The potential of municipal waste management for achieving the decoupling required to transition to a sustainable circular economy

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Introduction

The UK aims to transition to a circular economy, where economic growth is decoupled from waste, pollution and emissions. For this, municipal waste management **targets a 65% recycling rate and a reduction in landfill use to 10% or less by 2035** (Defra, 2021). Innovative processes are being employed to prepare materials like plastics, metals, and fibers, competing with virgin materials and offering resource security. Since the year 2000, the UK's recycling rates have tripled, **but over 50% of MSW still ends up in landfills** (DEFRA, 2021; Xevgenos et al., 2015). This shortfall is attributed to policy constraints, ineffective communication, and physical factors. Recovering value from waste, known as waste valorization, aims to transform waste into economically useful materials, contributing to economic growth and promoting a circular economy. Moreover, the country needs to go beyond recycling and resource and energy efficiency; it needs to keep products in the economy, by reusing them, repairing or upgrading them, then doing the same with product components and parts and only as a last resort having materials recycled, with manufacturers ultimately extending value throughout the life cycles of their products (Voulvoulis, 2022).

This study therefore evaluates the extent to which decoupling can be achieved through waste management practices to enhance the chances of England becoming more economically and environmentally secure. It considers the economic value of preventing waste and recovering materials, analyzing the cost implications of landfill taxes and gate fees. The environmental benefits of improved waste management practices, such as emissions reduction and resource conservation, will also be explored, in addition to other strategies that will be repoured to decouple the economy, deliver net zero and a sustainable circular economy.

