USPCAS-W
Mehran University
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Jamshoro, Pakistan

Food 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 Food Sector.
- Drivers of Eco-Innovation
- Identification of Eco-Innovation options

Summary of findings

(1) Feasible eco-innovation options are identified and listed in this report.
(2) A large segment of food units is engaged in organizational eco-innovation and process technology, and most innovations are adopted rather than created.
(3) Lack of R&D activities related to feasibility for eco-innovation due to absence of collaboration between organizations and research institutes.
(4) In Pakistan there is all kinds of food industries such as small, medium, and large-scale industries with sub-sectors of food.
(5) A large fraction of food industries in Pakistan are unconcerned with environmental regulations, even though they engage in environmental operations to satisfy customer demands.
(6) High cost of eco-innovation choices is a significant hurdle for industries.

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Introduction

Food Sector of Pakistan has come a long way to grab a significant position in the global market, as the rapid growth of population; demand for processed food and beverages has risen all over the world. After the textile sector, the food sector is the second largest sector of the country, it has been increasing the share of manufacturing sector in the national GDP since last two decades. The Ministry of National Food Security and Research in Pakistan notes that the food processing industry is a significant sector in the country's economy, employing over 16% of the total workforce and contributing to the country's food security and exports. The food sector accounting for 27% of the country's value-added production [1]. According to the Economic Survey of Pakistan 2020-21, the food, beverages industry accounts for 18.4% of the Large-Scale Manufacturing (LSM) sector in Pakistan, which is a significant contributor to the production of value-added products in the country.

The food industrial sector is an important part of Pakistan's economy, contributing significantly to employment, exports, and value addition. This sector is diversified, with four major industries: frozen food, value addition, beverages, bakery, and sugar confectionery.

There are about 2,500 food industrial and processing units in Pakistan besides, there are countless small food industries located in rural areas. Majority of food industries are targeting the national market to meet the domestic demands and only a small number of industries involved in the export [2]

The majority of Pakistan's food industry is situated in Punjab (60%) and Sindh (30%). However, KPK holds 6%, while Baluchistan and Islamabad (federal capital) both have 2% of food industries (**Figure 1**).

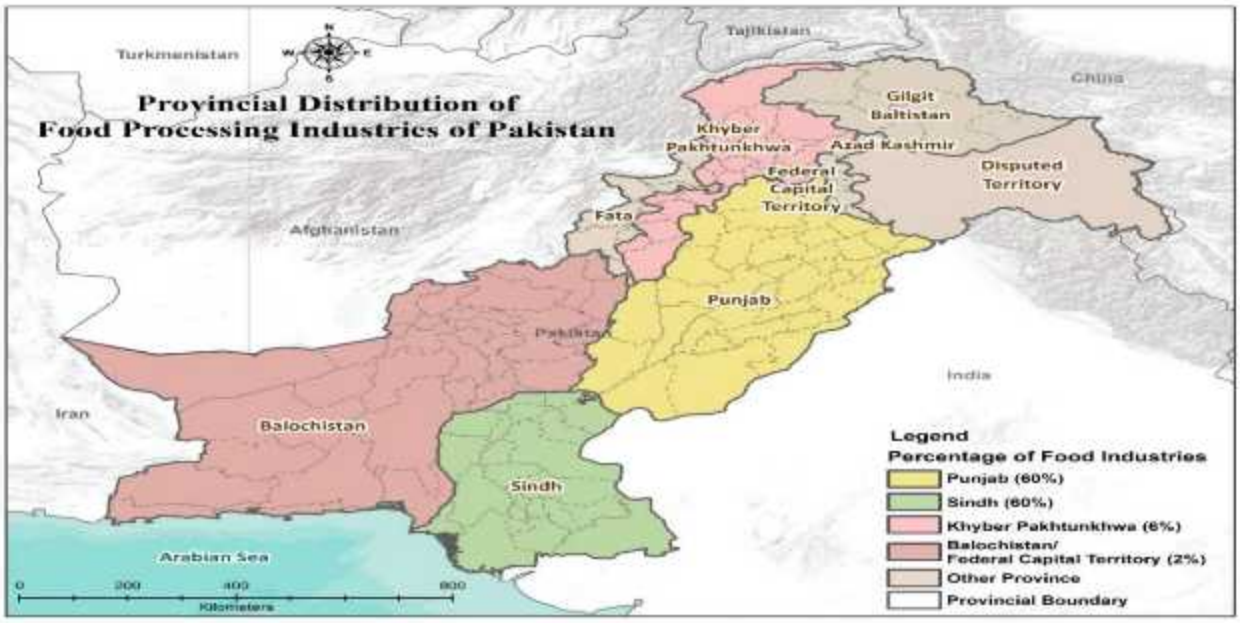


Figure 1 GIS Location Map of Food Industries in Pakistan

The food industry consumes high amounts of water, energy consumption and use of chemicals and other materials which also generate wastewater and waste which have significantly contributed to the rise in environmental problems. The food industry's primary environmental impact can be seen in the enormous waste 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. Present-day and long-term innovation are now considered as primarily driven by sustainability.

Approach and method

A comprehensive industrial survey was conducted to establish the current status of the Eco-innovation approach, understanding, and adaptation in the existing food sector. 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 SITE Association

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).

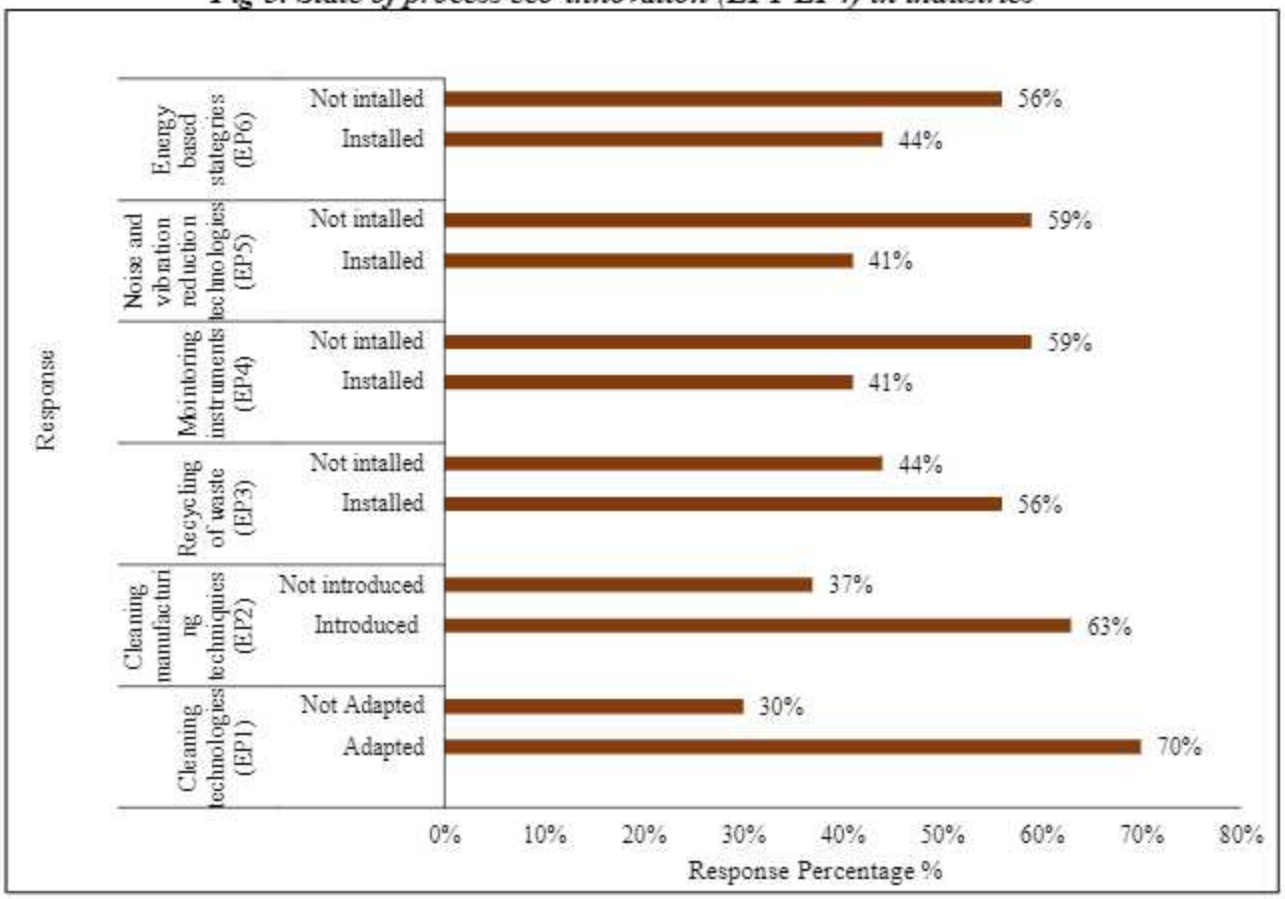
Table 1: Quarries for ranking the process technology innovation (EP)

