

# An empirical study regarding the environmental sustainability practices in the textile industry

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## ABSTRACT – REZUMAT

### An empirical study regarding the environmental sustainability practices in the textile industry

The textile industry causes various types of pollution due to extensive utilization of resources, resulting in harmful impacts on the natural environment and people's health. As a result, many environmental organizations and countries are implementing various environmental safety policies. The developing countries are making less effort in the protection of the global environment. Hence, it is very important to analyse the environmental sustainability situation of the developing production markets and subsequently provide suggestions for improvement. Pakistan is a developing textile market, providing a range of textile products around the world. This paper presents the results of a survey regarding the environmental sustainability in the textile industry of Pakistan related to energy sustainability, water sustainability, air sustainability, materials sustainability, transportation sustainability, safety & health and consumer use sustainability. For the data collection, this research uses a structured questionnaire, interviews, and personal visits to 122 textile mills. Data collected through a questionnaire related to the above areas of sustainability was analysed by calculating the frequency distribution, mean, and median in the statistical software SPSS. The results of the data analysis exhibited that the Pakistani textile companies are gradually improving many environmental sustainability areas. The paper identifies some weak sustainability areas which need more attention to accelerate the implementation process. In addition, the textile companies that are involved in international trade tend the implementation of environmental sustainability. In addition, this study integrates the insights for policymakers and practitioners to improve the environmental sustainability in the textile industry of the developing markets.

**Keywords:** textile sustainability, energy sustainability, materials sustainability, water sustainability, sustainable development, survey methods

### Un studiu empiric privind practicile de sustenabilitate a mediului în industria textilă

Industria textilă creează diverse tipuri de poluare din cauza utilizării pe scară largă a resurselor, având ca rezultat efecte nocive asupra mediului natural și sănătății oamenilor. Prin urmare, multe organizații de mediu și țări pun în aplicare diverse politici de siguranță a mediului. Țările în curs de dezvoltare depun eforturi mai reduse în protecția mediului global. De aceea, este foarte important să analizăm situația de sustenabilitate a mediului pe piețele de producție în curs de dezvoltare și, ulterior, să oferim sugestii de îmbunătățire. Pakistanul este o piață textilă în curs de dezvoltare, care furnizează o gamă largă de produse textile în întreaga lume. Această lucrare prezintă rezultatele unui sondaj privind sustenabilitatea mediului în industria textilă din Pakistan, legată de sustenabilitatea energetică, sustenabilitatea apei, sustenabilitatea aerului, sustenabilitatea materialelor, sustenabilitatea transportului, siguranța și sănătatea și sustenabilitatea utilizării de către consumatori. Pentru colectarea datelor, această cercetare utilizează un chestionar structurat, interviuri și vizite personale în 122 de companii textile. Datele colectate prin chestionar legate de domeniile de sustenabilitate de mai sus au fost analizate prin calcularea distribuției frecvenței, mediei și mediane în software-ul statistic SPSS. Rezultatele analizei datelor au arătat că, companiile textile pakistaneze îmbunătățesc treptat multe domenii de sustenabilitate a mediului. Lucrarea identifică unele zone cu interes scăzut pentru sustenabilitate, care necesită mai multă atenție pentru a accelera procesul de implementare. În plus, companiile textile care sunt implicate în comerțul internațional prezintă o tendință către implementarea sustenabilității mediului. În plus, acest studiu integrează perspectivele pentru factorii de decizie și practicieni, pentru a îmbunătăți sustenabilitatea mediului în industria textilă pe piețele în curs de dezvoltare.

**Cuvinte-cheie:** sustenabilitate textilă, sustenabilitate energetică, sustenabilitatea materialelor, sustenabilitatea apei, dezvoltare durabilă, metode de sondaj

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## INTRODUCTION

Environmental sustainability can be defined as the protection of the internal and external environment of an organization from the effects of harmful practices such as energy wastage, water pollution, air pollu-

tion, excessive solid waste, transportation emissions, and severe safety and health issues. The effects of these harmful practices are noticeable in the textile industry due to their unsustainable nature. For instance, the many environmental sustainability

issues are associated with the textile industry such as considerable water usage, discharging excessive waste into the land, intensive chemicals use, unsafe raw material processing, globalization of the industry, dangerous pollutants, use of considerable electricity, emission of harmful gases, greater transportation distances, unsustainable practices in the industry, and disposing the textile products into the municipal solid waste after end use [1–8]. Companies in the developed markets prefer the manufacturing of their products in the developing markets for cost-saving [9]. However, developing countries are facing serious challenges to deal with environmental issues.

For instance, the textile processing industry in Bangladesh discharges a considerable quantity of polluted and toxic wastewater into sewers and drains without any kind of treatment. In addition, an excessive quantity of effluents, solid waste, and sewage sludge are discharged into the environment [3]. Nowadays, an increased focus of customers and retailers on environmental issues has caused the companies in the developed markets to source only from environmentally friendly suppliers [7, 10]. In future, global companies will always prefer the textile markets that have implemented environmental sustainability practices. In addition, there is an increased awareness among consumers regardless of any specific market in the world. Therefore, only environmentally-conscious companies will survive in future. Pakistan is a developing textile manufacturing market and is involved in the production and export of all kinds of textile products from fibre production to garment manufacturing. Pakistan has a large number of small and medium-sized textile companies. All Pakistan Textile Mills Association (APTMA) is a leading association of textile companies which represents 396 textile mills [11]. Another association “All

Pakistan Textile Processing Mills Association (APTP-MA)” represents 386 textile processing mills in Pakistan. In addition, there are many textile companies which are not registered under these associations. The number of textile mills in Pakistan increased from 3 to 600 between 1947 and 2000 [12]. Consequently, the actual number of textile companies in Pakistan is more than 600. In addition, there are some multinational textile chemical suppliers in Pakistan. The contribution of the textile industry is 46% of the total manufacturing in Pakistan. The share of textile exports is 68%. The textile industry makes 8.5% of the gross domestic product (GDP) and 38% of the total employment [13, 14]. The textile industry in Pakistan is facing many challenges such as more cost, waste of resources, gas and electricity shortage, and use of unsustainable sources of energy [15].