Adapted from European Waste Catalogue (EWC)
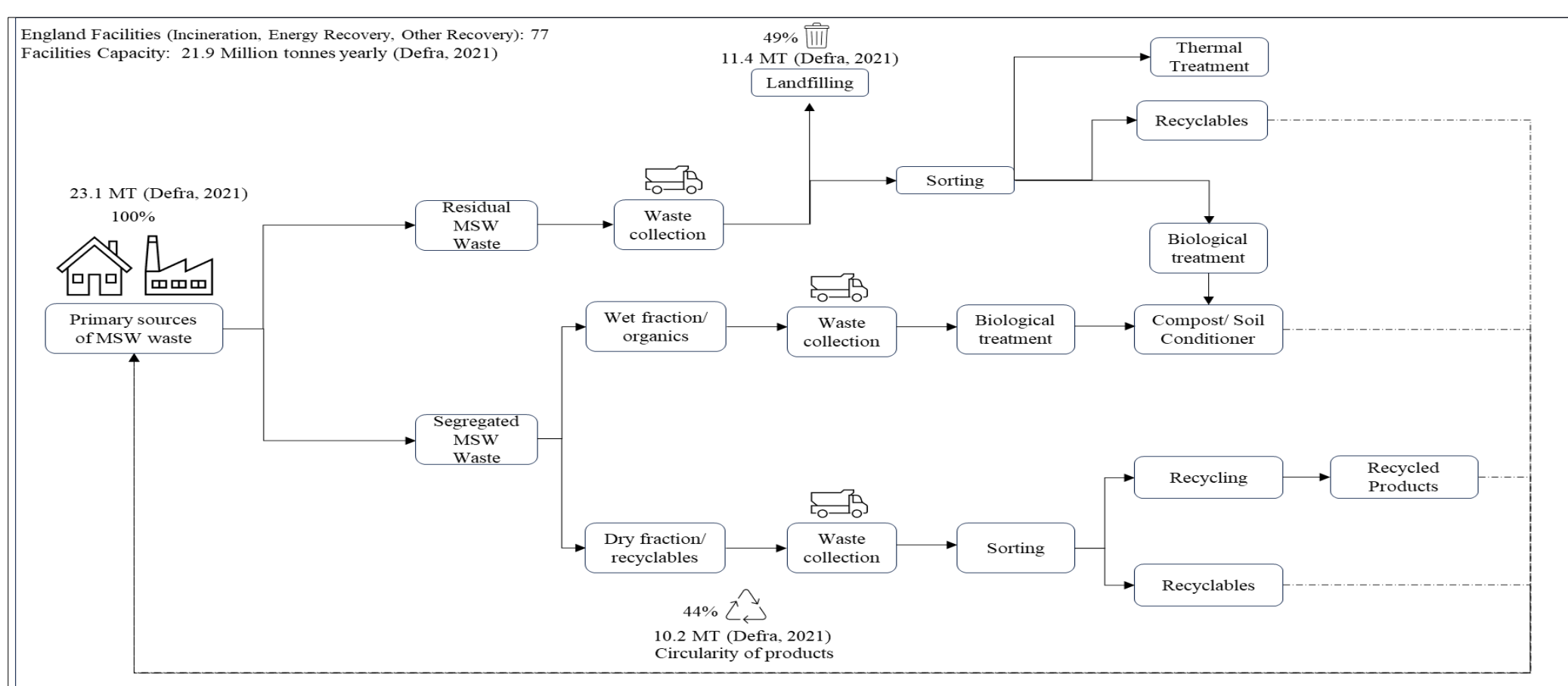