



# Textile Sector

## Brief Situation Analysis Report

*Eco-Innovation for Sustainable Industrial Growth of Major Industrial Sectors in Special Economic Zones (SEZs) Under CPEC-75*

(A Project funded by Higher Education Commission, HEC)

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**May 2023**

### Context to the study

- Status of Eco-Innovation in Textile Sector.
- Drivers of Eco-Innovation
- Identification of Eco-Innovation options



### Summary of findings

- (1) Feasible eco-innovation options are identified and listed in the current report.
- (2) Textile industries are heavily export oriented (37%) and continually invest in R&D.
- (3) Absence of collaboration between organizations and research institutions is a major reason behind lack of development and adaption of eco-innovation in the textile sector.
- (4) A large segment of textile units is engaged in organizational eco-innovation and process technology, and most innovations are adopted rather than created.
- (5) A large fraction of textile industries in Pakistan are unconcerned with environmental regulations, even though they engage in environmental operations to satisfy customer demands.

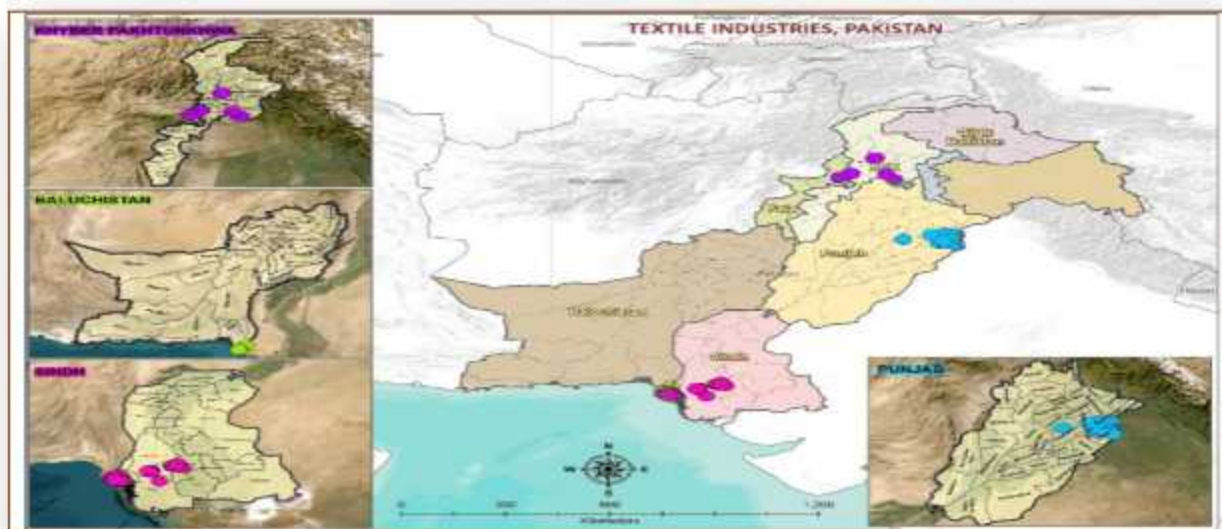
## Introduction

The textile industry is Pakistan's largest industrial sector in terms of exports and jobs. Almost 19 million people, or roughly 40% of the workforce, are employed in the industry, accounting for 46% of the nation's manufacturing sector and 8.5% of GDP. Much work goes into the transformation process, which starts with fibers and yarn and ends with fabrics that go through many steps, resulting in various distinct goods. In addition to technological advancements in recent years, advances in the textile industry have significantly contributed to the rise in environmental problems. The textile industry's primary environmental impact can be seen in the enormous chemical loads released afterward. High water and chemical use, energy use, air pollution, solid waste generation, and odor production are crucial factors. Innovation is essential for the textile sector and other sectors of the economy (1). Present-day and long-term innovation are now considered as primarily driven by sustainability (2).

Eco-innovation is an approach that aims to reduce environmental pollution and minimize resource consumption by encouraging reuse/recycled substitution of processes at organizational readjustment with maximization of production efficiency at output.

## Approach and method

A thorough industrial survey was conducted to determine the present state of the Eco-innovation approach, comprehension, and adaptation in the current textile sector. A total of 300 industries were contacted, and 43 industries responded. Among them were 31 from large scale, ten from medium scale, and the rest from small-scale industries.



*Figure1 GIS Location Map of Textile Industries in Pakistan*



A mixed data collection method was employed:

- *Interviews* with industries managers, environmental representatives, and owners
- Focused group meetings (*FGM*) and
- Questionnaire survey (*both online and in-person*).
- The assessment framework comprises three main elements [3] on which the questionnaire survey was designed. These key elements are given below.
  - i. *Eco-Innovation related to process technology (EP)*
  - ii. *Eco-Innovation related to Product (EPR)*
  - iii. *Eco-Innovation related to Organization (EO)*



Figure 2. FGM at USPCAS-W MUET Jamshoro

## Research Findings

### 1. State of Eco-Innovation

#### (i) Process technology innovation (EP)

New addition/modification in the process for environmental damage minimization. Six questions were asked, labelled as EP1, EP2, EP3, EP4, EP5, and EP6 (Table 1).

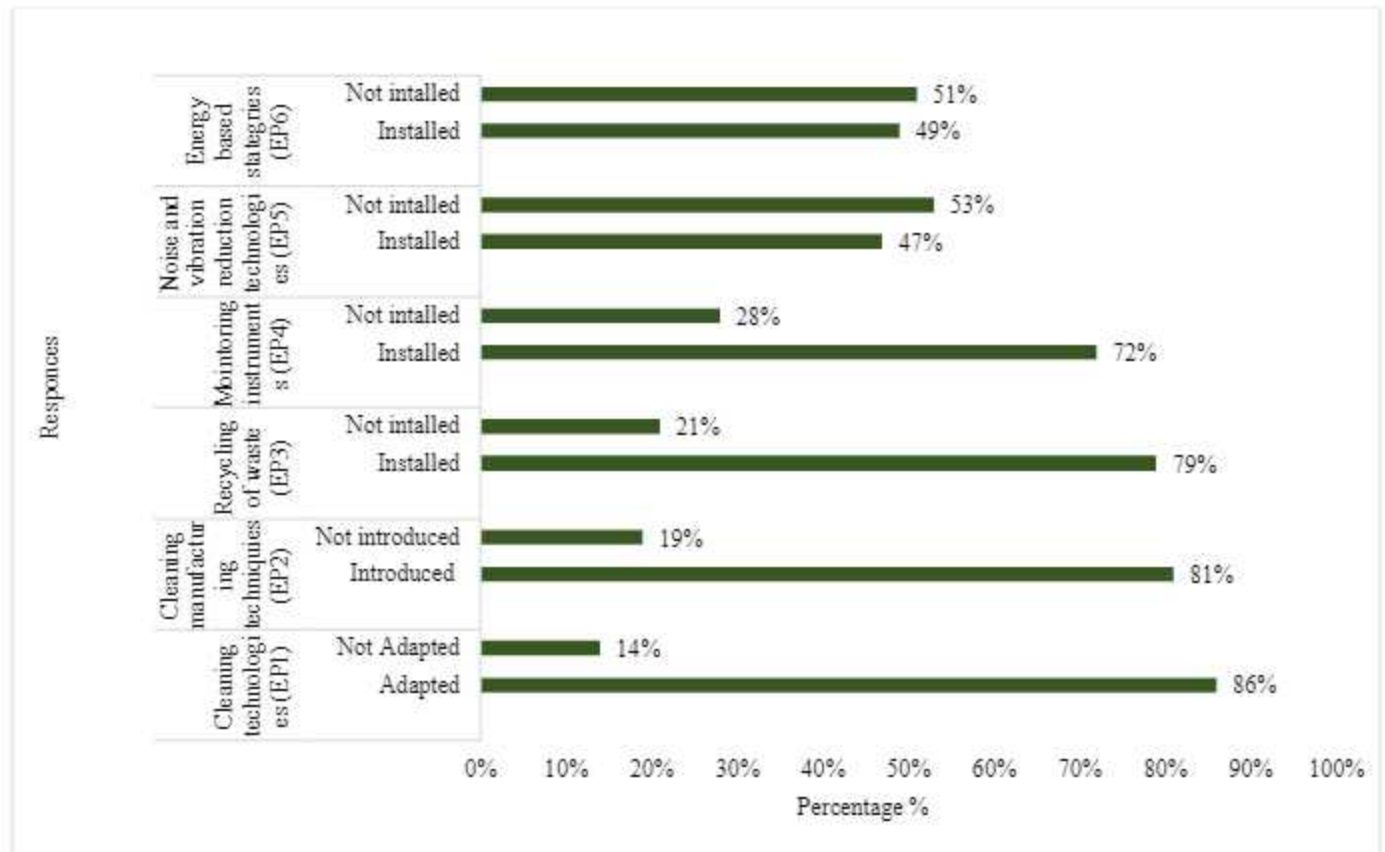
Table 1: *Quarries for ranking the process technology innovation (EP).*

