Why textiles win in the long run

Sustainability performance of table linen as compared to disposables

Summary

The following report examines the performance of two alternative types of table linen used in hotels and restaurants: textiles (product-as-service through professional textile services) and disposable paper products.

This investigation focuses on hygienic standards in cleaned and ironed linen, as well as the environmental performance and economic contribution to the society/creation of jobs, as these represent a social, ecologic and economic dimension which are the three pillars of sustainability. The report has an emphasis on four countries: UK, Belgium, Sweden and the US.

The present study shows that:

- The hygiene performance of textile table linen is equal to disposable table linen. Consumers do not see textiles as a relevant path for contamination from COVID-19.
- Using updated methods in the use of energy and water in washing of laundry decreases the climate impact from the use of textiles to only half of the impact generated by disposables.
- Different from the linear business model of disposables, the circular business model is applied when textile table linen passes through a large number of washing cycles, jobs are created on a local scale. Each job created in textile service industry creates another 0.25 indirect and induced jobs.

Hygiene

In the current pandemic situation, questions have been raised regarding the hygienic performance of textile linen, as opposed to disposable alternatives. This study shows that standards respecting hygiene concerns exist both for the textile service industry and for disposables. They are however more pronounced in the case of the textile service industry.

A survey taken by seven national-level organizations for professional textile service shows that thorough, comprehensive and systematic hygiene management is implemented in all investigated countries. Implemented hygiene management is also reviewed by third-party agents, guaranteeing compliance. This means annual monitoring of hygiene protocols, implementation of Risk Analysis and Biocontamination Control (RABC), unannounced control visits with microbial controls in outgoing goods etc.

As hygiene is a key aspect for the textile service industry, and different types of microorganisms are sensitive to different environments, decades of research and development has resulted in modern processes which rely on a combination of high temperatures and antimicrobial chemistry, mainly comprised of liquid detergents and disinfectants.

Independent research published in October 2020 states that amongst the different surfaces included in the study (plastic note, paper note, stainless steel, glass, vinyl and cotton fabric), cotton fabric was the material with the lowest half-life, implying that the COVID-19 virus dies faster on this type of surface compared to paper surfaces.

Finally, surveys amongst European consumers conducted during the pandemic situation, show very low levels of worry for contamination of COVID-19 through the use of textile linens.

Summary

Environment

Several previously performed studies with the aim of investigating the environmental performance of textile table linen as compared to disposables, have, identified laundry as contributing most to global warming among the various business processes required for textile service, such as raw material harvesting, manufacturing, distribution and end-of-life. These previous findings were revisited in the present study, using updated data from the textile service industry. As the climate impact from washing of textiles is greatly affected by the amount and type of energy used in the washing/drying process and the number of uses prior to disposal, updating this data radically changes outcomes from previous comparative studies between textiles as well as disposable restaurant and hotel material.

Using updated data for the use of energy and water in the washing of laundry decreases the climate impact from the use of textiles by around 40%, making textiles preferable to disposables by far. The same is seen when data from the industry on the number of uses of textiles is applied. And when combining updated energy and water use with a realistic number of washing cycles, the climate impact from textiles is reduced to half of that from disposable alternatives. Thus, the present report clearly shows that the environmental performance of textiles today is considerably higher when compared to disposables.

While lack of recycled paper fibres and increased pressure on the world's forests in recent years pose increased challenges for the sustainability of disposables, increased recycling of textile fibres, the use of alternative fibres in textile-production and increased usage of non-fossil energy in the washing process are continuously decreasing the environmental impact from textiles. Thus, several ongoing processes strongly point at further environmental benefits from use of textile table linen as compared to disposables in the future.

Economy

The textile service industry employs several thousand workers in each one of the countries included in the study. Including direct, indirect and induced jobs, the European and the US textile service sectors together support almost 330 000 jobs in total.

Perhaps just as important as the number of jobs created in and by the industry, is the type of jobs created. The reports shows that a large part of the workers in the textile service industry are of foreign descent. The diversity amongst workers in the sector clearly reflects the important role that the laundry and textile service industry has for the provision of jobs and opportunities for foreign-born people. The textile service industry is a motor for integration in countries through-out the world.

While use of disposable table linen mainly generates jobs in countries where paper products are produced, such as China – the world's largest exporter of these products, use of textile table linen also generates jobs locally through textile service companies. Supporting the sector is therefore critically important in times with rising unemployment.

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The **hygiene performance of textile linens** is equal to, and **often superior** to, that of disposable table linens.

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The textile service industry is an important sector in both Europe and the United States.

Around **140,000 are employed in Europe**, and almost **121,000 in the United States**.

1.0 Background

The textile service industry is an important sector both in Europe and the US, with around 140,000 employees in Europe in almost 2,000 companies and around 121,000 employees in the US. The Hotel/Restaurant/Food service sector is an important market for the textile service industry. In the US, laundry specialists in this sector comprise about 40% of the total number of firms in textile service (TRSA, 2020).

In larger organisations it is common practice that textiles are rented and cleaned from textile service companies who then collect and clean them. Instead of buying several different products all at once (textiles, washing machines, drying machines, detergents etc.), these organizations buy a singular service; clean and hygienic textiles of the right type and amount, delivered at the right moment.

Thus, the business model of the professional textile service is inherently circular, making it an important part of a circular economy (Figure 1). Circular economy business models seek to minimize waste, keep products and materials in use for as long as possible and find new uses for textiles once they can no longer be used for their first purpose through reuse, upcycling or recycling. This requires high-quality textiles, efficient and sustainable laundry methods, mending service as well as innovative reuse/recycling processes. Linear textile flows, on the contrary, make money from low quality textiles that are frequently substituted by new materials, resulting in tremendous resource use.

Being based on a circular business model, the textile service industry has sustainability in its veins and this sustainability corresponds to all three dimensions of the sustainability matrix: the environmental dimension, through the resource efficiency gained through circular flows and resource efficiency. Secondly, the social dimension, through laundry and decrease of risks for contaminations, and lastly, through the creation of jobs with different levels of needed skills and experience. Textile Services thus represent an important contribution to the local and national economy.

The textile service industry employs both highly skilled engineers within the area of industrial processes and logistics, as well as many thousands of workers with lower levels of formal education. The minimized need for advanced language skills is the main reason for the large amount of workers that are non-natives in the country where they work. This makes the professional textile service industry an important bridge to facilitating integration. As language skills develop, many of these workers advance to higher positions within the sector.

Figure 1 The ecosystem of professional textile service.

2.0 Aim

As stated previously, this study aims at analysing the performance of two alternative types of table linen used in hotels and restaurants: textiles (product-as-service through professional textile service) versus paper disposables

The investigation focuses on hygienic standards, environmental performance and the economic contribution to the society through creation of jobs, as these represent a social, ecologic and economic perspective, i.e. the three pillars of sustainability.

- **Environmental performance:** Several previous studies have investigated the environmental performance from use of hotel/restaurant textile services, as compared to that of disposables. Results from these are somewhat diverse – in some cases pointing at environmental benefits from textile service, and in other pointing to disposables. No attempt has, until now, been made to compile the available literature and analyse reasons for these differing in results. The aim of the present report is therefore to present up-to-date data on the environmental performance from the European textile service industry and compare these to data used in previous LCAs.

- **Hygienic performance**: In view of the current COVID-19 crisis, there are voices stating that disposables are needed to ensure hygienic safety despite the enormous use of resources required. There is therefore a need for an objective analysis of the hygienic performance of the textile service industry, delivering professionally washed and ironed linen, with emphasis on the hotel and restaurant segment.

- **Economic performance - Creation of jobs:** The COVID-19 crisis has also resulted in increasing levels of unemployment in many European countries as well as in the US. Creation of jobs is therefore increasingly important for local and regional development and stability. A third aim of the study is therefore to investigate the importance of the jobs created within the professional textile service industry.

