

WP T2 - INNOVATION ON TEXTILE WASTE MANAGEMENT

ACTIVITY A.T2.3 PILOT CASES

D.T2.3.3 PILOT CASES TECHNICAL REPORT

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ENTeR - Expert Network on Textile Recycling

ENTeR works in five central European countries that are involved in the textile business, to promote innovative solutions for waste management that will result in a circular economy approach to making textiles.

The project will help to accelerate collaboration among the involved textile territories, promoting a joint offer of innovative services by the main local research centres and business associations ("virtual centre"), involving also public stakeholders in defining a strategic agenda and related action plan, in order to link and drive the circular economy consideration and strategic actions.

The approach of the proposal and the cooperation between the partners is oriented to the management and optimization of waste, in a Life Cycle Design (or Ecodesign) perspective.



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1. Pilot case description - aim and scope

1.1. Introduction

“Reduction of the waste generation through prolongation of the service life of textile products”

The pilot case aims to compare the length of the service life of textiles from 100% cotton and from the cotton/PES blends used for hospital service textiles which are designed for the repeated washing. The aim is to demonstrate the prolongation of the service life in case of textiles made from blends and therefore the reduction of raw materials consumption and thereby reduction of amount of generated textile waste (end-of-life textile products).

Relating to the large-scale use of these textiles for medical facilities, there is an opportunity to reuse and recycle these relatively well-defined materials after their physical lifetime. For pilot verification of this direction, it is necessary to create mutual coordination between producers (textiles and protective clothing or bedding), users and, increasingly, industrial laundries offering the rental of these products. Besides the ecological effect and the step towards the sustainability of the material resources, this cooperation may bring additional economic effects; instead of the upcoming landfill and liquidation charges, to create prerequisite for partial compensation of acquisition costs through the recovery of waste in the circulating economy.

1.2. Aims of the study

The main aim of this study is to map the issue of textile waste from industrial laundries processing the linen from healthcare sector. The partial aims that will help to achieve the main aim will be:

- formulation of a questionnaire and completing it by industrial laundries, which will allow input of the information for the study. In order for laundries to be able to objectively fill out the questionnaires, only those who provide leasing of healthcare linen and thus they have the necessary data will be addressed.
- analysis of the quantity and fibre composition of textile waste from laundries processing linen from healthcare facilities
- discussion of the influence of fibre composition and type of linen from healthcare facilities on the amount of waste (or on the lifetime of linen)
- discussion of the influence of technology that processes linen from healthcare facilities on the amount of waste (or on the lifetime of linen)
- comparison of lifetime of 100 % cotton and blended fabrics (cotton / polyester at different percentages)
- a description of the criteria and system for the disposal of linen and methods of textile waste disposal.

Because the laundry sector is a little bit far from the textile technology industry, the study also includes a basic introduction to laundry processing and technical equipment.



2. Mapping of the market available technologies for waste pre-treatment in partner region

As the results of the study shown, discarded end-of-service life textile from laundries is usually used as secondary raw materials for the production of other technical applications - polishing discs, cleaning cloths, cleaning fabrics, textiles for the furniture industry and many other technical applications. (More details available in chapter 3).

Textile waste recycling technologies available in Czech Republic mostly comprise mechanical processing as tearing and cutting.

The following stakeholders belong to the group of companies which are processing, recycling or reusing textile waste: Arca Chrast, CzechFibre, DIMATEX CS, EKOTEX, Fatra, Green way recycling, H.B. TEXTILIE, H.B. TEXTILIE, Klatex, NISATRADE, MITOP, OSSY, OZO Ostrava, Recycling J&F, Recycling Textile, RETEX, WILTEX. Some of them are processing textile waste and selling it as a raw material for further use, some of them are using it as a raw material e.g. for production of cleaning rags and polishing discs, non-woven or technical textiles (geotextiles, upholsteries, insulations); one company produces the alternative fuel for a cement plant from waste paper, plastics, wood and textiles.

3. Market research in the field of leasing medical linen in the Czech Republic

To prepare a relevant solution concerning industrial companies (laundries) was necessary to map current situation on the market. Therefore, a market survey was prepared, in the field of textile leasing in laundries processing the textile from healthcare sector. Market survey works with the main hypothesis, that if the companies operated in the field of textile leasing in healthcare sector replace 100 % cotton by materials made from fibre mixture, the lifecycle of these textiles would be prolonged. This measurement will have a positive impact on reduction of waste textiles.

3.1. Questionnaire designing

First step was to analyse current situation in the sector, to collect information about laundry processing, technologies and textiles used in the industry. Second step was to prepare the questionnaire with relevant questions and also in suitable form. Questionnaire was divided into two parts. First part (A) includes principles for decommissioning, waste collection and final disposing. Second part (B) is focused on fibre composition of textile materials used in the sector of textile leasing, used technology processing and monitoring of lifecycle.

Final version of the questionnaire includes 40 questions, most of them are closed dichotomy questions, part of them are closed multiple choice questions and part of them are open questions with individual answers. This questionnaire was tested to see if the questions were



clear and understandable. Few questions were reformulated after this testing and few of them were replaced.

Questionnaire was prepared in two basic forms: the former document form in Microsoft Word to easy fill in answers or to printout and mark relevant answers; the latter online questionnaire made in a www.survio.cz portal to simple, fast and effective answer the questions with no need to do anything else (to scan and send by e-mail).

3.2. Target group description

The field of textile leasing in healthcare sector is a very specific and very demanding. Laundries, that supply textiles to a healthcare sector, are required to monitor textile care processing and to keep very strict hygiene and safety measurements to prevent a risk of infections and maintaining safety. These subjects are certified according to Industry Specifications, which clearly define parameters to be met to ensure the safe supply of textiles to healthcare facilities from a hygienic perspective.

There is a total of 13 entities in the Czech Republic that use the certification according to the Industry Specifications. These laundries were selected as suitable subjects for identifying ways of handling textile waste except two companies which do not provide textile leasing (GOLGOT spol. s r.o. and Vít Spáčil - prádelny a čistírny, spol. s r.o.):

TITLE	LOCATION
Fakultní nemocnice Hradec Králové	Hradec Králové
GOLGOT spol. s r.o.	Nymburk
CHRIŠTOF spol.s r.o.	Brno - Komárov
CHRIŠTOF spol.s r.o.	Štětí
Jan Fišer	Česká Třebová
Prádelna Fišer, s.r.o.	Hradec Králové
Prádelna Kyselý, a. s.	Vlašim
PRÁDELNY A ČISTÍRNÝ, a.s.	Náchod
Praní a Čištění, a.s.	Velká Hleďsebe
RENATEX CZ, a.s.	Ostrava - Poruba
RENATEX CZ, a.s.	Český Těšín
SALESIANER MIETTEX CHEMUNG s.r.o.	Praha - Thomayerova nemocnice
Vít Spáčil - prádelny a čistírny, spol. s r.o.	Prostějov



Table No. 1: List of certified Laundries in the Czech Republic (Asociace prádelen a čistíren ČR, z. s. , 2019)⁽¹⁾

3.3. Questionnaire survey distribution

Relevant respondents were contacted on 7th June 2019 by e-mail with simple instructions what to do. Deadline for answers was 19th June 2019. In the meantime, one reminder to keep their attention and do not forget to send the answers was sent.

3.4. Data collection

From a total of 11 relevant respondents we got 5 fulfilled questionnaires which accounts for 45,45 % of all.

Five companies did not respond at all and one company answered that they do not provide textile leasing (Fakultní nemocnice Hradec Králové). Nevertheless, Fakultní nemocnice Hradec Králové send a brief experience how they handle textile waste which is very helpful for the survey.