<i>Process technology eco-innovation</i>	EP1: Technologies for cleaning the air, water, soil, and solid waste.
	EP2: Cleaner manufacturing techniques
	EP3: Final disposal of recycling/waste equipment
	EP4: Instruments used in the industry to monitor solid, liquid, and environmental contaminants.
	EP5: Technology for reducing noise and vibration.
	EP6: Energy-based strategies for renewal (solar or wind energy)

## Findings

- In terms of EP, Pakistan's textile industries have better process technology.
- More than 80% of the respondents' respective industries reported using cleaning technology, better business practices, and waste management technologies.
- 47% of industries reacted favourably to noise and vibration control technologies.
- 51% of industries still largely dependent on non-green energy technologies.
- A few businesses used green energy sources made of steam and methane from their trash or by-products.
- 49% of industries have shifted to using green energy technology as their primary energy source.
- According to interviews, adopting these technologies is preferable because it is more affordable and readily available.

*Fig 3. State of Process technology innovation*



## (ii) Product technology innovation

Any modification/improvement in the product design. For environmental impact reduction during the lifecycle of the product. There were three questions EPR1, EPR2, and EPR3 (Table 2).

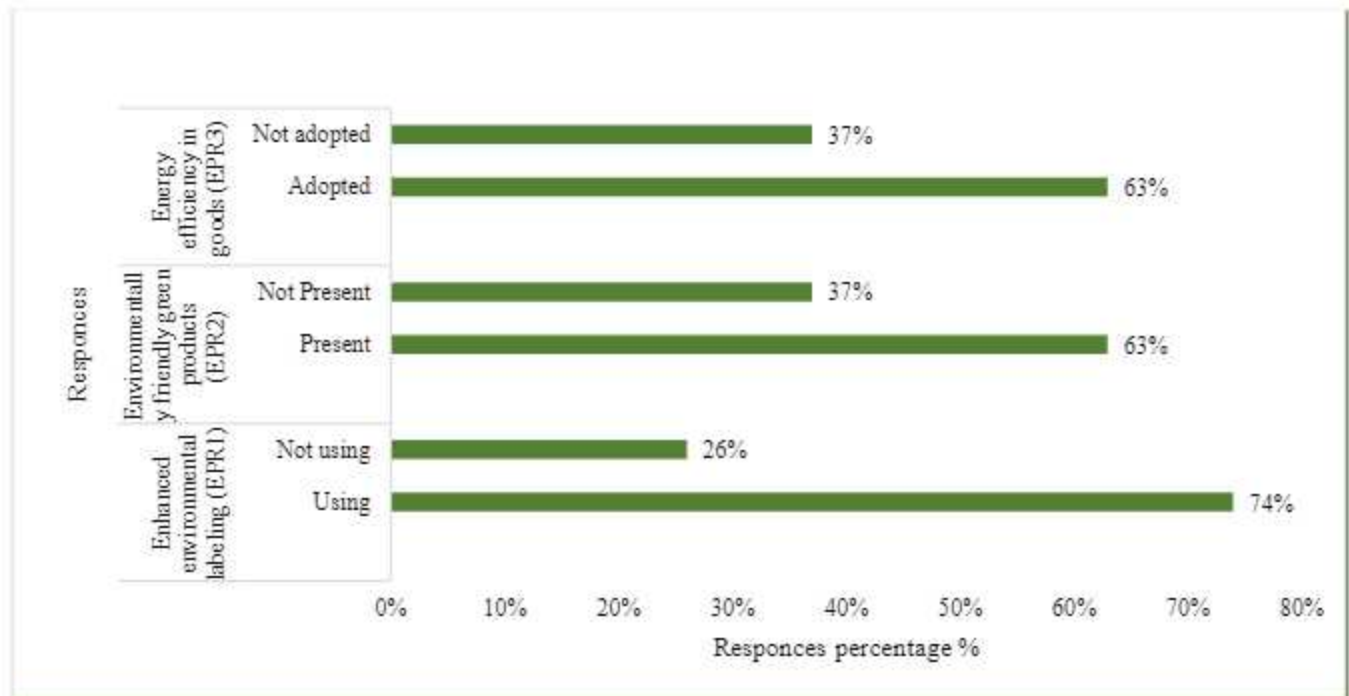
*Table 2. Quarries for ranking the product technology innovation (EPR).*

<b>Product technology eco-innovation</b>	<b>EPR1: Enhanced environmental labelling</b>
	<b>EPR2: Green products that are environmentally friendly.</b>
	<b>EPR3: Greater energy efficiency in goods and services</b>

### Findings:

- According to data, a company's R&D budget is primarily spent on product eco-innovation rather than process or organizational eco-innovation.
- More than 80% of the industries represented in this survey are export oriented.
- 74% of industries introduced energy-lower-emission products.
- While 63% introduced energy-efficient products

*Fig 4. State of product eco-innovation (EPR)*





### (iii) Organizational Eco-innovation

Organizational management system and coordination. Three questions were asked (i.e., EO1, EO2 & EO3). The description of questions is given in table 3.

