

SUSTAINABLE PRACTICES IN SUPPLY CHAIN: A CASE STUDY OF YUNUS TEXTILE MILLS

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Abstract

Textile sector of Pakistan is one of the great contributors in country's economy, and also the key contributor in making the environment polluted. Textiles have lengthy and complex supply chains (SC) which have crucial role in sustainability. Energy intensive business processes, excessive use of water and hazardous chemicals, use of synthetic yarns and fibers, make it crucial to implement sustainable practices in SC of textile industries. Pakistani textile sector does not fully adopt the sustainable practices that are being used around the world and it is not immediately clear to what extent the practices used in the local industry benefit the environment. The objective of this study is the analysis of ongoing sustainable practices of Yunus Textile Mills (YTM), impact of those sustainable practices and review of international sustainable practices that can be implemented at YTM. In this research quantitative and qualitative research methods have been used along with Triple Bottom Line Approach of Sustainability. Data gathered through business publication, onsite surveys & interviews. Results obtained from the study shows that sustainable practices used by Yunus textile have positive impact on environment.

Keywords: Supply chain management, sustainability, sustainable supply chain management, sustainable sourcing, sustainable raw material, textile industry, Yunus Textile Mills

Introduction

Textile Industry is one of the largest manufacturing industries of Pakistan. It contributes about 19% to the export of Pakistan, and in terms of GDP, it contributes around 8.5%. Textile sector employs around 45% labor force of the country. Pakistan is the eighth largest textile manufacturer in Asia and third largest consumer of cotton in World. In Pakistan, there are around 500 textile industries from which, 70% are located in Punjab, 25% are in Sindh and remaining are in KPK, Baluchistan and Azad Jammu Kashmir (APTMA, 2020).

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Along with huge contribution in country's economy, textile industry is also playing a massive role in making environment polluted. Textile sector is the significant contributor in World's carbon emission with 8-10% share in World's total CO₂ emission. (Walter Leal, et.al., 2022) It is due to the complex and lengthy supply chains, Energy intensive business processes, excessive use of water and chemicals, and an increased used of synthetic yarns and fibers. In modern age, businesses have considerable social, economic and environmental pressure from all stake holders to make their processes sustainable by reducing their carbon emission.

For this, businesses are shifting from their traditional practices towards sustainable practices and textile sector is paying more attention to the long-term viability of their operations in recent years due to increased pressure from customers, investors, government, and to retain brand integrity as well as to keep operating costs low. Textile organizations i.e.; YTM, Artistic Milliners, AGI Denim and Soorty Enterprises etc. are increasingly pursuing a variety of activities aimed at enhancing their environmental and social performance and ensuring their long-term sustainability. To monitor the environmental impacts, Government of Pakistan has several legislations i.e.; Major environmental laws, rules and regulations in Pakistan (See appendix 1) and detailed National Environmental quality standards (See appendix 2) which are applied to textile industries. In addition to legislations, there are regulatory bodies to monitor the performance of textile industries i.e.; Environmental Protection Agency (EPA), District Environment Officers etc.

The aim of this study is to analyze the sustainable practices of textile industry of Pakistan. In sustainable practices, we targeted the supply chain of textile industry due to the high potential of sustainability there i.e., in raw materials, in packaging, and in cotton production. Textile industries have started practicing sustainability in supply chain i.e.; Artistic milliners is working aggressively towards production of organic cotton, garment to garment recycling and use of non-hazardous chemicals. (Artistic Milliners Annual Sustainability Report, 2023) Keeping in view the importance of sustainable supply chain in textiles, and the switch of textile industries towards sustainability, we found it fruitful to study the sustainable supply chain practices of textile industry. Many textile industries were available for this study i.e.; Artistic Milliners, Soorty enterprises, MIDAS safety, YTM etc. From the available industries, we selected YTM for study, and the reasons of selecting YTM are their on-going sustainable practices program, their complex supply chain nature, their interest towards production of organic cotton and their continuous approach to meet World's sustainability targets.

The objectives of this study are:

- (1) To explore raw material, packaging and other sustainable practices of YTM, and
- (2) To analyze the impact of sustainable practices of YTM.

