

University of Mauritius

Department of Mechanical and Production Engineering

Development of a sustainability index framework for the Mauritian textile industry

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Outline of Presentation

Introduction

Rationale of the research project

Aims and Objectives of the study

Sustainability frameworks

Methodology

Sustainability Index Framework Development

Framework Testing

Results and Discussions

Conclusions

Future Work



Introduction



- Planet earth is our sole home
- Depletion of natural resources
- Consumption patterns- consuming the earth's resources at an accelerating pace as if we had one additional planet to draw upon
- Challenges of the 21st Century- climate change
- Necessity for a more sustainable world/planet
- Idea of Sustainable Development as a solution to improve life for upcoming generations dated back to 1972, during the Stockholm Conference (United Nations Conference on Human Environment)
- Sustainable Development Goals (SDGs) – support for a dedication towards a wide sustainability plan



SUSTAINABLE DEVELOPMENT GOALS

17 GOALS TO TRANSFORM OUR WORLD



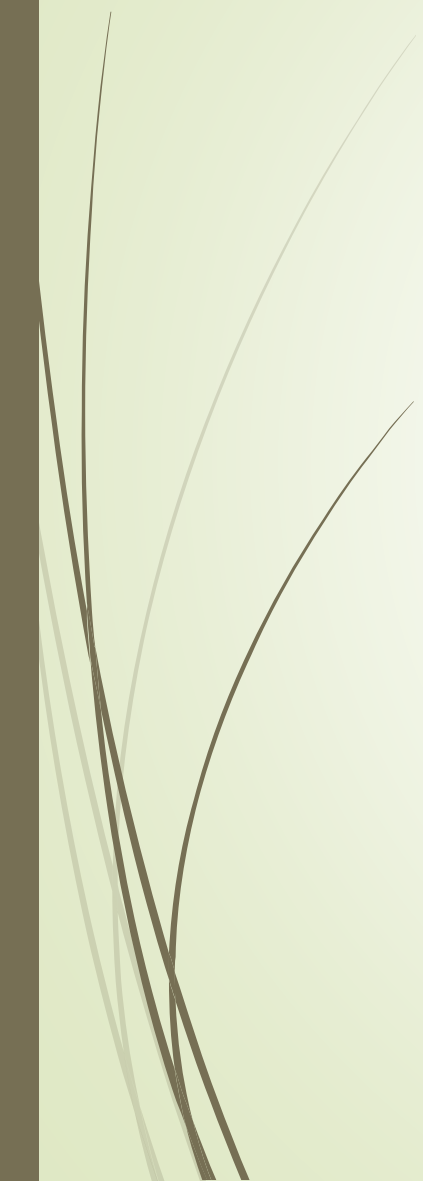
Mauritian textile industry

Success of the Textile Industry in Mauritius lied on three fundamental aspects:

1. Conducive environment for investment
2. Exogenous factors – (oil price, appreciation of euros, political uncertainties of competing countries, civil war in Sri Lanka from 1983 to 2009 etc...)
3. Preferential Trade Agreements (MFA, access to EU and US markets under the Lome Convention and the Generalized System of Preferences (GSP)

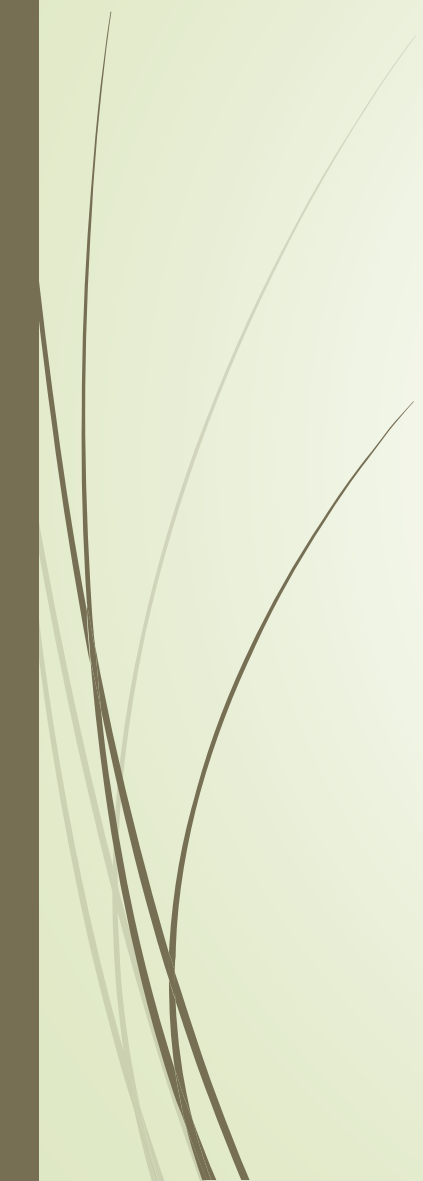


Current Situation of the Mauritian Textile Industry

- Mauritius has benefitted from numerous positive conditions which have helped to create a strong Textile Industry.
 - Impacts of phasing out or dismantling of trade/preferential agreements.
 - Increased competition from countries like China, India, Bangladesh, Vietnam etc
 - Employment in the textile industry has gone down from 80 000 worker and reached 53 000 persons, in a decade.
- 



Challenges of the Mauritian Textile Industry

- Develop strategies post AGOA to sustain beyond 2025
 - Too much reliability on imported raw materials
 - Focus on regional markets instead of traditional ones (EU, US)
 - Shortage of labor in the textile industry
 - Invest on innovative technologies
 - Focus on 'Sustainability' as an order winning criteria
- 

Environmental impacts of textile companies



Sustainability in the textile industry



Objectives of this project

- Studying the textile industry and assessing the level of awareness of textile companies with respect to sustainability
- Identifying a set of economic, social and environmental indicators relevant to the Mauritian textile industry
- Developing of an appropriate framework for sustainability assessment of textile companies in Mauritius



Sustainability frameworks in the world

Framework number	Name of framework
1	CDSB Climate Change Reporting Framework
2	Global Reporting Initiative (GRI) framework
3	Carbon disclosure project (CDP)
4	Ford Product Sustainability Index (PSI)
5	Dow Jones Sustainability indexes(DJSI)
6	A framework for advancing environmental and social sustainability in the United Nations system
7	IPIECA Climate Change Reporting Framework
8	Environmental Sustainability Index (ESI)
9	Organizations for Economic Cooperation and Development (OECD)
10	Environmental, Social, and Corporate Governance (ESG) Disclosure Framework
11	Global Framework for Climate Risk Disclosure
12	IFC Sustainability Framework
13	The Joint World Bank-IMF Debt Sustainability Framework for Low-Income Countries
14	CSD framework
15	Higg Index



Methodology

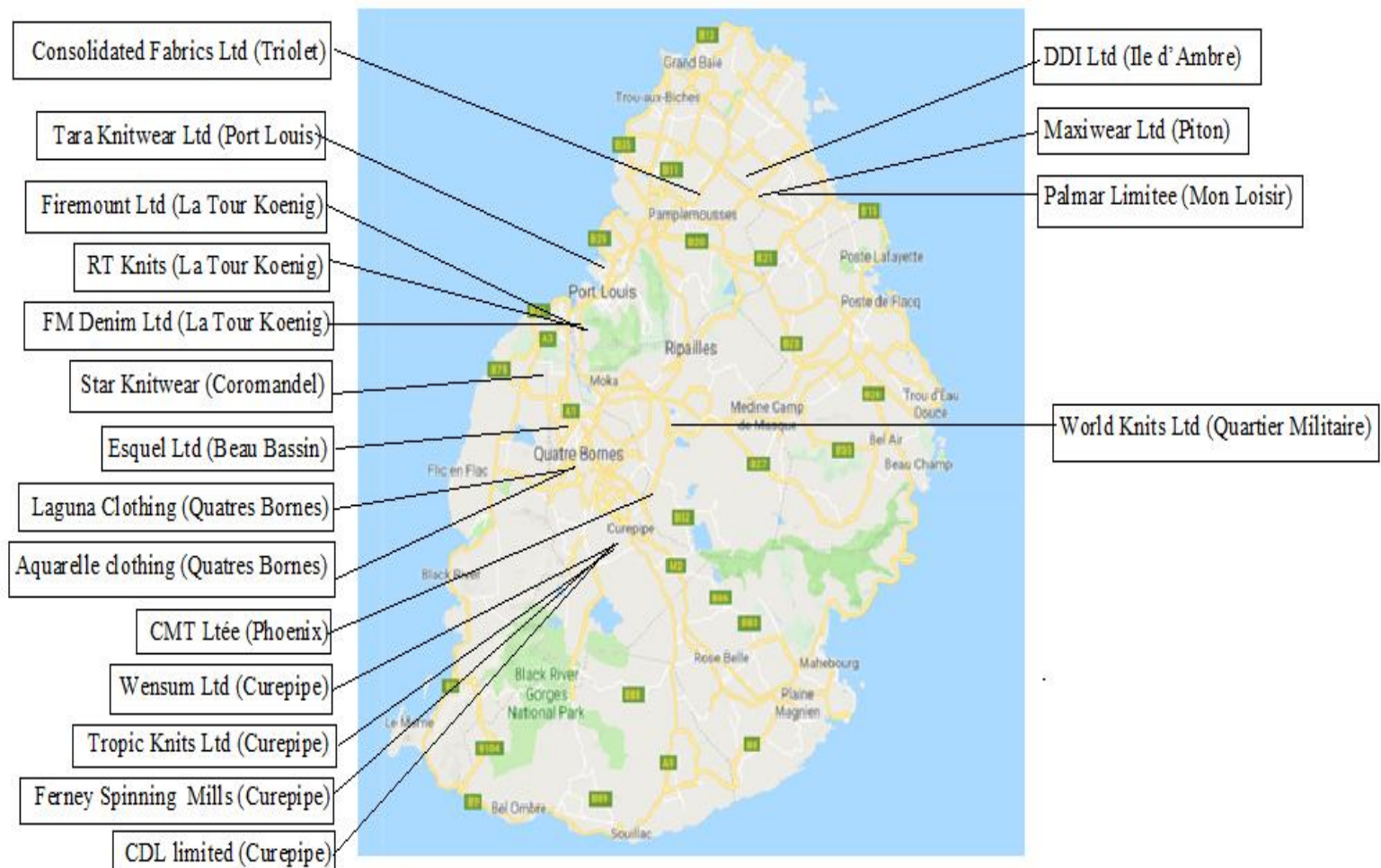
➤ Phase 1

- ☐ Review of sustainability frameworks worldwide
- ☐ Awareness of sustainability in the textile industry
- ☐ Identification of relevant parameters for the development of the sustainability framework for the textile industry

➤ Phase 2

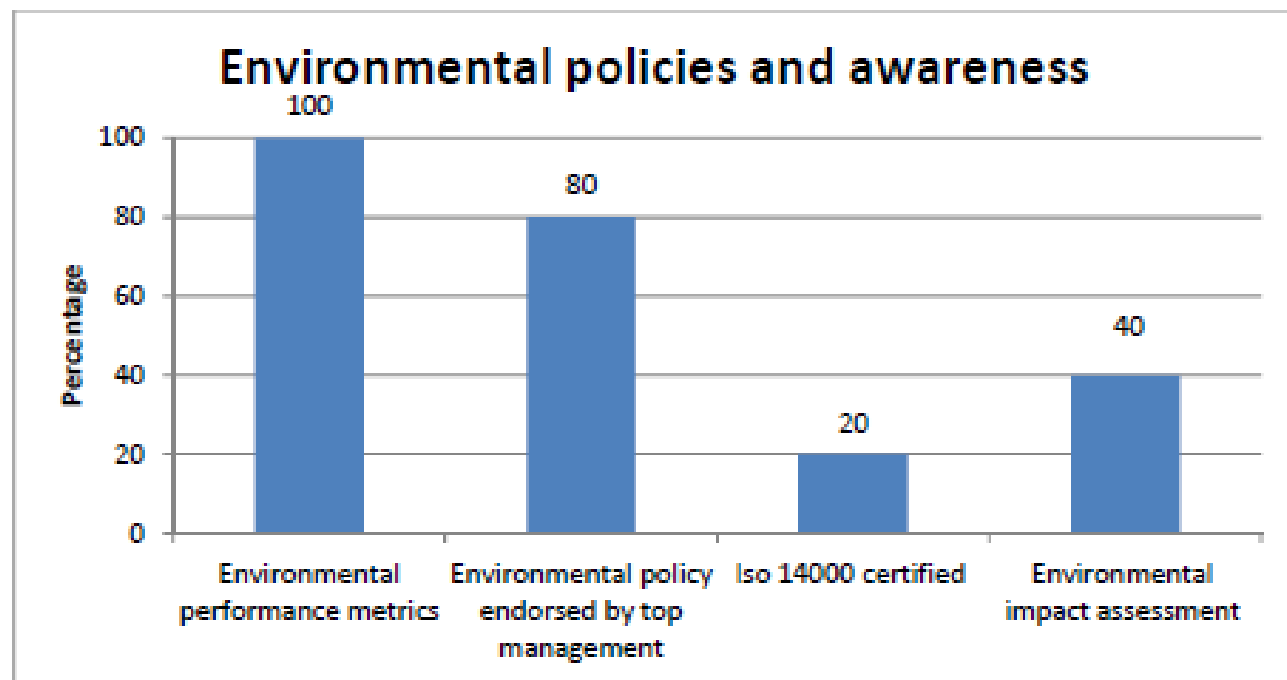
- ☐ Development of the sustainability framework for the Mauritian textile industry
- ☐ Testing of the framework in 5 companies