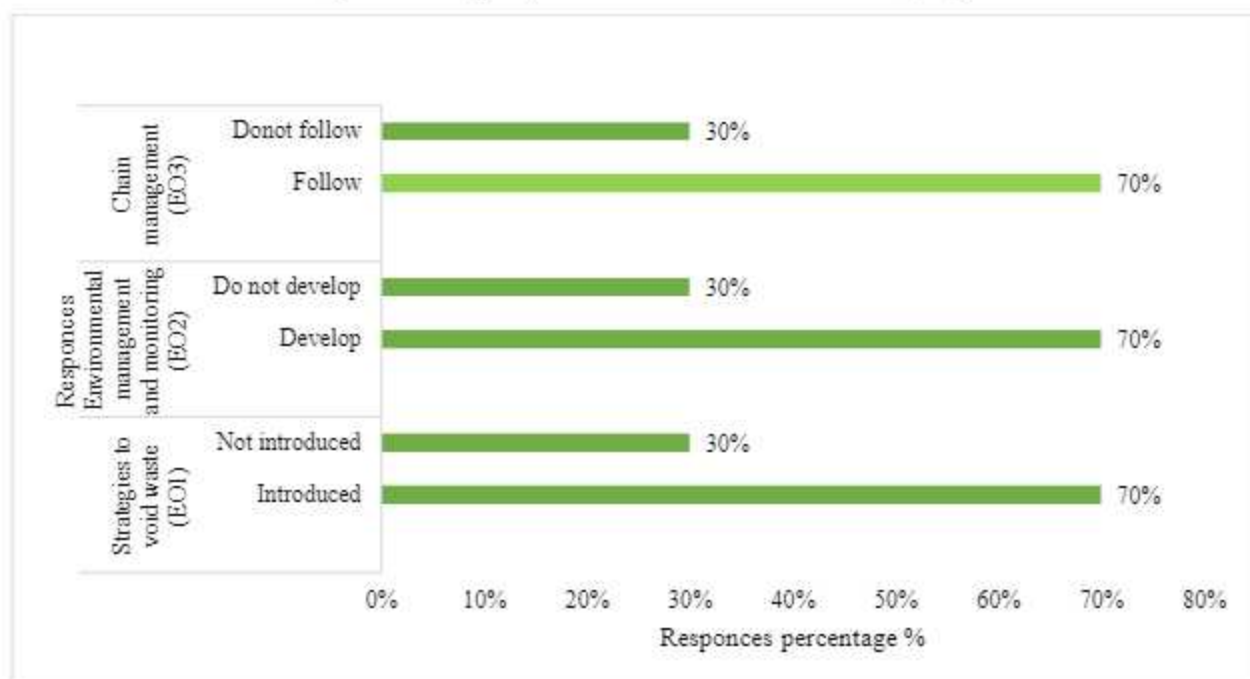
*Table 3. Quarries for ranking the product technology innovation (EO)*

<b>Organizational eco-innovation</b>	<b>EO1:</b> Avoid waste-producing management strategies.
	<b>EO2:</b> System for structured environmental management and monitoring (ISO 14001, EMAS, etc.)
	<b>EO3:</b> Chain management

### Findings:

- According to the industries, organizational innovation is essential to improving environmental performance.
- Environmental management and pollution prevention systems let industries combine all their efforts, assets, and skills to address environmental issues.
- According to the findings, 70% of businesses implemented pollution prevention plans.
- In addition to formal environmental management systems and pollution prevention/reduction plans, businesses are seriously pursuing chain management to decrease their carbon footprint further.
- 70% of the sectors have implemented formal environmental management systems, pollution prevention/reduction initiatives, and company collaboration.

*Fig 5. State of organizational eco-innovation (EO)*



## 2. Drivers of Eco-Innovation

The survey investigated the elements that influence eco-innovation and found both internal and external ones. These forces include the availability of resources, technological aptitude, ethical responsibility, buyer pressure, international standards, and local laws. The study covered six aspects of the factors that drive eco-innovation.

### (i) Environmental regulation

By establishing criteria and objectives for decreasing environmental impact and motivating businesses to create new technologies and methods to achieve those goals, environmental regulation can operate as a catalyst for eco-innovation. The survey included numerous aspects of environmental legislation as a catalyst for eco-innovation (Table 4).

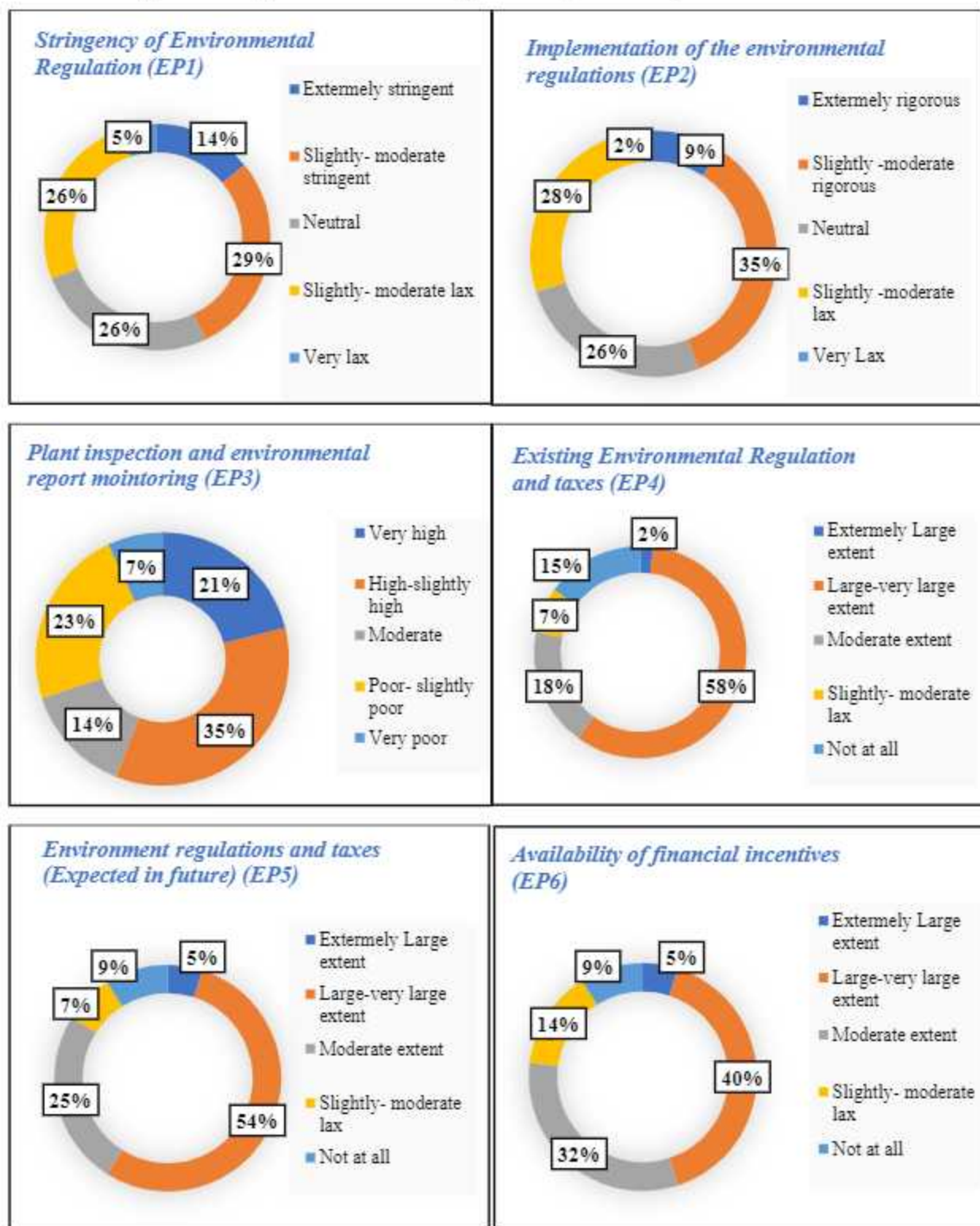
*Table 4. Quarries for ranking environmental regulations in industries (ER)*