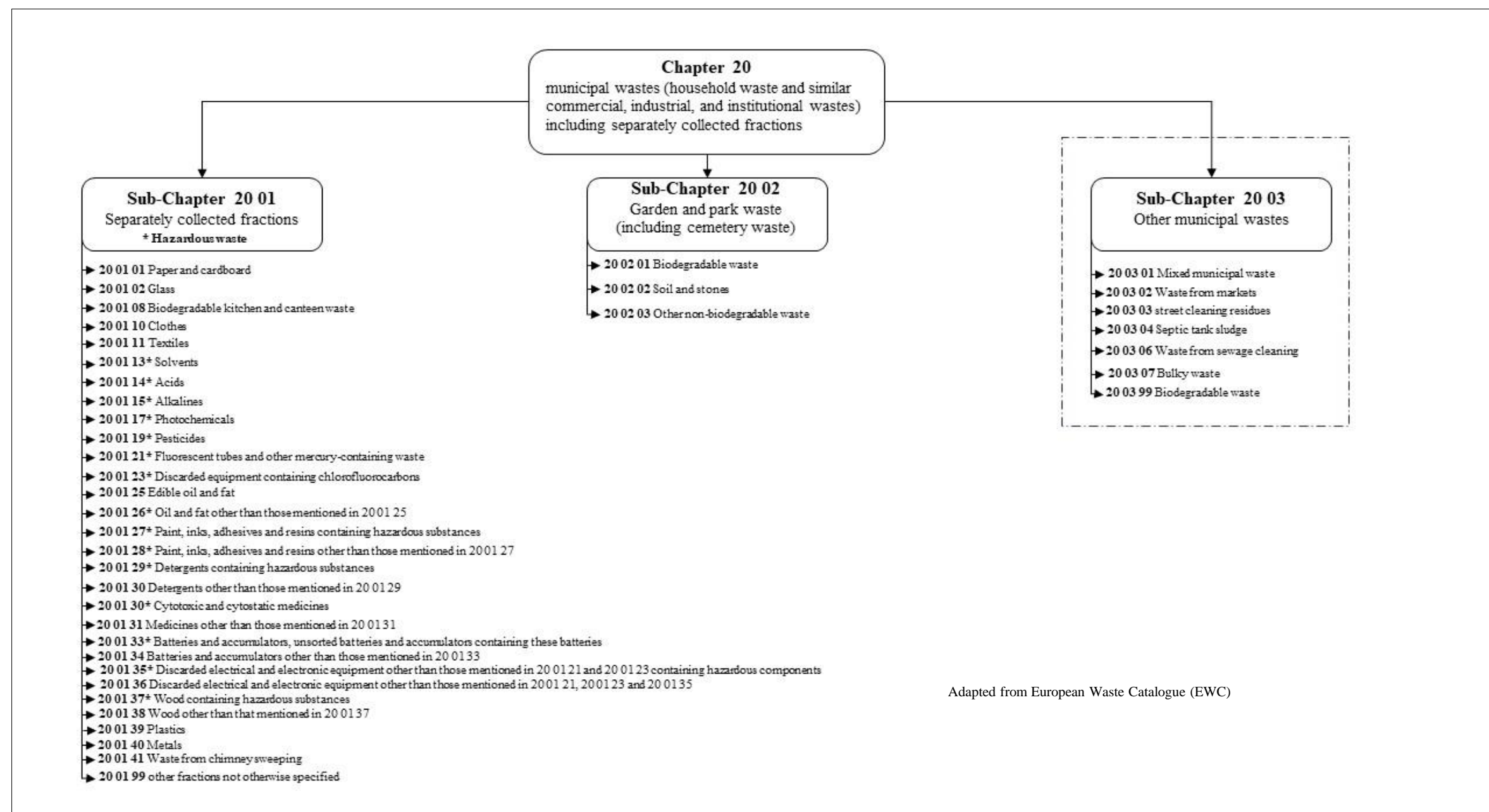
Methodology