Process technology eco-innovation	**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:

- More than 70% of the respondents' respective industries reported using cleaning technology, better business practices, and waste management technologies.
- 41% of industries reacted favourably to noise and vibration control technologies.
- 56% of industries said they are 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.
- 44% 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 eco-innovation (EP1-EP4) in industries



(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).

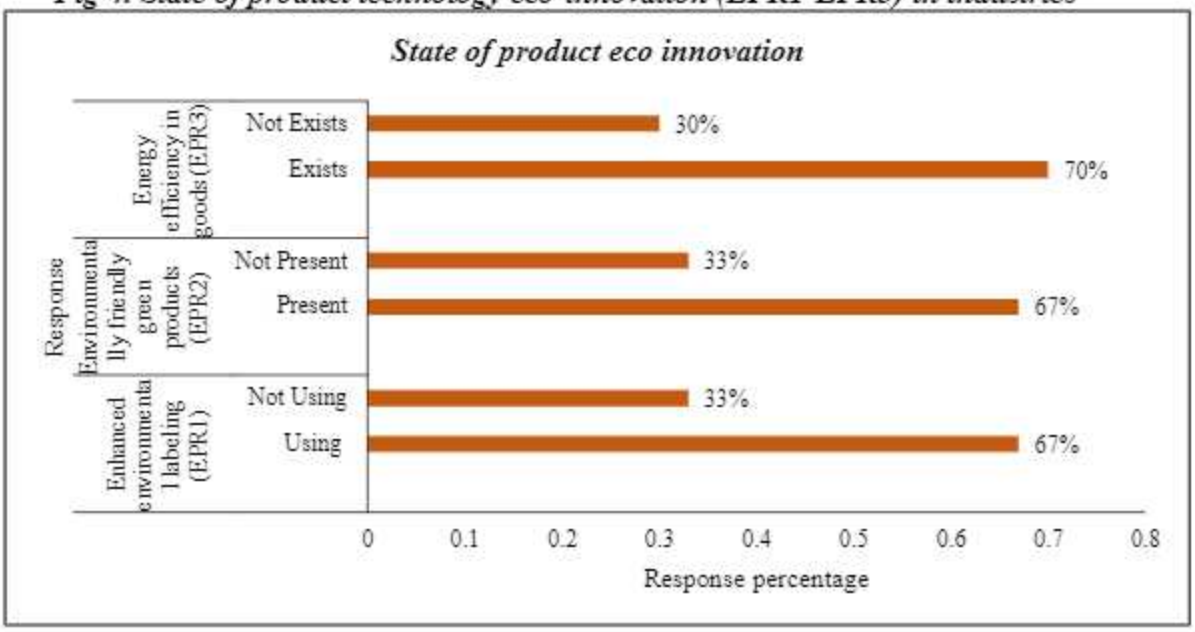
Table 2. Quarries for ranking the product technology innovation (EPR).

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

Findings:

- According to data, a company's R&D budget is primarily spent on product eco-innovation rather than process or organizational eco-innovation.
- 67% of industries introduced energy-lower-emission products.
- While 70% introduced energy-efficient products

Fig 4. State of product technology eco-innovation (EPR1-EPR3) in industries



(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.

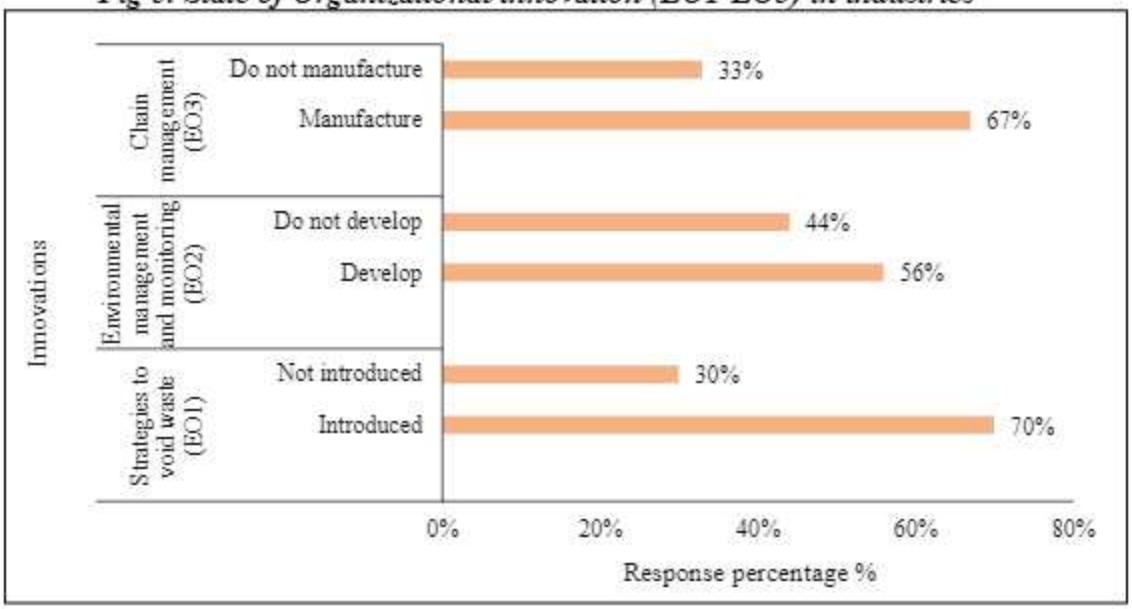
Table 3. Quarries for ranking the product technology innovation (EO)

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

Findings:

- According to their 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.
- 56% of the sectors have implemented formal environmental management systems, pollution prevention/reduction initiatives, and company collaboration.

Fig 5. State of Organizational innovation (EO1-EO3) in industries



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 (ER)

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).

