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The Role of Exports in Manufacturing Pollution in Sub–Saharan Africa and South Asia

Towards a Better Trade-Environment Governance

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Note

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UKaid
from the British people

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Acronyms and abbreviations

3Rs	Reduce, Reuse, and Recycle
ADB	Asian Development Bank
AEMs	African Eco-labelling Mechanisms
AfCFTA	African Continental Free Trade Area
AGOA	African Growth and Opportunity Act
APTA	Asia Pacific Trade Agreement
APTMA	All Pakistan Textile Mills Association
APTPMA	All Pakistan Textile Processing Mills Association
ARSCP	African Roundtable on Sustainable Consumption and Production
B4	Big Four
BAPA	Bangladesh Environmental Movement
BAT	Kenya British American Tobacco Kenya plc
BAU	Business as Usual
BCI	Better Cotton Initiative
BELA	Bangladesh Environmental Lawyers Association
BEPI	Business Environmental Performance Initiative
BEZA	Bangladesh Economic Zone Authority
BGAPMEA	Bangladesh Garments Accessories & Packaging Manufacturers & Exporters Association
BGMEA	Bangladesh Garment Manufacturers and Exporters Association
BHTPA	Bangladesh Hi-Tech Park Authority
BIMSTEC	The Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation
BKMEA	Bangladesh Knitwear Manufacturers & Exporters Association
BMZ	German Federal Ministry for Economic Cooperation and Development
BOD	Biological Oxygen Demand
BRAC	Bangladesh Rural Advancement Committee
BSCI	Business Social Compliance Initiative
BTAs	Bilateral Trade Agreements
BTMA	Bangladesh Textile Mills Association
CBI	Climate Bonds Initiative
CDM	Clean Development Mechanism
CGC	Corporate Governance Code
CMC	Carboxymethyl Cellulose
CO_2	Carbon Dioxide
CoCs	Codes of Conduct
COMESA	Common Market for Eastern and Southern Africa
COPD	Chronic Obstructive Pulmonary Diseases
CPCT	Cleaner Production Centre of Tanzania
CPEC	China-Pakistan Economic Corridor
CPF	Cooperation and Partnership Facility
CPI	Cleaner Production Institute
CPO	Crude Palm Oil
CSE	Chittagong Stock Exchange
CSR	Corporate Social Responsibility
CTCN	Climate Technology Centre and Network
CTI	Confederation of Tanzania Industries
C-TPAT	Customs-Trade Partnership Against Terrorism
CTP-Textile	Cleaner Technology Program for Textile
D-8	Developing 8 Organization for Economic Cooperation

DDA	Dalian Development Area
DDI	Domestic Direct Investment
DoE	Department of Environment
DSE	Dar es Salaam Stock Exchange Limited
DSE	Dhaka Stock Exchange
EABL	East African Breweries Limited
EAC	East African Community
ECO	ECO Mark Africa
ECOTA	Economic Cooperation Organization Trade Agreement
ECOWAS	Economic Community of West African States
EEIOA	Environmentally Extended Input-Output Assessment
EIA	Environmental Impact Assessment
EIP	Eco-industrial Parks
EKN	Embassy of Kingdom of the Netherlands
EMA	Environmental Management Act
EMCA	Environmental Management and Coordination Act
EMP	Environmental Management Plan
EMS	Environmental Management System
EPA	Economic Partnership Agreement
EPR	Extended Product Responsibility
EPZ	Exporting Processing Zone
EPZA	Export Processing Zone Authority
ESG	Environmental, Social and Corporate governance
ETP	Effluent Treatment Plant
FBA	Food Business Africa
FCDO	Foreign, Commonwealth and Development Office
FDAE	Fashion Design & Apparel Engineering
FDI	Foreign Direct Investment
FMO	Dutch Development Bank
FSC	Forest Stewardship Council
FSD	Financial Sector Deepening
FYDP II	Tanzania's Five-Year Development Plan 2016–2021
G2G	Government to Government Economic Zones
GATT	General Agreement on Tariffs and Trade
GBPK	Green Bonds Programme Kenya
GDP	Gross domestic product
GESIP	Green Economy Strategy and Implementation Plan
GFA	Global Fashion Agenda
GHG	Greenhouse gas
GID	Green Industry Development
GIZ	German Corporation for International Cooperation
GoP	Pakistan Government
GOTS	Global Organic Textile Standard
GRI	Global Reporting Initiative
GRS	Global Recycled Standard
GSCM	Green Supply Chain Management
GSTP	Global System of Trade Preferences
GTSF	Global Trade Supplier Finance
GVC	Global Value Chain
HDI	Human Development Index
HS	Harmonized System
i17	Instituto 17
ICT	Information and Communication Technologies
IFC	International Finance Corporation
IIDS	Integrated Industrial Development Strategy
ILO	International Labour Organization
INDSTAT	Industrial Statistics Database
IO-LCA	Input-output Life Cycle Assessment
IPCC	Intergovernmental Panel on Climate Change
IPE	Industrial & Production Engineering
IPPS	Industrial Pollution Projection System

ISIC	International Standard Industrial Classification
ISO	International Organisation for Standardization
ITC	International Trade Centre
IUMP	Industrial Upgrading and Modernization Program
JICA	Japan International Cooperation Agency
JRC	Joint Research Centre
KAM	Kenya Association of Manufacturers
KBA	Kenya Bankers Association
KCA	Karachi Cotton Association
KEPSA	Kenyan Private Sector Alliance
KITP	Kenya Industrial Transformation Program
KNCPC	Kenya National Cleaner Production Centre
LCA	Life Cycle Assessment
LDC	Least Developed Countries
LEED	Leadership in Energy and Environmental Design
MEA	Multilateral Environmental Agreement
MIT	Ministry of Industry and Trade
MOIED	Ministry of Industrialization and Enterprise Development
MPA	Manufacturing Priority Agenda
MSME	Micro, Small and Medium Enterprises
MTI	Ministry of Textile Industry
MW	Megawatt
NBCL	Nyanza Bottling Company Limited
NCPC	National Cleaner Production Centre Foundation
NEAC	National Environmental Advisory Committee
NECA	National Environmental Co-ordination Act
NEMA	National Environment Management Authority
NEMC	National Environmental Management Council
NEP	National Environmental Policy
NEQS	National Environmental Quality Standards
NGO	Non-Governmental Organisation
NIP	National Industrial Policy
NISP	National Industrial Symbiosis Programme
NMVOCs	Non-Methane Volatile Organic Compounds
NPO	National Productivity Organisation
NRDC	Natural Resources Defence Council
NSE	Nairobi Securities Exchange
OCS	Organic Content Standard
OECD	Organisation for Economic Co-operation and Development
OGP	Open Government Partnership
P2	Pollution Prevention
P4G	Kenya National Platform on Partnering for Green Growth and Global Goals
PAA	Polyacrylic Acid
PACT	Partnership for Cleaner Textiles
Pak-EPA	Pakistan Environmental Protection Agency
PCI	Productive Capacity Index
PEFC	Programme for the Endorsement of Forest Certification
PEG	Public Environmental Governance
PEPA	Pakistan Environmental Protection Act
PES	Pakistan Stock Exchange Limited
PET	Polyester
PHMA	Pakistan Hosiery Manufacturers Association
PISD	Programme for Industrial Sustainable Development
PPD	Public-Private Dialogue
PPE	Personnel Protective Equipment
PPP	Public-Private Partnerships
PRGMEA	Pakistan Readymade Garment Manufacturer & Exporter Association
PRGTTI	Pakistan Readymade Garment Technical Training Institute

PRI	Principles for Responsible Investment
PSES	Promotion of Social and Environmental Standards in the Industry
PTEA	Pakistan Textile Exporters Association
PTN	Protocol on Trade Negotiations
PVAc	Polyvinyl Acetate
PVOH	Polyvinyl Alcohol
QMS	Quality Management System
R&D	Research and development
RCS	Recycled Claim Standard
RECP	Resource Efficient and Cleaner Production
RFO	Residual Fuel Oil
RIVM	Dutch National Institute for Public Health and the Environment
RMG	Ready-Made Garment
RoW	Rest of the World
RSI	Responsible Sourcing Initiative
RTAs	Regional Trade Agreements
SADC	Southern African Development Community
SAFTA	South Asian Free Trade Area
SAPTA	South Asian Association for Regional Cooperation Free Trade Agreement
SCP	Sustainable Consumption and Production
SDC	Swiss Agency for Development and Cooperation
SDGs	Sustainable Development Goals
SEDEX	Supplier Ethical Data Exchange
SEIP	Skills for Employment Investment Program
SEI-York	Stockholm Environment Institute - University of York
SEZ	Special Economic Zones
SIDP	Sustainable Industrial Development Policy
SME	Small and Medium Enterprises
SMEP	Sustainable Manufacturing and Environmental Pollution
SOCAM	Service Organization for Compliance Audit Management
SSA	Sub-Saharan Africa
STP	Sewerage Treatment Plant
T&A	Textile and Wearing Apparel Manufacturing Sector
TBL	Tanzania Breweries Limited
TEDA	Tianjin Economic-Technological Development Area
TTBC	Textile Technology Business Centre
TVET	Technical and Vocational, and Education and Training
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNEP FI	United Nations Environment Program Finance Initiative
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
US$	United States of America Dollars
VOCs	Volatile organic compounds
VPO	Vice President´s Office
WAEMU	West African Economic and Monetary Union
WITS	World Integrated Trade Solution
WRAP	Worldwide Responsible Accredited Production
WTO	World Trade Organization

Executive summary

The Sustainable Manufacturing and Environmental Pollution (SMEP) programme has been established by the Foreign, Commonwealth and Development Office (FCDO) of the United Kingdom of Great Britain and Northern Irelandand is implemented in partnership with United Nations Conference on Trade and Development (UNCTAD). In this context, this study prepared by the Instituto 17, called "The role of exports in manufacturing pollution in sub–Saharan Africa and South Asia: towards a better trade-environment governance", herein referred to as "study", or "report", considers the role of exports in driving pollution in selected manufacturing sectors in four specific countries located in Sub-Saharan Africa (SSA) and South Asia.

The report aims to understand how the group of the SMEP target countries located in Sub-Saharan African (SSA) and South Asia have participated in the global trade, specifically investigating the role of trade in manufactured goods. They correspond to thirteen countries, of which ten are in SSA, namely the Democratic Republic of the Congo, Ethiopia, Ghana, Kenya, Nigeria, Rwanda, Senegal, Uganda, the United Republic of Tanzania, and Zambia, and three are in South Asia, namely Bangladesh, Nepal, and Pakistan.

The analysis relies on access to secondary data availability and Life Cycle Assessment (LCA) that estimates the impacts on the local environment associated with manufacturing pollution. This trade analysis helps guide the choice of export-oriented manufacturing sectors to be assessed in the case studies of four countries: Kenya, the United Republic of Tanzania, Bangladesh, and Pakistan. Furthermore, Regional Trade Agreements (RTAs) and public environmental governance may play an important role in improving pollution management. Therefore, the report identifies environmental and social challenges and gaps from public and private governance initiatives to control the pollution of manufacturing exports for these four countries.

