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RECYCLING OF WASTE ACRYLIC TEXTILES

D1.2: CLASSIFICATION SYSTEM: METHODOLOGY FOR WASTE CLASSIFICATION

Design of a plan for collection, organisation and storage of textile waste

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** R: Document, report (excluding the periodic and final reports)*

DEM: Demonstrator, pilot, prototype, plan designs

DEC: Websites, patents filing, press & media actions, videos, etc.

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EXECUTIVE SUMMARY

This deliverable has been created in the context of the Work Package 1 (Recollection, sorting and analysis of waste acrylic textiles; back logistic implementation) of the H2020-funded project REACT (Grant No. 820869).

The Deliverable "D1.2 - Classification System: Methodology For Waste Classification " describes and identifies the storage area for the waste storage insert at the Parà venue in Pontirolo Nuovo (BG - Italy).

The storage space has all the features necessary to host and develop the waste collection model described in the REACT project.

The document is structured in two blocks, starting with a brief introduction about the project and its main challenges. In the first block the objectives of the WP1 are recalled highlighting the characteristics of the storage space able to satisfy the waste collection and separation model to be treated in the subsequent phases of the project. In fact, it describes with more details the main results and achievements in WP1- Recollection, sorting and analysis of waste acrylic textiles; back logistic implementation.

The second block gives an overview of the impact so far achieved, including the assessment of Key Performance Indicators of WP1.

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ABBREVIATIONS

WP	Work Package
KPI	Key Performance Indicators
Q.C.	Quality Control
ToC	Table of contents

1 INTRODUCTION

The collection of acrylic textile waste concerned both industrial and post-consumer waste from PARA'.

The Deliverable, with the identification of the warehouse space in Pontirolo Nuovo (BG - Italy), is a necessary step in order to identify all the waste materials containing Acrylic to be analysed, treated and managed during the project.

The deliverable contains the collection management process:

- Logistic problems: identification and definition of the place for the collection and storage of acrylic waste;
- Industrial waste management: waste collection from the production process (spinning, warping / weaving, finishing) and their classification (fibre, yarn and fabric);
- Post-consumer waste management: logistic organization for the recovery of discarded products (awnings and / or upholstery fabrics); positioned curtains will come directly from end customers or sellers, with a vision a "rental service" and collection of the final product;
- Classification system: adoption / development of the registration methodology to store and classify all the collected waste,
- classifying them by type of waste, colour, quantity, model / texture, finish, place of installation (in relation to the volume of sales and atmospheric agents) and finishing category;
- Distribution: delivery of the collected waste, according to their classification, to other partners for the subsequent phases, such as elimination treatment of hazardous substances and mechanical recycling.

Parà is a producer of fabric for solar protection devices and for outdoor furniture made with dyed acrylic solution fibre. We receive yarn from spinning and we produce fabrics in our internal departments of warping, weaving and finishing. A different type of finishing, according to the end use, characterizes our products, fabrics for awnings, beach umbrellas, marine applications and outdoor furniture.

The main goal of the WP.1 is to identify waste sources and the right way of classification in order to facilitate the next steps of the project, which foresees the chemical treatment, and after the mechanical tearing.

The main features we have to keep in mind are:

- the type of chemical substances present in the waste
- shape of the waste

We have identified all waste sources along the production chain starting from the spinning till the post-consumer.

The sources are:

Spinning

during spinning we can collect 3 different kinds of waste: fibre, yarn and powder, white and mixed colours

Production department: weaving, finishing, quality control

In these different steps of production, we can collect waste as selvedges and fabrics with different finishing, white and coloured

Market: manufacturing department of direct customers and from the post-consumer

PARA' can collect the fabric coming from the manufacturing of awnings, beach umbrellas and furniture and the same from the post-consumer that today go directly to the landfill. The finish of fabric coming from manufacturing is easily identifiable, but on the used fabrics coming from the post-consumer different types of materials can be present : organic and inorganic materials, pollutions and so on.