Choosing **multi-use textile table linens** means combining local **job creation** with the goals of a **circular economy**.

3.0 Methodology

A variety of different methods are used to analyse the performance of the compared two alternative types of table linen used in hotels and restaurants. Information was gathered from general public sources and through direct contact with representatives from the two units under analysis (hotels and restaurants), with an emphasis on four countries: UK, Belgium, Sweden and the US.

- **Hygienic performance:** An overview is presented of existing requirements related to hygienic aspects in the professional textile service of hotel/restaurant textiles. Identified requirements are related to existing standards and the security of professionally washed and ironed linen is discussed and compared to disposables.

- **Environmental performance:** Collection of existing material from the European market, focusing mainly on previously performed lifecycle assessments (LCA) where textiles used in hotels and restaurants, using professional textile services, were compared to use of disposables. The emphasis here will relate to their impact on climate change, but also other relevant environmental impacts, such as acidification, eutrophication and photochemical ozone formation, are discussed in this analysis.

Key parameters, which are decisive for the overall environmental performance of textiles and disposables respectively, are identified. Up-to-date data on for example, energy, fuel and water use is collected from the industry. The aim is to investigate the robustness of results gained in performed studies, when the data representing the textile service industry is adjusted to present modern technology and handling.

- **Job creation:** Relevant national statistics related to job creation within the professional textile service are collected and analysed.

4.0 Hygienic performance

From the perspective of the professional textile service sector, laundry service goes well beyond stain- and odour-removal. Hygiene is in absolute focus in the professional textile service. Thus, it is important to emphasise that it is the professional textile service that is compared to disposables in the present report, not, for example, textiles washed in households or on-premise laundry (OPL).

4.1 The ingredients leading to hygienic performance

Bockmühl et al. (2019) investigate the different parts of hygienic laundry service. Different types of microorganism are sensitive to different environments.

Temperature The temperature of a washing process has various functions: firstly, it affects the microbial reduction on laundry items by thermal inactivation, it accelerates the activation of chemical additives such as bleach and it facilitates the mechanical removal of stains.

Chemistry Surfactants and bleaching agents in detergents influence the antimicrobial efficacy of washing processes. Surfactants account for the cleaning efficacy of the laundering process by removing hydrophobic soil and thus also microbial cells from textiles. Various studies demonstrate that the use of activated oxygen bleach (AOB) significantly increases the antimicrobial efficacy of the laundry process.

As there are several types of microbiological contaminants potentially present in dirty laundry, professional textile services are normally relying on a combination of high temperatures and antimicrobial chemistry, mainly comprised of liquid detergents and disinfectants, as seen in the below (Bockmühl et al., 2019):

- Studies suggest that, in general, temperatures above 50°C are able to significantly reduce bacteria on textiles, even without the use of bleach containing detergents. For heat-resistant strains most bacteria are effectively neutralized and terminated even at lower temperatures when bleach is used. Washing without bleach appears to be effective against gram-negative bacteria due to the presence of an outer cell membrane that seems prone to attacks from sulfactants

- Infections related to enveloped viruses are most efficiently reduced through the use of surfactants, disturbing the phospholipid envelope. For non-enveloped viruses (e.g. Norovirus) it has been shown that AOB substantially improves the antiviral efficacy of the laundering process.

- The antifungal efficacy of the washing process can also be of relevance. Bleaching agents can commonly be effective for this purpose. Experimental studies investigating the elimination of fungal pathogens such as Trichophyton and Candida from contaminated textiles shows that AOB and higher temperatures provides nearly complete inactivation

4.0 Hygienic performance

4.2 Hygiene in textile service in times of COVID-19

The hygienic performance of textile services has of course gained focus in the times of the pandemic. As enveloped viruses, the genetic material of which is coated by a layer of fat (lipid layer), coronaviruses generally reacts sensitively to substances that dissolve fat, such as surface-active agents, which are present in detergents such as grease removers (BfR, 2020).

Several studies have indicated that the survival rate of the virus differs between different types of materials. A study published in the spring of 2020 determined the survival time of the virus on plastics to be 72 hours and on paper surfaces to be 24 hours. At the same time, the virus can survive up to 3 hours as aerosol in the air (BfR, 2020). Another study, published in October the same year, compared the longevity of the virus on several different surfaces. In the later study, the time it took to achieve a 90% reduction of the virus on a specific surface was determined to 40% longer on paper notes, as compared to cotton textiles in normal room temperature (20°C). In fact, amongst the different surfaces included in the study (plastic note, paper note, stainless steel, glass, vinyl and cotton fabric), cotton fabric was the material with the lowest half-life, implying that the virus dies faster on this type of surface compared to several others (Riddell et al., 2020).

To support the industry, national interest organizations very rapidly developed guidelines for laundries on how to act to minimize risks for contaminations of workers and deliver high-standard hygiene textiles also in times of a pandemic.

Thus, the German Bundesinstiut für Risikobewertung (BfR) recommended that clothes, bedding, towels, etc. of ill persons should be washed at sufficiently high temperatures with suitable detergent and subsequent drying, and that relevant precautions are taken for the persons handling laundry – thus, calling for professional textile services to make sure that these precautions are met (BfR, 2020).

De Montfort University (2020) investigated the disinfection of the COVID-19 virus comparing domestic washing and professional washing. The study concluded that the virus can remain infectious after washing in domestic washing machines at low temperatures (≤ 40°C), while clothing was disinfected after industrial washing processes in temperatures of at least 67°C for 10 minutes (De Monfort University, 2020).

4.0 Hygienic performance

4.3 Hygiene standards amongst professional textile service organizations

The international standard EN 14065 Textiles - Laundry processed textiles - Biocontamination control system was presented in early 2000's (with the latest review completed in 2016) and has since then become an important reference within the professional textile service industry.

The standard describes a risk management approach, called "Risk Analysis and Biocontamination Control" (RABC), designed to enable laundries to continuously assure the microbiological quality of laundry processed textiles.

The RABC approach applies primarily for laundries handling textiles from food manufacturing/ processing and healthcare. However, it is more and more commonly used in other sectors and the RABC approach has influenced many of the national quality standards and authorization processes amongst national interest organizations for the professional textile service industry.

In the present study, minimum hygiene standards used as quality requirements linked to national interest organizations for the professional textile service industry in seven different countries were compiled and analysed.

Results are presented in Table 1. The summary shows that thorough, comprehensive and systematic hygiene management is implemented in the laundry industry. Implemented hygiene management is also reviewed by third-party agents, guaranteeing compliance.