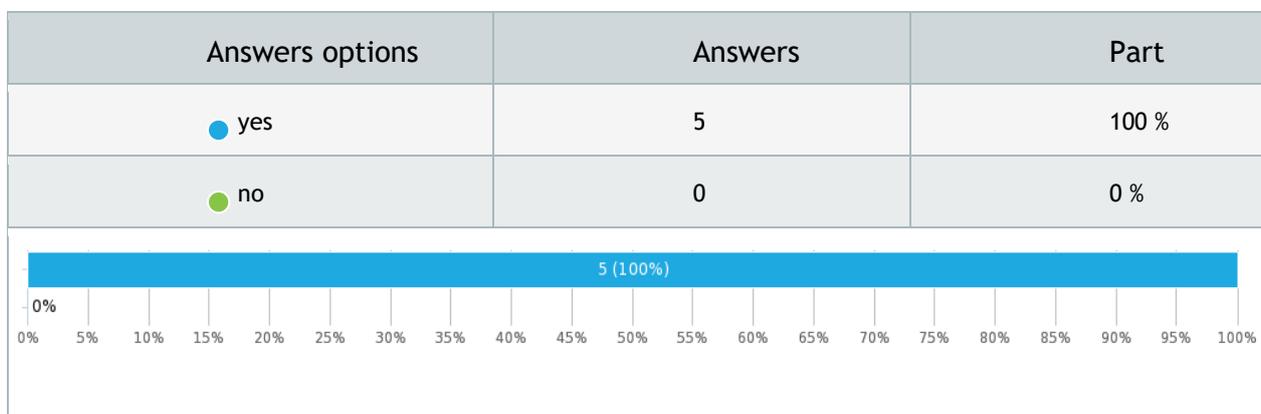
3.5. Questionnaire data analysis

In this chapter, the particular questions and answers are summarised.

1) For identification please provide an e-mail address from a personnel questionnaire

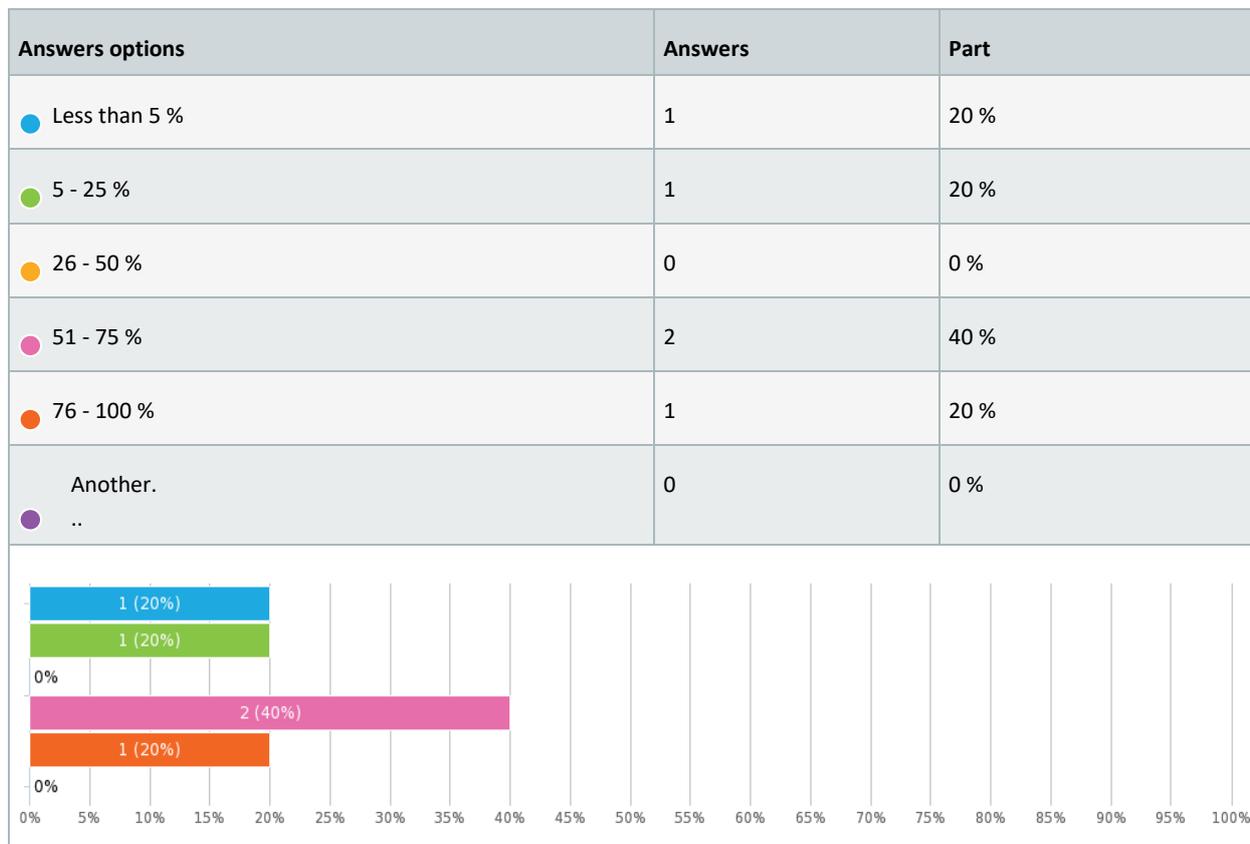
The survey was attended by a total of 5 companies certified for medical laundry from a table below.

2) Do you provide a textile leasing services for healthcare sector?



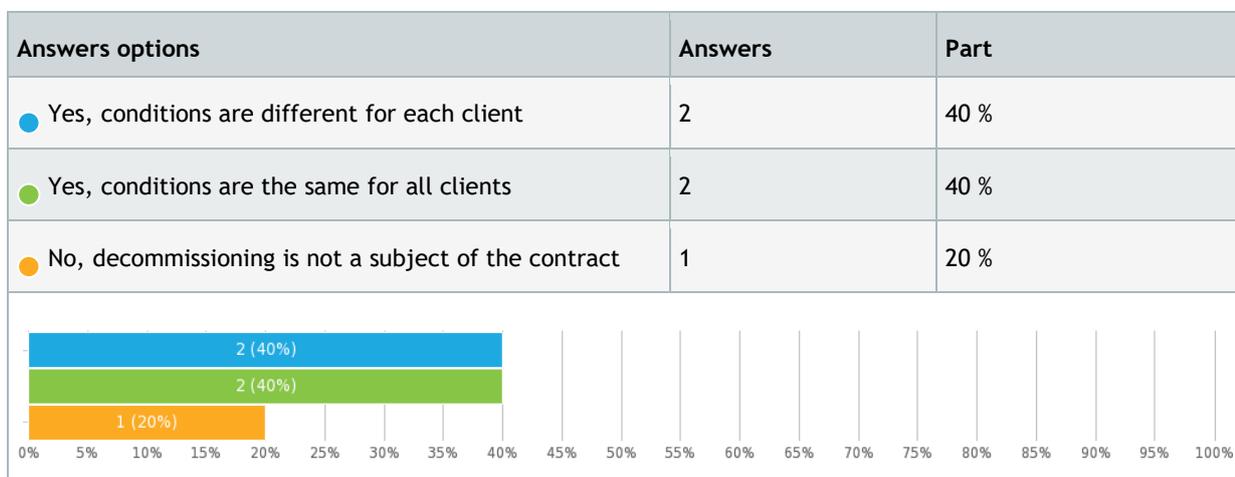
All five respondents provide a textile leasing service for a healthcare sector.

3) What is the volume of textile leasing services for healthcare sector in your Laundry?



The results show that in two subjects leasing medical linen constitutes a significant share of provided services, in one laundry even 76 - 100% of production. For the remaining two operations, this is a marginal service in one case (up to 5 %) and up to 25 % of the total contract volume in the second ones.

4) Do you have contractual conditions for decommissioning laundry with individual healthcare facilities?



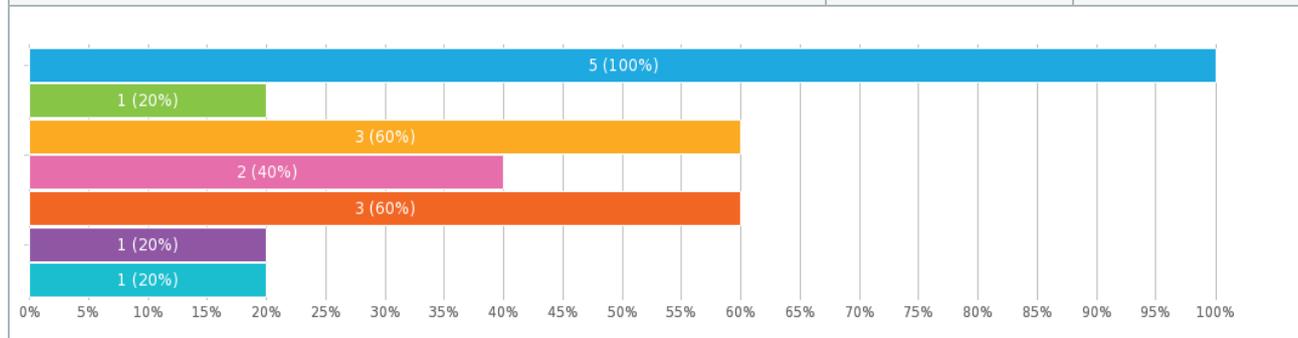
We were interested in how the contractual conditions for textile decommissioning are set. One company replied that they do not solve this area of collaboration contractually. Two companies



answered that conditions for decommissioning are the same for all clients and two companies answered that conditions for decommissioning are different for each client.