Sustainability awareness in Mauritian textile companies

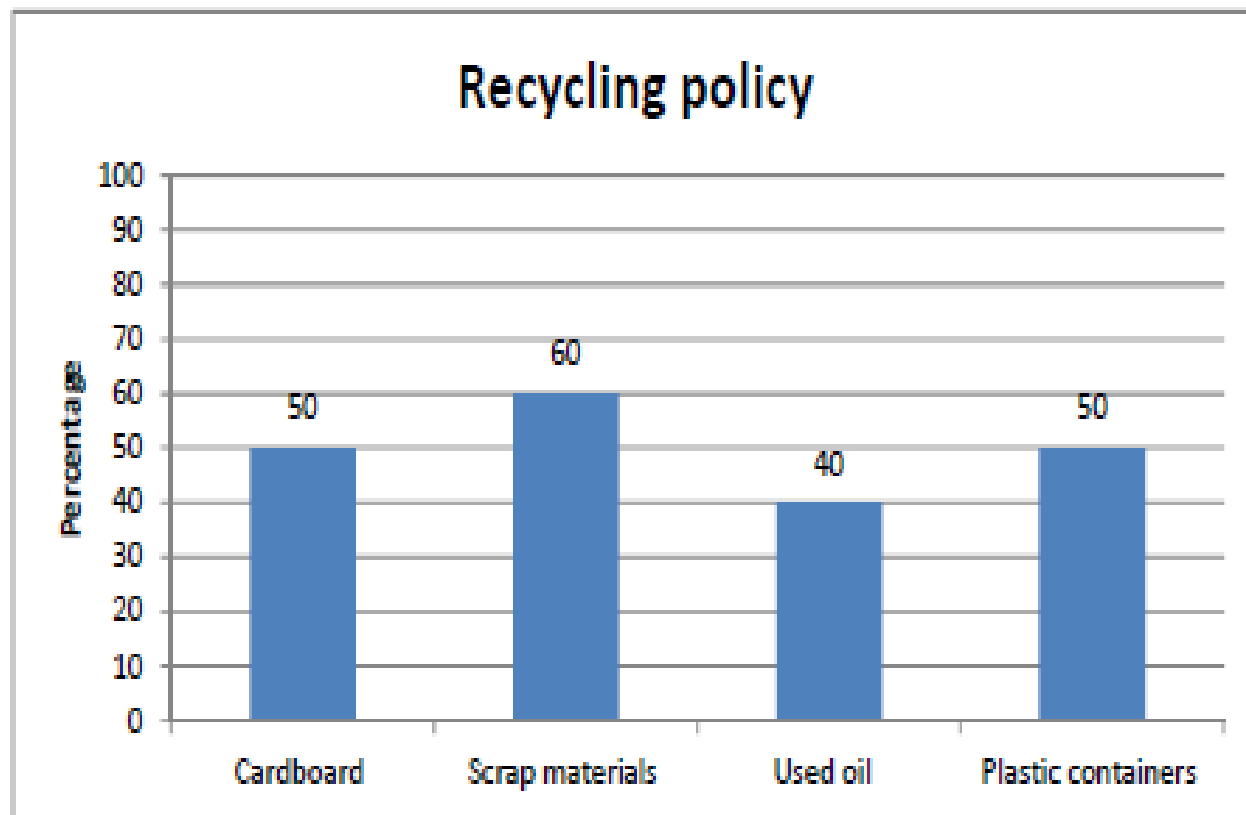


Sample results from Phase 1

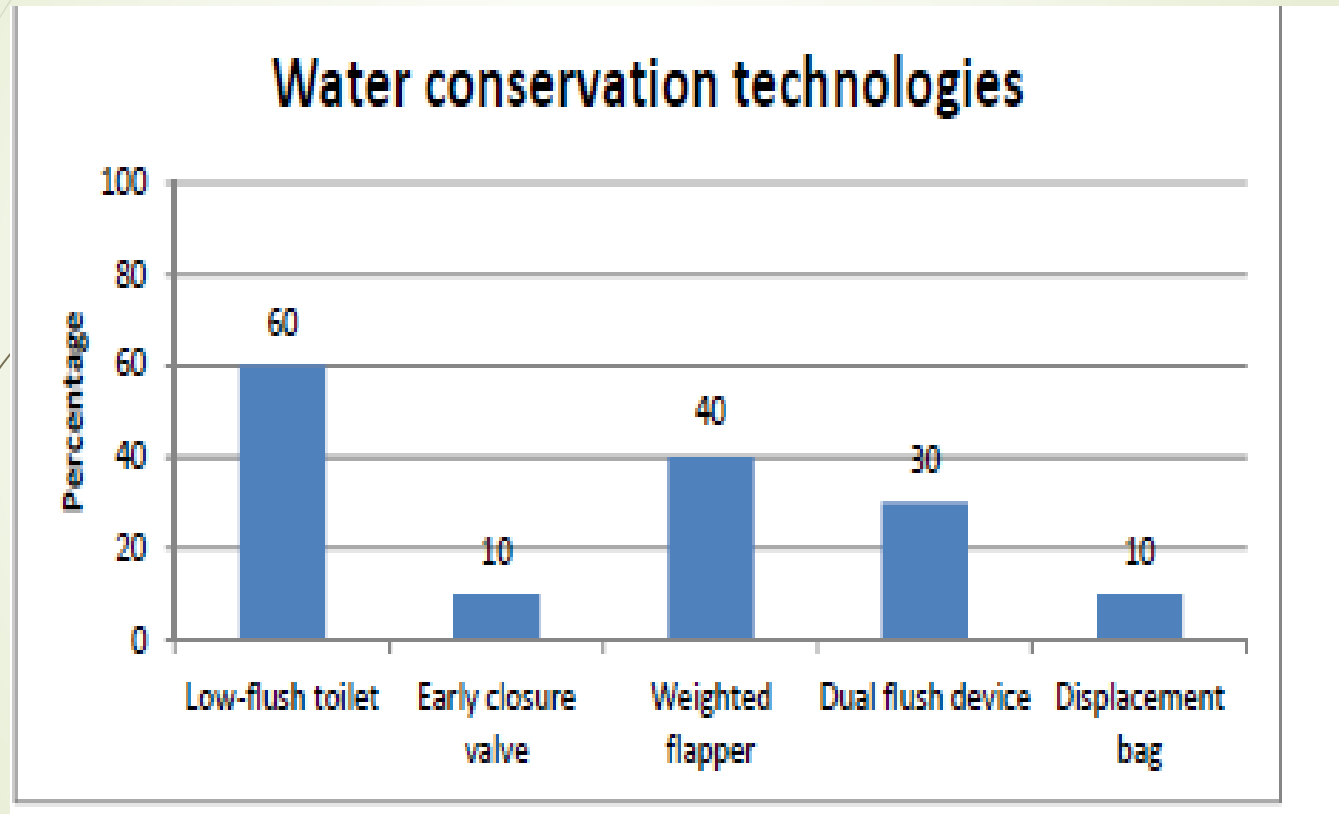
Environmental Policies, Procedures and Awareness



