

Approximately 7,000 - 10,000 litres of water is used for production of a pair of jeans.

The engines should be mechanically maintained after regular prescribed intervals.



Sustainable consumption practices are followed by big textile groups than SMEs.

The coal should be tested for its calorific value before its use.



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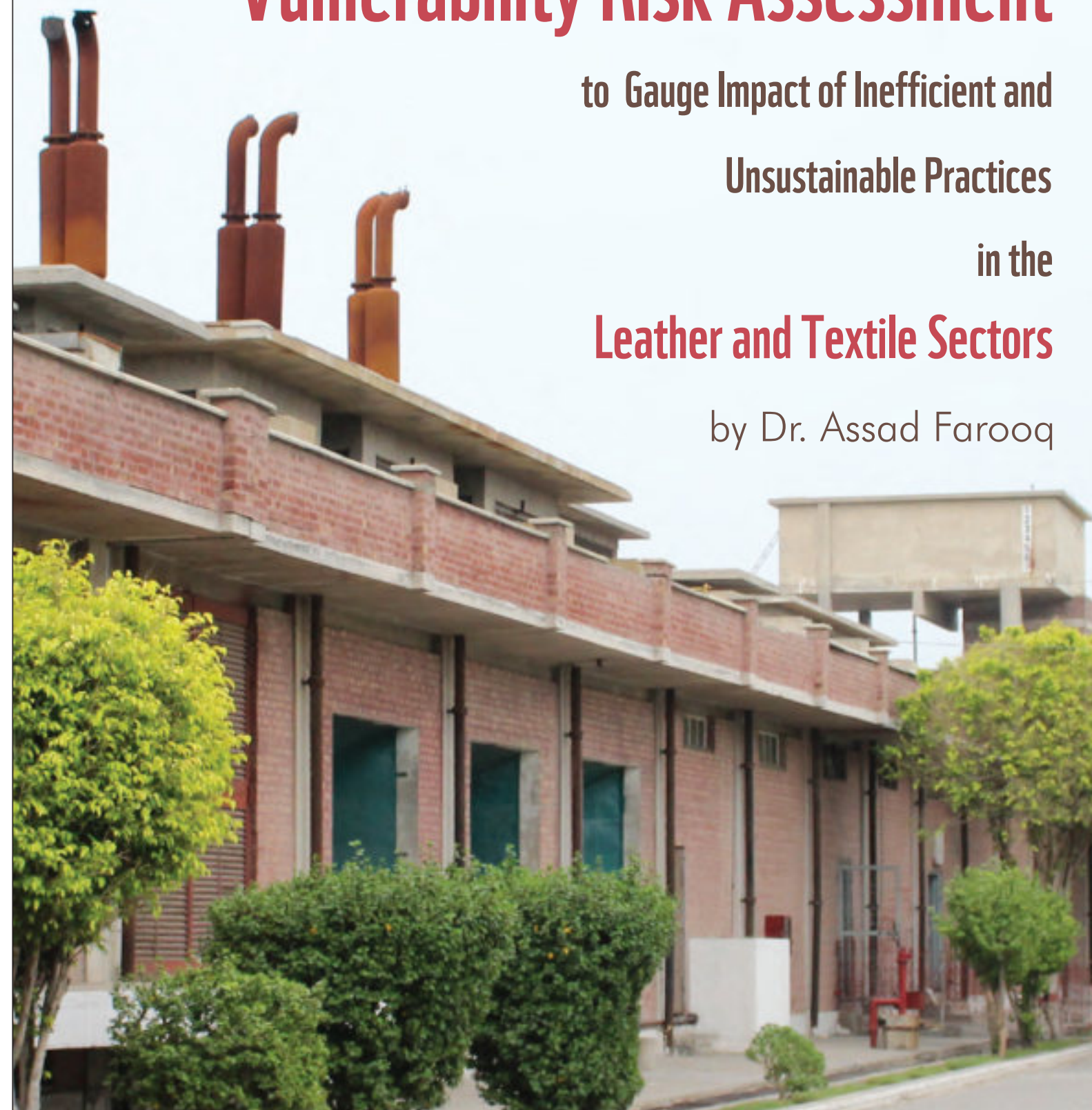
Vulnerability Risk Assessment

to Gauge Impact of Inefficient and
Unsustainable Practices

in the

Leather and Textile Sectors

by Dr. Assad Farooq





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List of Acronyms

AOx	Adsorbable Organic Halides
ASME	American Society of Mechanical Engineers
BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
dB(A)	Decible
DIN	Deutsches Institut für Normung
DO	Dissolved Oxygen
DOZ	Dozen
EPA	Environment Protection Agency
FAD	Free Air Delivery
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GSP+	Generalized Scheme of Preference
ILES	International Labour and Environmental Standards
ILO	International Labour Organization
NGO	Non-governmental Organization
OHS	Occupational Health and Safety
PE	Polyethylene
PET	Polyethylene terephthalate
PFC	Poly-fluorinated Chemicals
pH	Power of Hydrogen Ion Concentration
PP	Polypropylene
PVA	Polyvinyl Alcohol
QTY	Quantity
SMEs	Small and Medium Enterprises
SQM	Square Meter
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
VAT	Value-added Tax
VOC	Volatile Organic Compounds

Author's Profile

Dr. Assad Farooq is Ph.D. in Textile Engineering from Technical University Dresden, Germany and currently the head of the department of Fibre & Textile Technology, University of Agriculture, Faisalabad. His areas of research interest include cotton fibres technology, yarn manufacturing artificial intelligence in textiles and eco-friendly textiles. He has 17 years of teaching and research experience at undergraduate and postgraduate level. He is the author of more than 50 research publications and his research work has been published in international impact factor journals. He has also been presented his research work at many national and international conferences and seminars. Moreover, he is running various funded research project at the national and international level as principal investigator.



Reviewer's Profile

Dr. André Matthes is Deputy Head of Professorship Textile Technologies at Chemnitz University. He has an extraordinary textile expertise due to his many years of scientific activity in various textile areas. This covers textile material analysis, machine development and process analysis in the whole textile process chain, especially the fibre, yarn and fabric production technologies, yarn feeding simulation, measurement and sensor technologies and chemical treatment analysis.

In recent years, he has increasingly devoted himself to the issue of textile sustainability. In particular, the integration of sustainability aspects into university teaching events and the dissemination of textile sustainability topics like Restricted Substance Lists, textile sustainable labels and sustainable fashion brands through events and lectures. In addition, his recent research activities focus on new textile-based development approaches in the field of natural fiber-based textiles.



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Executive Summary

Under changing economic situation of the world, globalization has become inevitable and unavoidable. The integration of economies and ideas are exerting both positive and negative influence on the industrial sector. Globalization has left quite a mark on textile and leather industries. In recent past, the economy of Pakistan has shifted its focus to manufacturing and services sectors, despite its traditional agricultural background of following the example of other South Asian countries.

The growth in manufacturing sector has caused an increase in demand of energy, whereas urbanization and population growth have seen an upward trend. Consequently, it has raised concerns about subsequent environmental pollution. The lack of management and knowledge about the disposal of chemicals mainly from the textile wet processing and leather tanneries have intensified the environmental issues.

The total industrial wastewater generation in the Faisalabad region as reported by Environment Protection Agency (“EPA”), Faisalabad District is 1,215,000 m³/d, whereas it is approximately 355,000 m³/d from five industrial estates of Karachi.

Textile manufacturing processes are potential contributors of environmental pollution. The World Bank declares the textile industry as the second major polluting industry of the world as it is responsible for 20 per cent of the industrial pollution being discharged into rivers and land. The textile manufacturing is a chain process in which different processes causes different effects on the environment.

Fibre Production and Yarn Manufacturing

A significant amount of water is needed for the production of cotton fibre, which is approximately 7,000¹ -10,000² litres for a pair of jeans. Moreover, the exposure of farmers to the pesticides is environmental, as well as, a social issue. In comparison with cotton, the synthetic fibres use less water for their manufacturing. However, they need double amount of energy³, which gives rise to high level of emissions, arising from combustion and fuel burning. Yarn manufacturing is also an energy-intensive process.

Fabric Manufacturing

Noise pollution and fibre fluff are the main reasons resulting in the poor working conditions during fabric manufacturing. Moreover, the preparatory process like sizing is the contributor of Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) in the water and discharging the chemicals like Polyvinyl Alcohol (PVA) into water.

Wet Processing

The existing dyeing and printing processes (wet processing) are posing serious concerns for the environment, the labour working in these industries and the consumers. The major industrial water discharge is from wet processing. The

¹Source: <https://sustainable-textile-school.com/about>
²http://wwf.panda.org/what_we_do/how_we_work/our_global_goals/markets/mti_solutions/certification/agriculture/cotton
³<https://sustainable-textile-school.com/about/>

Worldwide a woman purchases 27 kg of clothing a year, of which 1/3 will never be worn.

use of hazardous chemicals and lack of management of industrial water discharge has made the situation worse. Greenpeace, an NGO working on saving the earth, has launched a campaign Detox to draw the attention of public towards the polluted Asian rivers and absorption of the residues of textile chemicals through skin.

