

# Bridging the gaps: recommendations for improving the status quo pertaining to textile waste data discrepancies in the Czech Republic

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## Summary

*This article provides an in-depth analysis of textile waste streams and pertaining data gaps at various levels in the Czech Republic, focusing on identifying and quantifying data gaps that hinder accurate material flow analyses. The research was conducted through a combination of existing data collection from available statistics and semi-structured interviews with 25 key stakeholders across the textile supply chain, including manufacturers, waste managers, and recycling entities. The study uncovered significant data gaps in areas such as textile waste from producers generating less than 100 tons per year, deadstock disposal, and textile waste in mixed municipal waste. These gaps present challenges to effective waste management and the implementation of the European Union's Strategy for Sustainable and Circular Textiles. The findings also highlight the critical need for standardised data collection methodologies and enhanced collaboration among stakeholders to improve data accuracy and support the transition to a circular economy in the textile sector. The article concludes with targeted recommendations for improving data collection practices and policy frameworks to address these gaps and facilitate better decision-making for sustainable textile management in the Czech Republic*

**Keywords:** Textile waste, data gaps, textile waste management, circular economy, circular waste management

## Introduction

The textile industry, alongside textile waste management are extremely complex ecosystems, which historically lack transparency and are entrenched in major social and environmental issues, including large amounts of emissions, land use, and water degradation, as well as dire human rights infringements, unfit working conditions and issues of child labour. It is difficult to approach the topic holistically due to the aforementioned lack of transparency, but it is also impossible to focus only on a certain part of it without underlining the importance of the bigger picture. Hence, though this publication's main area of focus is textile waste and data gaps in the Czech Republic, this topic is approached within the larger framework of a problematic global textile sector.

The Circular Economy (CE) is perceived as a means to move beyond the linear approach of producing and consuming, which involves taking, making, and disposing of products, and instead implementing a circular system that preserves the value of materials, products, and resources within the economy for as long as possible<sup>1</sup>. A simpler definition is used by the consultancy Material Economics, which states that they "include under the umbrella of 'circular economy' any opportunity to provide the same economic service with less primary material"<sup>2</sup>. With the aim of operationalizing these definitions through concrete steps, the European Union (EU) has decided to promote circularity by embedding it

within the European Green Deal. Specifically, the EU has taken a significant step towards sustainability in the textile industry with the introduction of the EU Strategy for Sustainable and Circular Textiles which was released in 2022, underscoring the pressing need to identify and regulate the social and environmental impacts caused by the fashion and textile sectors. The Commission emphasizes that addressing these issues is now more urgent than ever before<sup>3</sup>.

The implementation of CE in the textile industry encompasses not only environmental impacts, but also social aspects across the entire supply and distribution chain. These social aspects involve challenges that begin at the very outset of raw material cultivation, extending through manufacturing facilities, and are closely linked to working conditions, fair wages, and occupational health and safety. This also includes minimising health risks associated with the use of harmful chemicals, thereby protecting both workers and end consumers<sup>4</sup>. A key approach within this framework is the extended producer responsibility (EPR), which obligates manufacturers to manage the entire lifecycle of their products, aiming to promote circularity and enhance end-of-life management<sup>5</sup>. The activities associated with CE also pose a threat to occupational health and safety due to the global waste trade, which tend to flow from Global North countries to the Global South. These waste streams are driven by the high costs of waste management in domestic markets and gaps in global waste legislation. In the countries of the Global South, the most disadvantaged population groups are exposed to this waste, creating significant health and safety risks<sup>6</sup>.

One of the reasons why the EU focuses on textiles is the fact that annually approximately 2.1 million tonnes of consumer clothing and home textiles for recycling or sale on global reuse markets are collected in the EU. This accounts for roughly 38% of the textiles introduced to the EU market, leaving the remaining 62% to be disposed of as mixed waste, according to research conducted by Kohler et al. (2021)<sup>7</sup> and the European Commission (2022)<sup>3</sup>. The EU Strategy for Sustainable and Circular Textiles acknowledges the harmful environmental effects of the textile sector and aims to transform textiles into more durable, repairable, reusable, and recyclable products. Its implementation will have implications for consumers and businesses alike, both within and outside of the EU, with a focus on enhancing transparency, sustainability, and accountability throughout the textile supply chain. By embracing this strategy, the European Commission seeks to engage designers, manufacturers, retailers, advertisers, and citizens in reshaping the fashion industry. The main objectives of the EU Strategy for Sustainable and Circular Textiles are as follows:

- Improving the sustainability of the textile industry: The aim is to reduce the environmental impacts of the textile industry, including greenhouse gas emissions reduction, increased resource utilisation, and waste generation reduction, while promoting sustainable production and consumption of textile products.
- Supporting the transition to a circular economy: The strategy focuses on promoting the adoption of circular models in the textile industry. The goal is to, amongst others, support reuse, upcycling and recycling of textile products.
- Increasing transparency and awareness: The strategy aims to enhance transparency throughout the textile supply chain, provide consumers with information about the sustainability and composition of products, and promote conscious decision-making when purchasing textile goods.
- Supporting innovation and digitalization: The strategy emphasises the support for innovation and digitalisation in the textile industry to achieve sustainable and efficient solutions. It also promotes research and development of new technologies and materials.

To effectively achieve the set environmental objectives and benchmarks of the EU Strategy for Sustainable and Circular Textiles, it is imperative for policy-makers and all relevant stakeholders to employ strategies grounded in solid, empirical data. Yet, the gap in data on textile waste is significant at the moment. It is precisely for the positive political decisions related to measures in the area of the circular economy that the analysis of material flows is promoted as a tool. It is evident that mapping data gaps and the conduction of material flow analyses of textile waste for individual countries in the future will be crucial for fulfilling the objectives of the EU Strategy for Sustainable and Circular Textiles. Achieving effective combined CE monitoring will require harmonisation of data reporting across the supply chain and a more intensive dialogue between stakeholders involved in data provision, collection, and dissemination at the EU level. Current studies of material flow analyses in the EU textile industry

have highlighted significant data gaps and a lack of alignment of definitions for individual processes<sup>8</sup>. Some of the significant data gaps are the absence of data on the exchange and consumption of textiles due to stockpiling by consumers and non-uniform consumption practices of individuals, the distribution between private and institutionalised users, and recycling or downcycling according to the method of material use<sup>8</sup>. Additionally, data on the flow of exported textiles are also missing. Overall, filling these data gaps and aligning definitions for individual processes are necessary steps to promote sustainability and circularity in the textile industry.

Some data on textile waste streams are available upon request from the Czech Statistical Office, as can be seen on the table below, however these are not sufficient nor complete. This insufficiency is due to the absence of specific data, as the Czech Statistical Office does not publish waste management values according to individual catalogue numbers but only according to European Waste Classification codes (EWC-STAT).

**Table 1: Data on textile waste streams from the Czech Statistical Office**

Waste production (year / tons)							
Catalogue number	Waste type / category	2017	2018	2019	2020	2021	2022
040221	Waste from unprocessed textile fibres	321	202	278	175	124	161
040222	Waste from processed textile fibres	43 245	41 544	31 574	26 284	23 834	22 988
150109	Textile packaging	804	621	248	241	265	283
191208	Textile	3 819	6 701	7 743	5 610	6 364	5 932
200110	Clothing	19 631	20 188	23 525	22 852	18 660	24 443
200111	Textile materials	12 156	12 764	12 783	17 848	16 842	14 534
Handling of textile waste (year / percentage)							
	Dispose methods	2017	2018	2019	2020	2021	2022
	Energy recovery	19,1	11,8	14,7	20,0	22,9	22,9
	Material recycling	50,7	45,4	45,6	42,5	53,3	36,6
	Composting	1,8	2,4	2,0	1,3	2,9	2,7
	Landfilling (covering) / backfilling	0,0	0,0	0,0	0,1	0,0	0,0
	Incineration	0,1	0,1	0,2	0,2	0,3	0,3
	Landfilling	28,3	40,3	37,6	35,9	20,7	37,6

### **The importance of material flow analyses and future legislation**

The topic of reducing the environmental impact of textile production throughout its life cycle is not new<sup>9,10</sup>. However, until 2022, no study utilised a Material Flow Analysis (MFA) in the European context in accordance with the EU Waste Framework Directive<sup>11</sup>. The most recent work of this kind has produced a quantification of textile flows using an MFA, including basic theoretical and policy recommendations<sup>12</sup>. An MFA is a methodological tool used to quantify material and energy flows within social-metabolic systems, providing a systematic assessment of the inputs, outputs, and stocks of materials within a defined system boundary (e.g., a city, country, or industrial sector). A "social-metabolic system" refers to the complex interactions between human societies and their material and energy flows. This concept is rooted in the analogy to biological metabolism, where an organism processes nutrients to sustain its functions. Similarly, social-metabolic systems analyse how human societies extract, transform, use, and dispose of natural resources to maintain socio-economic activities. An MFA identifies the most critical flows of the entire system, such as barriers to recycling or missing data, which represents a suitable policy-making tool in the management of resources and waste<sup>13,14</sup>.