<b>Environmental Regulations (ER)</b>	<b>ER1:</b> Stringency of the environmental regulations
	<b>ER2:</b> Environmental regulations implementation
	<b>ER3:</b> Level of monitoring by the regulatory authority through audits and reporting
	<b>ER4:</b> Environmental benefits in response to existing environmental regulations or taxes on pollution
	<b>ER5:</b> Environmental benefits in response to the environmental laws or taxes to be imposed in the future
	<b>ER6:</b> Availability of government grants, subsidies, or other financial incentives

### Findings:

- **ER1:** About 29% responded think that environmental regulations are relaxed. 26% remain neutral. The reason of being neutral is, perhaps, reluctance due to 'unknown' fear from monitoring authority and 5% of them expressed that the environmental regulations are extremely stringent.
- **ER2:** Majority of industries (35%) think that implementation of environmental regulations is moderate rigorous.
- **ER3:** About 35% industries responded that level of monitoring by the regulatory authority through audits and reporting is high.
- **ER4:** 58% of respondents think that organizations do innovation in response to environmental regulation and taxes are to a very large extent.
- **ER5:** About 25% believe that industries generate innovation to a moderate extent in response to environmental regulation expected to be introduced in the future. While 54% responded that the industry does innovation to a large extent.
- **ER6:** In response to the availability of government grants or any other financial incentives provided around 9% of respondents believe that industry introduces no innovation. However, 40% of respondents have an opinion to large extent.

*Fig 6. Status of environmental regulations (ER1-ER6) in textile industries*





## (ii) Organization Efforts

Through policies, procedures, and investments in the development of eco-friendly practises and products, organisations can promote eco-innovation and reduce their environmental impact by giving sustainability and environmental stewardship a high priority. Table 5, describe the questions that were asked during survey.

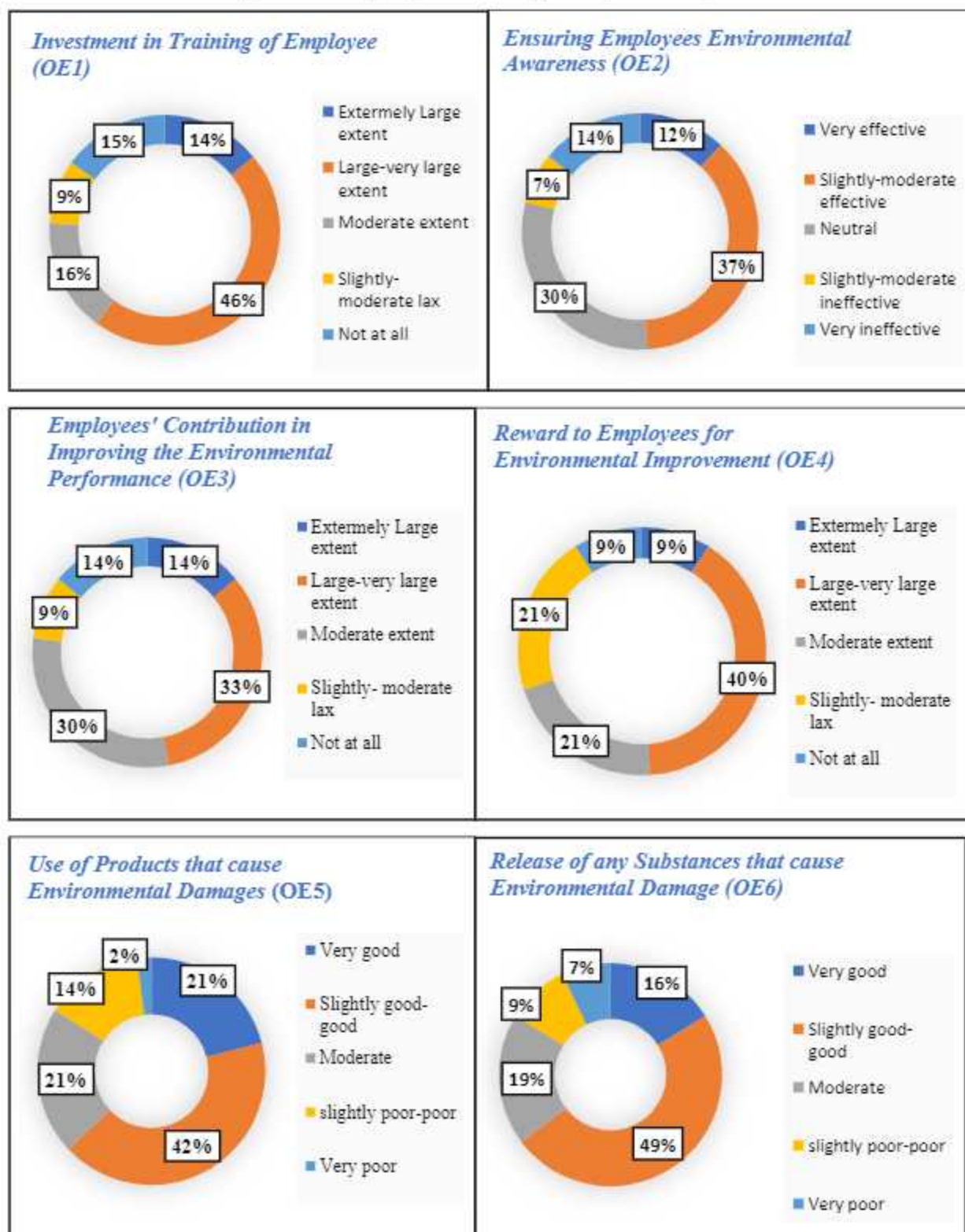
*Table 5. Qurries for ranking organization efforts (OE1-OE7) in industries*

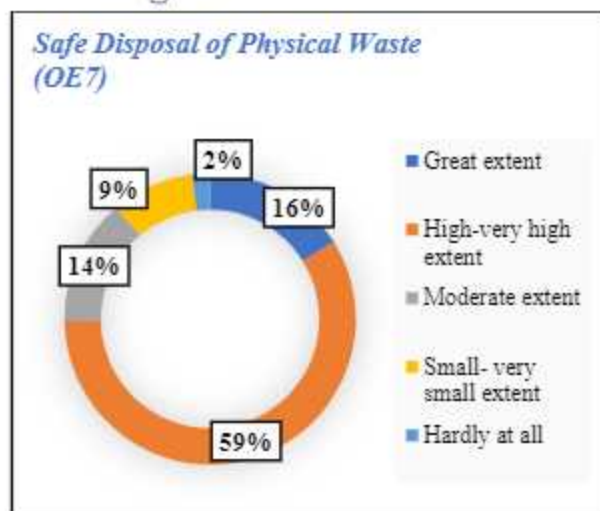
<b>Organizational Efforts (EO)</b>	<b>OE1:</b> Investment in environmental training and employee development.
	<b>OE2:</b> Efforts in ensuring employees' environmental awareness.
	<b>OE3:</b> Efforts to assess the role of employees in improving environmental performance.
	<b>OE4:</b> Reward (i.e., promotion and salary increase) to employees for environmental improvement.
	<b>OE5:</b> Efforts to eliminate the use of products that cause environmental damage.
	<b>OE6:</b> Efforts to eliminate the release of any substances that cause environmental damage.
	<b>OE7:</b> Efforts to dispose of physical waste through environmentally safe methods.