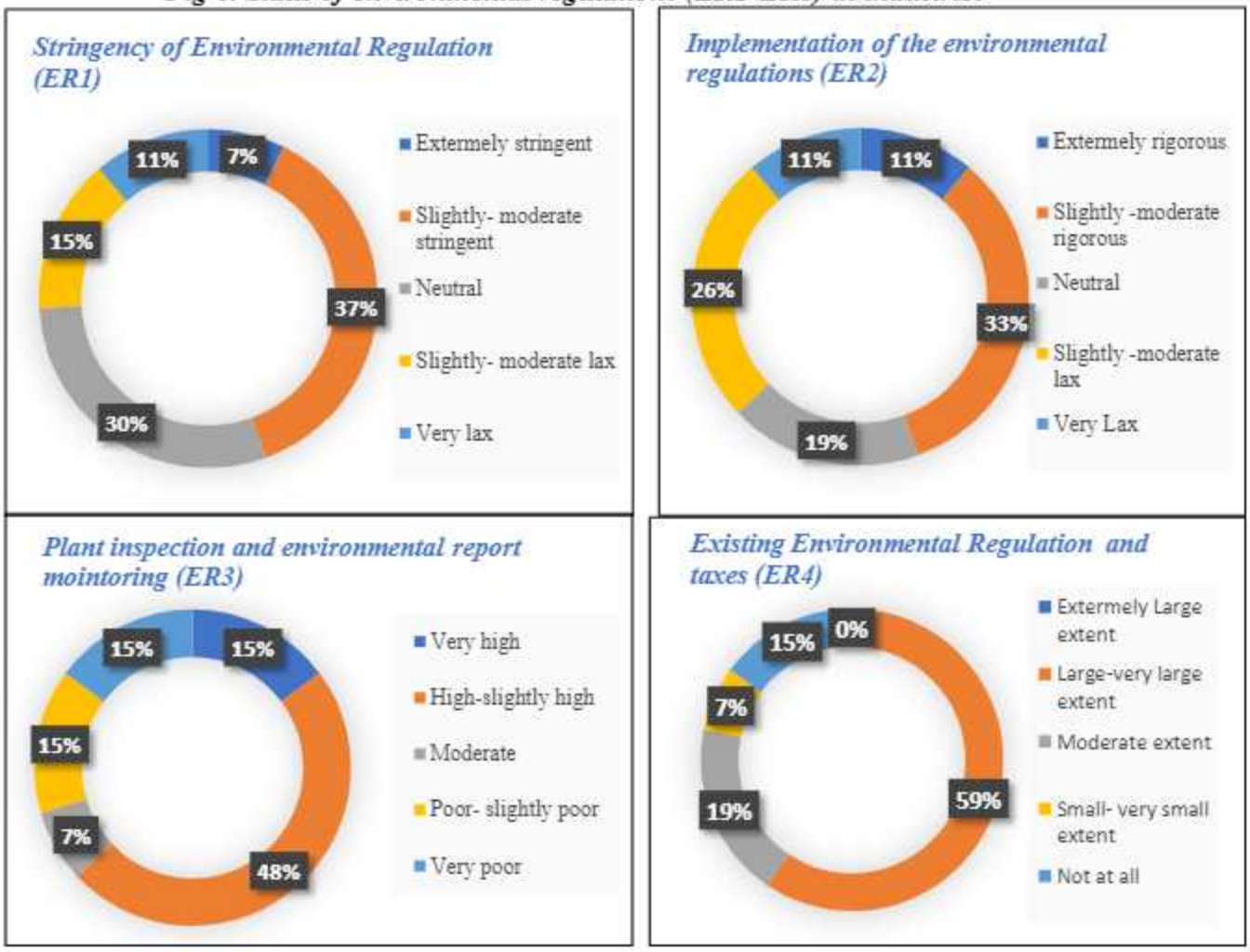
Table 4. Quarries for ranking environmental regulations in industries (ER1-ER6)

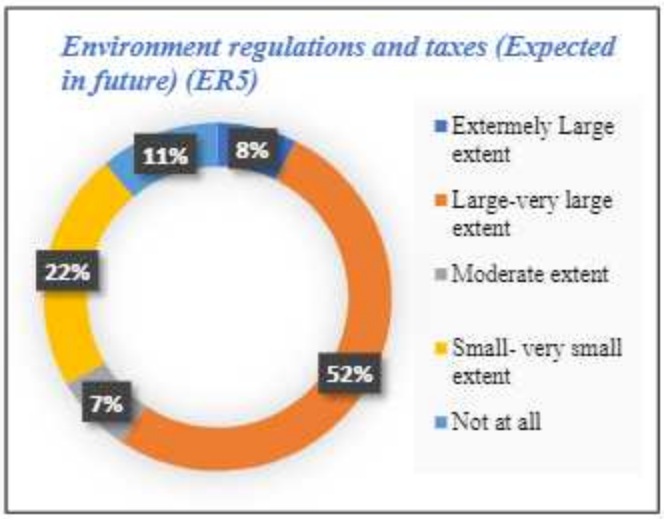
Environmental Regulations (ER)	**ER1**: Stringency of the environmental regulations
	ER2: Environmental regulations implementation
	ER3: Level of monitoring by the regulatory authority through audits and reporting
	ER4: Environmental benefits in response to existing environmental regulations or taxes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

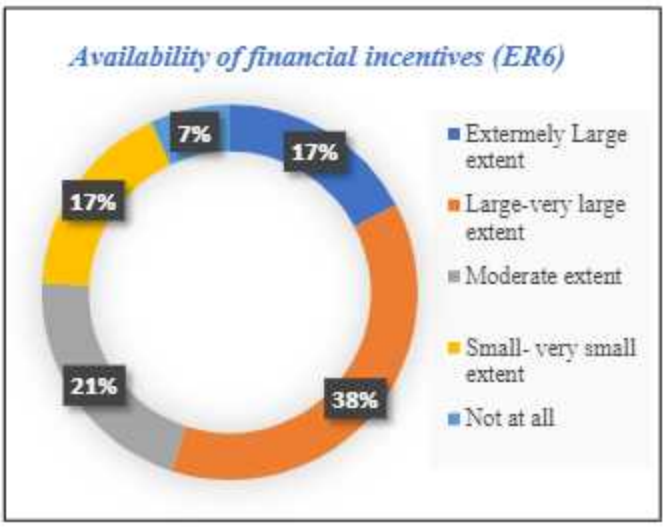
Findings

- ***ER1***: About %37 responded think that environmental regulations are slightly stringent, while 30% remain neutral. The reason of being neutral is, perhaps, reluctance due to 'unknown' fear from monitoring authority and 7% of them expressed that the environmental regulations are extremely stringent.
- ***ER2***: Majority of industries (33%) think that implementation of environmental regulations is moderate rigorous.
- ***ER3:*** About 48% industries responded that level of monitoring by the regulatory authority through audits and reporting is very high.
- ***ER4:*** 59% of respondents think that organizations do innovation in response to environmental regulation and taxes are to a large extent.
- ***ER5:*** About 52% believe that industries generate innovation to a high extent in response to environmental regulation expected to be introduced in the future. While 22% responded that the industry does innovation to a small extent.
- ***ER6:*** In response to the availability of government grants or any other financial incentives provided around 38% of respondents believe that industry introduces innovations at a large extent. However, 21% of respondents have an opinion to moderate extent.

Fig 6. Staus of environmental regulations (ER1-ER6) in industries







(ii) Organization Efforts

Through policies, procedures, and investments in the development of eco-friendly practices and products, organizations 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 the survey.