Textile Finishing

Finishing refers to the application of the functional substance on the surface of the fabric to impart special characteristics to it, such as oil and water repellent characteristic requires use of Poly-fluorinated Chemicals (PFC), which are established environmental hazardous chemicals. Similarly, the use of formaldehyde-based cross-linkers also poses serious problems.

Garment Manufacturing

The sustainability issues regarding garment manufacturing are mostly connected to social issues, such as low wages, long working hours and poor working environment. Some clothing brands launch up to twelve collections each year, and according to Sustainable Textile School, worldwide a woman may purchases 27 kilograms of clothing per year of which almost a third will never be worn⁴. At the same time, extensive marketing campaigns attract consumers leading to unjustified increase in consumption.

Sustainability as an Opportunity

Sustainability is becoming a critical factor for the textile manufacturers as far as the European consumers are concerned. In the near future, it is expected that being environment friendly can create a competitive advantage for the textile manufactures as “sustainability is going to be the new quality which allows the consumers to make an informed choice”.

Sustainability is gaining importance in the textile and leather industry worldwide. The transformation of existing textile and leather industries into a sustainable industry requires knowledge and commitment. The awareness about environmental, economic and social concerns has increased in recent years especially due to harmful side effects to society, which paved the way for varying initiatives on sustainability.

Demand for clothes made through environment friendly processes will be the new market for countries in Southeast Asia including Pakistan, which already have developed infrastructure of high performance textile machinery. This shift in focus of manufacturing towards such products will result in new job opportunities and conservation of natural resources used as raw material, which will strengthen the economy through foreign exchange earnings.

Recommendations

The awareness on sustainability is playing a pivotal role and reshaping the manufacturing processes. There are many vital issues in the textile and leather industries that can only be addressed by launching awareness campaigns or training programmes. For example, the public should be made aware of the water utilized during the production stage and its subsequent impact so that they become responsible consumers. Whereas, at the industry level the

⁴Sustainable Textile School

Dyeing at low temperature is the new concept to make textile industry sustainable.

awareness regarding reduce-reuse-recycle is very important.

In the global scenario, the new idea for the textile process chain is to make it circular, so that the natural resources may be conserved at the end of the process and minimum amount of waste is produced. The use of substitute chemicals and innovative wet processing methods can lead to reduced effluents from the processing industry. Dyeing at low temperature and at low dye to liquor ratio are the new concepts to make textile industry sustainable. Similarly, the optimized utilization of calorific value of conventional coal (the unit at which mass will burn and utilize energy) and other biomass based fuels for boiler combustion can lead to reduced product costs and carbon footprint. Moreover, the optimized design of the compressed air systems can save a large amount of energy. Last but not least, mind-set needs to be changed from



Introduction

1 Introduction

For textile manufacturing, environmentally hazardous and labour intensive process are in third world countries.

The origin of textile machinery and its manufacturing started from Europe and America. The invention of spinning machine by James Hargreaves in which the modifications were brought by Richard Arkwright and the invention of power loom by Edmund Cartwright increased the efficiency of the industry and created a huge potential demand for raw cotton. The abundantly available fibres that could be converted to apparel were cotton, silk and wool. However, major production of cotton was from Southeast Asia and the raw material was transported to Europe for production of textile. Some of the major developments in the field of textile were the efforts to replicate traditional fibres (polyester fibre was actually manufactured to make artificial silk) or skills (printing was invented to match hand embroidery skills) from Indian subcontinent and China.

Both environmentally hazardous and labour intensive, textile manufacturing was shifted to third world countries, where the local agriculture produced natural fibres for production. The developed countries also wanted the textiles to be affordable, that could only be done through poor and low wage countries. Due to massive production and export of textiles, the economic conditions of these countries started to improve and wages started to get higher and most importantly the environmental concerns were highlighted. By using free trade policies and other incentives, the textile industries were shifted from China, India and Pakistan to Bangladesh, Myanmar, Thailand, Malaysia and now to Cambodia and further to countries like Ethiopia in near future.

On the other hand, the textile machine technology from spinning to wet processing always remained with Europe. Moreover, the major textile chemical manufacturers are also from developed countries. While the European manufacturers are producing technical textiles, instead of conventional textiles, which have lower environmental impact with high value.

The increase in the global demand for textile continues to grow not only due to increase in world population, but also due to increase in the standard of living in the less developed countries. On the other hand, European markets have always been the driving factors for the changing textile manufacturing trends of Asia's textile industries. There is a wave of brands in European textile markets and putting a pressure on Asian manufacturers to keep the cost of production minimum⁵. Extensive marketing campaigns forces costumers to buy more than their requirements. In developed European countries like Germany, on an average the per annum purchase of clothing for a woman is approximately 30kg, out of which 10kg will never be worn due to sudden changes in fashion.

The textiles and leather are the two leading export oriented industries of the country and have their important roles within the national economy. However, due to their export potential these sectors are strongly influenced by the rapid changes in the global economic environment. Pakistan urgently needs to increase the product competitiveness of these sectors. In the modern changing market trends, the value addition and diversification of the products along with product quality are of special significance. Moreover, the promotion of the value added products is quite necessary. In the European market, the new trend of wearing sustainable products especially in the textile is gaining large acceptance. This can be a great opportunity for the already developed

⁵Taken from the conference proceedings of Socio-technical Environments Proceedings

textile and leather sectors of the country.

The role of NGOs in creating awareness about sustainability issues in the textile and leather sector is vital. In a survey conducted at Sustainable Textile School in Chemnitz Germany, it was found that main drivers for transformation of textile and apparel industry include NGOs, customer requirements and legal regulations. Environmental NGOs are particularly important as consumers and governments have been funding these for decades.

This study is a part of WWF-Pakistan's project 'International Labour and Environmental Standards (ILES) Application in Pakistan's SMEs', which has been funded by European Union, and is implemented in collaboration with International Labour Organization (ILO). The objective of the project is to promote sustainable and inclusive growth by supporting economic integration of Pakistan into the global and regional economy by improving compliance with labour and environmental standards and increasing competitiveness.

The objectives of this study include:

1. To conduct a baseline analysis of current resource use efficiency and environmental practices in textile and leather sectors.
2. To establish a comprehensive account of wide-ranging economic, environmental and social impacts induced by unsustainable practices in textile and leather sectors.
3. To facilitate industries to make strategic decisions based on their vulnerability risk assessment using environmental and economic indicators.
4. To provide relevant mitigation recommendations for the long-term sustainability of businesses.

In order to fulfil the objectives, a comprehensive discussion about the textile and leather sectors was conducted with all the relevant stakeholders including managers working at key positions in the industry, environmentalists, academicians, environmental protection agency staff members, economists, civil society etc. The data collection was carried out in following segments:

1.1 Literature review

Research papers and research articles were reviewed related to environmental sciences for establishing the background knowledge regarding the subject.

1.2 Telephonic Interviews

Interviews with relevant stakeholders were carried out and their opinions on the subject were gathered.

1.3 Industrial Visits

Textile and leather industries were visited keeping in view the fragmentation (large industries and SMEs) of the industry. It is an established fact that the sustainability practices are followed differently among big textile groups compared to the small and medium enterprises. Faisalabad and Lahore regions were visited for textile industries while for the leather industry the outskirts of Sialkot region (Sambrial) was visited.

1.4 Global Prospective

In order to gain the insight of the global scenario regarding environmental and economic sustainability, the Sustainable Textile School Conference was held in September 2017 at Chemnitz, Germany. The consultant attended the conference and had discussion with international experts on textile

Sustainable consumption practices are followed by big textile groups than SMEs.

sustainability from all three areas including ecology, economy and social aspects. The global perspective of Pakistan as sustainable textile goods exporter was the focus of discussion.

1.5 Data Analysis

The data collected from various sources was used to identify the unsustainable practices in the textile and leather industries and was also used to conduct risk assessment studies. The identified risks in environment, economy and social areas were mapped to have a broader look on how textile industry could be made more sustainable.

1.6 Recommendations

Keeping in view the both domestic as well as the global scenarios, recommendations were made.

This report is subdivided into four chapters:

- The first chapter highlights the significance of textile and leather sectors in national economy.
- The second chapter contains the detailed description of the sustainability issues in the textile and leather industries in all three aspects of the sustainability-ecology, economy and social.
- Based on the identified sustainability issues and unsustainable practices, the risk assessments are presented third chapter.
- The recommendations for improving and making the textile and leather sectors more sustainable are given in fourth chapter.

The textile sector of Pakistan is major contributor of country's economy both in terms of exports and employment.