Europe is preparing to tighten the collection of data on textile waste as part of a broader effort to increase the sustainability and circularity of the textile industry. A key action proposed in the EU Strategy for Sustainable and Circular Textiles is to stop the destruction of unsold and returned textiles<sup>15</sup>. On December 5, 2023, the Council of the European Union and the European Parliament reached a provisional political agreement on a proposed regulation establishing a framework for setting eco-design requirements for sustainable products (ESPR). This new regulation replaces the existing Ecodesign Directive from 2009 and extends its scope beyond energy-related products to significantly enhance circularity, energy efficiency, resource efficiency, and other environmental sustainability aspects for specific product categories placed on the EU market. Article 20 of the proposed ESPR establishes a general obligation of transparency for economic operators who discard unsold consumer products, including disclosing information on the number of unsold consumer products discarded per year. It also opens the possibility of adopting specific actions to prohibit the destruction of specific groups of unsold consumer products. The EU co-legislators are deciding on a direct prohibition of the destruction of unsold textile products. Small and micro companies would be exempted from this ban, while medium-sized companies would benefit from a six-year exemption. This ban would be applicable two years after the regulation comes into force<sup>16</sup>.

Currently, there is no specific information available on additional Czech national legislation aimed directly at the acquisition and refinement of data on textile waste. However, ongoing efforts to implement and develop strategies for sustainable and circular textiles will undoubtedly lead to further initiatives and legislative actions in this area. This comprehensive approach to data collection and legislative action underscores the importance of accurate material flow analyses and highlights the need for robust data to support the transition to a more sustainable textile industry.

### ***The first steps towards mapping the disposal of textile waste in the Czech Republic***

In the Czech Republic, the responsibility for waste management, including textile waste, falls primarily on municipalities rather than individual households. This is because Czech law mandates that municipalities are responsible for organising and ensuring the collection, transportation, and disposal of municipal waste, which includes waste generated by households. The relevant legislation is Act No. 185/2001 Coll. on Waste, which clearly defines the role of municipalities as waste managers within their jurisdictions. The Ministry of the Environment of the Czech Republic imposed the obligation to create a "methodology for a qualified and quantified assessment of textile production and the flow of worn and reused clothing and textile waste in order to determine the current state, obtain primary data and monitor the effectiveness of preventive measures in the following years" in the Government Regulation 352/2014 on the Waste Management Plan of the Czech Republic for the period 2015 – 2024. However, methodologies are still not available and data gaps are not addressed. The Ministry of Industry and Trade (MIT) stated in the document "The update of the Secondary Raw Materials Policy of the Czech Republic for the period 2019 – 2022"<sup>17</sup> that there is currently not enough basic information about the flow of raw materials in this area. For this reason, MIT has set as one of its main goals the monitoring of the textile industry and the creation of a body that will cover the industry. Currently, however, this has not yet started happening. Cooperation between ministries and the fulfilment of these methodologies is a key aspect for the availability of data for future MFA processing. This is why this article focuses on mapping the current gaps, so that in the near future, these gaps can be bridged by changing data recording obligations for companies and organisations involved in textile management throughout its life cycle. The need for the exploration of this article's topic was confirmed by a roundtable organised in the Czech Republic by Deloitte in 2021. Key stakeholders gathered to address the fundamental question: "What steps can we take today to prevent the waste management system from collapsing due to textiles in municipalities by 2025?" The main responses were two-fold:

1) Acquire comprehensive data and map the material flow: We possess only fragmented information, lacking a basic overall market mapping. It is therefore essential to first acquire comprehensive data and map the material flows of textile materials in the Czech Republic.

2) Support for products made from recycled materials: The support for products utilising secondary raw materials should begin with the state<sup>18</sup>.

The quest for relevant data and the effort to map current data led the Ministry of the Environment to announce a grant call through the Technology Agency of the Czech Republic, resulting in the establishment of CEVOOH (Center for Environmental Research: Waste and Circular Economy and Environmental Safety). The centre, formed by a consortium of eight research organisations and universities, focuses on conducting research in thematic areas related to the Czech Republic's transition from a linear to a circular economic model. One of the first outcomes of the research of CEVOOH is the Analysis of Textile Waste Issues in the Czech Republic, which provided preliminary modelling and the visualisation of textile material flows<sup>19</sup>. However, a significant portion of data that enters the analysis is either inaccurate or missing due to non-existent statistics or the absence of an obligation to report data on textile flows, for example in the prevention regime. The response rate of stakeholders involved in textiles is also low, making such a visualization merely a hypothetical framework and, without accurate data, an unusable political tool. Therefore, another aim of this work is to build upon this visualization and use it to illustrate where data gaps arise.

### ***Different approaches to manage data uncertainty in material flow analyses***

Analyses of material flows (MFA) of textiles and other waste materials at the EU level face several challenges related to data uncertainties, including the lack of standardisation, where different countries use varying methods for data collection, complicating comparisons. Another challenge is the quality and availability of data, as obtaining reliable information on textile flows is often difficult, with many countries lacking comprehensive data on textile consumption and waste management. Additionally, the opacity of supply chains, where the complex and global nature of the textile industry makes tracking materials difficult, leads to frequent inaccuracies. The lack of data on waste flows is not only a problem for the Czech Republic. Numerous MFA studies emerging from EU countries highlight similar issues. In 2015, Seigné-Itoiz et al.<sup>20</sup> conducted a general material flow analysis (MFA) of plastics in Spain, but without confronting official data, which were considered significantly insufficient. Pimentel et al.<sup>21</sup> emphasised the lack of data on material consumption and waste management in the EU, mirroring the situation in countries of the Global South. They also pointed out that MFA has significant potential in designing circular economy management policies. This was confirmed by research in southern European countries, where Lombardi et al.<sup>22</sup> stated that while it is important to conduct national studies to understand the reality in different countries, as the authors emphasise, a major problem in plastic MFA studies is the lack of data and the difficulty of obtaining it<sup>22</sup>. Specifically, in MFA, rather than preparing precise MFA models, basic schemes are often created, or attention is focused on individual sorting centres. Nynne Nørup followed this approach for a specific sorting centre in Sweden, where it was possible to obtain specific data for the facility<sup>23</sup>. In Switzerland, a sectoral analysis specifically for workwear in textiles was also recently conducted, identifying data gaps as a challenge for other countries<sup>24</sup>. Generally, it can be said that thanks to the increasing scientific activity highlighting these data gaps, discussions are currently taking place at the European Commission level not only about common circularity goals but also about data harmonisation. Activities at the level of individual states seem ineffective, uncoordinated, and dysfunctional for meeting common commitments.

Although it is known that MFAs need to be supported by a precise definition of data uncertainties according to known methodologies<sup>25</sup>, often the only available data are individual measurements, interviews, or historical sources. In such cases, uncertainties need to be "roughly estimated" by analysing the data source. The results can be influenced by the method used and the data collected<sup>26</sup>, and it has been shown that the data available in the Czech Republic are insufficient despite the possible additional calculation methods. A concrete possible solution is the Mathematical Material Flow Analysis methodology developed by Baccini and Bader<sup>27</sup>, which is a systematic approach to quantify and analyse the flows and stocks of materials within a defined system. This method involves creating a detailed accounting of all inputs, outputs, and accumulation of materials to understand the behaviour of the system. When data is incomplete or uncertain, mathematical models can be employed to estimate missing values and simulate the system's behaviour under various conditions. This allows for a comprehensive assessment of material cycles, helping to identify inefficiencies and opportunities for improvement. By using mathematical modelling to address uncertainties, the MFA method enhances the accuracy and robustness of environmental and resource management strategies.