There is a lack of literature about the environmental sustainability situation of the textile industry in developing production markets such as Pakistan. The key objective of this research is to measure the environmental sustainability in the textile industry of Pakistan. In this study, the data collection was performed using the following three methods: (a) a structured questionnaire was developed based on the literature review and discussion with textile experts, (b) interviews with management in the textile companies, and (c) personal visits in the textile industry. The results provide various insights to improve the environmental sustainability in the textile industry of developing markets.

## METHODOLOGY

This paper uses three methods for data collection. These methods include a structured questionnaire, interviews, and personal visits (figure 1).

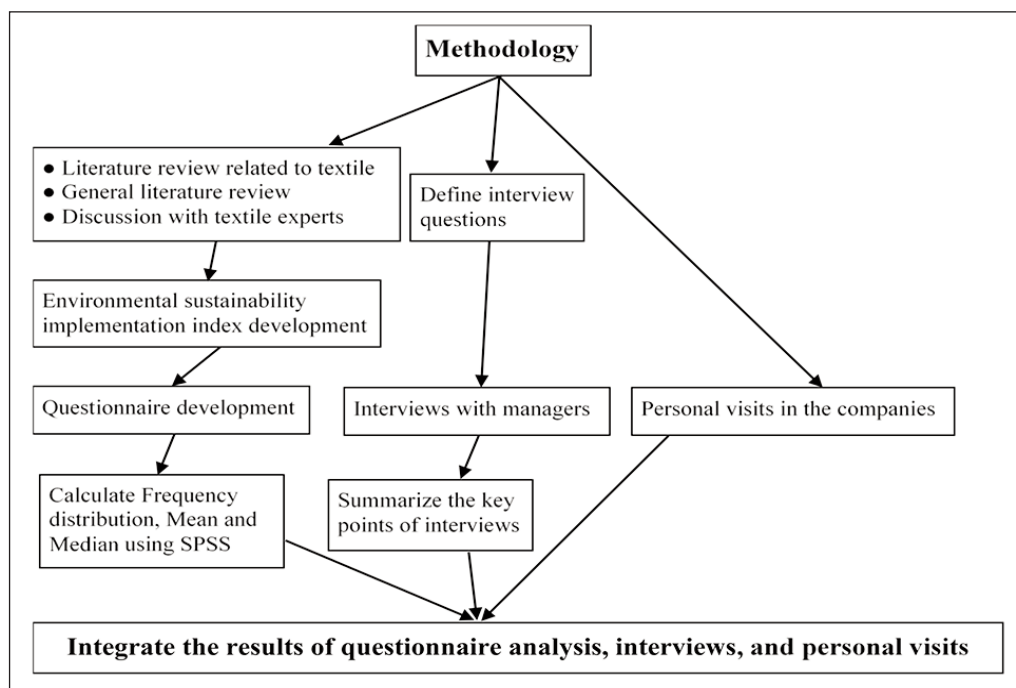


Fig. 1. Methodology

For the questionnaire development, thorough literature was reviewed. For the questionnaire development, several factors were identified from the existing literature related to environmental sustainability in the textile industry. Second, general literature about environmental sustainability was reviewed to enhance the inclusiveness of the index. Based on these two steps and discussions with experts in the textile

industry, an environmental sustainability implementation index was developed for the measurement of environmental sustainability in the textile industry. This index was divided into seven major factors which include energy sustainability, water sustainability, air sustainability, materials sustainability, transportation sustainability, safety and health, and consumer use sustainability (table 1).

Table 1

ENVIRONMENTAL SUSTAINABILITY IMPLEMENTATION INDEX FOR THE TEXTILE INDUSTRY			
Factors	Symbol	Environmental sustainability variables	References
Energy sustainability	ES1	Take practical steps to save energy, and initiate energy efficiency programs to minimize energy use.	[1,7,16]
	ES2	Prefer energy-efficient products and processes for efficiency in electric heating, electric motor, lighting, fuel use, and steam use.	[17]
	ES3	Use renewable energy sources such as sunlight, wind energy, and water.	[18,19]
	ES4	Involve everybody to improve awareness and knowledge about energy consumption and savings.	[18]
	ES5	Seek environmentally friendly materials/production methods that require the least natural resources.	[21]
	ES6	Use waste to produce energy such as heat, electricity, and fuel.	[22]
	ES7	Implement practices of efficient maintenance of machinery.	[23]
Water sustainability	WS1	Take practical steps to reduce the volume of freshwater used in production and introduce guidelines for saving water in all departments.	[1,7,16,17,24]
	WS2	Identify water sources and estimate water used in the production process.	[16]
	WS3	Use waterless or reduced water techniques (e.g. foam coating).	[17,20,21]
	WS4	Have a good system for water recycling, reuse, and discharge of polluted wastewater.	[1,7,21]
	WS5	Wastewater should not be discharged without treatment.	[1,7,25]
Air sustainability	AS1	Develop air emissions reduction strategies.	[18,26]
	AS2	Have availability of a good system to measure the level of direct and indirect greenhouse gas emissions.	[16]
	AS3	Have a system to trap and store hazardous gases such as carbon dioxide emitting from the production process (e.g., Carbone Capture and Storage).	[7]
	AS4	Encourage environment-friendly activities such as planting trees.	[18]
Materials sustainability	MS1	Encourage materials savings at every stage.	[1,17,21]
	MS2	Make strategies for efficient material utilization at every stage.	[1,17,20]
	MS3	Encourage using recycled input materials at every stage.	[16,27]
	MS4	The material should be selected based on the least toxicity when possible. Avoid the use of environmentally damaging auxiliaries and dyestuffs.	[1,20,24,26]
	MS5	Carefully estimate and purchase materials, and perform careful inventory control.	[1]
	MS6	Prefer environmental sustainability on price in purchasing and production (e.g., durable, reliable, reusable, re-manufacturable, repairable, recycled easily, energy recovery).	[7,16,17,21]
	MS7	Implement waste reduction strategies such as reducing weight, volume, toxicity, extending the life of materials, and energy use in the production process.	[1,7,16,28]
	MS8	Materials and products should have ecolabels with instructions to recycle and reuse, biodegradable, etc.	[7,16,21,24]
	MS9	Prefer electronic methods of communication instead of paperwork so that paper is not wasted.	[7,17]
	MS10	Reduce waste from product defects and overproduction.	[1,17]