2 Background of the Textile and Leather Sectors

2.1 Textile Sector of Pakistan

The textile sector provides 40 per cent of the employment in Pakistan.

Pakistan is the fourth largest producer and consumer of raw cotton therefore it holds an important place in the world textile markets⁶. The synthetic (polyester) fibre manufacturing plants, which are mainly located in Karachi, Lahore and Faisalabad regions, are able to fulfil the raw material requirements which is the most widely used synthetic fibre for apparels. The availability of the domestic raw material has made Pakistan one of the major players in the textiles industry worldwide. The textile sector of Pakistan is the main contributor to the country's economy, both in terms of exports and employment. The textile manufacturing has always been a long process chain, having numerous textile giants with state-of-the-art machinery and huge working capacity mostly in spinning and wet processing. However, there are many small and medium enterprises in between the process chain. For example, the enormous short staple yarn spinning industry of the country is fed by the ginning SMEs. This long process chain and fragmentation of the industry are the major hurdles for implementation of sustainable practices in the country. Nevertheless, this process chain has the potential for the value addition and sustainable improvements. The textile sector contributes approximately one fourth to the value addition in the economy, and provides 40 per cent of the employment in Pakistan. In addition, the textile sector also consumes nearly 40 per cent of the banking credit. In spite of cyclic and repeated fluctuations⁷, the export share of the textile sector is 60 per cent in the national economy⁷.

Commodities	Exports in (US \$ Millions) 2015-16 (July to March)
Cotton and Cotton Textiles	9,066
Synthetic textiles	222
Wool and Woolen textiles	74
Total Textiles	9438
Total Exports	15606
Textile as Percentage of exports	60%

Figure 1 Statistics taken from Economic Survey of Pakistan

Table: Export of Pakistan Textiles

⁶Economic Survey of Pakistan.
⁷Economic Survey of Pakistan.

There are about 2500 tanneries and footwear industries in the country.

2.2 Leather Sector of Pakistan

After textile industry, leather industry is the largest revenue earner for Pakistan. The present contribution of the leather sector in the exports of the country is around US\$918 million per annum⁸. Similar to textile, this sector can also increase the volume of exports through value addition, by improving the quality of the products, by diversification of products and by achieving the process efficiency. Garments and footwear are important part of this sector. This sector provides employment to a relatively large number of work force and earns foreign exchange for the country. There are different sub-sectors of leather industries, which include tanning leather, garments, gloves, footwear, shoe uppers and leather goods. Tanning is the process of changing the basic structure of leather to make it durable and wearable. The tanning industry uses the by-product of meat industry and provides the raw material for the leather garments, gloves and footwear. Pakistan is one of the leading exporters of gloves and leather garments.

The tanned leather and leather garments contribute 4 per cent in national GDP⁹. There are about 2500 tanneries and footwear industries in the country, out of which 725¹⁰ are registered. These are located in Karachi, Hyderabad, Multan, Kasur, Sialkot and Peshawar. However, the industry is export oriented and directly influenced by the demand of leather in foreign markets.

Commodities	Unit	July-June 2016-17	US \$ Thousand
		QTY	VALUE
Leather	'000' SQM	24	562 345
	Average Unit Price/Square meter		14.07
Leather Apparel & Clothing	'000' DOZ	742	291886
	Average Unit Price /Pcs		32.78
Leather Gloves	'000' DOZ	4873	187676
	Average Unit Price /Pair		6.42
Leather Footwear	'000' Pairs	5,766	80,889
	Average Unit Price /pairs		14.03
Other Leather Manufactures	'000' KGS		12,205
	Average Unit Price /Kg		
TOTAL			918,243

Table: Exports of Leather goods

⁸Economic Survey of Pakistan
⁹Economic Survey of Pakistan 2017
¹⁰Pakistan Tanners Association

Sustainability Issues in Textile and Leather Industries



3 Sustainability Issues in Textile and Leather Industries

Sustainable development is the development that meets the needs of the present without compromising the ability of future generations. The foundation of the sustainable development is on three pillars: economy, society and (ecological) environment, whereby the equivalent value of the pillars should be a goal, which certainly is difficult to achieve in practice.

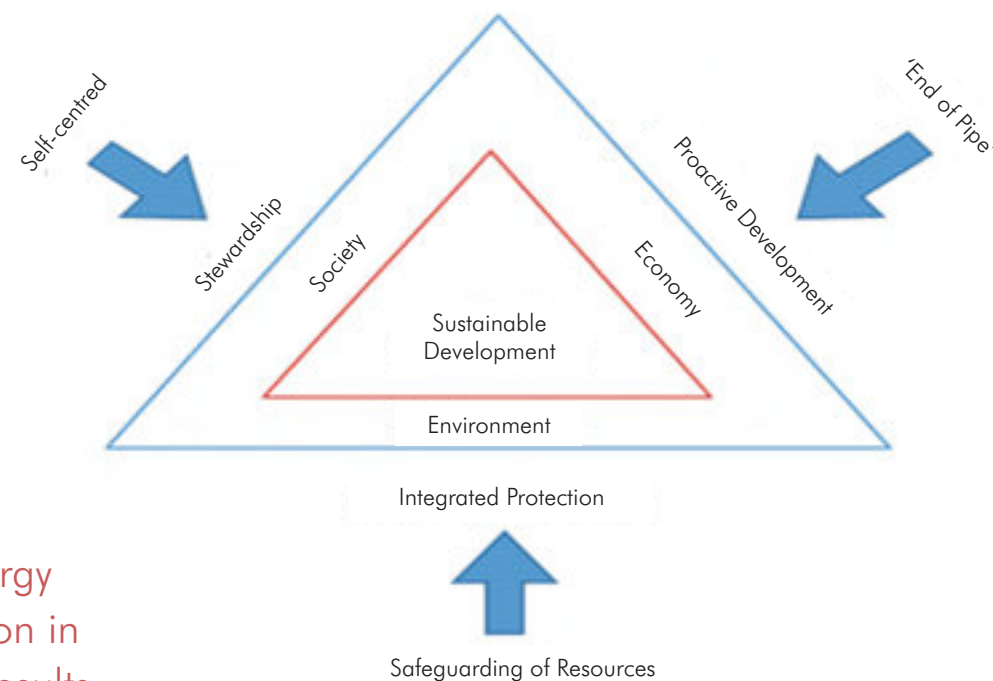


Figure 1: Sustainable Development

Ensuring sustainability in industries like textile and leather is difficult and complex and is not similar to other value-added chains like those in food industries etc. This is largely due to numerous processes, which are performed through a combination of large and small scale manufacturers.

3.1 Textile Sector

3.1.1 Economic Sustainability

Globally, the following issues related to economic sustainability have been identified for the textile manufacturing countries especially those in South Asian region:

- Competition from other countries in the region results in the lowering of product costs.
- High energy consumption in processes results in high cost of final products.
- Labour intensive processes result in high costs, human resource problems (availability and training) and social issues (occupational health and safety).

Pakistan enjoys a trade and duty advantage of 10 to 14 per cent over other South Asian countries.

- The fragmentation of textile industry into small-scale manufacturers working in the process chain results in increased resource consumption and reduces the potential of resource conservation.
- Limited investments from SMEs hinder innovation and sustainability.

European Union granted GSP+ status to Pakistan in December 2013, which enabled Pakistan to have duty free access to European Union on 96 per cent to its exports. After acquiring this status, Pakistan enjoys a trade and duty advantage of 10 to 14 per cent over other South Asian competitors like India, China, Thailand and Vietnam etc. However, Pakistani exporters are unable to harness the true potential of GSP+ status. Despite the GPS+ status, the country's exports have shown a decline in recent times. There are many issues in the textile and leather sectors that are causing hindrance in increasing the export volumes. The following lacunas were identified while discussing the issues of the economic sustainability with the textile experts and industrialists:

- Adverse business climate of the country obstruct the international investments especially from EU clients.
- Non-friendly tax regime issues in custom clearances and imposed duties on the various raw materials increase the price of the final product and make it less competitive in international market.
- The condition after the energy crisis is improving but the energy costs remain high as compared to other countries in the region.

There are several other issues and challenges faced by the textile industry that are directly or indirectly influencing the economic sustainability of the textile products which are being produced. The following issues should be addressed in order to achieve economic sustainability:

- Low technological base
- Lack of research and development
- Issues in human resource development
- Low quality standards
- Production skewed towards low end commodities
- Low value-addition
- Too much reliance on cotton as a raw material by Pakistan Textile

3.1.2 Environmental Sustainability

The textile process chain can be divided into:

- Dry processing
- Wet processing

The dry processing consists of ginning, spinning, weaving knitting and garment manufacturing while the wet processing consists of bleaching, dyeing and finishing processes.

Yarn Manufacturing

The environmental impacts of the pre-spinning, ring spinning or open-end spinning processes depend on the number of processes involved, raw materials utilized and products being manufactured.