Missing data can be modelled mathematically to handle uncertainties by stimulating the behaviour of the system under various conditions. However, the preliminary data collection process uncovered a significant number of missing data points, leading to a pivot towards addressing these gaps.

It is clear that if we want to make good decisions fulfilling the vision of the Strategy for Sustainable Textiles, we need to have as accurate a picture of reality as possible in future MFAs. Evaluating the uncertainty within data is a crucial component of all MFA processes. This ensures that any conclusions drawn can be critically assessed, allowing users and decision-makers to consider the importance of any variances found in the results<sup>28</sup>. And so the research team decided to answer the following basic research questions:

- 1) What are the biggest data gaps in the current management of textile waste in the Czech Republic?
- 2) How can these gaps be quantified?

The aim at this stage was to identify and justify, and ideally quantify data uncertainties, to achieve the highest possible accuracy and relevance of the future MFAs of textile material flow in the Czech Republic.

## Experimental part

In order to obtain a reliable picture of data gaps in the management of textile waste in the Czech Republic, thorough qualitative research was necessary. The first step was to create a list of key actors covering the entire life cycle of textiles, from producers, designers, processors, users, institutions to waste companies or organisations involved in cleaning up trash in nature, as well as research and institutional players. The basic identification of actors was done through snowball sampling, whereby interviewees suggest further relevant stakeholders to get in touch with<sup>29</sup>. The initial identification of actors prioritised those with a link to the circular economy – for research purposes, we identified participants from working groups, platforms, conferences and other programs dedicated to the above-mentioned thematic areas of textile material flows (from production to disposal). We attempted to identify those who play key roles in the textile material flow cycle across the entire lifecycle. This thus included a wide range of stakeholders partaking in activities such as production, collection, recycling or disposal system operation. In total, 25 in-depth semi-structured interviews were conducted. The goal was to find the most significant data gaps in the current system.

In order to comprehensively capture the various stakeholders involved in the textile circular economy, we conducted a structured selection process targeting key actors across the entire "circular cycle" from production to waste management. Initially, we approached members of the Czech Circular Hotspot, leveraging their established interest and active participation in circular economy initiatives. These stakeholders included textile material manufacturers, distributors, collectors, waste management platforms, and non-governmental organisations (NGOs). The selection was based on their visible engagement through media outputs and their demonstrated commitment to circular practices. Furthermore, we employed the snowball sampling method<sup>30</sup>, requesting recommendations from initial participants to identify additional relevant stakeholders. This approach ensured a thorough representation of entities involved in the circular management of textiles, encompassing both well-known and emerging actors within the sector. Some actors wished to remain anonymous.

**Table 2: Overview of interviewees**

Category	Selected actors for in-depth interviews	Number of in-depth interviews
Textile material manufacturers (fibre producers, fabric manufacturers, weavers, dyers, etc.) and garment manufacturers	Toray (yarn production), Anonymous #2 (Large textile manufacturer), Anonymous #3 (SME, textile manufacturer), Cirkulo (clothing company)	4
Distributors / retailers (textile brands distributing clothes to the Czech market)	Anonymous #1 (Wholesale seller of children's clothing), H&M fashion clothing distributor	2
Users (Households, municipalities, public and private institutions)	The City of Prague (waste department), SAKO Brno, Anonymous #4 mayor of a municipality (less than 5,000 inhabitants)	3
Organisations involved in textile reuse (second hand, exchange, resale)	SWAP Prague (organising clothing exchanges among household users), MOMENT charity shop selling vintage clothing	2
Collectors (companies ensuring take-back – both in the EPR scheme and waste management) and sorting lines	DIAKONIE BROUMOV (cooperative ensuring collection, sorting, redistribution of textiles), COMPAG Mladá Boleslav (textile collection)	2
Waste management platforms	CYRKL (digital waste marketplace)	1
Recyclers	Dimatex (textile collection, recycling), Retex	2
Disposal (energy recovery, landfilling)	ZEVO Prague, SAKO Brno (waste-to-energy facility),	2
Organisations involved in nature cleanup	Uklidme Česko( Let's Clean Up Czechia), Trash Hero	2
Research organisations / NGOs	INCIEN (NGO in the field of CE creating the platform Czech Circular Hotspot), RREUSE (think tank focused on reuse, operating at the EU level)	2
Associations, clusters, etc.	SOTEX (association), CLUTEX (association)	2
Government organisations (ministries, etc.)	Ministry of Industry and Trade (responsible for integrating the Strategy for Sustainable Textiles at the national level of the Czech Republic)	1
Total number of actors		25

An existing MFA would be an ideal basis for semi-structured interviews. However, since the data for that is currently insufficient, we have complemented the use of an existing visualisation created by the CEVOOH research team<sup>19</sup> with stakeholder consultations. This can then provide a basis or add legitimacy to MFA study results. A similar approach of combining an MFA with stakeholder consultations has been taken by Volk et al.<sup>31</sup>. Furthermore, the interviews conducted in this research had a semi-structured nature, which allowed the participants to freely engage in a debate after the initial introduction of the interviewee and the researcher in order to create mutual trust and obtain basic information<sup>32</sup>. Interviews are the most common data collection method used<sup>33</sup>, and these semi-structured formats are the most commonly used interview technique in qualitative research<sup>34</sup>. Based on semi-structured interviews, the basic categories of interested parties were determined. The method of collecting and reporting data on textile waste was discussed with individual representatives, including their personal expert experience in the field. The participants were invited into a general conversation on the topic of textile waste management. The individual questions were chosen according to whether they were waste producers or just interested players in the field. The general list of questions was as follows:

- Are you one of the companies that deal with textile materials in the form of physical handling? (production, logistics, recycling, waste management)

- Do you know the data gaps in the current data collection system on the production of textile waste?
- Do you know the exact amount of waste you produce?
- Are you required to report this data?
- Can you estimate the degree of uncertainty that arises when reporting data in the system?
- Do you know other actors who could share their relevant opinion on the subject of data gaps?

In conclusion, in order to visualize the findings in the area of post-consumer waste, a basic conception scheme of an MFA created using the STAN (subSTance flow ANalysis) software was developed according to the Austrian Standard ÖNORM S 2096, allowing consideration of data uncertainties<sup>35</sup>. The MFA methodological framework was applied using widely accepted guidelines based on the work of Brunner & Rechberger<sup>14</sup>. A production approach that uses physical inputs (textile waste) as opposed to monetary inputs (consumption-based approach) was used for quantification<sup>36</sup>. To measure circularity, the input and output flows of the system were aggregated over the entire estimated waste production, and the total regeneration flows were divided by the total output. This method is also used in the Circular Gap Reports studies<sup>37</sup>. The overall circularity rate is subsequently defined by the breakdown of material flows in tons.

### Basic definitions and terms in MFAs

The following relevant definitions and terms for processing an MFA in the above scope and with the given intention were taken from the work of Brunner and Rechberger<sup>25</sup>. Material is a common term in MFAs denoting both a substance and a product. The material in this analysis is the textile waste flow generated at the level of municipalities or textile production enterprises. A process is defined as the transformation, transport or storage of materials. The transformation of materials occurs during primary production processes, such as the production of textiles or the processing of textile waste. Usually, a process is defined as a black box, which means that internal processes within the black box are not considered. Only inputs and outputs are considered. If an internal process is important and should be included in the MFA, then it must be split into two or more subprocesses. Stock is the total amount of material that is in stock for a given process. Flow is defined as "the proportion of the material flow", eg. the proportion of the material flow per time between individual parts of textile processing. The physical unit in this MFA is the amount of tons per year. A system is defined as a group of elements and as relationships between these elements. In an MFA, system elements are called processes or flows. The system can be a company (e.g. a textile production company, a sorting line, a facility for the energy use of textiles), a region or a state. In the MFA system, each product is clearly identified through the origin and destination process. System boundaries for our model are defined within one year, space boundaries are represented by the Czech Republic. Flows within the system that enter individual processes are called inputs and flows that leave the process are called outputs. The STAN system is software used for analysing material flows in various systems, such as the waste textile flow analysis presented here. This software allows for the modelling of material flows and stocks within a specific system, taking into account data gaps and uncertainties in the measured values. The STAN system operates based on the principle of mass balance, meaning that total inputs must equal total outputs (including losses). When only limited or imprecise data is available, STAN allows for their supplementation through estimates or assumptions, which can lead to varying levels of uncertainty that are continuously recalculated and updated.