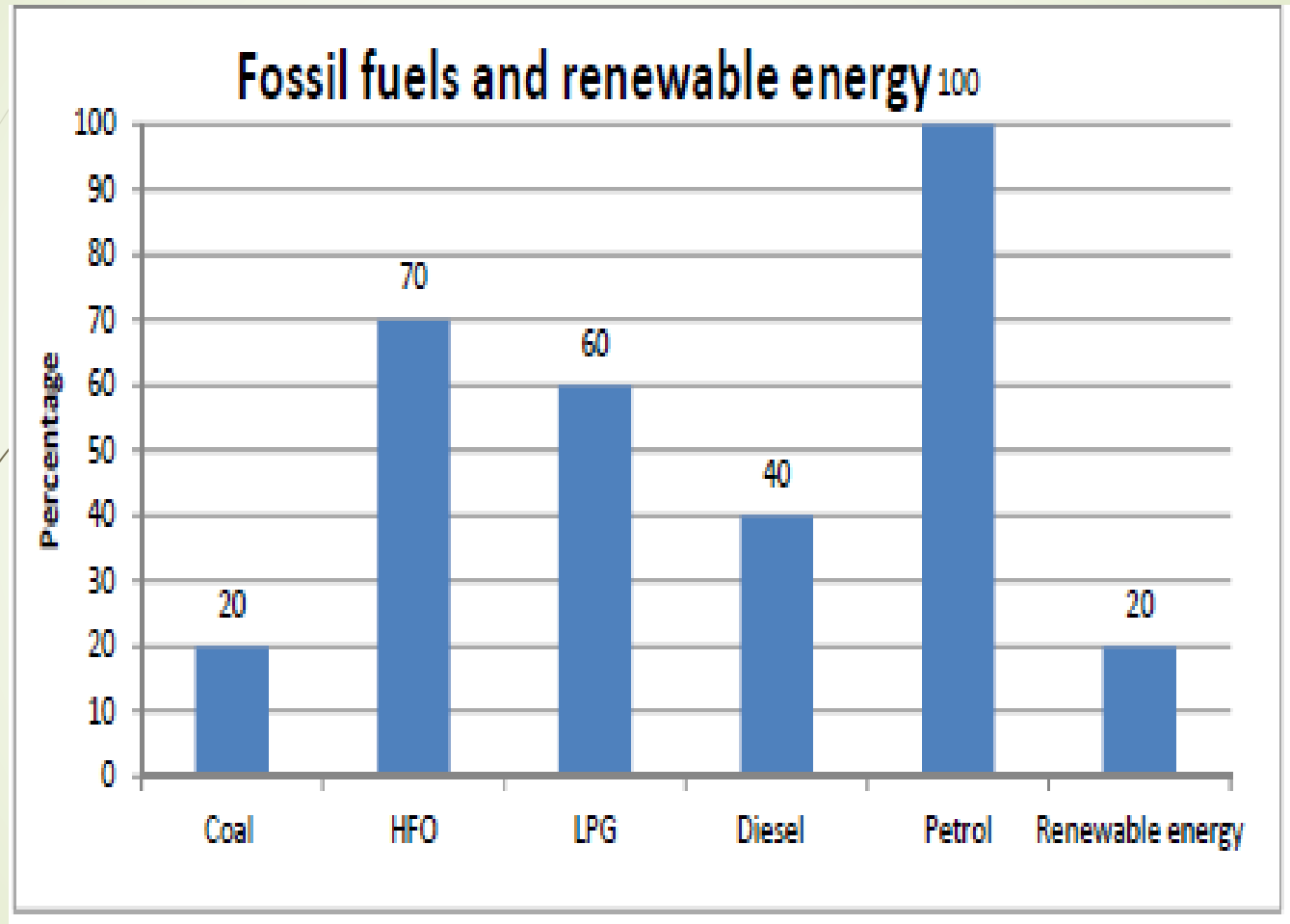
➤ Solid Waste Generation



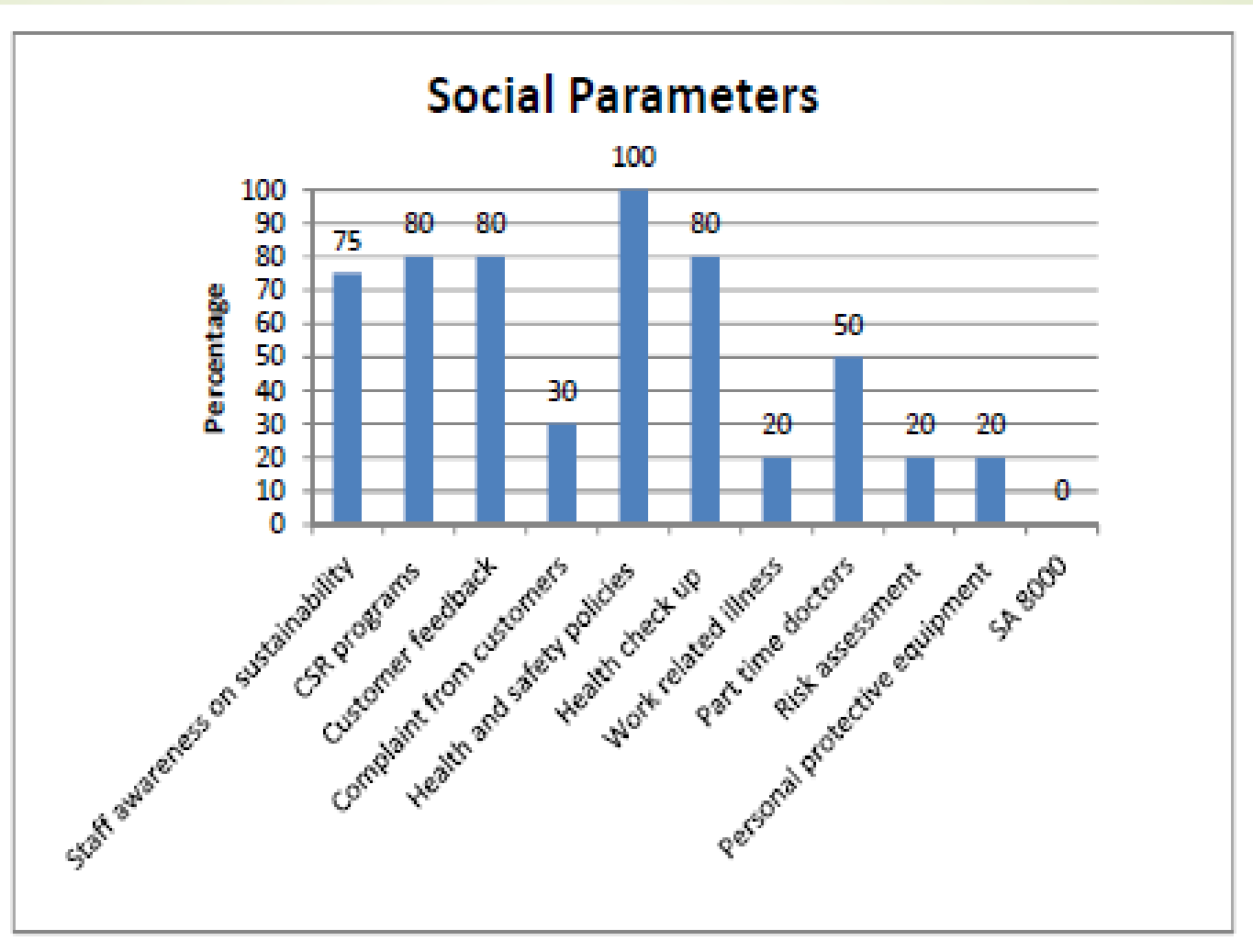
Water Use



➤ Energy Use

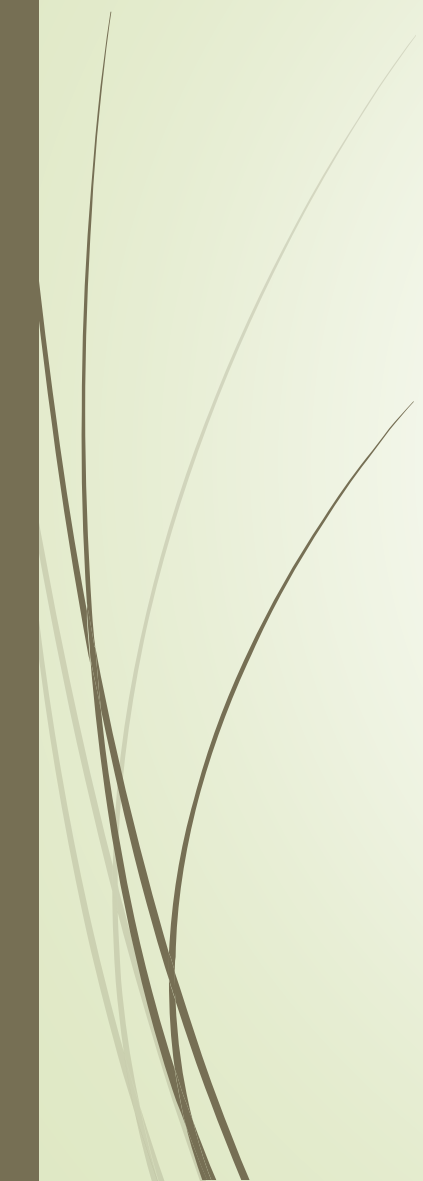


➤ Social





Development of sustainability framework

- Set of indicators formulated based on review of sustainability frameworks (see next slide) and the awareness survey findings.
 - The proposed framework has been developed using the indicators in the various categories as a worksheet to serve as an effective tool for analysis at various levels of details.
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Methodology



Water

Biodiversity

Air Emissions

Certification


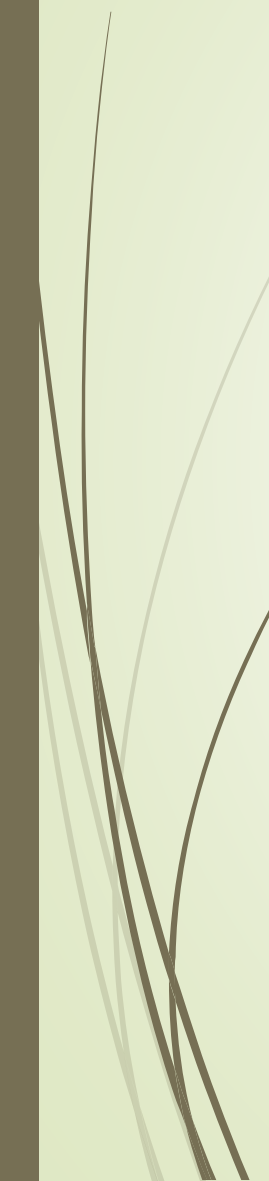
Ecological
Materials

Compliance

Energy

Transport

Hazardous
Materials
Handling

Category	Number of indicators
Environment	174
- Water	22
- Biodiversity	2
- Air Emissions	67
- Solid Waste	6
- Effluent	25
- Eco Materials	6
- Hazardous materials management	9
- Supply chain and products	2
- Compliance	2
- Certifications	10
- Transport	1
- Energy	22
Economic	15
Social	30
Total	219

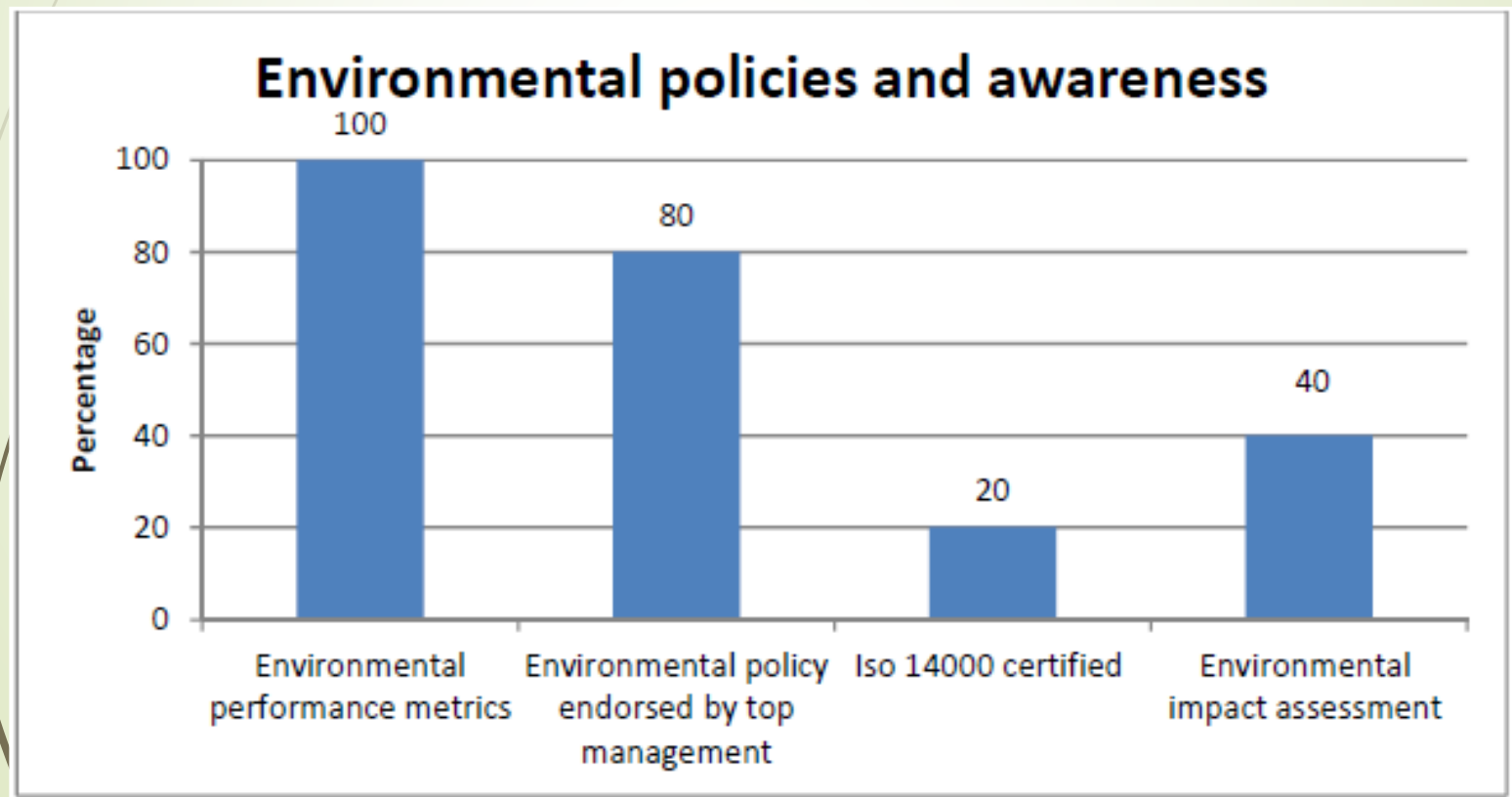


Development of sustainability framework

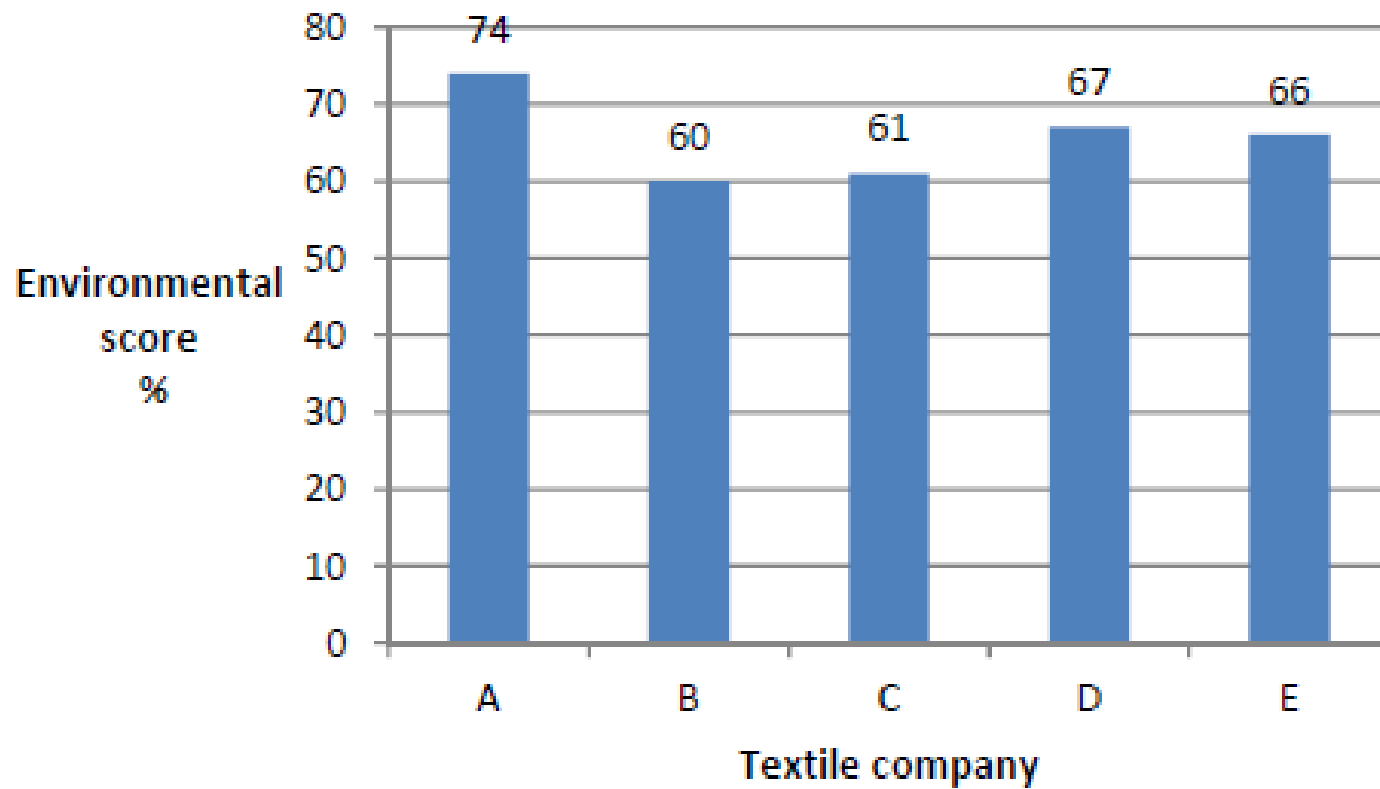
- A sustainability index is generated from the various inputs.
- The GHG emissions are also reported based on the various fuels used.
- The framework has been applied for five textile companies who were willing to run a sustainability audit and share their data.
- Detailed equations and thresholds used to develop the framework are provided in the project report.

Results

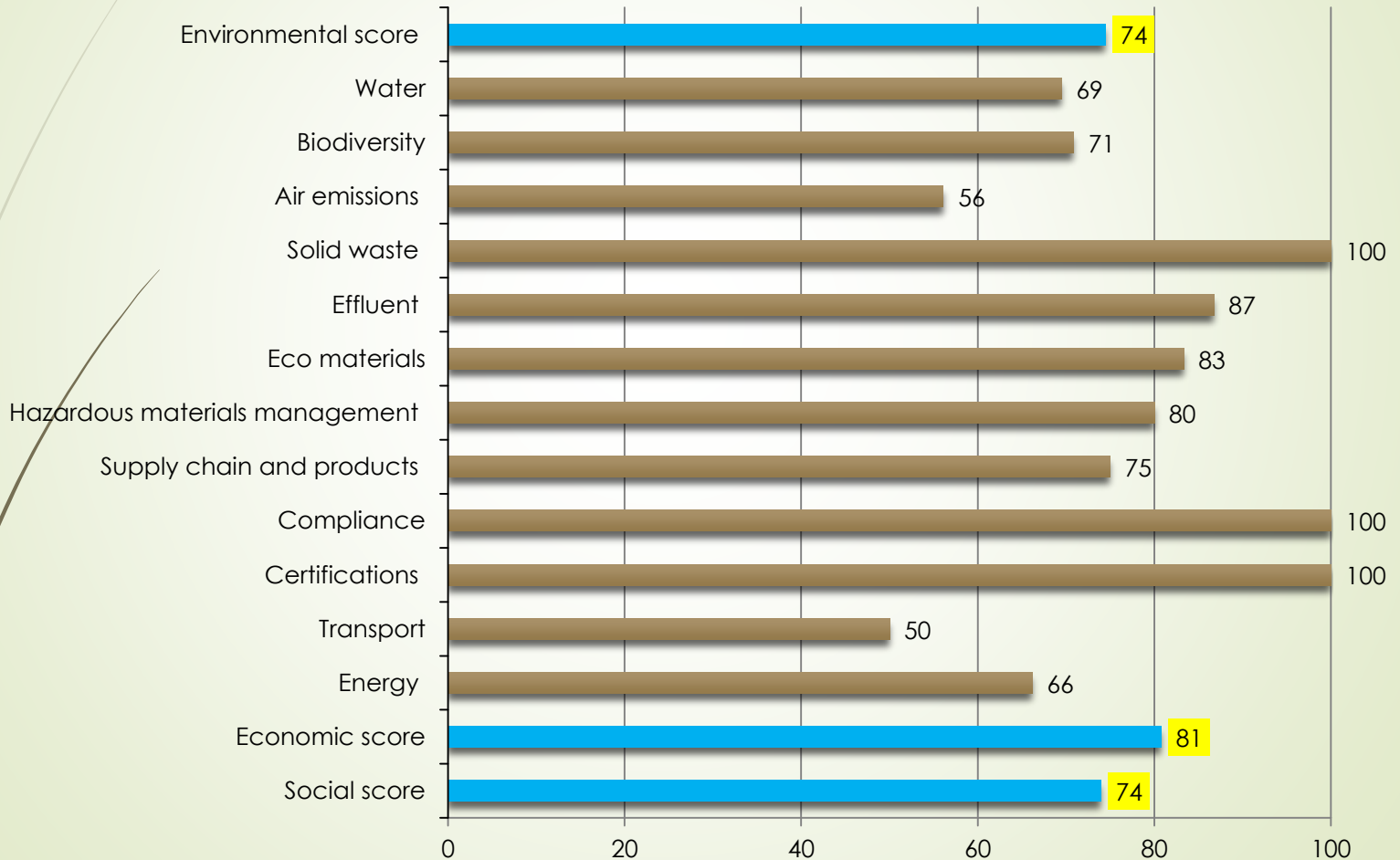
- 100% of companies surveyed reported to have a sustainability agenda, with 40% reporting to have a sustainability report.



