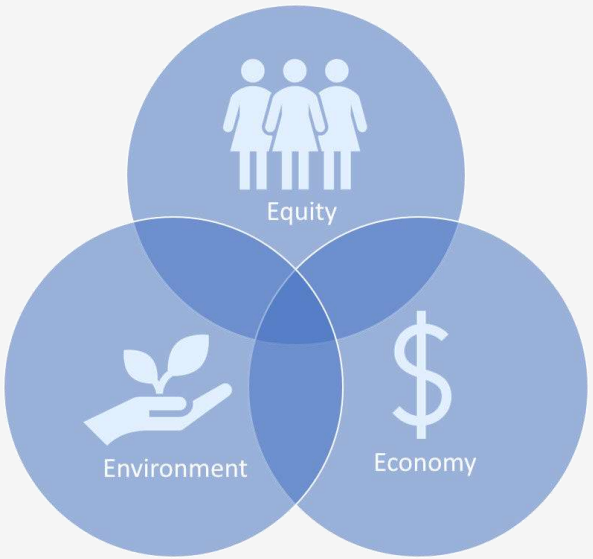
or

the three P's



or

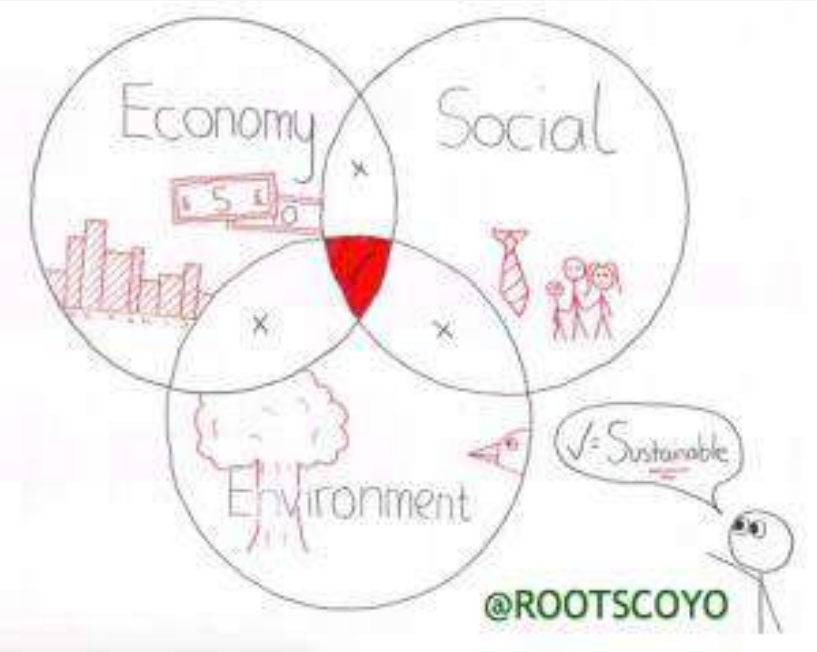
the three E's



https://sa-intl.org/programs/tbl/.
https://i0.wp.com/ecocation.org/wp-content/uploads/2022/01/triple-bottom-line.png?resize=768%2C725&ssl=1

Triple Bottom Line

https://www.mbaknol.com/modern-management-concepts/triple-bottom-line/



https://fairsnape.com/2015/07/30/it-is-time-to-move-on-from-thetriple-bottom-line/

1. Each dimension represents a necessary, but not sufficient condition for achieving sustainability. Organizations need to accomplish all of them!

2. The tree dimensions **interact**, **overlap** and sometimes **conflict** each other.
(e.g. cleaner production processes may require extra investments)

It is not just about understanding that we need to manage all of those

… but of how they are connected

Economic sustainability

aim to improve the standard of living

Sustainability must be economically feasible

https://sdlconference.org/economic-sustainability/

Environmental sustainability

Sustainable human activities must protect the earth's environment

https://www.feedough.com/environmental-sustainability-in-business/

The most common definition is from the **UN Brundtland Commission, 1987**

"Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

https://www.norway.no/contentassets/dbaa06c75b0245e7807672da925c8165/721804.jpg?preset=mainimagetop&v=1096025042

Gro Harlem Brundtland, the mother of Sustainable Development

Norway's first female Prime Minister Gro Harlem Brundtland chaired the Brundtland Commission which presented the Report on Sustainable Development in 1987.

Responsible workplace strategies

USE LESS !

1. Turn off machines when leaving office:
2. Turn off the lights if you will leave the room for > 15 minutes
3. Use natural light if your office has windows
4. Take the stairs instead of the elevator
5. Walk between buildings
6. Walk to lunch
7. User carpool, bus, train or bicycle to go to work
8. Reduce unnecessary meeting and travels
   use videoconferencing tools for online meetings
9. Print only when necessary
10. Always recycle paper after use
11. Provide electronic agendas for meetings
12. Use a water cooler instead of plastic bottles
13. Use a reusable cup instead of plastic

Millennium Development Goals (MDGs)

- They were signed by all 191 United Nation's member states in 2000
- They should have been achieved by 2015.
- They were mainly concerning developing countries.

MDG 1: Eradicate extreme hunger

MDG 2: Achieve universal primary education

MDG 3: Promote gender equality and empower women

MDG 4: Reduce child mortality

MDG 5: Improve maternal health

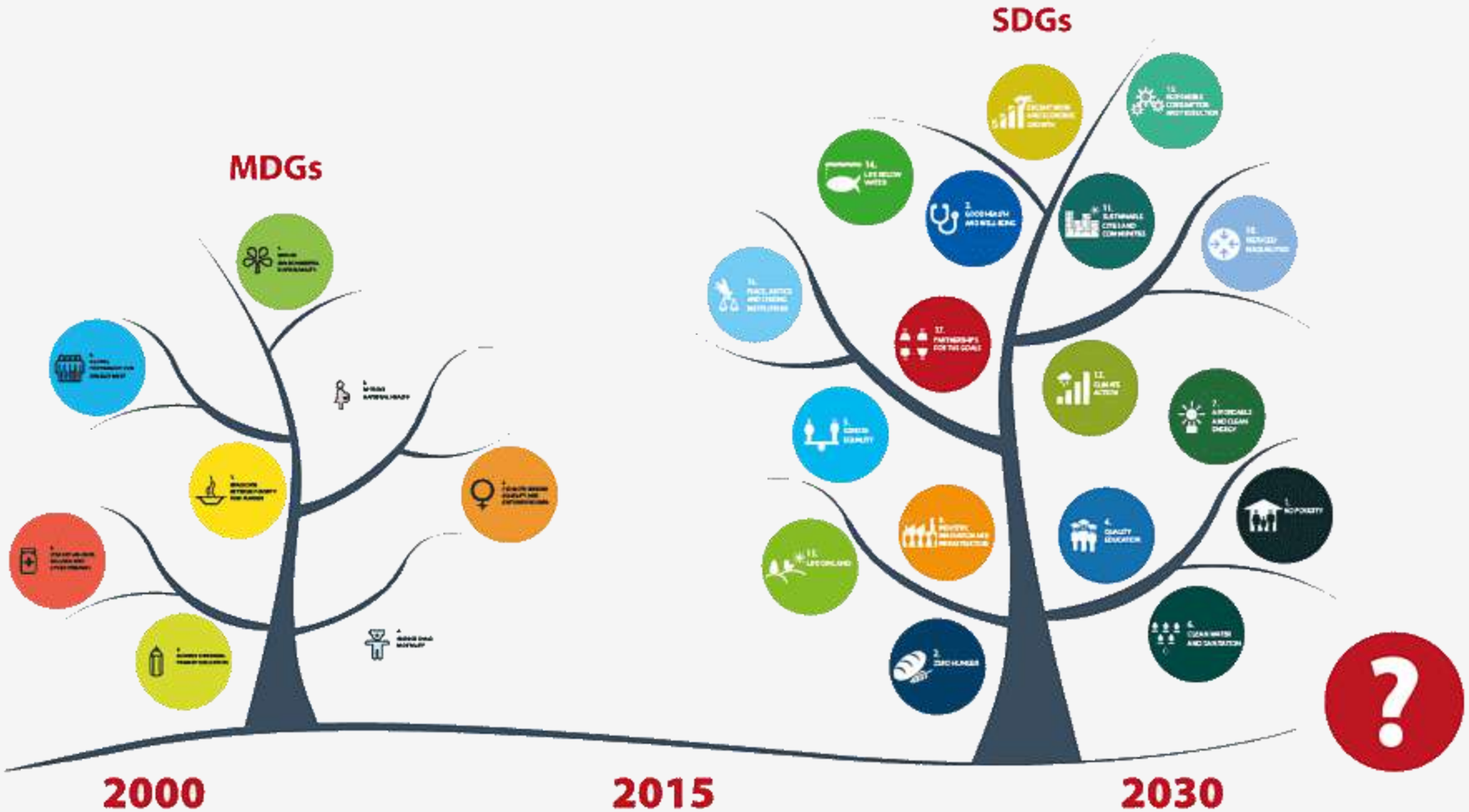
MDG 6: Combat HIV/AIDS, malaria and other diseases

MDG 7: Ensure environmental sustainability

MDG 8: Develop a global partnership for development

https://borgenproject.org/wp-content/uploads/mdgs-e1363991646213.jpg

MDGs to SDGs



https://sdgsnigeria.com/

SUSTAINABLE DEVELOPMENT GOALS

https://sdgs.un.org/goals

https://www.unesco.org/en/articles/gced-endorsed-target-education-sdg-united-nations-summit

Millennium Development Goals vs Sustainable Development Goals

Millennium Development Goals (MDGs)	Sustainable Development Goals (SDGs)
Adapted in 2000 and should be accomplished until 2015	Adapted in 2015 and should be accomplished until 2030
Concern developing countries	Concern ALL countries
8 goals, 18 targets, 48 indicators	17 goals, 169 targets, 230 indicators

Source: United Nations

SDGs Implementation

- Everyone is responsible for putting SDGs into practice!