	Input	Output
Bale opening Cleaning	Energy Air Fibres (Virgin/recycled)	Dust particles (flammable) Foreign fibres Stones, bark, stalks Short-fibres Packaging material (fabrics and bonding)
Carding	Energy Air	Garbage Dust Fibre waste (recycling) fibre waste (incineration)
Ring spinning OE spinning	Bobbins Cops Energy Air Water Wax	Fibre waste (recycling) Fibre waste (incineration) Yarn waste
Packaging	Plastic Pallets Energy	Plastic waste (recycling)
Bale opening Cleaning	Energy Air Recycled fibers	CO ₂ , NO _x , SO ₂ , (airborne emission) Dust particles (flammable) Foreign fibers Stones, barks, stalks Short fibers Packaging material (fabrics and bonding)
Carding	Energy Air	Garbage Dust Fibre waste (recycling) fibre waste (incineration)
Ring spinning OE spinning	Bobbins Cops Energy Air Water Wax	Fibre waste (recycling) Fibre waste (incineration) Yarn waste
Packaging	Plastic Pallets	Plastic waste (recycling)

Table: Environmental impact of yarn manufacturing processes

The major environmental concerns related to yarn manufacturing (cotton and synthetic) are the use of energy. The requisite energy comes from different sources and produces greenhouse gas (GHG) emissions. Moreover, the water is used for maintaining the temperature and relative humidity in the different yarn manufacturing departments. The

wastes of yarn spinning are vegetable matter, fibre fly (short fibres), cotton dust, hard waste (yarn waste) and packing materials. Out of these wastes, cotton is more dangerous from an occupational health and safety point of view. Dust consists of small and microscopic particles of various substances, which may be classified based on their size.

Particles	Size
Trash	Above 500 micro meter
Dust	50 - 500 micro meter
Respirable dust	Below 15
	The particles between 5 micrometres carries endo-toxins that cause lungs diseases

Figure 2 Taken from cotton science and technology book

Table: Types of cotton dust

Weaving

The weaving process can be classified into sizing and weaving processes. During the preparatory process, size is applied to the yarns to increase their strength and to enable them to withstand the weaving tensions. Different kinds of sizing agents are used ranging from natural starch to synthetics PVA along with different additives and preservation agents. The sizing wastewater is one of the main the sources of biological oxygen and chemical oxygen demand in effluent water.

The weaving machines also consume large amount of electrical energy. However, the amount of energy consumed depends on the type of weaving machines used. In the context of occupational health and safety, the noise level in the weaving shed is quite high and can be very harmful for the workers.

Input	Output
Raw material Weft yarn (different qualities) Warp yarn (different qualities)	Grey fabrics Finished fabrics Textile waste
Materials Bobbins Pallets Cardboard Packaging parts(replacement)	Pallets Garbage Paper and cardboard (recycling) Mechanical metals (solid waste), electronic waste
Auxiliaries Sizing agent Chemicals(laboratory) Lubricants and oil	Sizing agent (liquid waste) Chemicals(liquid waste) Oil (liquid waste), effluents Stain remover
Energy Electrical energy Thermal energy Compressed air	CO ₂ ,NO _x , SO ₂ (airborne emission) CO ₂ ,NO _x , SO ₂ (airborne emission) Contaminated air

Table: Environmental impact of weaving process

Knitting
The environmental concerns of the knitting process are mainly associated with energy requirements. Different environmental indicators for knitting are given in the following table.

Inputs	Wastes and Emissions
Yarns	Bobbins yarn waste
Electrical energy	CO ₂ , NO , SO ₂ (airborne emission)
Thermal energy	CO ₂ , NO , SO ₂ (airborne emission)
Air	Contaminated air
Water Pallets	Effluents Pallets
Lubricants, oils	Oil contaminated fabrics
Mechanical parts (replacement)	Metals (needles, etc.)

Non-Woven
Non-woven is one of the most progressive fields of the textile sector because of its cost effectiveness, manufacturing efficiency and vast range of applications from home, industrial and medical textiles. Moreover, the non-woven products are often disposables (persistent and biodegradable). Dumping the disposables like baby diapers or medical/surgical gowns into landfills can be a source of many environmental issues.

Technology	Products/applications (disposables)	Products/applications (durables)
Carded thermal bonded and resin bonded staple	Carded thermal bonded and resin bonded staple	Carded thermal bonded and resin bonded staple
Needle-punched staple fibres (carded)	Needle-punched staple fibres (carded)	Needle-punched staple fibres (carded)
Air laid	Air laid, Absorbent media in sanitary napkins, consumer wipes, industrial wipes	
Wet laid	Medical surgical disposable (second market share), industrial wipes, filtration media	Electronic components
Melt blown	Sanitary napkins, incontinence products (PP), elastic side panels in training pants, medical/surgical disposables (PET), consumer wipes, fabric softener (dryers), PET filtration media	
Spun-laced or hydro-entangled (carded, air laid and air entangled)	Medical/surgical disposables (PET), gloves, masks, sheets, pillowcases, consumer wipes (baby's) filtration media, industrial wipes, industrial protective apparel	(Coated) apparel with special requirements
Spun-laced or hydro-entangled (carded, air laid and air entangled)	Medical/surgical disposables(PET), gloves, masks, sheets, pillowcases, consumer wipes (baby's) filtration media, industrial wipes, industrial protective apparel. Laminates, combinations with film, foam, woven and knitted fabric	Durable papers, electronic components

Table: Environmental impact of Non-woven

Wet Processing

Textile wet processing is always considered to have highest energy requirements both in the form of electricity and thermal energy (steam production). The use of fossil fuels under the boiler for steam generation for finishing/curing is the major source of air pollution (CO₂, NO₂ and SO₂).

The wet processing can be divided into:

- Pre treatments
- Bleaching
- Dyeing

- Printing
- Finishing

The coloured effluents are considered to be most toxic. However, other materials present in effluent water are more dangerous than the dyes like caustic soda. Similarly, special functional finishes contain hazardous chemicals like poly fluorinated carbons (for oil and water repellent finishes) and resins/cross linkers which are mostly formaldehyde based.

Inputs	Outputs	Wastewater parameters
Pre treatment Caustic soda Peroxide Water Air Electrical energy Thermal energy Stabilizing agents	Caustic soda CO ₂ , NO ₂ , SO ₂ (airborne emission) Excess heat Stabilizing agent Organic waste (pectins, natural waxes oils, insects, minerals) Paraffin and knitting oils Heavy metals	pH TOC, COD, BOD, Heavy metals
Dyeing and Printing Salt Dyestuff Surfactants Auxiliaries, acids Water Electrical energy (based on thermal sources) Thermal energy Bonding agent	Salt Solid waste (Dyestuff) Surfactants , Detergents Chemicals (VOC, AOx, (Airborne Emissions)) Water Waste (oils and Filtered Particles, Dyestuff) CO ₂ , NO ₂ , SO ₂ (airborne emission) CO ₂ , NO ₂ , SO ₂ (airborne emission) Liquid waste	Conductivity pH, Heavy metals, P, SO ₂ , K TOC, DO, BOD, COD N
Finishing Resin Catalyst Enzymes Softener Auxiliaries Thermal Energy Electrical Energy based on thermal sources	Solid wastes Wastewater Airborne emissions CO ₂ , NO ₂ , SO ₂ (airborne emission) CO ₂ , NO ₂ , SO ₂ (airborne emission)	N, TOC,DOC,BOD,COD Heavy metals TOC,DO,BOD,COD

Table: Environmental impact of Wet Processing

The discharged wastewater from a wet processing industry has high BOD and COD contents.

Laundry and After Use

There is an increased concern in the European countries about the micro-plastics coming from home laundry which pollutes the rivers and marine environment. The main cause of the problem is fibre shedding from the synthetic fabrics (made up of plastics which are non-biodegradable) during the washing.

3.1.3 Environmental Issues Related with Textile Sector

There are many environmental and health problems associated with the textile industry especially with wet processing. The problems can be in the form of air and water pollution, landfilling of sludge, emissions, or OHS problems.

Water pollution

Textile wet processing is a water and energy intensive process. The dyed fabrics have to be washed many times to remove the unfixed dyes and excess auxiliary chemicals from the fabrics; these chemicals can otherwise be harmful for the consumer as they can be absorbed through the skin. Inefficient dyeing processes releases residual dyes in the hydrolysed or unfixed form. The discharged wastewater from a wet processing industry has high BOD and COD contents. Moreover, it is alkaline in nature (high pH), has high temperature, contains residues of dyes and pigments, has high turbidity and can contain toxic substances. Therefore, the wastewater should be treated to lower the values of afore mentioned parameters within the recommended limits in order to remove the toxic substances, before it is discharged in the public drains or rivers.