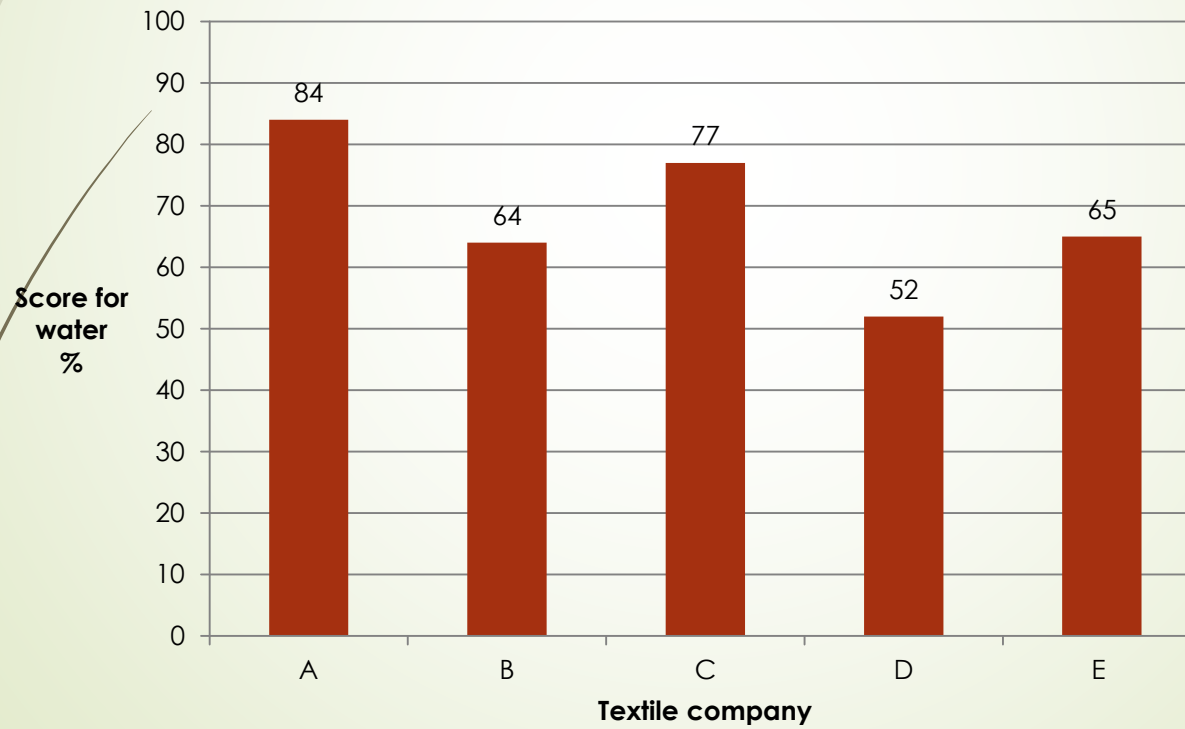
Results



Results



Water

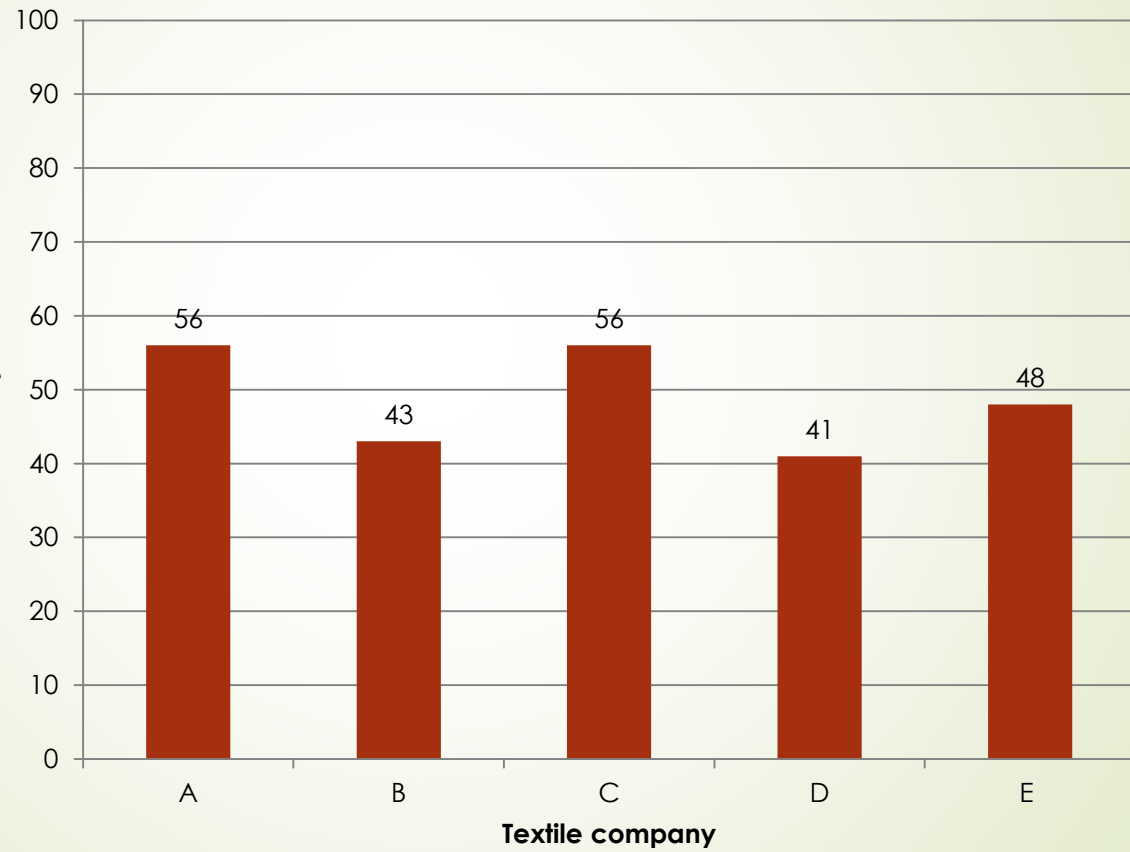


Water indicators

Indicators	Unit	Benchmark	Company				
			A	B	C	D	E
Measurement of monthly water consumption	NA	NA	✓	✓	✓	✓	✓
Total water use per month	m ³	NA	19639	2321	18952	33500	36000
Leak detection system	NA	NA	✓	✓	✓	✓	✓
Water audit	NA	NA	✓	✓	✓	✓	✓
Percentage of water recycled	%	NA	0	0	0	0	3
Boiler condensate recycling system	NA	NA	✓	✗	✓	✓	✓
Dyehouse water consumption per kilogram output of yarn	L/Kg	50	NA	NA	15	-	NA
Dyehouse water consumption per kilogram output of knitted fabric	L/Kg	120	45	NA	NA	-	-
Dyehouse water consumption per kilogram output of woven fabric	L/Kg	100	28	NA	NA	-	NA
Innovative DyeCoo waterless dyeing technology	NA	NA	✗	NA	✗	✗	✗
Innovative waterless AirDye technology	NA	NA	✗	NA	✗	✗	✗
Automatic shut-off valve	NA	NA	✓	✗	✓	✗	✗
Water conservation technologies in laundry	NA	NA	✓	NA	NA	NA	NA
Laundry water consumption per kilogram output	L/Kg	26	15	NA	NA	NA	NA
Scouring water consumption per kilogram output	L/Kg	6	NA	NA	-	-	NA
Mechanical dewatering equipment	NA	NA	✓	NA	✓	✓	✓
Reuse of rinsing water leftover from cleaning the printing belt	NA	NA	✓	NA	NA	NA	NA
Flow control devices	NA	NA	✓	✓	✓	✓	✓
Low flush features in bathroom facilities	NA	NA	✓	✓	✓	✓	✓
Water conservation technologies in toilets	NA	NA	✓	✓	✓	✗	✓
Percentage reduction in overall water consumption	%	NA	5	-	3	2	-
Severity of impacts on ecosystems by use of water	NA	NA	Marginal	Marginal	Marginal	Marginal	Marginal

Air emissions

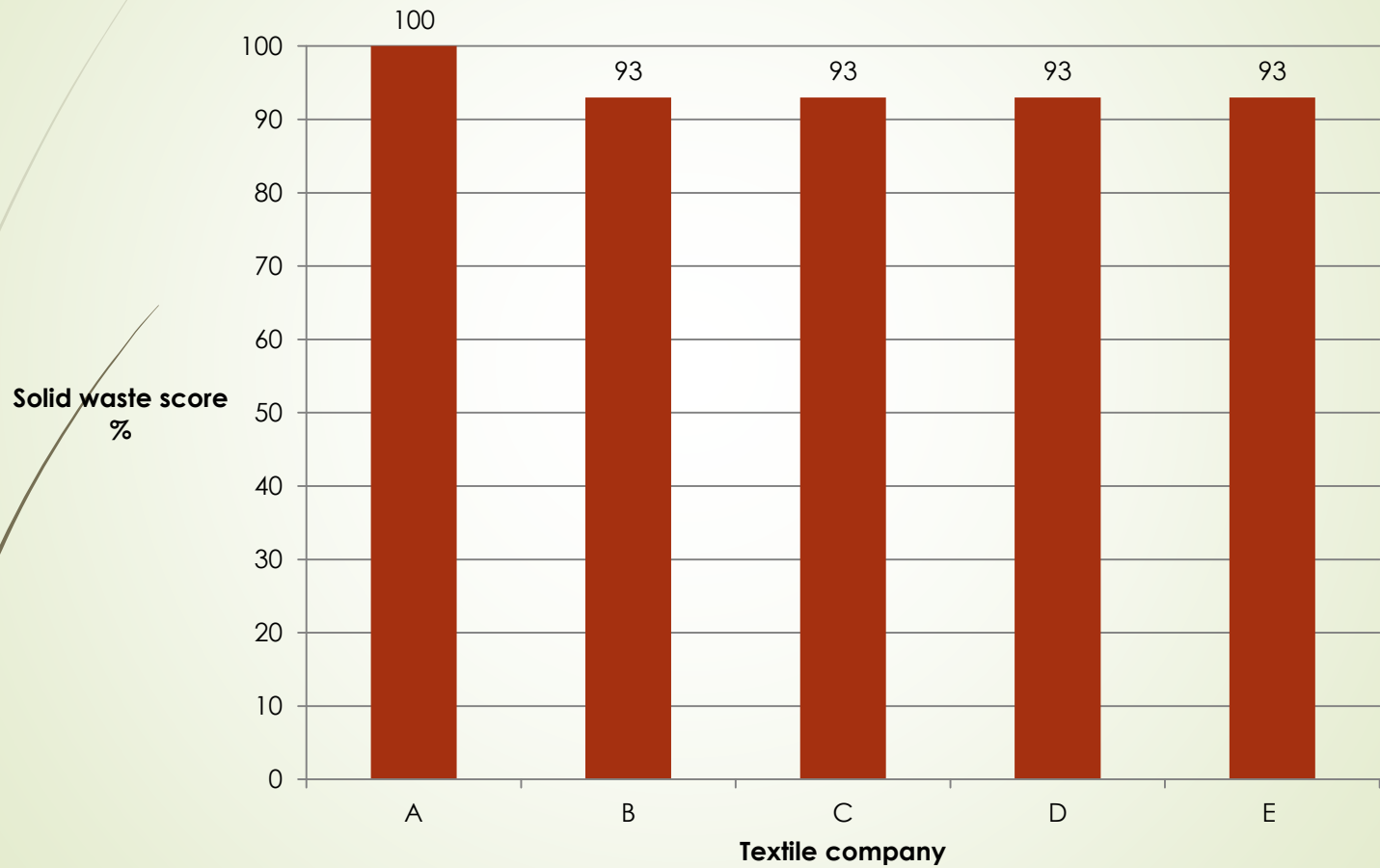
Air emissions score
%



Air emissions indicators

Indicators	Unit	Benchmark	Company				
			A	B	C	D	E
Measurement of monthly fossil fuel consumption	NA	NA	✓	✓	✓	✓	✓
Total direct GHG emissions from all fuels at source	tCO ₂ e	NA	449	13.46	368.73	873.75	382.14
Electricity consumption per month	KW	NA	327218	125322	253952	210384	326985
Total indirect GHG emissions from electricity consumption	tCO ₂ e	NA	134	51.64	104.64	86.69	134.73
Total GHG emissions (direct + indirect)	tCO ₂ e	NA	584	65.10	473.37	960.44	516.88
Electricity generation per month from renewable energy	kw	NA	0	0	0	0	0
GHG offset from renewable energy	tCO ₂ e	NA	0	0	0	0	0
Life cycle carbon emissions	tCO ₂ e	NA	-	-	-	-	-
Use of chlorofluorocarbons (CFCs)	NA	NA	✗	✗	✗	✗	✗
Implementation of strategies to reduce overall GHG emissions	NA	NA	✓	✓	✓	✓	✓
Stack emissions monitoring	NA	NA	✓	✗	✓	✗	✓
Carbon Monoxide (CO)	mg/m ³	1000	425	-	235	-	259
Sulphur Dioxide (SO ₂)	mg/m ³	2000	520	-	365	-	629
Sulphur trioxide (SO ₃)	mg/m ³	120	-	-	-	-	253
Oxides of Nitrogen (NO _x)	mg/m ³	1000	184	-	-	-	233
Actual Particulate Matter Load	mg/m ³	200	296	-	-	-	152
Control technologies to reduce CO emissions	NA	NA	✗	-	✗	-	✗
Control technologies to reduce particulate matter emissions	NA	NA	✓	-	✓	-	✗
Control technologies to reduce NO _x emissions	NA	NA	✗	-	✗	-	✗
Control technologies to reduce SO _x emissions	NA	NA	✗	-	✗	-	✗
Hydrogen Sulphide (H ₂ S)	mg/Nm ³	5	-	NA	NA	-	-
Volatile organic compounds (VOCs)	mg/Nm ³	75	-	NA	NA	NA	-
Formaldehyde	mg/Nm ³	20	-	NA	NA	NA	-