  Individual citizens, civil society, the private sector, the scientific community should put their efforts and interests to make SDGs a reality!

- Funding is very important to realize sustainable development!

  ✓ Funding sources can be public, private, national or international.

  ✓ The systematic implementation of projects funded by public and private sector will lead to synergies.

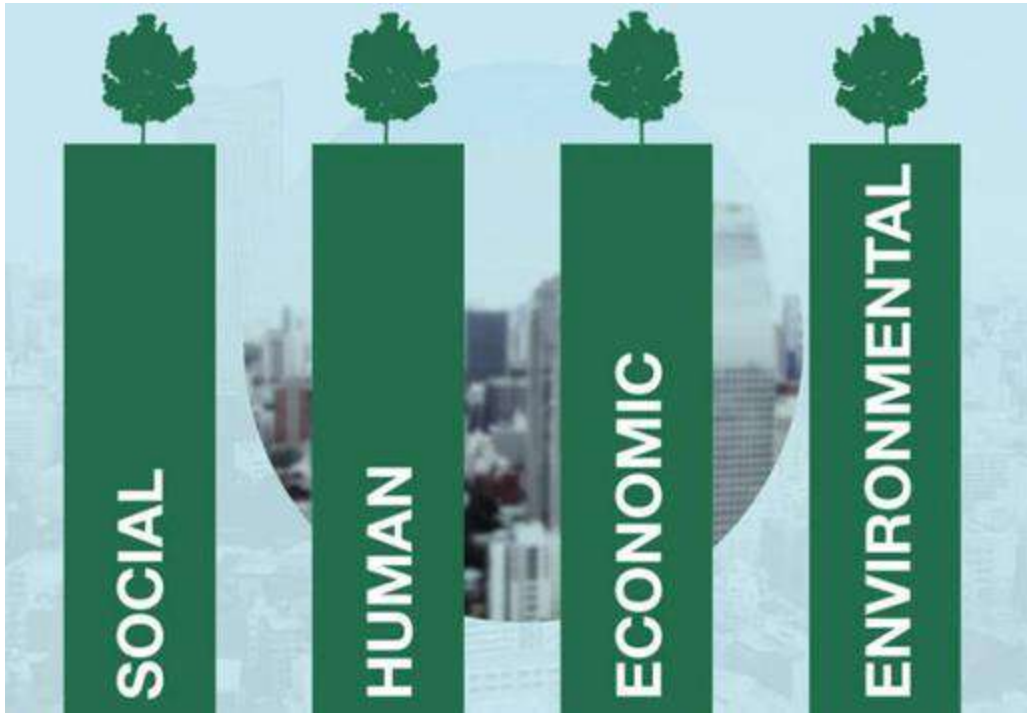
- Economic and social development should not achieved at the expense of the environment!

- SDGs are ambitious as well as complicated!

  17 goals, 169 targets, hundreds of indicators // some goals are specific while other are vague

Four pillars of sustainability

1. Social
2. Human
3. Economic
4. Environmental



https://www.futurelearn.com/info/courses/sustainable-business/0/steps/78337

To achieve sustainability in an organization or business, all four pillars of sustainability (human, social, economic, environmental) should be satisfied.

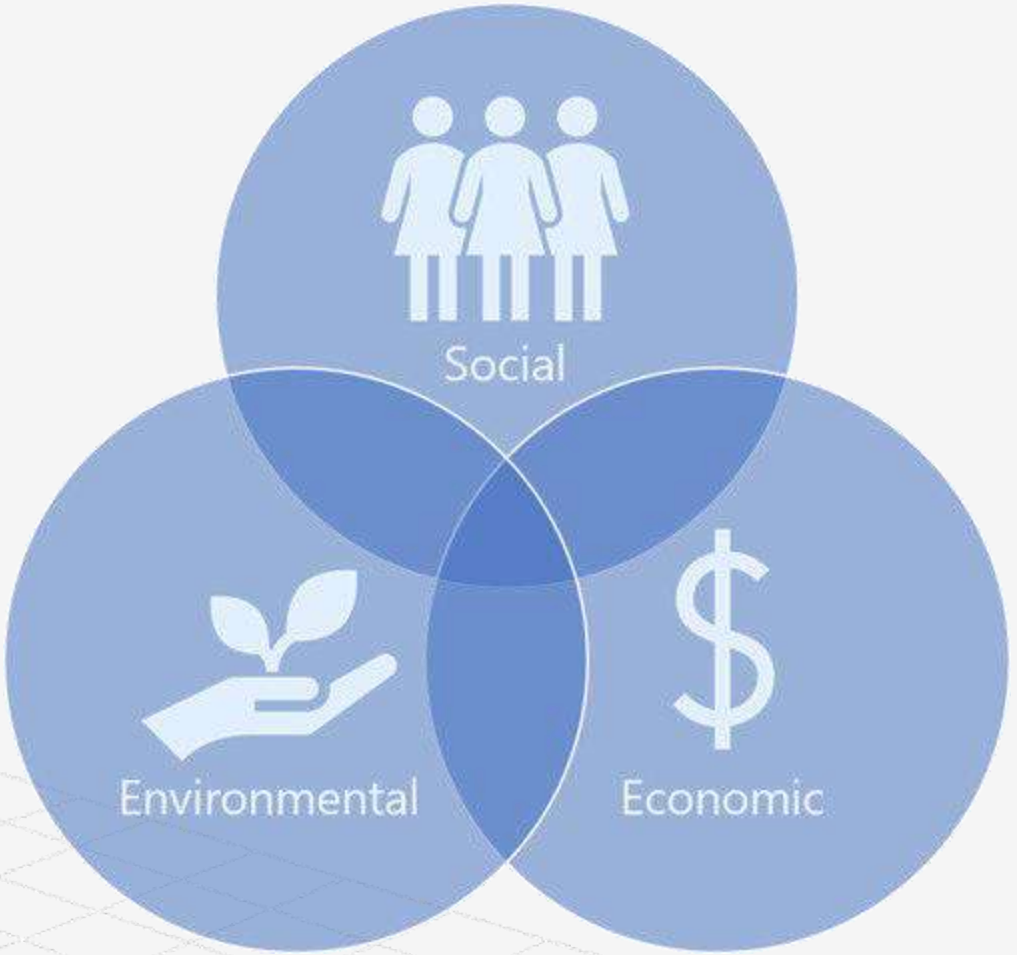
Source: https://www.futurelearn.com/info/courses/sustainable-business/0/steps/78337

Triple Bottom Line (TBL)

In the literature, sustainability consists of the three pillars: **social, economic** and **environmental** which constitute the **Triple Bottom Line (TBL).**

The sustainability concept was first introduced by the United Nations World Commission on Environment and Development in **1987**. That year, the commission defined sustainability as an economic development model that allows to "meet the needs of the present generation without compromising the ability of future ones to meet their own needs.

Sustainability is a multi-dimensional concept encompassing environmental, social, and economic dimensions.



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Source: Elkington, J. (1998). Partnerships from cannibals with forks: The triple bottom line of 21st-century business. *Environmental quality management*, *8*(1), 37-51.
Braccini, A. M., & Margherita, E. G. (2019). Exploring organizational sustainability of industry 4.0 under the triple bottom line: The case of a manufacturing company. *Sustainability*, *11*(1), 36

TBL-Environmental Dimension

Environmental dimension

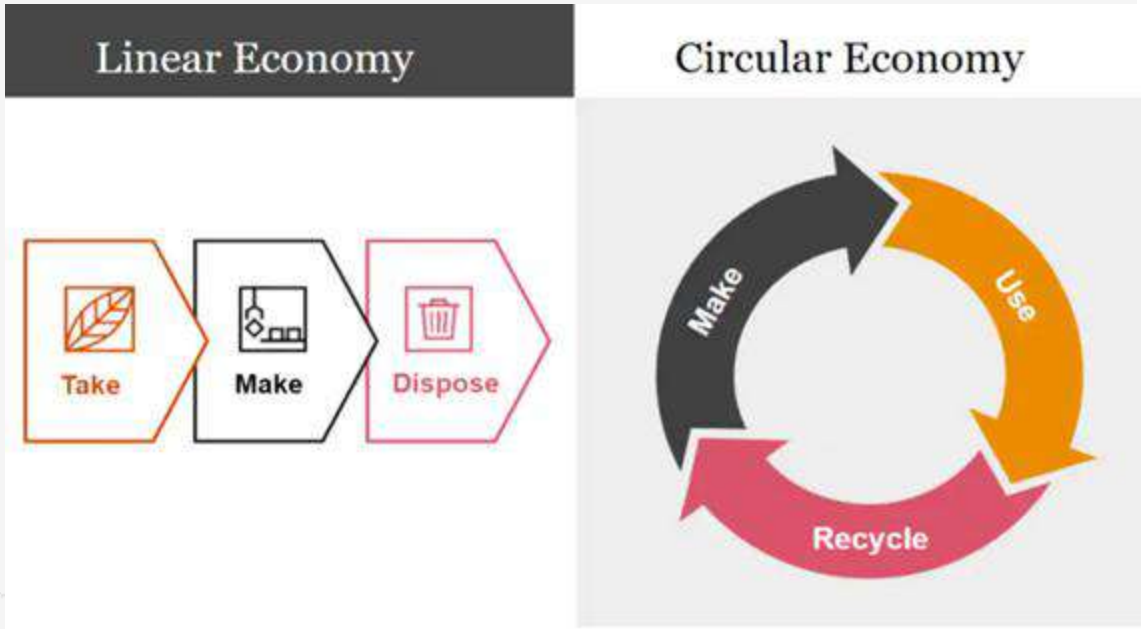
- compatibility between the trend of use and renewal of resources in nature.

