Digitalization for a Circular Economy

Summary notes of a practitioners' exchange about digital circular solutions

1. Background and Rational

Since 1970, global resource extraction has tripled and is, in combination with processing, responsible for about 50% of global greenhouse gas emissions and 90% of biodiversity loss (UN Environment, 2019). These global environmental challenges make a systemic sustainable transformation to a circular economy - as nature's equivalent of 'living within your means' - necessary as it reduces dependency on finite resources and decouples economic growth from resource consumption and environmental pollution. At the same time the Digitalization, the transformation of analog into digital processes, is an enabler for the circular economy.

Digitalization often also leads to an increased collection of data. Accurate, up-to-date, and relevant data sets are the foundation for quantitative and qualitative analyses and enhance **transparency** and **traceability**. Digital technologies can **improve** processes and logistics at different stages of the value chain e.g., through smart-waste management systems making collection, tracking, tracing, and/or recycling more efficient. The **conversion**, development, and establishment of business models is enabled through digital innovation. Digital exchange platforms for example, decrease transaction costs for reuse business models. Digitalization offers a variety of **transformative** opportunities if the circular economy is seen as data economy (Ramesohl, Berg, Wirtz, 2022). However, data only acquires a value if it is fit for purpose, accessible, and if the context of its collection is known (Ramesohl, Sebestyén, Berg, 2022). The kind of data needed for different purposes depends on the context and the stage of the value chain addressed. This shows that for a successful transformation, cooperation between relevant stakeholders from different sectors with different business models is crucial.

With more than 400 members from different fields and from all over the world, the PREVENT Waste Alliance can play a key role in promoting the exchange between digital circular economy actors and enabling data cooperation and to tackle challenges jointly. In November 2021 PREVENT started to discuss how digital tools can support a circular economy, especially in low- and middle-income countries.

In a first step members jointly defined challenges, common areas of interest and options for collaboration and exchange. The following main challenges to be jointly addressed included:

- Harmonization or interoperability of apps in same part of the value chain or into other supply chain enterprise software,
- Implementation of transparency and traceability in the supply chain,
- Indicators to measure effectiveness of digital approaches,
- Modularity or open source,
- Fraud prevention and
- Compliance with national reporting schemes.

Given the extremely wide scope of digitalization as a topic, the large diversity of activities of members which result in a large variety of challenges, the working group decided to break down its approach to three main steps. Firstly, it created a mapping of digital solutions within PREVENT along the whole value chain. To dive deeper into these digital solutions, 15 digital tools were presented and discussed in a *Digital Series*. The mapping and exchange were finally used to define the scope, mission, and specific challenges to be addressed by the working group.

2. Mapping of digital solutions within PREVENT

The role of each digital actor in the circular economy differs across the value chain. To use the full transformative potential of the digitalization for the circular economy, digital actors need to be aware of their own role and their interconnections to actors on other stages of the value chain. If for example a product is designed sustainably and manufactured in a reliable, modular, durable, repairable and/or expandable way, reusing or recycling it will be facilitated (Piétron, Staab, Hofmann, 2022).

To reach a better understanding of the roles of and interconnections between different digital actors within PREVENT, a mapping of digital solutions across the circular economy was created (see page 3). As a next step, the mapping was used to create a structured overview of these solutions: Airtable - Gallery Digital solutions within PREVENT. It includes the main functions, target group, technologies used, the main problems/ solutions addressed and the tool's geographical scope. Additionally, GIZ has published an overview on Digital Approaches for the Circular Economy in Low- and Middle-Income Countries (giz.de).

The mapping of solutions suggests that most PREVENT members cluster at the collection-recycling interface where products reach their end-of-life and enter the waste management system (status March 2023). As shown below this is also reflected in many tools' concrete goals and functions even if other parts of the value chain are also addressed. The mapping also shows that most solutions focus more than one part of the value chain or follow the product along its lifecycle.