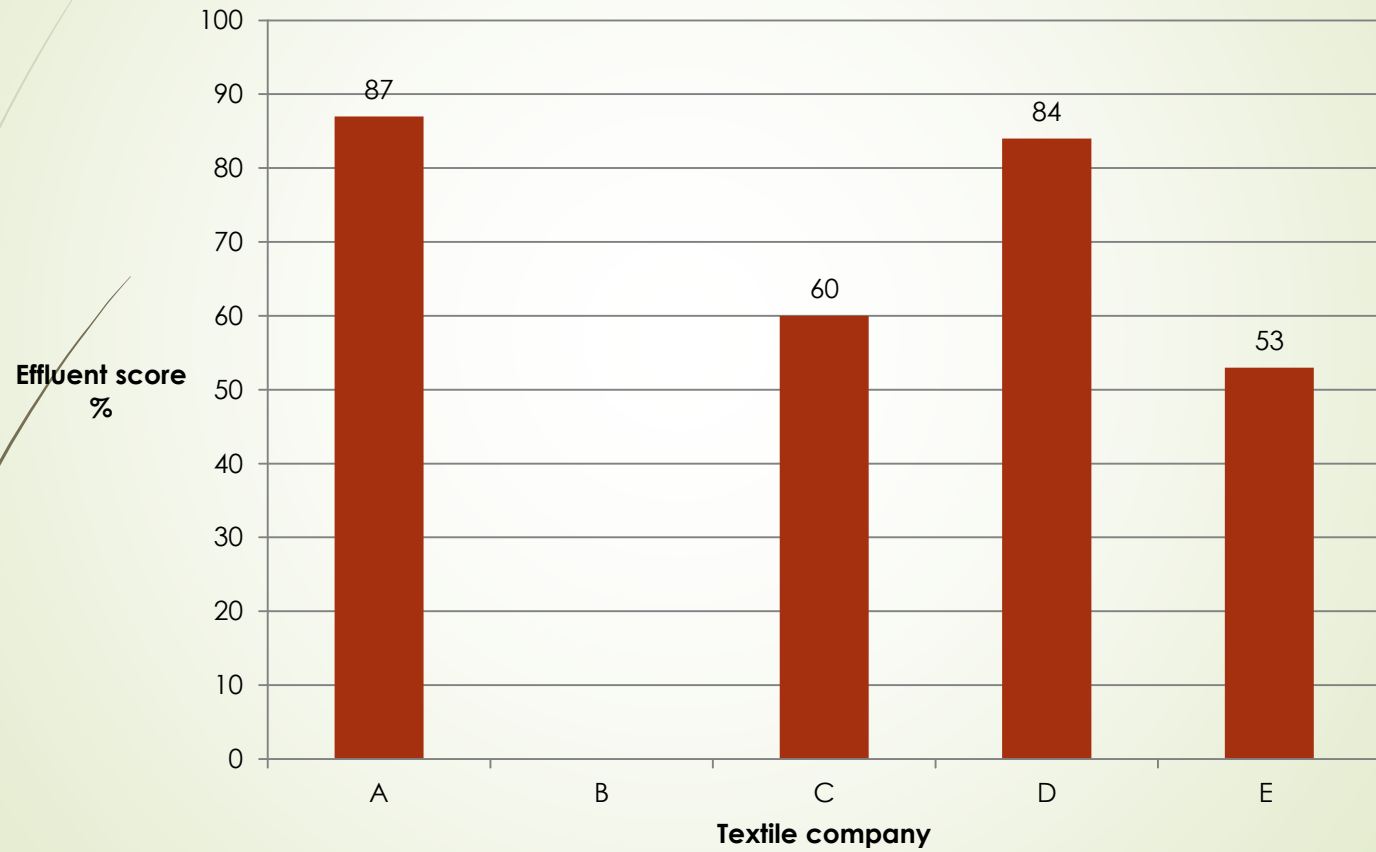
Solid waste



Solid waste indicators

Indicators	Unit	Benchmark	Company				
			A	B	C	D	E
Monthly measurement of amount of solid waste generated	NA	NA	✓	✓	✓	✓	✓
Total amount of waste generated per month	†	NA	32	8.5	510	2200	27
Transportation of any hazardous waste	NA	NA	✗	✗	✗	✗	✗
Production of any type of radioactive waste	NA	NA	✗	✗	✗	✗	✗
Recycling of any type of waste material for reuse	NA	NA	✓	✓	✓	✓	✓
Percentage of waste recycled and reused	%	NA	7	3	3	5	3

Effluent

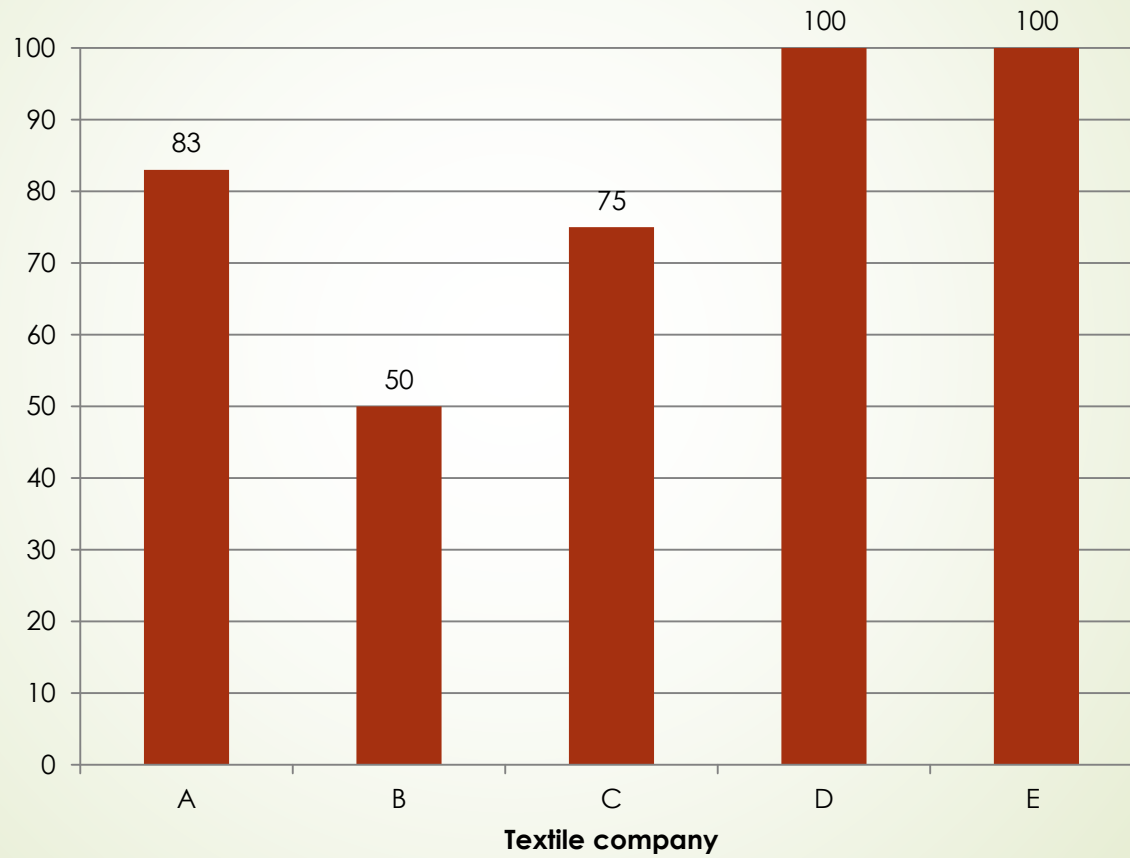


Effluent indicators

Indicators	Unit	Benchmark	Company				
			A	B	C	D	E
Production and discharge of industrial effluent	NA	NA	✓	✗	✓	✓	✓
Average volume of effluent generated per month	m ³	NA	15000	NA	1582	2200	30000
Effluent generation per unit product	L/kg	180	-	NA	-	-	-
Effluent treatment plant	NA	NA	✓	NA	✓	✓	✓
Implementation of advanced effluent treatment technologies	NA	NA	✗	NA	✗	✗	✗
Regular analytical testing of effluent	NA	NA	✓	NA	✓	✓	✓
Biological oxygen demand (BOD)	mg/l	40	20	NA	18.5	14	23
Chemical oxygen demand (COD)	mg/l	120	60	NA	46	81	52
pH	-	5 to 9	7.6	NA	7.2	8.1	6.8
Reactive Phosphorus	mg/l	1	0.12	NA	0.12	0	0.19
Nitrate as N	mg/l	10	1.2	NA	-	6.6	-
Nitrite as N	mg/l	1	0.05	NA	-	0	-
Ammoniacal nitrogen	mg/l	1	0.4	NA	-	0	-
Sulphate	mg/l	1500	30	NA	-	51	-
Sulphide	mg/l	0.002	0.002	NA	-	0	-
Oil and grease	mg/l	10	0.18	NA	1.5	0.18	0.2
Total Kjeldahl Nitrogen (TKN)	mg/l	25	5.9	NA	-	0	2.3
Total suspended solids	mg/l	35	12	NA	6.5	18	18
Temperature	°C	40	28	NA	24.6	27.9	25
Detergents	mg/l	15	-	NA	-	0	-
Zinc	mg/l	2	0.01	NA	0.05	0.01	-
Copper	mg/l	0.5	0.001	NA	-	0	-
Chromium	mg/l	0.05	0.001	NA	-	0.001	-
Proper disposal of sludge	NA	NA	✓	NA	✓	✓	✓

Eco materials

Eco materials score
%

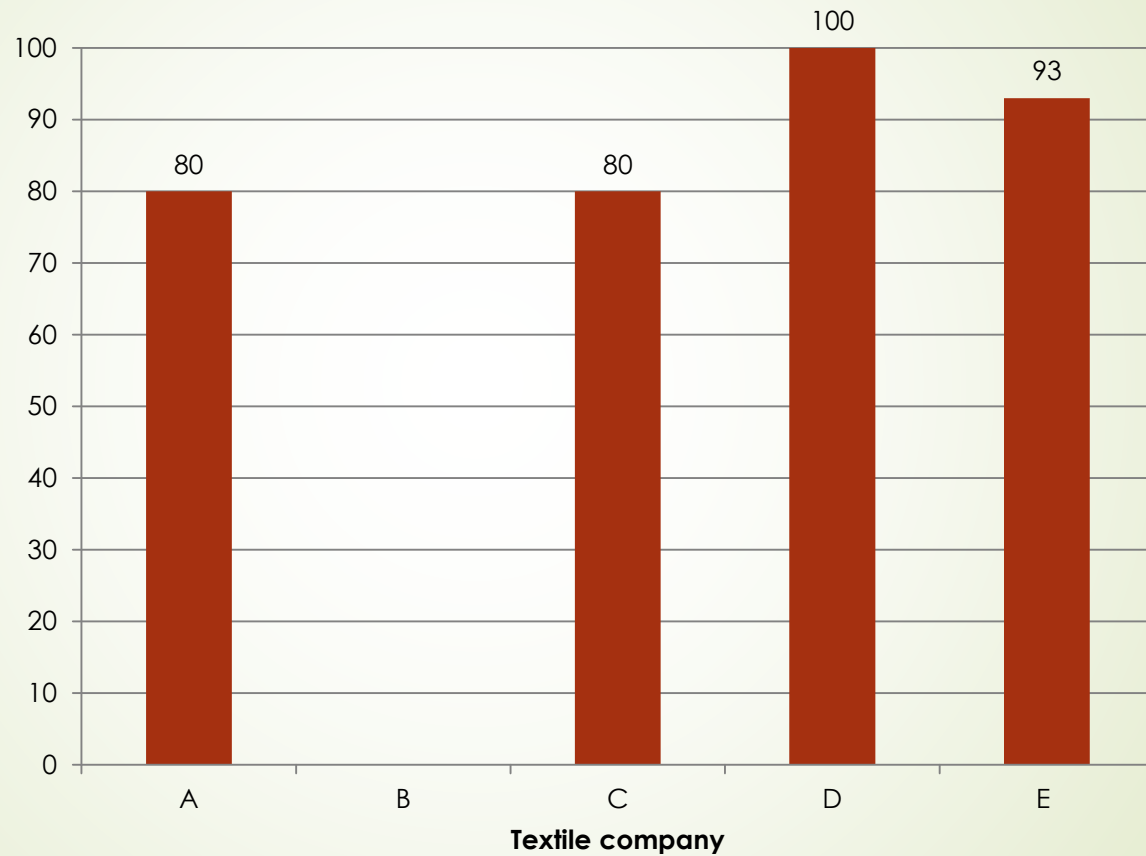


Eco materials indicators

Indicators	Company				
	A	B	C	D	E
Preference to natural dyes instead of synthetic dyes	✓	NA	✓	✓	✓
Preference to organic fibers instead of synthetic fibers	✓	✓	✓	✓	✓
Adoption of the innovative technique of making clothes with polyester fabric derived from recycled plastic	✗	✗	NA	✓	✓
Utilization of readily biodegradable detergents that do not give rise to toxic metabolites	✓	NA	NA	NA	NA
Utilization of industrial enzymes to remove impurities from fabric instead of chemicals	✓	NA	NA	NA	NA
Preference to dyestuff formulations that contain highly biodegradable dispersing agents	✓	NA	✓	✓	✓