Location and Time Frame

- The study analyzes data from 2010 to 2018 to provide a comprehensive view of trends and impacts over a decade.
- The Study focuses on waste generation in England's nine regions.

Data collection/sources

1. Municipal Solid Waste (MSW) data from local waste management authorities.
2. National statistics on waste generation, recycling rates, and landfill usage from governmental databases (e.g., DEFRA and Environment Agency Waste Interrogator).
3. Carbon dioxide (CO2) emission data related to waste management processes.
4. Financial data on landfill tax, gate fees, and costs associated with recycling and waste treatment facilities.

Statistical/correlation Analysis

Descriptive Statistics: Mean, median, standard deviation, and trends over the study period.

Correlation Analysis: Pearson correlation coefficient to understand the relationships between social variable correlation and waste fractions presented in the heatmap.

Trend Analysis: Linear regression to identify trends in recycling rates, landfill usage, and CO2 emissions over the years.

Scenario Analysis: Assessment of different scenarios based on current data and potential improvements in waste management practices.
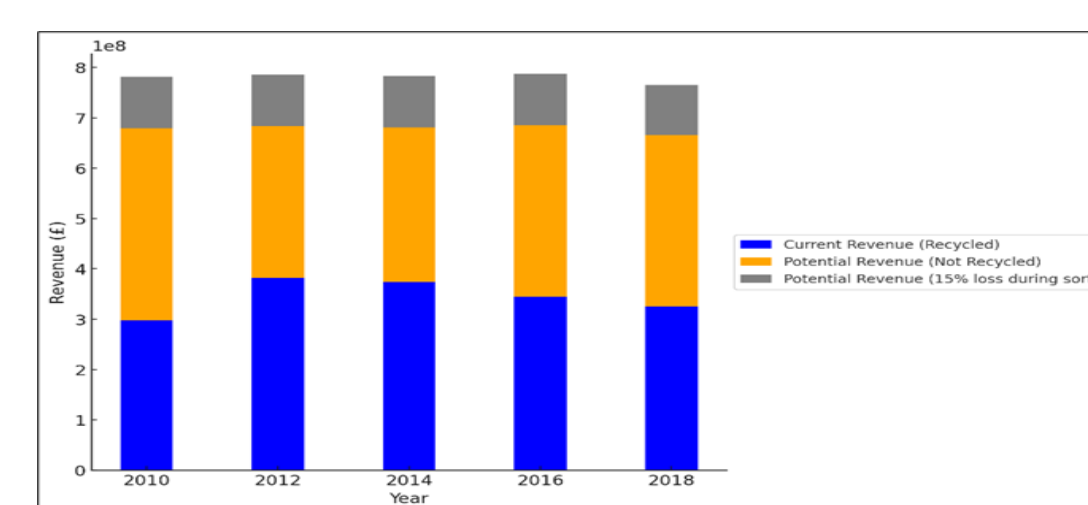
Unknown losses in HHW
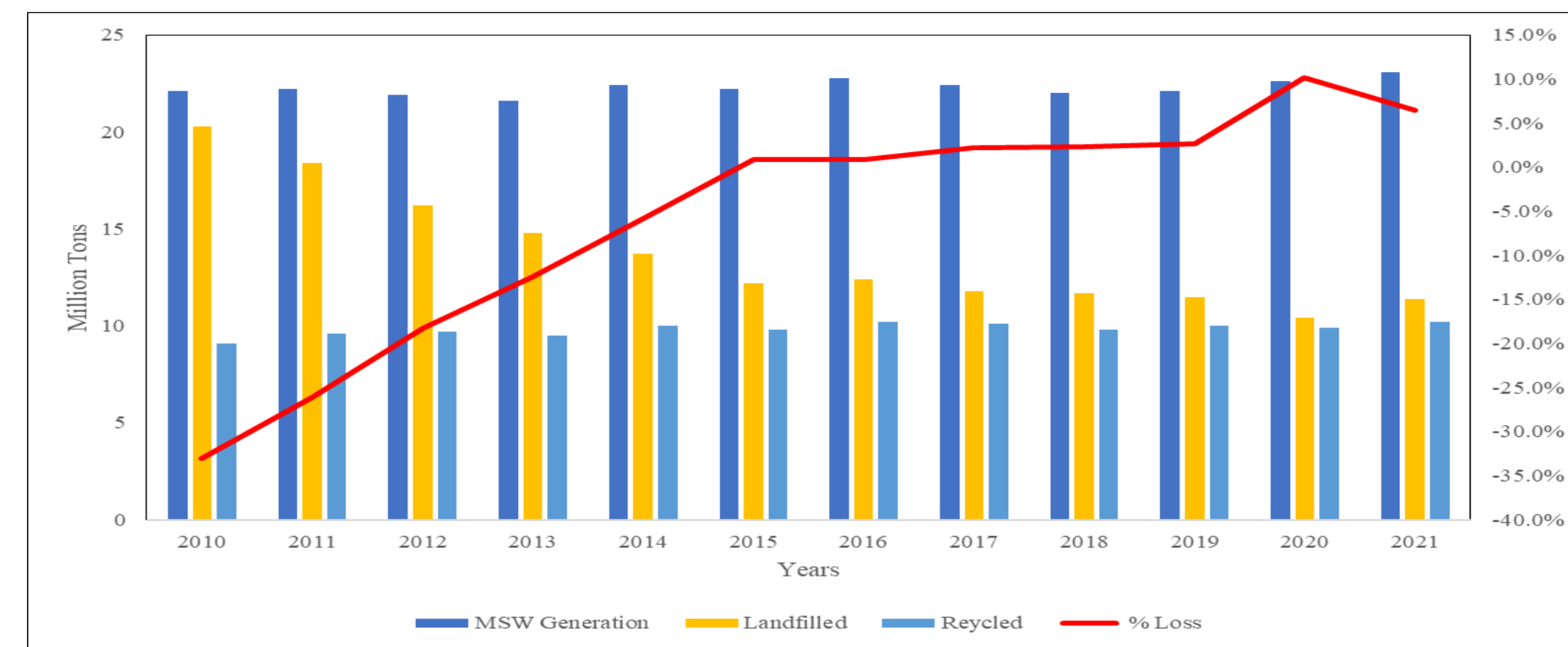
$$\%Loss = \left(\frac{Total\ MSW\ Generation - (Landfilled\ MSW + Recycled\ MSW)}{Total\ MSW\ Generation} \right) \times 100$$