Trade-growth-pollution nexus in Sub-Saharan Africa and South Asia

In a globalized world economy, trade is among the fundamental drivers of economic growth, creates jobs and contributes to poverty reduction, facilitates the diffusion of technology and knowledge spillovers, encourages competition in domestic and international markets and ultimately, leads to a higher domestic income level. The benefits for developing countries participating in global trade and value chains are often discussed and not questioned by the Report, and these are the benefits related to growth, job creation, and technological spillovers. In addition to that, a critical policy aspect calls for attention, which is trade-associated pollution or the trade-growth-pollution nexus. The latter has been increasingly underlined in trade policies and treaties worldwide, putting pressure on nations to improve environmental standards and reduce adverse effects.

SMEP target countries have weak productive capacities, affecting the design and implementation of policies, undermining the effective functioning of regulations and institutions tasked to ensure sustainable economic practices. Given that the production process of manufacturing sectors can be pollution-intensive, it could lead to an environmentally vulnerable pattern of trade. In terms of trade, it is crucial to foster productive capacities to enhance exports diversification and promote the necessary structural transformation to achieve sustainable development.

Life Cycle Assessment

There is growing attention to the environmental burdens associated with trade, especially considering the producer and the consumer perspectives. Studies addressing these burdens are frequently conducted by implementing Environmentally Extended Input-Output Analysis (EEIOA) combined with process-based Life Cycle Assessment (LCA) in a hybrid framework or, more recently, process-based LCA as a single approach. The input-output LCA (IO-LCA) recently emerged as a new approach to LCA and uses EEIOA tables as inventory data, following the impact assessment and interpretation phases. EXIOBASE is the supporting database for IO-LCA.

The analysis used two system boundaries approaches to map the environmental burden. The first considered

only the manufacturing activity inside the plant, and this approach is called gate-to-gate system boundary. The second adopted the supply chain perspective, from raw material production to the manufacturing process at the plant. This approach provides a broader view by including upstream processes from the supply chain, called the cradle-to-gate system boundary. The analysis stops at the plant gate, and it does not include downstream activities (e.g., transport and product's end of life and disposal), which lies in the exporting destination.

This study finds that the exports in the manufacturing sectors, when considering a gate-to-gate system boundary, have a significant contribution in terms of impact to the ozone formation and ecotoxicity categories. In the cradle-to-gate system boundary, the exports in the manufacturing sectors have a significant contribution in terms of impact to water consumption, freshwater eutrophication, and land-use changes. These impacts result from agricultural activities since these manufacturing sectors (e.g., textiles or food and beverages sectors) rely on renewable raw materials. For South Asia, analysis shows expressive participation of the textiles sector in all the impact categories, considering both the cradle-to-gate and the gate-to-gate system boundaries. In contrast, SSA shows the importance of the food and beverages sector, especially when considering the cradle-to-gate system boundary.

Key considerations – the case study analysis

Based on the gaps and challenges identified through case studies, the report proposes recommendations for Kenya, the United Republic of Tanzania, Bangladesh, and Pakistan along with the main three areas of research: (i) Environmental Law and Public Governance, (ii) Private Sector Governance, and (iii) Life Cycle Assessment. Even though at different stages, the four countries are building diversified economies by developing their industrial sectors. As exports play a significant role in their economic growth, those countries gain from more sustainable manufacturing practices.

Environmental law and public governance

The analysis shows that most of the Regional Trade Agreements (RTAs) and Bilateral Trade Agreements (BTAs) have environmental provisions valid for pollution control through a general exception to trade rules, cooperation in the environment, or the interplay with other legal tools, including Multilateral Environmental Agreements (MEAs). Recommendations include:

- Countries to consider at least the general exceptions of the international trade regime and the interplay with the ratified MEAs.
- Policy coherence and coordination, interplay, transparency, and accountability are governance principles that countries shall consider in negotiating and implementing RTAs and BTAs.
- Environmental information disclosure, especially regarding the BTAs.
- Strengthening institutional capacities for law enforcement.
- Developing governance mechanisms to tackling informal activities.
- Focus on social sciences and categories, such as culture, politics, power, poverty, gender.
- Strengthening public participation and social movements and Non-Governmental Organisations (NGOs).

Private sector governance

Adopting more sustainable practices to reshape the production base is a challenge for SMEP target countries, especially in the context of export-driven manufacturing pollution. Demand-side initiatives to meet sustainable consumption criteria in trade partners reinforce the need for improved manufacturing pollution management. Recommendations include:

- Green manufacturing guidelines accessible for different manufacturing sectors and companies.

- Countries could benefit from the Eco-industrial parks (EIP) concept.
- Adopting the National Industrial Symbiosis Programme (NISP) could enhance EIP development in SMEP countries and foster capacity building, regulatory framework, and sustainable manufacturing practices.
- Accelerated local Environmental Management System (EMS) certification.
- Adoption of Resource Efficient and Cleaner Production (RECP) measures.
- Create training courses on Circular Economy and identify opportunities for circularity across selected manufacturing sectors.

Life Cycle Assessment

The LCA approaches performed in this study enabled identifying the most relevant export-oriented manufacturing sectors regarding environmental and health impacts for the SMEP target countries. The following are the key considerations:

- Essential to create or update IO-LCA databases for the SMEP target countries since EXIOBASE present them aggregated as the Rest of the World (RoW).
- Improve export data quality and availability, especially regarding traded volumes. Creating a local database for SMEP target countries is pivotal to increasing the understanding of trade-environment governance.

INTRODUCTION

In a globalised world economy, trade is among the fundamental drivers of economic growth, job creation and poverty reduction. It facilitates the diffusion of technologies and knowledge, encourages competition in domestic and international markets, and ultimately lead to higher domestic income levels. However, trade and globalisation can become drivers for negative impacts on the environment and human health brought by local production, including manufacturing. In this context, the key aim of this report is to identify environmental governance gaps – public and private – and present recommendations for their improvement in selected case study countries.

The current analysis aims at trade-led growth strategies in target countries of the Sustainable Manufacturing and Environmental Pollution (SMEP) programme to understand how they encompass sustainability principles – for example, promoting sustainable production to limit pollution. Trade sustainability combines the economic, environmental, and social dimensions to ensure that participation in the international trading system delivers mutually acceptable benefits between partners (WTO, 2018). In other words, trade would support sustainable development[1] as it increases the income-generating capacity and environmental protection and social equity (The Economist Intelligence Unit, 2020).

This report is divided into three sections. Section 1 aims to understand how the SMEP target countries located in Sub-Saharan African (SSA) and South Asia have participated in the global trade, specifically investigating the role of trade in manufactured goods[2]. This trade analysis helps guide the choice of export-oriented manufacturing sectors to be assessed in the case studies of Section 2. The analysis relies on access to secondary data availability and Life Cycle Assessment (LCA) that estimates the impacts on the local environment associated with manufacturing pollution.

Regional Trade Agreements and their public environmental governance may play an important role to improve pollution management. Therefore, Section 2 identifies and understands their four case study countries: Kenya, the United Republic of Tanzania, Bangladesh, and Pakistan. This section is framed in the context of the most polluting manufacturing trade activity and estimates the export-driven environment impacts associated with exports. It also investigates the treatment of pollution caused by exports of manufactured goods under national environmental law and policy frameworks. In short, this section discusses the environmental and social challenges and gaps from public and private governance initiatives to control the pollution related to manufacturing exports.

Based on the gaps and challenges identified through case studies, recommendations are proposed in Section 3 for Kenya, the United Republic of Tanzania, Bangladesh, and Pakistan. Even though at different stages, the four countries are building diversified economies by developing their industrial sectors. As exports play a significant role in their economic growth, those countries gain from more sustainable manufacturing practices.

1 Sustainable development is a process of improving human well-being based on sustainable production and consumption scales, fair distribution and efficient allocation (Costanza et al., 2015).

2 Datasets were collected and analysed from UNIDO Industrial statistical database at the four-digit level (INDSTAT 4) of ISIC Revision and others. (ITC, 2021; The World Bank, 2021; UNCTADstat, 2021; UNIDO, 2021; WITS, 2021). Manufacturing industries are categorized according to the International Standard Industrial Classification (ISIC) and correspond to divisions 15 to 37 of the ISIC Rev.3 (United Nations, 2002). To allow alignment throughout the study, data collected originally in Harmonized System (HS) 2007 (at the 4-digit level) were mapped into the economic activities of ISIC Rev.3. For non-reporting countries, trade statistics reflect mirror estimates, that is, it is derived from partner countries statistics. (ITC, 2020) argues that mirror estimates give fairly reliable results given the geographical coverage of the United Nations COMTRADE statistics. Additional economic data were obtained to assess the relative importance of trade in domestic economies as well as manufacturing exports.

SECTION I. IMPACTS FROM MANUFACTURING EXPORTS IN SUB-SAHARAN AFRICA AND SOUTH ASIA

Global merchandise trade has increased substantially over the last two decades, albeit the most prominent growth occurred between 2001 and 2010, with an increase of 146 per cent, according to data from the International Trade Centre (ITC) (ITC, 2021). With a lack of consensus on the positive effects of trade openness on economic growth, industrial sectors benefit from trade integration by importing inputs and machinery to boost domestic production and better access foreign markets. The reduction in trade costs increases the likelihood of non-exporting firms to start exporting and the productivity of those already exposed to the international market due to the "*learning-by-exporting*" effect (Seck, 2017).

In addition to empirical demonstrations of the positive interplay between trade openness and economic growth, a growing body of literature is emerging to investigate the resulting impacts on the environment (Ben Jebli et al., 2015; Demissew Beyene and Kotosz, 2020; Frankel and Rose, 2005; Grossman, Gene.M Krueger, 1994; Mehmood and Tariq, 2020; Murshed and Dao, 2020; O'Neill et al., 2020). The relationship between trade and the environment is complex insofar it can engender economic gains, environmental costs, and social strains by fostering unbalanced growth through an unsustainable trade pattern. An environmental vulnerability in the dynamic of a country's export structure may undermine the promotion of sustainable development.

The concept of environmental vulnerability of trade refers to the environmental effects from production associated with natural resources degradation and pollution (Oliveira et al., 2016). These are typically seen as supply-side environmental problems, and they result from the production of goods for domestic and external markets. The production aimed at exports necessarily involves energy use for transportation, which results in air pollution and other environmental and health impacts. Trade liberalisation may have adverse effects on the environment if it leads to specialisation in pollution-intensive activities in some countries, considering that the stringency of environmental policy differs across countries, the so-called pollution haven hypothesis (Hille, 2014; OECD, 2021).