- consume only the natural resources that can be reproduced from nature

- produce emissions that can be absorbed naturally by the existing ecosystem

through

i. recycling
ii. regeneration of resources,
iii. redesign of processes and products to minimize resource usage,
iv. replacement of non-renewable with renewable resources,
v. adoption of models of the circular economy



https://www.pwc.com/gr/en/advisory/risk-assurance/sustainability-climate-change/circular-economy-model.html

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Technologies used in I4.0

- Internet of Things (IoT):

The connection of machines equipped with sensors to the Internet. Internet-connected machines can generate, process and communicate data in real time to humans or other machines.

Example: A sustainable smart building with connected IoT sensors will turn-off lights and air-condition when people exit a room.

- Robotics:

Devices that can autonomously perform gestures or movements. They are designed and programmed to perform any desired manipulation tasks. Robots can be autonomous in their operation, or collaborative with humans.

Example: In the assembly line, different kinds of robots take on the hard work into the process and workers act as supervisors.

- Additive manufacturing

Known as 3D printing. A wide range of different materials (e.g., plastics, metals, composite materials) can be used

Source:Braccini, A. M., & Margherita, E. G. (2019). Exploring organizational sustainability of industry 4.0 under the triple bottom line: The case of a manufacturing company. *Sustainability*, *11*(1), 36.

Technologies used in I4.0

- Cloud computing

Enable to IT infrastructure companies to offer services through the internet

- Big Data and Analytics:

The overwhelming and unstructured amount of data generated by I40 technologies within the organization. They are stored on servers through cloud computing and are analysed with business intelligence, machine learning and analytics software.

Example:

Data from smart vehicles are transferred to a cloud server, analysed and suggest routes and modes of transportation with the minimum environmental impact.

Source: Braccini, A. M., & Margherita, E. G. (2019). Exploring organizational sustainability of industry 4.0 under the triple bottom line: The case of a manufacturing company. *Sustainability*, *11*(1), 36.

Industry 4.0 – Advantages and Disadvantages

Advantages

- more effective ways of producing goods
- improve warehouse management (through sensors)
- reduce warehouse inaccuracy
- shorten time to market
- improve product manufacturing life cycles
- efficient use of resource
- balance energy consumption based on the needs
- ameliorate working environment (passing hard-muscular work to machines)
- safer workplace
- increase employees morale

Disadvantages

- pollution increase because of the exploitation of electricity and natural resources
- workforce reduction because many activities pass from humans to machines

Source: Braccini, A. M., & Margherita, E. G. (2019). Exploring organizational sustainability of industry 4.0 under the triple bottom line: The case of a manufacturing company. *Sustainability*, *11*(1), 36.

Industry 4.0 and sustainability

Industry 4.0 affects to:

- raw materials,
- energy,
- products,
- waste,
- assets,
- information

https://www.businessamlive.com/industry-4-0-affecting-sustainability-across-sectors

Industry 4.0 affects environmental sustainability positively or negatively?

Source: Bonilla, S. H., Silva, H. R., Terra da Silva, M., Franco Gonçalves, R., & Sacomano, J. B. (2018). Industry 4.0 and sustainability implications: A scenario-based analysis of the impacts and challenges. *Sustainability*, *10*(10), 3740.

Industry 4.0 and sustainability – Negative Impacts

Environmental sustainability restricts production within limits:

- The rate of exploitation of natural resources should not exceed the rate of regeneration
- The rate of waste generation should not exceed the absorbable capacity of the biosphere
- The reduction of non-renewable resources should require comparable substitutes

Consumers are not adopting principles of sustainable consumption → They are consuming far beyond their real needs!!

Source: Bonilla, S. H., Silva, H. R., Terra da Silva, M., Franco Gonçalves, R., & Sacomano, J. B. (2018). Industry 4.0 and sustainability implications: A scenario-based analysis of the impacts and challenges. *Sustainability*, *10*(10), 3740.

Industry 4.0 and sustainability – Positive Impacts

Benefits of proactive environmental activities:

the satisfaction of the stakeholders who currently have many environmental concerns,

- the elimination of pollution and environmental liabilities,
- the improvement of financial performance due to opportunities in new foreign markets,
- chances for an environmentally-friendly company to a supplier in a green supply chain
- obtain environmental certification, with the attached improvement in reputation.

Source: Bonilla, S. H., Silva, H. R., Terra da Silva, M., Franco Gonçalves, R., & Sacomano, J. B. (2018). Industry 4.0 and sustainability implications: A scenario-based analysis of the impacts and challenges. *Sustainability, 10*(10), 3740.

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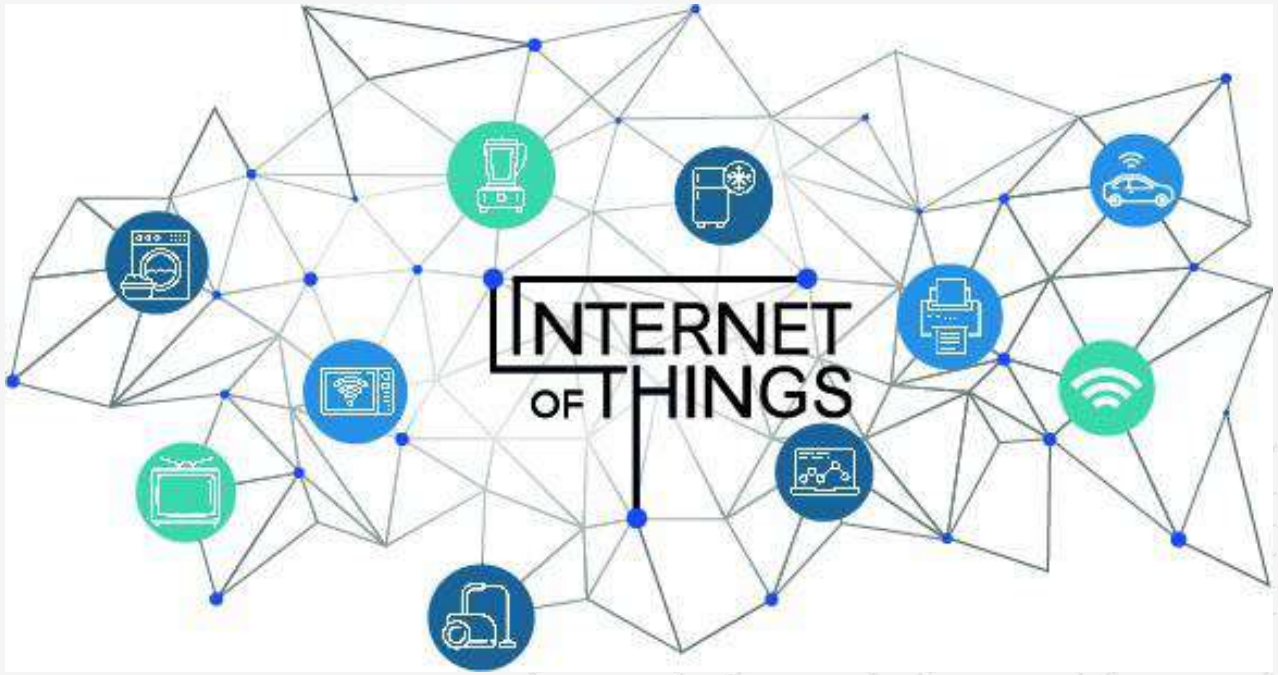

https://simonbrard017.medium.com/the-internet-of-things-iot-describes-the-network-of-physical-objects-so-known-as-things-cb8c9c994603

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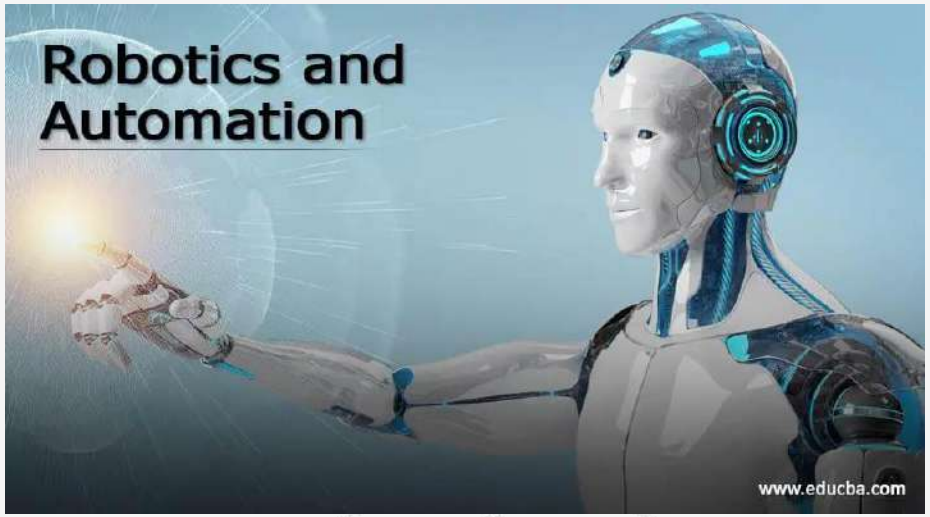

https://www.educba.com/robotics-and-automation/.