## Findings:

- **OE1:** 46% respondents said that investment in employee training is at large extent.
- **OE2:** About 12% of respondents believe that there is a very effective mechanism for ensuring employee awareness and training. 30% remained neutral in response.
- **OE3:** About 33% believe that organizations assess their employee contribution to improving environmental performance to an extremely large extent. About 14% responded that organizations made no efforts to access employee contributions.
- **OE4:** Many respondents (44%) said that there is a large mechanism for ensuring employee awareness and training.
- **OE5:** About 42% of respondents think that efforts made by organizations to eliminate the use of products that cause environmental damage are good, while 21% believe that organizations put moderate efforts.
- **OE6:** Majority of industries (49%) think that efforts made by organizations is good to reduce emissions/substances that cause environmental damage, and 19% believe that organizations put moderate efforts.
- **OE7:** Most respondents (about 59%) believe that organizations' efforts to dispose of the waste in an environmentally safe manner are to a great extent. While only 2% think that organization put no efforts.

*Fig 7. Status of organization efforts (OE1-OE7) in industries*





### (iii) Organizational Collaboration (OC)

Organizational Collaboration (OC) includes partnerships between companies in the same industry to share resources and expertise and collaborations with research institutions. Table 6 briefly describe the questions related to organizational collaboration.

*Table 6. Quarries for ranking Organizational Collaboration (OC1-OC3) in industries.*

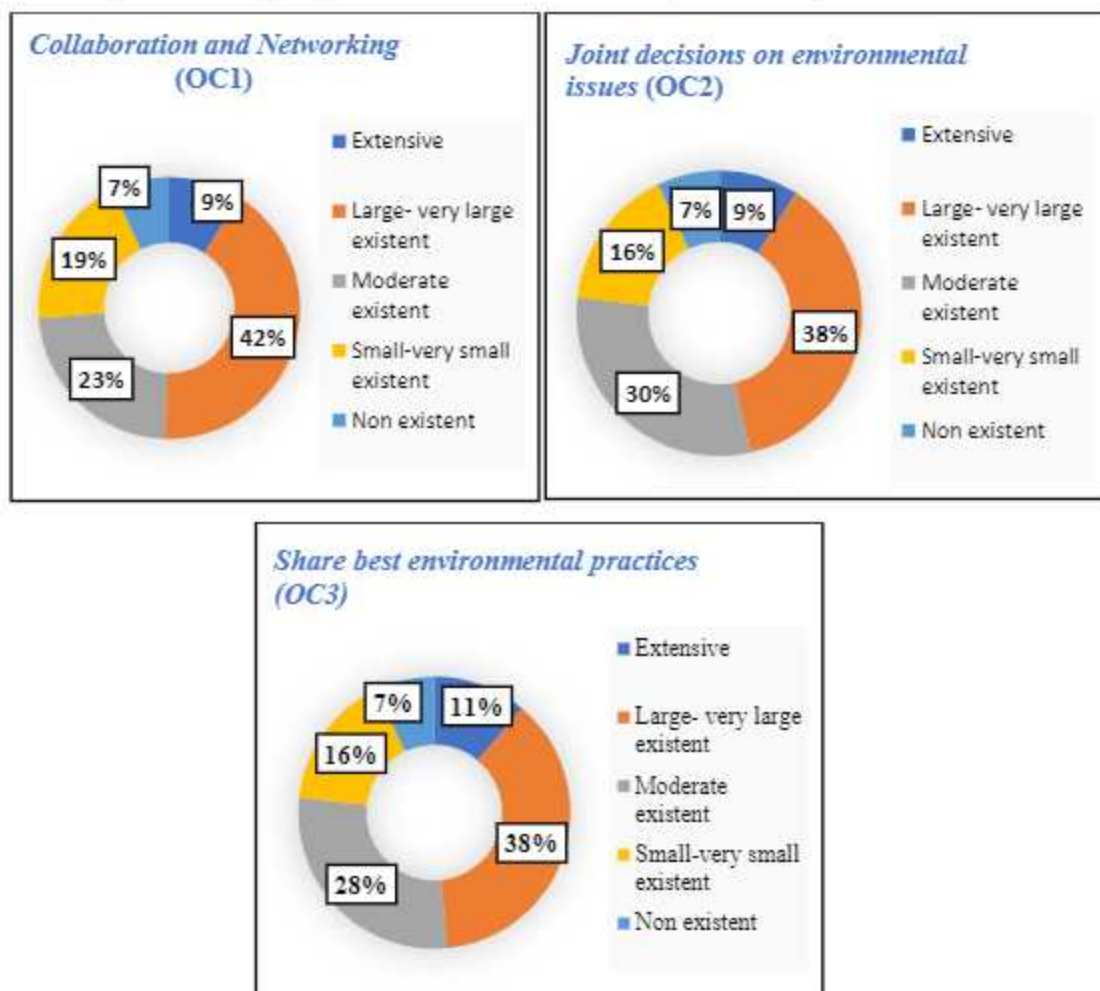
<b>Organizational Collaboration (OC)</b>	<b>OC1:</b> Knowledge/ information/ expertise related to environmental issues acquired through collaboration and networking (among groups, firms, suppliers, partners, and associations).
	<b>OC2:</b> Collaboration and networking to make joint decisions on environmental issues.
	<b>OC3:</b> Collaboration and networking to share best environmental practices

### Findings

- **OC1:** 42% respondents believe that they have a high level of partnership and networking to acquire knowledge and expertise on environmental issues. While only 7% responded that there is no existence of collaboration and networking.
- **OC2:** 38% responded that they have a higher level of collaboration and networking between industries to make joint decisions regarding environmental issues. Whereas 30% responded that they have a moderate level of collaboration and networking.
- **OC3:** 38% think that in industries, sharing information about best environmentally sustainable initiatives is at large extent.



**Fig 8. Status of organizational collaboration (OC1-OC3) in industries**



#### (iv) Environmental Management System (EMS)

An Environmental Management System (EMS) provides a framework for organizations to identify and manage their environmental impacts systematically. An EMS can also help organizations monitor and measure their environmental performance, providing valuable data that can be used to identify areas where eco-innovation is needed. Table 7 briefly describes the questions related to EMS.