Waste collection apps to enhance waste collection
- Connect waste collectors, recyclers and/or producers,
- Valorise waste through standardisation and certification
- Increase waste traceability e.g., through blockchain-enabled tracking
- Improving working conditions and fairer compensation for informal waste collectors through increased transparency
- Integrate informal waste collection with Extended Producer Responsibility (EPR)

Marine litter monitoring tools to facilitate the assessment of litter impact and the effectiveness of waste interventions

Tracer-based sorting to improve identification of different material fractions for the recycling process
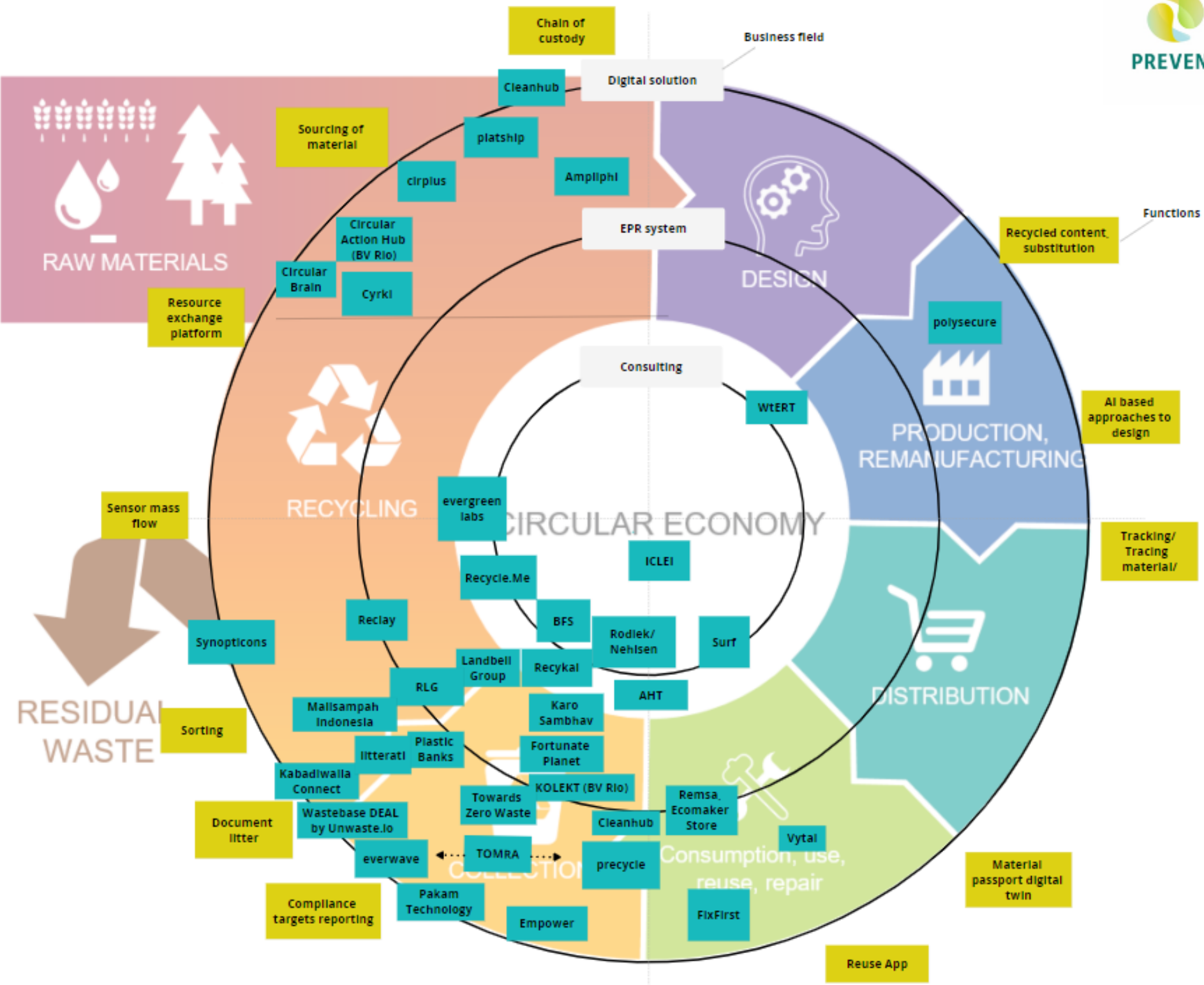
Standards in Resource Platforms to create a market for recycled materials
- Provide the infrastructure for reversed logistics
- Create digital marketplaces for recycled materials
- Ensure a quality standard for recycled material
- Establish standard market (and financing) mechanisms like plastic credits