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Industry 4.0 and SDGs

Industry 4.0 can help to achieve the Sustainable Development Goals (SDGs) by:

- enabling more efficient and sustainable production and consumption practices,
- reducing waste and emissions,
- promoting sustainable supply chains, and
- facilitating collaboration and innovation towards sustainability goals.

https://climate.mit.edu/posts/industry-40-industrial-revolution-heart-sdg-agenda-2030

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- high cost of implementation
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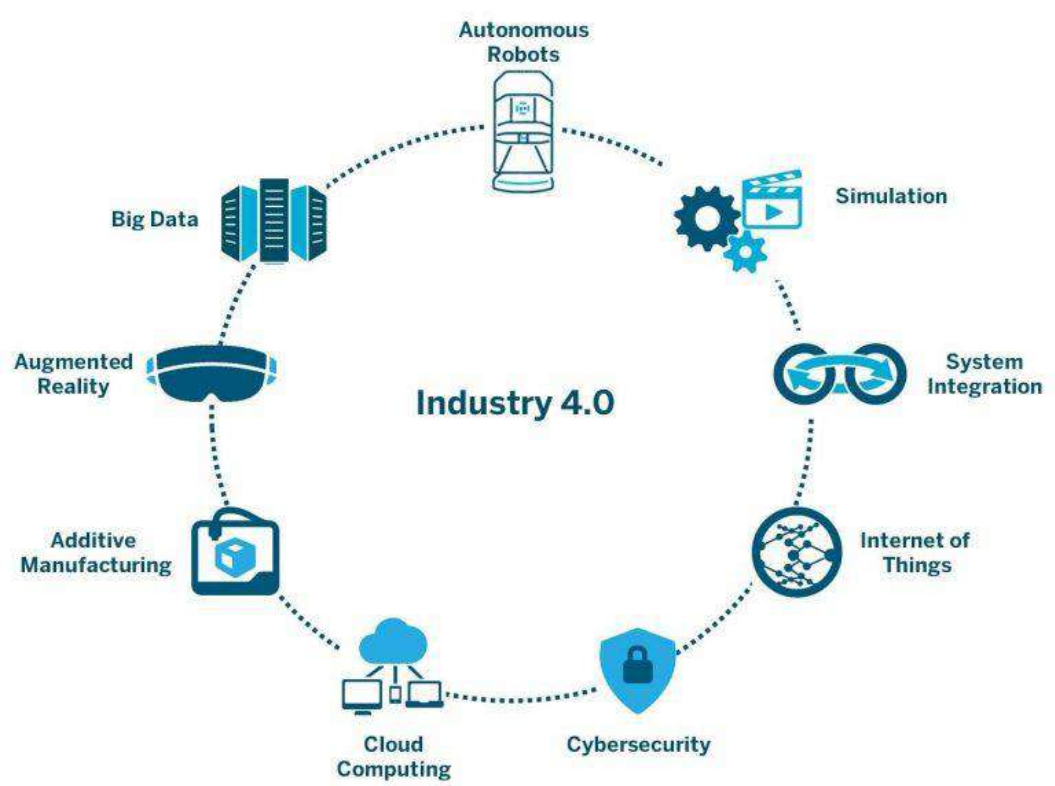


https://www.invoiceinterchange.com/industry-4-0-what-is-it-and-how-does-it-benefit-the-smes

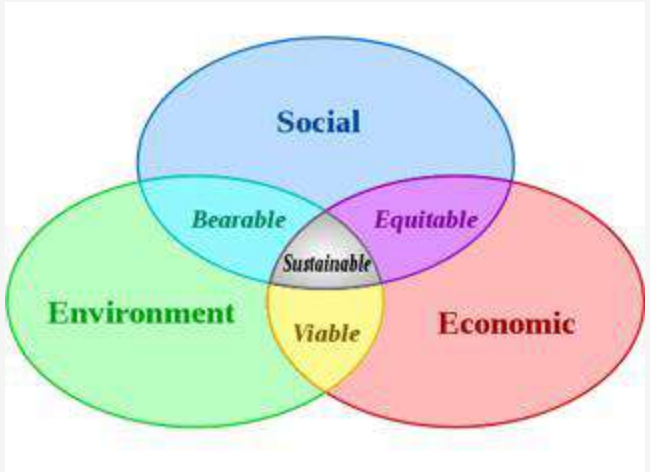
Source: Braccini, A. M., & Margherita, E. G. (2019). Exploring organizational sustainability of industry 4.0 under the triple bottom line: The case of a manufacturing company. *Sustainability*, *11*(1), 36

Sustainability Performance Metrics: Towards a Measurable Future

The Need for Indicators

Sustainability is too macro-level and multi-faceted to be measured by any one metric.

Analogous to indicator species used by ecologists to track ecosystem trends



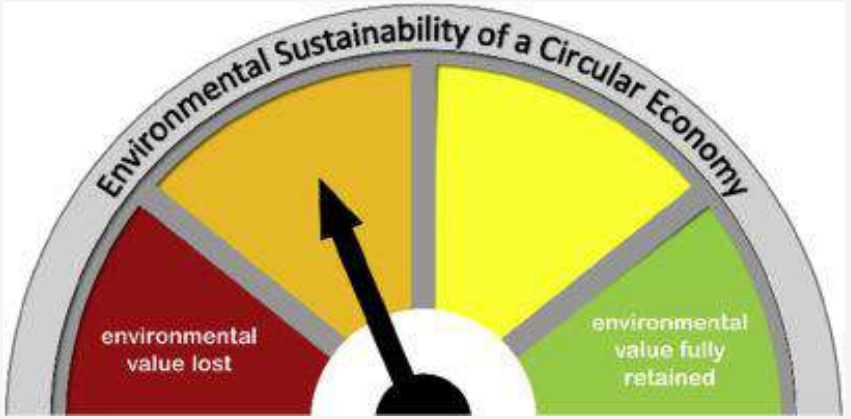
https://www.thwink.org/sustain/glossary/ThreePillarsOfSustainability.htm

Additional Questions: Scale

What is the physical or social system you are interested in measuring? City, Region, National, International, …

What is the time period you are interested in?

Past ten years, Next year, Next 40 years, …



https://www.sciencedirect.com/science/article/pii/S2665972719300054

Source: Haupt M. & Hellweg S. (2019), Measuring the environmental sustainability of a circular economy, *Environmental and Sustainability Indicators*. Vol. 1-2, doi:10.1016/j.indic.2019.100005.

From the MDGs to SDGs and the importance to measure and monitor them

8 Goals

21 targets

60 indicators for monitoring the progress.

Social priorities

to meet within the 2015 and designed mainly for developing countries.

"development " and sustainability " are still considered as separated topics

https://www.weforum.org/agenda/2016/02/3-ways-businesses-can-help-achieve-the-sdgs/

From the MDGs to SDGs: 8 Goals 21 targets 60 indicators

Eradicate **extreme poverty** and **hunger**	Target 1A: Halve, between 1990 and 2015, the proportion of people living on **less than $1.25 a day** Target 1B: Achieve Decent Employment for Women, Men, and Young People Target 1C: Halve, between 1990 and 2015, the proportion of people who suffer from hunger
Achieve universal **primary education**	Target 2A: By 2015, all children can complete a full course of **primary education/schooling, girls and boys**
Promote **gender equality** and empower women	Target 3A: Eliminate **gender disparity** in primary and secondary education preferably by 2005, and at all levels by 2015
Reduce **child mortality** rates	Target 4A: **Reduce by two-thirds**, between 1990 and 2015, the **under-five mortality rate**
Improve **maternal health**	Target 5A: **Reduce by three-quarters**, between 1990 and 2015, the **maternal mortality ratio** Target 5B: Achieve, by 2015, universal **access** to **reproductive health**
Combat **HIV/AIDS**, **malaria**, and other diseases	Target 6A: Have halted by 2015 and begun to **reverse the spread of HIV/AIDS** Target 6B: Achieve, by 2010, universal access to **treatment for HIV/AIDS** for all those who need it Target 6C: Have halted by 2015 and begun to **reverse the incidence of malaria and other major diseases**
Ensure **environmental sustainability**	Target 7A: Integrate the principles of **sustainable development** into **country policies and programs**; reverse loss of environmental resources Target 7B: **Reduce biodiversity loss**, achieving, by 2010 a significant reduction in the rate of loss Target 7C: Halve, by 2015, the proportion of the population without sustainable **access to safe drinking water** and **basic sanitation** Target 7D: By 2020, to have achieved a **significant improvement in the lives** of at least 100 million slum-dwellers
Develop a **global partnership** for development	Target 8A: Develop further an open, rule-based, predictable, non-discriminatory trading and financial system Target 8B: Address the **Special Needs** of the Least Developed Countries Target 8C: Address the **special needs** of landlocked developing countries and small island developing States Target 8D: Deal comprehensively with the **debt problems** of developing countries through national and international measures in order to make debt sustainable in the long term Target 8E: In co-operation with **pharmaceutical companies**, provide access to affordable, **essential drugs in developing countries** Target 8F: In co-operation with the **private sector**, make available the benefits of **new technologies**, especially **information and communications**

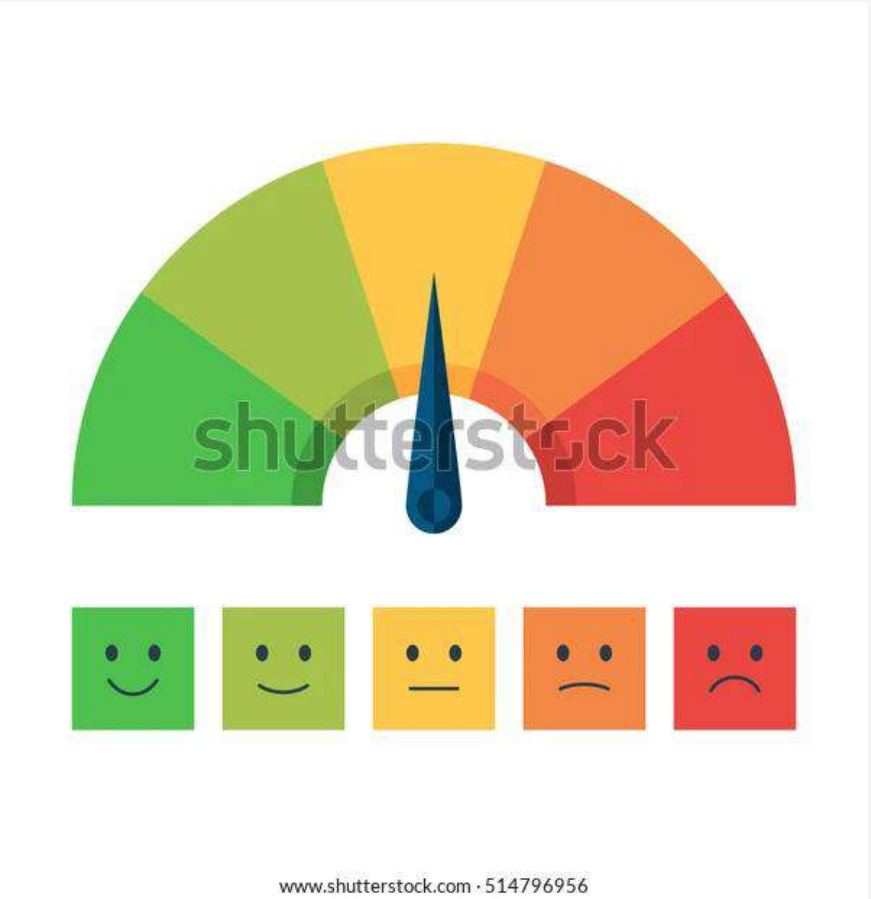
Source: The United Nations

Indicators as tool of measurement

Indicators are tools that measure, simplify and communicate important issues and trends.