The trade-growth-pollution nexus has been increasingly underlined in trade policies and treaties worldwide, putting pressure on nations to improve environmental standards and reduce negative effects. By supporting economic growth and development, increased trade can affect the environment positively by enhancing the capacity to manage pollution more effectively (OECD, 2021). The more integrated the world economy is, the more exposed the exports are to environmental standards imposed by trade partners. Another environmentally beneficial effect of trade is the ease of accessing environmentally friendly technology. Those technologies can make the local production process more efficient by reducing energy, water, and environmentally harmful substances inputs per unit of output. External incentives to adopt more stringent environmental standards are key drivers of backwards changes along the supply chain using cleaner production processes and technologies (Harris and Roach, 2013; WTO, 2018).

A more significant number of trade connections can arise with the economic development of Least Developed Countries (LDCs), which help integrate their markets and expand consumer bases for manufactured products. This effect raises concern on the extent to which trade will generate detrimental impacts on the local environment, notably local pollution. Most importantly, it highlights the importance of adopting sustainable practices into manufacturing before its expansion to prevent unsustainable industrial path dependences from emerging production development (He and Xiyan, 2020).

A. The role of trade and manufacturing sectors for the economies of SMEP target countries

The poor economic performance of many Sub-Saharan African (SSA) and South Asian countries has been associated with low growth of total exports, but mainly manufacturing exports (Hartmann et al., 2020; Nabi et al., 2010; Sundaram et al., 2011).

The SMEP target countries have been among the least economically performing countries globally in terms of GDP per capita and are less able to obtain trade gains. Table 1 comprises a set of indicators to characterise SMEP target countries.

For SMEP target countries, trade is a significant

Table 1. General description of SMEP target countries in 2019*

	SMEP Target Country	Population (million)	GDP per capita* (US$)	Trade openness (% GDP)	Share of total merchandise global exports (%)	Human development		Productive capacities		
						Ranking	Index	Overall index	Private sector	Structural change
South Asia	Bangladesh	163	1,865	39	0.25	133	0.632	26.9	72.7	16.5
	Nepal	29	1,058	64	0.01	142	0.602	26.3	70.6	15.9
	Pakistan	217	1,193	35	0.13	154	0.557	25.2	77.8	17.8
Sub-Saharan Africa	Democratic Republic of the Congo	87	586	58	0.04	175	0.480	19.9	61.2	14.4
	Ethiopia	112	849	28	0.02	173	0.485	23.5	67.3	13.1
	Ghana	30	2,153	69	0.09	138	0.611	26.9	75.7	13.9
	Kenya	53	1,846	35	0.03	143	0.601	25.7	74.5	16.5
	Nigeria	201	2,383	35	0.29	161	0.539	21.6	74.4	11.2
	Rwanda	13	815	57	0.01	160	0.543	25.4	70.5	14.3
	Senegal	16	1,483	65	0.02	168	0.512	26.3	78.6	17.4
	United Republic of Tanzania	58	1,109	32	0.03	163	0.529	24.2	69.5	13.9
	Uganda	44	742	39	0.02	159	0.544	24.9	70.3	16.8
	Zambia	18	1,373	70	0.04	146	0.584	24.2	54.6	15.2

Notes: *GDP per capita breaks down economic output per person by dividing GDP of a country by its population. It does not consider differences in the cost of living and does not express distribution of income, so figures should be look at cautiously.

Source: Based on data from ITC (2021), World Bank (2021) and UNCTADstat (2021). Except for productive capacities, whose data refers to 2018.

economic contributor. Since 2000, they have become more integrated into the global trade market, albeit trade openness[3] differs between South Asia and SSA countries. Interestingly, Ghana was the first to embark on significant trade reforms across SSA countries, while the Democratic Republic of the Congo was last (Kassim, 2015). The commodity price boom is an important driving factor for the increasing trade openness of SSA countries in the early 2000s and began waning at its end (2008-2009). It helped the region improve trade and enhanced its capacity to export and import (Moussa, 2016). In South Asia, Nepal has experienced a rapid increase in trade openness since 2017, being the most open economy in 2019.

The challenge for SMEP target countries is to accelerate and deepen their integration into global trade. Exports from SMEP target countries represented on average only 0.69 per cent (2001-2010) and one per cent (2011-2019) of total global merchandise exports. Exports from SSA countries have greater relevance in the global economy compared to South Asia countries. Between 2011 and 2019, SSA countries contributed 0.7 per cent of the global exports, whereas South Asia countries accounted for 0.3 per cent. Despite the 40 per cent increase from the first period to the second, it indicates that although SMEP target countries have been more open to the world economy, their role in world trade is still small. This low contribution is also observed when considering LDCs globally, which share in goods global exports

3 Openness to trade is measured by the ratio of exports plus imports over GDP.

accounted for 1.04 per cent in 2019 (WTO, 2020). It is understandable the need to develop their production and export capacities[4] (UNCTAD, 2021). As noted in the Sustainable Development Goal[5] 17, Target 11 aims to significantly increase developing countries' exports, mainly to double the LDCs' share of global exports by 2020. Hence, meeting Target 11 can become a driver for negative impacts on the environment and human health by increased local unsustainable production, including manufacturing.

The overall Productive Capacity Index (PCI)[6] for SMEP target countries presented in Table 1 ranges between 0 and 100. The PCI is a multidimensional index that can help compare the driving forces that fuel progress towards sustainability. SMEP target countries are at the bottom of the distribution of PCI scores, with considerable inter and intraregional variations in country-specific performances. A country with a high Gross Domestic Product (GDP) per capita or a high Human Development Index (HDI) generally experiences a high level of productive capacities (UNCTAD, 2021). These weak productive capacities affect both the design and implementation of policies, undermining the effective functioning of regulations and institutions responsible for ensuring sustainable economic practices. In terms of trade, it is crucial to foster productive capacities to enhance exports and promote the necessary structural transformation to achieve sustainable development.

The poor performance observed for SMEP target countries regarding structural change demonstrates a dependence on commodities exports and their low degree of integration into global value chains. The private sector category indicates that SMEP target countries face barriers to cross-border trade regarding costs and business support. However, there has been an increase in gross capital formation (e.g., investment) in SMEP target countries over the last

4 "The productive resources, entrepreneurial capabilities and production linkages which together determine the capacity of a country to produce goods and services and enable it to grow and develop" (UNCTAD, 2020).

5 Agenda 2030 for Sustainable Development, Sustainable Development Goals (SDGs): see (https://sdgs.un.org/2030agenda).

6 PCI covers 193 economies for the period 2000-2018 and combines 46 indicators into 8 dimensions (Information and communication technologies (ICT), structural change, natural capital, human capital, energy, transport, private sector and institutions).

Figure 1. GDP components in percentage based on expenditure per selected year

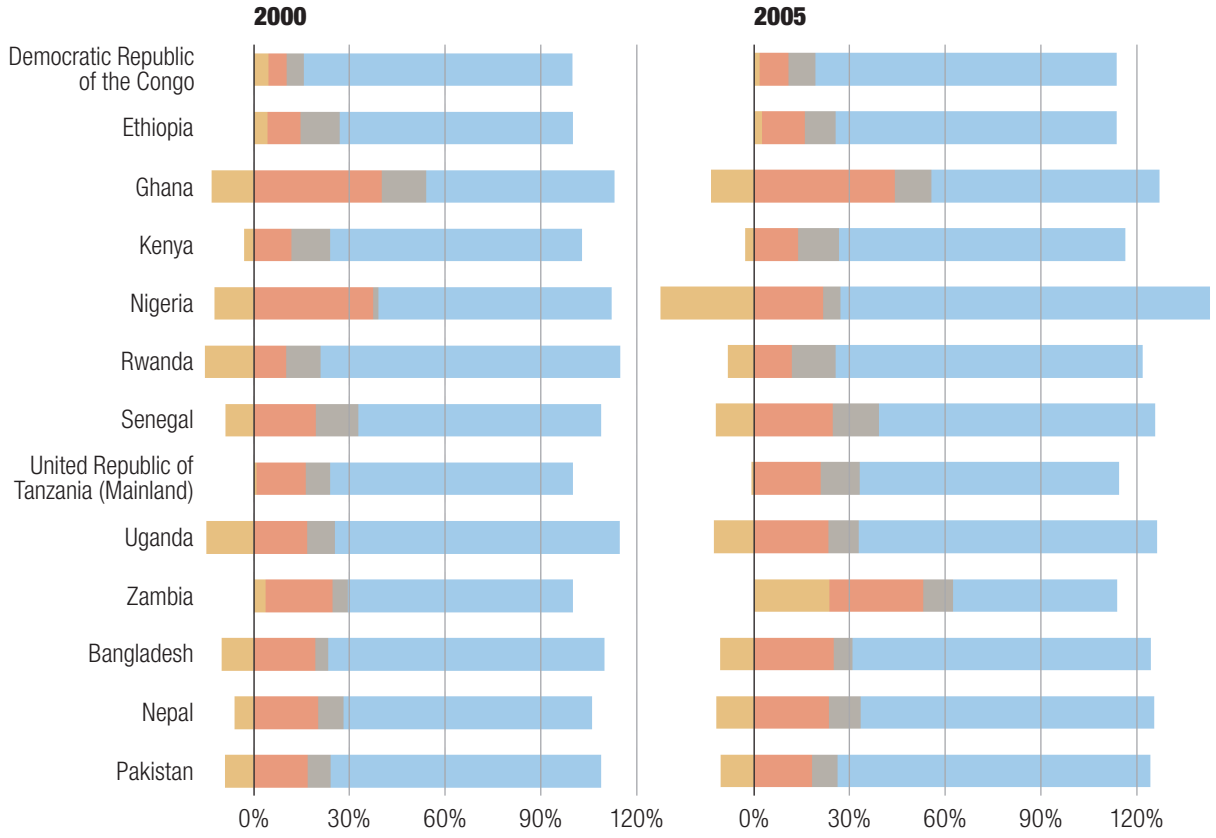
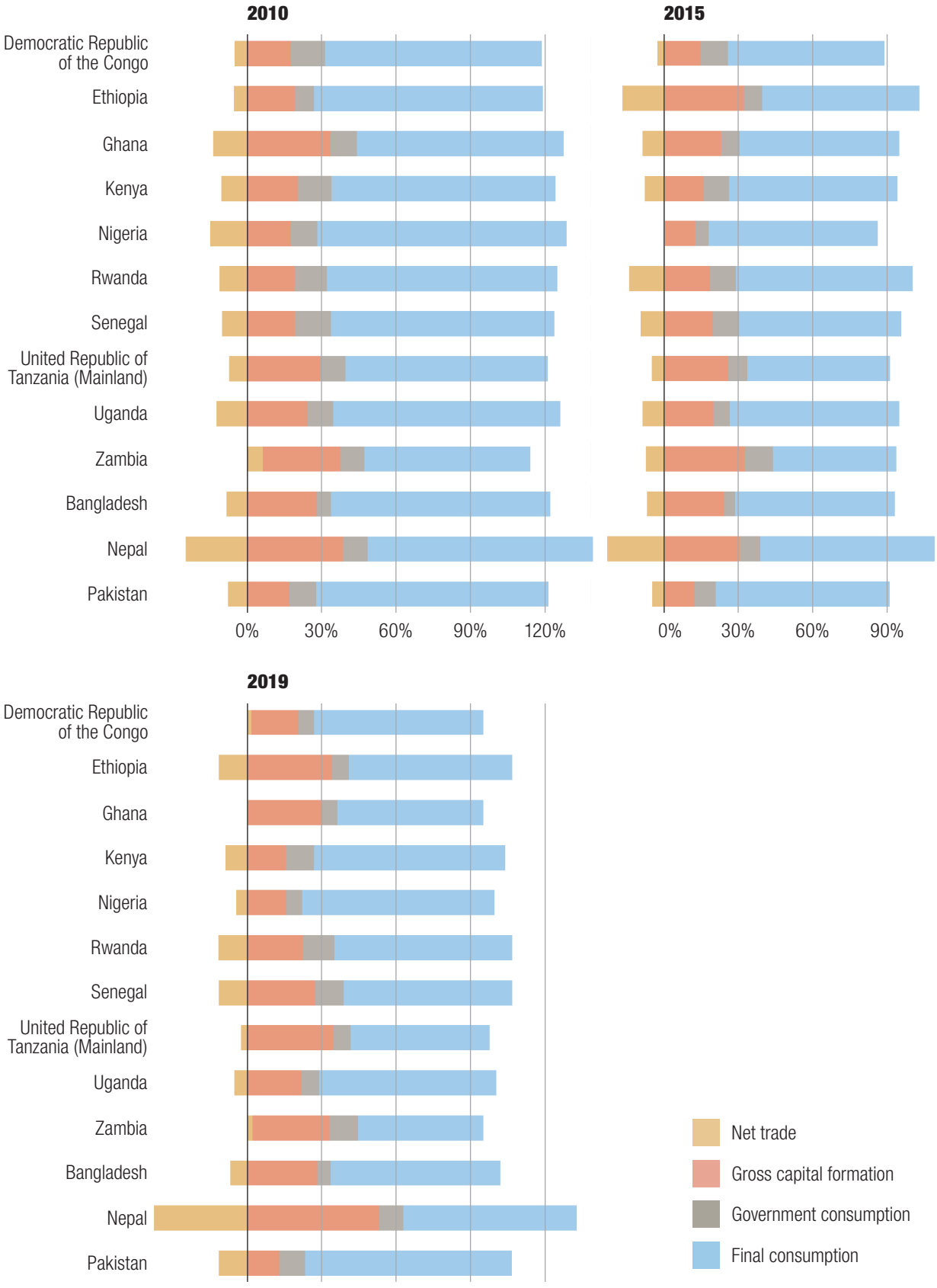