Recycling guidance to make recycling easier for consumers

Digital compliance reporting tools which assist companies to achieve sustainability requirements
- Increase transparency and traceability of material streams
- Connect waste collection with companies' reporting schemes
- Help companies to understand and reduce their environmental footprints
- Support companies to fulfill their Extended Producer Responsibility (EPR)

PREVENT

CIRCULAR ECONOMY

Business field

Functions

Business fields (circle segments)
- RAW MATERIALS
- DESIGN
- PRODUCTION, REMANUFACTURING
- DISTRIBUTION
- Consumption, use, reuse, repair
- COLLECTION
- RECYCLING
- RESIDUAL WASTE

Function labels (yellow)
- Chain of custody
- Sourcing of material
- Resource exchange platform
- Sensor mass flow
- Sorting
- Document litter
- Compliance targets reporting
- Reuse App
- Material passport digital twin
- Tracking/ Tracing material/
- AI based approaches to design
- Recycled content substitution

Center labels (white boxes)
- Digital solution
- EPR system
- Consulting

Organizations (teal boxes)
- Cleanhub
- platship
- Ampliphi
- cirplus
- Circular Action Hub (BV Rio)
- Circular Brain
- Cyrkl
- polysecure
- WtERT
- evergreen labs
- ICLEI
- Recycle.Me
- Reclay
- BFS
- Rodiek/ Nehlsen
- Surf
- Synopticons
- Landbell Group
- Recykal
- AHT
- RLG
- Malisampah Indonesia
- Karo Sambhav
- litterati
- Plastic Banks
- Fortunate Planet
- Kabadiwalla Connect
- KOLEKT (BV Rio)
- Remsa. Ecomaker Store
- Wastebase DEAL by Unwaste.io
- Towards Zero Waste
- Cleanhub
- Vytal
- everwave
- TOMRA
- precycle
- FixFirst
- Pakam Technology
- Empower

3. Circular economy aspects addressed through digital tools

The exchanges in the *Digital Series* demonstrated that digital tools usually cover more than one part of the value chain and several functions such as traceability, financing, and compliance reporting. The main aspects addressed by digital tools are:

Traceability is important for high quality input material and recycling. It is not clear how information on e.g., bar codes can be transferred through the whole plastics value chain. Product passes or collecting data on all steps of the value chain, including production, could improve traceability in the future.

Transparency generated by digitalization is not welcomed by all stakeholders as this may lead to having to pay for additional taxes. Thus, the perspectives of different stakeholders (waste pickers but also recyclers or aggregators) should be considered. Transparency also contributes to fraud prevention by e.g., making double-bookings of collections more difficult.

Fraud prevention and trust remain challenges. One main risk is the duplication of certificates. This might be avoided by control mechanisms like the distribution of responsibilities and mandatory open-source registries that disable double bookings. Still, random checks and stock controls must take place. Real stocks and stocks in system or bar codes alone do not solve the problem. Possible solutions include using photos of material and scales. Further the establishment of a reputation system which differentiates between "good" and "bad" operators can be applied. Evaluation criteria could be the responsiveness, liability, and quality of deliveries. Blockchain solutions with trust-building records might be a technological solution.

Demonstrate Compliance: Digital tools can also be used to demonstrate compliance in terms of collection, recycling, and recovery rates within a regulatory framework. This can for example happen through reporting (declare what has been collected as base for payment and audit), transactions (trigger activity of reverse chain actors and track waste to increase trust on waste reported), and traceability and documentation as alternative to manual waste transfer notes. One main challenge to compliance reporting are the different compliance standards among countries. Hence there is a need to integrate all participants, e. g. through apps, API, clerk, or email, and data from different sources and for a support system for the compliance schemes and government programs. As adjustments to the systems are needed all the time, it also has to take changes in regulation into account. Yet, there is too little harmonization on the global level. Reporting tools can simplify this process and ensure that datasets of different systems are comparable. Karo Sambhav for example created a reporting system that went beyond compliance requirements. Thereby, compliance becomes a small part of larger dataset contributing to further reporting requirements and improving living conditions, and not focusing on cost saving elements often associated with digital approaches. This shows that, even if systems are set up for compliance, their advantages can go beyond reporting.