2 OBJECTIVES OF THE STORAGE LOCATION

The WP forecast to develop a model for collection and sorting of different kind of acrylic textile waste. The waste is coming from different phase of industrial production process and from post-consumer with different sites. A business and logistic plane is developed in order to collect the quantity needed to forward phase of the project. The acrylic waste collected is characterized in order to correctly address its following treatment.

2.1 Back logistic approach

The back logistic approach is the first Task of the WP 1.
Task 1.1, **back logistic approach**: Where the collection of acrylic textile waste both industrial and post-consumer waste are organized. The management of the collecting process, innovative business models are adopted and developed, to deal with: logistic issue, industrial waste management, post-consumer waste management, classification system, distribution.

The activities carried out:

- Logistic issue: identification and definition of locations to collect and store acrylic waste;
- Classification system: adoption/ development of registration methodology to store and sort all the collected waste, classifying them by waste type, colour, quantity, pattern/texture, finishing, installation place (related to sales volume and weathering) and finishing category;
- Industrial waste management: collection of waste coming from production processes (spinning, warping, weaving, finishing, quality control) and separation by different shape (fibre, yarn and fabric);
- Distribution: delivery of collected waste, according to their classification, to other partners for the next steps, such as elimination treatment of hazardous substances and mechanical recycling.

2.1.1 Explanation of the work carried

REACT want increase the recycling rate and reduced landfill and incineration of secondary raw materials Therefore, REACT aims to reduce the incineration rate of waste from landfill acrylic fabrics by at least 30% for the external sector (awnings and furniture).

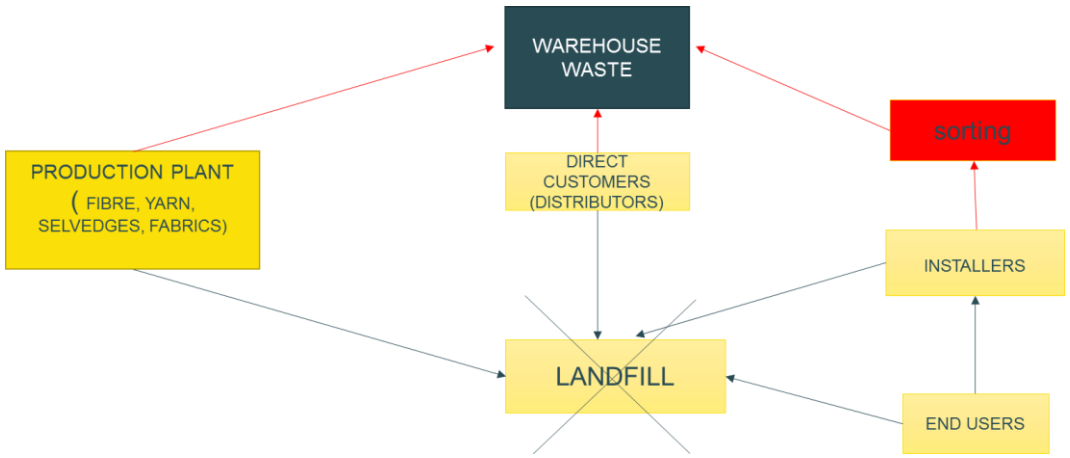


Figure 1: REACT Approach

In this context, PARA 'to design the warehouse waste (storage) has first analyzed the entire production chain and highlighted all types of waste produced. Below, table 1 defines the purposes for classifying waste and the types of waste produced during the PARA production processes.

Actions	Approach
Classification system	adoption/ development of registration methodology to store and sort all the collected waste, classifying them by waste type, colour, quantity, pattern/texture, finishing, installation place (related to sales volume and weathering) and finishing category
Industrial waste management	Collection of waste coming from production process (spinning, warping, weaving, finishing) and their classification (fibre, yarn and fabric).

Table 1 : Classification System & Industrial Wasted Management

PARA' identified all the different types of waste from the different stages of the production cycle. It should be noted that fabrics and / or products that generate waste can be sub-categories in three other categories. The sub-categories are closely related to the type of finishing applied to the fabric that makes up the product.