Figure 1. GDP components in percentage based on expenditure per selected year (cont.)



Source: Based on data from World Bank (2021).

two decades. Figure 1 shows the drivers of economic performance through the lens of expenditure.[7] A critical opportunity to shape capital formation emerges from the expansion of investments. In other words, it allows making investments to move away from traditional business as usual practices, for instance, building productive infrastructure that mitigates pollution. Besides propelling a rise in GDP by supporting business and generating income, improving the domestic productive capacity can further facilitate trade for export-oriented industries. Investment has been widely acknowledged as a strategic engine in the growth process of developing countries (Ikpesu et al., 2019).

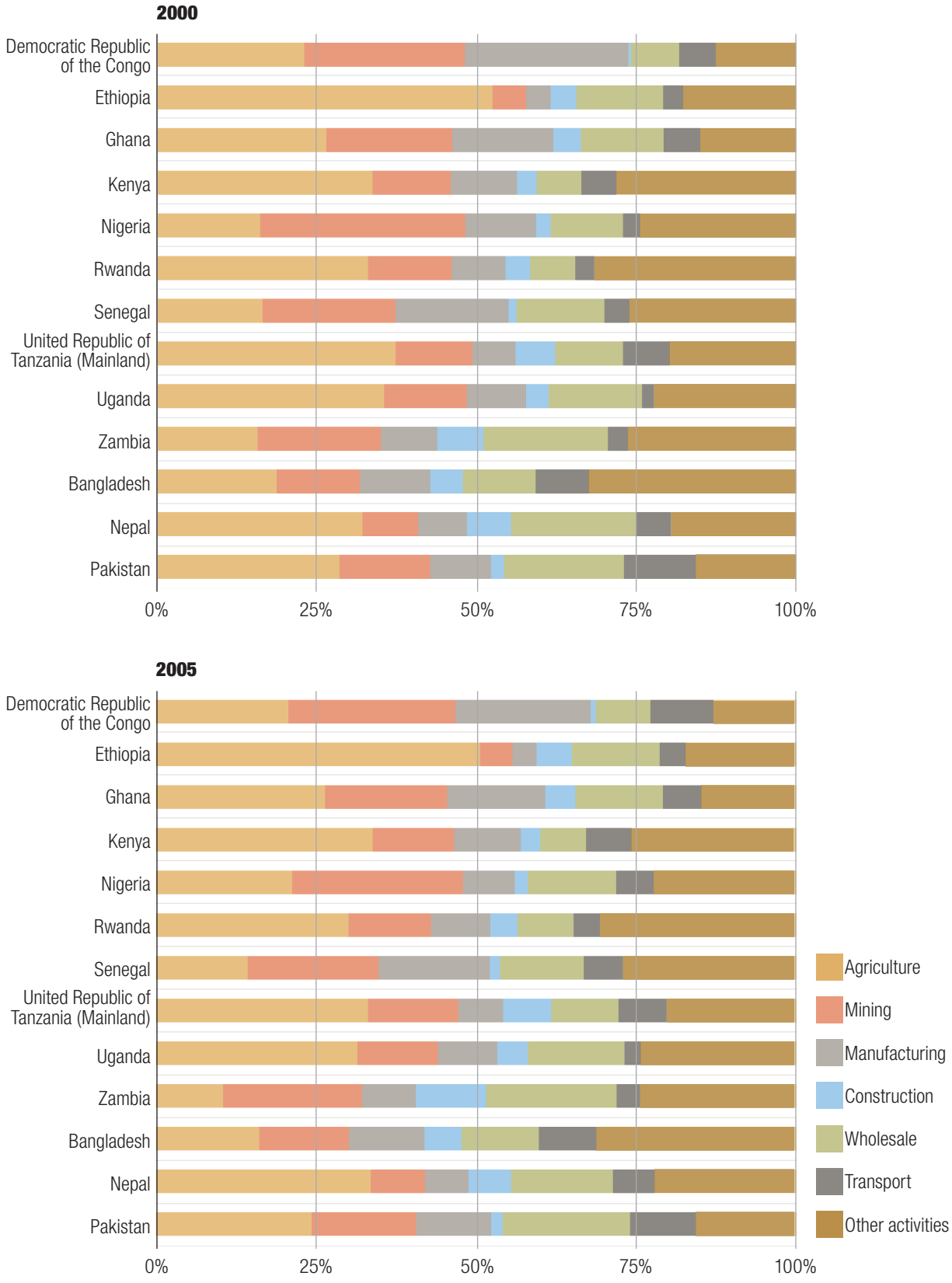
Evidence on the economic structure of SMEP target countries has also revealed that a common feature to most SMEP target countries is the net-importer profile. The internal demand for goods and services has strongly driven their GDP increases in those countries, particularly household consumption. The export-to-GDP ratio average of SMEP target countries is about 19 per cent in the 2000-2019 period, substantially below the developing country average of about 35 per cent (UNCTAD, 2018). The relatively minor role exports play in the economic performance of SMEP target countries has been shifting over time, with the expansion of exports partially outweighing the reduction of domestic demand. This shift means that by developing productive and export capacities, SMEP target countries can surpass structural obstacles, becoming more competitive and further increase their degree of integration into global value chains. Regulations imposing restrictions on unsustainable trade, whether through tariff or non-tariff barriers such as environmental, health or safety standards (UNCTAD, 2020, 2013), can stimulate a more rapid transition towards sustainability. Specific policies and efforts enable environmentally sustainable progress that fosters less-polluting activities and socially inclusive development (The World Bank and OECD, 2012) in SMEP target countries.

Manufacturing industries have been increasingly generating negative externalities from pollution and health impacts in SMEP target countries (O'Neill et al., 2020), and globalisation of trade exacerbates these effects. The importance of manufacturing trade has been recognised as a potential force for creating jobs, stimulating domestic production and exports, and absorbing gross capital formation. Compared to other economic sectors, such as Agriculture and Mining, Figure 2 shows a minor role of the manufacturing sector as part of SMEP economies.

Given that the production process of manufacturing sectors can be pollution-intensive, it could lead to an environmentally vulnerable pattern of trade. The following subsection explores trade data, shedding light on the observed pattern of manufacturing exports. The trade analysis can confirm whether export-oriented manufacturing sectors are also key polluting industries.

