Closing the Loop for Used PPE

Workplace Barriers and Enablers for Circular Solutions

AUTHORS

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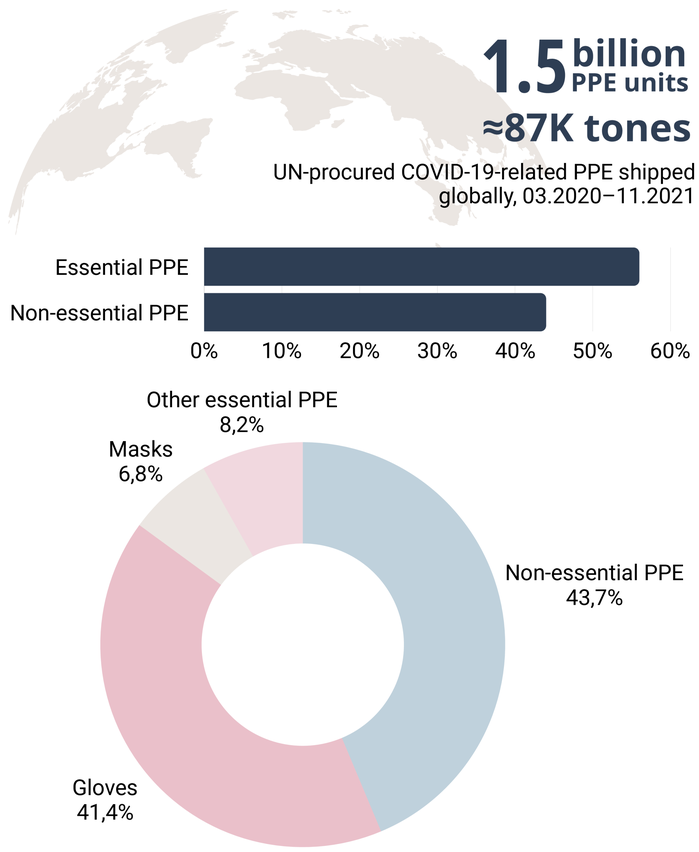
ABSTRACT

The use of personal protective equipment (PPE) across sectors, together with circular-economy expectations, increases pressure to move beyond disposal toward recycling, downcycling, and upcycling of used PPE. In real workplaces, PPE waste is rarely homogeneous: it often combines mixed polymers, multi-material designs, coatings and adhesives, and variable levels of biological or chemical contamination. These features create major technological and organizational barriers, from segregation at source and temporary storage to transport, pre-treatment, and quality assurance of secondary materials. Existing guidance is fragmented, leading to uncertainty about minimum collection conditions, contamination control measures, traceability, and acceptance criteria used by waste operators and recyclers.

OBJECTIVE

This poster presents initial findings from a national research task conducted under the VII stage of the Polish Government Programme for Improving Working Conditions, based on mapping of PPE waste types, volumes, current disposal practices, contamination scenarios, and logistical constraints. Building on the identified gaps, we outline priority standardization needs and suggest initial directions for recommendations to enable safe, scalable pilots and more predictable circular routes for used PPE.

FIGURE 1. PPE WASTE STREAMS AND VOLUMES



CIRCULAR PATHWAYS

Quantitative data on PPE waste volumes come mainly from the COVID-19 period and show the scale of the problem rather than total global PPE waste. UN-procured COVID-19-related PPE alone represented approx. 87K tonnes, including 49K tonnes of essential PPE and 38K tonnes of non-essential PPE (Fig. 1).

PPE waste is heterogeneous in terms of materials, design, contamination, use patterns and regulatory requirements (Fig. 2), which makes one universal recovery pathway difficult to define. A practical first step is to focus on PPE made mainly from thermoplastic polymers, such as selected face masks, safety helmets and eye/face protectors. Although these products differ in function, they may share comparable processing routes, including sorting, disassembly, decontamination, mechanical recycling, reprocessing and polymer recovery.

Effective implementation requires not only technical recycling options, but also enabling actions such as source segregation, stream identification, pre-treatment protocols, dedicated collection procedures, standardised labelling, traceability, clear acceptance criteria, collaboration, training and pilot programmes (Fig. 3). These elements provide the operational and organisational foundation for moving PPE from disposal-oriented management towards circular recovery pathways.