An indicator is a variable that describes the state of a system

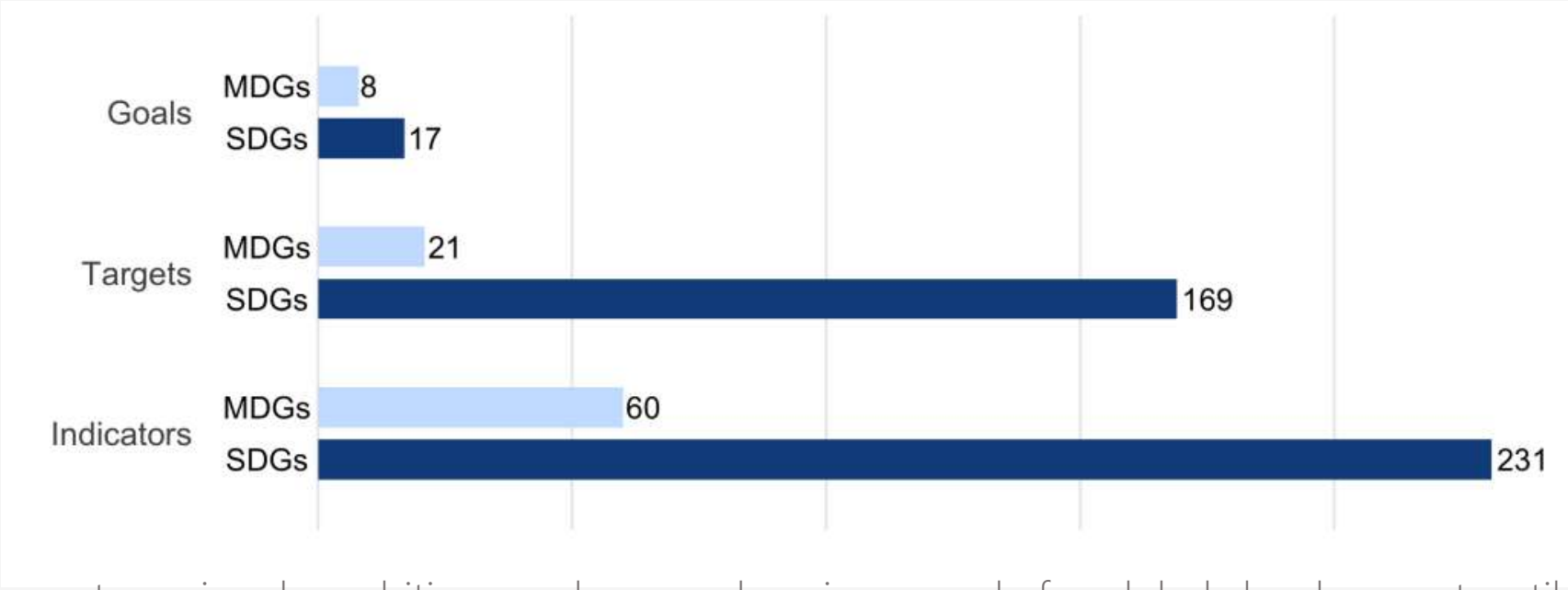
"An indicator may be defined as a characteristic which, when measured repeatedly, demonstrates ecological trends, and a measure of current state or quality of an area" (Ferris and Humphrey, 1999, p. 313f).



https://www.shutterstock.com/el/image-vector/color-scale-arrow-red-green-emotions-514796956

Source: Ferris, R., & Humphrey, J. (1999). A review of potential biodiversity indicators for application in British forests. Forestry, 72, 313-328.

Increased Data Requirements by SDGs



The 17 SDGs lay out a uniquely ambitious and comprehensive agenda for global development until 2030.

Achieving these goals is not the only challenge. Monitoring progress towards these goals represents an enormous task for countries' statistical systems.

The SDGs include 231 indicators for 169 targets.

Yet in 2015, the target year of the MDGs, countries reported on average data on only 68% of the MDG indicators.

Source: https://blogs.worldbank.org/opendata/are-we-there-yet-many-countries-dont-report-progress-all-sdgs-according-world-banks-new

Indicators in SDG

As part of the *2021 World Development Report: Data for Better Lives*, the World Bank recently launched the Statistical Performance Indicators (SPI).

The SPI assess the performance of countries statistical system across five pillars:

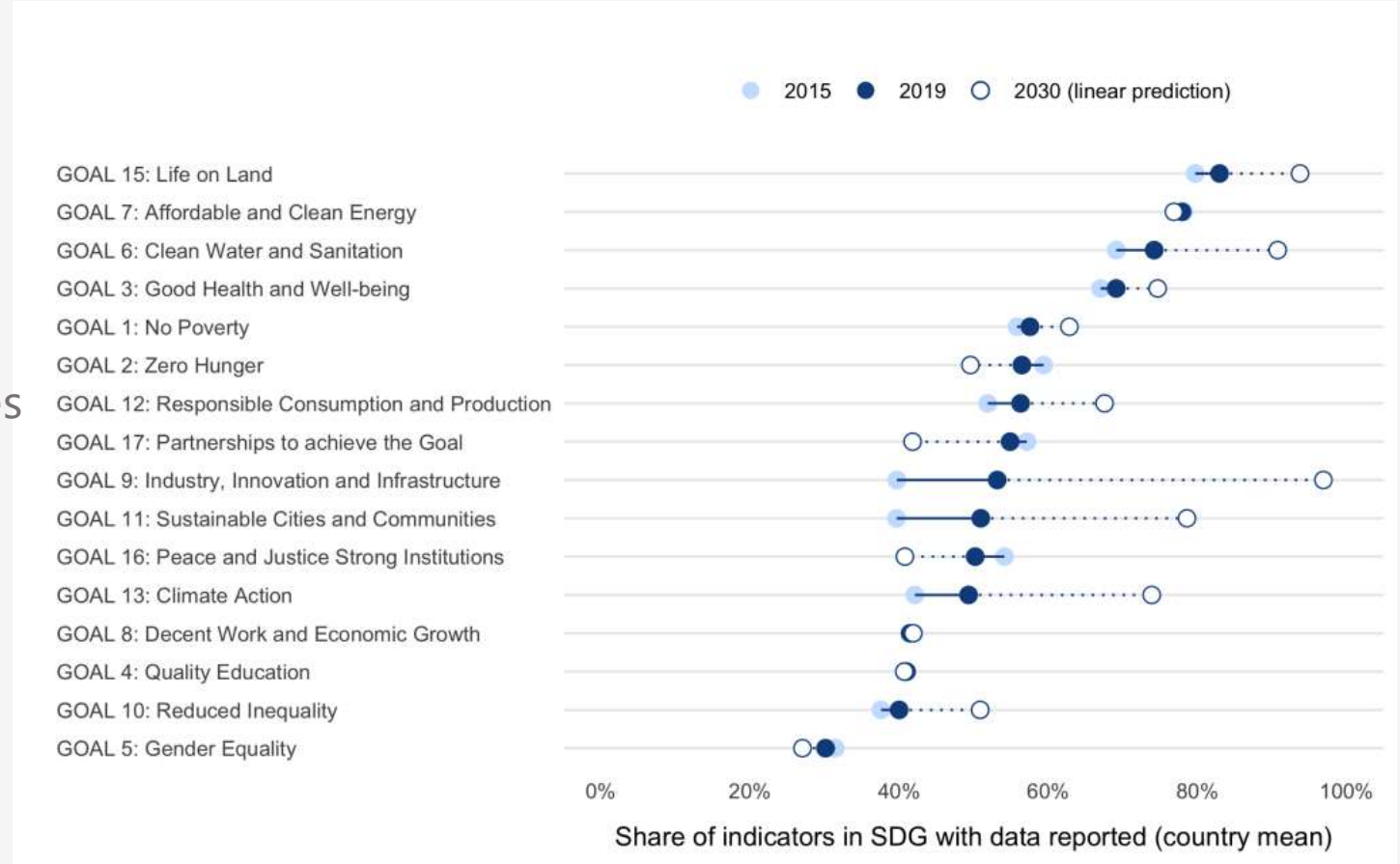
(i) data use,

(ii) data services,

(iii) data products,

(iv) data sources, and

(v) data infrastructure.



Source: https://blogs.worldbank.org/opendata/are-we-there-yet-many-countries-dont-report-progress-all-sdgs-according-world-banks-new

Indicators in SDG - commend

The excluded values were produced by an international organization through modeling and are either country reported, country adjusted, estimated, or are included as global monitoring data.

Goal 14 is not included as land-locked countries don't report on it.