YTM is one the leading exporters of home textiles in Pakistan which supplies its products to European and American markets under private labels. It is a vertically integrated company with a production capacity of 10 million meters per month. The sustainability framework of YTM is based on Triple Bottom Line (TBL) strategy, which is to serve

People, Planet and Profit. YTM has established several milestones to serve 2050 carbon neutral goal which will inspire the whole value chain. YTM has attained and complies with a number of certifications to meet its customer demand such as BCI, GOT, ISO 9001 and has its own ETP and RO plants for recycling purposes. YTM is also following certain sustainable practices which aids to minimize the overall negative impact of their supply chain.

The body of this paper comprises of five sections. The paper starts with introductory section which provides a significance of study, brief introduction of textile sector of Pakistan and introduction of YTM. Section 2, which is a literature review, presents an in-depth analysis of the subject of this study. This section presents the evidence from literature in relation to the framework of this paper. The methodology section describes the pathway of how this study is carried out, including the research framework, nature of data, research approach of this study and the techniques used to collect data. Section 4 highlights the analysis and finding discussed in accordance with the literature in terms of similarities and limitations. Finally, outlines the conclusion and suggestions for future research.

Literature Review

Textile Industry

Textile is one of the world's most polluting sectors. (Boström, Magnus, and Michele Micheletti, 2016) Seventy-three percent of textiles are disposed of in landfills or incinerated, while 12 percent are lost in the manufacturing process, 14 percent are collected for recycling in lower-value applications such as mattress stuffing or insulation material, and less than 1% are used to make new textiles. (Ellen Mac Arthur Foundation, 2017)

Most textiles and clothes are made up of a combination of fibers that are difficult to separate with current technologies, resulting in non-recyclable fibers. (GFA. CEO Agenda, 2019) According to Remy et.al, the environmental footprint of the garment and clothing sector will be much bigger by 2025 —if 80 percent of the rising nation markets approach western world per capita consumption levels.(Remy, et.al. 2016)

Environmental consequences are produced at several stages of the textile product life cycle. (Zamani, Bahereh et.al, 2017) Literature identifies the use of pesticides, herbicides, and artificial fertilizers as hotspots in the raw material phase, particularly in cotton production, which involves a large amount of residual toxic and harmful substance in the soil and groundwater, as well as the use of water, which leads to water resource depletion. (Mani, Venkatesh, et.al. 2016)

Furthermore, it is becoming evident that a traditional approach to operations is unsustainable, and businesses must alter their procedures in order to comply with rules and maintain long-term viability.

Sustainable Supply Chain Management

According to Datta et.al, (Datta, Saurav, 2013) the operations of supply chain management range from the acquisition of raw materials to the delivery of completed goods, also called (forward supply chain), and (Reverse supply chain management) includes collecting old merchandise from customers. (Charkha, Pranav G. et.al. 2014) In the literature, the concept of sustainability in the context of supply chain management (SCM) has been explored using a variety of terminologies. Green supply chain management (GSCM) and sustainable supply chain management (SSCM) are the two names that most directly relate sustainability with SCM ideas. (Ashby, Alison et.al. 2014)

Sustainability as the development of products “to meet the needs of the present without compromising the ability of future generations to meet their own needs”. (Simon and David, 1987) The topic of sustainability in the sustainable supply chain has gotten a lot of attention. The process of converting raw materials into completed clothes has substantial negative environmental and social consequences, including air and water pollution and human resource exploitation, particularly when production is outsourced to nations with cheaper labor costs. (Shen, Bin, 2017)

Implementation of Sustainable Supply Chain Management in Textile Industry

Parisi et.al. have mentioned their studies that the textile manufacturing uses a lot of water and generates a lot of waste and effluent.(Parisi et.al. 2015) These effluents, if left untreated or handled poorly, can harm water bodies and aquatic ecosystems.(Dimakis, A., 2016) The textile manufacturing process necessitates a lot of thermal energy and a lot of chemicals, which results in toxic emissions and solid waste.(Hasanbeigi, Ali, Lynn Price, and Elina Lin, 2012) Researchers found a lack of understanding and training on the appropriate management of chemicals used in textile manufacturing. High energy consumption in the production of fibers, yarn, and operations such as washing and drying; consumption of water and other chemicals in the production process; solid wastes generated from carbon footprints arising from transportation in the SC.(Beton A., 2014)

Firms are responding in a variety of ways to meet the challenge of being environmentally sustainable, including working on environmentally friendly production processes or focusing on green product markets. (Alkaya, Emrah, et.al. 2014)