4.0 Hygienic performance

4.3 Hygiene standards amongst professional textile service organizations ...cont'd

COUNTRY	HYGIENE QUALITY STANDARD	CONTROL	REFERENCE
Sweden	Annual authorization process includes the following requirements: Physical separation of in and outgoing textiles. Washing in 70°C for at least 10min. Hygiene policy communicated written and orally to all workers. Documented method for cleaning transportation vehicles.	Randomized controls with short announcement where information provided by the company is controlled and tests are taken in outgoing textiles analyse to colony forming units (cfu/cm^2)	The Swedish Textile Service Association, 2020
Belgium	Care4Quality (C4Q) is a voluntary system and certificate of quality and a quality-management system based on EN 14 065 for companies offering textile care. The certificate is until now mostly used by companies handling textiles from the food industry and healthcare sectors.	Controls are carried out by independent certification partners (3 BELAC accredited organizations: Vinçotte, BQA & PME Cert). Analytic results of microbiological surveys on annual basis	Belgian Federation for Textile Care, 2019
UK	UK Hospitality and TSA guidelines on Managing Linen in Hotels and the Hospitality Sector is a checklist for Covid Secure operations for TSA-member organizations, developed in collaboration with the hospitality industry. Interim Healthcare Laundry Certification is aimed at re-purposing hospitality laundry to process healthcare items in line with EN 14065.	Independent certification partners (UKAS accredited for ISO/IEC 17025 accreditation) conduct final product testing and onsite environmental tests	The Textile Service Association, 2020
US	Hygienically Clean certification recognize linen, uniform and facility services companies' commitment to cleanliness through laundry plant inspection and third-party, quantified biological testing. The certification process verifies plant processes used in these facilities meet appropriate hygienically clean standards and best management practices (BMPs) across all laundry customer market segments.	Laundries must pass third-party inspections for BMPs and 3 rounds of outcome-based microbial testing, indicating that their processes are producing Hygienically Clean textiles & negligible presence of micro-organisms. Following initial certification, tests are conducted quarterly, and facilities are inspected every 3 years	Hygienically Clean, 2020
Denmark	The Danish textile service organization (BVT) has developed separate protocols to be used by member companies to guarantee hygiene standards in different parts of the textile service cycle (transports, sorting, washing & after treatment/ delivery). Members must follow guidelines for handling of textiles developed by the National Infection-hygienic Guidelines (NIR)	Unannounced control visits with bacteria controls	NIR, 2020 BVT, 2020
Germany	RAL 992/1 (commercial linen) certification covering, for example, technical, organizational, personnel and hygiene requirements for the laundry facility and laundry treatment.	Certification is built on unannounced visits by Independent Textile Research Centre at the Hohenstein Institute	German service industry interest organization (DTV), 2020
France	Requirements in CTTN guidelines including: Physical separation of in & outgoing textiles. Application of FIFO-principal. Washing in 60°C for at least 30min. Staff education in hand hygiene. Frequent cleaning with disinfectants of all surfaces & relevant items. Minimal mixing of worker-teams. EN 14065 is widely implemented through trainings by CTTN (Research Institute for textiles cleaning)	Third-party verification of the systematic hygiene management system	CTTN, 2020

Table 1 Minimum hygiene standards used as quality requirements linked to national interests-organizations for the professional textile service industry in a selection of countries.

4.0 Hygienic performance

4.4 Textiles in the eyes of the public

How is the risk of being contaminated by the COVID-19 virus through the use of textiles perceived amongst the public? This has been studied since the end of March by the German Federal Institute for Risk Assessment (BfR). The latest data (September 2020) shows that amongst over 1000 respondents in Germany, contamination through textiles was perceived as a risk amongst only 7%. Only contamination via pets was perceived as a lower risk amongst respondents (BfB Corona Monitor, 2020).

4.5 Hygiene aspects in disposables

What are the equivalents to the well-developed systematic hygiene control in the professional textile service industry when it comes to disposables?

The BRC Global Standard for Consumer products was published for the first time in 2003 by the British Retail Consortium. The aim of the standard is to increase the quality and safety of consumer goods through consistent quality- and risk management. Certified companies must pass an audit (partly made remotely).

Although sometimes presented as a" hygiene-standard" (Duni, 2020), the BRC Consumer products covers a wide range of quality aspects, such as reporting of incidents, sustainability of packaging used for produced products, with hygiene being one of many aspects. The scope of Consumer Products (issue 3) covers a wide range of non-food products, including shampoos, paints and cosmetics, televisions and toys, electrical goods and furniture (BRC, 2020). Thus, the standard does not present specific requirements in the sector of disposable

4.6 Impartial studies of quality management systems in the professional textile service industry

Although not many, some studies have been performed with the aim of investigating hygiene quality in industrial laundries. One example is the study by Heintz and Bohnen (2017), investigated compliance with the Robert Koch Institute's (RKI) hygiene requirements and Risk Analysis and Biocontamination Control (RABC) quality management system through hygiene tests conducted at ten German industrial laundries. Transfer of the bacteria to hands and surfaces as well as the water quality and air quality were analysed. The results were satisfactory as all the dry textile samples were free of bacteria. This states that industrial laundries employ efficient processes which ensure compliance with hygiene requirements.

Laird and Owen (2020) reference a number of studies that indicate that microorganisms can survive washing to a higher extent in domestic and on-premise laundry (OPL) setting. This underlines the infection control benefits of the measures taken in a commercial laundry, compared to those in a domestic or on-premise setting.

5.0 Environmental performance

5.1 Results from assessed LCA-studies

Based on a comprehensive literature search, five studies with the aim of investigating the environmental performance of textile table linens as compared to disposables, were identified. The studies were commissioned by different sectors; the professional textile service industry, the disposable paper-product industry or independent research institutes. A summary and analysis of the results is presented below (Table 2).

Results from analysed studies show that:

- Production of raw material and napkins are the processes that contribute the most to climate change in the case of disposables.
- For textile products, laundry service is the most contributing process in relation to global warming, representing 55 to 70 % of total GHG-emissions in previously performed LCAs (presented in Table 2).
- The climate impact from washing textiles is affected by the type of energy used in the washing/drying process, making assumptions on sources of electricity and fuel used in the laundry process is important for the outcomes.
- This is true also for the case of waste management, in countries where waste is incinerated with energy recovery. This means that disposable materials are given a greater climate benefit in countries where energy from combustion of paper napkins to a large extent will substitute fossil energy.
- Due to the climate impact from the production of textiles, the number of washing cycles during the life of the textiles has a major impact on the climate impact of the textiles. Assumptions in previous studies vary vastly; from 25 to 103 washing cycles prior to disposal. The highest number was the only case when data was based on a survey amongst laundries. In all other cases, assumptions were made.
- Only in one of analysed studies are textiles assumed to be reused for other purposes prior to disposal.

5.0 Environmental performance

5.1 Results from assessed LCA-studies ...cont'd

STUDY*	COMPARED ALTERNATIVES	GENERAL RESULTS FOR GLOBAL WARMING	MOST IMPACT TO LIFE CYCLE (IN RELATION TO GWP)
ENV COM-19-04, The Danish Laundry Association, 2004 (Denmark)	Coloured tablecloths from cotton, polycotton, polyester and paper	Contribution to global warming is more than twice as high from paper napkin, compared to cotton textile napkin, and three times as high for polyester textile napkin, while polycotton lies between the two.	Production of napkins – both for textile and paper napkins.
EDIPTEX - Environmental assessment of textiles, EDIPTEX, 2007 (Denmark)	Textile tablecloth with print, 384g	Contribution to global warming highest from laundry, followed by production of textile fibres and ironing.	Laundry service.
Life cycle assessment of premium single-use and reusable napkins for restaurant dinners, IVL, 2011 (Sweden, Germany and UK)	Duni tissue napkin (40x40cm, 7,2g), Dunilin (40,5x40,5cm, 11,6g), Dunicel (41x41cm, 23,5g), Cotton napkin (45x45cm, 42,3g), Linen napkin (45x45cm, 46,6g)	The 7,2g issue napkin had the lowest contribution to global warming compared to the alternatives in all three countries. **Sweden**: Contribution to global warming is higher from Dunicel compared to cotton and linen napkins, and slightly higher from Dunilin compared to linen napkins. **Germany**: Climate impact from Dunicel is 25 and 35% lower compared to linen and cotton napkins, respectively. Climate impact from Dunilin is 48 and 60% lower compared to linen and cotton napkins respectively. **UK**: Contribution to global warming from Dunicel is equivalent cotton and 14% higher than linen napkin. Climate impact from Dunilin is 30% lower compared to cotton and 15% lower compared to linen napkins.	In all countries: Textiles: Laundry service In Sweden: Paper napkins: Production of napkins In Germany and the UK: Paper napkins: Production of napkins and waste management
Life Cycle Analysis of hand-drying systems, Öko-Institut e.V. 2006 (6 central/ northern European countries)	Cotton roll, Virgin paper towel and 50% recycled paper towel	Contribution to global warming is equal between compared systems, if only one paper napkin is used per hand drying. If two napkins are used, contribution to global warming from the cotton roll is 50% compared to the paper napkin.	Textiles: Laundry service Paper napkins: Production of napkins and waste management
Comparative Life Cycle Assessment of Reusable vs. Disposable Textiles, Exponent/PE International, 2014 (Global)	Textile napkins and paper napkins	The study presents three scenarios: Worst, Mid and Best case. The Worst and Mid case of disposable material is worse than all textile scenarios. Textile Worst and Mid cases are worse than the Best case for disposables.	Textiles: Laundry service Paper napkins: Production of napkins

Table 2 Key information from analysed studies.