For this research approach, the principle of so-called emergent design was also used, which is based on the ability to adapt to new ideas, concepts, and findings that emerge during the exploration<sup>38</sup>. Unlike more deductive and structured approaches, emergent design works inductively, adapting to changes in conceptualization, data collection, data analysis, and the composition of research phases. Ongoing proposals facilitate adjustments when participants, events, or data present unexpected information<sup>39,40</sup>. A typical example where emergent design research makes sense is in qualitative interviews or focus groups<sup>39</sup>. At the same time, it is an interactive and situational research where the researcher



continuously evaluates fresh developments and progress and includes new and research-relevant inputs into them<sup>41</sup>. Given the research team's previous experience with material flow analyses, where it was often necessary to change the research approach and supplement data with qualitative research and investigation in practice, the principles of emergent design were chosen as a continuous agile approach to the work in preparing this paper.

## Results

In-depth discussions with key stakeholders revealed a list of fundamental data gaps that need to be addressed in the near future. Only by covering these gaps is there a chance for modelling an accurate analysis of material flows, which can become a relevant basis for sound decision-making by government organisations in the future. To clarify the individual data gaps, a visualisation of each gap is set within the already used scheme by the CEVOOH research team. Although, for example, the CEVOOH team did an excellent job in mapping the current state of textile handling and collecting available data, it turns out that a number of data points are not only missing, but even with maximum effort to obtain data through direct questioning, this approach proves unworkable. Specifically, despite directly contacting stakeholders, some actors (e.g., textile collectors) are not obligated to respond. Consequently, only two textile collectors participated, which is insufficient to cover the entire sector comprehensively. This lack of participation is particularly problematic, as precise information on collection and subsequent handling is crucial for accurate mapping and analysis. These data gaps will be further elaborated in the individual sections detailing the discovered deficiencies.

Given the clarity and quality of the groundwork provided by this study, this schematic diagram was utilised to visualise missing data for a better understanding of the complexity of the entire situation in the experimental part of this work.

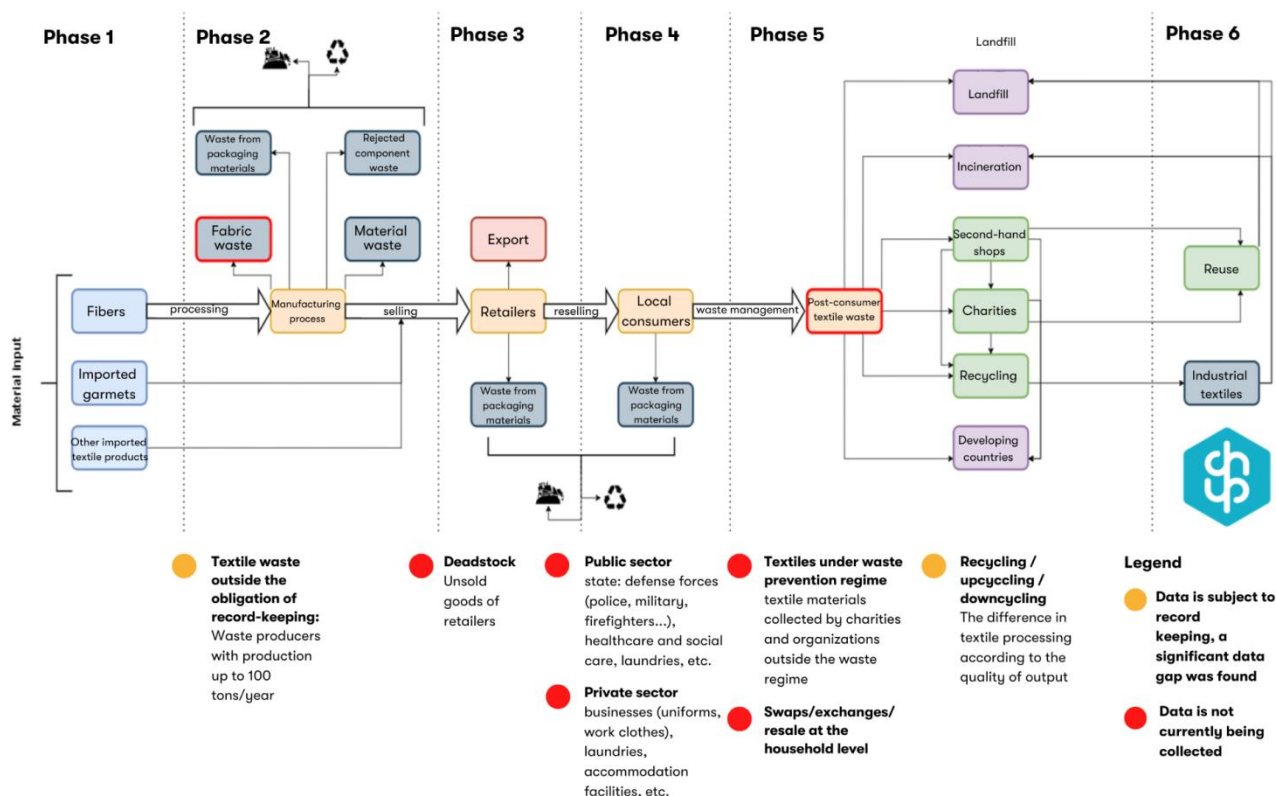


Figure 1: Material Flow Analysis of the Textile Industry (CEVOOH<sup>19</sup>) with Indicated Data Gaps by Degree of Accuracy

**Absence of data on textile waste for producers under 100 tons/year:** The absence of data on textile waste from producers under 100 tons/year was one of the valuable inputs for identifying gaps. The possibility of working with data collected from interviews conducted by Veronika Marešová from the company Cirkulo, whose business model is based on the principle of utilising textile remnants from textile companies, was instrumental. Veronika mapped the activities of 50 companies (knitters, weavers, clothing manufacturers, fabric stores, etc.) with inquiries about the quantity of available textiles and their qualities. The transcripts of the interviews were made available for this research and provide insight into the quantity of textiles produced, how they are further utilised, and in some cases, their estimated amount. About 90% of the respondents in this study deal with textile waste outside the reporting obligations arising from Czech legislation, the Waste Act No. 541/2020 Coll., which mandates reporting waste after exceeding the limit of 600 kg for hazardous waste or 100 tons/year for other wastes (including textiles). These companies thus do not report their data, creating a data gap in otherwise available data in the ISOH database (Information System of Waste Management). These producers often talk about quantities on a weekly level (which can also be estimated considering the export of textile waste by waste companies, transfer for processing to other entities, or donations for charitable or creative purposes to local charities or schools). These companies produce textiles in the range of approximately 50 kg - 4 tons/month. In annual totals, these could be lower tens of tons, which although not subject to registration, could in the final estimated total constitute thousands of tons outside of waste records.

**Deadstock:** Discussions with representatives of waste-to-energy facilities confirmed that their facilities carry out material disposal (albeit with energy recovery) of unsold textiles or other stock from private entities. This is new merchandise, which the producer has no interest in reselling or donating to charities or other organisations. This issue is actively addressed by the EU within the new EU Ecodesign Regulation, which concerns a direct ban on the destruction of unsold textiles and footwear. The estimated amount of textiles based on qualitative interviews is in the range of thousands of tons annually within the Czech Republic.