Packaging & Sustainability

A packaging is a product's "face", and it is frequently the only product exposure consumers get prior to purchase.(Marsh, Kenneth, and Betty Bugusu, 2007) Packaging serves two basic functions: protecting items or product parts from harm and external influences (e.g., temperature, weather, mold, transportation) and providing customers with important product information (e.g., ingredients, size, price, place of origin).(Siracusa, Valentina, and Marco D. Rosa. 2018) Product packaging, aside from these useful roles, is also a waste-generating medium. The majority, if not all, packaging components are thrown as soon as the product is purchased. As a result, packaging trash

accounts for a major portion of municipal solid waste, posing significant environmental issues. (US, EPA, 2018)

From 17 SDGs of UN, SDGs 11 (Sustainable Cities and Communities) and 12 (Responsible Consumption and Production) encourage stakeholders to implement creative waste-reduction measures in cities, communities, and the supply chain as part of the SDG agenda. As a result, foreign governments have begun enacting legislation to restrict and/or decrease packaging waste, as well as to enhance trash-reuse procedures. (Islam and Samsudin, 2020). According to Hassini et.al. a percentage of long-term company failures are caused by the absence of sustainability goals in the corporate vision. (Hassini, Elkafi, et.al. 2012)

Sustainable packaging innovation is gaining traction in the public eye, yet there is still a lack of awareness of what constitutes "sustainable packaging".(Boz, Ziyinet, et.al., 2020) According to Zhang, Guirong, and Zongjian Zhao, the phrase "sustainability" alone has over 300 definitions; so, the term "sustainable packaging" is likely to have several definitions as well.

Logistics and supply chain management are linked to the circular economy. On one hand, there is a strong correlation between packaging and logistics.(Zhang, Guirong, and Zongjian Zhao, 2012) A new concept termed 'Sustainable Packaging Logistics' (SPL) presented by García-Arca et.al.,(García-Arca et.al., 2019) has emerged in recent years to encapsulate this link between green packaging and green transportation.(Lai, Kee-hung, et.al., 2010) Indeed, the lengthening of global supply chains necessitates the usage of many packing layers across the chain.(Ranjani, K.S., 2019)

Textile packaging waste is a potential source of raw materials if the following conditions are met:

1. Implementation of a closed loop value chain.
2. Adherence to packaging waste management principles.
3. Compliance with the essential requirements regarding the manufacture and composition.
4. The reusable and recoverable character of the packaging.
5. Modelling the causes and effects of waste production based on the ability to look at packaging production.

Raw Material Sourcing

The fast rise in global awareness of ethical commitments to the environment, economy, and society has accelerated the adoption of sustainable supply chain strategies.(Akbari, Mohammadreza, et.al., 2017) However, the most significant barrier identified by fashion firms and manufacturers is a lack of sustainable sourcing sources and apparel solutions.(Lawless, Erin, and Katalin Medvedev, 2016) Sustainable Sourcing (SS) is becoming a key feature of best-practice procurement,(Christopher, Martin. 2016) with the procurement team's use of SS having a significant impact on the company's long-term viability.(Schneider, Lena, and Carl Marcus Wallenburg, 2012)

The purchasing function is especially likely to contribute to a company's long-term viability. (Tate, Wendy L., 2010) Prior researches of Cooper, et.al. and Carter Creg on sourcing have primarily focused on either (1) social (Cooper, Robert W. et.al., 2000) or (2) environmental issues(Carter, Craig R., and Joseph R. Carter. 1998). Assuring morally acceptable supplier–buyer interactions, creating codes of conduct, limiting child labor and addressing minority-owned suppliers are among topics covered in social aspects of sourcing research. (Krause, Daniel R., and Gary L. Ragatz. 1999)

Environmental sourcing research began with a focus on purchasing's responsibility to facilitate recycling, reuse, and resource reduction,(Krause, Daniel R., 1999) and later expanded to include strategic topics such as new product development and strategic risk minimization.(Bowen, FE, et.al., 2002)

The application of the stakeholder concept to purchasing department activities builds on previous research in two ways: first, because stakeholder influence is an important driver for implementing sustainability on a corporate level, (Brown, Tom J. et.al. 2006) it is reasonable to assume that stakeholders are also relevant on a functional level. Second, the buying department used to be known for its "unique contact with a diverse group of stakeholders, including customers, suppliers, contractors, the community, and internal workers in most of the company's other functional areas". (Carter, Craig R., and Marianne M. Jennings, 2004)