## Results (Case studies of Paper and Textile Fractions)

Paper fraction

* The total potential revenue highlights the significant economic benefits that could be realized if all paper waste were recycled, underscoring the need for enhanced recycling infrastructure and policies.
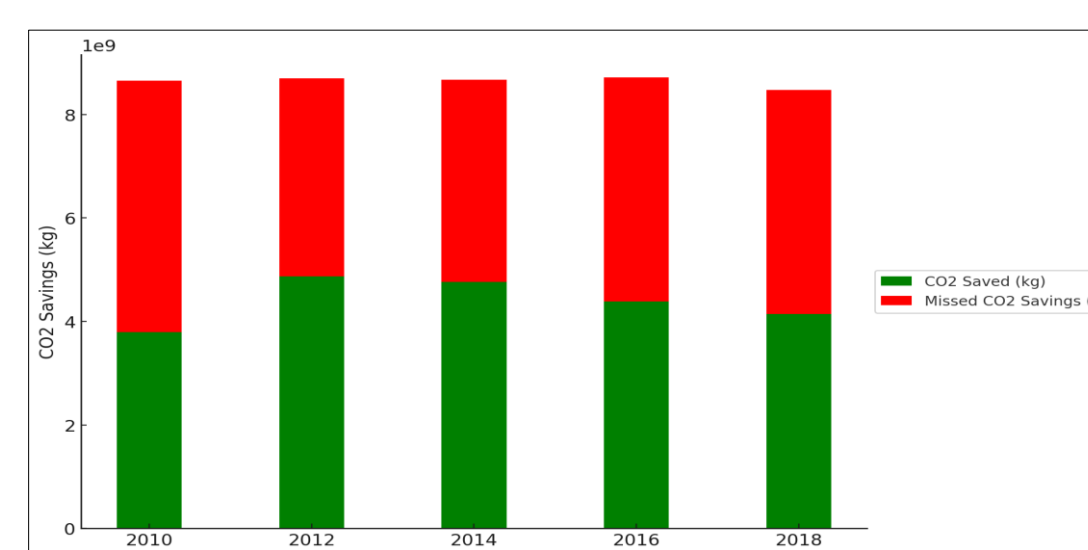

* The analysis indicates substantial missed CO2 savings due to untreated paper waste, emphasizing the critical role of recycling in mitigating climate change and the need for improved waste management policies.
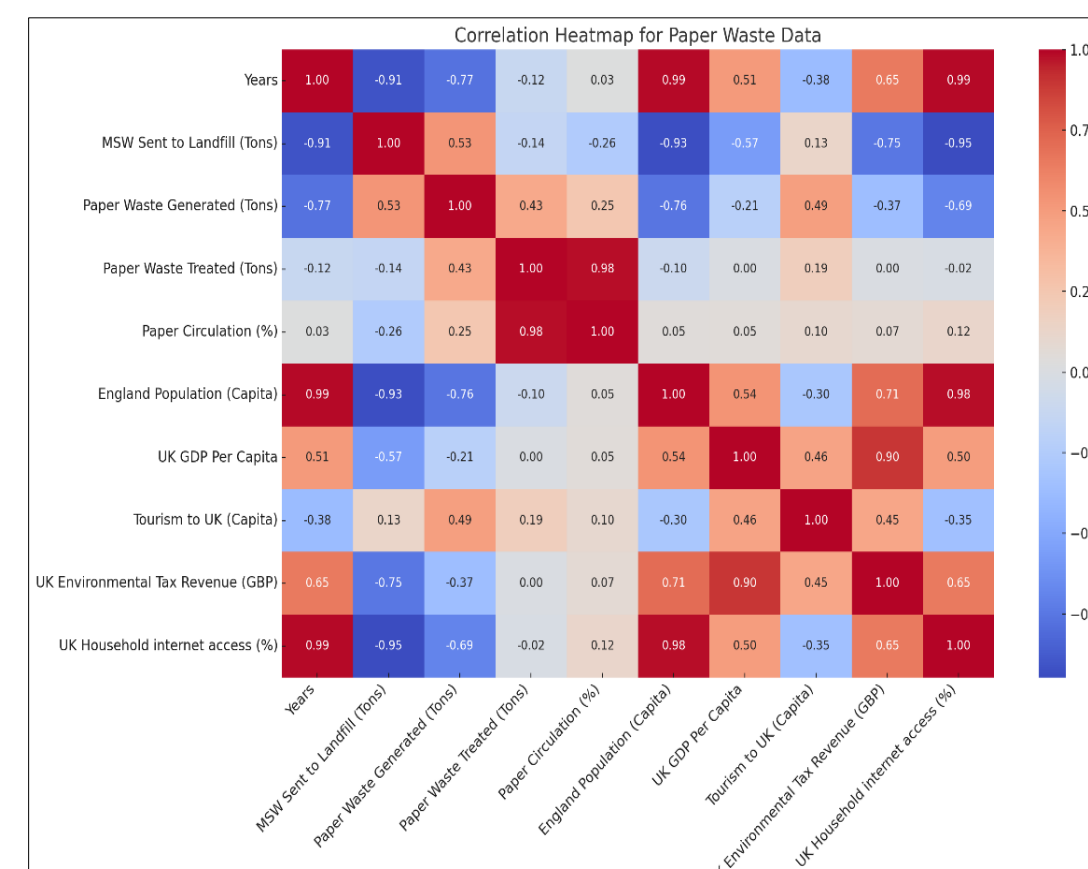
* The strong negative correlation between the decrease in waste sent to landfills and the years, particularly for paper waste, indicates a successful trend in waste reduction over time.