Figure 2: Types of Finishing

Below all the different types of waste from the different phases of the production cycle identified by PARÀ:

1) Spinning:
   - **Waste 1-1W** from carding: no-separable multicolour (1) or white (1W) fibre;
   - **Waste 2** from carding : powder coming from suction filters – no-separable multicolour fibre;
   - **Waste 3** from spinning machine: no-separable multicolour fibre;
   - **Waste 4-4W** from spinning machine: no-separable multicolour (4) and white (4W) yarn;
   - **Waste 5** from winder machine: single-colour separable yarn.

2) Weaving:
   - **Waste 6**: multicolour yarn coming from the cutting of selvages (weaving department).

3) Finishing:
   - **Waste 7:** from finishing machine: multi-colour selvages with finish applied.
     - Waste 7A: selvedges comings from finishing of awnings and umbrella
     - Waste 7B: selvedges coming from finishing of waterproof awnings and marine fabrics (coated fabrics))
     - Waste 7C: selvedges coming from finishing of fabrics for outdoor furniture

4) Quality Control:
   - **Waste 8** processing waste: finished fabrics coming from the quality control department with the same finish as waste 7.
     - Waste 8A: multicolour fabrics with finish for awnings and umbrella
     - Waste 8AW: white fabrics with finish for awnings and umbrella
     - Waste 8B: multicolour fabrics with waterproof finish for awnings and marine fabrics (coated fabrics)
     - Waste 8BW: white fabrics with waterproof finish for awnings and marine fabrics (coated fabrics)
     - Waste 8C: multicolour fabrics with finish for outdoor furniture
     - Waste 8CW: white fabrics with finish for outdoor furniture

Collection of awnings and furniture fabrics at the end of their life –logistic organization and pick up:

5) Customer's processing waste:

   Waste 8X1or 8XW1: these kinds of waste are the same of those coming from Quality departments because they are produced during the operation of cutting and sewing for the manufacturing of awnings, beach umbrellas and products for outdoor furniture;

   - Waste 8A1: multicolour fabrics with finish for awnings and umbrella
   - Waste 8AW1: white fabrics with finish for awnings and umbrella
   - Waste 8B1: multicolour fabrics with waterproof finish for awnings and marine fabrics (coated fabrics)
   - Waste 8BW1: white fabrics with waterproof finish for awnings and marine fabrics (coated fabrics)
   - Waste 8C1: multicolour fabrics with finish for outdoor furniture
   - Waste 8CW1: white fabrics with finish for outdoor furniture

6) Post consumer:
   Waste 9X: awnings, umbrellas , elements of outdoor furniture at the end of life
   - Waste 9A: multicolour awnings, umbrellas, elements of outdoor furniture
   - Waste 9AW: white awnings, umbrellas, elements of outdoor furniture
   - Waste 9B: multicolour coated awnings, umbrellas

- Waste 9BW: white coated awnings, umbrellas
- Waste 9C: multicolour fabrics for outdoor furniture
- Waste 9CW: white fabrics for outdoor furniture

The following shows all the waste identified with the active sources of supply of the raw materials used during production.