ENVIRONMENTAL SUSTAINABILITY IMPLEMENTATION INDEX FOR THE TEXTILE INDUSTRY			
Factors	Symbol	Environmental sustainability variables	References
Transportation sustainability	TS1	The company should be located close to the suppliers for sourcing materials. Prefer on buying local materials/products.	[1,7,21]
	TS2	Implement environmentally friendly methods of transporting such as transport network optimization, fuel-saving driving, use of the full capacity of transportation, and route optimization.	[1,7,26]
	TS3	Measure the environmental impacts associated with the transportation of materials and products.	[1,7,16]
Safety and health	SS1	Have clear guidelines for the health and safety of employees.	[7,17,28,29]
	SS2	Machinery should be well maintained to reduce the level of noise. Workers should be provided with earplugs.	[1]
	SS3	There should be proper ventilation and lighting as required for the specific work.	[28]
	SS4	Proper dust control equipment should be set up and maintained to reduce the exposure of workers to dust. Workers should be provided with masks.	[28]
	SS5	Trained medical personnel and first aid facilities should be available. Medical examinations of workers should be conducted regularly. If health problems are observed, take appropriate measures.	[17]
	SS6	Safety equipment such as fire extinguishers and fire alarms should be available.	[28]
	SS7	In units where there is heavy exposure to dangerous chemicals, workers should be provided with safety gloves.	[1]
	SS8	Avoid Restricted Substance List (RSL) that considers health impacts on workers and other people.	[7]
	SS9	Encourage practices to determine whether or not the chemicals, materials, products, and processes are linked with harmful health effects.	[1,7]
	SS10	The company should be certified with any reputable environmental testing and certification system (e.g., ISO 14001, eco-labelling, etc.)	[7,16]
	SS11	Have waste treatment technologies for disposal of hazardous waste. Before disposal, waste should be transformed into less hazardous substances using techniques such as oxidation/ reduction, precipitation, and PH neutralization.	[1,7]
Consumer use sustainability	CS1	Produce multi-functional, durable products designed with fewer materials and made to last more than one season.	[17,21]
	CS2	Seek technical coatings to reduce laundering at the consumer use phase.	[17,21]
	CS3	Ensure colour resistance to washing, rubbing, perspiration, and light exposure.	[28]
	CS4	A company's products should be capable of being returned safely to the environment at the end of their useful life.	[17,29]
	CS5	The company's products should be capable of being washed at low temperatures using environmentally friendly laundering agents.	[29]

In table 1, some of the research papers have been referred to present the important factors related to the implementation of environmental sustainability in the textile industry.

In table 1, each environmental sustainability variable has been defined with a symbol. These symbols were supposed for a good presentation of the results. The environmental sustainability implementation index in table 1 was adopted as the environmental sustainability questionnaire using a 5-point Likert scale (5 indicates the strong support for a statement, and 1 indicates the least support for a statement). "All the statements in table 1 were modified in such a way that each statement showed the extent of the imple-

mentation in a company. For instance, the first statement in table 1 is "take practical steps to save energy, and initiate energy efficiency programs to minimize energy use." In the actual questionnaire, this statement was adapted as "Your company takes practical steps to save energy, and initiates energy efficiency programs to minimize energy use". The 5-point Likert scale has several advantages such as ease for participants and the more reliability of results [30–32].

The questionnaire was sent to the management of 298 textile companies around Pakistan. Out of these 298 companies, 122 companies responded positively. Some of these companies sent more than one reply. 140 filled replies were included in the statistical

analysis (47 per cent response rate). The companies comprised one or more of the following textile divisions:

- Yarn manufacturing division (24 responses, 24 companies);
- Fabric manufacturing division (14 responses, 14 companies);
- Wet processing division (44 responses, 38 companies);
- End-product/garment manufacturing division (18 responses, 12 companies);
- Composite divisions comprising more than one division (40 responses, 34 companies).

The incomplete responses were excluded from the analysis. The confusion in the questionnaire data was clarified with the management of the related companies. Many companies did not respond to the first request. Therefore, the reminders were sent to these companies. In some cases, the respondents did not respond despite several reminders. In these cases, the authors visited those companies and filled out the questionnaire by discussing it with managers. Most of the textile companies in Pakistan are small and medium-size companies with one or more divisions of the textile manufacturing processes. This was evident from the production and exports of these companies. Hence, the responses from the large companies were fewer. Most medium-size companies are involved in global trade. Some multinational companies are involved in the textile business in Pakistan. Hence, there were a few responses from the multinational companies. All the respondents were in senior management positions in their organizations. In addition to the questionnaire, the interviews were arranged with managers of the different textile companies to collect their views on the different questions about the implementation of environmental sustainability. The following were the key questions that were asked:

- Which practices are used by the company to improve environmental sustainability?
- In your opinion, what is the best way to implement environmental sustainability measures in the company?
- What are the difficulties in the implementation of environmental sustainability measures in the company?
- Has the company any ecolabel or environmental certification? If not, what are the reasons?
- What are the further remarks about the environmental sustainability in the textile industry?

Moreover, personal visits to the different textile companies were arranged to examine the situation of the textile companies from an environmental sustainability perspective. Data collected through a questionnaire were analysed using the Statistical software SPSS. SPSS has several advantages such as a user-friendly interface, wide availability, suitable for questionnaire data analysis, and less time consumption [33–35]. The frequency distribution, mean, and median were performed in SPSS. Frequency distribution represents “what number or percentage of

companies believes a specific point”. In statistics, mean and median are the measures of central tendency. Mean represents “the average value for the responses of companies about a specific point”. The median separates the upper half of a data set from the lower half. In the case of an odd number of observations, the median is the middle value. In the case of an even number of observations, the median is the mean of two middle values. Questionnaire data analysis along with interviews and personal visits increased the credibility of the results. The questionnaire was available as both the paper-based and the online google survey form. The online survey responses were accumulated into an excel sheet. On the same excel sheet, the paper-based responses were added by the authors as soon as the individual responses were received. The data based on interviews and personal visits were analysed, discussed, and updated regularly by the authors.

## RESULTS AND DISCUSSION

This section summarizes the results of the study based on the questionnaire analysis, interviews, and personal visits. It has been revealed that most industrialists are serious and willing to implement environmental sustainability because the retailers are encouraging them. Managers believe that it is a war of survival and a need to sustain the market. New multinational textile brands are focusing on environmental sustainability. They prefer to be partners in sustainable industries. Therefore, the companies have to work on environmental sustainability on a priority basis.