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

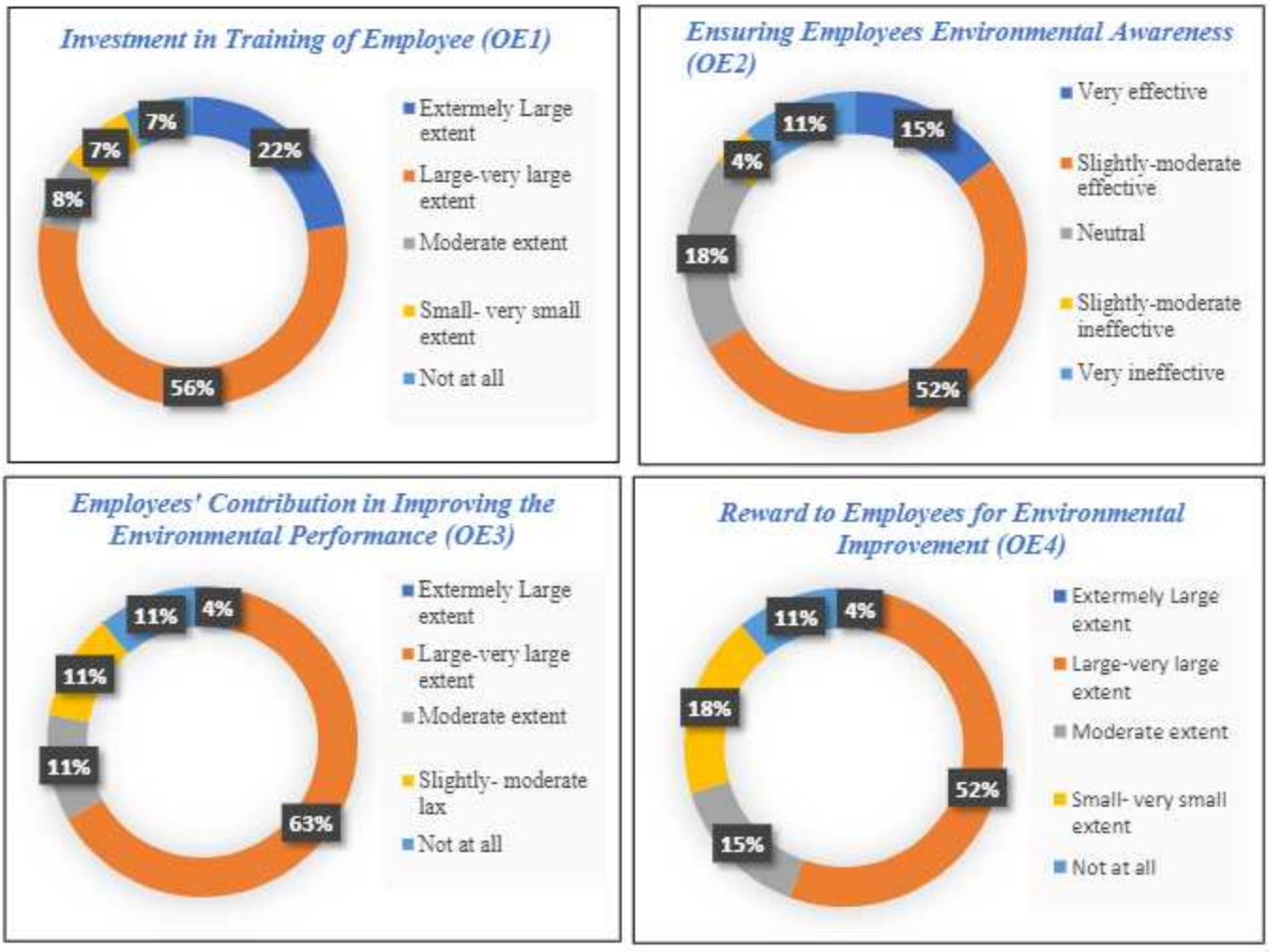
Organizational Efforts (EO)	**OE1:** Investment in environmental training and employee development.
	OE2: Efforts in ensuring employees' environmental awareness.
	OE3: Efforts to assess the role of employees in improving environmental performance.
	OE4: Reward (i.e., promotion and salary increase) to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

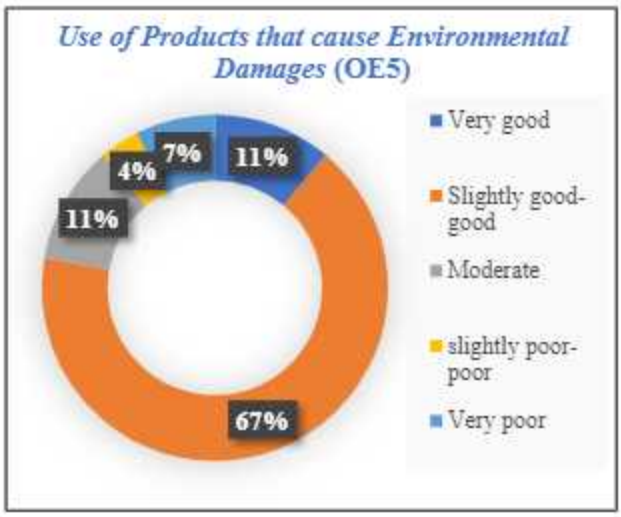
Findings

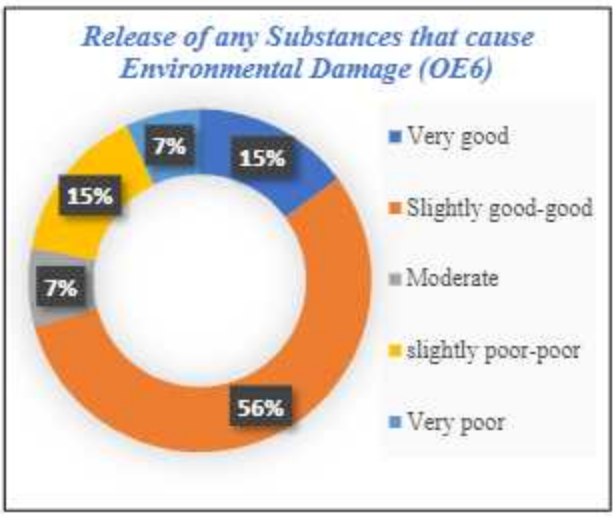
- ***OE1***: 56% respondents said that investment in employee training is at large extent.
- ***OE2***: 18% remained neutral in response. While (about 52%) respondents believe that there is effective mechanism for ensuring employee awareness and training.
- ***OE3:*** About 63% believe that organizations assess their employee contribution to improving environmental performance at a large extent. About 11% responded that organizations made no efforts to access employee contributions.

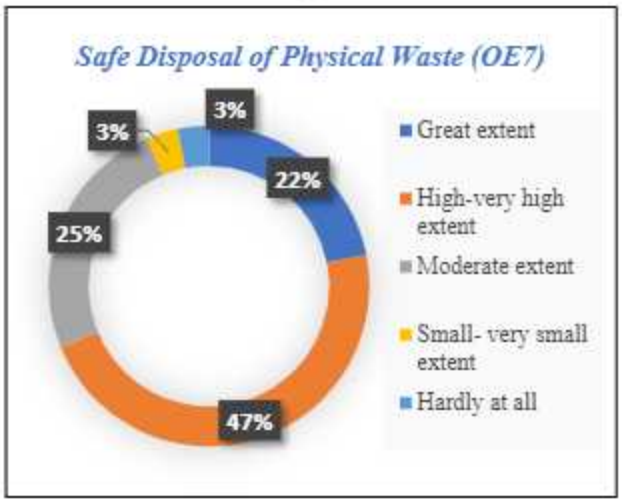
- ***OE4:*** Many respondents (52%) said that there is a large mechanism for ensuring environmental improvements.
- ***OE5:*** About 67% of respondents think that efforts made by organizations to eliminate the use of products that cause environmental damage are good, while 11% believe that organizations put moderate efforts.
- ***OE6:*** Majority of industries (56%) think that efforts made by organizations to reduce emissions/substances that cause environmental Damage is good, while 15% believe that organizations put poor efforts.
- ***OE7:*** Most respondents (about 47%) believe that organizations' efforts to dispose of the waste in an environmentally safe manner are to a high extent. While only 3% think that the 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.