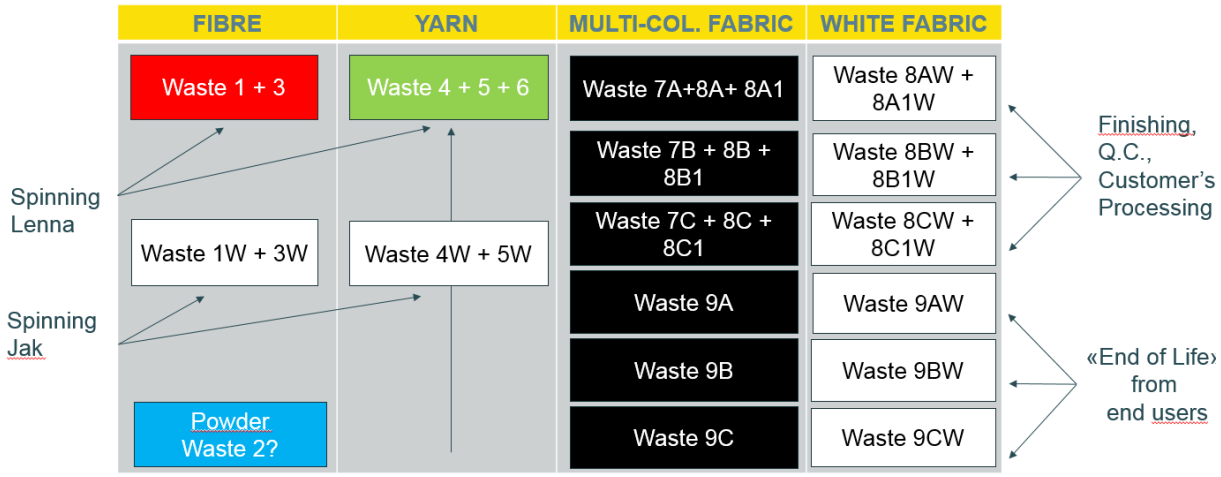


Figure 3: Plan design of waste storage

On this table we have collected the waste in 4 categories: fibre, yarn, coloured fabric and white fabric. Considering that the selvedges and the fabrics coming from production departments having the same finishing can be treated and teared together the total number of types of waste can be reduced to 16 types.

If during the next steps of this project, after the tearing test in Ceti, we can consider that the yarns and fibre can be teared together, we will have only 2 types of yarn+ fibre (i.e. coloured and white) in this case the number of waste types decreases to 14..

If the substances deposited on the fabrics at the end of their life, as pollution, organic and inorganic substances, can be eliminate with the same treatment used for the virgin fabric, then the number of types of waste can decrease till 8 , which is a much more manageable number.

In summary:

Category 1: fibre+yarn coloured;

Category 2: fibre+ yarn white;

Category 3: selveges+coloured fabric for awnings and beach umbrellas coming from finishing department, quality control, manufacturing;

Category 4:white fabric for awnings and beach umbrellas coming from finishing department, quality control, manufacturing;

Category 5: coated selvedges and coated coloured fabric for awnings and beach umbrellas coming from finishing department, quality control, and manufacturing;

Category 6: coated white fabric for awnings and beach umbrellas coming from finishing department, quality control, manufacturing;

Category 7: selvedges+ coloured fabrics for outdoor furniture coming from finishing department, quality control, manufacturing;

Category 8: white fabrics for outdoor furniture coming from finishing department, quality control, manufacturing.

Legenda	Description	Source	
Waste 1	fibre from carding multicolour	Lenna	spinning
Waste 1W	fibre from carding white	Jak	spinning
Waste 2	no-separable multicolour powder coming from suction filters (??)	Lenna	spinning
Waste 3	fibre from spinning machine multicolour	Lenna	spinning
Waste 4	multicolour yarn from spinning machine	Lenna	spinning
Waste 4W	white yarn form spinning machine	Jak	spinning
Waste 5	multicolour yarn from winding machine	Lenna	spinning
Waste 6	multicolour selvedges from weaving dpt	Pontirolo	Industrial
Waste 7A	multicolour selvedges of awnings/umbrellas from finishing dpt	Pontirolo	Industrial
Waste 7B	multicolour selvedges of coated awnings from finishing dpt	Pontirolo	Industrial
Waste 7C	multicolour selvedges of furniture fabric from finishing dpt.	Pontirolo	Industrial
Waste 8A	multicolour fabrics for awnings/umbrellas from quality control dpt.	Pontirolo	Industrial
Waste 8AW	white fabrics for awnings/umbrellas from quality control dpt.	Pontirolo	Industrial
Waste 8B	multicolour fabrics for coated awnings from quality department	Pontirolo	Industrial
Waste 8BW	white fabrics for coated awnings from quality dpt.	Pontirolo	Industrial
Waste 8C	multicolour fabrics for outdoor furniture from quality dpt.	Pontirolo	Industrial
Waste 8CW	white fabrics for outdoor furniture from quality dpt.	Pontirolo	Industrial
Waste 8A1	multicolour fabrics for awnings/umbrellas from customers	market	direct customer/Industrial
Waste 8AW1	white fabrics for awnings/umbrellas from customers	market	direct customer/Industrial
Waste 8B1	multicolour fabrics for coated awnings from customers	market	direct customer/Industrial
Waste 8BW1	white fabrics for coated awnings from customers	market	direct customer/Industrial
Waste 8C1	multicolour fabrics for outdoor furniture from direct customers	market	direct customer/Industrial
Waste 8CW1	white fabrics for outdoor furniture from direct customers	market	direct customer/Industrial
Waste 9A	multicolour awnings/umbrellas from end users	market	post-consumer
Waste 9AW	awnings/umbrellas white from end users	market	post-consumer
Waste 9B	multicolour coated awnings from end users	market	post-consumer
Waste 9BW	white coated awnings from end users	market	post-consumer
Waste 9C	multicolour outdoor furniture covers from end users	market	post-consumer
Waste 9CW	white outdoor furniture covers from end users	market	post-consumer