Pay for service provision not material value. Waste pickers receive payments depending on the value of material and are not being paid for the work they do, which leads to insufficient incentives to collect low value material. A possible solution is paying a premium price for services based on the area cleaned, hours worked or other shadow prices which are not based on market value of the material. Digital tools could offer that service.

Need to cover all types of materials/waste in the value chain. Therefore, a commonly agreed definition on the core process steps of the value chain of waste management and recycling would be helpful. Please refer to the PREVENT dialog on Plastic Credits.

Working with trading platforms. Circular Brain integrated a logistic solution developed by Mercado Libre and cooperated with a start-up in Brazil which manages small retail shops in Brazil. There, users can drop their products which are then transported to a warehouse. This reduced collection costs. Other experience showed that it seems tempting to use power of B2C platforms, but it is more complex to create constant procurement streams between companies (B2B) than to manage B2C purchases: different sale scale as you want to include companies, higher quantities, products are much less standardized, higher volume of money.

4. Interoperability as a challenge for the digital circular economy

It became clear that, similar approaches are being developed in the same operational space and targeting the same section of the value chain. Some of the tools are developed locally, others internationally and then entering local markets. In Indonesia alone about 20 national and international apps exist in parallel. Therefore, interoperability has been identified as the main challenge for the digital circular economy.

The need and potential to **interoperate** among the individual solutions/ platforms seems obvious to increase impact in an international market in which not all platforms do operate in all countries. Allowing for information exchange amongst the different systems can ensure that duplication and double counting of efforts are avoided, and internationally developed solutions do not drive local operators out of the market.

This can cover linking collection apps to resource marketing platforms, or the integration into enterprise business software of producers or other actors (e.g., SAP supply chain software). Several providers (e.g., Empower) have started working on this and these enterprise solutions might be an interesting way forward.

Another possibility to increase interoperability that has been discussed, is the integration of different apps in a modular way using low level data, such as phone numbers, as connection and entry points. If apps are open from technical point of view, functions can be integrated to other apps or software through well-defined Application Programming Interfaces (APIs) as done e.g., by KOLEKT in Vietnam (by BVRio) with phone numbers, so that standard dimensions/measurement units are matched (e.g., bottle, vs. tons, and kg). The collected data could be integrated into a centralized data base.

There are also several challenges for improved interoperability such as the differences of local contexts. These have to be considered for the adaptation of technologies (e.g., start from generators, not collectors). Moreover, some providers may be more open to share data than others. Collaborative data sharing is not a common practice among actors in the private sector.

Three types of interoperability

- Syntactic interoperability: Systems use common data formats and communication protocols and can communicate with each other
- Semantic interoperability: The ability of systems to automatically interpret the information exchanged meaningfully and accurately to produce useful results as defined by the end users of both systems.
- Cross-domain interoperability: Multiple stakeholders work together for a common interest or information exchange.

Recommendations to foster interoperability between apps targeting different parts of the value chain:

Connecting different actors: There are many different actors in the waste sector like (informal) waste pickers, recyclers, or private companies. To effectively reduce waste and increase recycling, especially those actors who cover different parts of the value chain must be connected. The national and local governments should also be included in the process.
This includes considering the specific needs of each group. Waste pickers in the informal sector might for example not own a bank account, nor a smartphone. These challenges could be tackled by prepaid card systems or shared smartphones using face identification.

Information/data sharing: Everyone can agree on the need of data collection. In this context it is crucial to verify the included data. At the same time, local conditions and regulations on the data collection must be considered. That usually starts with glossary of terms and including harmonized data points and dimensions.