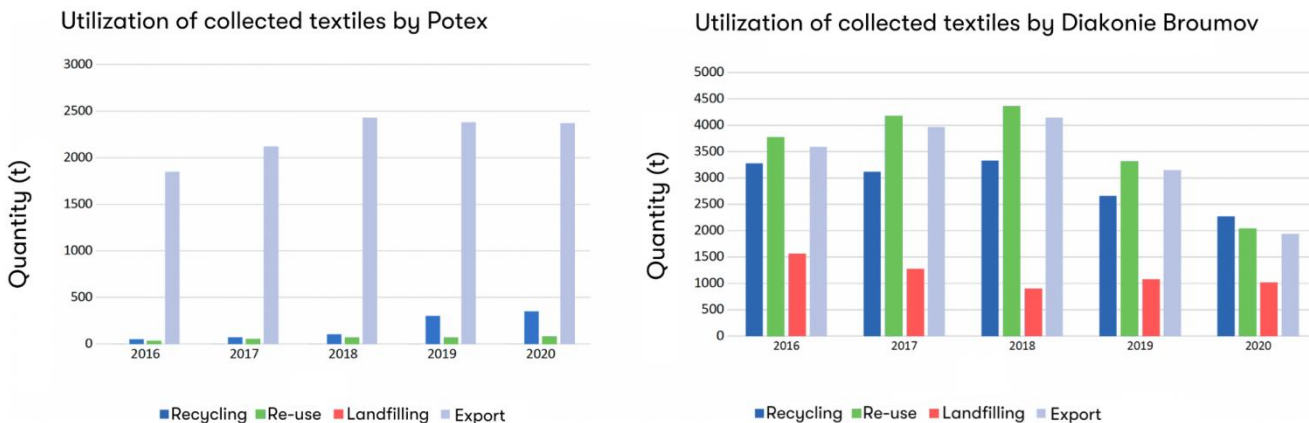
**Textiles in waste prevention mode:** The collection of sorted textiles is carried out in the Czech Republic within a decentralised system of textile collection containers. Currently, about 20 companies collect used textiles in the Czech Republic, which, according to earlier estimates by the Ministry of the Environment, have about ten thousand containers across the country<sup>18</sup>. This data is partially confirmed by an interview with representatives of the organisation Clean Up Czechia (Uklid'me Česko), which operates the "Kam s ním" ("Where to with it?") portal, aiming to map all the places where it is possible to sort waste or return unused products to the cycle in the Czech Republic, with more than 7500 containers or places for textile disposal. It is worth noting that the organisation collects data on textile disposal sites on its own and thus does not provide a completely exhaustive list. Representatives of Clean Up Czechia confirm that the data contains about 80% of the sites. The list is not complete, as many organisations have little interest in visualising collection sites due to competition, not always authorised places for container placement, and also because they are not obliged to provide such complete information. However, textile containers are intended for good quality textiles (damaged textiles should be within mixed municipal waste collection). This material is then transported by the collection system operator to the sorting line, where individual materials are sorted depending on the needs of further processors<sup>42</sup>. Households that currently sort textiles thus practically contribute to two systems: the waste system and waste prevention, although they are not always sufficiently informed about this issue.

Organisations operating a textile collection system can be divided into two groups according to how they handle used material:

- 1) Companies that are authorised to deal with textile waste and used clothing (recorded in the ISOH CENIA database) and
- 2) charitable organisations that collect worn clothing in a waste prevention scheme.

Companies are not legislatively required to record the amount of textiles and report it to the relevant authorities. However, the amount of textiles collected for prevention is a significant part of the collected textiles and remains outside of records, thus representing a data gap and a source of discrepancy in data on total production. Organisations such as Diakonie Broumov, Potex, Dimatex, Czech Red Cross,

Textil Eco, Klok Tex, and Coretex are considered charitable because they collect used textiles and redistribute them to those in need, support various social programs through the proceeds of textile sales, and promote environmental sustainability through recycling efforts. By providing essential clothing to vulnerable populations, funding social and community projects, creating employment opportunities for marginalised groups, and engaging the public in responsible consumption and recycling practices, these organisations deliver significant social, economic, and environmental benefits, thereby embodying the essence of charitable work. The largest collectors include Diakonie Broumov, Dimatex, Potex, and Textil Eco. However, only two organisations provided data, despite high efforts to involve as many organisations as possible.



**Figure 2: Graphs 1 and 2 from CEVOOH defining the amount of textiles collected by survey respondents and the paths of its further utilisation**

When comparing the charts on textile management between two organisations, both of which focus on waste prevention, it is also important to highlight the differences in how they handle this material. It is evident that Potex is highly focused on export (over 90% of the collected textiles), while Diakonie Broumov strives to find ways to recycle or reuse the textiles locally (primarily within the Czech Republic). Two-thirds of the textiles collected by the organisation are processed or utilised in this way. In the future, it will be essential to accurately monitor not only the quantity collected by these organisations but also how the textiles are subsequently managed. The CEVOOH study also states that: "The social cooperative Diakonie Broumov has 852 containers and employs 105 employees, Potex has 11 employees, operates as a private entity, and services 600 containers. Currently, Potex does not charge fees for container collection, while Diakonie Broumov mentioned that they do collect a fee, but its amount is voluntary and depends on the size of the municipality and the number of installed containers." When converting the total amount of collected textiles according to available data (the total amount is not mentioned precisely in the text, therefore the sum is estimated based on visual graphs and the y-axis representing the amount of textiles) and using the knowledge of the number of containers for each company, the amount of textiles collected by other collectors was also estimated. For the company TextilEco a.s., information about the number of containers was found on the website. The company states on its website that it operates more than 7000 collection containers in the Czech Republic, and for the calculation of average yield based on data from POTEX and Diakonie Broumov, it can be assumed that the company annually handles approximately 30 000 - 40 000 tons of textiles.

**Absence of data on textile waste from public and private institutions:** Public institutions (hospitals, hospices, children's homes, other social security institutions, police, military, etc.) and private enterprises (accommodation institutions, companies providing workwear to their employees, etc.) can also potentially be considered significant producers of textile waste. However, data on the amount of textile waste disposed of is not available at all. The data could potentially be mapped through organisations providing garment care (laundries, etc.), but even these entities do not provide data, as they are private entities without a recording obligation. These could amount to lower thousands of tons

annually. Due to the lack of further research focused on mapping textile waste generated by institutions, we can at this point estimate the amount of textile waste from workwear in the Czech Republic by extrapolating from data provided for Switzerland, which is the only relevant study available.<sup>24</sup> In 2019, Switzerland consumed approximately 3,200 tons of workwear, equating to 0.4 kg per capita and 1.6 kg per worker annually. By applying these figures to the Czech Republic, with a population of approximately 10.7 million in 2019, the estimated consumption of workwear would be around 4,280 tons per year based on per capita consumption. Alternatively, considering the approximately 5.3 million economically active individuals in the Czech Republic, the estimated consumption could reach up to 8,480 tons annually based on per worker consumption. This range highlights the potential variation in workwear textile waste generation, emphasising the need for more precise data tailored to the specific economic and occupational conditions in the Czech Republic.

**Textile waste in mixed communal waste:** One of the most significant material flows outside official statistics of standard catalogue numbers is textile waste contained in mixed municipal waste (MMW). Data on textile waste in municipal waste have only been measured in a few scientific projects, with the most extensive dataset provided by The Institute of Circular Economy (INCIEN). The first set of data has already been published and demonstrates that this material flow is evidently substantial in volume. According to the Czech Statistical Office (CSO), the average amount of MMW produced in the Czech Republic between 2018 and 2020 is 2,798,126.67 tons. The average share of textile waste during this period, based on analysed locations, is 6.56%, equating to 183,557 tons. However, this amount is adjusted using a coefficient of 0.74 to account for moisture content, reducing the final amount of textile waste in MMW to 4.86%, or 135,989 tons. In its latest statements, the Ministry of the Environment also indicates that, according to expert estimates, the amount of textiles in mixed municipal waste may reach up to 180,000 tons, highlighting that this data gap is by far the most significant<sup>43</sup>. This highlights the considerable presence of textile waste in MMW and underscores the need for comprehensive data to inform waste management and recycling strategies.

**Data on textile exchange, reuse and further sale:** Another data gap can be identified in the area of clothing reuse. According to the platform "Where to with it?" (and discussions with representatives of Clean Up Czechia, which stands behind it), there are about 50 reuse centres in the Czech Republic, and about 80% of them state on their websites that they accept textiles. This information is also confirmed by the CEVOOH survey. However, reuse centres do not record the amount of textiles reused. Charities also focus on reuse, sorting usable and saleable textiles (see Graphs 1 and 2) and record it as part of reuse (Diakonie Broumov and Potex together state that they return about 1000 tons of textiles to circulation per year through this method). Given the low level of available data and the high number of organisations operating in the waste prevention regime, it is possible that further thousands of tons of textiles are reused annually.

Similarly, other textile sellers are not obliged to record the amount of textiles resold. However, a good practice example is the charitable shop MOMENT, which keeps meticulous records that could serve as a model for implementing systemic changes. In the most recent data available from the year 2023, MOMENT is reported to have sold a total of 66 tons of textiles, amounting to 199,632 individual items. Cumulatively, since they began detailed record-keeping in 2017, they have sold a total of 612 tons of textiles, equating to 1,499,251 pieces. These sales were conducted through seven different outlets in 2023. MOMENT stands out as the only seller that has maintained a detailed and specific record of their textile sales since 2017, demonstrating their commitment to transparency and precise inventory management. This meticulous tracking allows for an accurate assessment of their contributions to textile recycling and reuse efforts.