* The strong positive correlation between "Years" and "UK Household Internet Access (%)" suggests that increased internet access may be associated with enhanced environmental awareness and more efficient waste management practices.

Textile fraction
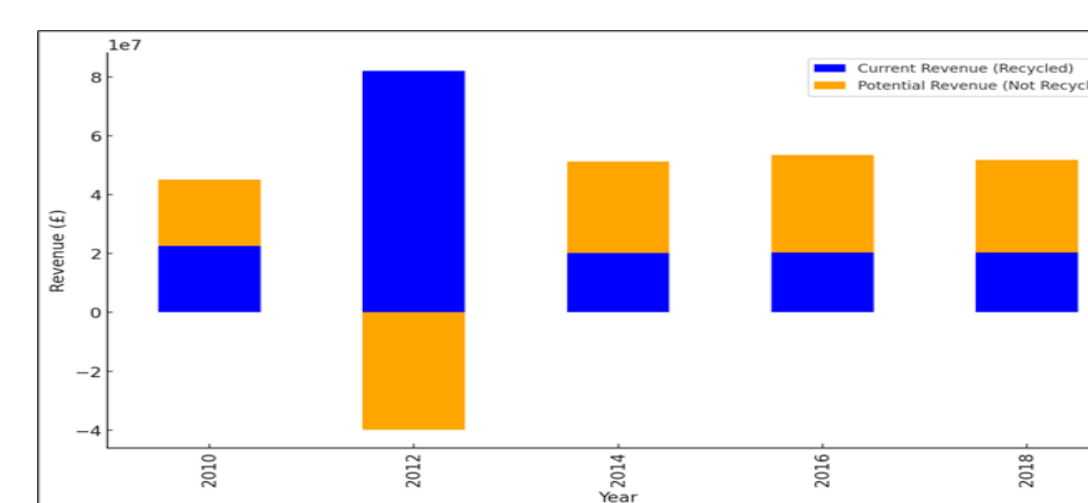
* The negative potential value in 2012 suggests a positive scenario where recycling processes exceeded expectations, highlighting the capability to handle more waste than initially reported.

