Existing tools used in the framework of environmental performance

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The monitoring and assessment of Environmental Performance (EP) constitutes a critical yet complex area of interest in today's world. The exploration of EP is often not understandable to non-experts, as the challenges, barriers and data collection to monitor EP are often limited by knowledge, acceptance, involvement of the individual as well as from the use of scattered and non-user-friendly monitoring techniques (Pappas et al., 2022). Since the adoption of the 2030 Agenda for Sustainable development of the United Nations (SDGs) in 2015, a catalytic pathway has been provided for the world's economy and sustainability to harmonize, as SDGs provide 169 targeted, measurable goals, linked with both the European Green Deal (EGD) and the Circular Economy Strategy (CES), which can be monitored by approximately 230 indicators (Loizia et al., 2021). To provide an even easier pathway regarding the monitoring of these goals collectively for EP, different assessment tools are being used including Key Performance Indicators (KPIs), software tools and predictive models, Management system Standards and Environmental Standards (ISO 14001, ISO 14031, ISO 37101, ISO 37120, EMAS, Ecolab etc.), providing clear, reliable guidelines and steps concerning the EP of a chosen institution (i.e. Business, city, country etc.), like planning, implementation, operation, corrective actions and management reviews (Loizia et al., 2021; Sharifi, 2020; Zorpas et al., 2021).

According to Pappas et al. (2022), waste management, a base pillar of EP, is a key factor to a functioning society. Most commonly, the tool in use for most waste management and Environmental Assessment models is KPIs. The purpose of KPIs is the simplification and accurate prediction of an outcome by providing quantifiable performance data (Pappas et al., 2022). They represent computational sets, both financial and non-financial which provide reliable information on Environmental footprint, waste management for scientists, stakeholders, decision makers and organizations (Loizia et al., 2021).

The KPIs most commonly used for realistic data extraction regarding waste management alone are Waste Compositional Analysis (MSW-C), Municipal Solid Waste Production and Recycling (MSW-P & MSW-R), Waste production and recovery Rate (WPR & WRR), Waste Infrastructure (WI), Clean Index (CI), Accumulation Rate and Index (AR & AI), Mobility, Renewable Energy, Air Pollution, Prevention Activities and Strategies (Loizia et al., 2021; Pappas et al., 2022; Zorpas et al., 2015). Indicators as such, have been used in many different scenarios like the monitoring of tourist activity to balance the correlation between tourist accumulation, hosts and waste accumulation in the area and also the development of collective targets based on EGD, SDGs and CES like the Environmental Performance Index, Green City Accord, Smart City and in non-EU countries, the Asian Green City Index (Falanga et al., 2021; Sharifi, 2020; Wendling et al., 2020). These types of indicators, whether they are in-process measures of EP (leading indicators) or measure the direct effect of an action on the environment (Environmental condition indicators), provide a successful metrics model which can be used for combining them with business or city data for data collection, reporting and strategic management, to diminish redundance but also tackle common metropolitan area issues like urban spread, loss of green space areas, wastewater treatment, waste management and treatment, air and soil pollution by increased mobility and overpopulation management (Loizia et al., 2021; Pappas et al., 2022). In any case, the environmental system tool to be used, must supply information concerning the improvement of environmental business and urban practices, showcase the pathway to the reduction of the Environmental Footprint of the target area as well as the cost of those actions in all areas of political, economic, social, technical, environmental and legislative value (Loizia et al., 2021). Important tools for such strategic qualitative evaluation of the KPIs to be used for both the targets set by a constitution (i.e. City) and the means of achieving those targets is the combination of the SWOT (Strength, Weaknesses, Opportunities, Threats) with PESTEL (Political, Economic, Social, Technical, Environmental, Legislation) analysis, assessing the effect of internal and external factors for strategic, targeted, efficient and effective decision-making (Loizia et al., 2021).

Surprisingly, little attention is being given to digitalization (i.e. Internet of Things (IoT), virtual reality, artificial intelligence etc.), predictive models and software for the monitoring of EP aspects (Rosecký et al., 2021). Since the development of a CE mindset, EU requires closing the loop on financial and material processes from public administrative figures, therefore an accurate prognosis of KPIs can be achieved by the development of appropriate software tools and models for monitoring EP (Rosecký et al., 2021). An accurate representation includes knowledge of the behavior and socio-economic profile of an area, as well as the integration of the KPIs according to the demographics and municipal waste production. According to Rosecký et al. (2021), in Czech Republic, the use of traditional modeling techniques like linear regression, generalized linear model, tree-based machine learning models (i.e. regression trees, random forest), showed that each traditional model could be used differently according to the desired outcome (i.e. The linear regression model giving an acceptable trade-off between model results and real-life data, whereas the use of random forest model is best for accuracy). At the same time, the use of software tools for recording and assessing data regarding aspects of EP, can be very beneficial regarding the direct access to data, monitoring of current practice efficiency and effectiveness (i.e. Mobility schedules and air pollution), the extraction and storage of specific historical data, capability of data processing and the creation of reports to be used for the monitoring of the obligations of the country or organization to EU regulations (i.e. EGD, CES, Directives etc.) or local quality standards (i.e. ISO 14001, ISO 14031, ISO 37101, ISO 37120, EMAS, Ecolab) (Pappas et al., 2022; Zorpas, 2020). Such models can be developed to allow individuals to assess the level of EP aspects like waste management, energy efficiency, water consumption, air and soil quality and other, without unnecessary complexity which would only decrease the audience sample from which such systems could be used (Pappas et al., 2022).

In this paper, the existing tools for the evaluation and assessment of EP are reviewed, showcasing the plethora of current pathways for choosing valid and reliable monitoring methods for decision-making, in regards to European and local legislations.

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