Effects of dyes and pigments on the environment

There are four potential routes through which the colorants can enter the environment:

- Disposal of extra materials and residues of processes.
- The accidental release of the hazardous chemicals.
- Disposal of dye/chemical containers (solid waste).
- Through routine process of effluent or emissions.

The discharged effluents have alkaline pH, high temperature and strong odour. They contain residues of the colours/dyes that were used during the dyeing process. Some colouring materials (dyes and printing pigments) and chemical auxiliaries used for the dyeing and printing process are toxic in nature and some of the chemicals, including dyes and pigments can lower the dissolved oxygen content of receiving water.

Polluting potential of colorants

The pollution contribution of the dyestuffs itself is less than the auxiliary chemicals used in the dye bath. According to research, the total contribution of dyes to the COD is 2-5 per cent while dye bath chemicals contribute about 25-35 per cent. For example, acetic acid which is used in the dyeing of polyester contributes approximately 50 to 90 per cent of dyeing BOD. However, the polluting potential of the dye depends on its chemical composition. The use of metal complex dyes or the salts of heavy metals are the main sources of heavy metals in the

effluent water. Most of the dyes are highly stable molecules which are synthesized to resist the degradation on exposure to light, chemical treatment or biological treatment. Colouring material in the wastewater also absorbs the sunlight and affects the photosynthesis of aquatic plants.

Effect of solid wastes

There are different kinds of waste produced in the textile industry. Some of the waste is reused or recycled like the waste from fibres, yarns and fabrics. However, the most dangerous solid waste in the textile industry comes from the sludge and the containers of different chemicals. The workers who deal with disposal of such hazardous solid waste are most exposed to the toxic effects.

Noise Pollution

There are different processes in the textile chain that can produce noise level above the allowed limit (90 dB(A)) and can cause problems especially for the workers. The dry processes produce more noise than the wet processes. The noise level in the ring spinning and winding sections as well as the weaving shed and garments manufacturing departments are higher than recommended ranges. The main reason for this noise is the fast-moving parts in the processing machines, which is another danger for the workers along with the hearing problems.

Effects of Pollutants on Health

The textile chemicals and other processing waste have adverse effects on the health of the industry workers, community, and the consumers. The toxic nature of the chemicals can create health issues during processing and usage of final product. The major health issues, from occupational health and safety point of view, are the respiratory problems due to breathable cotton dust in spinning mills and the fumes of different chemicals coming out during wet processing. The releases of nitrogen oxides, sulphur oxides or other particulates from boilers also cause health issues. The absorption of different toxic chemicals in the skin of consumers is also a big concern. The Green Peace has launched a campaign called “Detox”, which aims to create awareness against such substances. The dumping of textile sludge in the surroundings of textile mills and effluent discharge in the drains without treatment are the main causes of different diseases for people living in the surrounding areas.

3.2 Leather Sector

As previously described, leather and the leather products are vital for Pakistan's economy. After textile sector, it is the second largest foreign exchange earner for the country. Due to its agricultural background, the availability of livestock provides the raw material for local leather industry. However, the different sectors of the leather industry viz. tanning, footwear, garments/gloves and leather goods face different challenges. Most serious of them are connected with the environmental sustainability while other are inter-linked with economic and social aspects.

Tanning	Footwear	Garments/Gloves	Leather Goods
<ul style="list-style-type: none">• High proportion of damaged local hides and skins due to diseases, improper slaughtering/preservation.• Shortage of local hides and skins• Compliance to environmental standard.	<ul style="list-style-type: none">• Undeveloped industry• Non-availability of quality shoe components/accessories• Lack of marketing linkages• Lack of trained human resources	<p>Procedural impediments in import of raw material (finished leather and accessories)</p> <ul style="list-style-type: none">• Narrow product mix• Lack of design/development facilities	<ul style="list-style-type: none">• Undeveloped industry• Low technological levels• Lack of marketing linkages

3.2.1 Environmental Issues Related with Leather Sector

The most commonly used tanning method in Pakistan's leather industry is chrome tanning. However, vegetable tanning and the combination of both vegetable and chrome tanning are also exercised. The water intensive nature and the use of as many as 130 different chemicals, makes this process environmentally hazardous. The water is used from initial process of soaking to dyeing and finishing. However, the number of chemical used in the process depends on the type of raw material and the kind of finished product produced. The chemicals used for the leather processing can be subdivided into pre-tanning, tanning, wet finishing and finishing. The environmental concerns that are connected with tanning and finishing process of leather are:

- Heavy metals
- Wastewater
- Air emissions
- Solid waste

Heavy Metals

Leather tanning is carried out by using chromium which is discharged into the wastewater. The effluent water was tested by government and was found to be toxic. The presence of the other metals like cadmium etc. was also observed. The level of heavy metals is well above the recommended standard values. According to a study, the following metals with given concentrations are present in effluent water.

Metal	Concentration
Copper	0.30 (mg/litre)
Cadmium	0.15 (mg/litre)
Zinc	7 (mg/litre)
Nickel	1.14 (mg/litre)
Lead	1.8 (mg/litre)
Chromium (Total)	12-36 (mg/litre)
Chromium (III)	0.97-13.25 (mg/litre)
Chromium (VI)	11-28 ppm

Table: Heavy metals and their concentration in wastewater

Most of the tanneries in the country do not have effluent treatment plants and effluent discharged water is directly released in the nearest drain or river. This wastewater is released without any treatment, recycling or end of pipe arrangement.

A study conducted in Sialkot shows increasing heavy metal pollution in the indoor dust samples. The heavy metals were also found in the blood, urine, and hair samples of the exposed workers. Cr, Ni, Cd, and Pb are the identified heavy metals which pose highest health risks and induce oxidative stress in the workers.

Industrial Process Wastewater

Raw materials, number of processes and the techniques used in the leather industry greatly influence the discharged wastewater. The water consumption is higher in pre-tanning processes like soaking, fleshing, de-hairing and liming etc. as compared to post tanning. The effluents present in wastewater coming from different processes are given in following table.

COD/BOD and Suspended Solids

The major source of COD/BOD is from the liming and de-hairing processes, which is approximately 75 per cent of the total organic load.

Chromium is a heavy metal found in wastewater from leather industry and considered toxic for humans.

COD/BOD from living and de-hairing process is 75 per cent of total organic load.

De-greasing process is also a source of COD/BOD in wastewater. However, the most of the suspended solids came from de-hairing process. The total COD/BOD level can be up to 200,000 mg/litre.

Processes	Wastewater
Soaking, fleshing, de-hairing, liming	Blood, dung, dirt, organic matter and suspended solids
De-liming and bating	Sulphides, ammonium salts, Calcium etc
Tanning	Depends on the tanning technique used Chromium III or Chromium VI
Finishing	Polymeric liquor, colour pigments and Coagulants

Table: Wastewater from different leather manufacturing processes

Salt and total dissolved solids

The effluent coming from the soaking process contains dissolved salts which are used for curing hide. This contributes to about 60 per cent of the total dissolved chlorides in wastewater. The total dissolved solid can reach up to 15,000 mg/litre in effluent wastewater. Other sources of the TDS include pickling, tanning and dyeing processes.

As a result of using inorganic sulphides and lime treatments during de-hairing process, sulphide containing liquors are released in effluent wastewater. Ammonia nitrogen is primarily released from the tanning process, which comes from the ammonium salts used during tanning. Ammonia nitrogen is also being released from animal proteins and dyeing.

Chromium salts, mostly trivalent chromium, is the most commonly used tanning agent. Approximately 75 per cent of the chromium comes from the tanning process while the remaining 25 per cent comes from the post tanning process. The finishing or post tanning processes use many chemicals like impregnating agents, masking agents, fat liquors and dyes.

Air Emissions

There are many sources of air emissions; these may occur during the leather processing. Air emissions greatly depend on the chemicals and the process. For example, if the organic solvents are used during finishing or other processes, the emission of volatile organic compounds (VOCs) may occur. Same is the case with the use of organic solvents during de-greasing process. Moreover, ammonia can be released during de-liming and de-hairing if the ammonia is used during dyeing for effective dye penetration. Similarly, the sulfides may

be released in the air during liming and de-hairing processes. The buffing process can also release small particles in the air which can carry traces of chromium.

Solid Waste

Large amount of solid waste is produced from the leather processing industry which is mostly organic in nature. These are in the form of splits, trimmings and fleshing from un-tanned or tanned leather from raw hides or semi-processed leather. The trimmings of raw hides may contain lime or sulfides. Similarly, the wet blue shavings/trimmings may contain the chromium oxide. These solid wastes must be treated and disposed properly in order to tackle the issues of soil and groundwater, odour emissions and release of GHGs in the atmosphere.