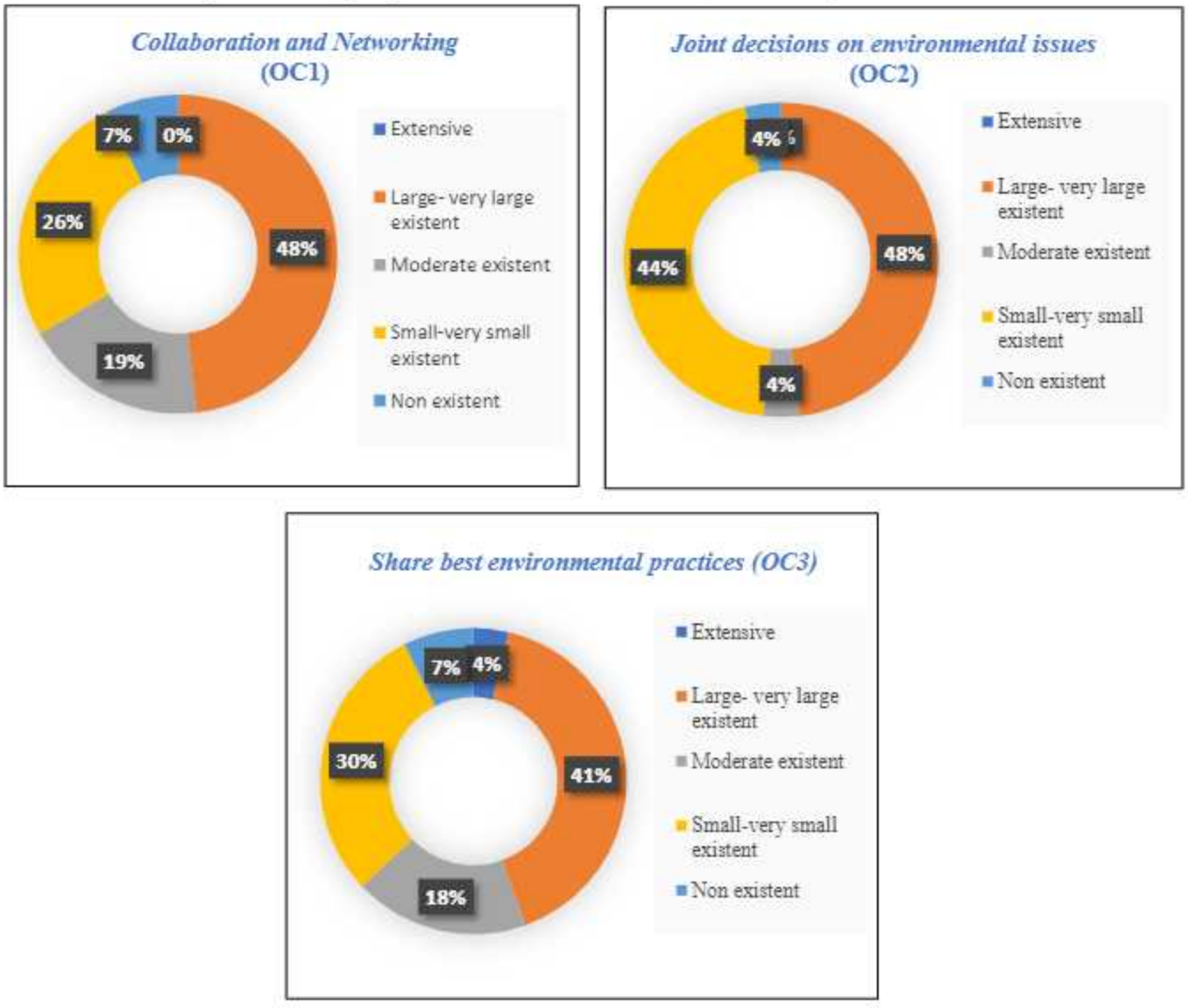
Table 6. Quarries for ranking Organizational Collaboration (OC1-OC3) in industries.

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

Findings

- ***OC1:*** 48% respondents believe that they have a high level of partnership and networking to acquire knowledge and expertise on environmental issues. While 7% responded that there is no existence of collaboration and networking.
- ***OC2:*** 48% responded that they have a higher level of collaboration and networking between industries to make joint decisions regarding environmental issues. While 44% responded that they have a smaller level of collaboration and networking.
- ***OC3:*** 41% think that in industries, sharing information about best environmentally sustainable initiatives is at high 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 describe the questions related to EMS.

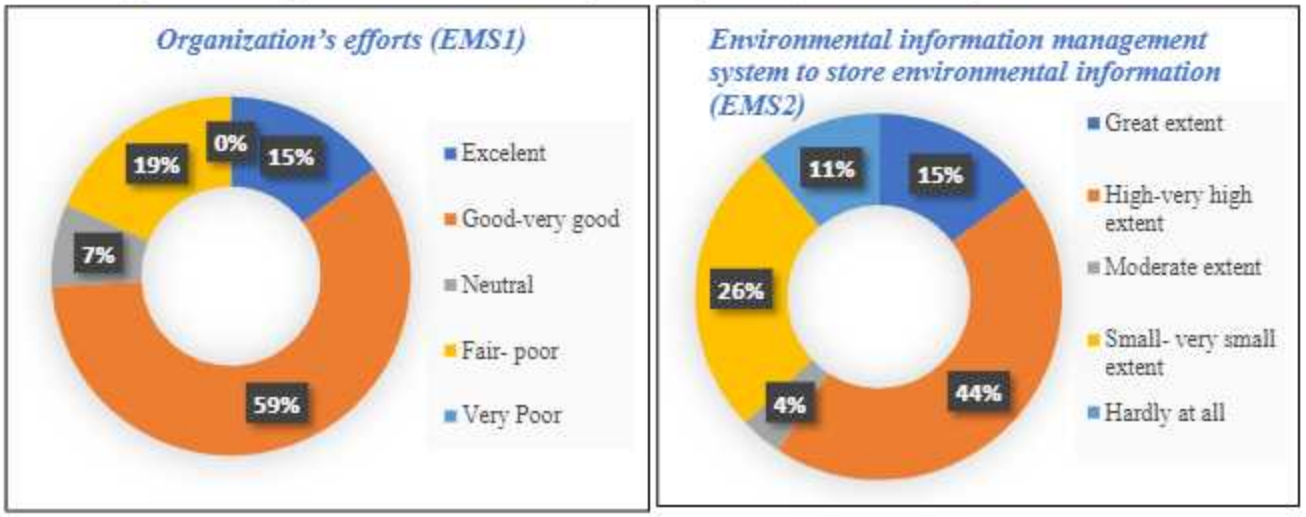
Table 7. Quarries for ranking Environmental Management System (EMS1-EMS4) in industries.