Hazardous materials management

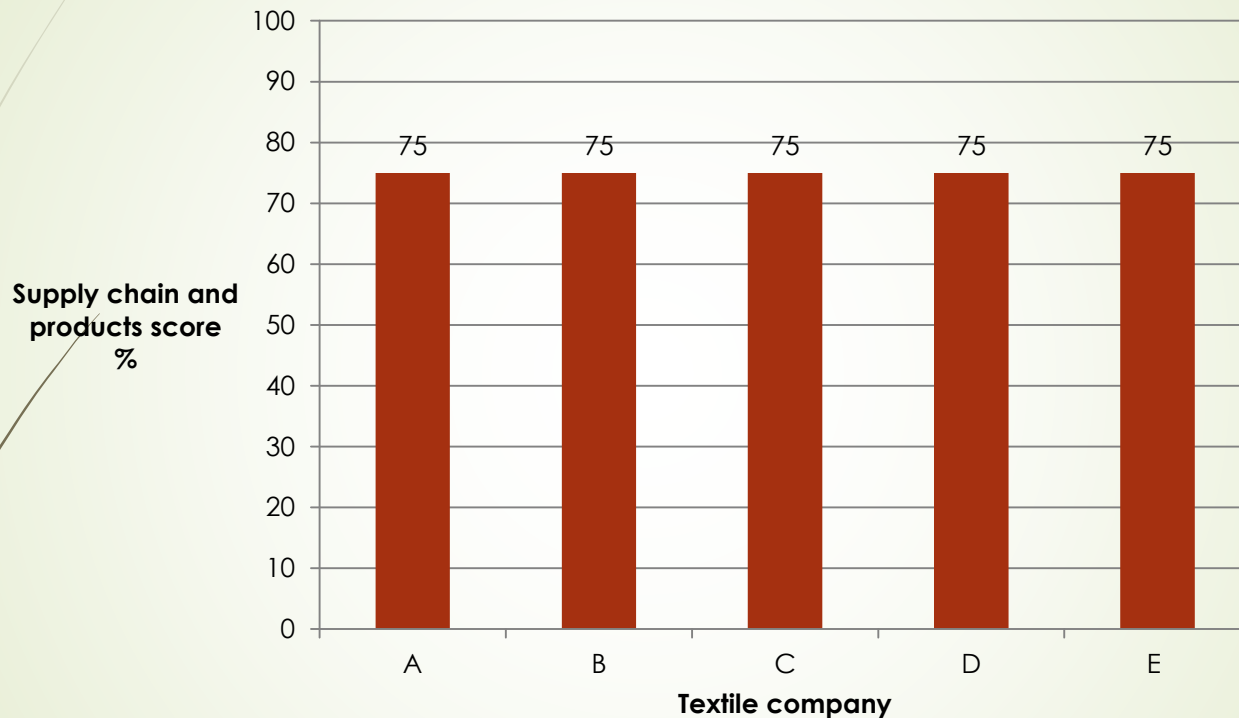
Hazardous materials
management
score
%



Hazardous materials management indicators

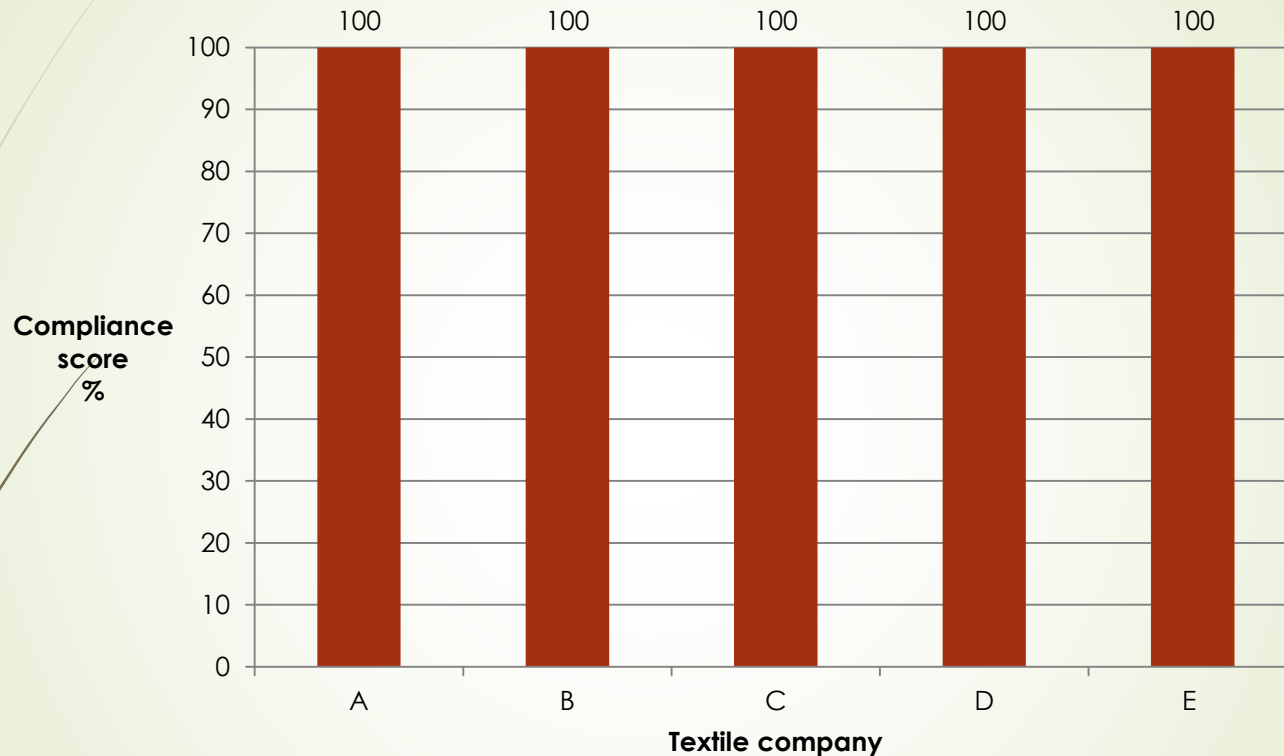
Indicators	Company				
	A	B	C	D	E
Compliance with all chemicals in the Restricted Substances List	✓	NA	✓	✓	✓
Chemical hazard signage in areas where chemicals are used	✓	NA	✓	✓	✓
Plan to improve chemicals management program	✗	NA	✗	✓	✓
Quality assurance program that lays emphasis on the quality of chemicals	✗	NA	✗	✓	✗
Utilisation of AZO colorants as dyestuffs (Azodyes)	✓	NA	✗	✗	✗
Use of non-biodegradable complexing agents in the dyeing processes	✓	NA	✗	✗	✗
Use toxic textile preservation chemicals like chlorinated compounds and dieldrin	✓	NA	✗	✗	✗
Preference to hydrogen peroxide bleaching agent instead of sulfur and chlorine based bleaches	✓	NA	✓	✓	✓

Supply chain and products



Indicator 1: Purchasing of products from suppliers that have environmental criteria
Indicator 2: Severity of environmental impacts from principal products and services

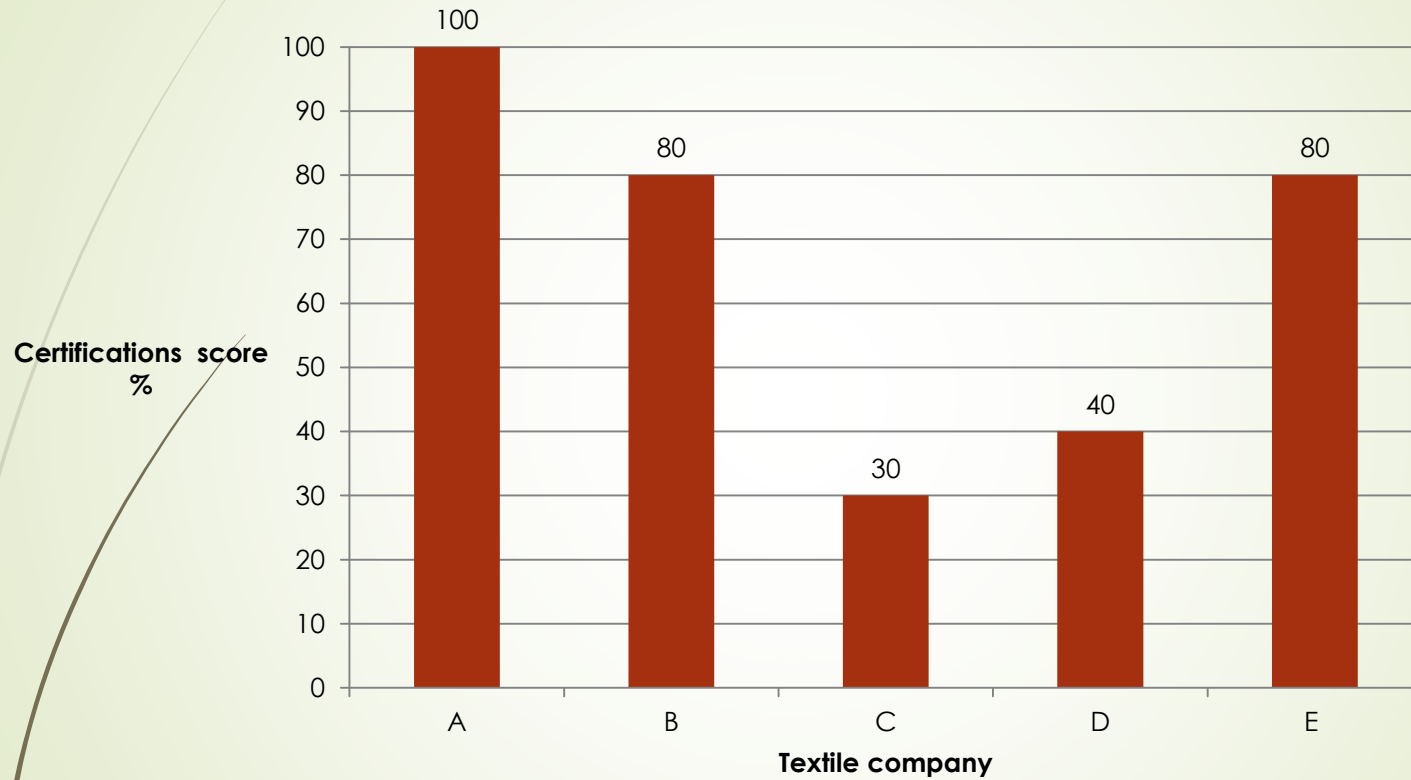
Compliance



Indicator 1: compliance with all existing national environmental laws and regulations