* Origin of data used in each study within brackets.

5.0 Environmental performance

Due to the large impact from laundry services on the results in previous LCAs, it is relevant to investigate the data used in the modelling of this process in previously made LCAs. In the figure below, data used in previous studies are compared with up-to-date data collected from business interest organizations and larger companies. Due to the many times lower transparency in previously performed LCAs, it was possible to extract relevant data of energy and water use for comparison only in one case. In the comparison presented in Table 3, it is seen that the assumptions made in previous studies are more than the double compared to up-to-date data. At the same time, the information on of the number of washes prior to disposal is considerably higher compared to the assumptions made in previous studies.

	UNIT	PREVIOUS STUDIES	BELGIUM[1]	UK[2]	SWEDEN[3]
Number of washes	Number	25 to 103[4]	150-200	70-110	No data
Electricity	kWh/kg textile	0,3	0,1	0,15-0,20	0,25
Energy for steam production	kWh/kg textile	2,0	1,0	0,7-1,00	1,0
Water	L/kg textile	12	10	2,75-4,00	6

Table 3 Up-to-date data from the professional textile service industry, compared to data used in previous studies.

[1] Best practice from the hotel/restaurant sector (FBT, 2020).
[2] Best practice from the hotel/restaurant sector (TSA, 2020).
[3] Berendsen/Elis sustainability report (Berendsen/Elis, 2020).
[4] Previous assumptions include 25, 40, 53, 55, 100 and 103 washing cycles prior to disposal.

5.2 Effects from updates for laundry service input data

Based on data presented in Table 3, it is interesting to investigate how updated data for this process would impact the robustness of the results. Thus, one of the previously presented LCAs (IVL, 2011) was updated with information from the professional European textile service market.

The products compared in the figure below are paper napkins (23.5 g/napkin, 41x41 cm) from a leading producer in northern Europe, and cotton napkins (42.3 g/napkin, 45x45 cm) . In the original study, primary data from production sites were used in the case of paper napkins, while literature data and LCA-databases were used in the case of cotton napkins. Energy and water use in laundry services was based on criteria used in the public procurement of textile services in 2008.

Updated information on energy and water use in laundry services

Data gathered from the textile service industry in three different European markets (Sweden, UK and Belgium) were used to create an average of the energy input in laundry services representative for the year of 2020. Data on the average European energy production was used to model electricity use in laundry processes and (as in the original study) natural gas was the assumed fuel for steam generation.

5.2 Effects from updates for laundry service input data ...cont'd

As seen in Figure 2 laundry, services represent more than 60% of overall GHG-emissions per use of napkin. Using updated data on energy and water use in modern laundry service facilities, GHG-emissions from laundry services are reduced by 60%. The fraction of overall GHG-emissions related to laundry service is reduced to less than 40%. Overall GHG-emissions from the use of cotton napkins is reduced by almost 40%, making textile napkins preferable to disposables through a 25% lower contribution to climate change. Data for specific countries are presented in Appendix A.

Some conservative measures were undertaken to decrease risks for the under-estimation of GHG-emissions from textile napkins in comparison to paper napkins:

- In the case of cotton napkins, distribution and logistics of laundry is included in the section "laundry". Although vast investments have been made in the fossil-free distribution of laundry between client and textile service institutions over the last decade (since the publication of the original study), no changes were made in assumptions of GHG-emissions from distribution.
- Negative emissions from waste-treatment of paper napkins refer to energy recovery from combustion of napkins. Due to the rapid change of the energy system to carbon-lean sources, benefits from energy recovery would probably be radically lower today compared to the time of the original study (2011).

Figure 2 Climate impact from paper napkin and cotton napkin, using old (left, from IVL 2011) and updated information on energy and water use in laundry services (right, based on information provided in this report).

5.2 Effects from updates for laundry service input data ...cont'd

The number of washing-cycles

The number of wash cycles a textile item passes through prior to disposal is of high importance to the overall environmental impact from professional textile services. Based on data from the original study (without updating data for energy and water use in the washing process), break-even is reached around 70 washing cycles. Reaching 100 washing cycles, textile napkins are preferable to disposables by 8%, increasing to 15% if the number of washing cycles reaches 150 (Figure 3).

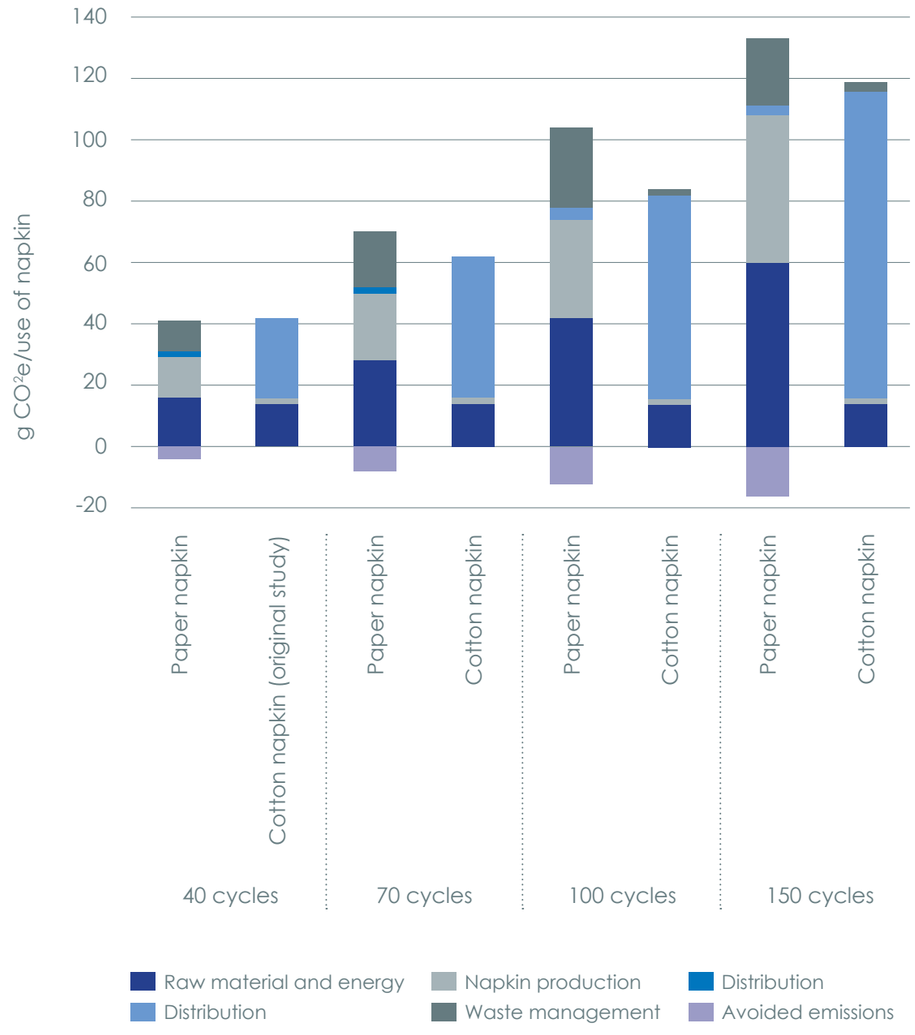


Figure 3 Influence on the number of washing cycles, based on information presented in this report, on overall results (with data on energy and water use presented in IVL, 2011).