5) What are your parameters to evaluate laundry as „at the end of its lifecycle“ and decommissioned to waste: (multiple answers can be selected)?

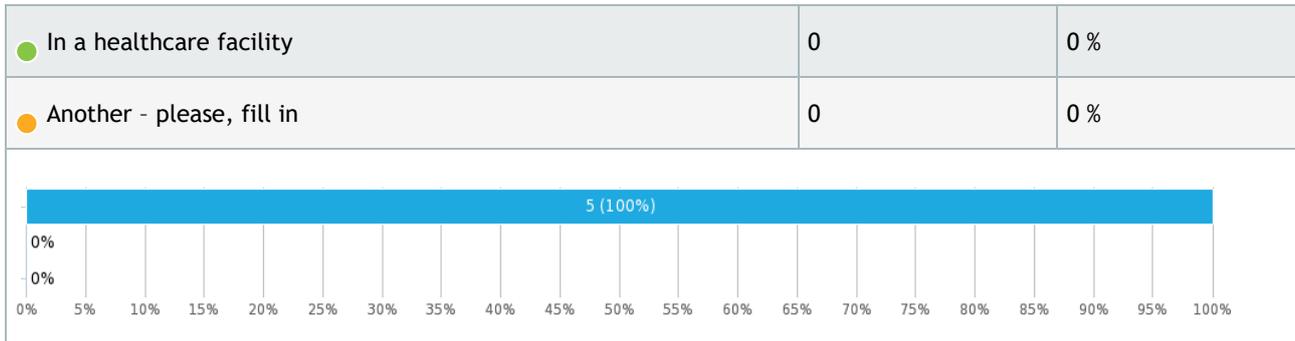
Answers options	Answers	Part
<input checked="" type="radio"/> Visible damage (holes)	5	100 %
<input type="radio"/> More than 5 repairs	1	20 %
<input type="radio"/> Colour stains (big or more small stains)	3	60 %
<input type="radio"/> Significant weight reduction	2	40 %
<input type="radio"/> Significant colour change	3	60 %
<input type="radio"/> Recommended number of maintenance cycles achieved	1	20 %
<input type="radio"/> Another - please, fill in...	1	20 %



All respondents agreed that visible damage (holes) is the most important for removal from circulation, also change of colour, including possible spots. Reduction in basis weight is a less important parameter for rejection. The least essential for the decommissioning of a textile is the parameter of more than 5 repairs, the number of expected maintenance cycles or complaints achieved.

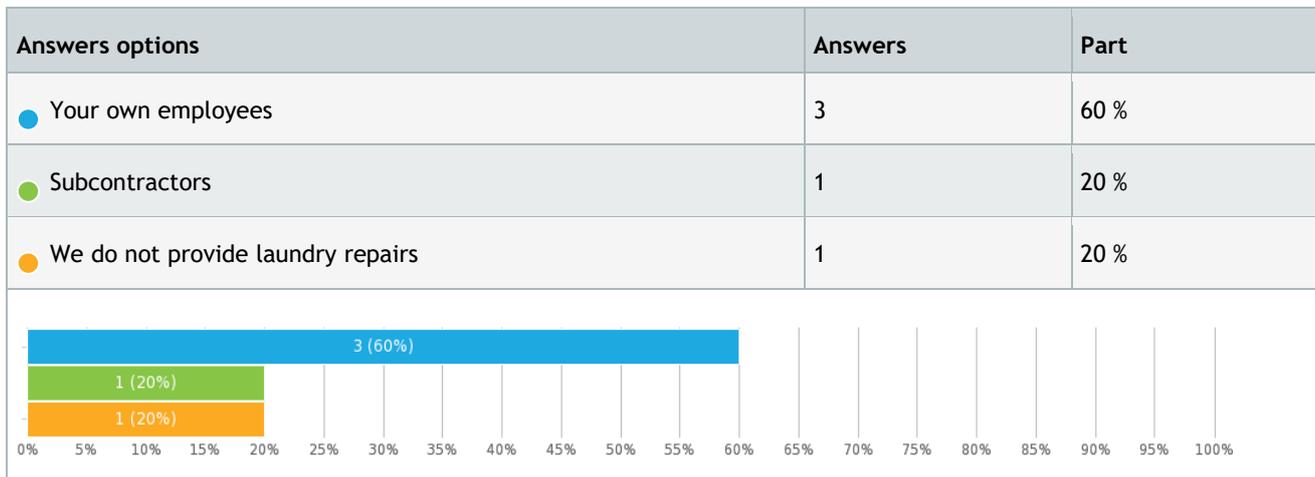
6) Where does laundry decommissioning usually take place?

Answers options	Answers	Part
<input checked="" type="radio"/> In laundry	5	100 %



All respondents agreed on the practice that clothes are always disposed of in the laundry.

7) Laundry repairs are provided by:



Repairs of damaged laundry are provided by the majority of the respondents. Only one laundry is not making repairs. Others are providing repairs mostly by their own employees, one laundry provides repairs by subcontractor.

8) Please estimate what % of the laundry to be disposed of by one customer (one department of the healthcare facility) can be used for another customer (another department of the healthcare facility)?

Answers options	Answers	Part
<input checked="" type="radio"/> < 5 %	5	100 %
<input checked="" type="radio"/> 5-25 %	0	0 %
<input checked="" type="radio"/> 26-50 %	0	0 %
<input checked="" type="radio"/> 51-75 %	0	0 %



● 76-100 %	0	0 %
● Another - please, fill in	0	0 %

We were wondering whether the discarded linen from one customer could be used for another (or another department) customer. All responded consistently said, that this is only possible to a small extent, maximum up to 5 %.

9) How many kg (or pieces) of hospital laundry do you dispose of annually?

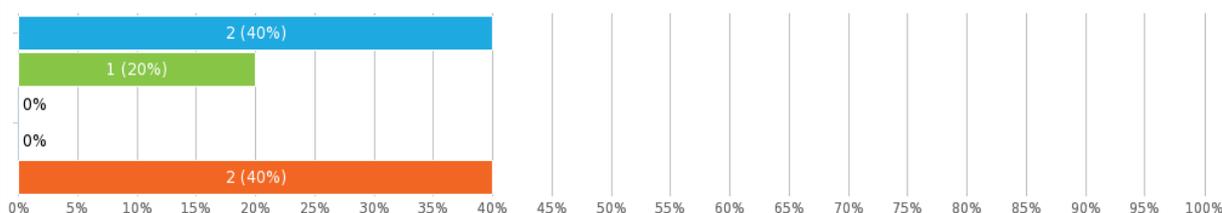
Individual answers of respondents:

- 6000 pc/per year
- 9000 pc/per year
- approximately 49 000 pc/per year
- 9712 pc/per year
- maximum 50 pc/per year

In total 68,762 pieces of textile are discarded annually from the surveyed laundries.

10) What % of the total discarded laundry relates to the hospital laundry?