Figure 4: REACT Waste collected

Considering in the first year of the project the sales of fabrics produced, delivered and recollected (about 3000 kg- see tab.5) as waste from the manufacturing and from the post-consumer, we obtain that the collected quantities of waste is very low for category 6 and 8 .

This is because the white fabric for furniture and the coated white fabrics for awning , that were the bestsellers in the past, today they are not longer for different reasons . We suggest to group any quantities collected in these two categories with the coloured ones: therefore the category 6 could flow into category 5 and the category 8 into category 4

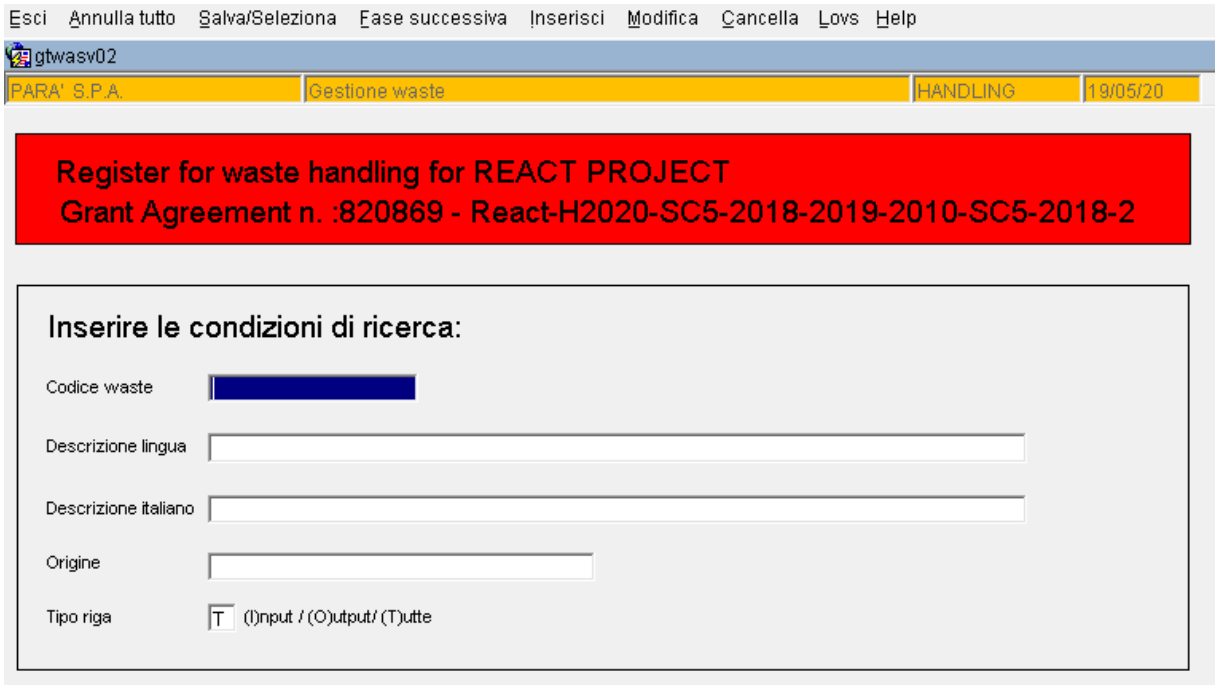
In this way we should handle only 6 types of waste.