5.0 Environmental performance

5.2 Effects from updates for laundry service input data ...cont'd

The number of wash cycles prior to disposal will depend on two factors: the quality of the fabric in combination with the quality of the laundry process.

The number of linked glucose units, called the degree of polymerization (DP)

Cotton fabric quality is commonly measured as the degree of polymerization (DP), and will determine the wearing due to fibre loss and subsequent visual impact of the linen. According to the survey performed in the present study, for good quality 100% cotton, 110 to 200 washes is likely (TSA, 2020; FBT, 2020), while this number drops to as low as 50 washes if the polymerization degree of the cotton is lower than 800-900. Polyester can be washed up to 300 times.

The quality of the laundry process will determine the level of stain-removal and greyness in linen after washing. High quality washing machines and detergents will remove stains and maintain original colours of the linen for longer periods. Since professional textile service companies rent textiles to their customers, they have strong incentives to buy high quality textiles and use highly efficient and gentle washing chemicals. In this way, the same textile can be used and washed many hundreds of times over a long-term contract period.

A recently published report on the climate footprint of Swedish textile consumption (Roos and Larsson, 2018) states that 93% of all climate impact is linked to the purchase of new products, and only 7% goes to washing and drying. Therefore, there is great potential in further increasing the lifespan of textiles. This is done primarily by investing in high-quality textiles and washing them gently but efficiently, in a way that reduces the risk of textiles being discarded prematurely due to inadequate stain removal.

5.0 Environmental performance

5.2 Effects from updates for laundry service input data ...cont'd

Combining modern laundry processes and actual number of washes

Combining updated energy and water use with a realistic number of washing cycles, the climate impact from textiles is around 50% compared to disposable alternatives; 55% when assuming 70 washing cycles, 48% when assuming 100 washing cycles and 42 when assuming 150 washing cycles (Figure 4).

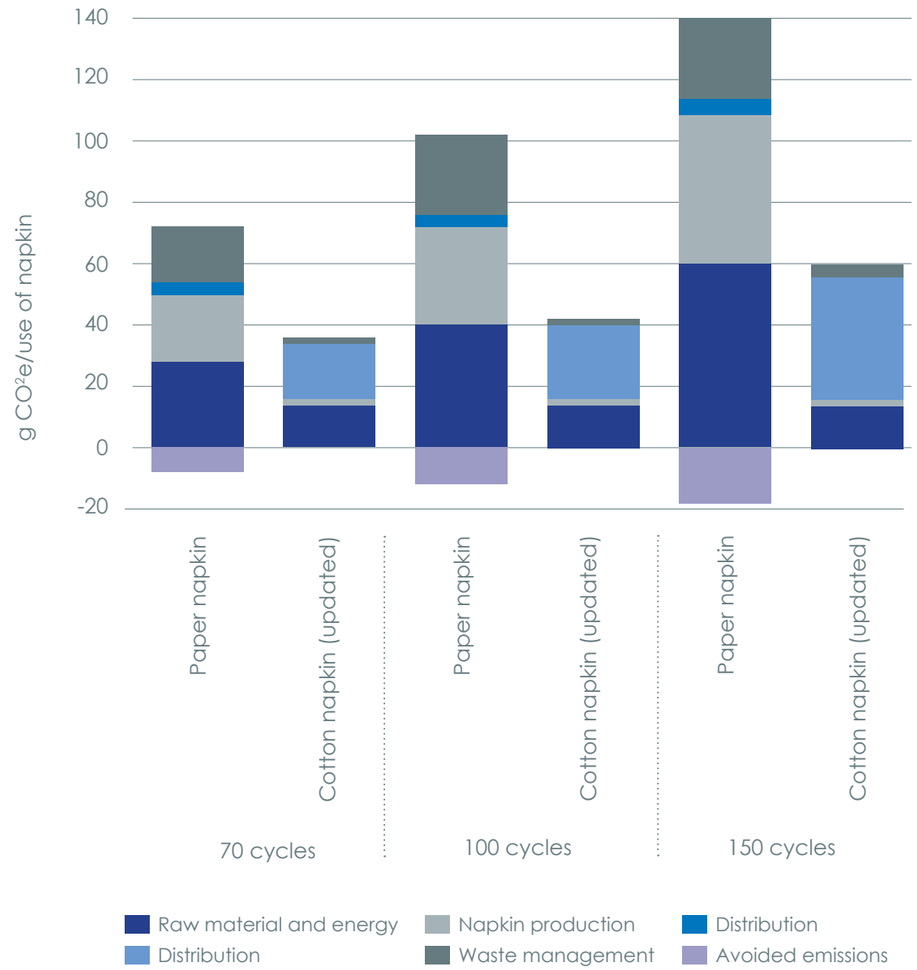


Figure 4 Results when combining updated laundry service data on energy and water use with realistic number of washing cycles, based on information provided in this report. Non-laundry processes and paper napkin processes were presented in IVL (2011).

5.0 Environmental performance

5.3 Trends that will affect outcomes from similar studies in the future

Both the textile service industry and the disposable paper product industry are dynamic, thus affected by several trends that, with time, can have impact on the overall sustainability of respective sector.

5.3.1 Fibre trends

Cotton is the currently dominating fibre in production of table linen. However, the rather significant environmental impact from cotton production is a strong driving force behind a growing interest from the side of the textile industry to find alternative fibres, such as flax, cellulose from the wood industry and recycled polyester. A growing interest is also seen in the use of organic cotton. Among the studies analysed above, only one contained a comparison between different types of textile fibres. The results of this study, which compared the use of cotton and linen, show that the climate impact from the production of linen napkins amounts to only one third of that from the production of cotton napkins. There are several products on the market already today, using recycled plastic bottles as raw material for production of table linen, REPREVE, RieNu® and Bottlecloth being three examples.

5.3.2 Energy trends

An LCA is typically based on historical data, e.g. what the electricity mix in a country looked like a few years ago. When making decisions, it is more relevant to consider what conditions will look like in the future. It is therefore important to consider whether the assumptions made are still valid today and for some time in the future. As an example, the latest sustainability report from the Swedish Textile Service Association shows that more and more laundries are converting their boilers from fossil fuels to bio-based ones (biogas, woodchip or bio-oil) (Swedish Textile Service Association, 2020).

As the energy mix in most parts of the world gets less and less carbon intensive, climate impacts from production of both textiles and paper products will decrease. A decrease will also be seen in relation to the laundry process. At the same time, the benefits from the incineration of disposable materials with energy recovery will decrease, as the energy that is replaced is increasingly fossil-free.

5.3.3 Use of recycled fibres in disposable table linen

While the fraction of recycled fibres in table linen as a whole is unknown, it has been stated that in 2017, nearly 39% of the fibre used in tissue production globally came from recycled paper sources (Tissuestory, 2017). The demand for secondary paper fibres has increased in later years and the current pandemic situation has resulted in global shortage, as many of the streams of paper waste normally resulting in recycled fibres vastly decreased when offices, take-away restaurants and malls were shut down. Recently, producers of disposables made from recycled paper fibres announced that recyclable fibres were no longer used, due to the shortage (Chinet, 2020).

5.0 Environmental performance

5.3 Trends that will affect outcomes from similar studies in the future ...cont'd

An increasing demand for secondary paper fibres has led to a decreased quality in such fibres in recent years (Tissuestory, 2017). This is a clear sign of a time where few companies get away with non-green product profiles, and the demand for recycled paper will probably continue to increase. One could think that this would result in more products with 100 % recycled fibres. However, there is a limited number of times that paper fibres can be recycled. According to the US EPA (2020), every time paper is recycled, the fibres get shorter. After being recycled five to seven times, the fibres become too short to bond into new paper. New fibres must therefore constantly be added to replace the unusable fibre that wash out of the pulp during the recycling process.