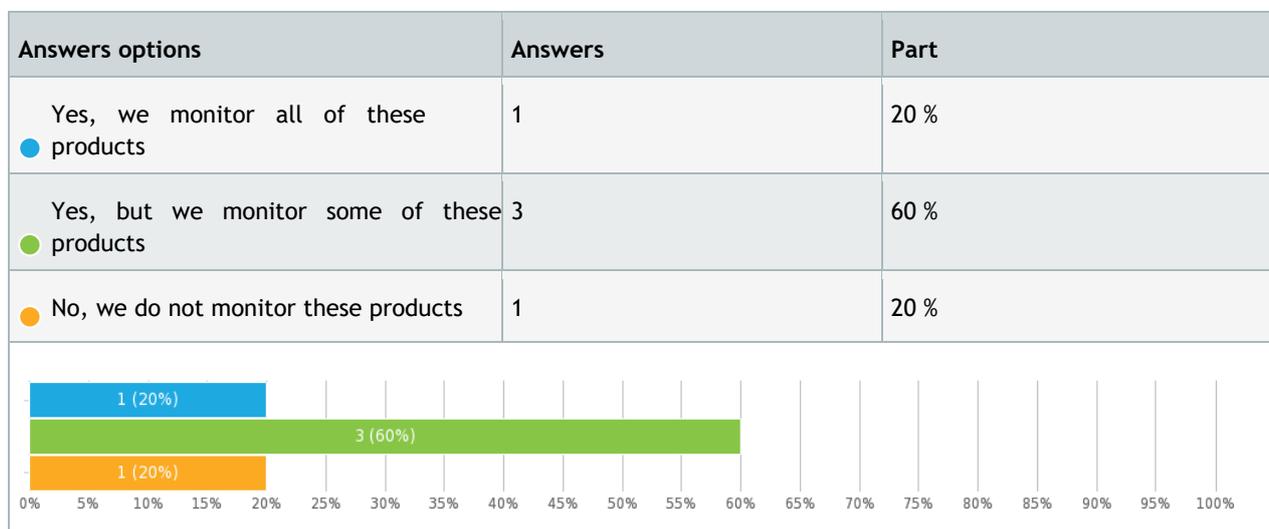
Answers options	Answers	Part
● < 5 %	2	40 %
● 5-25 %	1	20 %
● 26-50 %	0	0 %
● 51-75 %	0	0 %
● 76-100 %	2	40 %



Two respondents consistently replied that the share of leasing medical linen in total disposed laundry was less than 5 %. One laundry answered that the discarded medical clothes account for 5-25 % of the total discarded laundry. For the remaining two laundries, discarded medical laundry is the majority (76 - 100 %).

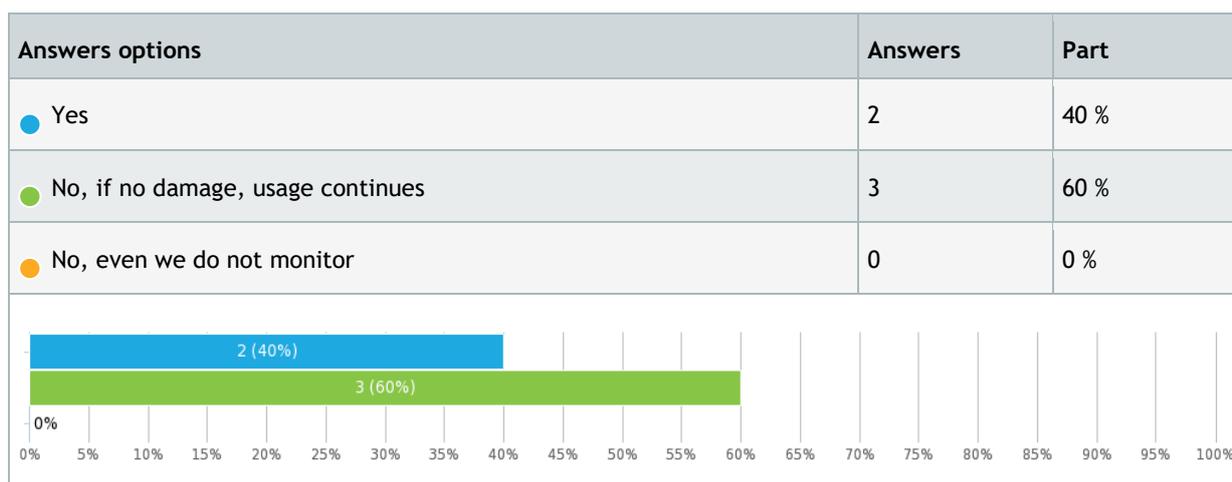


11) Does your laundry monitor maintenance cycles for surgical textiles (surgical drapes, gowns and clean air suits)?



The number of textile care cycles for surgical textiles is monitored by one laundry for all pieces, part of this assortment is monitored by three laundries and one laundry does not monitor the usage of these products at all.

12) Does your laundry dispose of surgical textiles based on recommended maintenance cycles number achievement?



Two laundries discard surgical fabrics after the number of recommended maintenance cycles has been completed, while three laundries do not discard surgical fabrics if they are undamaged.

13) Have you ever dealt with the disposal of a bloodied, infectious, etc. laundry - classified as hazardous waste?



Answers options	Answers	Part
<input checked="" type="radio"/> Yes	2	40 %
<input checked="" type="radio"/> No, but liquidation was solved by a hospital	2	40 %
<input checked="" type="radio"/> No, laundry never solve the liquidation of dirty laundry, it is always washed first	1	20 %

Answer Option	Count	Percentage
Yes	2	40%
No, but liquidation was solved by a hospital	2	40%
No, laundry never solve the liquidation of dirty laundry, it is always washed first	1	20%

Four laundries have experience with the disposal of infectious textiles, two of which have solved this problem, and in two cases were the disposing solved by the hospital.

14) Where and how is disposed laundry stored before sufficient amount to be discarded is collected?

Individual answers of respondents:

- The laundry is always separated after washing (clean). Discarding takes place at the expedition and the laundry is placed in cage trolley. Textiles are stored separately from clean and used laundry at a special place.
- Discarded textiles store
- At a designating place
- We do not collect discarded textiles; we usually provide it to technical maintenance department or it is kept by a medical facility for further use.

In principle, we got two answers to the question of where and how to dispose of the washed laundry - we do not collect the discarded laundry but we provide this textile to maintenance department that uses them in their work. We received a similar answer from the hospital laundry, which sells the discarded textiles to various industrial companies, which then use it as a cleaning material (cloths). The second group of responses specified the method of storing in the store of discarded laundry, according to the assortment, without monitoring devices (chips).

15) How many discarded textiles must be collected to be taken away?

Individual answers of respondents:

- At minimum 2 tons
- It depends on the actual storage space and free handling technique, but around 1000



kg.

- According to an agreement with the company that transports laundry, an estimated 200 kg.
- It is transported every week with no limitation of quantity
- We do not collect discarded textiles; we usually provide it to technical maintenance department or it is kept by a medical facility for further use.

The transport of discarded laundry depends on the size of the operation and the method of handling the discarded textile. If discarded textiles are used as cleaning cloths, the laundry does not solve the removal. If the laundry sells discarded textiles to a waste management company, the smallest quantity of textiles is about 200 Kg. Transport intervals also depend on the size of storage areas, so in some cases it is 1000 Kg, sometimes more than 2000 Kg.

16) How often is discarded laundry transported out from your laundry?

Individual answers of respondents:

- (2x) Every two months
- In average 10 times per year.
- Every week
- We do not collect discarded textiles; we usually provide it to technical maintenance department or it is kept by a medical facility for further use.

The transport interval is two months in two cases, roughly five weeks in one case and weekly in one case. One laundry is disposed of in a different way, so there is no need for transport.

17) Please, indicate your annual costs of discarding of disposed laundry:

Individual answers of respondents:

- 0 CZK - discarded textiles are sold to the customer, so we issue an invoice. (customer reprocesses this textile into cleaning cloths etc.)
- 52 000 CZK/ annually
- Textiles are sold as a waste material, so costs are 0 CZK
- -
- No costs. We do not collect discarded textiles; we usually provide it to technical maintenance department or it is kept by a medical facility for further use.

Only one company has been able to calculate the cost of disposing of laundry. Other laundries stated that they would sell the discarded textiles or use the discarded textiles as a cleaning material for their own use or for the customer (they will leave them free of charge).