Environmental Policies for Textile Industries

Sustainability is the need of time and organizations are switching towards sustainable practices to keep the environment livable. The unsustainable practices resulted in increase in world's temperature, increased in pollution and increased threat to marine life, and much more. To overcome this, rules and regulations are made for every industry in world. In Pakistan, for textile industries Government of Pakistan has several legislations i.e.; Six major environmental legislations (See Appendix 1) and detailed National Environmental quality standards (See Appendix 2) and Pakistan Environmental protection Act (PEPA 1997 & 2000) also available for the monitoring, protection and improvement of environment. In addition to this, Textile industries are also bound to follow NEQS 2001 (See Appendix 3)

Research Gap

To conduct the research on sustainable supply chain practices in textile business of Pakistan, we studied broader range of Literature covering textile operations, sustainability, supply chain, and sustainable supply chain, and found that substantial work has been done in sustainable practices of textile businesses. There is scope available to study the sustainable supply chain practices of textile firms and also to find the impact of sustainable practices on environmental, financial and social performance of textile businesses. Considering it, we aimed to study the sustainable supply chain practices of YTM.

Methodology

Research Framework

The approach used for this study is the Triple Bottom Line (TBL) approach. TBL is a three-dimensional paradigm that considers social, environmental, and financial performance. It is different from other approaches as it considers environmental and social metrics into account as well. In TPL approach, three Ps are used which are, People, Planet and Profit. TBL is the approach used to measure sustainability considering the financial, social and environmental aspects of steps taken in sustainable domain. Besides TBL, it is difficult to monitor the impact of sustainable practices on all three aspects called 3Ps.

Research framework used in this study is Hybrid model which contains both qualitative and quantitative analysis.

In qualitative analysis, semi structured and short interviews, on site surveys and guided discussions were conducted. YTM has many production and processing floors, each of which is supervised by single individual. Semi structured interviews were conducted by five supervisors, one supply chain manager and an assistant manager compliance (making it a sample size of seven people). Along with interviews, onsite surveys were conducted to understand the operations and sustainable practices. The onsite surveys were conducted for three weeks to obtain significant knowledge to support the study. The third method used to collect qualitative data was the guided discussions with manager supply chain and an assistant manager compliance. Interviews, surveys and guided discussions also helped in quantitative analysis along with qualitative analysis.

For quantitative analysis, primary and secondary data were also collected. Primary data was collected from the interviews conducted with supervisors, manager supply chain and assistant manager compliance (as stated above) and secondary data was collected from YTM quarterly published reports.

Thematic and impact analysis were performed on the responses of interviews, guided discussions and onsite surveys. In addition to this, data from business publications were used to analyze the impact of YTM sustainable practices.

Analysis & Discussion

Qualitative Analysis

Thematic analysis was performed on the responses of interviews, on the basis of onsite surveys and on the context of guided discussions. The interviews and guided discussions were designed to collect data about sustainable practices in supply chain, which helped to identify the common themes of sustainability in YTM. All the themes are discussed below.

Sustainable Raw Material

For a sustainable supply chain, sustainable raw materials play an important role. From responses and interviews at YTM, it was found that they are working on sustainable sourcing and also taking steps to sustain their upstream supply chain. Cotton is a key raw material for textile production and organic cotton is one of the major components of producing sustainable products in textile. They are promoting manufacturing with organic cotton and sustainable raw materials like Tencel, Bamboo, Hemp, Flax and Silk fibers. These are eco-friendly fibers and do not require any pesticides or chemicals to grow. Eco clothes are long lasting and high quality, due to which people need less clothes, means less raw materials and less energy is required. (S.Kavitha et.al. 2015)

YTM also made an agreement with OceanSafe – Switzerland in 2021 to focus on the development and production of circular and toxin free raw material from ocean plastic. Raw material produced from this collaboration is focusing on production with zero carbon emission. In result of this agreement, YTM started production of sustainable products, and in Nov 2022 YTM was awarded GOLD cradle to cradle certificate.(YTM & OceanSafe, 2021) The Home Textiles produced by YTM are biodegradable and are available in a variety of styles, sizes and colors. Products are made natural fibers, such as cotton or man-made cellulosic fibers, or from a combination thereof.