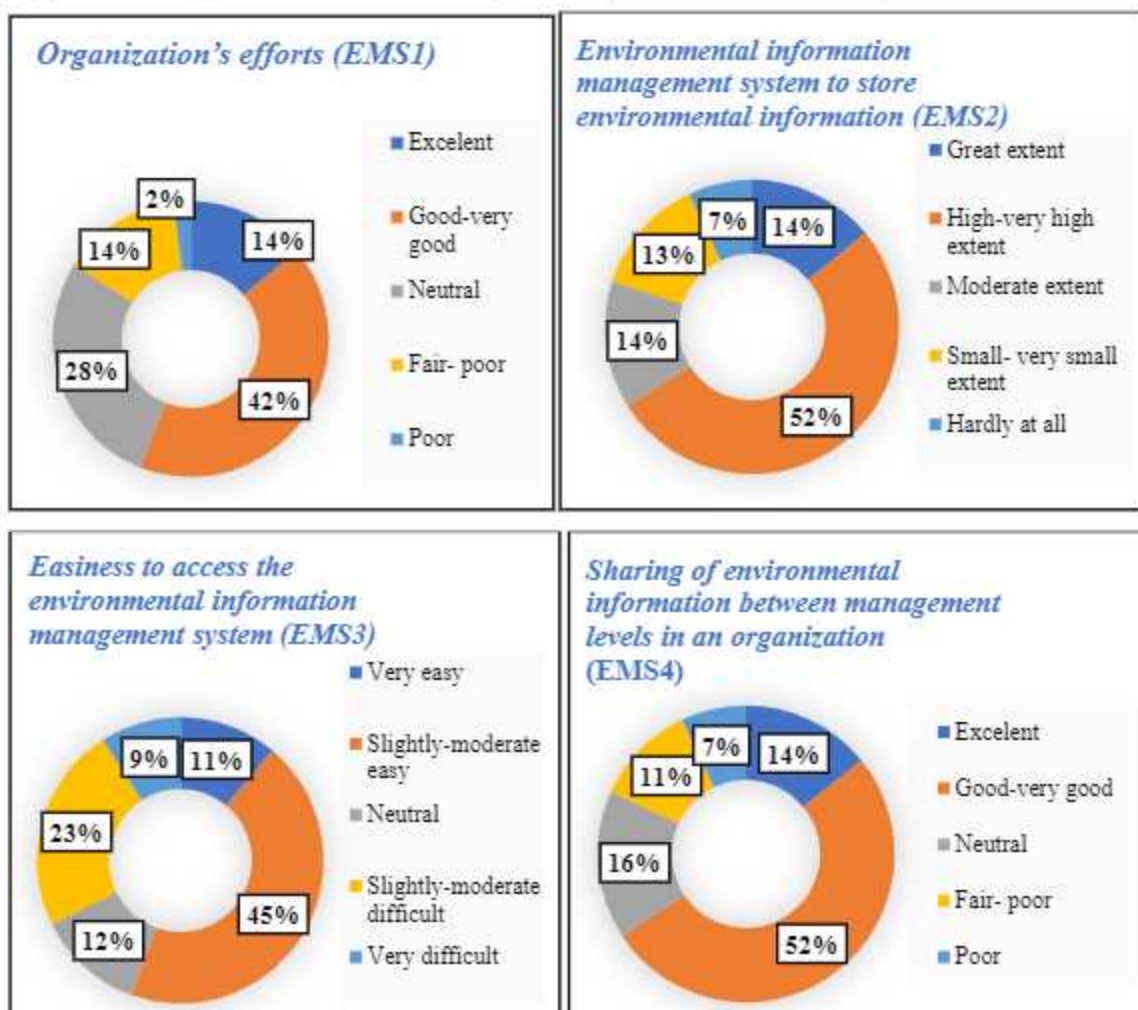
**Table 7** *Quarries for ranking Environmental Management System (EMS1-EMS4) in industries.*

<b>Environmental Management System (EMS)</b>	<b>EMS1:</b> Organization's efforts to routinely update its environmental information.
	<b>EMS2:</b> Environmental information management system to store environmental information
	<b>EMS3:</b> Easiness to access the environmental information management system.
	<b>EMS4:</b> Sharing of environmental information between management levels in an organization

## Findings:

- **EMS1:** About 42% responded that the EMS system existed at a higher level.
- **EMS2:** About 52% believe that organizations continuously update their environmental information at a high level. About 14% responded as neutral while answering this question.
- **EMS3:** 45% responded that access to environmental information management (MIS) is slightly easy to access environmental information in the industry.
- **EMS4:** 52% think the flow of environmental information between the managers within the industry is satisfactory (good to excellent) quality.

*Fig 9. Status of environmental management system (EMS1-EMS4) in industries*



#### (v) Customer's Pressure

With the increasing demand for sustainable products, industries may be motivated to invest in research and development to create new eco-friendly products and services. It can lead to the development of new technologies and manufacturing processes that are more sustainable. The questions regarding customer pressure are given in table 8.

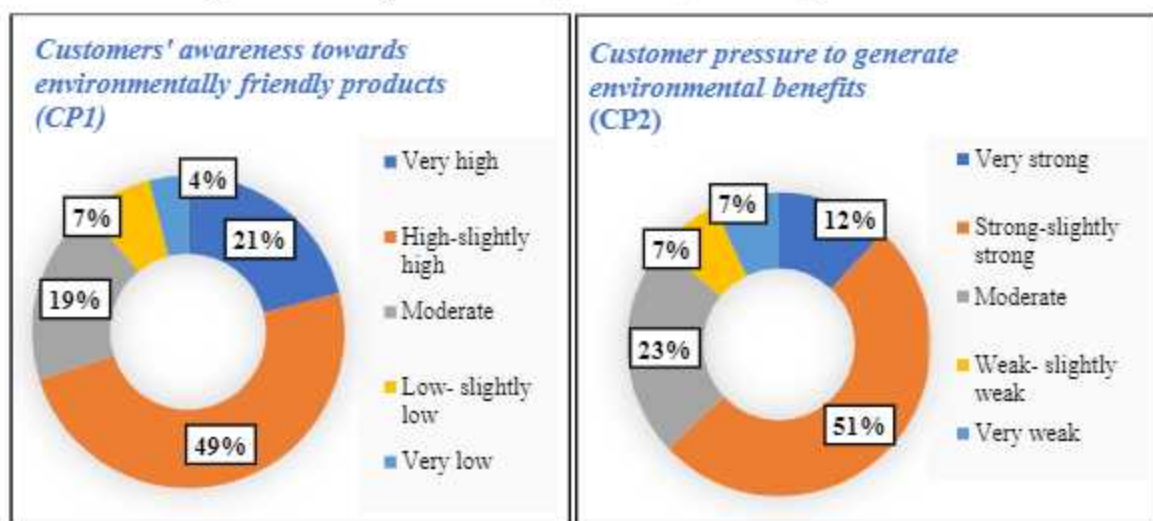
*Table 8. Quarries for ranking customer pressure (CP1-CP4) in industries.*

<b>Customer's Pressure (CP)</b>	<b>CP1:</b> Customers' awareness towards environmentally friendly products.
	<b>CP2:</b> Customer pressure to generate environmental benefits.
	<b>CP3:</b> Customers' requirement to fulfill their environmental regulations/standards (for example, ISO14001, REACH, RoHS, chemical labeling, and others).
	<b>CP4:</b> Influence of Customers' environmental regulations on a firm's environmental and business decision-making

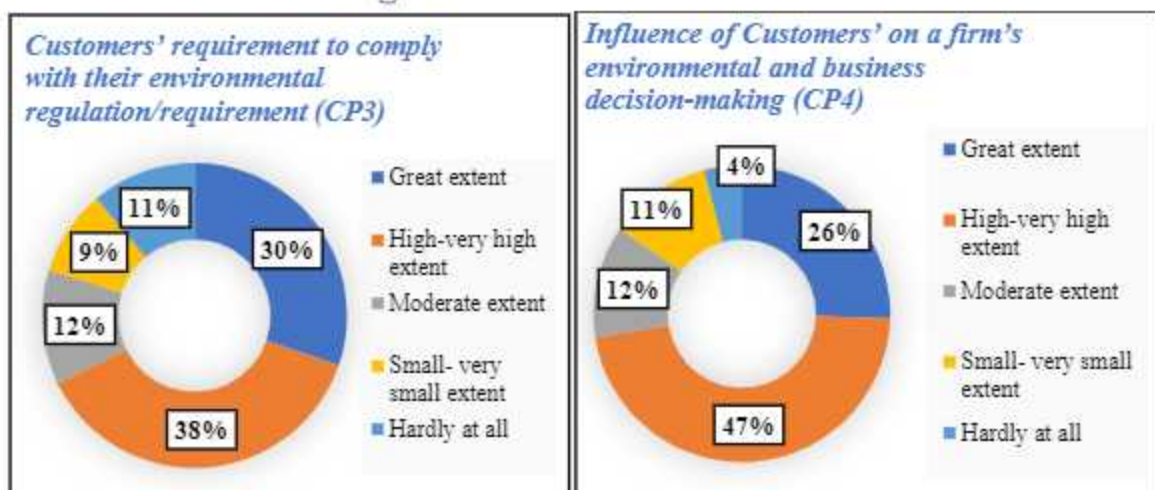
#### Findings:

- **CP1:** About 49% responded that customers' awareness towards environmentally friendly products is at high level. However, 7% of respondents rate the customers' attention about sustainable products in the organizations in the range of low to slightly low.
- **CP2:** Many responded (51%) with a view of high stemming from customers. However, 23% responded customers' pressure as a driving force for the industry to generate environmental benefits is moderate.
- **CP3:** About 38% have the opinion customer requirement to comply with their environmental regulations and procedures is, to a high extent.
- **CP4:** 47% think customers' environmental regulations greatly influence industry decision-making, whereas 11% responded that customers' influence on decision-making is small.