18) Please, indicate what do these costs consist of (e.g. discarding, storage, transport....) and if possible, identify % of these parts:

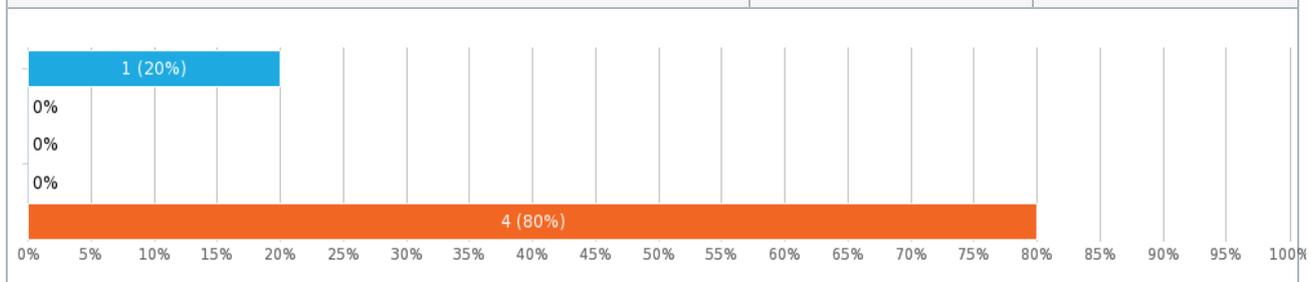
Individual answers of respondents:

- no costs - transport costs will be covered by the invoice for discarded textiles
- Personnel costs for discarding, sorting, depreciation, manipulation and invoice issuing.
- (3x) -

For the most part, laundries do not monitor the activities related to the decommissioning and disposal of textile waste. In three cases they did not mention any activities related to this activity, in one case the laundry reported activities related to textile decommissioning (decommissioning, sorting, depreciation, handling, sales billing). Again, in one case, the laundry said that the cost of transport would be covered by the revenue of the textiles sold.

19) What is the way of disposal of discarded laundry?

Answers options	Answers	Part
<input checked="" type="radio"/> Transfer to landfill	1	20 %
<input type="radio"/> Transport to incinerator	0	0 %
<input type="radio"/> Recycling - handover to the relevant organisation	0	0 %
<input type="radio"/> Handover to authorized waste disposal company	0	0 %
<input checked="" type="radio"/> Another - please, fill in	4	80 %



Respondents' answer "Another - please, fill in":

- This textile is clean and due to the high cotton content it is still used as cleaning cloths etc. Approximately 2% of this is not used and this is liquidated by the customer.
- Sale of discarded textiles to companies that use this textile as a secondary raw material, for example for the production of polishing wheels, or the production of shredding.
- Sale for further use



- It is solved by hospital

Disposal of discarded textiles is carried out in three ways - either by handing it to landfill (in one case) or by selling it for further processing of textiles into new products, which is the most common method. In practice, the waste textile is also used for maintenance department, or the laundry leaves the textile free of charge to the hospital as a cleaning clothes and maintenance purposes.

20) We would like to find out how the discarded textile is being disposed of. Therefore, we would like to ask you for the name of the company that provides for you the disposal of textile waste and possibly also the contact person who we can contact:

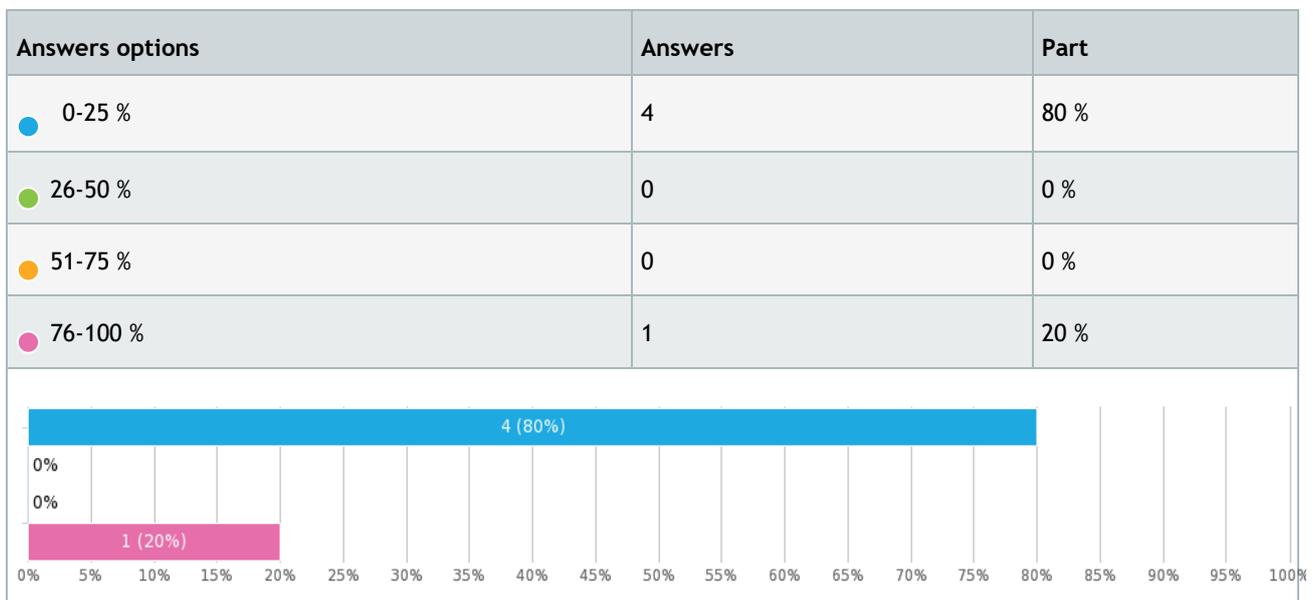
Individual answers of respondents:

- Dimatex
- MICRON PLUS spol.s.r.o., Dimatex CS, spol. s r.o., SOZOL servis, spol. s r.o., trucks services, tool shops etc.
- (2x) -
- Linen and terry laundry is stored, then sold. We do not discard textiles.

Respondents stated the names of companies that buy textile waste for further processing into other industrial products - for example, polishing discs or cleaning rags especially for technical fields (engineering, wood-processing industry etc).

Two laundries did not answer the question.

21) What % of leasing textiles is 100 % cotton:





In four companies is laundry of 100 % cotton made up to 25 % of all rented textiles. One laundry rent just products made of 100 % cotton.

22) Please, specify which products are mainly concerned:

Individual answers of respondents:

- blanket cover, pillow-case, sheets, underlay
- (2x) terry products
- t-shirts
- linen, surgical, staff apparel

Textiles which are made of 100 % cotton are mostly bed linen (pillow-case, blanket cover, sheets, underlays...), also is this textile material used for personnel products and surgical laundry.

23) Please, indicate three most used fibre compositions of blended material laundry (including % of each materials) which is used in your laundry:

Individual answers of respondents:

- 66% polyester and 33% cotton staff apparel, in average 60% cotton a 40% polyester for linen products
- polyester/cotton 65/35% - staff apparel, polyester/cotton 20/80 linen
- 80% cotton/20% polyester - linen; 75% polyester/25% cotton - staff apparel; 50% cotton/50% polyester - patient apparel
- 65% polyester/ 35% cotton personnel laundry; 50% cotton/ 50% polyester, smocks and t-shirts; 50% cotton/ 50% polyester polo-t-shirts
- mostly 100 % cotton

Material composition of blended textiles is demonstrated in the table below. There you can see that in the field of linen products is dominated majority part of cotton than in the field of patient apparel. The lowest part of cotton contains personnel laundry. In one laundry still dominate 100 % cotton, so this answer is not reckoned.

Linen	Personnel laundry	Laundry for patients
60 % cotton 40 % polyester	66 % polyester 33 % cotton	
80 % cotton 20 % polyester	65 % polyester 35 % cotton	
80 % cotton 20 % polyester	75 % polyester 25 % cotton	50 % cotton 50 % polyester
	65 % polyester 35 % cotton	50 % cotton 50 % polyester

Table No. 2 Different material composition used for rented textiles



24) What fibre composition do you use for surgical textiles?

Answers options	Answers	Part
<input checked="" type="radio"/> 100 % cotton	1	20 %
<input checked="" type="radio"/> 65 % polyester / 35 % cotton	2	40 %
<input type="radio"/> 50 % polyester / 50 % cotton	0	0 %
<input checked="" type="radio"/> Another - please, fill in...	2	40 %

Respondents answer “Another - please, fill in”:

- only polyester - we have a minimum of surgical textiles (in the field of surgical textiles we do just washing, not renting. This kind of laundry is mostly from 100 % cotton)
- 25% cotton / 75% polyester

In the field of surgical textiles is 100 % cotton presented in one case, in two cases 65 % polyester and 35 % of cotton. Material composition 75% polyester and 25% cotton was also mentioned. In one case, 100% polyester is mentioned. From the above information, it can be concluded that polyester / cotton blends are used for most surgical textiles, with polyester dominating.

25) Please, indicate the most important criteria for purchasing of leasing textiles (e.g. suppliers stability, material quality declared by the certificate, declared lifecycle, recommended textile care, offered price, supplier’s industry experience, way of handling complaints....)