Many textile companies in Pakistan are implementing environmental sustainability due to the increased pressures from local and international factors. Multinational companies and companies with global trade exposure are aware of environmental sustainability issues. For instance, a renowned textile company in Pakistan responded that they tend the full implementation of environmental sustainability measures. They have implemented the maximum certifications that exist in Pakistan. Another textile company with all the textile divisions responded that it has implemented several possible measures such as wastewater recycling, treated water for crops, complete health and safety measures for workers, and a successful reduction in energy consumption. A multinational textile company (i.e., a processing lab) in Pakistan responded that they have implemented many environmental sustainability measures.

However, they do not have a system to trap and store hazardous gases such as carbon dioxide emitting from the production process. They responded that “our company is equipped with state-of-the-art facilities to improve sustainability. We have all products with ecolabels. We do not waste even a single drop of water in the production process. We use wastewater for irrigation of plants and crops.” For this company, it was observed during the personal visit that they follow all the health and safety rules. They take steps

for sustainable products. They encourage their employees to follow the sustainability rules in transportation. The above evidence shows a tendency of the textile companies toward environmental protection. However, most companies lack the proper implementation of eco-friendly practices. This section examines the environmental sustainability practices in the textile industry of Pakistan. In this section, the figures with frequency distribution present the results in a different way than the figures with mean and median. A figure with frequency distribution shows the sorting of the number of companies regarding the extent of implementation of a sustainability measure. In contrast, a figure with mean and median shows the overall implementation of a measure in all the companies. The mean and median values range between 1 and 5 because they have been calculated from the results of the Likert scale for each company.

### Energy sustainability

Figure 2, a shows the frequency distribution for energy sustainability. ES1 to ES7 are the symbols of the seven variables under energy sustainability (table 1). For frequency distribution, 5 is a strong agreement of specific companies about a variable, and one is a strong disagreement about a variable. The numbers 2, 3, and 4 are intermediate values of the 5-point Likert scale. Figure 2, a shows that the % companies do not use renewable energy sources. Similarly, most companies do not produce energy from waste (98.6%). In Pakistan, the energy crisis has pressurized the textile industry to produce energy from harmful fuels and cut forests. These practices are disturbing the balance of the natural environment, resulting in severe health issues for people. Government should overcome the energy crisis on a priority basis and discourage such practices. For instance, the waste produced from the cotton ginning can be used as an alternative energy source because cotton fibres are the major parts of textile fabrics. Besides, there is an increased tendency of many companies towards the adoption of energy-saving practices (companies take practical steps (64%), prefer energy efficiency (71%), involve everybody (60%), seek eco-friendly materials/methods (55%), and ensure efficient maintenance of machinery (75%)). Figure 2, b presents the mean and median for each variable in energy sustainability. The use of renewable energy sources and the production of energy from waste has the least mean and median. These findings are consistent with the results of frequency distribution.

### Water sustainability

Due to the rapid increase in the population of Pakistan, the residential areas are coming close to the industrial areas. This is causing the release of industrial wastes and water into the surroundings, resulting in serious health issues for communities. Only some dedicated companies have invested in the water treatment plants, but the other companies lack a complete understanding of the benefits. Hence, the

situation of water sustainability is not good in the textile industry of Pakistan. Near an industrial area, it was observed that the wastewater from the many textile companies was entering the main drain provided by the government. However, most companies discharge wastewater into the drain without any treatment. A similar situation was observed near another industrial area. Near these industrial areas, a few well-known textile companies responded that they have the latest water treatment technology to treat wastewater before discharge. However, they criticized that there is no benefit of water treatment because the other companies near them drain the water without any treatment. In a home textile company (spinning to stitching), it was observed that they have a proper drainage system, and the water pools were covered. They have Oeko-Tex Standard 100 testing and certification system. However, they lacked the focus on some other sustainability measures like safety and plantation. Another textile company responded that they have a water drainage problem, and they have no environmental certification. It was observed that this company has a very poor implementation of sustainability except for some health and safety rules inside the organization. There were leaked pipes and holes of water in the drainage system. Another textile company specialized in spinning responded that they have not taken any satisfactory steps for sustainability. They are not involved in international trade. They have poor water sources and drainage systems. During the visit, it was observed that the wastewater was stored in a pool inside the company. They were facing several issues such as the absence of any environmental certification, no health and safety measures, and no plantation. The management suggested that the major reason for the least environmental sustainability is the lack of government support. Some companies said that the wastewater treatment plant cost is very high and they are not able to afford its installation. After the awareness, most of the managers suggested that the second most effective strategy for implementing environmental sustainability could be "government support". Many textile companies complained about the lack of resources for environmental sustainability. Companies described that they have a lack of capital for the implementation of sustainability, and the key difficulty is to bring funds and support for sustainability. Government, industry, and institutions should join hands to work on weak areas such as renewable energy, water and energy-saving techniques, air emissions control, relocation of the industry etc. Managers suggested that the textile companies can protect the global environment by saving resources like water, energy and materials. For instance, the recycling of water can contribute to the efficient utilization of water. It can be said that only the multinationals and the companies involved in international trade are willing to water saving, recycling, and treatment.

Quantitative analysis shows that 71% of textile companies lack the implementation of waterless or

reduced water techniques (figure 2, c). There is a tendency of the textile companies towards the adoption of other measures (54% of companies reduce fresh-water use, 50% monitor used water and its sources, 49% have a system to control wastewater, and 46% discharge water after treatment). However, the overall situation is unfavourable and requires special attention from the Pakistani government to join hands with the textile companies to protect the environment. Government should closely monitor the performance of the whole textile industry. Also, the government should appreciate the performance of the textile companies which have taken the initiatives to improve water sustainability. Figure 2, *d* presents the mean and median for each variable in water sustainability.

### **Air sustainability**

From the quantitative data analysis (figure 2, *e*), it is obvious that 40% of textile companies have some tendency toward the development of strategies to reduce air emissions. Also, 69% of companies are encouraging the planting of trees. However, all the companies lack a system to trap and store hazardous gases. Also, 9% of companies have a good system to measure the level of direct and indirect greenhouse gas emissions. Figure 2, *f* presents the mean and median for each variable in air sustainability.