Thus, discardable paper products will always generate need for virgin wood fibres, and therefore compete with all other sectors where wood currently is seen as one of the answers to phasing out of CO2-intensive materials, such as the construction industry, where the demand is increasing vastly (Swedish wood, 2020).

5.3.4 The increasing pressure on the forests

Relating to The FAOSTAT presents yearly statistics on forestry production and trade, there are no specific statistics on the amount of paper used for disposable table linen (tablecloths and napkins), but the amount of "other paper and paperboard" amounted to 380 million tonnes in 2019 (FAOSTAT, 2020). Using pines as an example, it takes around 6 trees to produce 1 tonne of paper products, meaning almost 2,3 billion trees to produce 380 million tonnes of "other paper and paper board" products (Skogssverige, 2020).

Nevertheless, one aspect that was not addressed in any of the LCA-studies presented in Table 2, is the increasing pressure on the world's forests today. Several sectors, such as those involved in the production of energy, fuel in case of the transport sector, packaging, construction, plastic disposables etc. have in recent years looked more and more towards the forest industry for solutions to solve their climate dept. Use of wood fibres is commonly seen as an easy solution, as they can substitute for fossil energy carriers in fuels, plastic molecules in packaging and disposables and concrete in housing. However, several scientists have in recent years flagged that there is a limit to what our forests can provide in terms of biomaterials and biofuels (UNFF, 2018). Thus, one will have to prioritize between different uses, focusing on such areas where there are a) practically no alternatives to the use of wood fibres, b) were wood fibres substitute products with high environmental impacts and c) where the wood fibres are used in products with long lifecycles, and where there is high potential for reuse/recycling without quality degradation.

From this perspective, the use of wood fibres as substitute for cotton in production of high-quality textile linen would be relevant, while use of virgin and even recycled wooden fibres in production of disposables, would not be prioritized.

5.3 Trends that will affect outcomes from similar studies in the future ...cont'd

5.3.5 Policies for circular economy

Several recent initiatives are clearly showing an increased political focus on circular business-models, where the textile service industry is frequently referenced as a good example for other domains of the textile industry as well as other sectors of the economy, such as vehicles. The European Commission's Action plan for a cleaner and more competitive Europe (European Commission, 2020) states that the product-as-a-service and circular materials should be further incentivised, and that reuse, and recycling should be facilitated – in line with current development within the textile service industry.

An increased focus on end-of-life criteria in the recently updated EU-waste legislation already increases the chance for reuse and recycling of textiles (EU, 2018), and in Sweden, a new tax has recently been enforced on waste incineration. This will increase the cost for disposables and increase incentives for use of reusable materials, such as textiles (Swedish Tax Authority, 2020).

5.3.6 Recycling of textiles

The textile service industry relies on a circular business model, providing services rather than products. However, after hundreds of uses and mending, textiles grow too worn to be used further. In order to become even more circular and sustainable, the textile service industry has over the last years become increasingly active in finding solutions that result in reuse and recycling of textiles and textile fibres.

These initiatives are also driven by enforced legislation. By 2025, separate collections for reuse and recycling of textiles will be mandatory within the EU. The textile service industry is however already well prepared with respect to this question. In 2018, a survey was made amongst 175 ETSA member firm laundries on end-of-life of textiles for calendar year 2016. Results from the study shows that 93% of linen is reused or recycled. Half of this volume is sent for reuse, mainly for cutting up to produce cleaning cloths, and the other half takes the recycling route for miscellaneous purposes. A small but increasing share are upcycled into new textile products (SDU, 2018). Several initiatives are currently operating to increase the circularity of the business model even further. Some of these are presented in the text below.

Several research studies have previously stated that recycling processes for fibres can significantly reduce the consumption of energy and resources, and some recycling processes for fibres are already well established:

- OnceMore® is developed by the Swedish forest and wood-product company Södra. The process separates cotton and polyester from polycotton blends. The cellulose from the cotton fibres is then combined with cellulose from wood. The product is a high-quality dissolving pulp that is used by the textile industry, just like our pulp for viscose and lyocell. The recycling content in the pulp is currently around 20%, but the goal is to reach 50% by 2025 (Södra, 2020).

- In the Lyocell process, N-methylmorpholine-N-oxide (NMMO) is used as a solvent in direct dissolution of powdered cellulose. The process can also be applied on mixed textiles (polycotton). Blended textiles are mixed with NMMO and dissolved cellulose is afterwards separated from the polyester residue by filtration. Remaining polyester is washed and used for further recycling. This process can save around 5,5 tons of CO2eq./tonne of textile waste, when compared to production of virgin cellulose and polyester yarns (Zamani et al. 2014).

5.3 Trends that will affect outcomes from similar studies in the future ...cont'd

5.3.6 Recycling of textiles cont'd

- In the Patagonia process, polyester of a certain grade is turned into dimethyl terephthalate (DMT) and polymerized to polyester granules in a closed loop for production of new polyester textiles. This process can save around 2 tons of CO2eq./tonne of textile waste, when compared to production of virgin cellulose and polyester yarns (Zamani et al. 2014).

- In the Renewcell process, garments with high cellulosic content (cotton and viscose) are shredded, de-buttoned, de-zipped, de-coloured and turned into a slurry from which contaminants and non-cellulosic content are separated. The slurry is dried to produce bales which are fed into the textile production cycle. A pilot plant has been running since 2017 in Sweden, and a full-scale plant will be running by 2022, recycling 60 000 tons of textiles a year (Renewcell, 2020).

Thus, there are several techniques for mechanical and chemical recycling of textiles, approaching fully commercial scale. However, a barrier to accomplish textile recycling is the large mix of materials, coatings, dyes, and non-textile objects in many textiles (Palme et al., 2014). There are examples of commercial facilities that help solving this problem. One example is SIPtex, the first full-scale automatic textile sorting facility in Sweden, with a capacity of sorting 4,5 tons of textiles per hour. Textiles are sorted by fibretype and colour for further recycling (Sysav, 2020).

However, table linen, together with bedlinen and towels, are the easiest textile flows to reuse and recycle, as they commonly are made from 100% cotton, flax or a combination of a few fibres (polycotton) that can be separated with commercially mature technologies. Logos and prints can be a problem, but technology is being developed to solve this dilemma. The Swedish company Vividye has developed a paint for logos and prints that easily can be washed away, using a unique detergent. The company is already collaborating with the textile service industry in order to facilitate reuse of table linen, flat linen, workwear etc (Textilia, 2020). Another innovation that will facilitate textile recycling originates from Belgium, where Resortect Smart Stich has developed a sewing thread that melts at high temperatures and makes for cheap and easy disassembly and recycling (Resortecs, 2020).

In many modern textile service facilities, all items are chipped with a certain radio frequency ID. This unique ID has information about the current client, number of washes etc. the type of fibres in each item is easily detectable. Other data and information could hypothetically be included, if needed to facilitate recycling for instance. This facilitates recycling immensely, and table linen is already becoming circular. As cotton-fibre production has a relatively high influence on the overall environmental performance from textile table linen, increasing use of fibre recycling and circular textiles will mean further improvement to the environmental performance of textiles compared to linear and disposable alternatives.

More local jobs are created when applying a **circular business model** wherin textile table linen passes through a large number of wash cycles - **as opposed to the linear business model** of disposable linen.

6.0 Economic performance – creation of jobs

6.1 The importance of the textile service industry for national economics

Textile services is to be considered a key enabling sector that allows sectors such as hospitality, health care and the food industry to focus on their core business and provide fundamental services to society.