Individual answers of respondents:

- Quality of textile products (basis weight of textiles / stability / colour fastness), eco-label, know-how of the supplier
- Long-term collaboration with a selected supplier, collaboration of the clothes design development, material testing and its composition in industrial laundry condition, capacity of deliveries of individual laundry assortments f. e. g. company logo, colour variants, possibilities of usage of logo’s and different printings
- Material quality, the way of recommended textile care, price
- Processing method - difficulty
- Supplier stability, material quality, price

It is evident from the above answers that the selection of the supplier is a multi-criterial choice. When purchasing textiles for leasing, the most of the respondents agreed for quality of material, stability of supplier, it’s professional know-how, the way of textile care up to



the price. Important is also flexibility of the supplier, including design requirements (design, colour variants, custom printings and logo's).

26) Please, specify textile care technology most used for 100 % cotton Laundry. (Please, specify Laundry machine used, washing temperature and finishing methods - e.g. ironing press, ironer lines, tunnel finisher).

Individual answers of respondents:

- Tunnel washing machine / 60°C, 15 minutes washing/ mangel for linen and staff apparel, optionally cylinder ironers for doctor's clothing
- We use mostly blended materials, cotton mostly as terry products, technological processing is set as chemo-thermo disinfection, mostly at 60 °C, some products i.e. kitchen textiles, table cloths and infection laundry is washed at 90 °C. Tunnel washing machine or washer extractors, automatic pre-drying and drying, garment is on 85 % processed at tunnel finisher, other textiles and flatwork at cylinder ironers, drying and automatic folding
- Tunnel washing machine, drying
- Barrier machine, temperature 60°C, dryer, cylinder ironer
- Tunnel washing machine, 90°C, cylinder ironer

The most used technology processing is in continuous tunnel washing machine at 60 °C with chemo-thermo disinfection, which is a procedure for hygienic washing of the laundry in the influence of the chemical agents and temperature. In one case is thermo-disinfection used, which is procedure when laundry is washed at minimum 15 minutes under the 90 °C temperature. Next steps are the same - squeeze press and drying. Garment is finished in tunnel finisher, flatwork at cylinder ironers, machine drying and folding.

27) Please, specify textile care technology most used for Laundry made from fibre mixture if different from 100 % cotton. (Please, specify Laundry machine used, washing temperature and finishing methods - e.g. ironing press, ironer lines, tunnel finisher)

Individual answers of respondents:

- Washing the same as for 100% cotton, finishing at tunnel finisher
- The same as for cotton products
- Continuous tunnel washing machine, tunnel finisher
- Barrier machine, temperature 70°C, tunnel finisher
- -



According to the respondents, the textile care for blended textile is nearly the same. The difference is just at the temperature - for 70 °C.

28) Please, estimate average and maximum number of usage cycles for laundry made of 100 % cotton:

Individual answers of respondents:

- 125 washing cycles
- From 80 to 100
- Average 50, maximum 80
- Average 20, maximum 30
- Average 100, maximum 200

The experience with the numbers of usage cycles for 100 % cotton products are very different - from 20 cycles of usage to 200. In the average it is 75 cycles per one cotton product, in maximum than 102,5.

	Average number of usage cycles	Maximum number of usage cycles
	125	
	80	100
	50	80
	20	30
	100	200
Average	75	102,5

Table No. 3 Number of usage cycles of 100 % cotton

29) Please, estimate average and maximum number of usage cycles for laundry made of blended material:

Individual answers of respondents:

- 175 washing cycles
- From 80 up to 180
- Average 70, maximum 110
- Average 100, maximum 150
- -

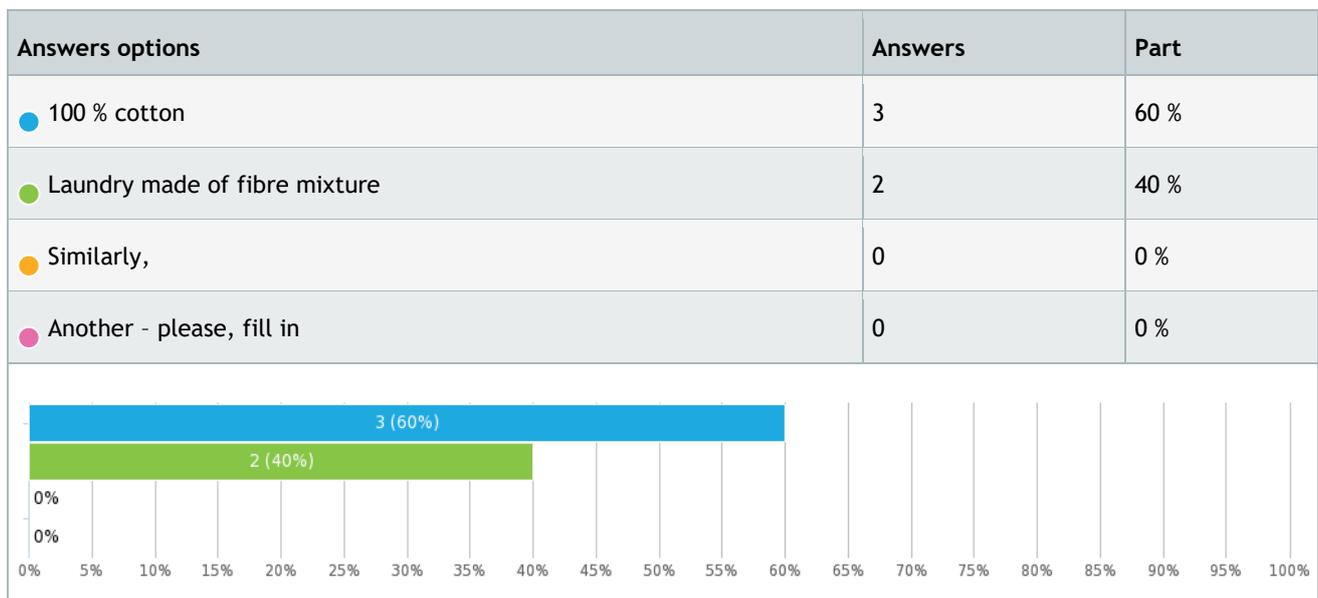


	Average number of usage cycles	Maximum number of usage cycles
	175	
	80	180
	70	110
	100	150
Average	106,25	146,67

Table No. 4 Number of usage cycles of blended material

The experience with textile care cycles with blended materials up to the end of life are different - since 106 cycles up to nearly 150 usage cycles. Compared to cotton the average increase is approximately 25 %, in maximum numbers of usage cycles it's almost 30 %.

30) Which laundry (in terms of the number of items) is being discarded annually more?



Most of the respondents said that in terms of number of pieces they discard more products made of 100 % cotton.

31) For the selected answer, please, specify whether flat linen or garments are being discarded more:

Individual answers of respondents:

- Garments
- Garments
- Garments (in term of number of pieces)



- Flat linen
- Flat linen

Respondents answered that in the case of 100 % cotton is being discarded more garment (in three cases) and in two cases it is flat linen.

32) What is the fibre composition of the most frequently discarded laundry (in case of blended materials):

Individual answers of respondents:

- 100% cotton
- polyester/cotton 65/35 %
- 25%cotton/75 %polyester
- 65% polyester /35% cotton
- -

The first answer is irrelevant. In two cases is the most frequently discarded laundry made of the same material composition - 65 % polyester and 35 % cotton. In one case is mentioned composition 75 % polyester and 25 % cotton. Last respondent did not answer because they use for textile leasing just 100 % cotton.

33) Could you specify a type of this laundry:

Individual answers of respondents:

- t-shirt
- Mostly trousers and smocks, reasons - worn out, colour changes, sheets, underlays in both colour stains
- staff apparel
- garment
- -

All three relevant answers agree that are more discarded garments (for worn out or colour change), in case of flat linen, there are colour stains as frequent reason for discarding.