Management in a well-known textile processing company responded that they have implemented all the environmental sustainability measures except the use of wastes to produce energy and a system to trap and store hazardous gases. The company has been constantly investing in environmental sustainability. Another similar textile processing company responded that they have implemented all the environmental sustainability measures except a system to trap and store hazardous gases. These two companies have a good system to measure the level of direct and indirect greenhouse gas emissions. Hence, some companies are willing to take practical steps to increase air sustainability. However, it is not enough because most companies are ignoring the effects of harmful emissions.

### **Materials sustainability**

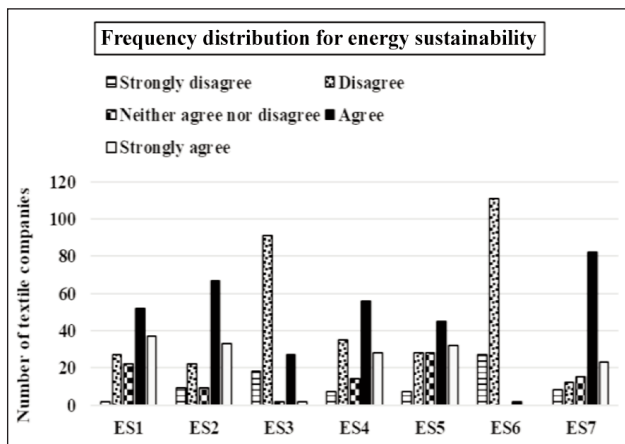
From the quantitative analysis (figure 2, *g*), it can be said that textile companies tend to materials saving (74% of companies encourage material saving, 71% make strategies to save materials, 73% perform careful material planning and control, and 71% reduce waste from poor quality and excess production). However, many companies lack some measures (48% of companies prefer the environment on price, 53% select materials based on least toxicity, 50% prefer electronic methods of communication instead of paperwork, 51% have ecolabels, 44% implement waste reduction strategies, and 41% use recycled input materials. Figure 2, *h* presents the mean and median for each variable in the sustainability of the materials. Management in a textile company responded that the products should be selected based on their toxicity and hazard. Materials should

be biodegradable and produced with renewable energy sources. However, they agreed that they lack the actual practice for materials sustainability. Another textile company responded that “they did not take a proper step towards the sustainability of the materials. However, they are focusing on the reduction of paper wastes.” Managers in several textile companies responded that the key target given to them is to reduce expenses. The focus is not the environmental protection. Hence, there is a lack of material sustainability in many textile companies.

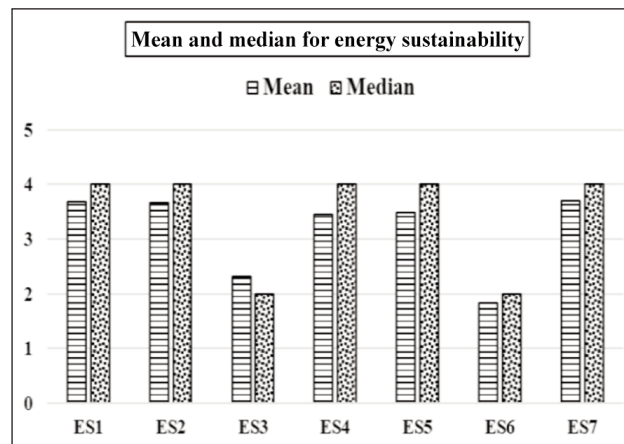
Many companies complained that the customer demand is fluctuating and there is no proper planning for production management. Therefore, their whole focus is on fulfilling the customer’s order. In this situation, they cannot focus on environmental issues. Hence, proper production planning and control could help these Pakistani companies to address this issue. A few companies said that the product cost is high. They use cheap materials which are harmful to the environment. Some companies revealed that they use nontoxic chemicals, recycled fibres, remanufacture materials, implement a lean manufacturing system, study material safety data sheet (MSDS) of the dyes and chemicals before selection, follow the manufacturing restricted substances list of ZDHC (Zero Discharge of Hazardous Chemicals), and prefer the local production of materials.

### **Transportation sustainability**

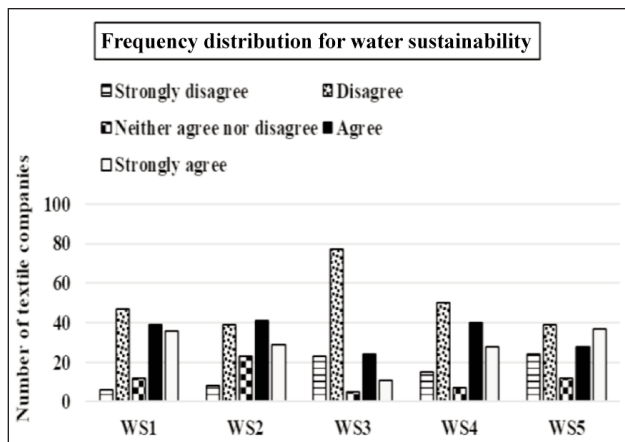
In a few textile companies, it was observed that they have implemented transportation sustainability measures. In a multinational textile company (i.e., processing lab), it was observed that the management encourages the employees to follow the sustainability rules in transportation. From the quantitative analysis, it is obvious that 44% of companies are located close to the material suppliers (figure 3, *a*). However, most companies select the nearest suppliers for cost-saving instead of the emissions reductions related to the transportation of the materials. 46% of textile companies implement environmentally friendly methods of transportation and 37% of companies measure the environmental impacts associated with transportation. Figure 3, *b* presents the mean and median for each variable in transportation sustainability. For a textile company, a good transportation system was observed. However, it lacked the implementation of the other sustainability measures. Hence, a good transportation system does not guarantee the implementation of transportation sustainability. For this purpose, textile companies should intentionally integrate transportation sustainability into their supply chains. Several companies admitted that the lack of awareness is a major difficulty in implementation of the environmental sustainability. Most textile companies suggested that the best way to implement environmental sustainability is to promote awareness among people about advantages of the environmental sustainability. Employees should take the implementation of environmental sustainability as a social responsibility. Companies should