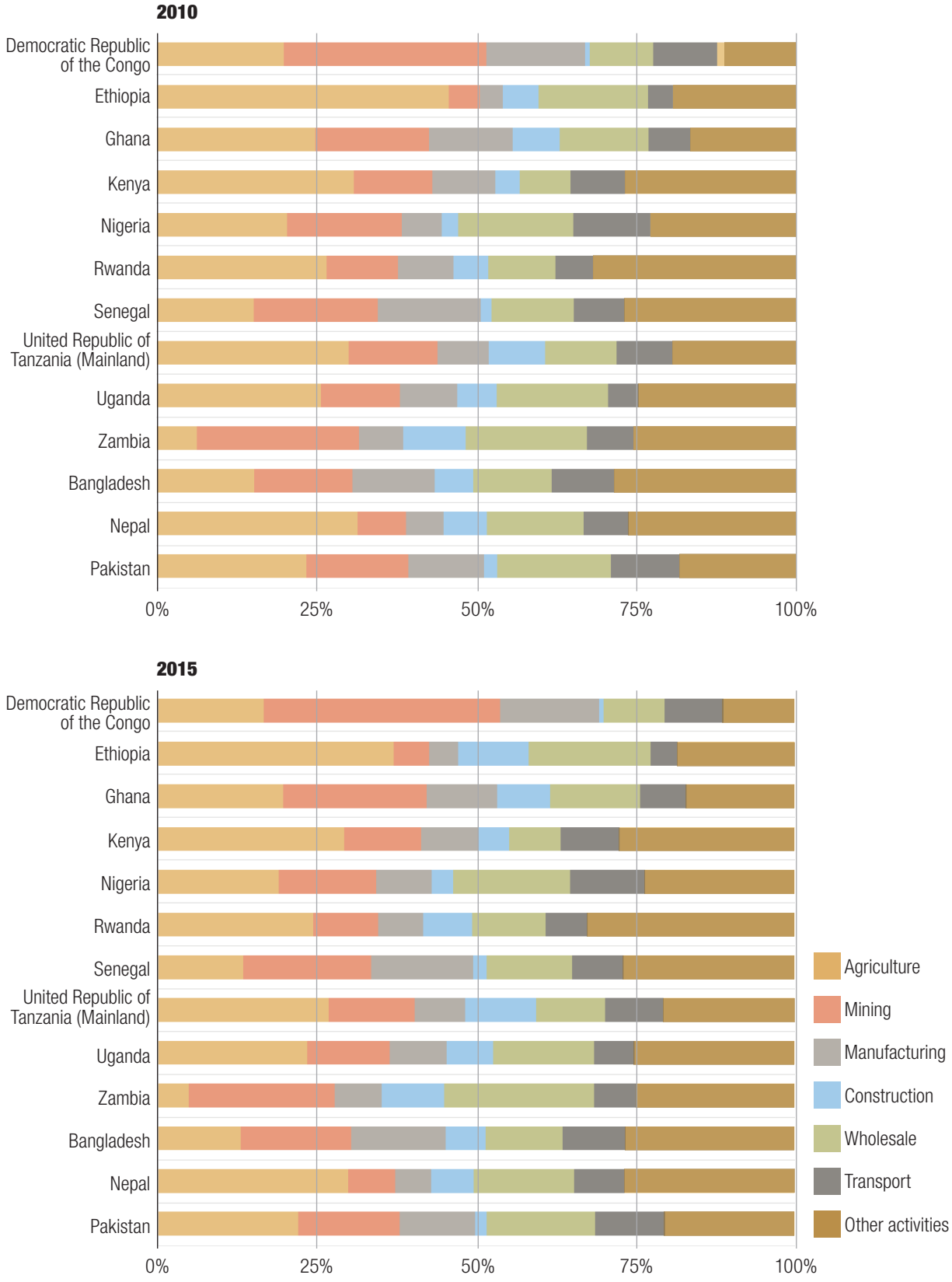
7 It is an expression of the GDP, which accounts for household and government consumption, gross capital formation, and net trade (exports – imports).

Figure 2. Value-added share of economic activities per selected year



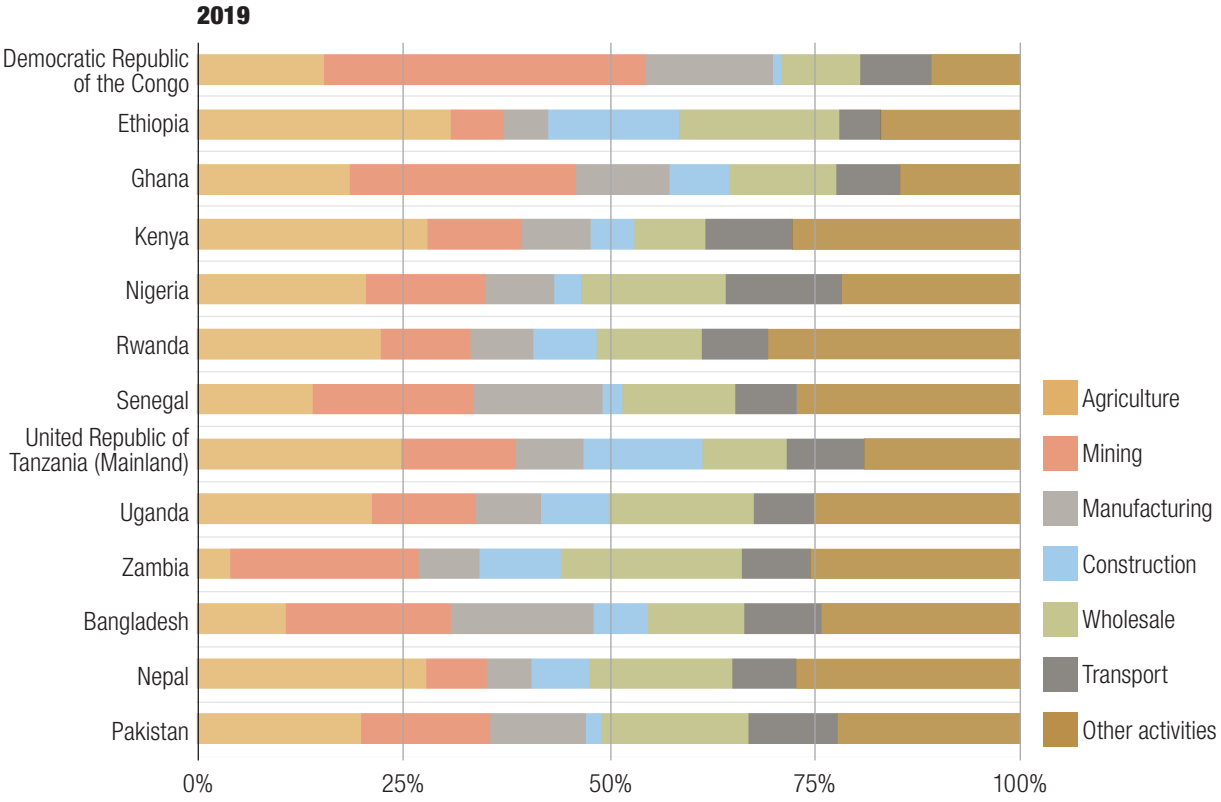
Source: Based on data from World Bank (2021).

Figure 2. Value-added share of economic activities per selected year (cont.)



Source: Based on data from World Bank (2021).

Figure 2. Value-added share of economic activities per selected year (cont.)

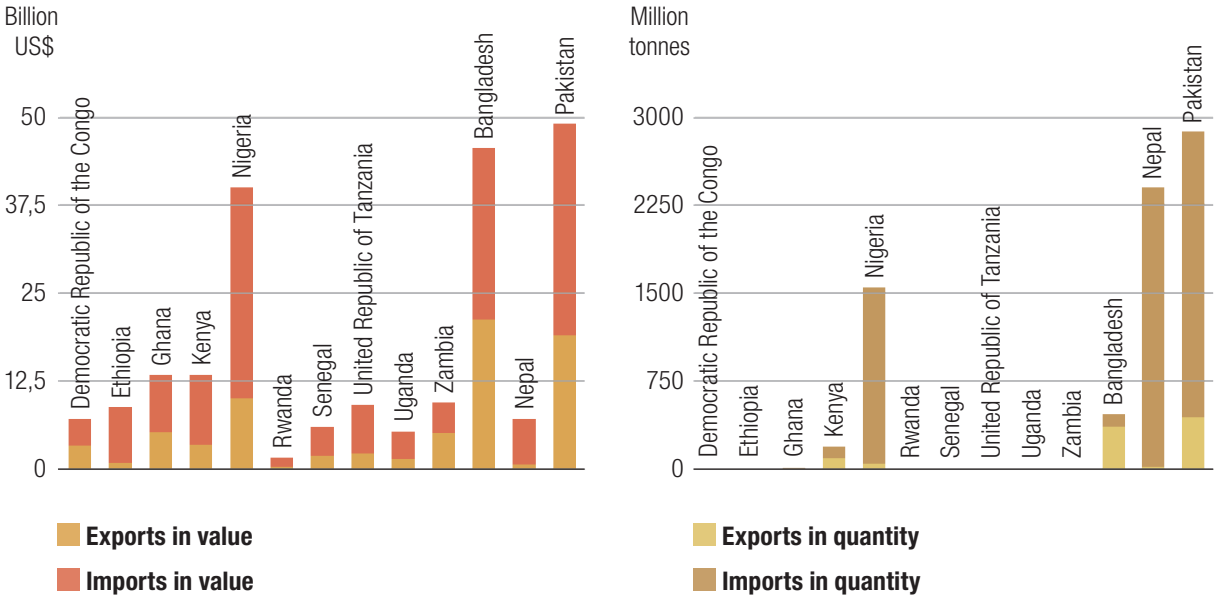


Source: Based on data from World Bank (2021).

1. Trade analysis for manufacturing sectors

LDCs share a relative dependence on exports of traditional commodities, which serve as inputs to other countries' exports in several sectors (UNCTAD, 2018). This dependence has been gradually changing as productive capacities develop. For SMEP target countries, this implies that manufacturing exports still represent a small percentage of global exports, accounting for less than one per cent of total value in the 2001-2019 period. The top 3 SMEP target countries based on manufacturing exports to the global market are Nigeria, Bangladesh, and Pakistan, respectively, 0.07 per cent, 0.15 per cent and 0.13 per cent of total global exports in the same period. Note that these shares are not proportional to the GDP or population size. As shown in Figure 3, most SMEP target countries are usually net importers of manufactured goods.

Figure 3. Manufacturing trade-in value and quantity for SMEP target countries (average figures between 2001 and 2019)



Source: Based on data from ITC (2021).

Evidence suggests that there has been steep growth in total manufactured products exports attributed to SSA countries. The total export value increased from US$ 26 billion in 2001 to US$ 108 billion in 2019. The increase in manufacturing exports of the South Asia region is also noticeable, from US$ 6.5 billion in 2001 to US$ 48 billion in 2019. Comparing the growth in manufacturing exports between SSA and South Asia regions, the growth in SSA manufacturing exports in the 2001-2019 period is almost fourfold the growth of South Asia countries.

A first assessment of the potential environmental vulnerability of SMEP target countries pattern of trade is obtained by observing the total quantity of products exported, as shown in Figure 3.[8] This value indicates the scale of economic activity to environmental quality (Grossman, Gene.M Krueger, 1994). Scale and composition effects, in combination, lead to higher levels of pollution from trading, which can be compensated through the technique effect (e.g., the adoption of more efficient and environmentally friendly technologies and practices). Hence, the volume of total manufacturing exports in quantity is generally lower than the volume imported for SMEP countries, except Bangladesh, a net exporter in

8 This is the data used as input to the analysis of content of domestic pollution related to exports in the following sections.

volume[9] between 2001-2019[10].