34) Fill in, please, the most frequently used technology for laundry processing:

Individual answers of respondents:

- Washer extractor, capacity 200 kg with dividing wall + tunnel finisher
- Tunnel washing machine, chemo-thermo disinfection 60°C, machine pre-drying, tunnel finisher for garments steam/hot air 135 °C, flat linen at cylinder ironer 185°C
- Tunnel washing machine, tunnel finisher



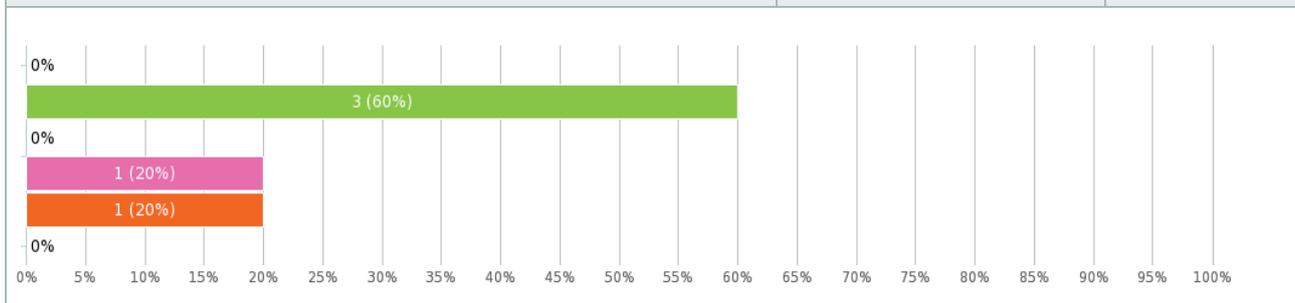
- Tunnel washing machine, temperature 65 °C, ironer

● -

In one case there is a washing in washer extractor and in three case sis use tunnel washing machine. In two cases is used chemo-thermo disinfection method (60 °C or 65 °C). Others do not specify how to disinfect laundry.

35) How often do your customers complain about laundry being after its end of life?

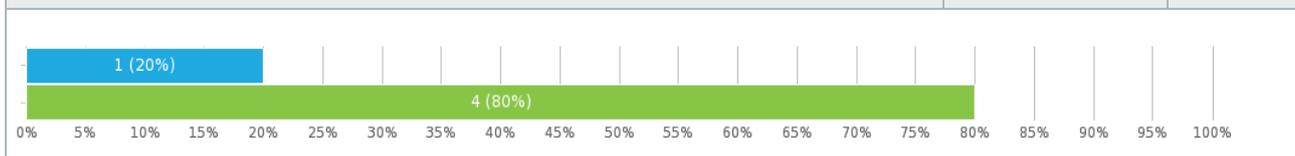
Answers options	Answers	Part
● Several times per week	0	0 %
● Several times per month	3	60 %
● Several times per year	0	0 %
● Exceptionally	1	20 %
● Never	1	20 %
● Another - please, fill in...	0	0 %



Customers complains concerning the exceeding of lifetime of the textiles occur in the respondent's companies in three cases several times per month, in the remaining two companies exceptionally or never.

36) If the answer is different from never, complaints are more concerned about:

Answers options	Answers	Part
● 100 % cotton	1	20 %
● Mixed fabrics, please, indicate the most concerned textile mixture	4	80 %



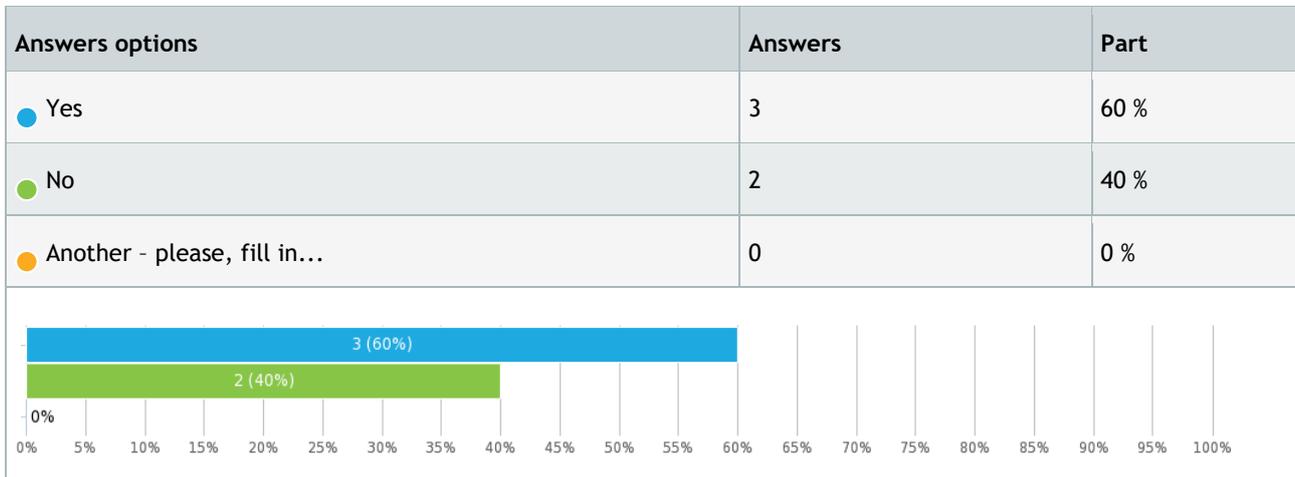


Individual answers of respondents:

- We use almost exclusively composition polyester/cotton (except terry programme).
- 25% cotton/75% polyester
- 65% polyester/35% cotton
- Answer for the question No. 35 is never

Consumer claims are concerned exclusively of mixed textiles which are predominant at the market of textile leasing.

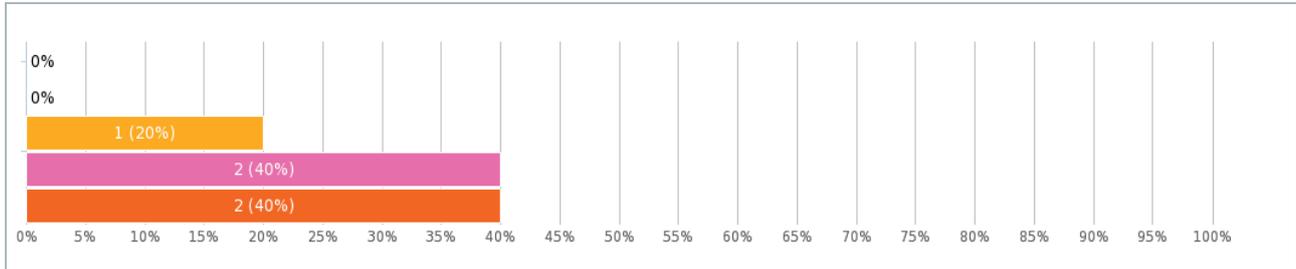
37) Do you use any items on your laundry that's are necessary to remove before discarding laundry (e.g. chips):



Three of five respondents said that for leasing textiles uses elements which is necessary to remove before discarding.

38) If yes, could you specify the volume of this laundry:

Answers options	Answers	Part
● 0-25 %	0	0 %
● 26-50 %	0	0 %
● 51-75 %	1	20 %
● 76-100 %	2	40 %
● Another - please, fill in...	2	40 %



Respondents answer Another - please, fill in:

- irrelevant
- Answer for the question No. 37 is No

Two of respondents do not use any of special elements. Remaining three respondents use monitoring elements. Two of them in the volume of 76 - 100 %. One respondent in the volume of 51 - 75 %.

39) On which type of linen are these elements used:

Answers options	Answers	Part
● Bed linen	3	60 %
● Staff apparel	3	60 %
● Patient apparel	2	40 %
● Another - please, fill in...	2	40 %

Response	Count	Percentage
3	3	60%
3	3	60%
2	2	40%
2	2	40%

Respondents answer Another - please, fill in:

- irrelevant
- -

Three of the respondents answered that they use these elements on bed linen and staff apparel. Two respondents use these elements even at patient apparel. We can assume that these two laundries use these elements for all textiles, one laundry just for bed linen and staff apparels, not for patient apparels. Two laundries do not use chips or different monitor elements.



40) What are the costs to remove these elements from the laundry:

Individual answers of respondents:

- irrelevant
- See the answer No. 17 and 18. We do not monitor elementary costs to remove chips, total costs during the year 52 000 CZK.
- negligible
- Our own seamstress
- -

The chips removal costs are monitoring by one company include in tracking of annual laundry disposal costs. Other laundries do not monitor these specific costs because they are included, for example, under the linen repairs (seamstress wage costs) or are negligible.

4. Summary of the results from the market research

The respondents that answered the questions from the questionnaire survey are representatives of medical textiles rental sector in the Czech Republic. Two of this subjects provide textile rental services in the range of 51-75 % of production, in one case even 76-100 % of the production volume. One laundry provides rental of medical textiles in the range of 6 - 25 % of the services provided and the last respondent in the range of 0 - 5 % of the production volume. The extent of the fields covered varies among respondents - from almost 100 % of the textile rental service to a small volume of up to approximately 5 %.