Efficient Use of Energy

The impact of energy usage in the textile and leather industries is associated with all three aspects of sustainability, i.e. environmental, economic and social. Textile processes are energy and labour intensive. This requires energy is in the form of electricity as well as thermal. The energy resources can be renewable and non-renewable. In Pakistan, hydropower and natural gas accounts for more than 50 per cent of power generation. The electricity and natural gas is provided by the government which have always been the prime energy sources for the textile industry. However, the supply of electricity and natural gas to the industry depends on different policies of the government, which may vary during the year. Most of the textile manufacturers have their own natural gas/oil fired engines to generate power for running their industry in a smooth manner.

Before the energy crisis, these two resources were mainly used in the textile as well as in the leather industry for meeting their energy requirements. However, to overcome the energy crisis in the country, the government has tried all the alternative renewable and non-renewable resources like wind, solar power along with coal and crude oils, respectively, to meet the increasing energy demands. In the textile industry particularly in the textile finishing process, where a lot of thermal energy/steam generation is required, use of coal and other biomass/fuels like wood, rice husk etc. have become common due to shortage of natural gas. However, the GHGs emissions from these resources are very high. On the other hand, there are a number of textile and leather SMEs, which do not have the capital investment to switch to the alternative energy sources and are adversely affected by the present energy crisis. The following table shows the overview of different kinds of energy that is used in the textile process chain.

From an environmental sustainability point of view, natural gas has lower environmental impact than the crude oil for energy generation. However, in terms of economic sustainability, lack of knowledge and experience about the usage of coal and biomass causes energy inefficiency and as a result the calorific value of the fuel is not fully utilized. This in turn increases the cost of production and makes the products less competitive.

The efficient use of energy is an important influencing factor regarding environmental and economic sustainability. Most of the machines were selected in the industry based on their production capacity and quality. However, with energy crisis and the rising cost of

In Pakistan, hydropower and natural gas accounts for more than 50 per cent of power generation.

energy in the country, the energy efficiency of a machine has become an important selection criterion. The energy efficient machines have state-of-the-art operating technologies and efficient drive or heating systems that enable optimum quality and productivity at low energy levels. The role of good maintenance cannot be ignored either; it helps in keeping the machines efficient.

As a rule for the manufacturing industries including the textile, the productivity and quality are inversely proportional. Therefore, the energy consumption is dependent on the product's quality. For example, the energy requirement of the fine yarn production is much more than the coarser yarn.

Textile Process chain	Processes	Energy type
Cotton ginning	Saw Ginning and pneumatic transport of fibres	Electricity
Polymerization (in case of synthetic)	Chemical reaction	Thermal Energy
Filament spinning	Melt spinning & Wet spinning	Thermal Energy Electricity
Cotton spinning	Power supply Pneumatic transport and air conditioning	Electricity
Weaving & knitting	Power supply and Air conditioning	Thermal Energy Electricity
Finishing (Dyeing printing)	Power supply	Thermal Energy Electricity
	Fixing & Curing	Thermal Energy
Transportation	Truck, ship, airplane	Thermal Energy
Illumination	All processes	Electricity

Illumination	All processes	Electricity
Heating	Cold climates	Thermal Energy
Cooling	Hot climates	Electricity

Table: Types of Energy required for different textile processes

3.3 Link between Heat -Water- Greenhouse Gases

Heat quantity for heating 1 m³ water from 20°C to 100°C
(1000 kg * 4.184 kJ/kg K * (373-293)) = 335.200 kJ = 93 kWh (therm)
Heat quantity for evaporating 1 m³ water (100°C)
(1000 kg * 2,260 kJ/kg) = 2,260,000 kJ 628 kWh (therm)
(Without consideration of efficiency)
721 kWh (therm). corresponding to natural gas consumption: 72 m³ natural gas
(Fuel value for natural gas~10 kWh/m³)
628 kWh (therm). corresponding to a greenhouse effect: 152 kg CO₂
(242 g CO₂ -equiv./kWh GEMIS)
Each m³ water that does not need to be heated, and each therm of steam that is not required for heating the water represents a significant energy, cost and CO₂ saving.

3.4 Issues Regarding Energy Resource Efficiency

The efficient use of energy exerts a greater economic and ecological influence on the textile and leather sectors. The key issues with respect to efficient use of energy are being discussed on the basis of existing situation. These issues and relevant recommendations are discussed below.

Improper line sizing for air, oil and steam

During air, oil, water and steam piping installation, no design is followed. The length and diameter of the lines are reduced or increased without proper understanding of its impact on the energy losses. For example, the pressure losses due to increase in length or diameter will reduce the pressure and increase the energy losses. During the visit to an industry, it was observed that the steam consumption remains unaffected even when the production is at minimum.

Improper selection of Compressors, Water Turbines and Boilers

Mostly, compressors and water turbines are selected on the basis of kilowatts of motor without knowing the Free Air Delivery (FAD) of compressors and discharge capacity of water turbines. Moreover, most of the boiler and oil heaters used in the industry are overloaded. Industries usually increase the

The coal should be tested for its calorific value before its use.

The coal with smaller size results in an increase of fly ash which has adverse effect on the human health and causes air pollution.

number of machines but boilers, oil heaters and compressors remain the same, which causes fabric production to be low as machines are unable to attain their optimum efficiency due to low pressures which also affects the quality. Overloaded boilers can be overheated which can cause accidents.

Lack of Awareness Regarding Input Source, i.e. Coal, Gas, Electricity and Liquid fuel

Coal

Industries lack the basic information regarding coal consumption. The information regarding calorific value, amount of sulfur and moisture production is not known or tested. High sulfur can damage the boiler parts and has adverse environmental effect. Coal grade from 0 to 50mm is used by number of industries. The coal with smaller size results in an increase of fly ash which has adverse effect on the human health and causes air pollution. As the coal is used without knowing the calorific value, therefore, the feed rate for coal cannot be adjusted which results in increased consumption of coal along with economic and environmental losses.

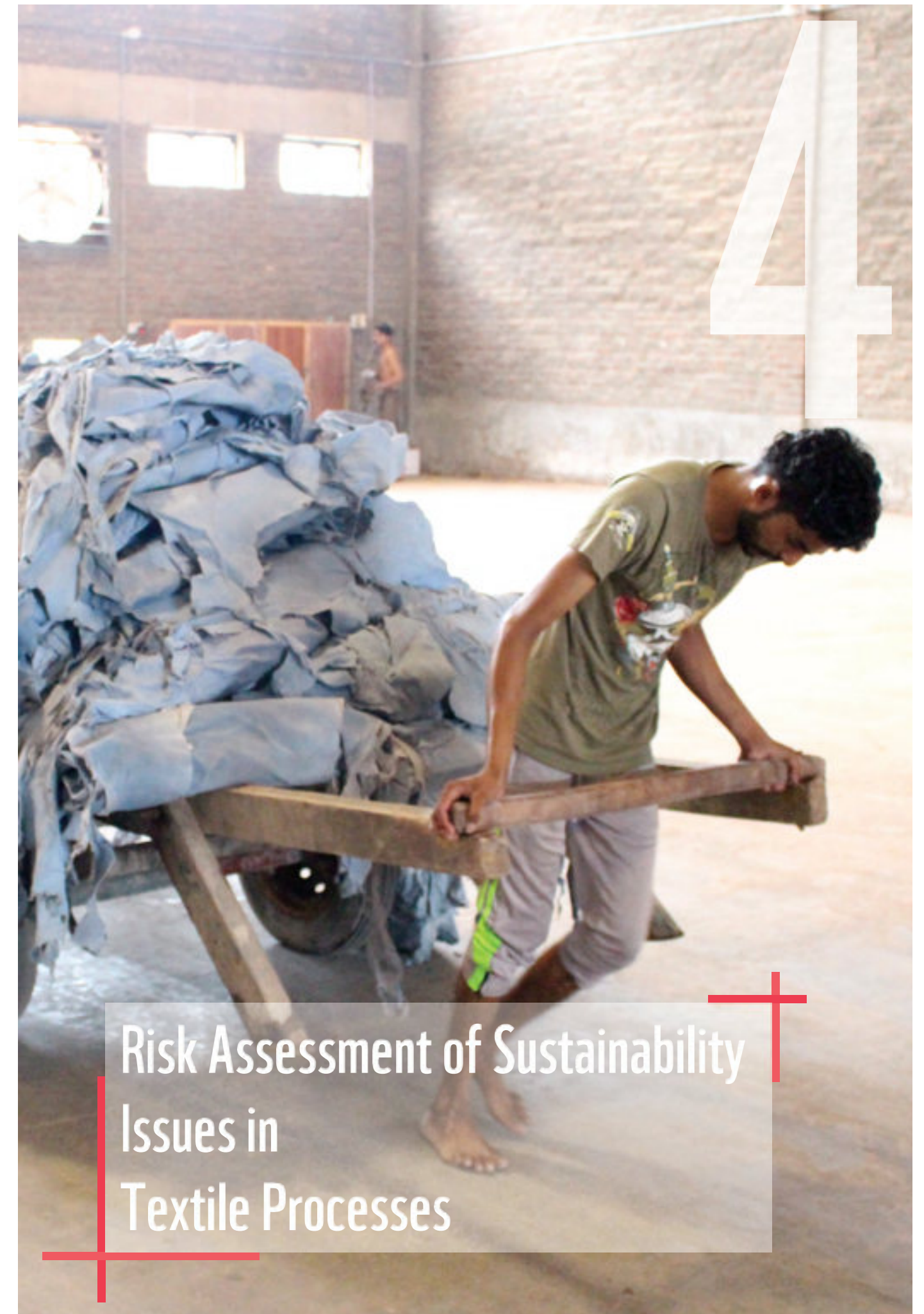
Gas & Liquid Fuels

The maintenance of the engines operated with gas and liquid fuel is not carried out after a defined maintenance period, which results in increased inputs of gas and liquid fuel. The condition of the engines also deteriorates and the disturbance level (noise level) also increases as a result of delayed maintenance.