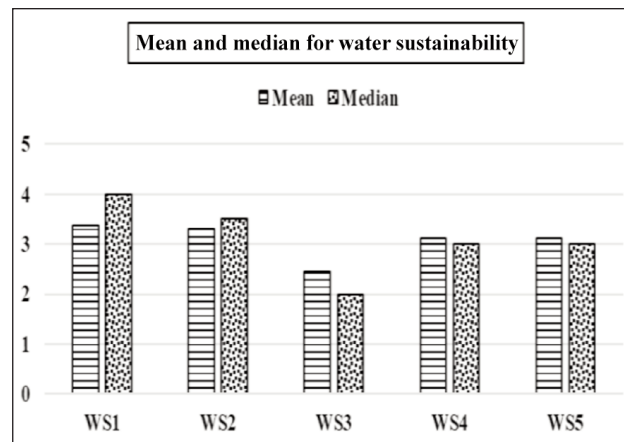
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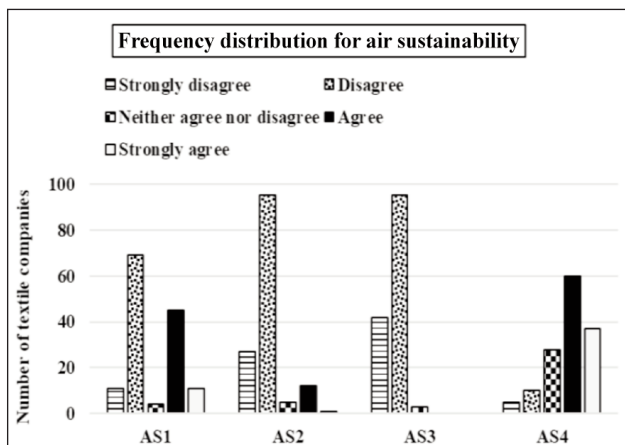
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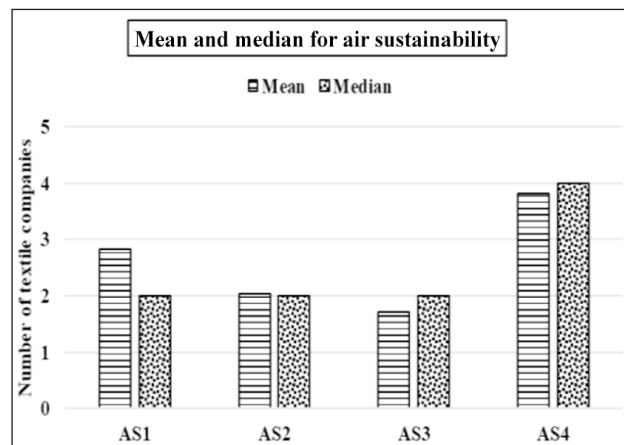
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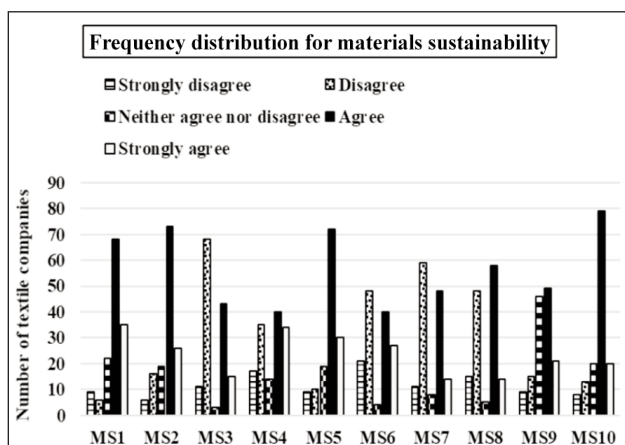
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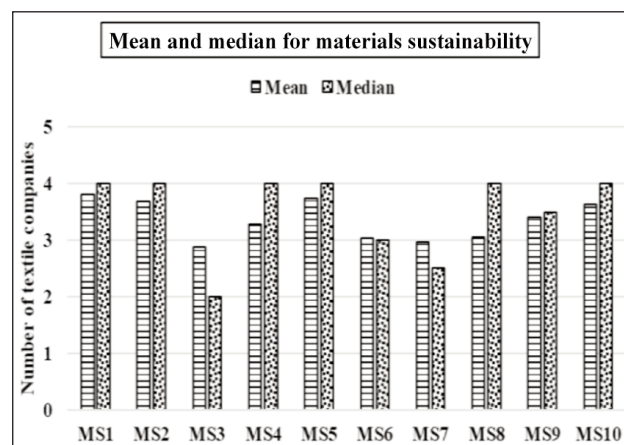
**e**



**f**



**g**



**h**

Fig. 2. Frequency distribution, mean, and median for energy, water, air, and materials