*Fig 10. Status of customer's pressure (CP1-CP4) in industries*







#### (vi) Cost barrier

Cost can be a barrier to eco-innovation, as implementing sustainable practices and developing new eco-friendly products and services can be costly. The cost of research and development, as well as the cost of new equipment and technology, can be a significant barrier to eco-innovation. Table 9 shows the quarries related to the cost barrier.

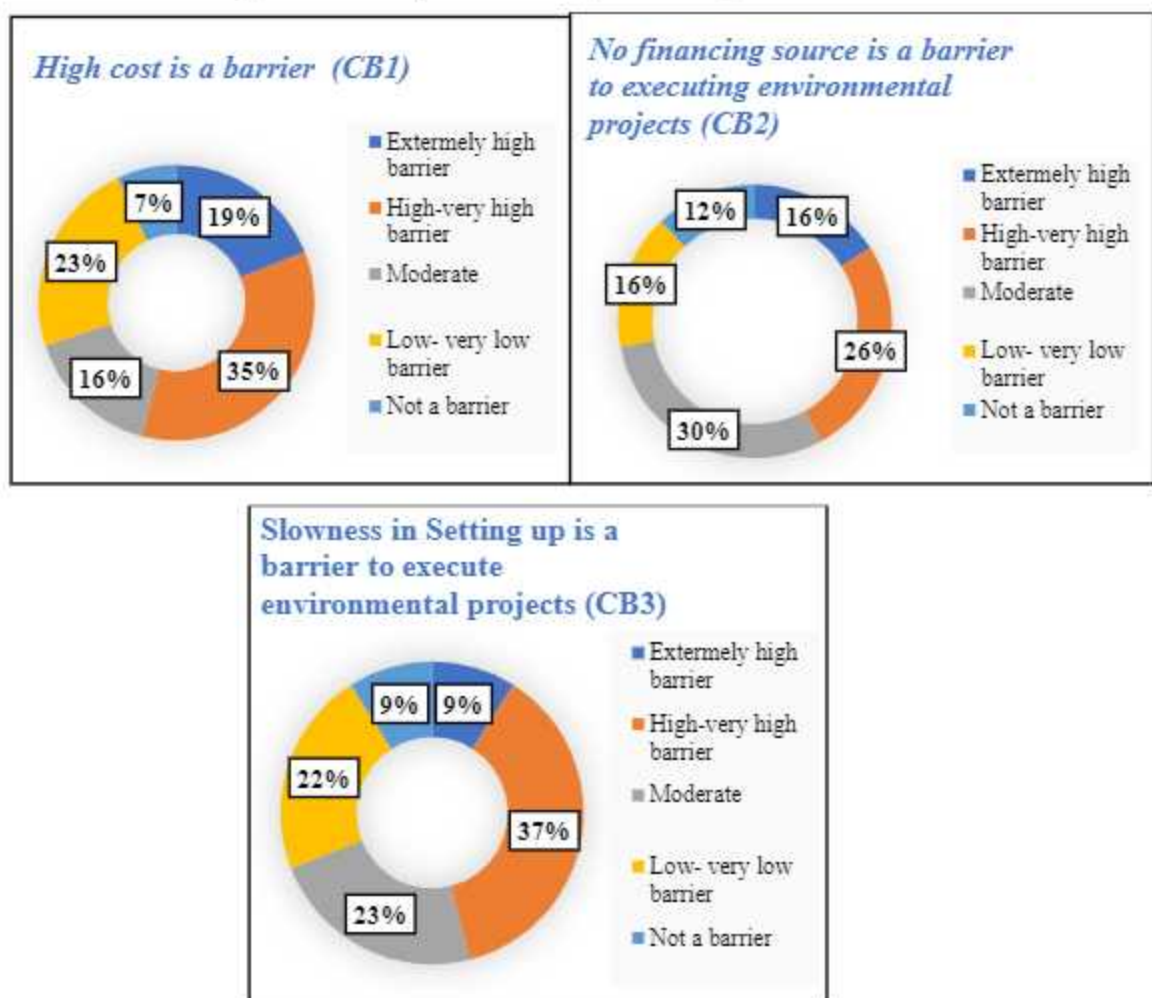
*Table 9. Quarries for ranking customer barrier (CB1-CB3) in industries.*

<b>Cost Barrier (CB)</b>	<b>CB1:</b> High cost is a barrier to executing environmental projects/activities/innovations.
	<b>CB2:</b> No financing source is a barrier to executing environmental projects/activities/ innovations.
	<b>CB3:</b> Slowness in creating funds is a barrier to initiating environmental projects/activities/innovations.

#### Findings:

- **CB1:** About 35% respondents believe that high cost is a barrier for industries to introduce innovations. While 7% thought the financing source was not a barrier.
- **CB2:** 26% responded that the high cost to execute environmental projects is high to an extremely high barrier.
- **CB3:** 37% have similar opinions that it is a high barrier. Whereas 9% responded think it is a not a barrier.

*Fig 11. Status of cost barrier (CB1-CB3) in industries*



## IDENTIFICATION OF ECO-INNOVATION OPTION

The study project team came up with a list of environmental policies that have been established by various industries around the world. During the in-person or online discussions with the experts, the identified environmental measures were closely examined while considering the local circumstances for the textile sector. The identified eco-innovation options were concentrated on industrial activities, including best management practices for resource consumption reduction, recycling/reuse, resource conservation, and minimization of pollutant emissions (zero discharge, etc.), which necessitates a thorough cost-benefit analysis, including payback periods.



### **(i) Use of the latest washing machine (rainforest) and Laser Technology**

The denim washing business can improve everyday washing results by as much as 60%, using less water, steam, and chemicals.

Laser technology can be applied to denim fabrics as it improves the quality without using any chemicals, lowering the amount of wastewater released into the environment.



*Figure 5: Rainforest washing machine (4).*



*Figure 6: Laser-based machine for denim textile (5)*

### **(II) Ozone technology for bleaching in denim textile processing**

The use of ozone for bleaching is an alternative to Hydrogen peroxide and other chemicals. Ozone techniques can be generated on-site and use less water, saving water. The process results in releasing ozone as a gas, which is easily scavenged before being released into the atmosphere.

### **(iii) Waste heat recovery from the boiler**

Installing a waste heat recovery (WHR) boiler or an economizer will allow to recovery the waste heat from the boiler's exhaust (such as flue gas from boiler operations) and use it to produce steam (5).