Supplier Management

Conscious customers demand YTM to source material from suppliers which follows sustainable practices. Also, they ensure that suppliers of Yunus Textile Mills are aware of the environmental concerns and follow sustainable practices through audits and evaluations. Hence, Yunus Textile Mills has a strict criterion of management of the supplier base. They are required to produce raw materials which are environment friendly and does not involve use of toxic chemicals. YTM launched a supplier development program to evaluate and enlighten them about their production patterns, recycling of water during production and waste generation. Suppliers who lack awareness and does not fulfill the criteria are guided with different trainings about environmental concerns and sustainable production of raw material. According to our findings, sustainable sourcing for YTM ultimately means that managing of supplier base to improve the performance of triple bottom line referring to people, planet and profits.

Sustainable Packaging

Since packaging plays an important role in representing sustainability of a product, YTM is also working on this aspect. During interview with personnel from sustainability department, it was found that company is focusing on eliminating plastic packaging by corrugated cartons and recycled plastics. Plastic pouches made from recycled plastics are being used to promote sustainability and cradle to cradle concept. Packaging also displays various certifications and labels which ensures the sustainability and traceability of product as well as the company. To show their concern regarding environment, YTM also registered for many eco-labels i.e.; EU Ecolabel, OKEO-TEX, Global Recycled standards, Organic 100 content standard etc., to promote the concept of green packaging.

Recycling

Recycling is an important component in promoting the concept of sustainability. YTM focus on the adoption of circular economy. During questionnaire fulfillment and interviews, it is found that following cradle-to-cradle concept, company is focusing on using recycled plastics in production as well collecting the used products to recycle it so that no product of YTM ends up in landfills. During research it was found that company has installed a treatment plant to recycle water which has saved 242-million-gallon water till now. Company is also working on de-carbonization to reduce the impact of greenhouse gases and carbon footprint. Ocean Safe agreement focuses on the recycling of ocean plastic to fiber which serves as an important environmental activity. The recycled material is used in production of raw material, accessories and packaging material of YTM.

Chemical Management

Chemicals are used in various processes of textile production for instance, bleaching, dyeing, printing and washing. YTM is focusing on eliminating the hazardous chemicals in dying process and moving the chain towards digital printing. They treat chemicals after processing and separate the hazardous substance and dump it in environmentally friendly ways. YTM successfully recycles textile wastewater using a membrane bioreactor (ultrafiltration) followed by reverse osmosis (RO). This textile wastewater recycling plant is the first of its kind in Pakistan and is an important benchmark for all future developments in textile wastewater treatment (WWT). In the past ten years, YTM is adopting production practices which involves processing with sustainable chemicals and not with harmful and hazardous chemicals.

Quantitative Analysis

Quantitative data gathered from the interviews, guided discussion with YTM team members and YTM business publications. From quantitative analysis, we have compared the YTM performance before and after implementation of sustainable practices.

Raw Material Management

Cotton is key raw material of textiles, for which YTM started organic production and adaptation of natural fibers as discussed in qualitative section. After cotton, fiber is second most important raw material used in spinning. YTM has achieved great result in utilization of fiber in fabric production after adopting sustainable material handling practices. YTM was producing 2400 pieces (4000 kg) of fabric from fiber before implementation of sustainable material handling practices, and after implementation number increased to 6500 pieces (10000 KG).

Packaging & Waste Management

YTM focuses on the usage of recycled bio-degradable plastic bags and corrugated cartons which are more environment friendly than the traditional plastic packaging which are dumped in landfills.

From our study, we analyzed that 1kg of new cardboard requires approximately; 3kg of wood, 350 liters of water, between 7 and 14 kWh of electricity. When using recycled materials, water consumption can be reduced by 50%, and energy use by 25%. In landfill, cardboard takes between 2 and 12 months to decompose whereas, plastic takes between 400 and 1000 years to decompose.

Table - 1

Components	Plastic	Cardboard		Plastic	Cardboard
Wood/Petroleum	2	3	After recycling	2	3
Water	180	350		180	175
Power / Electricity	32	14		4	3.5

Conclusion

It is critical to implement sustainable practices in supply chain of textiles, because textile is considered as one of the most polluting sectors in the world. Considering this, YTM is working effectively towards implementation of sustainable practices in their supply and value chain.