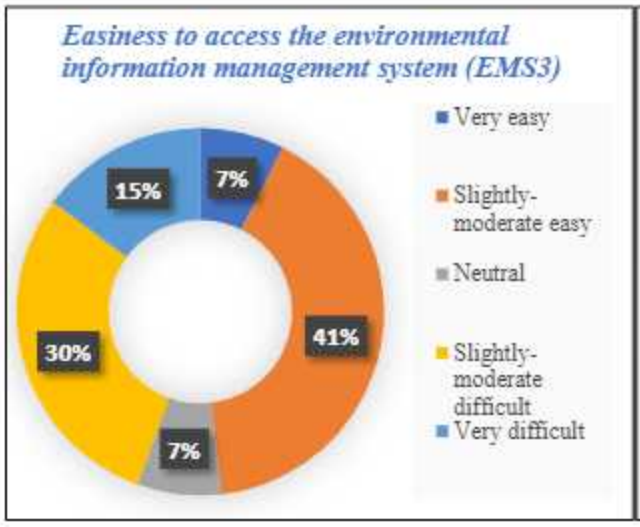
Environmental Management System (EMS)	**EMS1:** Organization's efforts to routinely update its environmental information.
	EMS2: Environmental information management system to store environmental information
	EMS3: Easiness to access the environmental information management system.
	EMS4: Sharing of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

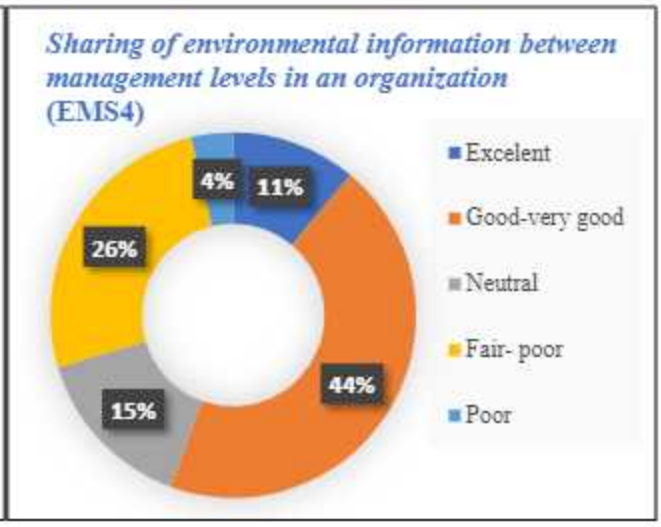
Findings:

- ***EMS1***: 59% responded that the EMS system existed at good level.
- ***EMS2***: 44% believe that organizations continuously update their environmental information at a reasonable level (in the range of high to very high). About 4% responded as neutral while answering this question
- ***EMS3***: 41% responded that access to environmental information management (MIS) is slightly easy in the industry.
- ***EMS4***: 44% think the flow of environmental information between the managers within the industry is satisfactory (good to very good) 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.

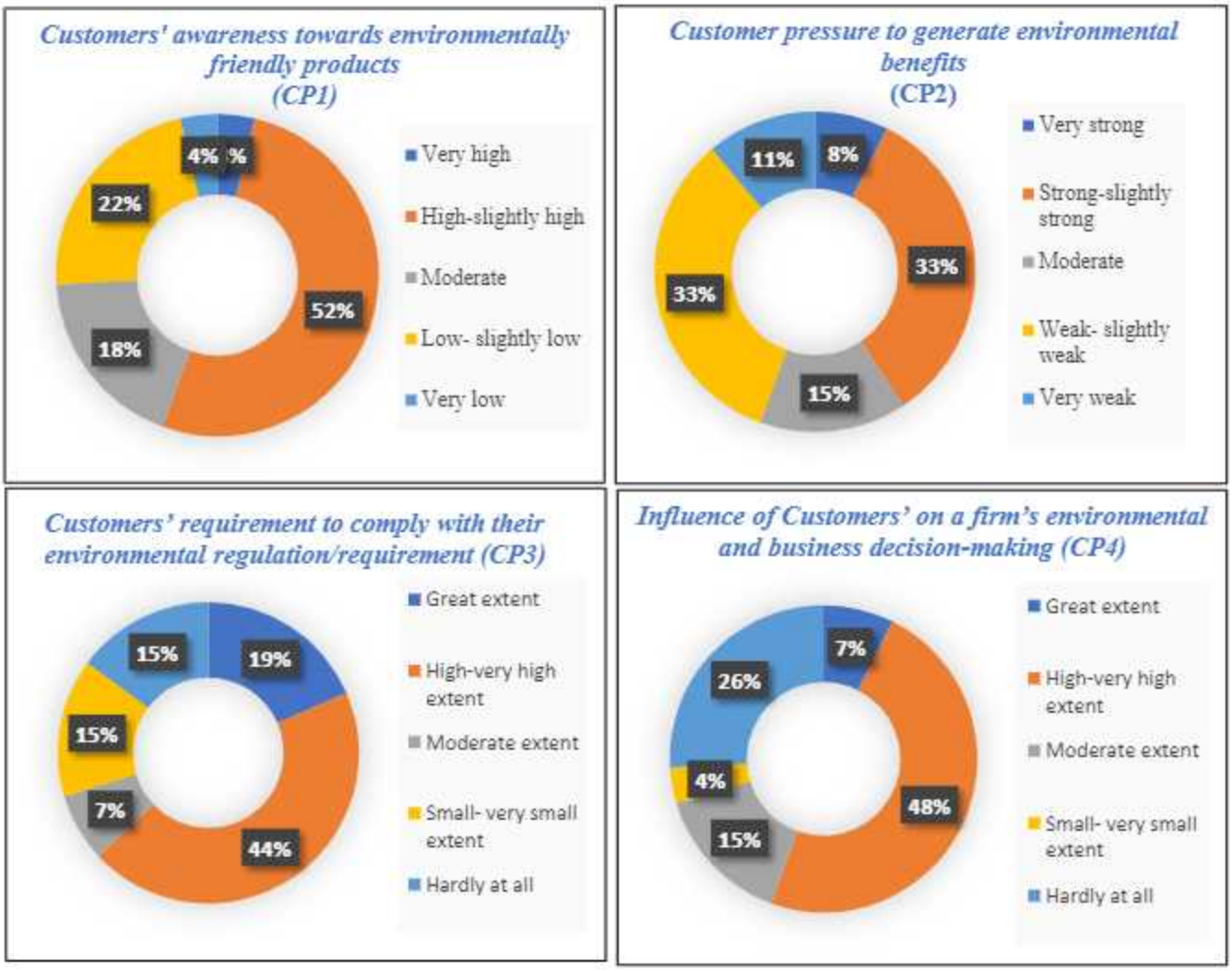
Table 8. Quarries for ranking customer pressure (CP1-CP4) in industries.

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

Findings:

- ***CP1***: About 52% responded that customers' awareness is moderate. However, 22% of respondents rate the customers' attention about sustainable products in the organizations in the range of low to slightly low.
- ***CP2***: Many responded (33%) with a view of strong stemming from customers. However, 15% responded customers' pressure as a driving force for the industry to generate environmental benefits is vital.
- ***CP3***: About 44% have the opinion customer requirement to comply with their environmental regulations and procedures is, to a high extent.
- ***CP4***: 48% responded that customers' influence on decision-making is high whereas, 7% think customers' environmental regulations greatly influence industry decision-making.

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.