Results (Continued)
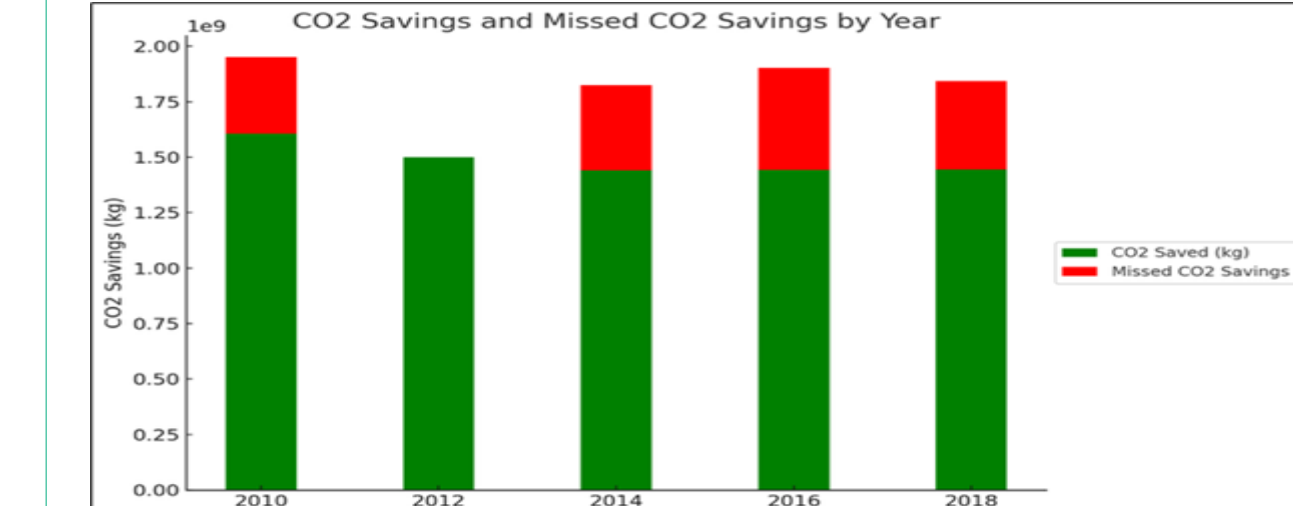
* Compared to paper waste, textile waste offers a significantly higher carbon emission saving of 14,760 kg.CO2e per tonne recycled, yet paper waste consistently has higher overall CO2 savings due to its much larger generation rate.
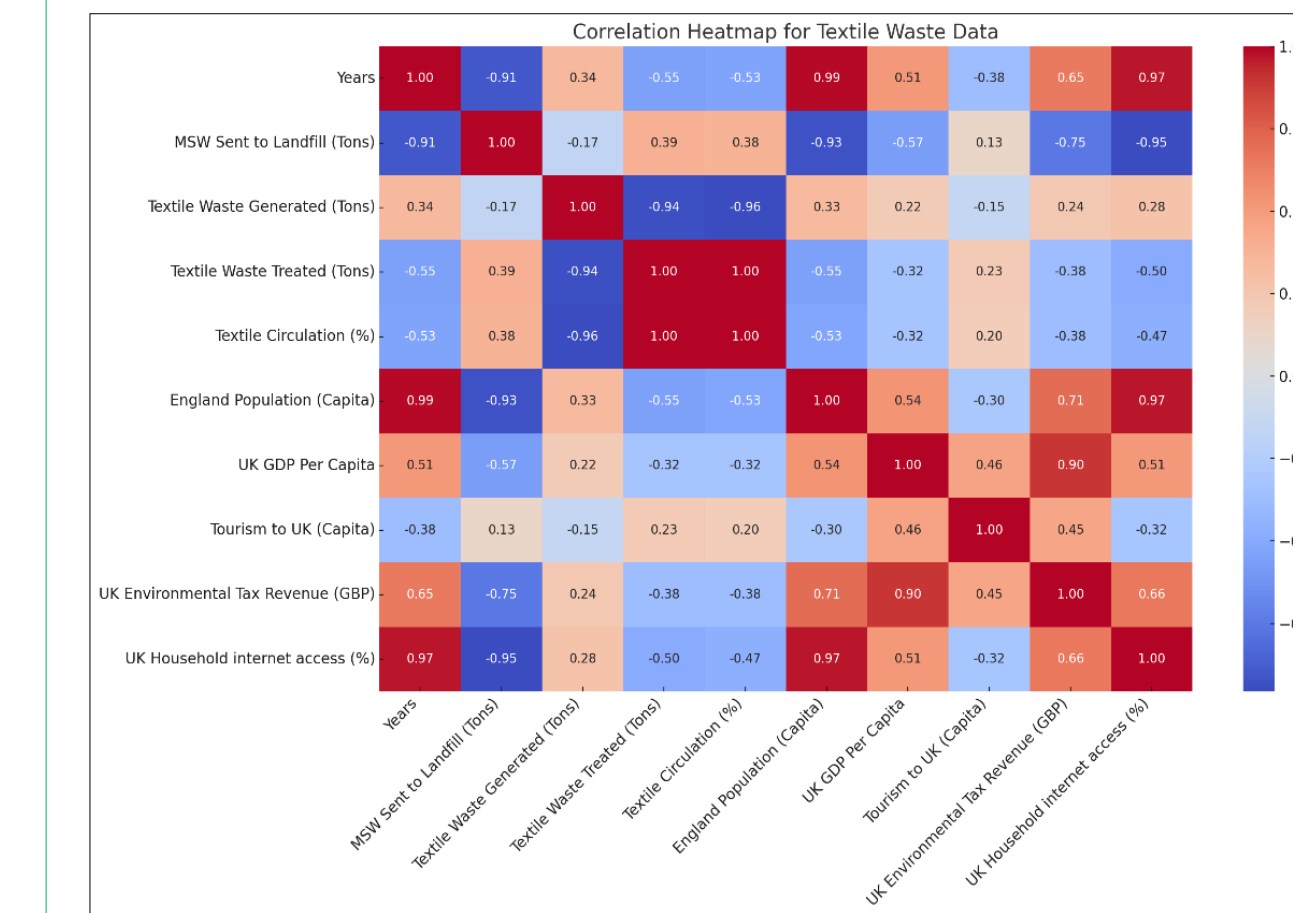
* The moderate negative correlation between the treatment of textile waste and the years suggests improvements in textile waste management, although not as pronounced as for paper waste.