4.1. Part A - laundry decommissioning

In most cases, laundries have contractually solved disposal conditions for discarded textiles. In two cases the conditions are set the same for all clients, in two cases the conditions differ individually. In one case the disposal of discarded textiles is not dealt with by the laundry.

There are several parameters for discarding textiles from the use cycle. The most important are the holes, change of colour shade and possible stains. It is also important parameter the reduction the basis weight. Less significant is the number of repairs or the achievement of usage cycles expected.

Decommissioning of textiles is always done in laundries.

Four out of five laundries provide laundry repairs. The vast majority (three of the four answers) of the laundries provide repairs by their staff. In one case they use an external company for repairs.

Discarded linen from one customer or department can be used at about five percent for another customer or department.

The respondents to this questionnaire survey discard nearly 70,000 pieces of medical textiles annually. According to expert estimates it is about 35 tons. These textiles make up from 5 -



100 % of the total discarded textiles in the laundry. The share depends on the product portfolio of the laundry.

The surgical laundry care cycles are 100 % monitored by one laundry, three laundries monitor this parameter partially, one laundry does not monitor usage cycles at all. Two laundries discard surgical fabrics when the recommended cycle limits are reached. However, two Laundries continue to use these textiles, provided the surgical fabric does not show any signs of damage.

Laundry employees are partly experienced in the disposal of infectious textiles as hazardous waste. Two of five laundries have already solved this situation. Two Laundries also encountered this problem, but the disposal was resolved by the hospital.

Storage, removal and disposal of discarded textiles

The discarded linen is transported as needed depending on the requirements of the discarded linen customer or the storage capacity. In some cases, 200 kg is carried away, in others 1000 or 2000 kg. The pick-up interval is also different - in some operations every couple of weeks, sometimes 5 weeks, and sometimes every two months.

Only one laundry was able to quantify the exact annual costs. Other companies do not monitor the disposal costs of discarded textiles separately. In addition, the sale of discarded textiles generates revenue in some cases.

There are basically three ways to dispose of laundry:

- pass to landfill (in one case)
- sale for further processing. The discarded textile is used as a starting material for the production of polishing wheels, cleaning rags for industrial operations (engineering, car service, tool shop...), or for the production of non-woven textiles.
- handing over textiles, for example to maintenance department for use in the machinery repairs, or handing over to a hospital that also uses textiles for the maintenance or cleaning purposes.

In many cases, discarded textile is used as secondary raw materials for the production of other technical applications - polishing discs, cleaning cloths, cleaning fabrics, textiles for the furniture industry and many other technical applications.

4.2. Part B - Information about textile materials, material composition and laundry technology

100 % cotton textiles are used in textile leasing sector in minority volume. In four out of five respondents, 100 % cotton underwear accounts for up to 25 % of the volume. Only one company uses mainly cotton. 100 % cotton can be found especially in bed linen, terry program and also as surgical and staff apparel.

From the above answer, it can be concluded that mixed materials dominate in the sector of medical textiles renting. It is not possible to read clearly the three most frequently used



material compositions from the answers; in any case, the answers can be summarized by mathematical methods as follows:

- Bed linen is mostly made of a mixture of 80 % cotton, 20 % polyester (on average the material composition is 73.3 % cotton and 26.6 % polyester)
- Medical staff's apparel is mostly made of 65 % polyester / 35 % cotton (on average the material composition is 67.75 % polyester and 32 % cotton)
- Patient apparel is made from a mixture of 50 % cotton and 50 % polyester

Surgical textiles are in two cases made of 100 % cotton (once rented laundry and once as a laundry service), in two cases a blend of 65 % polyester and 35 % cotton and once 75 % polyester and 25 % cotton.

The most important parameters for the purchase of leasing laundry are the quality of the material, stability and professional know-how of the supplier and the price offered. There is also a requirement for cooperation with the design development, material testing in industrial laundries, sufficient capacity to supply the assortment and the company logo.

The technological process of maintenance of laundry with different material composition (blended X 100% cotton laundry) is almost identical. The reason is the processing of large loads of laundry and very similar character of textiles. Therefore, washing in a continuous washing line (tunnel washer) with a bath temperature of 60 ° C and chemothermal disinfection prevails. It is followed by squeeze press, pre-drying and drying. Depending on the character - garments in a tunnel finisher, other textiles then ironing on a cylinder ironer or dryer and machine folding. The difference in cotton is only in one Laundry at the temperature of the washing bath - it is 10 ° C higher (i.e. 70 ° C).

The durability of the laundry is defined by the number of maintenance cycles until it is discarded. Products with 100 % cotton can be used on average 75 times (even 76, 6 times after removal of extremes), up to 102.5 times (after removal of extremes 90 times). For mixed material products, the average number of maintenance cycles is 106.25 and at maximum 146.7. It is therefore more than evident from the above information that the blended materials significantly extend the life cycle of textile products and increase their use rates.

In laundries, is decommissioned more often textiles made of 100 % cotton, mainly (related to the fact that cotton is used more for flatwork). In the case of mixed materials, the garments with a composition of 65 % polyester and 35 % cotton is most often discarding group of textiles. The laundry is mainly processed in a continuous washing line with chemo thermal disinfection.

Complaints that laundry is used beyond the declared maintenance cycles are faced by laundry operators several times per month and are typically mixed textiles.

On the Czech market, laundry monitoring equipment is used, which must be removed before discarding. Among the respondents there are three Laundries that use these elements and two Laundries that do not use these elements. One laundry uses these facilities for 51-75 % of the volume of leasing laundry, two laundries use chips for almost the entire range. Tracking devices are used for a wide range of rented textiles - from flatwork (bed linen, towels, etc.) to shaped (patient and staff apparel).



As a rule, laundries do not separately track the cost of disposing of laundry, as many activities are covered by other processes (for example, decommission of on dispatch, removal of tracking chips at a sewing workshop, etc.). Also, for part of laundries, discarded textiles represent revenues in the form of the sale of this textiles as a secondary raw material for further industrial products.

In addition to independent work with textiles and their discarding, it is also possible to encounter considerable dust and sedimentation of textile particles in the interiors of laundries. This dust is called production dust and is similarly found in textile factories. It is a mixture of small particles of textile and air and can be explosive in greater concentration. In any case, it is a contamination of the working environment that can cause various allergic reactions to workers. Production dust is not recycled but disposed of as municipal waste.

5. Conclusion

A survey conducted in the field of medical textiles has shown that the textile renting companies for medical facilities use mixed materials in their practice. These fabrics, with a suitable material composition, provide both wear comfort and durability, which is represented here by the proportion of synthetic fibres. The survey clearly showed that textiles with a chemical fibre content have a life cycle up to a third longer than 100 % cotton products. The results thus confirm that industrial laundries with a suitable material composition contribute to the reduction of the production of textile waste.

Laundries have an efficient way of disposal of discarded textiles in the form of sale for further processing as secondary raw materials. Discarded textiles, after further processing, find use as cleaning cloths, insulating fabrics, cleaning fabrics, polishing wheels or fabrics for the furniture industry.

Thus, the principles of circular economics are already applied in this sector - both for the used textile materials (a combination of synthetic and natural fibres and the use of their specific properties) and for the disposal of discarded textiles - the use as secondary raw materials. Environmental footprint is also reduced by providing repairs of small damages, which prolong of textiles usage.

The situation is different for hospitals that operate their own laundry. Here, the use of 100% cotton linen, which has clearly shorter lifespan than blended linen, still prevails. The question is also the quality of the purchased laundry, whose main parameter is mostly favourable price. The study provides strong arguments for the purchase of mixed textiles in hospitals. Here, it is necessary to educate the staff of the hospital laundry purchase department, who can prolong the life of medical textiles by appropriate selection of the material composition of the laundry and thus reduce the amount of waste generated.

The second area that offers the potential to extend the lifespan of textiles is the hotel sector. Hotels and other accommodation facilities generally have high demands on the look and handle of the textiles used. Usually it is bed linen and terry textiles made of 100% cotton. The use of blended materials with a predominant share of natural fibres could extend the



service life of the material without noticing consumers. This would reduce the environmental impact not only of the textile waste generated but also of savings in the textile care process (lower water consumption).

6. Bibliography

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