However, it is necessary to mention that reuse does not only occur after the collection phase within the container system mentioned in the previous chapter. An interesting trend in recent years is the exchange of clothing at the local, community level. From discussions with organisers of so-called SWAP events (clothing exchange events), it was found that since 2017, when these events began being organised in the Czech Republic, about 13,000 visitors have attended, and 115 tons of textiles have been returned to circulation. However, the measurements also include small items such as toys or other household equipment. About 80% of textiles are returned to circulation on-site, and the rest is given to the textile collection company at the event site, especially charitable organisations. The usability rate can

reach up to 97% if it is clearly communicated before the event that only textiles in excellent condition without signs of damage are suitable for exchange. (Note: One of the authors of this work participated in the introduction of a system for weighing garments for pilot testing the amount of textiles returned to circulation at these events).

Repairs and donations should also be mentioned in the category of reuse. In a consumer behaviour study in the field of textile management by Nencková<sup>44</sup>, it was found that only 26% of respondents repair, darn, or re-sew unnecessary clothing, with older people and people from low-income groups doing it most often. However, clothing repairs are crucial in terms of compensating for the environmental impact during the product life cycle: if the average number of times a piece of clothing is worn were to double, then greenhouse gas emissions would be 44% lower<sup>45</sup>. Worn and no longer needed pieces of clothing and other textiles are also further traded on online platforms, which have been gaining users' interest in recent years. In the Czech Republic, the platform Vinted is most widely used, with the international platform Sellpy gaining popularity last year. Sellpy, an online platform for second-hand clothing, has seen a notable increase in popularity in recent years. As of 2023, Sellpy has facilitated the sale and reuse of numerous textile items, contributing to the reduction of textile waste. The platform has garnered attention for its role in promoting sustainable fashion by allowing users to buy and sell pre-owned clothing items. Sellpy operates primarily in Europe and has been expanding its user base, making it a significant player in the second-hand market alongside other platforms like Vinted.

However, data on the amount of textiles reused and resold through these platforms are not available. Further sale and reuse are mainly motivated by economic factors and environmental interests<sup>46</sup>. In recent years, platforms like Vinted have also played an increasingly significant role in the resale and redistribution of textiles. Vinted, a major online marketplace for second-hand clothing, has facilitated the circulation of millions of textile items. As of 2023, Vinted has over 105 million registered users and generated €596 million in revenue, indicating its substantial impact on reducing textile waste by promoting reuse<sup>47,48</sup>. The platform's extensive user base and significant volume of transactions contribute to diverting textiles from landfills and encouraging a circular economy in fashion.

**Overview of upcycling, recycling, and downcycling:** In the Czech Republic, textile upcycling, recycling, and downcycling are key components of sustainable textile management. Upcycling is primarily facilitated by companies such as Cirkulo, which transforms old garments into new, high-quality products, often through creative redesign and repurposing. This process not only extends the life of textiles but also adds value by creating unique, desirable items. Fibre-to-fibre recycling, which involves the mechanical processing of textiles back into fibres for the production of new textiles, is still emerging. Companies like NILMORE are pioneering this method, producing new fibres from recycled materials, although detailed data on the scale and output are limited. Downcycling is more prevalent, where mixed textile waste is mechanically recycled into lower-quality products such as insulation materials or industrial rags. According to the Ministry of the Environment and CENIA, basic aggregated data from individual producers and waste management entities are available, though comprehensive data on fibre-to-fibre recycling and downcycling stages are sparse. This highlights the need for enhanced data collection to better understand these material flows and set targets for continuous improvement in textile recycling practices.

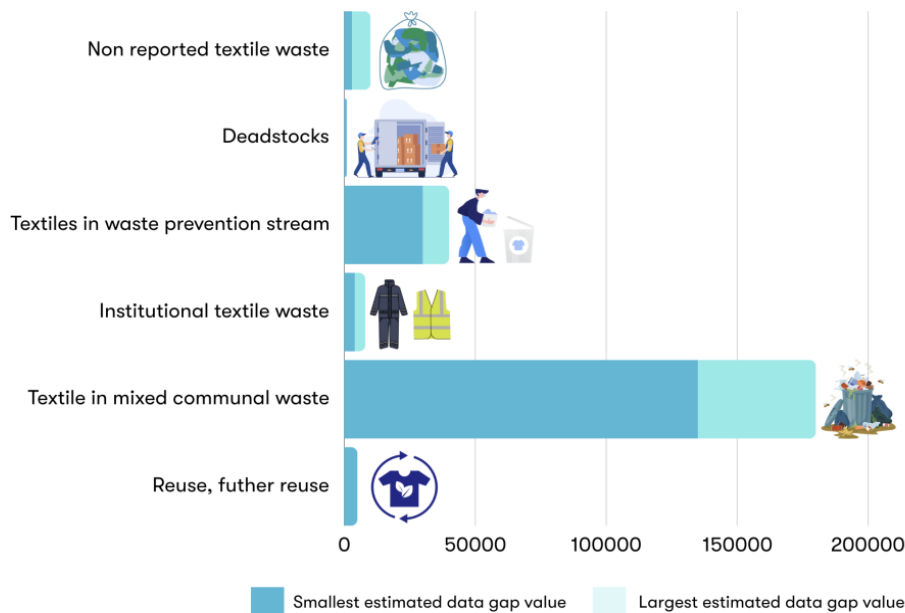
Textile fibre recycling in the Czech Republic mainly occurs in the so-called "downcycling" category. Recycling in such low-value applications can be referred to as downcycling, which is the practice of using recycled material for an application of lower value than the original purpose of the material<sup>49</sup>. Respondents of in-depth interviews focus on mechanical recycling.

The table below shows a summary of the main data gaps and an estimated quantification of the total amounts of various textile streams based on the interviews carried out.

**Table 3: A summary of the main data gaps and their estimated quantification based on interview findings**

Data gap	Quantification of the total amount (t/year)
Textile waste for which there is no reporting obligation (below 100 t/year/producer)	3000 – 10 000
Deadstocks	< 1000
Textiles in waste prevention mode	30 000 – 40 000
Absence of data on textile waste from public and private institutions	4 000 – 8 000
Textile waste in mixed communal waste	135 000 – 180 000
Data on textile exchange, reuse, and further sale	< 5000

The data gaps identified in table 3 reflect significant challenges in accurately quantifying textile waste management within the European Union. The most substantial gap lies in the textile waste found in mixed communal waste, with estimates ranging from 135,000 to 180,000 tons per year, highlighting a critical need for better waste sorting and data collection. Similarly, the absence of data on textiles in waste prevention mode, estimated between 30,000 to 40,000 tons annually, emphasises the importance of capturing the full spectrum of textile reuse and recycling efforts. Additionally, non-reported textile waste due to lack of reporting obligations (3,000 to 10,000 tons) and the lack of data from public and private institutions (4,000 to 8,000 tons) further complicate efforts to develop comprehensive waste management strategies. The smaller yet still significant gaps in deadstocks (less than 1,000 tons) and data on textile exchange, reuse, and further sale (less than 5,000 tons) indicate the need for more precise data to support circular economy initiatives and improve textile waste management practices across the EU. For the purpose of visualising the total amount of waste material flows, the following visual scheme was also created. This scheme, along with the subsequent MFA model for municipalities, can assist users—particularly policymakers—in defining priorities to focus their attention on addressing these flows.



**Figure 3: Visualisation of textile data gaps (their median values) of textile waste in the Czech Republic (original work of the authors)**

The final step in the creation of an MFA diagram is the visualisation of waste material flows. The visualisation in figure 4 was created for the municipal level, with a breakdown into individual processes. This diagram presents a comprehensive overview of the material flow analysis (MFA) for textile waste at the municipal level in the Czech Republic. It illustrates the movement of textile waste (TO) from its initial generation to its final disposal or reuse, highlighting key processes and material losses.