* The less strong correlation between socioeconomic factors such as "England Population (Capita)" and "UK GDP Per Capita" with textile waste indicates that textile waste generation and landfill usage are not directly proportional to economic and population growth.

Future work

Future research will comprehensively analyze the **20 03 01** waste stream to identify economic and environmental losses. This includes quantifying all types of municipal waste, assessing current practices, and calculating potential revenue losses and CO2 emissions from non-recycled materials. A model will be developed to optimize waste management strategies, aiming to maximize recycling rates and minimize landfill use. The research will create a robust, scalable strategy to validate in selected regions and formulate policy recommendations to support improved practices. This holistic approach will enhance economic efficiency and environmental sustainability, providing a framework applicable to various regions and waste contexts enabling them to decouple growth form resources and waste, facilitating their sustainability transformation.

References

1. DEFRA. (2021). Statistics on waste managed by local authorities in England in 2020/21.
2. Defra. (2021). Waste Management Plan for England. www.gov.uk/defra
3. Environment Agency, SEPA, & Natural Resources Wales. (2021). Guidance on the classification and assessment of waste (1st Edition v1.2.GB) Waste Classification. www.sepa.org.uk
4. European Environment Agency. (2019). Reducing loss of resources from waste management is key to strengthening the circular economy in Europe.
5. Voulvoulis, N. (2022). Transitioning to a sustainable circular economy: The transformation required to decouple growth from environmental degradation.
6. Official Journal of the European Union. (2008). DIRECTIVE 2008/98/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 November 2008 on waste and repealing certain Directives.
7. Xevgenos, D., Papadaskalopoulou, C., Panaretou, V., Moustakas, K., & Malamis, D. (2015). Success Stories for Recycling of MSW at Municipal Level: A Review. In Waste and Biomass Valorization (Vol. 6, Issue 5, pp. 657–684). Kluwer Academic Publishers. https://doi.org/10.1007/s12649-015-9389-9