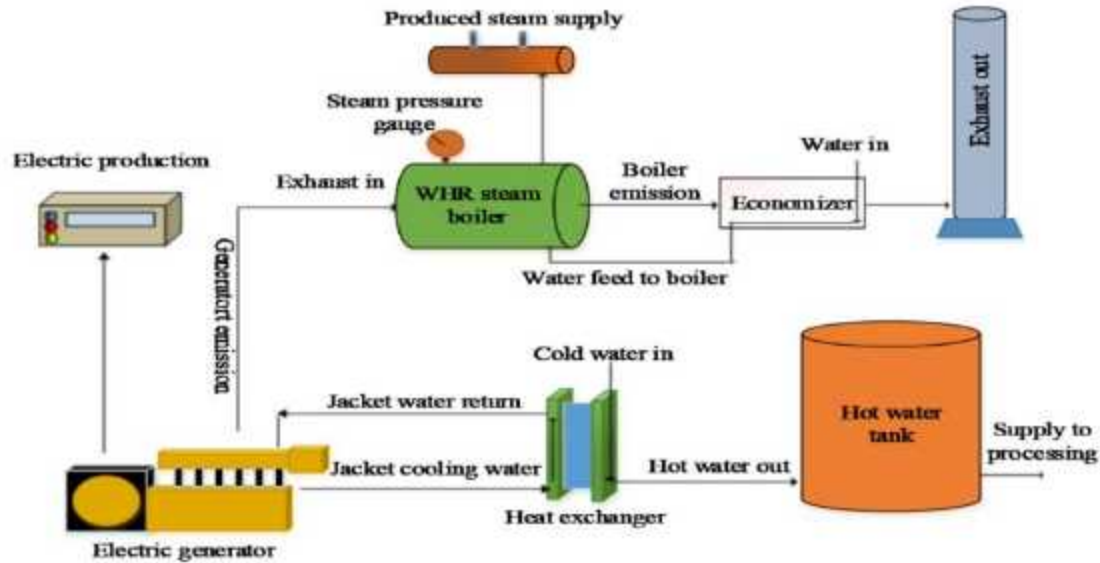


FIGURE 7: Waste heat recovery (6)

#### (iv) Condensate and heat recovery

- At various points in the system, the steam condenses after being generated. Condensate that is recovered and added back to the boiler feed water will make the system more effective. By doing this, the requirement for makeup water is diminished, and the boiler feed water temperature may be somewhat increased. As a result, energy conservation is feasible.

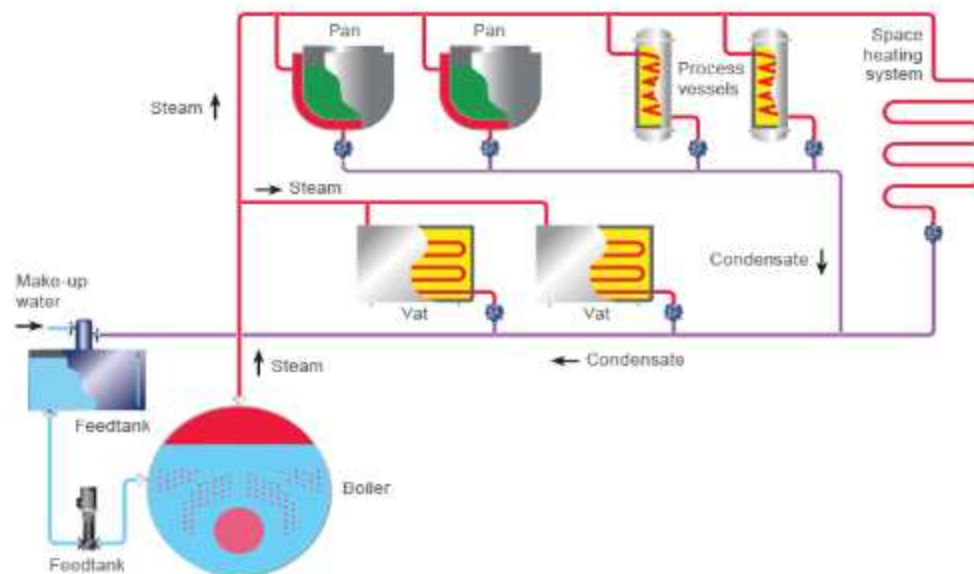


FIGURE 8: A typical steam and condensate circuit (7)

**(v) Textile wastewater heat recovery**

- The dye-processing heated liquor is released into the sewers after dying. Before discharging this liquor to a wastewater treatment facility, the hot water can recover heat. It is possible to warm the process feed water using the recovered heat. So, there may be energy savings.

**(vi) Chemical leasing**

- The concept is to "outsource" a "process" to a chemical supplier rather than purchasing chemicals from that supplier. The provider assumed responsibility for process execution at the required caliber as a result. A contract is signed between the operator and the supplier in a win-win situation. The provider then carries out the process under ideal circumstances to preserve the chemical because they are an authority. The operator can optimize the operation and supplier working together. In doing so, the provider uses fewer chemicals while increasing profit.

**Conclusion**

The textile sector in Pakistan is moving towards eco-innovation, with a large majority of industries using waste management, cleaning, and EP technology and offering goods with lower emissions and higher energy efficiency. However, fewer industries have made investments in technologies that reduce noise and vibration, and just 50% have switched to renewable energy sources. Many firms are not concerned with environmental rules, despite the fact that many have developed environmental management systems, pollution prevention strategies, and corporate partnerships. Additionally, cost is a major barrier to eco-innovation, as is a lack of R&D activities and collaboration between businesses and academic institutions

## References

1. Guarnieri, P.; Trojan, F. Decision Making on Supplier Selection Based on Social, Ethical, and Environmental Criteria: A Study in the Textile Industry. *Resour. Conserv. Recycl.* 2019, 141, 347–361. [CrossRef]
2. Niinimäki, K. Ethical Foundations in Sustainable Fashion. *Text. Cloth. Sustain.* 2015, 1, 3. [CrossRef]
3. Keshminder, J. S., & Chandran, V. G. R. (2017). Eco-innovation in the chemical manufacturing firms: Insights for policy response. *Institutions and Economies*, 9(1), 21–42.
4. Frame captures from <https://www.facebook.com/Yilmakbangladesh/videos/yilmak-rainforest-rf-60-sample-machine/737713120125259/>
5. Jeanologia. (n.d.). Laser marking technologies for textile industry <https://www.jeanologia.com/garment/laser/>
6. Gadhi, T. A., Ali, I., Mahar, R. B., Maitlo, H. A., & Channa, N. (2021). Waste Heat and Wastewater Recovery in Textile Processing Industry: A Case Study of Adopted Practices. *Mehran University Research Journal of Engineering and Technology*, 40(3), 606–616. <https://doi.org/10.22581/muet1982.2103.14>
7. SPIRAX SARCO. (n.d.). Introduction to condensate recovery <https://www.spiraxsarco.com/learn-about-steam/condensate-recovery/introduction-to-condensate-recovery#:~:text=Condensate%20is%20distilled%20water%2C%20which,energy%20lost%20from%20the%20boiler.>



# Project Team



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The proposed research aims to develop a policy framework for adopting the eco-innovation approach.

The objectives of the research are:


- (1) To examine existing environmental measures in major industrial sectors.
- (2) To develop new eco-innovation options.
- (3) To develop a plan for the management of underlying factors creating challenges in the adoption of eco-innovation strategies.

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