From qualitative analysis it is clear that YTM is using sustainable practices in their supply chain and they are working in direction to be more sustainable i.e.; procurement of sustainable packaging material, production of organic cotton, using non-hazardous chemicals, lesser disposal of waste water and procuring material from sustainable suppliers.

From quantitative analysis it is clear that YTM is using recycled plastic and paper for packaging, which has a positive impact on consumption of water, energy and use of wood. In addition to this, implementation of sustainable material handling practices has resulted in increased production of fabric from fiber in spinning process.

After analysis of quantitative and qualitative data, it is evident that YTM is adopting sustainable supply chain practices which are positively impacting their financial, environmental and social performance.

Suggestions for further research

This study was conducted on one of the leading textile mills of Pakistan “Yunus Textile Mills”. From study, it is found that YTM is using sustainable practices in their supply chain which are positively impacting their financial, environmental and social performance. Since YTM has vertically integrated supply chain, so practices adopted by YTM are also favorable for other textile industries because of similar processes in textile supply chain and production. In future, research can be done on other textile industries

and results of this research can be used for recommendation. In addition, results of this research, and practices of YTM can be presented as an example to other industries as well.

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Appendix 1: Major Environmental Laws, Rules and Regulations in Pakistan

Environmental Law & Major Provisions for Environmental Monitoring and Reporting	Section/Sub-Section No./Clause No.	Explanation
Pakistan Environmental Protection Act (PEPA) 1997		An Act to provide for the protection, conservation, rehabilitation and improvement of environment, prevention and control of pollution, and promotion of sustainable development.
NEQS, Self-Monitoring and Reporting Rules (2001)		Under “Self-Monitoring and Reporting System” industry will voluntarily provide their levels of pollution to EPAs on regular basis in which NEQS-Self Monitoring and Reporting Rules-01 for classification, priority parameters both for liquid & gaseous emissions and environmental monitoring & reporting format are given.
PEPAs, Sampling Rules (2001)	Section (7) of PEPA-1997(clauses “h” and “i”)	An authorized person taking samples shall divide the sample into three portions in the presence of person from whom the sample is taken and take samples of any materials, products, articles or substances or of the effluents, wastes or air pollutants being discharged or emitted or of air, water or land in the vicinity of the discharge or emission/arrange for test and analyses of the samples at a certified laboratory.
PEPAs, Pollution Charges and Collection Rules (2001) -	Sub-section (2) of Section 11 of the PEPA Act-1997	“Pollution Charge” means the pollution charge payable, collection of which should be done through industrial associations and Chambers of Commerce and Industry (see Pollution Charge-Calculation Rules-01).
NEQS, Certification of Environmental Laboratories, Regulations (2000) –	Section-6, Sub-section (2), and Clause (e) of PEPA Act- 1997	Functions of the federal agency, establish and maintain laboratories to help in the performance of its functions under this Act and to conduct research in various aspects of the environment and provide or arrange necessary assistance for establishment of similar laboratories in the private sector.

PEPAs, Initial Environmental Examination (IEE) Regulations (2000) -		These regulations may be called the Pakistan Environmental Protection Agency Review of IEE-”initial environmental examination” means a preliminary environmental review of the reasonably foreseeable qualitative and quantitative impacts on the environment of a proposed project to determine whether it is likely to cause an adverse environmental effect for requiring preparation of an environmental impact assessment,
PEPAs, Environmental Impact Assessment (EIA), Regulations (2000) -		EIA-”environmental impact assessment” means an environmental study comprising collection of data, prediction of qualitative and quantitative impacts, comparison of alternatives, evaluation of preventive, mitigatory and compensatory measures, formulation of environmental management and training plans and monitoring arrangements, and framing of recommendations and such other components as may be prescribed.
Environmental Tribunal Rules (1999)-	Section 20, Sub-section (1) of PEPA Act-1997	”Environmental Tribunal” means the Environmental Tribunal constituted under the Act i.e. The Federal Government may by notification in the official gazette, establish as many Environmental Tribunals as it considers necessary and, where it establishes more than one Environmental Tribunal it shall specify territorial limits within which, or the class of cases in respect of which each one of them shall exercise jurisdiction under this Act.