The coal should be tested for its calorific value and amount of sulphur and moisture should be known before its use. In addition to this, feed rate should be adjusted after calculating the output of the boiler and coal consumption should be optimized. Wet scrubbers should be used to reduce fly ash and the engines should be mechanically maintained after regular prescribed intervals.

Non-Utilization of exhausts of boiler, engine and oil heaters

The exhausts of boilers, engines and oil heaters are wasted in air, which is the one of the major causes of the inefficient use of resources. For example, the exhaust of 1 MW gas engine can produce 0.75 ton of steam per hour that costs about PKR 1,200. This adds up to approximately PKR 10 million per year that is being wasted and released in air. The exhausts of oil heaters and boilers can be used to heat the water as hot water is extensively used in processing industry. Air preheaters can be employed to recover heat which is inherently safe process.



Risk Assessment of Sustainability Issues in Textile Processes

4 Risk Assessment of Sustainability Issues in Textile Processes

Risk assessment is simply a careful examination of whatever in work or workplace could cause harm to people, so that relevant precautions and controls could be determined and established to prevent distress.

Risk assessments are subjective and require interpretation of information. In this instance the risk assessment will also depend on local and enterprise variables like physical location, management systems, the economy, the skill level of the workforce, external events and available technologies. This risk assessment is against a number of issues within economic, social and environmental sustainability. This list of issues is not exhaustive and there are many ways that sustainability issues can be described and categorized.

The risks have been rated using a scale for likelihood (probability) and impact (consequence).

Likelihood (Frequency)	Impact
High= highly likely	High = high impact
Medium = might happen	Medium = moderate impact
Low = less likely	Low = limited impact

Table: Risk Classification

4.1 Risk Assessment of Economic Sustainability Issues

Issue	Textile Processes				Description
	Materials	Yarn Manufacturing	Fabric Manufacturing	Wet Processing	
<ul style="list-style-type: none">High Energy costCompetition with other developing countries of the South Asia	High/High	High/High	High/High	High/High	<ul style="list-style-type: none">High cost of energy (gas and electricity) especially in wet processing,New competitors in the region like Bangladesh and Cambodia having lower labour costs and thus being more competitive in international markets.
<ul style="list-style-type: none">Costs & financial risksValue added and intellectual propertyEfficiency	High/High	High/High	High/High	High/High	<ul style="list-style-type: none">Fragmentation of the industry, with SMEs unable to invest in innovation and sustainability.

4.2 Risk Assessment of Environmental Sustainability Issues

Issue	Textile Processes				Description
	Materials	Yarn Manufac-turing	Fabric Manufac-turing	Wet Processing	
Textile raw materials Packaging for the intermediate and final products.	Medium/High	Medium/Medium	Medium/Medium	Medium/High	·Cotton being water intensive requires a lot of water for growing. On the other hand synthetic fibre does not need much water instead it requires more energy for production ·Packaging uses for intermediate or final products is not re-useable or recyclable. The containers used for dyes and other hazardous chemicals must be disposed properly.
Energy consumption · Sources (Types of fuels)	Medium/Medium	High/High	Medium/Medium	High/High	·All the textile processes are energy-intensive and requires electricity for manufacturing. However, the textile wet processing needs both electricity as well the thermal energy. ·The fossil fuels and biomass/ agricultural waste used in boilers for thermal production have a significant impact on the environment.

Water ·Requirement ·Discharge in drains / rivers etc.	High/High	Medium/Medium	High/High	High/High	·Cotton production needs more water than the synthetics for the production. ·The washing and cleaning of the textile is done by using excessive amount of water ·The discharged water may contain dyes, pigments and other auxiliary chemicals that can raise the pH, temperature, COD and BOD of the water. However, the risk depends on the quality and types of raw material, chemical and products.
Pollutants and emissions · Greenhouse gas emissions · Solid wastes ·Hazardous chemicals	Medium/Medium	Medium/Medium	Medium/Medium	High/High	·The cotton dust /floating fibres may contain the endotoxins that can be deposited in the lungs ·The energy intensive processes cause the emission of GHGs ·Non-degradable and non-reusable wastes from the different textile processes can pollute the air, land and water.

4.3 Risk Assessment of Social Sustainability Issues

Water ·Requirement ·Discharge in drains / rivers etc.	High/High	Medium/Medium	High/High	High/High	·Cotton production needs more water than the synthetics for the production. ·The washing and cleaning of the textile is done by using excessive amount of water ·The discharged water may contain dyes, pigments and other auxiliary chemicals that can raise the pH, temperature, COD and BOD of the water. However, the risk depends on the quality and types of raw material, chemical and products.
Pollutants and emissions · Greenhouse gas emissions · Solid wastes ·Hazardous chemicals	Medium/Medium	Medium/Medium	Medium/Medium	High/High	·The cotton dust /floating fibres may contain the endotoxins that can be deposited in the lungs ·The energy intensive processes cause the emission of GHGs ·Non-degradable and non-reusable wastes from the different textile processes can pollute the air, land and water.

Community · Complaints	Low/Low	Low/Low	Low/Low	Low/Low	· The SMEs (mainly weaving units) established in the residential area can cause complaints/disputes due to high noise level. · Due to long but fragmented process chain, complaints about the quality may arise between the buyer and sellers
Product responsibility · Safe & sustainable products ·Labeling, stewardship and transparency	Medium/Medium	Medium/Medium	Medium/Medium	Medium/Medium	·Due to increasing awareness about the sustainability of the textile products, the consumers want information about the life cycles, impacts and carbon foot prints of the product. In the new era of textiles, sustainability is new quality.

4.3.1 Constituents of Wastewater from Wet-Processing (Cotton and Blends) and Their Environmental Impact

Processes	Constituents	Impact	Description
Sizing			BOD, COD, Temperature
	Starch derivatives	High	
	Semi-synthetic sizing agents (CMC)	Medium	
	Synthetic sizing agents (PVAs, polyacrylates)	Low	
	Additives:		
	Urea, Glycerin	Medium	
	Waxes and Oils	High	
De-sizing	Preserving agents	High	BOD, COD, Temperature
	Acids	High	
Scouring	Enzymes	High	Oily fats
	Saponified waxes, oils, fats	High	
	Surfactants	High	
	Alkali	High	
Bleaching	High temperature	High	Temperature
	Residual bleaching agents	Low	Peroxide
	stabilizers, surfactants	Medium	pH
Mercerization	wetting agents, mild alkalinity	High	Temperature
	Alkali (NaOH)	High	BOD
	Surfactants	High	pH (high)

Dyeing	Dyestuffs (direct, vat, reactive, sulphur, pigment)	High	Toxicity
	Electrolytes ,Carriers	High	BOD
	Acids and alkali	High	pH
	Heavy metals Oxidizing agents Reducing agents	High	Suspended solids
	Surfactants, Levelling agents	High	Strong colour
Printing	Dyestuffs	High	Toxicity COD BOD
	Acids, Alkali,	High	pH
	Reducing agents	High	Suspended solids
	Thickeners	High	Strong colour
	CH ₂ O, Urea and Salts	High	
Finishing			
	Acid catalysts	Low	Alkalinity
	Surfactants, Softeners,	Low	BOD (low)
	Lubricants and Metal salts	High	Toxicity

4.3.2 Major Emissions from Textile Industry (Gaseous or Particulate) and Their Environmental Impact

Process	Impact	Description
Cotton Yarn spinning, weaving and knitting	Medium	Cotton dust and small particles
Weaving preparatory (Sizing) process	Low	NO ₂ , SO ₂ , CO
Bleaching with chlorine compounds	Medium	Chlorine and Chlorine dioxide
Disperse dyeing using carriers	High	Carriers, H ₂ S
Sulphur dyeing	High	
Printing	High	Hydrocarbons, ammonia
Finishing Resin finishing	High	Formaldehyde
	High	Carriers, Polymers

4.3.3 Solid Waste in Textile Industry and Its Environmental Impact

Processes	Impact	Constituents
Yarn Manufacturing	Low	Short Fibres and yarn hard waste
Knitting	Low	Short Fibres, yarns, cloth waste
Weaving	Low	Short Fibres, yarns, cloth waste
Sizing, desizing, mercerizing	Low	Cloth wastes
Bleaching, washing,	Low	Flock
Dyeing and printing.	High	Containers of dye chemical substances
Chemical finishing,	High	Containers of dye chemical substances
Dyeing and Finishing of Yarn	High	Containers of dye chemical substances
Wastewater treatment	High	Sludge and short micro fibres
Packing material	Low	Non-degradable packing material
Workshops	Low	Metal scraps

Recommendations



5

5 Recommendations

5.1 Awareness regarding sustainability

Creating awareness about sustainability is vital both in textile and leather industries. There are many areas where the awareness campaigns should be launched in order to improve the knowledge of the general public and the textile workers about the sustainability.