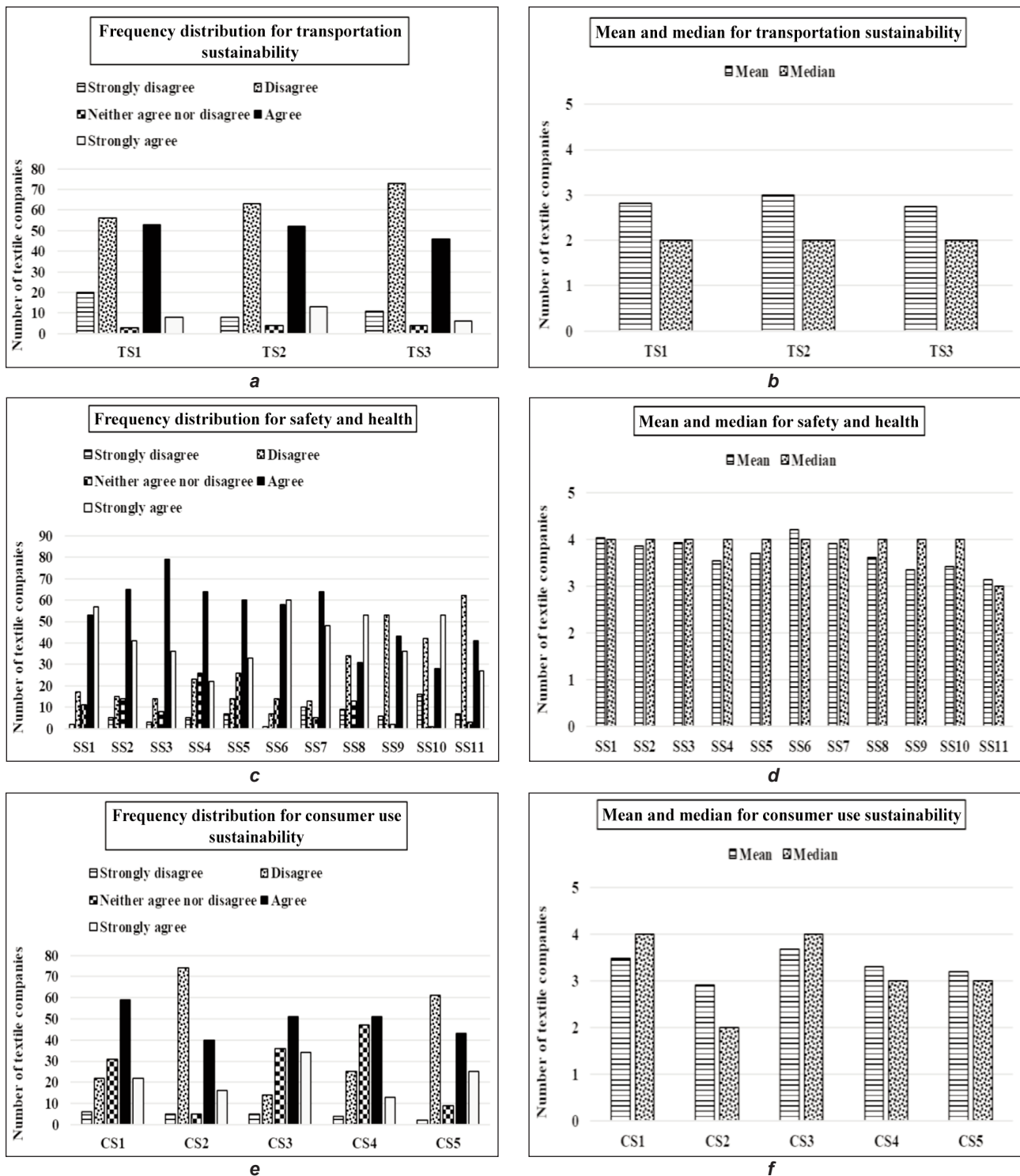


Fig. 3. Frequency distribution, mean, and median for transportation, safety and health, and consumer-use sustainability

discuss the environmental issues in their meetings at all levels. The top management should know the importance of environmental sustainability. The involvement of the top management can encourage the employees the better implementation of sustainability. Many companies said that the mindset of the industry is a major difficulty. Employees should take ownership. Companies should change their mindset at a basic level. Employees should be motivated to follow the rules related to the environment. Everybody should participate unconditionally in the protection of the environment.

Some companies said that the importance of environmental sustainability can be discussed with employees by organizing training and session presentations. Some companies suggested that environment, health, and safety teams should be formed. A few companies argued that people do not think about the future of the next generations. It is necessary to make this world a place where the next generations can survive, and the improvement in the environmental sustainability of the textile industry can play an important role.

## Safety and health

Most textile companies tend the implementation of safety and health measures for their employees (figure 3, c). It is noticeable that 79% of companies have clear guidelines for health and safety, 76% manage noise pollution, 82% have proper ventilation and lighting, 84% have safety equipment such as fire extinguishers and fire alarms, and 80% have safety gloves in the dangerous areas. However, many textile companies lack the full implementation of safety and health rules. It is evident that 61% of companies adopt dust control measures, 66% have medical adequacy, 60% avoid restricted substance list, 56% check the materials harmfulness, 58% are certified with a reputable certification system, and 49% have the waste disposal technologies for the hazardous waste. From the above statistics, it can be said that the textile companies in Pakistan are making a considerable effort toward the health and safety of their employees. Besides, several weak areas can be observed. Figure 3, d presents the mean and median for each variable in safety and health.

Several key facts were captured during the interviews and personal visits. For instance, a textile company responded that they have implemented small measures for environmental safety such as filters for dust collection, safety masks, planting trees, and a tendency to improve environmental sustainability. They have no certification, but they are hopeful to get the environmental certification shortly. They have a separate health and safety department. Another textile company responded that they are certified with ISO 14001 and OSHA 1800 systems. Many companies revealed that they lack the acquisition of reputable certifications. They said that the existing certifications need to be strict to get real benefits. Some companies revealed that the local laws are very flexible regarding environmental issues and the textile companies are taking full advantage of it. There are very low fines and least monitoring of the environmental issues inside and outside the textile companies. Therefore, the local laws should contain strict criteria for environmental sustainability, and the progress should be monitored. The companies should perform the proper monitoring of their environmental issues, such as monitoring wastewater, solid wastes, and sources of energy. The government must devise guidelines and laws that must be followed. Then, these laws and guidelines should be implemented strictly. Many companies said that improper monitoring and the flexibility in the international certifications are two important reasons for the improper implementation of environmental sustainability in the textile industry of Pakistan. The customer is demanding environmental certifications. The international certifications should implement strict criteria for certifications. Some companies said that they have installed machines that create much

noise pollution. Similarly, a good implementation of some measures such as the proper air ventilation system and the proper training was observed in some companies. The textile industry in Pakistan should increase efforts in the weak areas to ensure the health and safety of their employees.

## Consumer-use sustainability

Many textile companies agreed that they are producing durable (58%) and colour-resistant products (61%). 56% of companies lack products with technical coatings. 49% of companies agreed that their products allow environmentally friendly washing. 46% of companies said that their products are recyclable. From the quantitative data, it can be observed that many companies prefer the option “neither agree nor disagree” for durability, colour resistance and recyclability (figure 3, e). It may be because these companies are not sure about the environmental performance of their products at the consumer use phase. Figure 3, f presents the mean and median for each variable in consumer-use sustainability.

The textile industry affects the natural environment from the production of raw materials to the end-use of textile products [29, 36]. For example, textile and clothing products are at least 4% of municipal solid waste in the United States [29]. To reduce the harmful effects of products, textile companies and customers should consider consumer-use sustainability for producing a product. Nowadays, customers and retailers know that consumers are aware of the consequences of non-sustainable products. Therefore, sustainability at the consumer-use phase is demanded by environmentally conscious customers. Durability, colour resistance, technical coatings, recyclability, and eco-friendly washing are the key characteristics that can improve sustainability at the consumer-use phase.