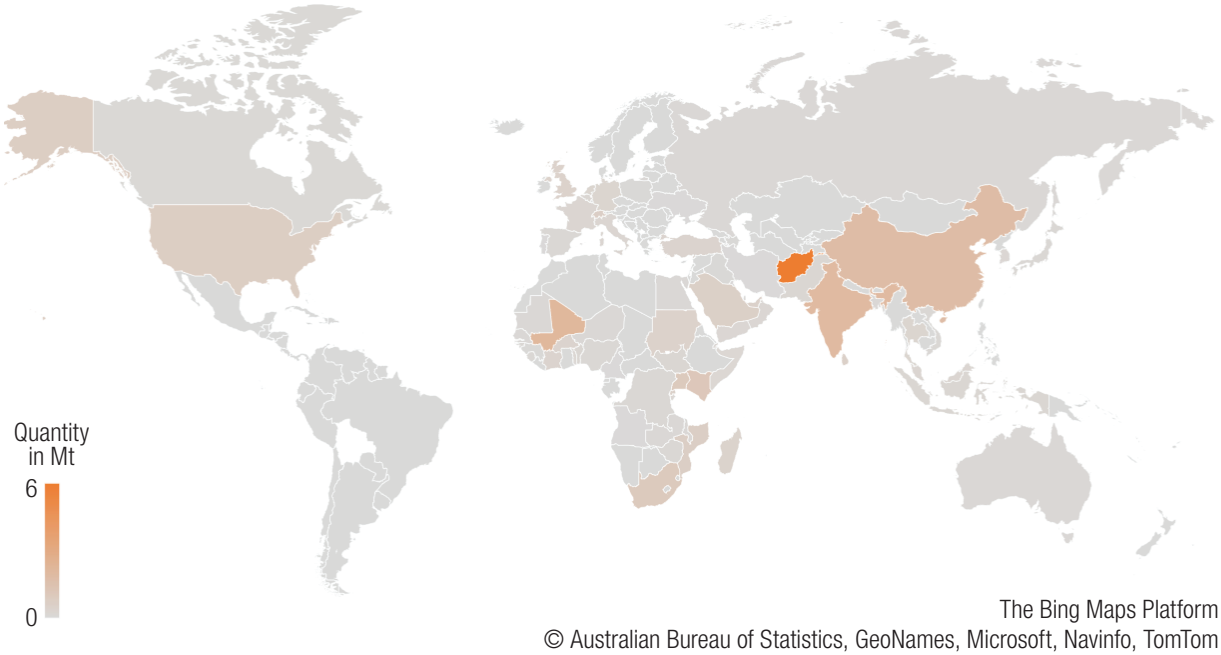
Foreign demand plays an essential role in trade volumes coming from SMEP target countries. The geographical distribution of tradable goods from SMEP target countries is concentrated in a few partners: five countries were the leading destination in 2015, representing 42 per cent of manufacturing exports[11]. They are Afghanistan, Mali, India, the Democratic Republic of the Congo, and China. Figure 4 portrays a comprehensive picture of the market in which SMEP manufacturing exports participate.

9 It is worth noting that the trade database in quantity for SMEP target countries is mostly incomplete, with divergences in the years and products (HS) available.

10 It is out of the scope of this report to evaluate the pollution responsibility (Zhou and Tan, 2012) between exporting and importing countries, but it should be considered in future analysis.

11 Exports data by destination in quantity for the 13 SMEP target countries is only available for 2015.

Figure 4. Manufacturing exports of SMEP target countries by destination in 2015 (million tonnes)



Source: Based on data from ITC (2021).

Over the last decade, five SMEP countries stand out in the quantity of manufacturing exports, namely Pakistan (441 million tonnes), Bangladesh (363 million tonnes), Kenya (92 million tonnes), Nigeria (47 million tonnes) and Nepal (15 million tonnes). The extent to which exports in quantity imply more pollution will depend on sustainability measures in resource and production processes. This analysis of exports data in quantity (e.g., volume) is essential because it gives the basis for the environmental impact analysis of this report.

The fast expansion of trade in manufactured goods can be detrimental to local air quality if this expansion relies on dirty technologies. Considering only carbon dioxide (CO_2) emissions at the country level, the literature shows a positive relationship between trade openness and carbon emissions, as indicated in the study of Onoja et al. (2014) for the African continent (Onoja et al., 2014). Figure 5 illustrates the level of territorial emissions[12] by SMEP target countries, totalising 590 million tonnes of carbon dioxide

12 It refers to carbon dioxide emissions attributed to the country in which they physically occur.

equivalent[13] (CO_{2eq}) in 2019. This emission level is relatively low compared to the 16 gigatonnes the region of Asia emitted in the same year. Developed countries in the European region, for instance, released 5.5 gigatonnes of CO_{2eq} in 2019.

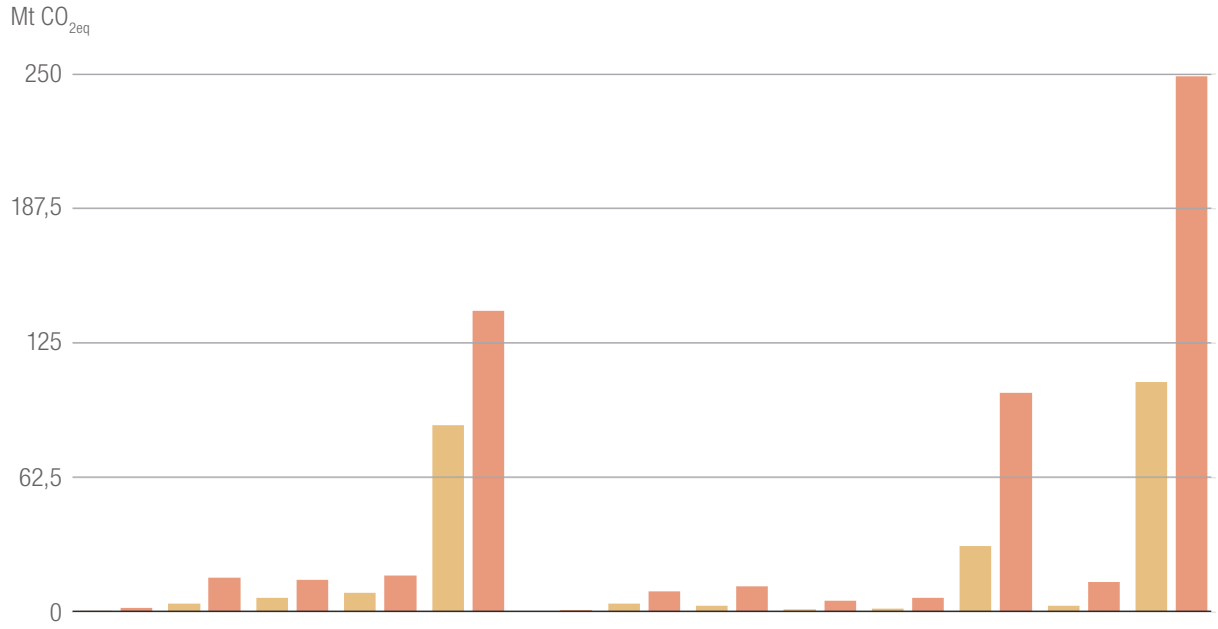
An increase in emissions between 2001 and 2019 raises concerns about local pollution levels, whether due to the rise of carbon emissions or other types of pollutants. Consequently, it requires that countries make efforts in all sectors of the economy to reduce pollution and promote sustainability. As manufacturing processes are also affected, there is a need to adopt more sustainable practices to reshape the production base. This shift is a challenge for SMEP target countries, especially in the context of export-driven manufacturing pollution. Demand-side initiatives to meet sustainable consumption criteria in trade partners reinforce the need for improved manufacturing pollution management, which could become a prerequisite for accessing markets such as the European Union, where the Sustainable Products Initiative is under discussion[14].

Looking exclusively at SMEP target countries, there are substantial differences in the composition of exports among the largest polluters, particularly Nigeria, whose manufacturing sector is based on natural resources such as coke, refined petroleum products, and nuclear fuel. However, manufactured products exported by Bangladesh and Pakistan are mostly lower complexity goods such as textiles and wearing apparel. Considering the role exports composition plays in increasing pollution, analysing the pattern in manufacturing exports is relevant to identify key sectors with growth tendency in merchandise trade.

13 A carbon dioxide equivalent is a metric measure used to compare the emissions from various greenhouse gases because of their global-warming potential, by converting amounts of other gases to the equivalent amount of carbon dioxide with the same global warming potential.

14 See detailed information at: https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12567-Sustainable-products-initiative_en/.

Figure 5. Carbon emissions of SSA and South Asia countries in 2019



	Democratic Republic of Congo	Ethiopia	Ghana	Kenya	Nigeria	Rwanda	Senegal	United Republic of Tanzania	Uganda	Zambia	Bangladesh	Nepal	Pakistan
2001	0.8	4.3	6.7	9.2	87	0.5	4.3	3	1.4	1.9	31	3.2	107
2019	2.3	16	15	17	140	1.1	9.8	12	5.5	6.7	102	14	249

Source: Based on data from ITC (2021).

2. Manufacturing exports portfolio

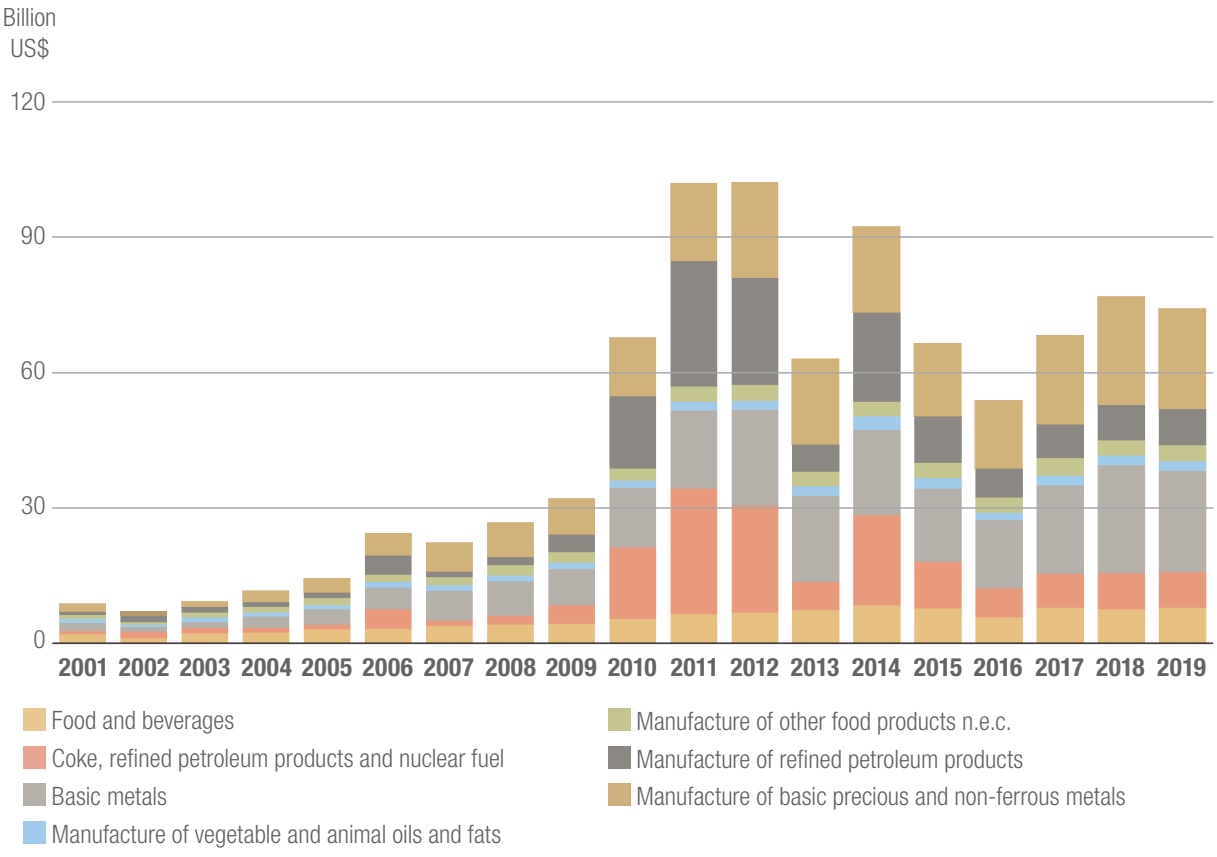
Evidence on manufacturing exports of economic activities in SMEP target countries relies on resource-based manufacturing in SSA countries and low-technology manufactured products[15] in South Asia countries. Figure 6 and Figure 7 depict the evolution of the three main sectors that are more integrated into global value chains in both regions and specify the main manufacturing activities leading the growth in manufacturing exports.