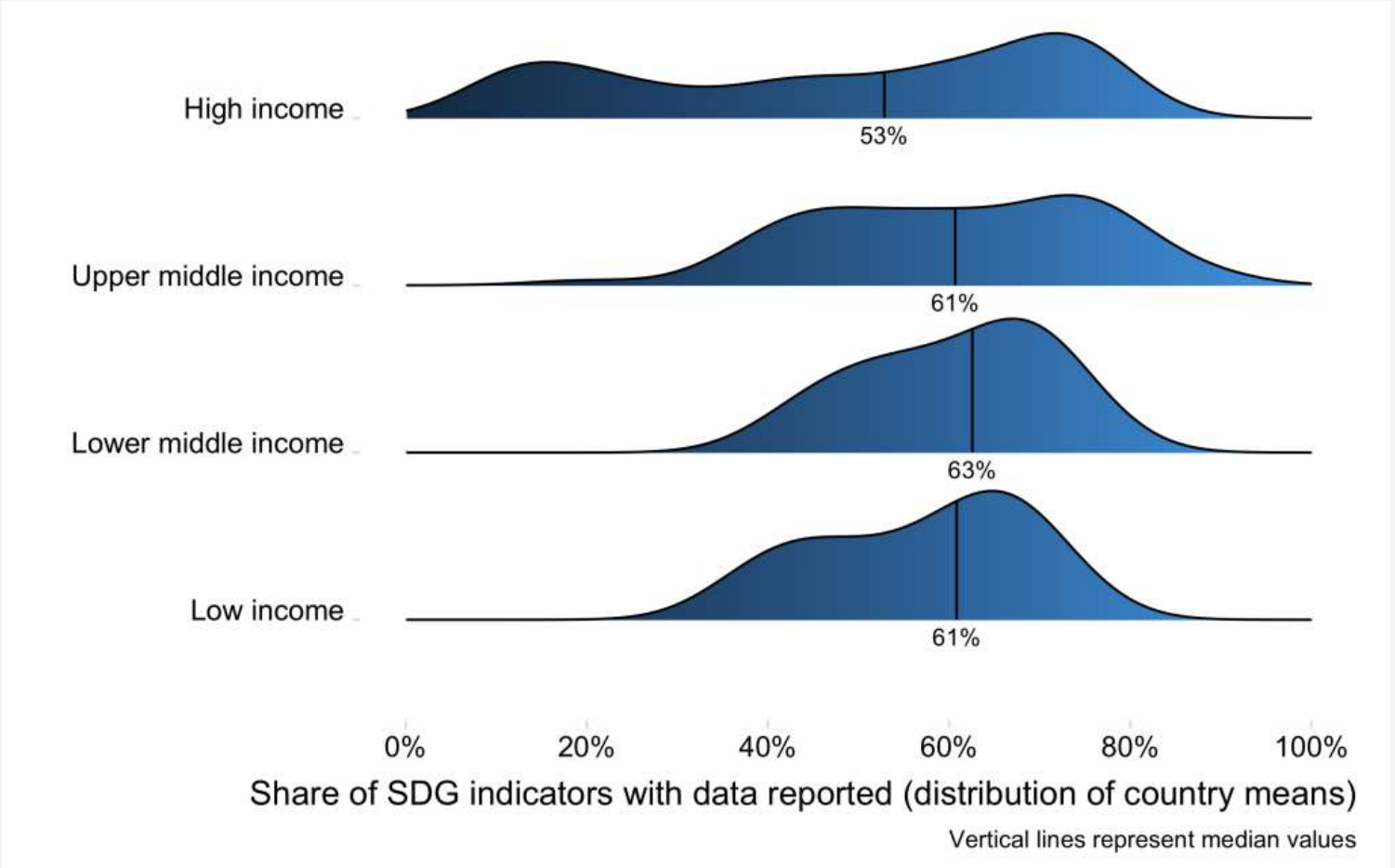
The predictions are based on linear models estimated by OLS on all data points from 2015 to 2019.

https://sdg-tracker.org/oceans

SDG indicators

Not every indicator may be relevant for all countries, but the SDGs are global goals for global challenges, with many topics of direct relevance for wealthy countries.

For example, high-income countries reported a mere 25% of the indicators on gender equality (goal 5). Ending discrimination and violence against women (targets 5.1 and 5.2), ensuring women's equal opportunities for leadership (5.5), and universal access to sexual and reproductive health (5.6) can hardly be considered priorities for low-income countries alone.



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SDG data reporting

Another indication that SDG data reporting may not only be a function of statistical capacity but perhaps also of political will is that the correlation between pillar 3 of the SPI, which measures data reporting on SDGs, and the other pillars of the SPI is lower than the correlation between the other pillars.

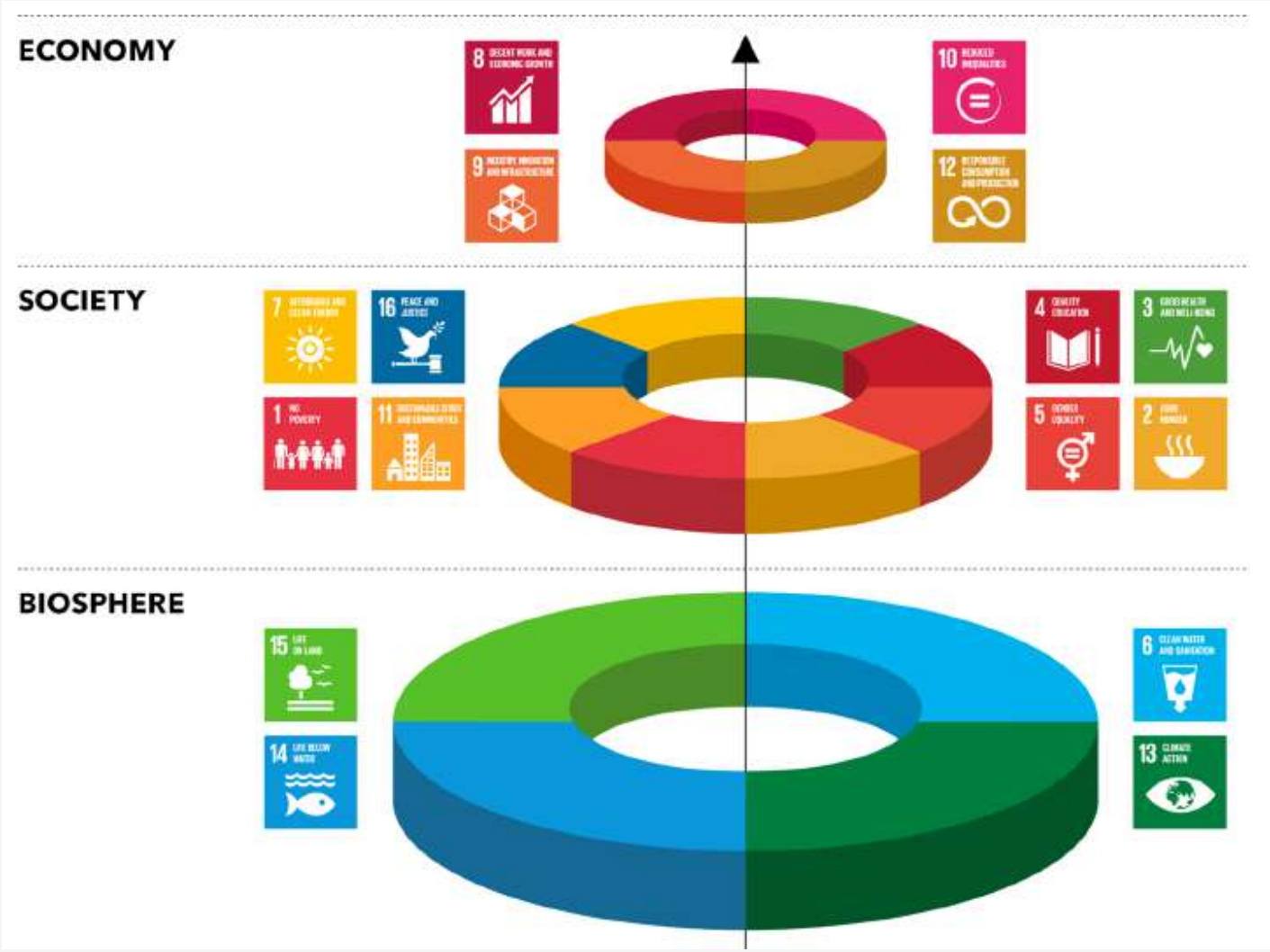
It is possible that some countries collect data on more indicators than they submit to the UN SDG database.

The value of reporting SDG data goes beyond monitoring progress. Previous research suggests that countries' performance on measuring progress towards the MDGs was positively correlated, if not causally associated, with actually making progress on the goals.

By keeping track of what gets measured, the SPI can help countries shed light on where they fall short on SDG reporting, and, ultimately, where they still have work to get done.