FIGURE 2. MAIN BARRIERS TO CIRCULAR ROUTES

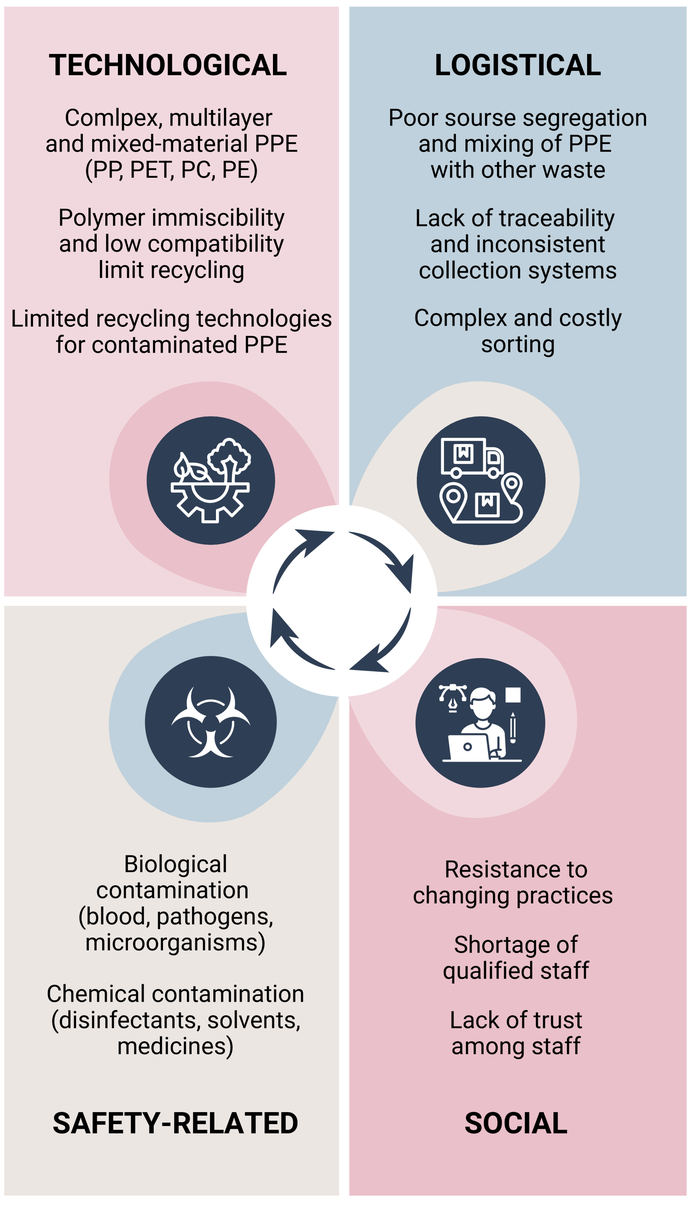
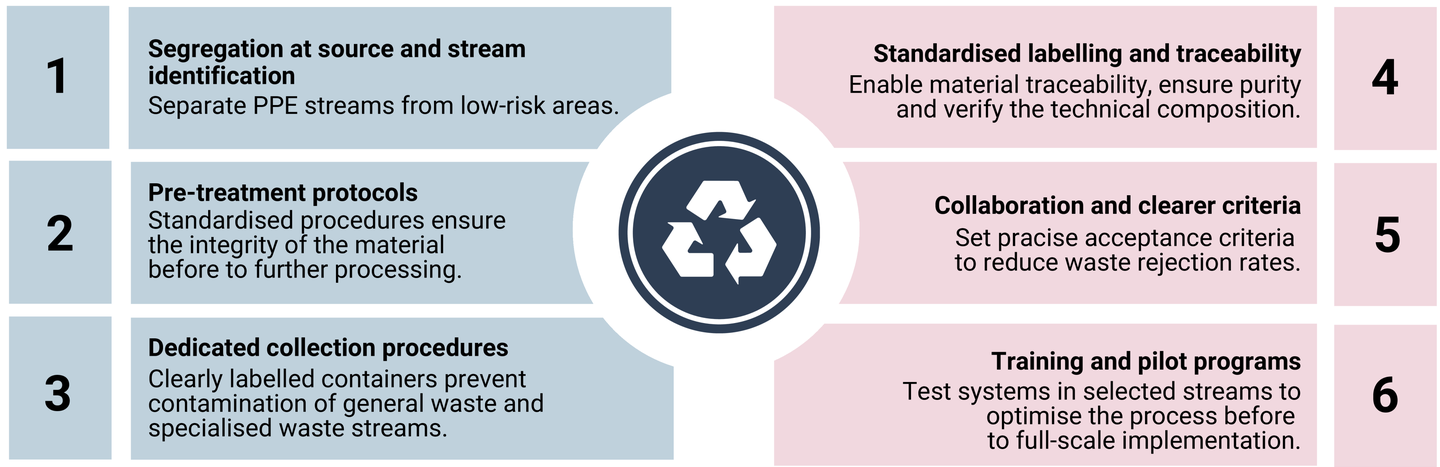


FIGURE 3. ENABLERS AND PRIORITY ACTIONS



CONCLUSIONS

- Used PPE is rarely a clean, homogeneous waste stream, which limits straightforward recycling pathways.
- Workplace-level conditions - especially segregation, contamination control, storage and traceability - are critical determinants of circular feasibility.
- Circular solutions should initially focus on selected, lower-risk PPE waste streams with clearly defined collection and acceptance criteria.
- Further guidance and standardisation are needed to enable safe pilot schemes and support the transition from disposal to circular management of PPE waste.
- Further research is needed to determine which PPE waste streams can be safely and effectively redirected to circular routes, taking into account material properties, contamination levels and OSH requirements.

REFERENCES

1. WHO. Global analysis of healthcare waste in the context of COVID-19. 2022.
2. Rowan NJ, Laffey JG. Sci Total Environ. 2021;752:142259.
3. Singh SK et al. Int J Prod Res. 2022;60(10):3282–3303.
4. Infurna G et al. Polymers. 2026;18(3):336.
5. Belyamani I. Waste Manag Bull. 2025;3(4):100269.
6. European Commission. Circular Economy Action Plan. 2020.
7. European Commission. EU Strategy for Sustainable and Circular Textiles. 2022.
8. European Commission. Ecodesign for Sustainable Products Regulation. 2024.
9. European Commission JRC. Safe and Sustainable by Design framework. 2024.

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