To improve resource efficiency and enable interoperability between apps a minimum standard of data or information sharing should be agreed on. One possible low-level connection point might be the phone number. However, due to risks of conflicts of interest, too much information sharing might not be desirable for apps targeting the same part of the value chain. Therefore, to enable pro-active data sharing, there should also be a trustworthy data governance including a clear infrastructure and an agreed-upon limit to information sharing.

Common standards on plastics: Procuring and trading recycled plastics is not easy. As markets are fragmented, it is difficult to secure a consistent quality and quantity. Furthermore, market actors are often not digitalized. For collector's apps the pick-up/collections needs should be synchronized. That would harmonize the collected materials by function (cups, food trays, etc.), haptic (e.g., rigid plastic, soft or mixed plastics) and international types. In practice the classification of plastics can differ substantially. While some providers use rather simple classifications, some send samples to different certified laboratories to test e.g., the quality of plastics. The industry standard facilitated by cirplus and DIN for the classification of recycled plastics based on data quality levels for use and digital trading (DIN SPEC 91446) is relevant in this context. The next step is to try to turn the DIN norm into a European Standard at CEN/CENELEC and apply it in practice.

Data security & adopting to technology standards. Data security is important and best practice needs to be applied. Working remotely with low connectivity, solutions may need to be made available offline, which creates special requirements such as encryption. Although smart phones become more common, feature phones are still used widely. KOLEKT uses face recognition that allows phone sharing for those who do not own their own device. MallSampah applies a hybrid format where collectors can also contact an admin to connect users and collectors.

5. Reflection of the exchange round

The exchange was perceived very positive among members and has led to matchmaking and exchange. The quotes above show, that the PREVENT working group seems to enable active collaboration and information sharing among its digital members and can therefore be seen as a *Circular Economy Ecosystem* which can contribute to increasing interoperability.

Voices on PREVENT´s potential role

"Our strength - in our relatively young industry and in PREVENT - is the collaboration and information sharing which is important for interoperability. For functional waste management, we need to ask ourselves, what we can bring into the discussion, and we must decide which information to share." *(Pascal Ritter, 25.03.2022)*

"We would benefit by having as much support as possible as we are currently building the base for an open-source registry and are talking to many potentially interested organisations. PREVENT and its network would be a good partner to make this happen." *(Wilhelm Myrer, 05.05.2022)*

To align the needs and interests of its diverse digital members, the digitalization working group will continue to find synergies between actors through matchmaking sessions. In these sessions local actors provide knowledge on local conditions and international companies can share insights on international markets. Actors with similar interests and goals to increase their individual impact will continue to be connected, e.g. specific collaborations with experts in Artificial Intelligence. Lessons learned from pilot projects and processes within PREVENT (e.g. the Indonesian Pilot Project) will be shared.

6. Next Steps: Call for interoperability

As one lever for better data and digital cooperation interoperability was identified. To improve interoperability among data sets and digital solutions, the working group will initiate a Call for Interoperability:

Call for interoperability on marine litter prevention addressing the specific challenges of municipal litter detection and plastic assessment. The call addressed two challenges 1) Detecting plastic litter via non-traditional data sources such as satellite data, drone imagery, crowdsourcing data and 2) Using the identified litter hotspots to suggest counter measures – through prediction mechanism of most effective measures, based on a quick assessment (e.g., Waste Flow Diagram). This is builds on experience of a joint project of the GIZ data lab, the GIZ project Go Circular and Ampliphi showing how non-traditional data can substantially reduce research and development costs while improving the robustness of plastic leakage assessments.

The call invites PREVENT members and interested organizations to join and may follow these steps:
- Agree on information that needs to be shared to let interoperability work
- Collecting data samples from stakeholders
- Identify connection points between different tools and data sources
- Assessing interoperability potential of collected data samples and defining recommendations for enhanced interoperability
- Facilitation of agreeing on common standards and common data protocols
- Publish project insights and establish data cooperatives
- A further call for interoperability might initiated depending on demand from the PREVENT members and experience of the first call.

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This paper was developed within the PREVENT sub-working group on digitalization. The views and opinions of the authors do not necessarily reflect the positions of all PREVENT Waste Alliance members or official policy positions of the governments involved.