Source: https://blogs.worldbank.org/opendata/are-we-there-yet-many-countries-dont-report-progress-all-sdgs-according-world-banks-new

From the MDGs to SDGs: 8 Goals 21 targets 60 indicators



https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcSlnRW_v9bo7-iIXC8N5s3k6vLGagzz5ZOi3y88yPA0Gw2LWP0FQsOrBX_FNCa_twsJAoQ&usqp=CAU

Characteristics of a good indicator

- Validity: the indicator ensures an accurate measure of a behavior, practice, task that is the expected output or outcome of the intervention
- Reliable: the indicator is measurable over time, in the same way by different observers
- Precise: the indicator is operationally defined in clear terms
- Measurable: the indicator quantifiable using available tools and methods
- Timely: provides a measurement at time intervals relevant and appropriate in terms of program goals and activities

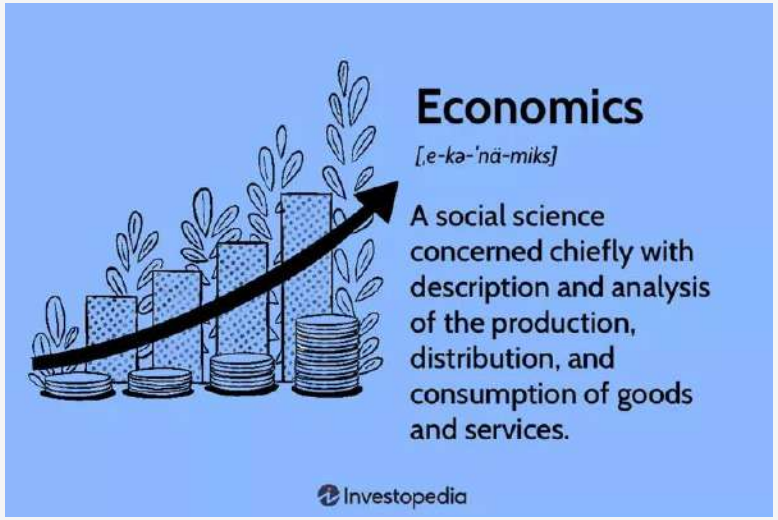
https://talonconsulting.com/characteristics-of-effective-performance-indicators/

Characteristics of indicators

Indicators need to be able to communicate information related to a specific phenomenon

The simplification should ensure also a proper interpretation of the phenomenon

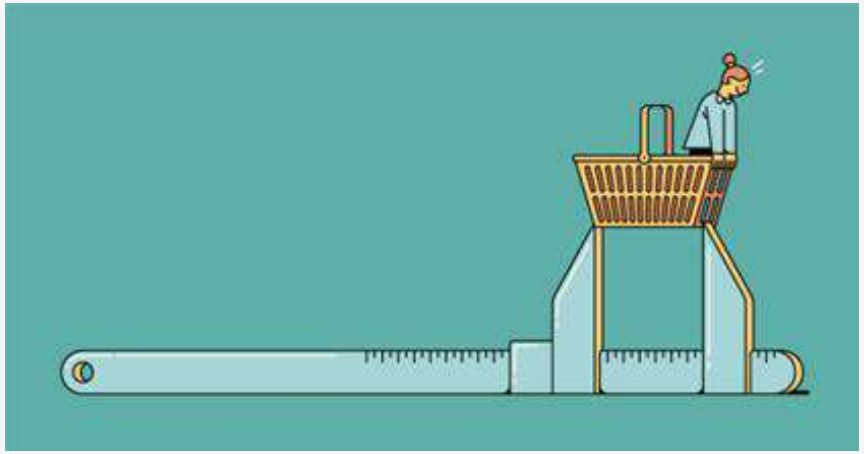
- Physical context specific physical or morphological characteristics can influence the result or the interpretation of it.
- Cultural and social context by knowing the cultural context it is possible to add or remove significant or insignificant indicators from a standardized dataset.
- Economic context with an in-depth knowledge of the economic context it is possible to identify valid and credible target.



https://www.investopedia.com/terms/e/economics.asp

Four steps to build an indicator

1. Select the unit of analysis → what are you observing?
2. Understand the context → what are the variables able to impact and to modify the observed phenomena?
3. Data selection → according to the identified variables, select the necessary data. In this phase it is fundamental to check if the data are valid, credible, reliable and precise
4. Normalization → according to scope of the indicator (comparable in years and/or in the space). It is necessary to provide a denominator that is able the results comparable

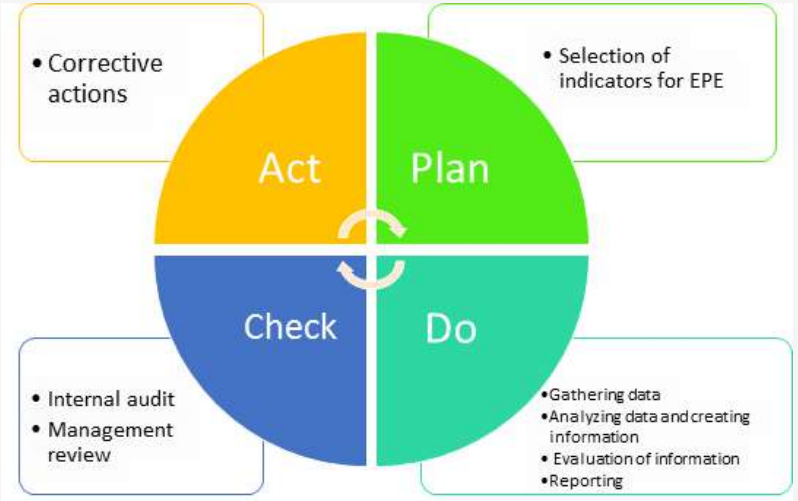


https://www.shopify.com/blog/7365564-32-key-performance-indicators-kpis-for-ecommerce

Indicators' standardization

Standardized indicators are useful to:

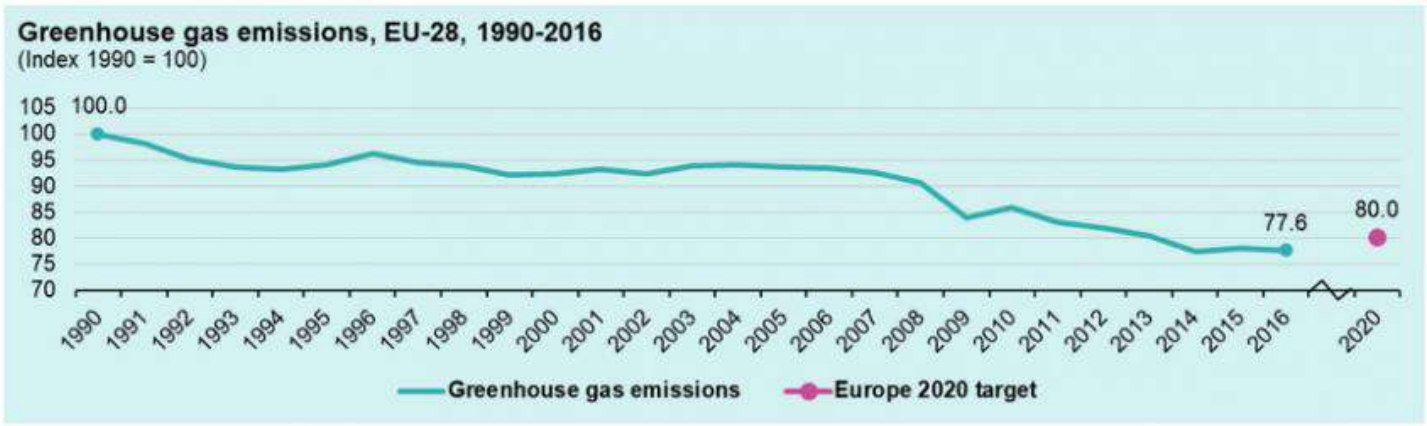
- compare similar products made by different companies;
- compare different processes producing the same product;
- benchmark of units within corporations;
- rate company against other companies in the(sub -sector)
- assess progress towards sustainable development of a sector



At company scale in term of measurement and evaluation, the ISO Standard 14031 gives a definition of Environmental Performance Evaluation (that is an internal process and management tool to provide the management with information about the organization's environmental performance. This information should be reliable and verifiable.

Source: C. M. Jasch, Environmental performance evaluation and indicators. February 2000, Journal of Cleaner Production 8(1):79–88London: Elsevier, DOI:10.1016/S0959-6526(99)00235-8

The use of sustainability indicators



Note: total emissions, including international aviation and indirect CO_2, but excluding emissions from land use, land use change and forestry (LULUCF).

Source: European Environment Agency, Eurostat (online data code: t2020_30)

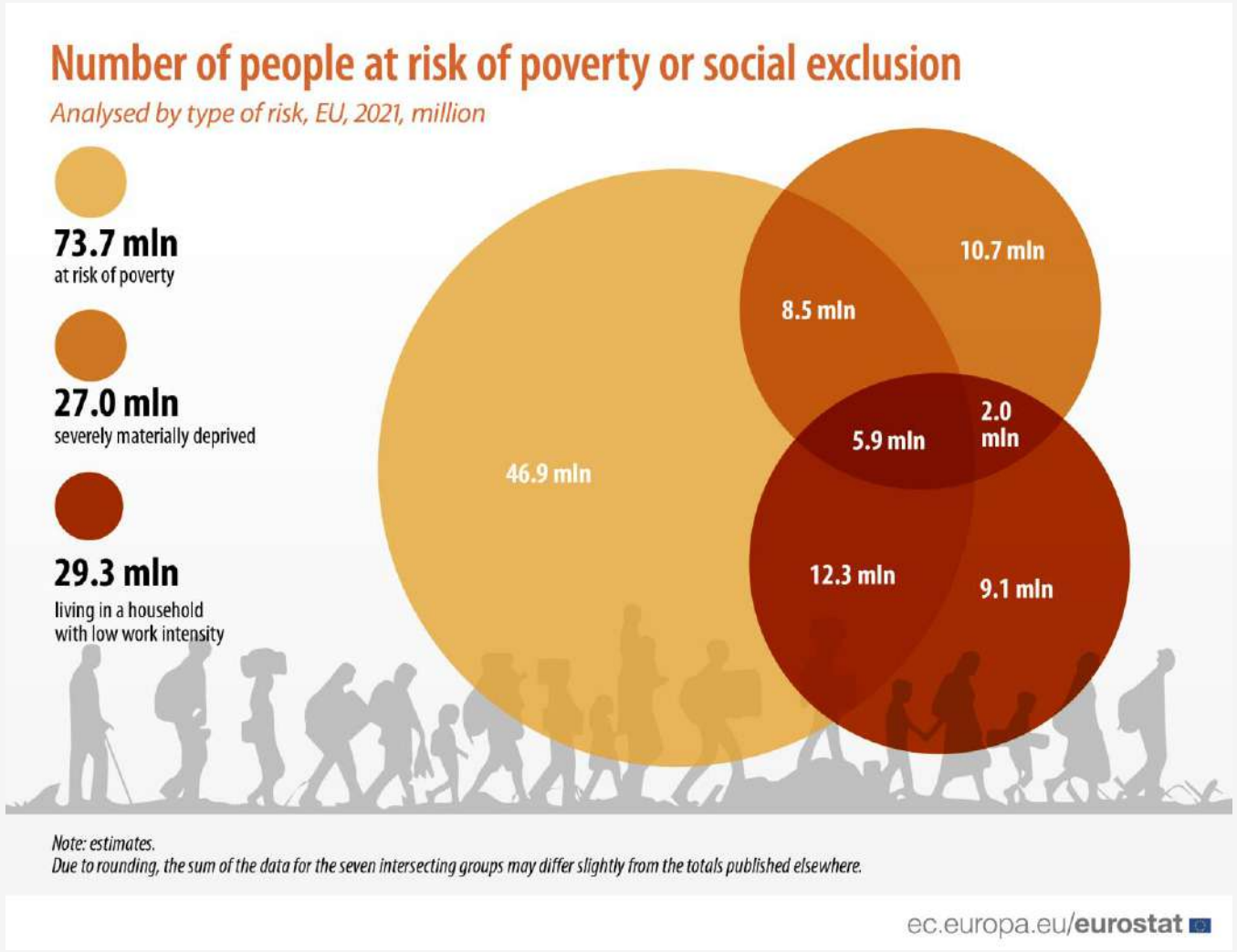
eurostat

Sustainability indicators are those indicators aimed at measure the sustainability level of a country.