Here are some suggestions:

- The awareness campaigns regarding the real price of the textile product should be launched. Instead of different kinds of certification labelling, a mark showing consumers the amount of water used for the production of the textile apparel should be mentioned. The focus should be to stop the buyer from buying unnecessary textile products. WWF can initiate its own water mark and can make it internationally acceptable.
- Awareness should be created on the use of fabrics and micro-plastic originating from home textile washings.
- From occupational health and safety point of view, awareness and trainings should be conducted in order to train workers regarding handling of hazardous chemicals and working in fumes and high temperatures in the textile and leather industry. For example, the tannery workers are exposed to hazardous chemicals as well as the biological hazards like bacteria, fungi, mites and parasites etc.
- Therefore, the workers should be aware of the potential hazards. SMEs should be made aware of their negative impact on environmental sustainability and how small measures like good housekeeping can reduce that impact.

Making the Textile Chain “Circular”

The new concept in the sustainable textile is looking to make the conventional textile chain “circular”, which can be simplified as reduce-reuse-recycle. Pakistan is one of the major world players and is producing impressive quantities of apparels and home textiles. The amount of waste produced as a result is also huge. There are many SMEs that are working on the recycling of textiles; however, this sector has never been highlighted. Currently, the following reuse/recycling processes depending on the type and size of the waste are being carried out.

Making textile sustainable a new concept is to make textile chain “circular” i.e. reduce-reuse-recycle.

Types of Waste	Processes	End product
Spinning wastes (Taker-in droppings, fly, Noil etc.)	Mixing with good fibres, open spinning	Yarn
White Colour Fabric Strips (small width) Cotton or Polyester/Cotton	Shredding and sterilization	Surgical Cotton
Raw Colour Fabric Strips (small width) Cotton	Shredding, Open end spinning, blended with good fibres	Cotton Yarn
Fabric strips (small width) Different colours	Shredding	Quilt filling
Fabric strips of larger width	Stitching	Accessories for Apparel, pillow covers and other home textiles
Miss Printed fabric	Printing	Exported to underdeveloped countries like Afghanistan
Export Left over (due to quality issues)	Dyeing and Printing	Used in domestic market

Similarly, spinning of polyester yarns from PET bottles is also being done. Efforts must be made to promote this sector and more innovative solutions for recycling like sorting of mixed wastes should be proposed. Due to the absence of the recycling facilities, the industries are now burning the fabric strips under the boiler for steam generation, which is causing environmental pollution.

Sustainability at SMEs

The fragmentation of the textile industry should also be considered. The economic and environmental sustainability at SMEs level is also as important as industrial level. The SMEs in the textile value chain do not have the capital to invest in sustainability therefore pollution from SMEs is growing rapidly. Government support should be provided to the SMEs to help them build environmentally sustainable infrastructure.

Water turbines should be selected on the basis of their capacity rather than consumption of electricity.

5.2 Energy/Resource Use Efficiency

The energy use efficiency exerts great economic and ecological influence on the textile and leather sectors. The key issues and recommendations with respect to energy use efficiency, on the basis on existing situation, are discussed below:

Proper Line Sizing for Air, Water, Oil and Steam

A proper/optimized isometric piping design should be followed for the pipeline erection for air, oil and steam as per American Society of Mechanical Engineers (ASME) or DIN standards (German International Standards) based on velocity and pressure calculations.

Selection of Proper Compressors, Water Turbines

Recommendations

Compressors and water turbines should be selected on the basis of their capacity rather than consumption of electricity. Selection of turbines must be done keeping in view the future extensions.

Awareness Regarding Input Source, i.e. Coal, Gas, Electricity and Liquid Fuel

The coal should be tested for its calorific value and amount of sulphur and moisture should be known before its use. The feed rate should also be adjusted after calculating the output of the boiler and optimized coal consumption. Wet scrubbers should be used to reduce fly ash. The engines should be mechanically maintained after regular prescribed intervals. The measurement of steam output is also vital; therefore flow meters should be installed.

Utilization of Exhausts of Boiler, Engine and Oil Heaters

For the sake of waste heat recovery, boilers and water heaters should be installed to save the resources and reduce the cost of production.

Wet Processing

Waste reduction at source

The impact of dyes and chemicals used in the wet processing industry can only be reduced by decreasing the amounts of release for treatment. In the conventional treatments, the wastewater is changed to solid waste, which then has to be buried in the landfill. The problems like groundwater contamination and odours are associated with it, which implies that wastewater treatment is not waste cure. With the increased awareness about environmental sustainability, the buyer is demanding more sophisticated waste treatments which results in an increase in the cost of production. The solution of this problem is waste reduction at the source. This mind shift is necessary to reduce pollution before treatment or recycling. The technological changes, modifications of the processes (depending upon the raw material and quality of product etc.) and substitution of chemicals can reduce the pollution load, which can make the treatment easy and less costly.

Improved dyes and chemicals are:

- Dyes with optimized degrees of fixation.

- Eco toxicologically (having reduced impact on the environment) best dyes, auxiliaries, chemicals and recipes for the individual application; if feasible without inherent technical and economical disadvantages.
- C₆ chemistry instead of C₈ of poly-fluorinated carbons (used for oil water repellent finishing).
- Non-formaldehyde/zero formaldehyde cross-linker for finish fixation.

New/improved dyeing processes:

- Dyeing at low liquor ratio
- Optimized after soaping and rinsing processes
- Combination of preparation/dyeing and finishing in one bath
- Pre treatment for better dyestuff fixation
- Substitution of ecologically problematic processes

Dyeing systems free of water (using CO₂)

Opportunities for textile manufacturers in future can be achieved through:

- A consistent combination of productivity, cost, quality, labour and environmental protection.
- Innovative products and processes.
- Continuous improvement of quality of processes and products.
- Constant search for ways to save water, chemical substances and energy which results in continual improvement in resource efficiency.
- Regular review and reduction of emissions into the atmosphere, along with wastewater and refuse which will enable to achieve continuous improvement of sustainable production.

Chemicals Use

Categorization of Chemicals Used in the Textile and Leather Sectors

The use of chemicals in the textile (especially wet processing) and leather industries is very extensive. One of the major causes is the lack of awareness about the sustainability and the nature of chemicals used. The chemicals are being sold on trade names and exact formulation of the chemical substances is a global trade secret. In this scenario, more specific actions cannot be implemented successfully. However, general classification/categorization of chemical substances used in the textile and leather industry should be carried out. For example:

- Chemicals produced by humans or nature with certain functionalities in the final product, should be mentioned as 'Functional Chemicals' – often detected in high concentrations in the product.
- Chemicals produced by humans or nature with no functionality in the final product, should be mentioned as 'Residues' from the production processes or impurities – seldom detected in high concentrations in the product.
- Chemicals that occur through unintended production by humans or nature, should be mentioned as 'Impurities' – never detected in high concentrations in products.

Prioritization of Chemicals Used in the Textile and Leather Sectors

Many substances used for manufacturing of textile products are hazardous like azo dyes or heavy metals. In-depth assessment should be conducted for extremely hazardous chemical substances based on its degree of causing hazard and quantity used/produced.

Knowledge of Chemical Reactions during Processing

There is lack of knowledge about the chemical reactions taking place during textile wet processing and leather manufacturing. The oxidization of Chrome III to Chrome VI at high temperatures and alkaline medium is an example of that. Awareness should be created about where highly hazardous substances are formed during processing. Similarly, if the pH value of the effluent wastewater from leather tannery is less than 8.0, the alkaline sulfides can be converted to H₂S and this gas will be released.

5.3 Recommended Studies

As mentioned in the recommendations, there are certain areas for improvement. Future work in these areas can bring fruitful results both in terms of environmental and economic sustainability. The following studies are suggested under the course of ILES project:

- Investigations related to the utilization of actual calorific potential of coal and other agricultural wastes used for combustion in boilers.
- Survey regarding the existing industries for textile recycling and finding the ways for their improvement and promotion.

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