What is the importance of the textile service industry on the economics of a country? Let's start with an example. In any typical hotel, the textile service industry provides a number of different types of textiles; from clean bed sheets, pillowcases, towels, tablecloths and napkins to the uniforms of chefs, waiters, receptionists and room-cleaners, as well as cleaned floor mats in receptions, hallways etc. For example, failing deliveries from a textile service industry to a hotel would have severe consequences, quickly impairing, the function of the hotel, meaning no income for the hotel and no jobs for the chefs, receptionists, waiters and room-cleaners. Thus, this industry is not only essential to job creation directly (Table 4) but also indirectly.

COUNTRY	NUMBER OF EMPLOYMENTS	REFERENCE
Belgium	6,500	FBT, 2020
UK	22,800	TSA, 2020
US	121,000	U.S. Census Bureau, 2017
Sweden	5,000	Swedish Textile Service Association, 2020
Europe	140,000	ETSA, 2020

Table 4 Number of employees in the textile service sector. Numbers are rounded.

6.0 Economic performance – creation of jobs

6.2 Creation of indirect and induced jobs

Previous research on the economic impact from the textile services sector also shows that it contributes vastly with creation of jobs in an indirect manner.

In the UK, the sector directly supports 22 800 people, and creates further 1 900 jobs through supply chain effects. The sector purchases inputs such as machinery, equipment, energy, linen etc. which creates jobs at the supplier level. Another 4 100 induced jobs are created through employee expenditure effects. This means that for every direct job in the sector, there is another 0.25 jobs created through indirect and induced effects (Regeneris, 2020).

Similar results have been found in Sweden, where Statistics Sweden have been commissioned to calculate multiplier effects. For every 1000 employments directly in the sector, another 100 were expected to be employed in the supply chain with150 more induced jobs being created through employee expenditure, resulting in 0.25 indirect and induced jobs per job created within the textile service industry in Sweden (Öster Research, 2018).

If we assume that the same relationship between direct, indirect, and induced jobs is similar in the rest of Europe and the US we can estimate the total number of jobs the sectors contributes to. For example, we estimate that the around 140 000 jobs in the European Union, the industry supports another 35 000 jobs through supply chain and employee expenditure effects. The 121 000 jobs in the United Stated can be estimated to support another 30 250 jobs in other sectors. Thus, the European and the US textile service sectors together support almost 330 000 jobs in total.

6.3 The textile service industry – an enabler for integration

Behind every figure in the table above, there is a person. Each job created by the textile service industry means someone is earning a salary, being able to support family members, consume goods and services and is paying taxes.

Perhaps just as important as the number of jobs created in the industry, is the type of jobs created. In Sweden, half of the blue-collar workforce within the industry are born outside of Sweden. Asia and Europe (not including the Nordic countries) were the most represented regions (Swedish Textile Service Association, 2020).

The situation is similar in the UK. Immigrants from Eastern Europe, Asia and Africa have been employed to an increasingly frequent extent in the textile service industry, while native-born residents have been focused on jobs outside the laundry business (TRSA, 2015).

This clearly reflects the important role that the laundry and textile service industry has as a motor for integration and new opportunities locally and regionally.

6.0 Economic performance – creation of jobs

6.4 Creation of jobs as compared to the disposable textile industry

It is difficult to compare the number of jobs within the professional textile service industry to the number of jobs created through the production of disposable alternatives as, 1) laundries commonly take care of several different types of textiles and the workforce in laundries handling table linen is therefore difficult to establish, and 2) there are few official statistics on the number of employees involved in the production of disposable table linen. Some general differences between these sectors in relation to job creation can however be made clear.

6.4.1 Global versus local

Paper-based tablecloths and napkins are global goods, and China is the world's largest exporter of these products. Disposable table linen is transported globally to different markets. Textiles are also typically produced in Asia. However, once they reach their target market, the transport to a local laundry is kept to a minimum, as nearby laundries commonly are contracted as textile service partner. Thus, while use of disposable table linen mainly generates jobs in faraway countries, use of textile table linen generates jobs locally.

6.4.2 Labour-intensity

The labour-intensity is commonly higher in circular products when compared to linear ones. This is the case also for table linen. As an example, in Sweden the latest industry report shows that companies spend about 45 % of their revenue on labour costs (Öster Research, 2020).

Duni Group is one of the leading suppliers of disposable table linen, with around 20 % of the market and 2398 employees worldwide in 2019, working not only with table linen, but also candles and food-packaging (Duni 2019 and 2020). This is less than half of the employees in the professional textile service industry only in Sweden (Table 4).

These are merely some examples, but they clearly show a very different level of labour-intensity in the circular textile service industry, as compared to the linear disposable sector.

The environmental impact of textile linens is half of that from disposable alternatives.

Textile linens are a valuable part of the circular economy and will help us all become more sustainable.

7.0 Conclusions

The present study has compared textile table linens and the use of textile services to disposables from three perspectives: hygiene, environment and creation of jobs, with the following conclusions.

Independent research published in October 2020 states that amongst the different surfaces included in the study (plastic note, paper note, stainless steel, glass, vinyl and cotton fabric), cotton fabric was the material with the lowest half-life, implying that the COVID-19 virus dies faster on this type of surface compared to paper surfaces. Hygiene is closely monitored in laundries. Third-party certification of comprehensive and systematic hygiene management Risk Analysis and Biocontamination Control (RABC) is increasing. The hygiene performance of textile table linen is equal to disposable table linen and consumers do not see textiles as a relevant path for contamination of COVID-19.

Previous studies have assumed that the laundry process contributes heavily to climate impact. However, due to strong advances in resource efficiency in recent years, use of updated data for the use of energy and water in washing of laundry reduces the climate impact from the use of textile table linen to half of the impact from disposables. In addition, strong advances are made in the area of textile reuse and textile fibre recycling. These advances are making the already circular business model of the textile service industry even more environmentally sustainable in the coming years. Thus, from an environmental perspective, textile linens are preferable to disposables.

Different than the linear business model of disposables, the circular business model applied when textile table linen passes through a large number of washing cycles, jobs are created on a local and regional scale. Each job created in textile service industry creates another 0.25 indirect and induced jobs. The European and the US textile service sectors together support almost 330,000 direct, indirect and induced jobs in total. Furthermore, a large proportion of the workers in the textile service industry are of foreign descent and the textile service industry is a motor for integration throughout the world. From a job creation perspective, the use of textile table linen is preferable to disposables.

8.0 References

Belgian Federation for Textile Care, 2019. www.care4quality.be

Berendsen/Elis, 2020. Sustainability report 2019.

BfB Corona Monitor, 2020. https://www.bfr.bund.de/cm/349/200929-bfr-corona-monitor-en.pdf

Bockmühl et al. 2019. Laundry and textile hygiene in healthcare and beyond. Microbial Cell. DOI: 10.15698/mic2019.07.682.

BRC, 2020. https://www.brcgs.com/brcgs/consumer-products/.

BVD, 2004. ENV COM-19-04. Prepared by Rikke Frederiksen

BVT, 2017. https://www.danskindustri.dk/globalassets/billedarkiv/medlemsforeninger/bvt/vejledn.-f.-vaskerier----januar-2017.pdf

BVT, 2020. www.danskindustri.dk/globalassets/billedarkiv/medlemsforeninger/bvt/vejledn.-f.-vaskerier----januar-2017

Chinet, 2020. https://www.mychinet.com/products/sustainability.

Duni 2019 Års- och hållbarhetsredovisning 2018.

Duni 2020 Års- och hållbarhetsredovisning 2019.

Duni 2020. https://www.duni.com/sv/produkter/ecoecho/.

EDIPTEX, 2007. Environmental assessment of textiles. https://www.researchgate.net/publication/242656918_EDIPTEX_-_Environmental_assessment_of_textiles

EPA, 2020. https://archive.epa.gov/wastes/conserve/materials/paper/web/html/faqs.html.