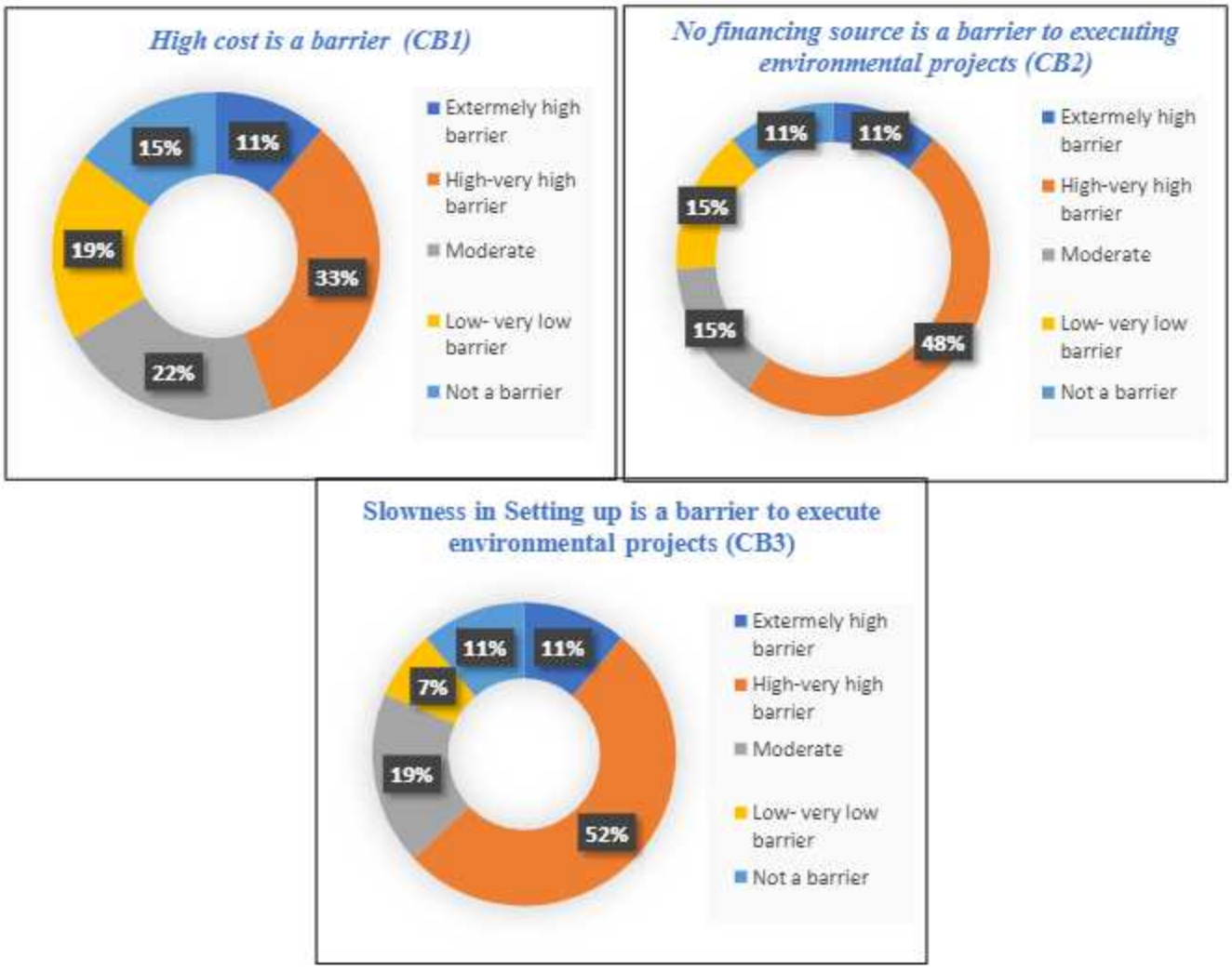
Table 9. Quarries for ranking customer barrier (CB1-CB3) in industries.

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

Findings:

- ***CB1***: About 33 % respondents believe that high cost is a barrier for industries to introduce innovations. While 19% thought the financing source was a small barrier.
- ***CB2***: 48% responded that the high cost to execute environmental projects is high barrier.
- ***CB3***: 52% have similar opinions that it is a high barrier. Whereas 11% responded think it is a not a barrier.

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



IDENTIFICATION OF ECO-INNOVATION OPTION

(i) Membrane-based end-of-pipe treatment

The food industry generates high-strength wastewater containing elevated levels of organic contaminations (measured aggregately by BOD, COD). Conventional treatment systems (e.g., activated sludge followed by sedimentation) are often adopted to treat biodegradable organic-rich effluents. The membrane-based process is becoming popular in reducing pollution loads from food industry wastewater. The membrane-based process can be divided into four types, depending on the types of membrane used: microfiltration (MF), ultrafiltration (UF), nanofiltration (NF), and reverse osmosis (RO) [4]. A considerable quantity of high-quality water can be recovered and reused by membrane separation. Moreover, the membrane-based treatment system requires less area than conventional treatment systems [5], making it more suitable for urban-setting industrial units.

(ii) Cooling Water Heat Recovery

Waste Heat recovery from the cooling water involves capturing the heat removed from an equipment/generator and using it for a secondary purpose. It can improve overall energy efficiency by reducing waste heat and potentially reducing the energy needed for other processes. Some common methods for recovering heat from cooling water include using the heat for space or process heating, preheating feed water for boilers, or producing steam for electricity generation. The heat recovery process is simple and can be carried out using a heat exchanger. The size and quality of the material used for the system may determine the initial installing costs. The payback periods can then be calculated depending on the amount of heat recovery. However, as per various experts' opinions, the options are only feasible if the payback periods remain within 1-2 years after installing the system.

(iii) Recovery of Waste Heat from the emissions of a steam boiler

The waste heat from the boiler's exhaust (e.g., flue gas from boiler operations) can be recovered for steam production by installing a waste heat recovery (WHR) boiler or an economizer [6]. The combustion of turbines, power generators, and steam boilers produced exhaust gases containing vast amounts of heat. The flue gas temperature ranges from 250 – 280° [7] . A schematic diagram of waste heat recovery options is given in Figure 3. The exact payback period after installing such a system depends on various parameters and can't be estimated now. However, a payback period of 2 years will make such a system financially feasible for installation.

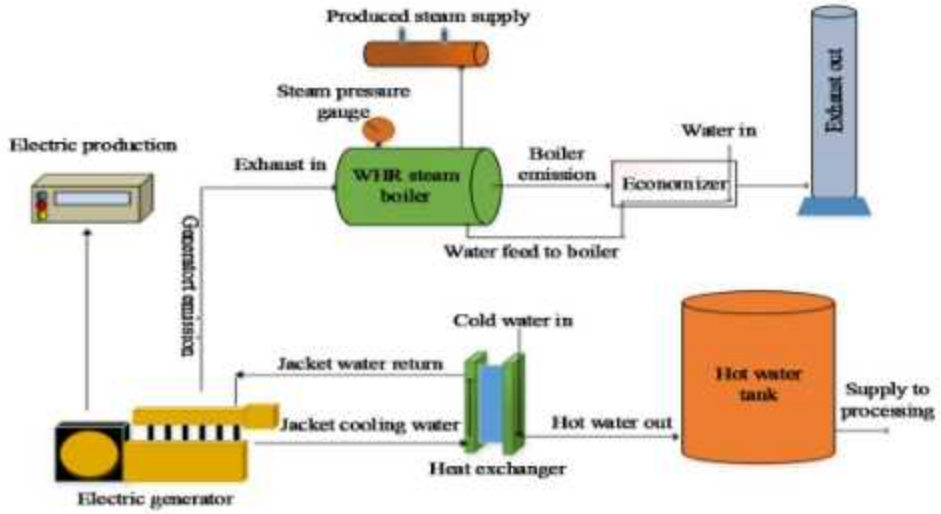


Figure 3: Schematic Diagram of Waste Heat Recovery Options in Industry [7]

(iv) Heat Recovery from the boiler blowdown

Heat recovery from the boiler blowdown can be used for preheating boiler feed water using a heat exchanger. The option of heat recovery from a boiler's blowdown is suitable for the boiler with a blowdown rate greater than 5% of the steam generation rate [8]. This practice will provide energy and improve overall energy efficiency. This option is suitable for high-pressure boilers. A schematic of the possibility of using a boiler's blowdown is given in Figure 4.