## Weak sustainability areas

Figure 4 prioritizes the weak sustainability areas identified based on the least mean and median. The variables which indicated the means and medians nearly 4 or more than 4 may be considered as the strong areas of the textile industry of Pakistan. Strong areas include the availability of safety equipment

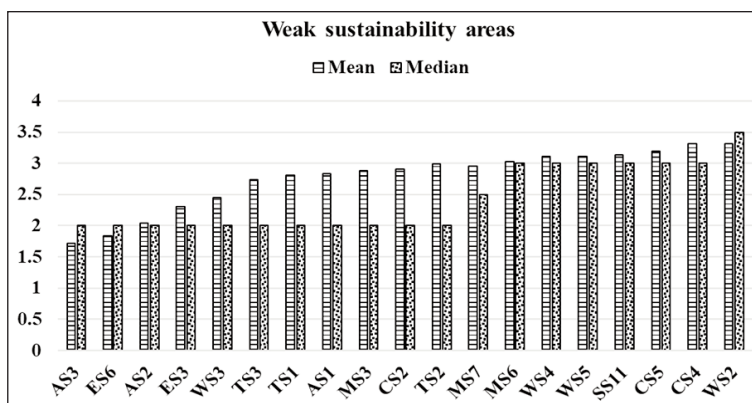


Fig. 4. Prioritization of weak sustainability areas based on least mean and median

such as fire extinguishers and fire alarms, clear guidelines for suitable lighting and ventilation, health and safety, the use of safety gloves in dangerous places, and the management of noise pollution. The variables which indicated the means and medians remarkably less than 4 may be considered as the weak areas. These weak areas should be given more preference to balance the efforts in all areas of sustainability. These results confirm the results achieved through frequency distribution.

### Comparison between seven major factors of the environmental sustainability

Figure 5 presents the comparison between the seven major factors of environmental sustainability based on the mean sustainability (i.e., grand mean) of each factor. The grand mean for each factor was calculated by taking the average of the means of all the variables within a factor. It can be observed that the safety and health factor looks superior to all the other six factors. However, a remarkable sustainability gap can be observed for each factor in figure 5. Hence, there is no strong factor of sustainability in the textile industry of Pakistan.

### INSIGHTS FOR POLICYMAKERS AND PRACTITIONERS

This research provides various insights for policymakers and practitioners. The proposed survey instrument contains a strict and comprehensive environmental criterion to evaluate the existing practices in the textile industry. Based on the results, policymakers and practitioners can make possible policies to increase the practical implementation of the proposed tool. The results of the proposed survey help in the identification of various policies and practices. These policies can be used the improvement of the existing situation in the maximum number of textile companies. However, the development and implementation of the relevant policies cannot be achieved without the proper involvement of the government, the textile industry, and society. Today, international customers and retailers are under pressure to select the manufacturing destination based on strict environmental criteria. As a result, they are reconsidering the manufacturing destinations based on the environmental criteria. The manufacturers with poor environmental practices will be eliminated from the lists of international customers. Hence, the local governments should help the textile industry in the recent challenges. Otherwise, the gradual decrease in international customers will cause an economic crisis and unemployment. Such issues can be addressed through the implementation of various strategies. The first strategy is to increase awareness among all the concerned groups focusing on the topics such as social responsibility, implementation of eco-friendly techniques, benefits of the clean environment, and

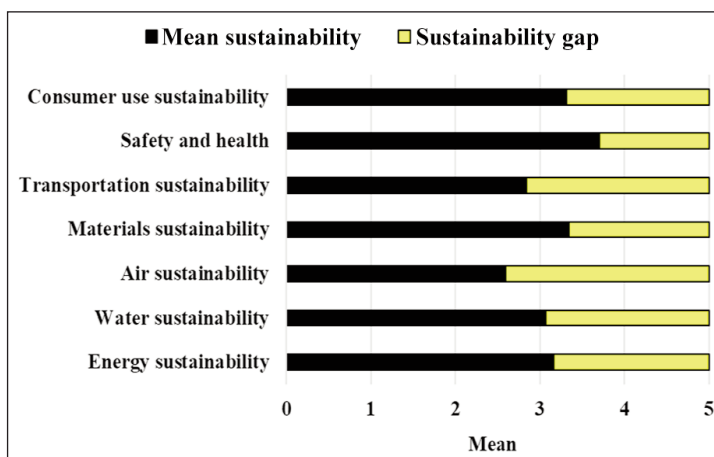


Fig. 5. Mean sustainability for seven factors

health and safety rules. Many textile companies in developing countries do not have enough resources to deal with environmental challenges. In this regard, government support is a very powerful tool for the implementation of eco-friendly practices. The collaboration of government, textile industry, and institutions is the best way to achieve sustainable development goals. In addition, the government should implement eco-friendly and practical policies, guidelines, and laws for the textile industry. Moreover, there should government, textile industry, and relevant institutions should develop effective mechanisms for monitoring environmental issues, such as wastewater, solid wastes, and sources of energy. In addition, the policymakers and practitioners should encourage the textile industry the adoption of ecofriendly techniques and technologies to save water, energy, and materials.

### CONCLUSION

This research evaluates the environmental sustainability situation of the textile industry in Pakistan. It can be concluded that the Pakistani textile industry has not achieved an adequate level of sustainability in any area. The industry has some strong areas that include some health and safety variables. There are many areas in which the performance is weakest such as trapping and storing hazardous gases, using waste to produce energy, measuring the level of emissions, using renewable energy sources, and using waterless or reduced water techniques. Hence, these weakest areas need more attention. However, the textile companies need to focus on all the variables enlisted in the environmental sustainability implementation index. Moreover, the companies that have negligible interaction with international customers lack the implementation of environmental sustainability due to flexibility in the local laws. The companies involved in international trade tend the adoption of environmental sustainability practices due to the motivation and pressure from international customers. However, they are not very successful due to the national issues and weaknesses in the international certifications. Hence, the textile companies

need special focus on the proper sustainability practices regardless of having or not having exposure to the international markets. Besides, the textile companies are unsuccessful in the satisfactory adoption of environmental sustainability due the issues such as lack of awareness and knowledge, lack of government support, flexibility in the local laws, flexibility in the international certifications, lack of monitoring by managers, ineffective utilization of resources, the non-interest of the top management, and improper

production planning. In the end, it can be concluded that although the Pakistani textile industry has started taking certain steps regarding environmental sustainability, they are far behind the international standards and a lot of efforts are needed at a rapid pace. This study suggests that the implementation of environmental sustainability practices can be achieved through effective collaboration between policy makers, practitioners, and relevant institutions.

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