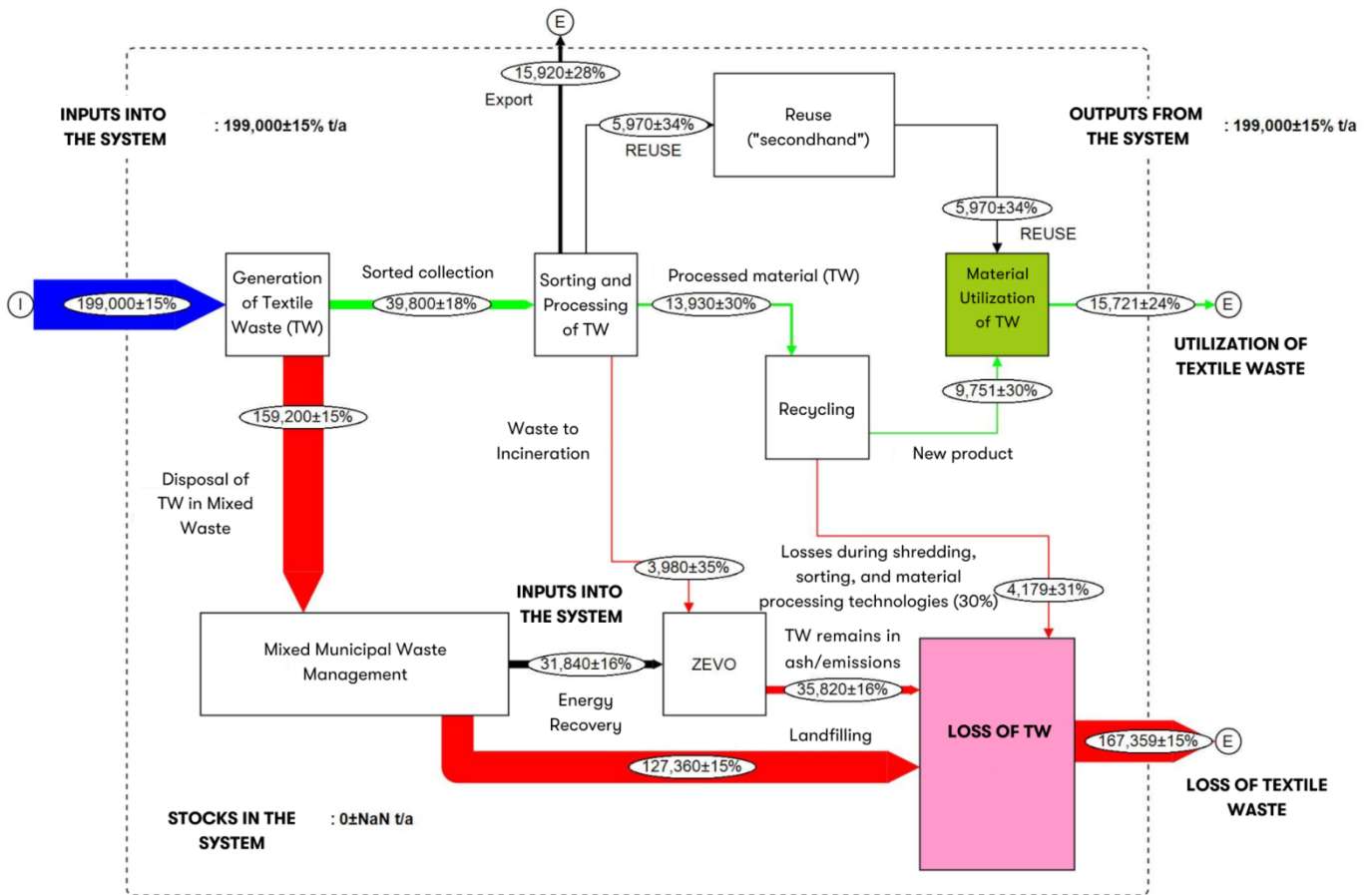


Figure 4: Material flow analysis (MFA) for municipal textile waste in the Czech Republic

The uncertainty rates (in percentages) are an expert estimate derived from the opinions of respondents during semi-structured interviews. The system begins with the sale of textiles, representing the primary input into the system at 199,000 ± 15% tons per year. From this input, textile waste (TO) is generated, amounting to 159,200 ± 15% tons per year, with a portion of this waste entering the mixed municipal waste stream. A segment of this textile waste is collected through sorted collection systems, accounting for 39,800 ± 18% tons, which is then subjected to further sorting and processing. A portion of the sorted waste is reused, amounting to 5,970 ± 34% tons, either through second-hand markets or by being exported, with exports reaching 15,920 ± 28%. Textile waste that undergoes processing is transformed into recycled material, contributing 9,751 ± 30% tons to the production of new products. However, during this stage, there are losses primarily due to the inefficiencies in shredding, sorting, and material preparation technologies, resulting in a 30% loss. A significant portion of the textile waste that cannot be reused or recycled is either sent to incineration plants (ZEVO) for energy recovery or ends up in landfills. The incineration process contributes to energy production, but a notable quantity of textile waste remains as ash or emissions, amounting to 35,820 ± 16%, which leads to further losses totaling 167,359 ± 15% tons. The total outputs from the system are balanced with the inputs, ensuring that all material flows are accounted for. The MFA diagram in figure 5 emphasises the material losses that occur throughout the system, whether through disposal, energy recovery, or processing inefficiencies. In conclusion, this MFA diagram provides valuable insights into the lifecycle of textile waste at the municipal level in the Czech Republic. It highlights the challenges in achieving higher rates of reuse and recycling, pointing out significant losses during the waste management process. The diagram serves as a crucial tool for policymakers and stakeholders to identify key areas where improvements can be made to enhance the circularity of textile waste management.

## Discussion

The previous chapter highlighted a critical lack of data on textile flows in certain areas, or the absence of harmonised data among different organisations. A reliable source of data is the Czech Statistical Office, where data on the import and export of clothing (both new and used), including export and import destinations, are recorded within the goods movement database. However, what is missing are the weight expressions of the quantity of clothing produced in the Czech Republic, as well as data on e-commerce. The amount of textiles representing stocks in the system and a detailed description of the user phase are also unknown. Data on the amount of textiles that are part of mixed municipal waste vary significantly depending on the organisation conducting the data collection. To eliminate this problem, inter-organizational cooperation and the unification of the methodology for analysing the composition of mixed municipal wastes are essential. Another significant data gap is the absence of diversified statistics on the amount of clothing undergoing mechanical recycling and data on the export of these products abroad.

Data on the amount of collected and sorted clothing within the textile collection container system are inconsistent, stemming from the nature of reporting obligations in various waste management regimes or its prevention.

*Recording textile flows outside the waste regime:* For the creation of a detailed Material Flow Analysis (MFA), recording just the catalogue numbers of waste is insufficient. It will be necessary to set a harmonised policy also for recording material flows outside the waste regime, whether in the context of waste prevention (online and offline platforms for textile reuse, recycling, etc.) or in the context of secondary raw materials (definition of secondary raw materials stated in the Glossary of Terms and Abbreviations) arising within industrial processing enterprises and exempt from the waste management regime. Quantification should be based on the amount of waste (in tonnes).

*Introduction of digital product passports:* The recording of textile material flows should also be in line with the proposals of the EU Strategy for Sustainable and Circular Textile Products<sup>12</sup>. Quantification should also comply with the new requirements of "digital tags" or "digital product passports", introduced by the new EU Strategy for Sustainable and Circular Textile Products<sup>15</sup>, which mentions the introduction of a digital product passport for textile products in accordance with the regulation on the ecodesign of sustainable products. The digital product passport will contain mandatory information requirements on circularity and other key environmental aspects. The Commission also plans to review the regulation on the labelling of textile products, "which requires that textile products sold in the EU market be labelled with a clear identification of material composition and indicating all non-textile parts of animal origin"<sup>50</sup>.

*Data gaps:* The identified data gaps can be divided into the following areas:

a) Poor data quality: Data on textile waste material flows are often incomplete and inconsistent, which can cause inaccuracies in analysis and decision-making based on this data.

b) Lack of harmonised data standards: Currently, there is no uniform standard for collecting and processing data on material flows of textile waste, which can lead to loss of information and the impossibility of comparing data from different sources.

c) Lack of transparency: Some sources of data on the material flows of textile waste may be restricted due to trade secrets and the competitiveness of companies, which may cause a lack of transparency in the analysis and decision-making based on this data. However, data openness at national level can help optimise textile waste flows and truly deliver on the essence of the Green Deal for Europe.