ETSA, 2020. Personal communication with Robert Long, Secretary General at the

European Commission, 2020 A New Circular Economy Action Plan for a Cleaner and More Competitive Europe, COM(2020)98.

European Textile Service Association, November 2020.

EU, 2018. DIRECTIVE (EU) 2018/851 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 30 May 2018 amending Directive 2008/98/EC on waste.

Exponent/PE International, 2014. Comparative Life Cycle Assessment of Reusable vs. Disposable Textiles. Prepared by John Jewell.

FBT, 2020. Interview with Marc Callewaert. FBT Federatie van de Belgische Textielverzorging vzw, October 2020.

German service industry interest organization (DTV) 2020. RAL Quality Certification Mark RAL-GZ 992/1

German service industry interest organization (DTV), 2020.

IVL, 2011. Life cycle assessment of premium single-use and reusable napkins for restaurant dinners. https://www.duni.com/globalassets/startpage/about-us/corporate-responsibility/lca-of-duni-napkins-and-textile.pdf

Manuel Heintz, Jürgen Bohnen, 2017. Hygiene in gewerblichen Wäschereien (Hygiene in Industrial Laundries), wfk - Cleaning Technology Institute e.V., Krefeld, Germany.

NIR, 2020. hygiejne.ssi.dk/retningslinjer/nir

Owen and Laird (2020). The role of textiles as fomites in the healthcare environment: a review of the infection control risk, available from the TSA website.

Palme, A., Peterson, A., de la Motte, H. et al. Development of an efficient route for combined recycling of PET and cotton from mixed fabrics. Text Cloth Sustain 3, 4 (2017). https://doi.org/10.1186/s40689-017-0026-9.

8.0 References

Regeneris, 2020. The Economic Value of the Textile Services Sector of the UK Economy. www.flipsnack.com/textileservices/the-economic-value-of-the-textile-services-sector-to-the-uk/full-view.html

Renewcell, 2020. https://renewcell.se/news/

Resortecs, 2020. https://resortecs.com/

Riddel et al. 2020. The effect of temperature on persistence of SARS-CoV-2 on common surfaces. Virology Journal.

Roos, S och Larsson, M 2018. Klimatdata för textilier. https://www.naturvardsverket.se/upload/miljoarbete-i-samhallet/miljoarbete-i-sverige/uppdelat-efter-omrade/hallbar-konsumtion/rapport-klimatdata-for-textilier-swerea-2018.pdf

SDU report on end-of-life of laundry textiles. Part 3 – Survey of ETSA member firms – 2016 data. Henrik Grüttner and Birgitte Lilholt Sørensen SDU Life Cycle Engineering, Syddensk Universitet Odense, Denmark, April 2018.

Skogssverige, 2020. https://www.skogssverige.se/1-hur-manga-a4-ark-ger-ett-trad-2-hur-lange-racker-varldens-skogar

Swedish Laundry Association, 2020. Sustainability report 2020.

Swedish Tax Authority, 2020. https://www.skatteverket.se/foretagochorganisationer/skatter/punktskatter/avfallsforbranningsskatt.4.7eada0316ed67d728244a8.html

Swedish wood, 2020). https://www.swedishwood.com/wood-facts/about-wood/wood-and-the-environment/wood-is-a-sustainable-construction-material/

Sysav, 2020. https://www.sysav.se/om-oss/forskning-och-projekt/siptex/.

Södra, 2020. https://www.sodra.com/en/global/pulp/oncemorebysodra/

Textilia, 2020. https://newsroom.notified.com/textilia-1/posts/pressreleases/vividye-vinner-textilias-hallbarhetspris-2020

Tissuestory, 2017. https://www.tissuestory.com/2017/03/12/tissue-a-social-environmental-and-economic-sustainability-star/

TRSA, 2020. Member survey 2020.

TSA, 2020. Interview with Shyju Skariah, Technical Services Manager, TSA, October 2020.

UNFF, 2018. Sustainable consumption and production of forest products. Background study prepared for the thirteenth session of the United Nations Forum on Forests. https://www.un.org/esa/forests/wp-content/uploads/2018/04/UNFF13_BkgdStudy_ForestsSCP.pdf.

WTO, 2019. https://www.wto.org/english/tratop_e/agric_e/item_3_icac_wto_cotton_by_products_june_2019_final.pdf

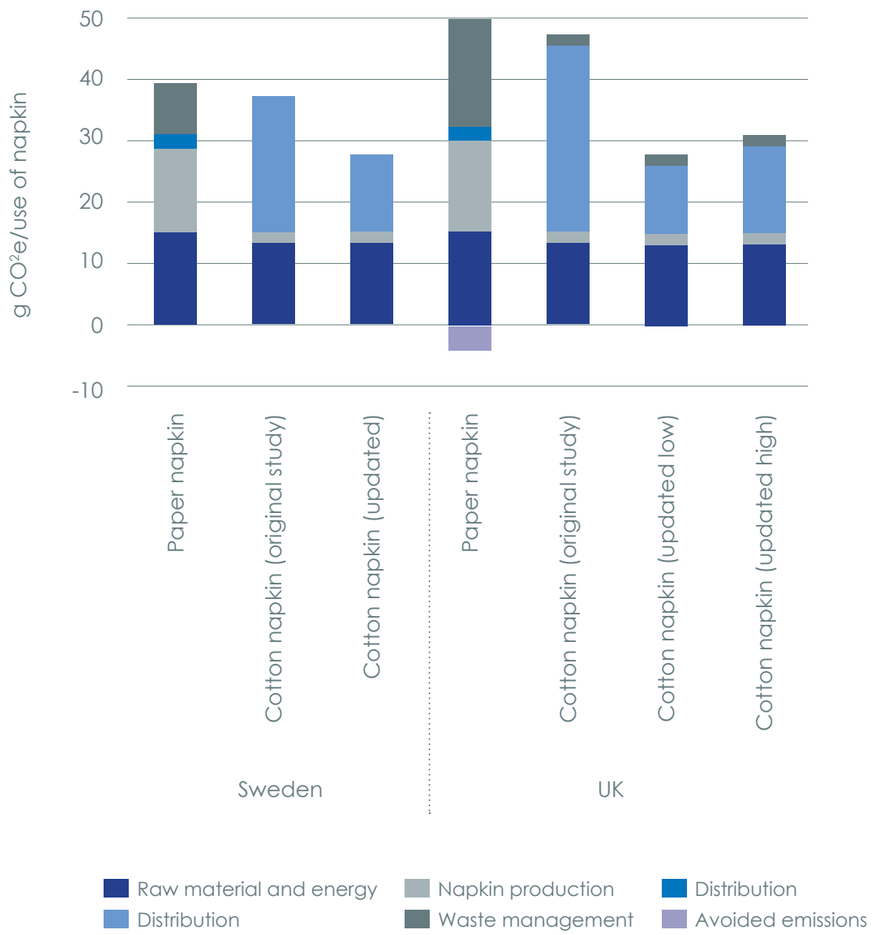
Zamani et al. 2014. A Carbon Footprint of Textile Recycling: A Case Study in Sweden. Journal of Industrial Ecology 19(4). DOI: 10.1111/jiec.12208.

Öko-Institut e.V. 2006. Life Cycle Analysis of hand-drying systems. Prepared by Eberle, U and Möller, L. https://www.oeko.de/en/publications/p-details/life-cycle-analysis-of-hand-drying-systems-supplement/.

Öster Research, 2020. Swedish Textile Service Association yearly report 2020.

9.0 Appendix A

LCA adjusted with up-to-date data on energy and water use in laundry services for UK and Sweden (data is presented in Table 3 in the main report), as these countries were included in the original study.



Why textiles win in the long run

Sustainability performance of table linen as compared to disposables

Developed by Klorofyll Miljökonsult on behalf of:

ETSA- European Textile Service Association
Fédération Belge de l'Entretien du Textile (FBT) BE
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