Appendix 2: National Environmental Quality Standards for Municipal and Liquid Industrial Effluents (mg/l, unless otherwise defined)

Parameter	Existing Standards	Revised Standards		
		Into Inland Waters	Into Sewage Treatment (5)	Into Sea (6) Waters
Temperature or Temperature Increase*	40°C	≤30°C	≤30°C	≤30°C
pH value	6-10	6-9	6-9	6-9
Biochemical Oxygen Demand (BOD) ₅ at 20°C(1)	80	80	250	80
Chemical Oxygen Demand (COD) (1)	150	150	400	400
Total suspended solids (TSS)	150	200	400	200
Total dissolved solids (TDS)	3,500	3,500	3,500	3,500
Chloride (Cl ⁻)	1,000	1,000	1,000	SC
Sulphide (S ²⁻)	1.0	1.0	1.0	1.0
Ammonia (NH ₃)	40	40	40	40
Cadmium (4)	0.1	0.1	0.1	0.1
Chromium (trivalent and hexavalent) (4)	1.0	1.0	1.0	1.0
Copper (4)	1.0	1.0	1.0	1.0
Nickel (4)	1.0	1.0	1.0	1.0
Arsenic (4)	1.0	1.0	1.0	1.0
Chlorine	1.0	1.0	1.0	1.0

Appendix 3: Details of Calculation of Pollution Charge for Liquid Effluents

Determination of Pollution Level

The pollution level in a production unit shall be measured once a year. The measurement shall be carried out jointly in the presence of at least one representative each from the production unit and the concerned EPA. Interested NGOs shall be allowed to accompany EPAs on such visits to ensure transparency and neutrality in the process. The production of the unit during the determination period shall also be recorded to ensure that normal operational conditions of the unit prevail. Alternatively, pollution charge may also be figured out on the basis of self-monitoring reports submitted under NEQS (Self-Monitoring and Reporting by Industry) Rules, 2001, in mutual agreement with the concerned EPA.

Calculation Procedure

1. The effluent flow of a production unit shall be measured for a limited period, ranging from a minimum of a day to about a week, under normal operating conditions.
2. During this period, effluent samples shall be taken at regular intervals, ranging from once an hour to once in eight hours and the concentration of pollutant parameters of concern shall be established through laboratory analysis.
3. Net quantity of pollutant being discharged (in kg) shall be calculated by dividing the net quantity of pollutant being discharged by the amount defined as one pollution unit for the parameter under consideration.
4. Number of pollution units for each parameter shall be calculated by dividing the net quantity of pollutant being discharged by the amount defined as one pollution unit for the parameter under consideration.
5. The number of pollution units per unit of production shall be calculated by dividing the number of pollution units with production in the period during which tests were carried out.
6. Number of pollution units shall be calculated on the basis of production in the period for which pollution charges are to be paid.
7. The amount to be paid, as pollution charge shall be calculated by multiplying the chargeable pollution units with the applicable rate for a pollution unit for the year.

Schedule for payment of pollution charge

Pollution charge shall be payable on a biannual basis, calculated according to the established discharge rate per unit of production, and the actual production of the unit in the preceding six months.

Calculation of Pollution Charge in USD (Example):

NEQS Parameters.		Recorded.	Effluent levels.
COD.	150 mg/l	5200	mg/l
TSS	150 mg/l	500	mg/l

Annual Operating Day.	160 Days.	
Product Rate	6,000 Tons	
Effluent flow rate	5,300 m ³ /day or 848,000 m ³ /year	Chargeable

Actual Pollution Level.		Annual Pollution Load.	Net Chargeable Units.
COD	5,200 mg/l	4,282,400 kg	85,648
TSS	500 mg/l	296,800 kg	5,936
Total Units Chargeable.	91,584 Units		

Base Rate per Unit.	*1 USD./Unit (For example)		
Total Pollution Charge	Year 1	Year 2	Year 3
USD/year	18,316.80	36,633.60	54,950.40

Considering “100 PKR is used as base rate per unit” as an example for calculating Pollution charge given in “The Pollution Charge for Industry (Calculation and Collection) Rules, 2001”. All figures here are in USD for better understanding, where (1USD=100.01PKR), Conversion Rate (for converting PKR into USD) = 0.009999 as calculated on 13 Jul 2013 from www.exchange-rates.org