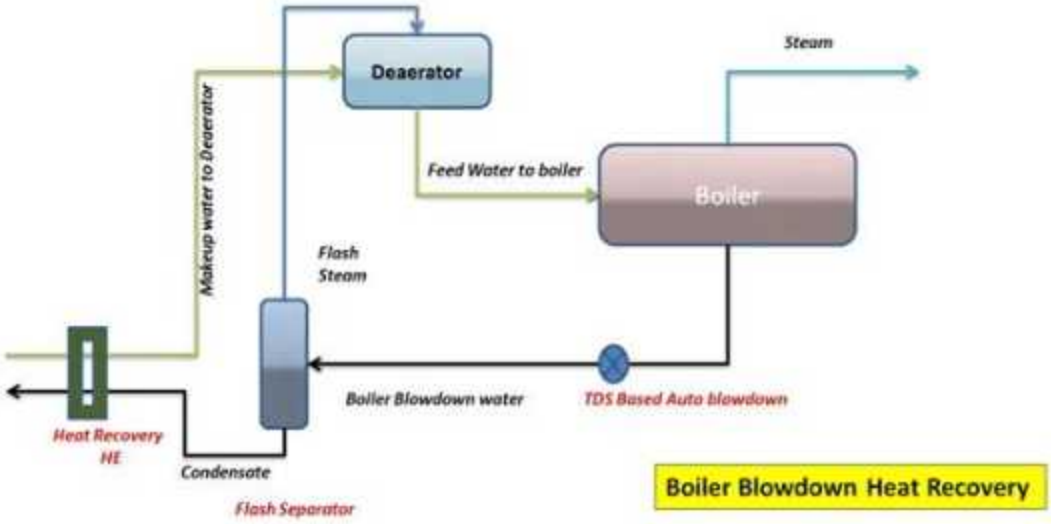


Figure 4: Heat Recovery from Boiler Blowdown [9]

(v) Chemical leasing

Chemical leasing is a new business model concept, which might require high-level partnership among different parties and based on better trust among the participants [10]. The idea is that a "process" is outsourced to a chemical supplier instead of buying chemicals from that supplier. In this way, the supplier became responsible for process execution with the required level of quality. The contract is made between the operator and the supplier with mutual benefits (win/win situation). The supplier then executes the process with optimized conditions to conserve the chemical since the supplier is an expert on that chemical. Both the operator and supplier can work together to optimize the process. In this way, the supplier uses less amount of chemicals and increases profit. The operator outsources the "process" to the supplier, which costs less than if the operator performs it.

For example, let's consider a scenario if washing 1000 bottles are to be done. Let's assume the operator washes the bottle itself (*Table 10*).

Table 10: Normal business scenario using chemicals at the operator level

Washing process: by the operator	**Suppliers sell the washing chemicals**
Chemical cost: 100 $ per 1000 bottles	Profit by selling 100$ (for 1000 bottles): 20$
Overhead: 20 $ per 1000 bottles	Overhead: 5$
Total cost: 120 $ per 1000 bottles	**Total profit: 15 $ per 1000 bottles**

If service is outsourced to the supplier and 10% of chemicals are saved after optimization (*Table 11*).

Table 11: Chemical leasing scenario by outsourcing the "process" to the chemical supplier.

Washing process: by the operator	**Suppliers just sell the washing chemicals**
Washing cost: 80 $ per 1000 bottles	Profit by washing 1000 bottles: 30$ per
Overhead: 10 $ per 1000 bottles	Overhead: 10$
Total cost: 100 $ per 1000 bottles	**Total profit: 20 $ per 1000 bottles**

So, if the washing service is outsourced, the operator saves 20$ more, the supplier gains 5$ more, and 10% of chemicals are saved for the same washing of 1000 bottles. The overall profit will be to the environment as less amount of chemicals will be discharged. Also, the cost of wastewater treatment, if any, will be reduced.

The idea of chemical leasing is new to our country, and the industrialist felt it is difficult to execute due to the trust level among the partners. As mentioned by UNIDO, who introduced the idea first, the trust level is of prime importance. Further, no structured model exists, and the partners may develop their model. However, a strong partner, such as UNIDO or any governmental agency, might be very beneficial to execute the model.

(vi) Conservation of chemicals by adding less

The idea of using less amount of chemicals than mentioned in the "formula" (or recipe) of the process is used in some food/chemical/pharmaceutical industries. The central focus is to use chemicals optimally without compromising the taste of a product. For example, if 1 gram of sugar is required by the recipe per kg of confectionery product, then only 0.98 grams of sugar is added per kg of the product. Apparently, the amount of 0.02 g (20 micrograms) per kg of product is not significant. If the taste (or quality) is not compromised, then a saving of 0.02 g might bring a considerable amount of chemicals saving (and financial savings) to the industry. It is envisaged that optimizing chemicals is a regular practice in industries, but revisiting the actual practices might make a difference.

Conclusion

The food industry is working hard to be sustainable and environmentally responsible. The bulk of industries are concentrating on implementing waste management techniques, pollution prevention plans, and the introduction of environmentally friendly goods. Although formal management systems and environmental monitoring technology usage are both relatively modest, the general trend towards organisational eco-innovation is positive. The industry appears to be heading towards a more sustainable future with 44% of industries switching to green energy and 67% concentrating on product innovation for reduced emissions and energy efficiency. The survey's findings suggest that the food industry is moving significantly in the direction of a future that is more environmentally friendly and sustainable, even though there is still space for improvement in several areas. Additionally, the high cost of eco-innovation and the absence of cooperation with research institutes, however, are significant impediments to implementing eco-friendly practises in Pakistan, where many enterprises have a neutral attitude on environmental legislation.

References

1. Borad of Investement. (2021). *Sector Profile Food Processing*. Retrieved from https://invest.gov.pk/food-processing
2. International Trade Center. (2023). *Pakistan Export Strategy Processed Food and Beverages*. Retrieved from https://tdap.gov.pk/wp-content/uploads
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. Muro, C., Riera, F., & Carmen Diaz, M. del. (2012). Membrane Separation Process in Wastewater Treatment of Food Industry. *Food Industrial Processes - Methods and Equipment*. https://doi.org/10.5772/31116
5. Compton, M., Willis, S., Rezaie, B., & Humes, K. (2018). Food processing industry energy and water consumption in the Pacific northwest. *Innovative Food Science and Emerging Technologies*, *47*(April), 371–383. https://doi.org/10.1016/j.ifset.2018.04.001
6. U.S. DoE. (2012). Recover Heat from Boiler Blowdown (steam tip 10). *U.S. Department of Energy - Energy Efficiency & Renewable Energy - Advanced Manufacturing Office*.

7. 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
8. Advanced Manufacturing Office. (2012). Recover Heat from Boiler Blowdown (steam tip 10). *U.S. Department of Energy - Energy Efficiency & Renewable Energy* -. Retrieved from https://www1.eere.energy.gov/manufacturing/tech_deployment/pdfs/steam10_boiler_blowdown.pdf
9. Energy Purse. (n.d.). Boiler Blowdown and heat recovery. Retrieved January 30, 2023, from https://www.energypurse.com/boiler-blowdown-and-heat-recovery/
10. Thomas Jakl, & Schwager, P. (2008). *Chemical Leasing Goes Global*. *SpringerWien NewYork* (Vol. 4).

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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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