In SSA countries, food and beverages, coke, refined petroleum products, nuclear fuel, and basic metals are responsible for approximately 75 per cent of the growth in manufacturing exports. This trade pattern in manufacturing exports reflects specialisation in lower value-added sectors, influenced by the boom of commodity prices during the 2000s. The food and beverages sector has been experiencing a consistent upward trend since 2001. It comprises important exporting activities for SSA, such as vegetable and animals' oils and fats and other food products.

In South Asia countries, the export pattern is directly linked to the domestic and sectorial productive capacity, and it depends on relative costs and technologies determining whether the sector can be competitive in the global market. The manufacturing trade pattern of the South Asia region differs from SSA's as textiles and wearing apparel; dressing and dyeing of fur dominate exports composition in South Asia. In 2001, exports from the manufacturing sectors of South Asia represented US$ 17.3 billion, of which US$ 13.5 billion refer to those two sectors. By 2019, the upward trend in exports has been accompanied by a greater concentration on exports of textiles and wearing apparel, dressing and dyeing of fur (e.g., 92.3 per cent of manufacturing exports). More specifically, on products of wearing apparel (US$ 28.6 billion) and knitted and crocheted fabrics and articles (US$

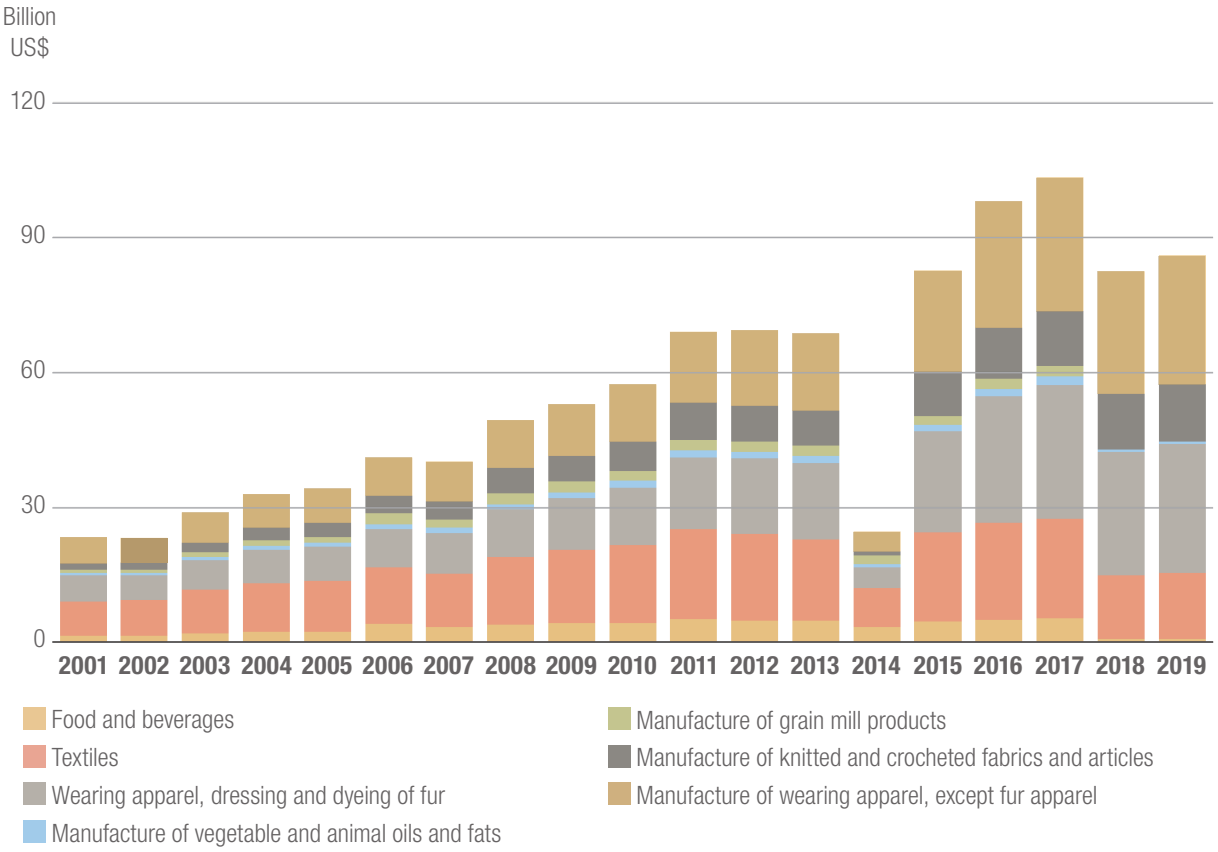
15 Technological categories of exports as defined by Lall (2000).

Figure 6. Evolution of main SSA exporting activities (2001-2019)



Source: Based on data from ITC (2021).

Figure 7. Evolution of main South Asia exporting activities (2001-2019)*



Source: Based on data from Global Carbon Atlas (2021).

*There is no export data of 2014 available for Bangladesh at ITC (2021).

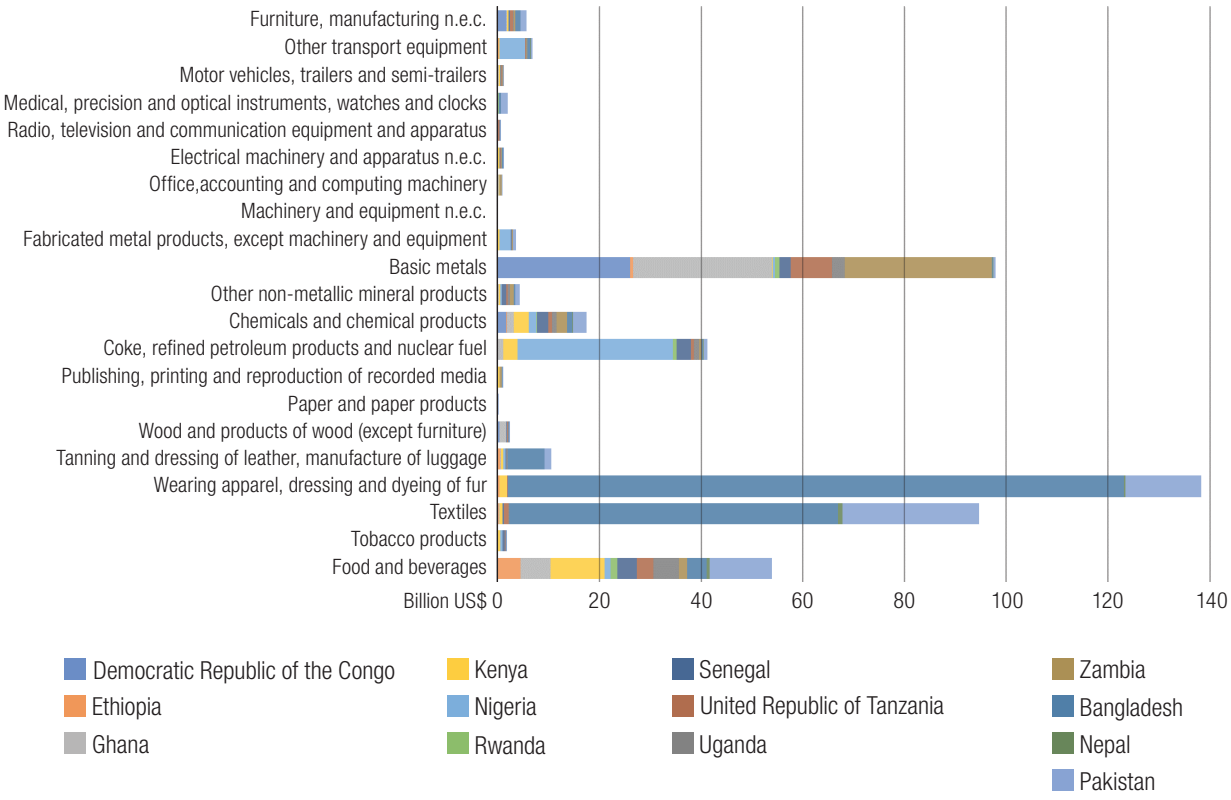
13.7 billion). Food and beverages are also a relevant income source flowing from trading partners to the South Asia region like the SSA region. In this sector, exports of vegetable and animal oils and fats are common exporting activity between Bangladesh and Pakistan.

The majority of SMEP target countries are active in some way in one or more food and beverage segments. For instance, in Kenya and the United Republic of Tanzania, the total value exported between 2015-2019 was US$ 10.7 billion and US$ 3.2 billion, respectively. Pakistan, in contrast, exported US$ 12.1 billion and Ghana US$ 5.9 billion in the same period. Figure 8 illustrates the distribution of SMEP manufacturing exports, which combines the trade performance of manufacturing and individual countries.

Figure 8 also shows that few SMEP target countries are specialised in certain manufacturing activities, such as Bangladesh and Pakistan exports of textiles, wearing apparel and tanning, and dressing of leather. Figure 9 corroborates this in exports penetration, indicating that SMEP target countries have already reached proven markets given the high index. Most of these markets for manufactured goods lies within Asia and Africa. Manufacturing exports from SSA and South Asia to developed countries correspond to approximately 46 per cent and 12 per cent, respectively (ITC, 2021). A low index of exports penetration may imply barriers to trade that prevent companies from expanding the number of markets they export, thereby affecting export competitiveness. More stringent environmental standards requirements are examples of potential barriers SMEP countries may face to access markets in developed countries.