These suggestions can become actions only knowing the results of chemical treatments and the trials of tearing of our partners.

We have studied a method of identification of all types of waste for storage and deliveries to other partners

We can manage all inputs and outputs of the waste collected for this project using our Oracle program that was implemented with a special section dedicated to this project.

The figure 5 below are the example of our system in Oracle where the input and output quantities of waste are registered by mean of the date of movement, quantities, source and destinations.



			Input			Output			
Waste.	Descrizione in italiano	Origine	Data operazione	Quantita	N. pallet	Data operazione	Quantita	Numero documento	Destinazione
1	fibra multicolore da carda	LENNA	19/09/2019	17.00	W1L1				
5	filato multicolore da ritorcitoio	LENNA	19/09/2019	65.00	W5L1				
7A	cimosse multicolore da finissaggio da tenda da sole /ombrelloni mu	PONTIROLO	19/09/2019	92.00	W7AP2				
3	fibra multicolore da filatoio	LENNA	19/09/2019	57.00	W3L1				
4	filato multicolore da filatoio	LENNA	19/09/2019	58.00	W4L1				
8A1	tessuto multicolore per tenda da sole/ombrelloni da cliente	MERCATO	12/11/2019	150.00	W8A1M4				
8A	tessuto multicolore per tenda da sole/ombrelloni da controllo qualita	PONTIROLO	14/02/2020	250.00	W8AP3				
8B	tessuto multicolore per tenda da sole rimpermeabile da controllo qualita	PONTIROLO	24/09/2019	42.00	W8BP1				
6	cimosse multicolore da telaio	PONTIROLO	05/09/2019	120.00	W6P1				
7A	cimosse multicolore da finissaggio da tenda da sole /ombrelloni mu	PONTIROLO	12/09/2019	279.00	W7AP1				
8AW	tessuto bianco per tenda da sole/ombrelloni da controllo qualita	PONTIROLO	24/09/2019	14.00	W8AWP2				
8A1	tessuto multicolore per tenda da sole/ombrelloni da cliente	MERCATO	27/02/2020	85.00	W8A1M6				
8A	tessuto multicolore per tenda da sole/ombrelloni da controllo qualita	PONTIROLO				24/09/2019	2.00	60001	SOFT CHEMICALS S.R.L
1W	fibra bianca da carda	JAK	20/09/2019	87.00	W1WJ1				
4W	filato bianco da filatoio	JAK	20/09/2019	35.00	W4WJ1				
8C	tessuto multicolore per arredamento outdoor da controllo qualita	PONTIROLO				24/09/2019	2.00	60001	SOFT CHEMICALS S.R.L
8AW	tessuto bianco per tenda da sole/ombrelloni da controllo qualita	PONTIROLO				24/09/2019	1.50	60001	SOFT CHEMICALS S.R.L
8A	tessuto multicolore per tenda da sole/ombrelloni da controllo qualita	PONTIROLO				24/09/2019	2.00	60002	CENTRO TESSILE COTONIERO E ABBIGLI

Figure 5: REACT Waste collected – Oracle

2.1.1 Back logistic from post-consumer

Generally, the fabrics for awnings and furniture at end of their life go directly to landfill coming directly from the end users or through their installers. Everything, including fabrics, goes to landfill together with aluminum parts, small pieces of lead used to maintain tight the tends ... and so on. None of our customers is organized to separate different materials; only some of them use recovery specialized companies to separate the materials before sending the fabric to landfill.

To collect the data regarding the quantity of old fabrics sent directly to landfill is a real problem because of their very high numbers of installers (a medium-sized direct customer can have 200-300 installers). For this reason, we are studying with the support of some customers an alternative way to recover the old fabrics. This will be the next challenge of this WP1.

The only type of old fabric easy to collect is that used for beach umbrellas: in this case, usually our customers work directly with the end users (large bathhouses) and they collect the beach umbrellas to change the old fabrics that they partially recover.