The lack of data extensively described in this paper has also commonly been identified as a barrier to greater circularity, according to 59.32% of the respondents in questionnaires and interviews<sup>51</sup>. Individual stakeholders often do not sufficiently collect their own data in cases where they are not required to do so, and they struggle with the lack of coordination of public data. The situation is worsened by the globalised nature of the textile industry, due to which companies commonly lack information on their own material flows (e.g. where fibres come from, what happens to their waste, etc.). Moreover, insufficient data makes setting and enforcing any targets on improving the situation difficult. This contributes to the uncertainty experienced by the stakeholders and their perception of the policy environment as unclear.



Only 5.26% of the respondents reported having all the information that they need on 'changes to environmental policy at the EU level and the implications of the Green Deal', with over half being unaware of the implications that these policies would have on them. This can be related to insufficient communication of the upcoming legislation, as well as the lack of certainty and ambitiousness around some of it<sup>51</sup>.

The final challenge associated with legal measures is a clear definition of the methods of collection and measurement of textile waste. These should be improved both locally and globally. Similar methodologies have already been proposed in the area<sup>52</sup> and similarly European institutions should propose appropriate measurement methodologies for data collection and comparison of results between Member States in the areas of waste registration or direct measurement at the point of origin (e.g. flow analysis based on mass balance sheets or waste composition analyses). Data availability (preferably with the highest possible level of detail within open access) is a prerequisite for setting specific goals, but also for evaluating the effectiveness of individual interventions<sup>53</sup>.

It has been demonstrated that companies handling used textiles, such as MOMENT, are highly proficient in recording both the weight and the number of items sold. If such detailed record-keeping were mandated by legislation, it would significantly enhance the transparency and understanding of textile data management. This regulatory requirement could provide a comprehensive overview of how textiles are processed and recycled, facilitating better planning and goal-setting for sustainable practices in the industry.

### **Recommendations for further research**

This comprehensive analysis of textile waste data in the Czech Republic reveals several key areas for future academic research. Firstly, it is crucial to develop standardised data collection methods, including mandatory reporting for all textile producers. Accurate and comprehensive data is essential for effective waste management and policy-making. Secondly, exploring technological innovations like digital product passports and blockchain for tracking textile waste can enhance transparency and efficiency in the supply chain. Thirdly, fostering stakeholder collaboration through regular engagement can help harmonise data collection standards and address data gaps.

Additionally, research should investigate consumer behaviours promoting the repair and reuse of textiles, supporting platforms like Vinted and Sellpy for second-hand textile redistribution. Conducting detailed Material Flow Analyses (MFAs) to identify inefficiencies and model policy impacts is also essential. Targeted research should address specific data gaps, particularly in underreported areas such as small producers, public and private institutions, and textile waste in mixed municipal waste. Lastly, investigating new recycling technologies, including fibre-to-fibre recycling, and supporting innovative upcycling and downcycling methods can extend textile lifecycles and enhance industry sustainability.

Currently, the Institute of Circular Economy (INCIEN) is carrying out a project focusing on the quantification of textile waste streams in the Czech Republic, as part of a larger European consortium, in which analyses of separately collected textile and mixed municipal waste are taking place in order to present a representative sample and gain more insight into amounts of waste nationally. This project aims to address the data gaps, which are present at the moment, and its results will be available this year. Such further research is an example of what needs to be done at local, national and EU levels.

## Conclusion

The fact that data is necessary for measuring the circular economy is evergreen. In order for data to be socially beneficial, it must be easily accessible, shared across the entire network of actors, and used for decision-making<sup>54</sup>. This article identifies and delves into significant data gaps within the Czech Republic's textile waste streams, highlighting the need for a more robust and circular material flow. It emphasises the necessity of accurate data collection and the implementation of the European Union's Strategy for Sustainable and Circular Textiles to ensure the industry's transition towards sustainability and circularity.

The key data gaps identified include the absence of detailed information on textile waste from both public and private institutions, including significant producers like hospitals and accommodation facilities. Moreover, the lack of data on the amount of textiles reused, recycled, or disposed of, particularly from smaller producers generating under 100 tons/year, presents a significant challenge to achieving a comprehensive understanding of the textile lifecycle and waste management practices.

To address these gaps, several recommendations have been proposed. These encompass the enhancement of data collection methods, such as leveraging in-depth interviews with stakeholders and utilising existing data sources more effectively. The establishment of clear and mandatory reporting requirements for all textile producers, regardless of their size, could significantly improve data accuracy and availability. Additionally, fostering collaboration between government bodies, research institutions, and the textile industry is crucial for developing a cohesive and effective approach to textile waste management. It is also necessary to mention that the identified data gaps range from a few tons to hundreds of thousands of tons of waste, highlighting the significance of addressing this material flow, which should receive adequate attention from policymakers in the future. The quantity can be compared to the data on e-waste collection, which amounted to 170,000 tons in the Czech Republic in 2023<sup>55</sup>. For e-waste, there are already functioning organisations for its collection as well as a financial participation system through extended producer responsibility (EPR). This EPR system could play a key role in the future in building and financing a robust textile collection network, which will become mandatory for municipalities starting in 2025.

The recent legislative developments in the EU, aimed at tightening the handling and reporting of textile waste, offer a valuable framework for national efforts. The introduction of a direct ban on the destruction of unsold textiles and footwear, as part of the EU's broader strategy to promote circularity and sustainability in the textile sector, sets a precedent for the Czech Republic to follow. Implementing similar regulations at the national level, alongside the EU's ecodesign requirements for sustainable products, could drive significant progress in addressing the identified data gaps and enhancing the circularity of the textile industry. And therefore, one of the goals of this article is to assist local policymakers by providing the necessary groundwork to identify priority areas for bridging data gaps in the coming years. Although key documents such as the Strategy for Secondary Raw Material Management by the Ministry of Industry and Trade define areas for material analysis, this goal cannot be achieved without accurate data. A deeper understanding of the origins of these gaps, including their quantification, can significantly aid in this prioritisation.

Ultimately, bridging these data gaps requires a concerted effort from all stakeholders involved in the textile lifecycle, from production to disposal. By aligning national strategies with the EU's legislative direction, the Czech Republic can significantly improve its textile waste management practices, paving the way for a more sustainable and circular textile industry. This endeavour not only aligns with the global push towards environmental sustainability but also offers economic opportunities by promoting the reuse and recycling of textiles, thereby reducing waste and fostering innovation in the sector.

## Acknowledgements

A special thanks to Professor Bedřich Moldan for his help with the formulation of research questions, as well as with focusing attention on the most essential aspects of the research in the field of circular economy and textiles. The article was supported by the Grant Agency of Charles University for the project entitled Mapping of waste textile material flows in the Czech Republic and number 265021.

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## **Překlenutí mezer: Komplexní analýza nesrovnalostí v datech o textilním odpadu v České republice**

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### **Souhrn**

*Tento článek poskytuje podrobnou analýzu toků textilního odpadu a souvisejících datových mezer na různých úrovních v České republice, zaměřuje se na identifikaci a kvantifikaci datových mezer, které brání přesné analýze toků materiálů. Výzkum byl proveden prostřednictvím kombinace sběru existujících dat z dostupných statistik a polostrukturovaných rozhovorů s 25 klíčovými aktéry v celém dodavatelském řetězci textilu, včetně výrobců, správců odpadů a recyklačních subjektů. Studie odhalila významné datové mezery v oblastech, jako je textilní odpad od producentů s produkcí menší než 100 tun ročně, likvidace neprodaného zboží (deadstock) a textilní odpad ve smíšeném komunálním odpadu. Tyto mezery představují výzvy pro efektivní nakládání s odpady a implementaci Strategie Evropské unie pro udržitelné a cirkulární textilie. Zjištění také zdůrazňují kritickou potřebu standardizovaných metodik pro sběr dat a zvýšenou spolupráci mezi zainteresovanými stranami ke zlepšení přesnosti dat a podpoře přechodu na cirkulární ekonomiku v textilním sektoru. Článek uzavírá cílenými doporučeními pro zlepšení praxe sběru dat a politických rámců k řešení těchto mezer a usnadnění lepšího rozhodování pro udržitelné řízení textilního odpadu v České republice.*

**Klíčová slova:** *Textilní odpad, mezery v datech, management textilního odpadu, cirkulární ekonomika, cirkulární odpadové hospodářství*