Environmental or sustainability indicators can be used to guide the design of national policies and the definition of national targets

Source: Eurostat

The use of sustainability indicators

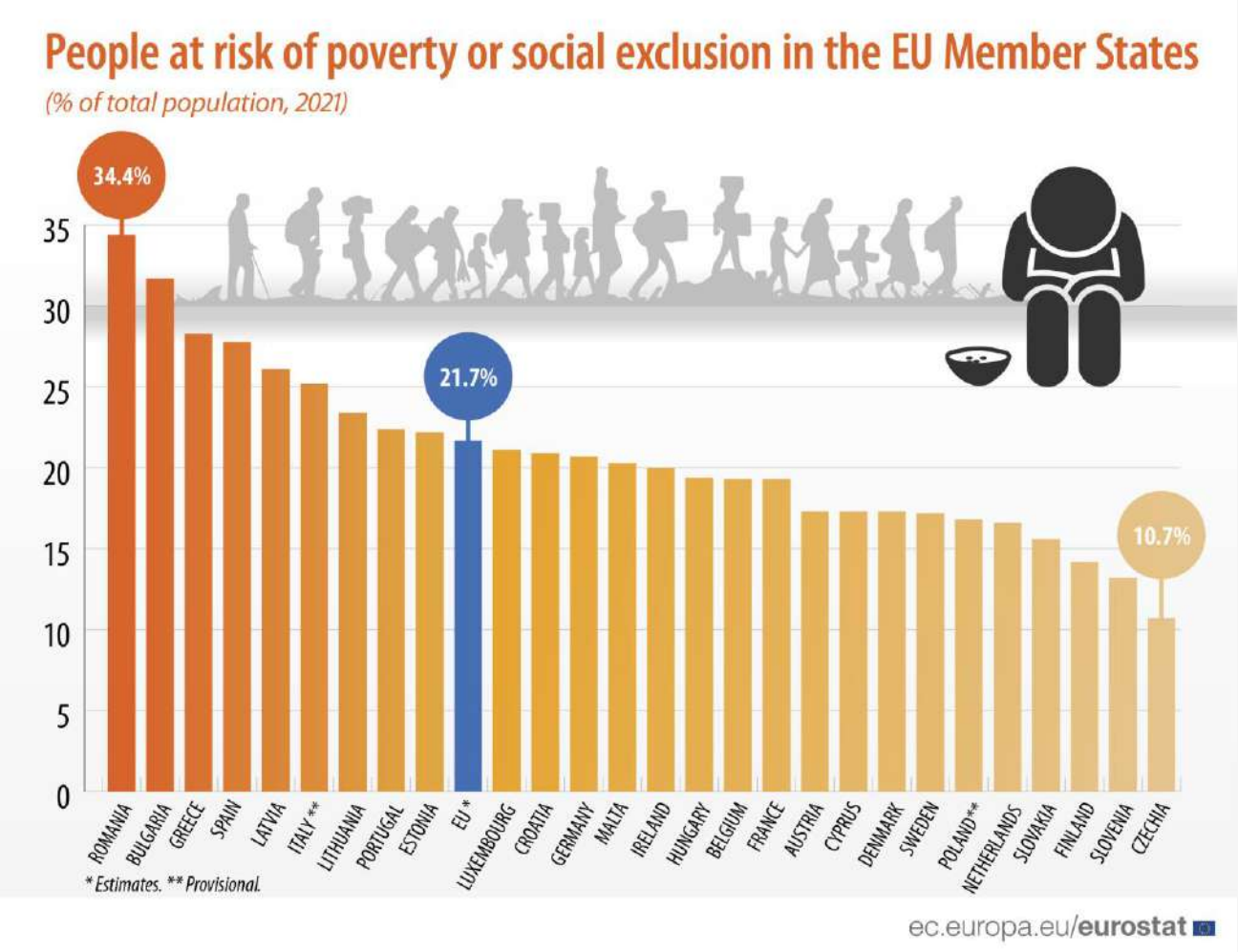


In 2021,

- 95.4 million people in the EU, representing 21.7% of the population, were at risk of poverty or social exclusion.
- 5.9 million (1.3% of the total population) lived in households experiencing all three poverty and social exclusion risks simultaneously.

Source: Eurostat
https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20220915-1

The use of sustainability indicators



The risk of poverty or social exclusion varied across the EU Member States.

The highest shares of people at risk of poverty or social exclusion were recorded in Romania (34%), Bulgaria (32%), Greece and Spain (both 28%).

In contrast, the lowest shares of people at risk of poverty or social exclusion were recorded in Czechia (11%), Slovenia (13%) and Finland (14%).

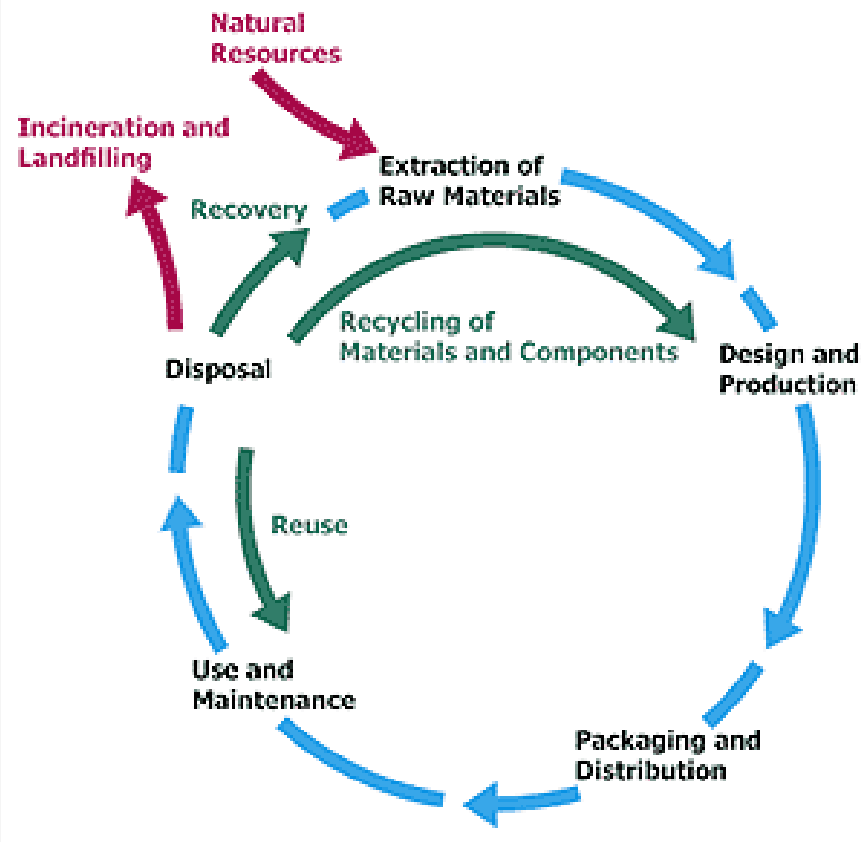
Source: Eurostat
https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20220915-1

Sustainability Indicators OPI, MPI, ECI

Operational Performance Indicators (OPI): related to operations of an organization and can cover topics such as emissions, product and recycling of raw materials, energy consumption.

Management Performance Indicators (MPI): related to management activities to provide the necessary support necessary for the success of environmental management.

Environmental Condition Indicators (ECI): provide information on the quality of the environment surrounding the organization or on the local, regional or global environmental status



https://www.lifecycleinitiative.org/activities/what-is-life-cycle-thinking/

Source: C. M. Jasch, Environmental performance evaluation and indicators. February 2000, Journal of Cleaner Production 8(1):79–88London: Elsevier, DOI:10.1016/S0959-6526(99)00235-8

Sustainability reporting

Sustainability reporting is the practice of measuring, disclosing, and being accountable to internal and external stakeholders for organizational performance against specific environmental, social and economic/governance ("ESG") goals and metrics.

Reporting to whom? to all its stakeholders (customers, suppliers, etc after mapping them

Object: Social and environmental practices (economic results are in the ordinary balance sheet, the Consolidated Report and Account)

What? Enterprise outputs, but also its direct and indirect outcomes (by means of performance indicators). It is both a management tool for the company (programming, control and internal information) and a communication and dialogue tool towards the external world

Source: Eurostat

Reporting tools

Environmental balance sheet

Social balance sheet

Environmental report

Sustainability report

https://vidooly.com/blog/best-custom-reporting-tools-software/

Any questions?

Thank you ☺

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