2.1.2 Method of identification: labelling

In order to clearly identify all these 29 types of waste we have devised a double system for labelling: one for the quantities arriving into our warehouse and a second one for the deliveries to the other partners. In this way we can avoid any mistake of classification and cross contaminations of feedstocks for the further steps of the project.

PARA' has developed a new type of "talking label" in which it is possible to obtain information regarding the sending partner, the type of waste, its origin and the date of shipment.

In order to better understand how it is possible to recover post-consumer waste, we have released some interviews with our most important customers in different sectors of use of acrylic fabrics, awnings, umbrellas and furniture.

This labeling action is useful for the characterization and distribution phase of the waste to the project partners in order to proceed with laboratory analyzes and / or subsequent chemical and mechanical tests.

The quantities/ qualities of delivered waste are listed here:

Waste.	Output			
	Data operazione	Quantita	Numero documento	Destinazione
8A	24/09/2019	2.00	60004	AV UNIVERSITEIT GENT
8A	24/09/2019	2.00	60003	UNIVERSITA' DEGLI STUDI DI BERGAMO I
8A	24/09/2019	2.00	60002	CENTRO TESSILE COTONIERO E ABBIGLI
8A	24/09/2019	2.00	60001	SOFT CHEMICALS S.R.L
8AW	24/09/2019	1.50	60004	AV UNIVERSITEIT GENT
8AW	24/09/2019	1.50	60003	UNIVERSITA' DEGLI STUDI DI BERGAMO I
8AW	24/09/2019	1.50	60002	CENTRO TESSILE COTONIERO E ABBIGLI
8AW	24/09/2019	1.50	60001	SOFT CHEMICALS S.R.L
8C	24/09/2019	2.00	60004	AV UNIVERSITEIT GENT
8C	24/09/2019	2.00	60003	UNIVERSITA' DEGLI STUDI DI BERGAMO I
8C	24/09/2019	2.00	60002	CENTRO TESSILE COTONIERO E ABBIGLI
8C	24/09/2019	2.00	60001	SOFT CHEMICALS S.R.L

Figure 6: Waste list delivered

LABELLING ON INPUT WASTE

We use the same classification in tab.1 where we add the provenience:

- L spinning
- J spinning
- P for Pontirolo
- M for the market
- with a progressive number of input
- W1 L1= waste type 1 coming from spinning box number 1

Figure 7: Storage location - warehouse

LABELLING ON OUTPUT WASTE

This label provides 13 digits:

- POSITION 1 – 2 DIGIT the short name of the partner that is making the delivery:
    - CC= Centrocot
    - CE= Ceti
    - SC= Soft Chemicals
    - JS= Jack Spinning
    - MA= Martel
    - PA= Parà
    - UG= University of Ghent
- POSITION 2 DIGIT1: _
- POSITION3 DIGIT1: source of waste:
    - I= Industrial waste
    - D= direct customers- manufacturing departments
    - P= post-consumer waste
- POSITION 4 DIGIT1: colour of waste
    - W= white waste
    - C= coloured waste
- POSITION 5 DIGIT1: kind of finish

  - U=unfinished
  - A=finish for awnings
  - K=coated (waterproof fabrics)
  - F= finish for outdoor furniture
- POSITION 6 DIGIT1:
- POSITION 7 DIGIT1: treatment applied during the recycling process (if none skip to 9)
- POSITION 8 DIGIT1: _
- POSITION9 DIGIT6: the date of shipment (ddmmyy)
  - example: PA_ICA_04052020
  - means: PARÀ is shipping a coloured waste of fabrics for awnings coming from production department on 4th of May 2020

3 CONCLUSION

The scheme applied to Pontirolo Nuovo (BG - Italy) has the advantage of being close to production and also reduces the cost of handling waste.

At the same time, the production scheme based on waste, made by PARÀ, presents an important advantage because it gives the possibility to monitor all the waste present in production.

Over the next few months, we will also be thinking of collecting post-production waste. We are committed to collaborate with our direct and market-leading customers to recover the customer's processing waste. Meanwhile we will collect information on the "end of life" collection of awnings and furniture fabrics from end users. A new collection strategy will be developed in collaboration with our direct customer.