Indicator 2: cases of fines associated with environmental laws and treaties

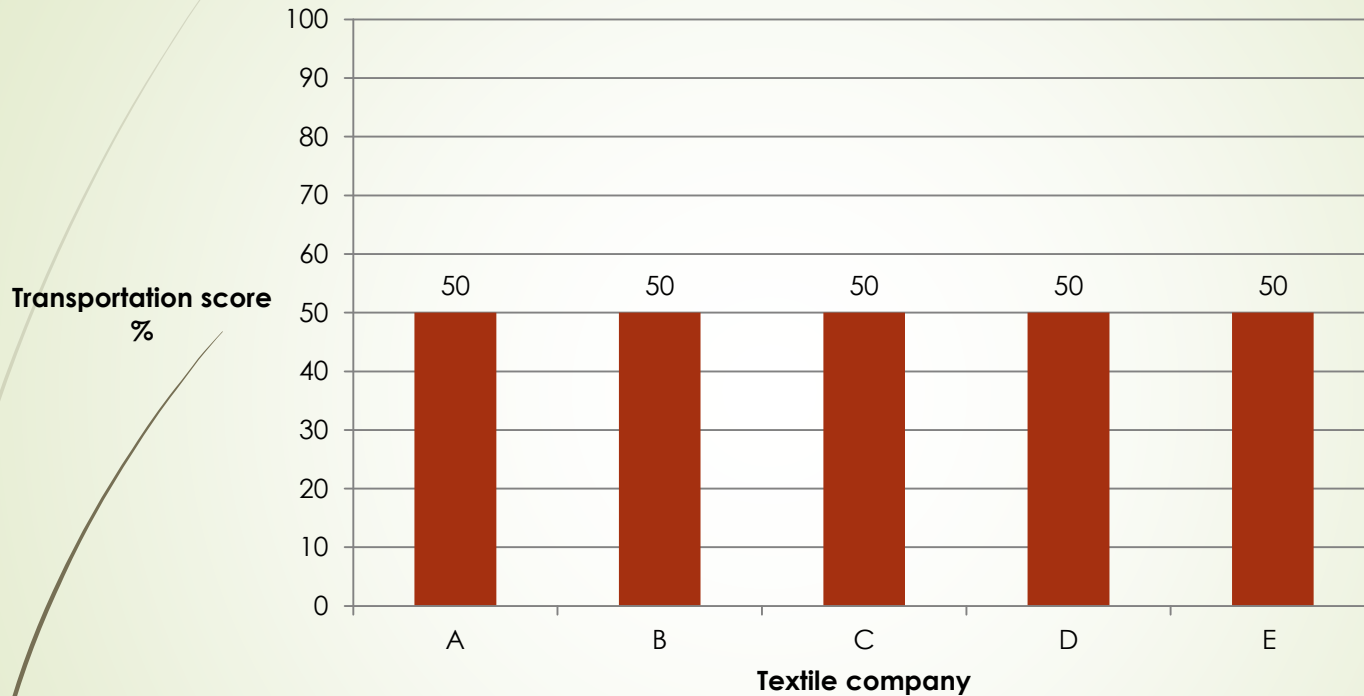
Certifications



Certification indicators

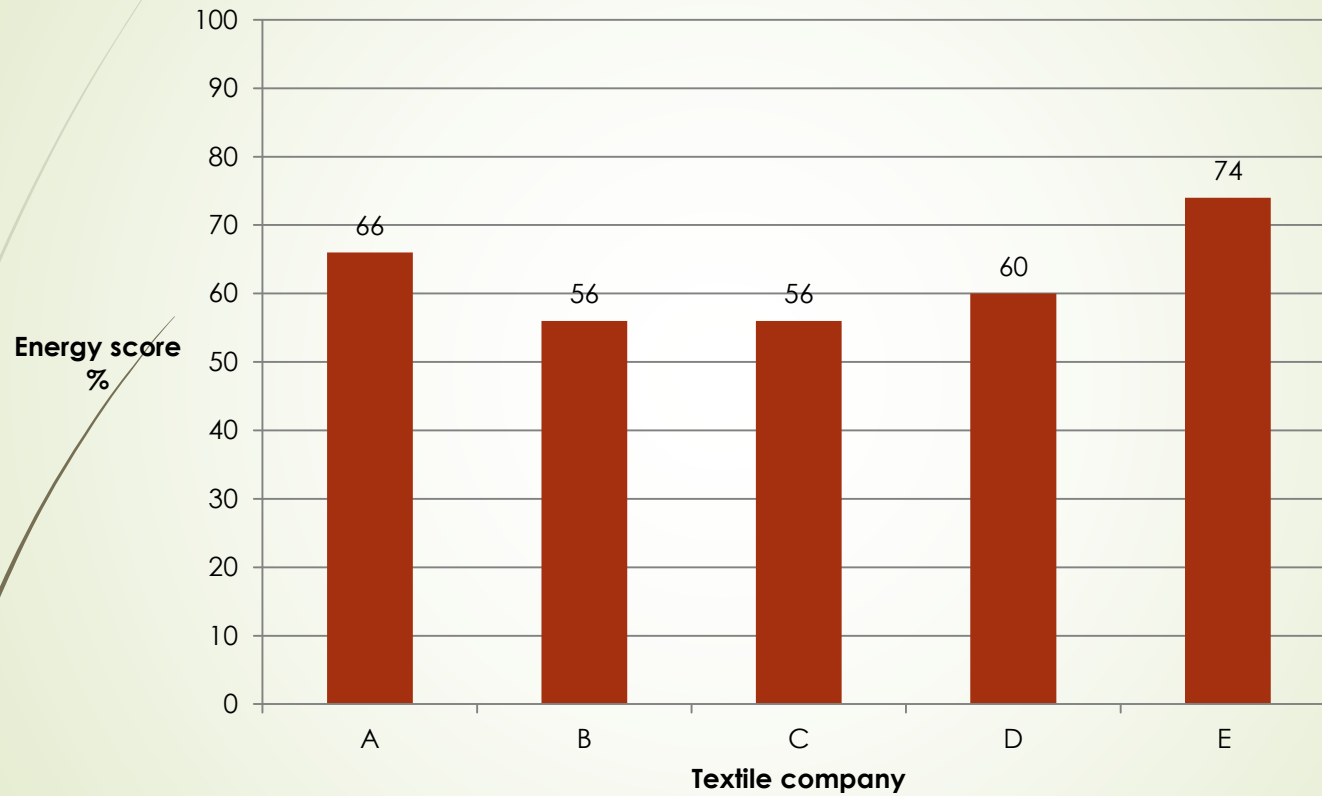
Indicators	Company				
	A	B	C	D	E
ISO 14001					
WRAP	✓	✓			✓
OEKO-Tex	✓	✓	✓	✓	
Organic blended content standard					
Fairtrade	✓	✓			
Global organic textile standard	✓		✓		✓
SMART					
Greenguard					
BCI				✓	✓
EU Eco Label			✓		

Transportation



Indicator : Severity of environmental impacts of transportation used for logistical purposes

Energy

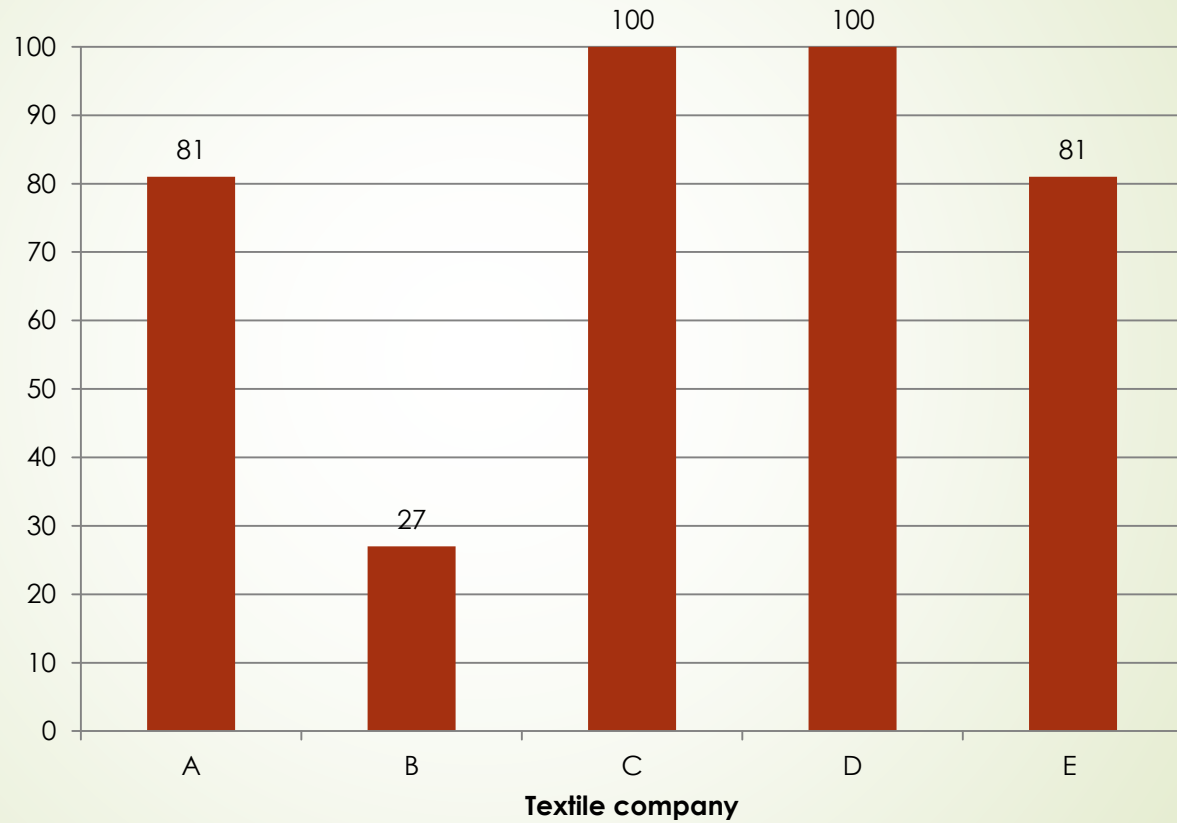


Energy indicators

Indicators	Unit	Benchmark	Company				
			A	B	C	D	E
Monthly measurement of electricity consumption	NA	NA	✓	✓	✓	✓	✓
Total electricity use per month	KW	NA	327218	125322	253952	210384	326985
Percentage of electricity from renewable energy sources	%	NA	0	0	0	0	0
Energy audit	NA	NA	✓	✓	✓	✓	✓
Purchasing policy that preferences energy efficient products	NA	NA	✓	✓	✓	✓	✓
ENERGY STAR air conditioning with Eco refrigerants	NA	NA	✗	✗	✗	✗	✗
ENERGY STAR laundries	NA	NA	✓	NA	NA	NA	NA
Optimisation of lighting system	NA	NA	✓	✓	✓	✓	✓
Lighting power density	W/m ²	11.8	5.6	-	-	6.9	-
Boiler combustion efficiency	%	80	85.3	85.6	86.2	85	92.2
Stack flue gas exit temperature	°C	260	174	-	153	219	186
Thermal lagging of steam pipes to prevent heat loss	NA	NA	✓	✓	✓	✓	✓
Thermal insulation of boiler to prevent heat loss	NA	NA	✗	✗	✗	✓	✓
Regular cleaning of boiler tubes to prevent fouling and scaling	NA	NA	✓	✓	✓	✓	✓
Implementation of economisers in boilers to improve boiler efficiency	NA	NA	✓	✓	✓	✓	✓
Implementation of turbulators in boilers to increase heat transfer efficiency	NA	NA	✓	✓	✗	✗	✓
Implementation of air preheaters in boilers to preheat combustion air	NA	NA	✗	✗	✗	✗	✗
Optimisation of process to enable dyeing at lower temperature	NA	NA	✓	NA	✓	✓	✓
Thermal energy consumption for yarn dyeing per kilogram output	MJ/Kg	16	NA	NA	-	-	NA
Thermal energy consumption for knitted fabric dyeing per kilogram output	MJ/Kg	20	-	NA	NA	-	-
Thermal energy consumption for woven fabric dyeing per kilogram output	MJ/Kg	30	-	NA	NA	-	NA

Economic

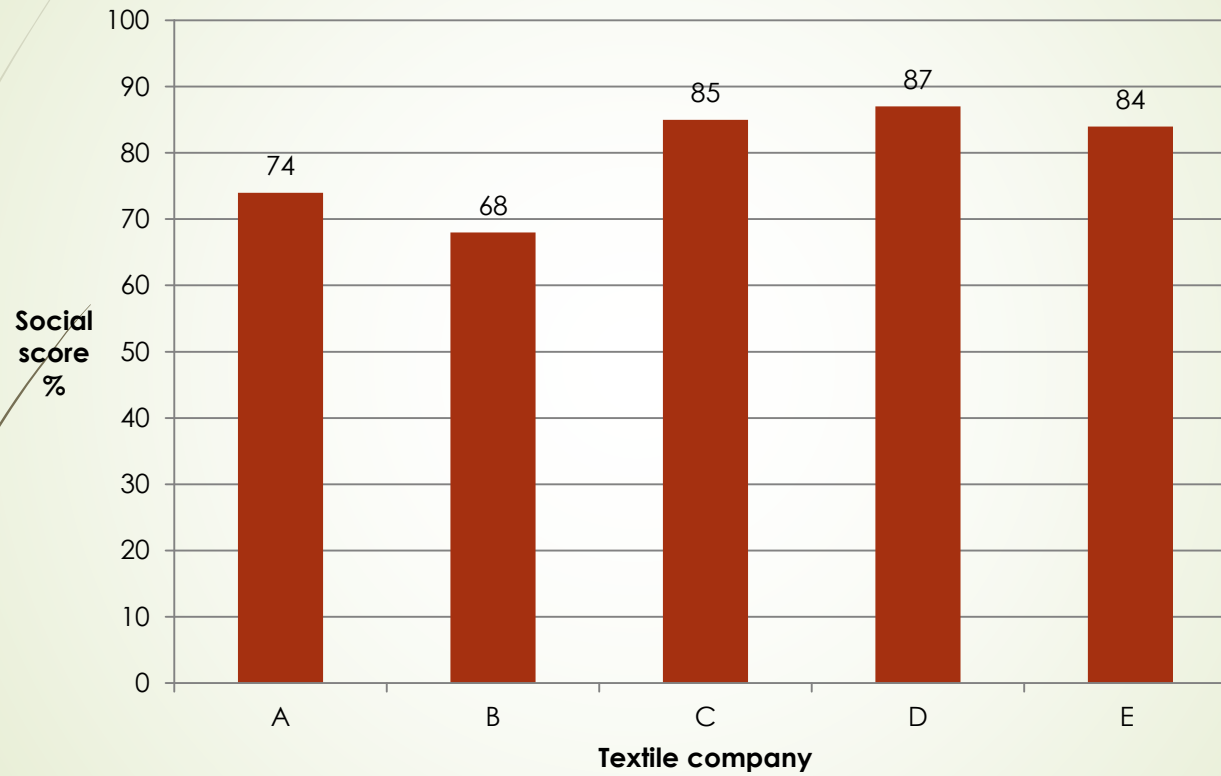
Economic score
%



Economic indicators

Indicator	Unit	Company				
		A	B	C	D	E
Turnover	Rs	801046757	176473888	728349195	1000900653	918640131
Cost of Sales	Rs	735241196	143969308	450172176	904704548	430781907
Gross Profit	Rs	65805561	32504580	278177019	96196105	487858224
Other Income	Rs	2269433	0	19003893	18222374	5242676
Distribution Costs	Rs	15654549	0	0	0	0
Administration Costs	Rs	60646546	49208536	242596509	37660506	414801569
Other Expenses	Rs	-124351285	0	18215025	0	32814351
Finance Costs	Rs	38619527	-673207	9225065	24240265	2614123
Profit/Loss Before Tax	Rs	77505657	-16030749	27144313	52517708	42870857
Tax Expense	Rs	11625848.55	-2404612.35	4071646.95	7877656.2	6430628.55
Profit/Loss	Rs	65879808.45	-13626136.65	23072666.05	44640051.8	36440228.45
Expenditure on environmental related projects	Rs	-	×	-	995000	-
Expenditure on social projects	Rs	-	-	-	829266	-
Expenditure on research and development	Rs	×	×	-	-	×
Subsidies obtained from the Government	Rs	×	×	×	×	×

Social

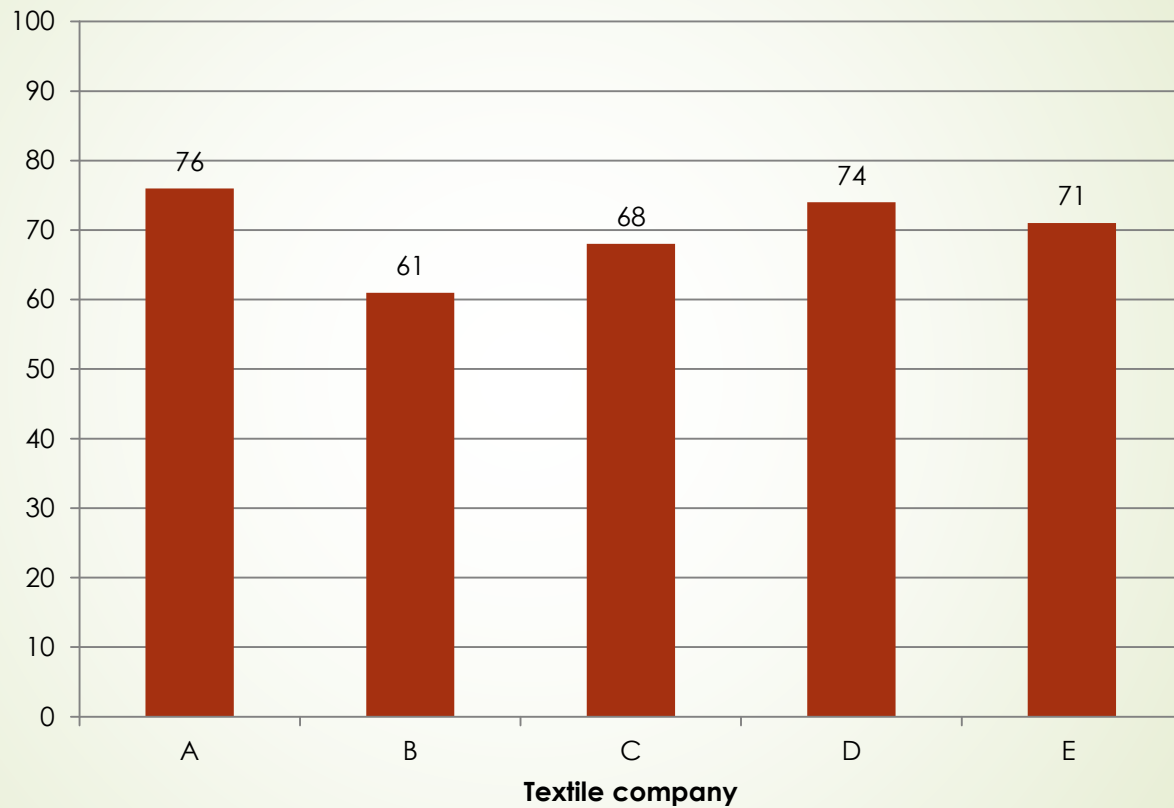


Social indicators

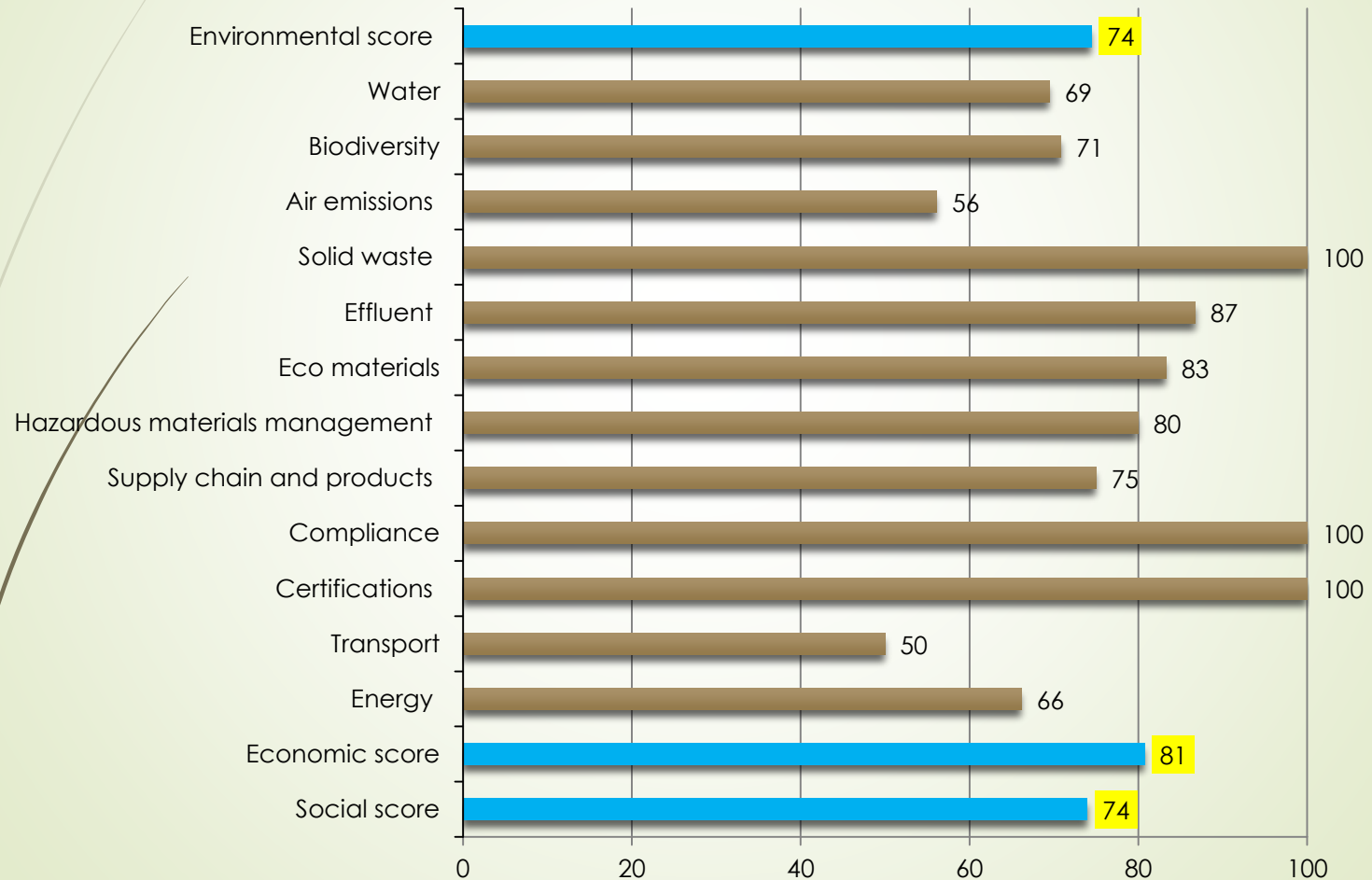
Indicators	Company				
	A	B	C	D	E
Staff awareness of the importance of sustainability	X	X	✓	✓	✓
Participation of staff in sustainability practices	X	X	✓	✓	✓
Cancer causing dyes	X	X	X	X	X
Health and safety policies	✓	✓	✓	✓	✓
Senior management and worker representatives in health and safety committees	✓	✓	✓	✓	✓
Regular health checkup of employees	✓	✓	✓	✓	✓
Doctor working in the organisation	X	✓	✓	✓	✓
Work related fatalities in the organization	X	X	X	X	X
Risk assessments	✓	✓	✓	✓	✓
Personal protective equipment (PPE)	✓	✓	✓	✓	✓
Implementation of regular housekeeping procedures	✓	✓	✓	✓	✓
Dust extraction and ventilation systems	✓	✓	✓	✓	✓
Asbestos fibre	X	X	X	X	X
OHSAS 180001 certification	X	X	X	X	X
Training to all employees	✓	✓	✓	✓	✓
Programmes for skills management or for lifelong learning	X	X	X	X	✓
Regular performance and career development review	✓	X	✓	✓	✓
Both male and female workers in governance bodies	✓	✓	✓	✓	✓
Human rights violations	X	X	X	X	X
Process to assess potential impacts and risks related to respecting human rights	X	X	X	X	X
Employees trained in human rights policies	X	X	X	X	X
HVAC systems	✓	✓	✓	✓	✓
Equal remuneration for women and men for the same job position	✓	✓	✓	✓	✓
Measures to contribute to the effective abolition of child labor	✓	✓	✓	✓	✓
Cases of corruption	X	X	X	X	X
Assessment of operations for risks related to corruption	X	X	X	✓	X
Corporate social responsibility (CSR) programs	✓	X	✓	✓	✓
University enrolments	✓	✓	✓	✓	✓
Research and development	X	X	✓	✓	X
Participation in international environmental agreements	✓	X	✓	✓	✓

Sustainability index

Sustainability index
%



Results





Conclusion

- Seeking sustainability is one of the strategies in which textile companies need to embark to achieve competitiveness and success
 - From the survey and the research, textile companies are on the path of sustainable development, even with limited resources
 - Novel approaches of manufacturing, taking into consideration the sustainability aspect have to be considered for implementation
 - Novel way of thinking and approaches are also important
 - The developed sustainability index framework will be of great support and guidance for textile companies in Mauritius to assess and hence providing an insight on their level of sustainability.
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Publications

► Papers submitted to referees

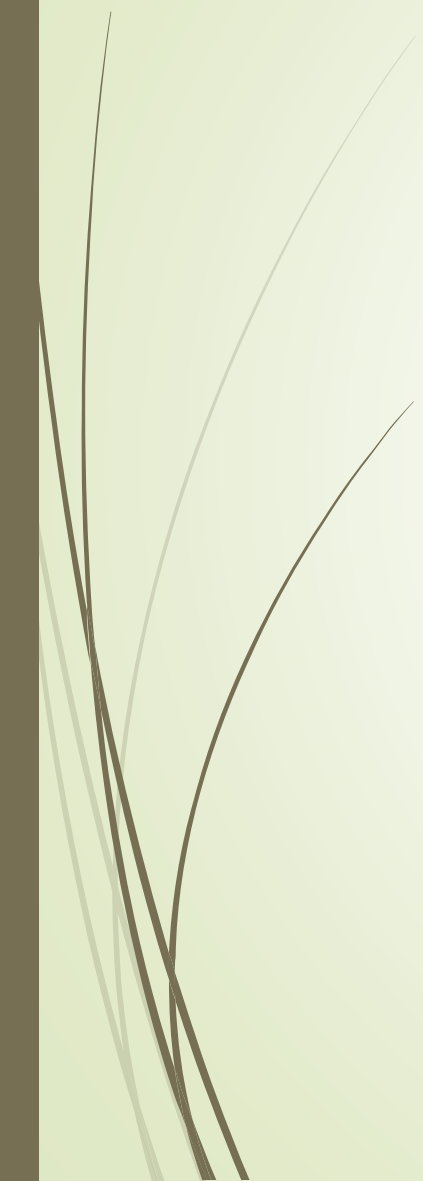
D.S. Callychurn, M. Gooroochurn, D.K Hurreeram , S. Savoo (2019), Development of a sustainability index framework for the Mauritian textile industry. *Journal of Cleaner Production*.

► Conference paper (accepted)

D.S. Callychurn, M. Gooroochurn, D.K Hurreeram , S. Savoo (2019), Sustainability awareness in the Mauritian textile industry- a first step towards developing a sustainability rating system. *The International Society for Ecological Modelling Global Conference 2019 (ISEM), Salzburg Congress Centre, Austria*

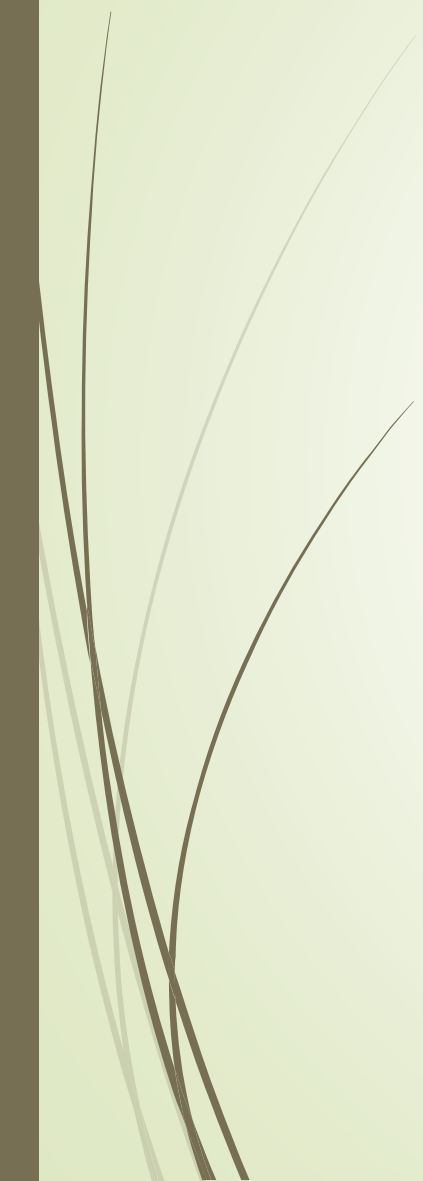


Further work

- Testing of the framework in more textile companies in Mauritius
 - Adapting and using the Sustainability Index Framework in other important sectors of the Mauritian economy.
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Acknowledgement

- MRC
 - Participating companies in phase 1 & 2
 - University of Mauritius
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Thank you for your attention