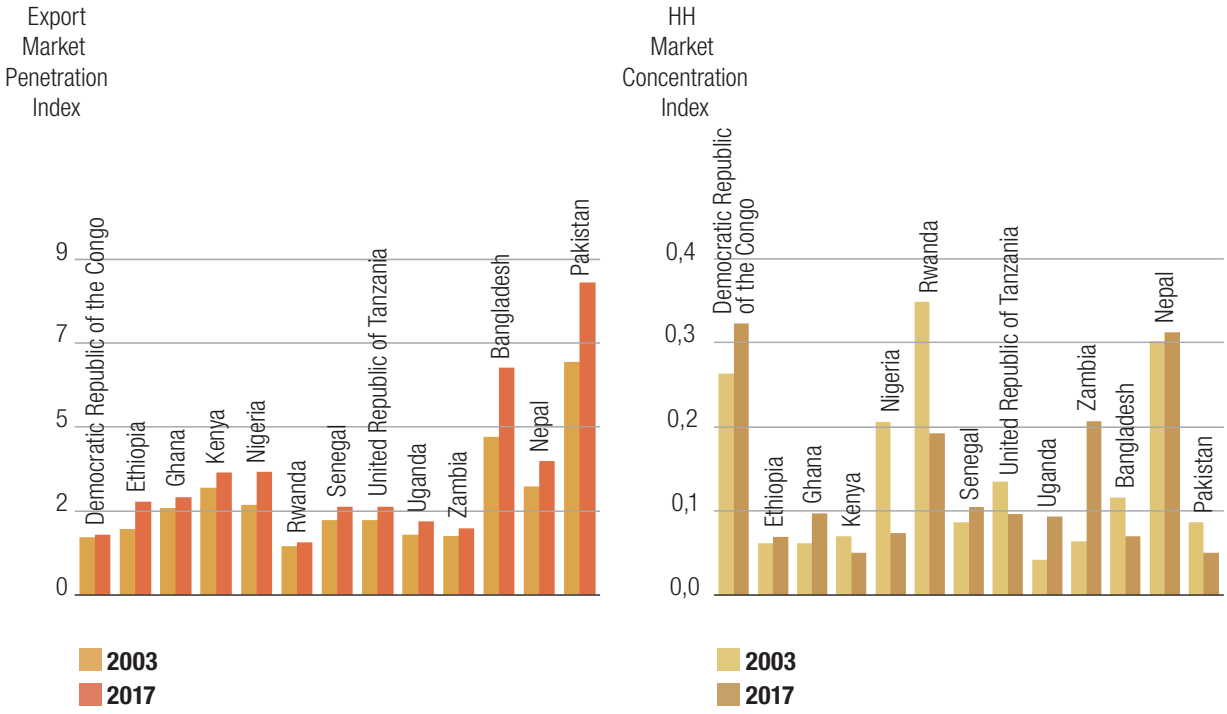
Environmental regulations could be a source of these trade barriers, imposing pollution-intensive products exported by less regulated countries. For SMEP target countries, the chemicals and chemical products

Figure 8. Value of manufacturing exports by activity and country (2015-2019)



Source: Based on data from ITC (2021).

Figure 9. Trade indicators of exports penetration and concentration*



Source: Based on UNCTADstat (2021).

*Data is displayed for the available years of all SMEP target countries.

sector is another important exporting activity, usually highly polluting production. The sector generated US$ 17.5 billion between 2015-2019 in the region. Its prominence occurs specifically in the Democratic Republic of the Congo with 10 per cent, Kenya with 16 per cent, Pakistan with 15 per cent, Senegal with 12 per cent, and Zambia with 11 per cent. Pollution driven by the increase of exports of chemicals and chemical products and other pollution-intensive manufacturing industries is detrimental to the environment and health. However, exposing exporters to different product standards and regulations in various countries can help pressure manufacturing industries to transit more rapidly towards sustainability. In other words, developing the necessary production capacity to promote structural transformation, resulting in a more diversified manufacturing exports[16] portfolio and a higher degree of integration into global value chains of SMEP target countries.

Manufacturing development has not yet translated into economic structural changes that could ensure exports diversification[17] (Haraguchi et al., 2017) and promote sustainable trade. An export pattern characterised by a pollution-intensive manufacturing portfolio and leading to large scale exports can potentially undermine long-term sustainable development. The SMEP target countries remain less specialised than other developing countries in manufacturing exports, with a relatively limited trade portfolio.

B. Manufacturing pollution and associated environmental impacts

There is growing attention to the environmental burdens associated with trade, especially considering the producer and the consumer perspectives. Studies addressing these burdens are frequently conducted by implementing Environmentally Extended Input-Output Analysis (EEIOA[18]) (Kanemoto et al., 2014; Peters et al., 2011; Steen-Olsen et al., 2012; Weinzettel et al., 2013; Wiedmann et al., 2015; Wood et al., 2018) and EEIOA combined with process-based Life process-based Life Cycle Assessment (LCA)[19] in a hybrid framework (Heinonen and Junnila, 2011; Huppes et al., 2006; Pairotti et al., 2015) or, more recently, process-based LCA as a single approach (Corrado et al., 2020). EEIOA enables capturing a complete picture of economic exchanges, considering goods and services, and selecting relevant representative products to be included in the analysis to estimate the environmental burden of exports.

1. Input-output Life Cycle Assessment (IO-LCA)

The input-output LCA (IO-LCA) recently emerged as a new approach to LCA and uses EEIOA tables as inventory data, following the impact assessment and interpretation phases. EXIOBASE (Merciai and Schmidt, 2018) is the supporting database for IO-LCA. This database is a global, detailed multi-regional, environmentally extended database developed in projects financed by the European research framework programme. It was developed by harmonising and detailing supply-use tables for many countries, estimating emissions and resource extractions by industry, and linking country supply-

16 Diversification reflects changes in the export composition and structure of a country, and can be described as widening the variety of products that a country is exporting (Dennis et al., 2007).

17 Cieslik & Parteka (2021) argue that the immaturity of the economy, the inability to use the production factors efficiently, or the excessive dependence on natural resources are key drivers of the low level of diversification in LDCs (Cieslik and Parteka, 2021).

18 EEIOA is based on the extension of monetary input-output tables with environment-related information for each sector, such as its emissions, primary resource use, land use and other external effects per sector. Monetary input-output tables give insight into the value of economic transactions between different sectors in an economy, including output for exports, capital formation and final government and private consumption. When added by the environmental externalities, they calculate how increased demand for output from one sector influences the input of resources from or the output of pollutants to the environment.

19 LCA, in turn, is the "compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle", as described by the ISO 14040. It is the factual analysis of a product's life cycle (or part of it) in terms of sustainability. Each part of a product's life cycle, from the extraction of raw materials to the end of life, can impact the environment and be evaluated.

use tables via trade. Estimating the environmental burden of SMEP countries uses datasets built at a country level and considers only quantities exported by the manufacturing sectors[20].

The IO-LCA uses a set of impact categories from ReCiPe 2016 (Huijbregts et al., 2016) to represent the total environmental impact embedded in EXIOBASE (Steinmann et al., 2018) (Annex 1.B). This set includes headline indicators proposed by Eurostat (European Commission, 2020) and consists of:

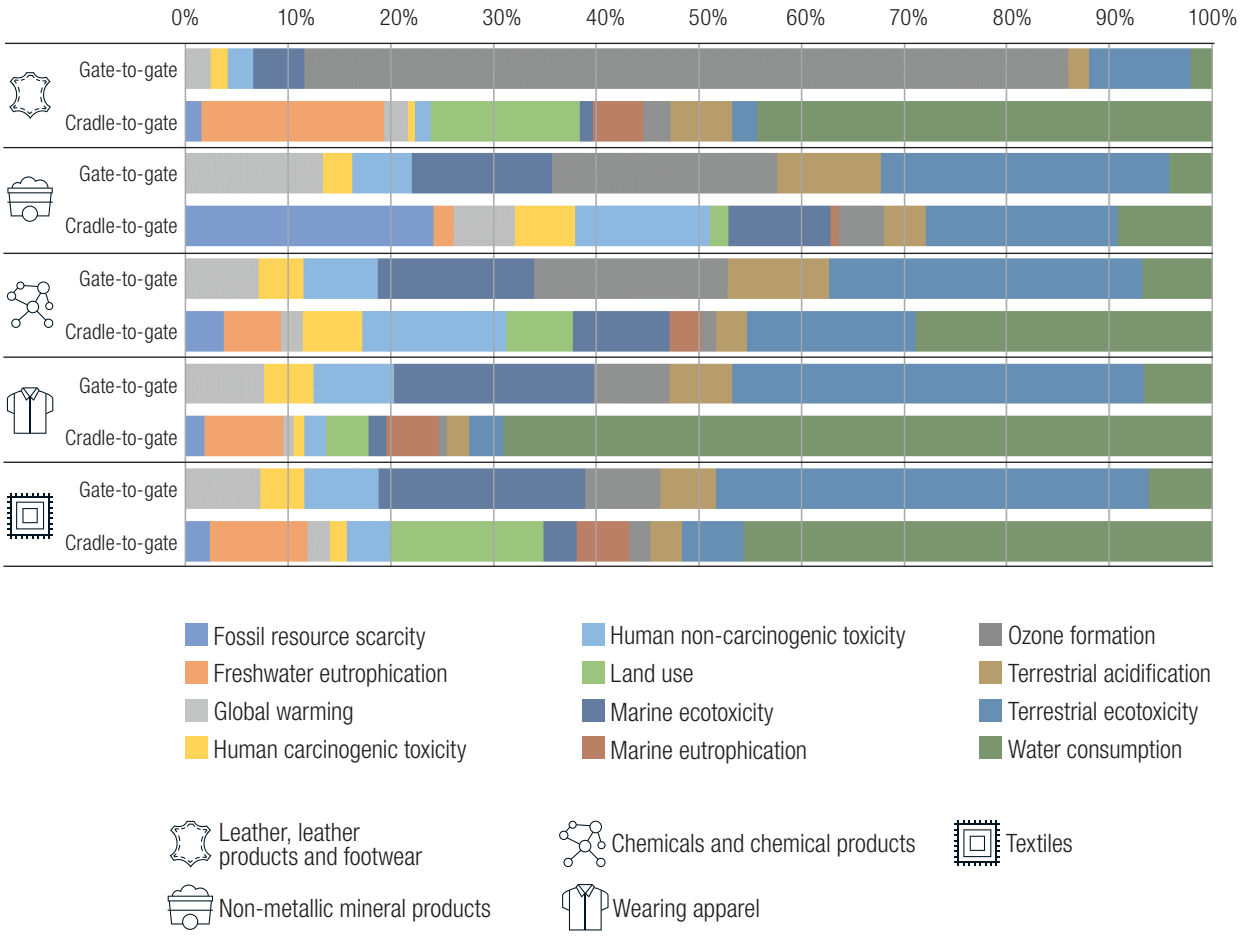
- Fossil resource scarcity
- Freshwater eutrophication
- Global warming
- Human carcinogenic toxicity
- Human non-carcinogenic toxicity
- Land use
- Marine ecotoxicity
- Marine eutrophication
- Ozone formation
- Terrestrial acidification
- Terrestrial ecotoxicity
- Water consumption

The analysis normalises the results to highlight manufacturing sectors and their environmental impact. Normalisation[21] makes it possible to translate

20 ISIC rev. 3 is chosen as a default classification to maintain consistency with the SEI-York study countries (O'Neill et al., 2020).

21 Normalisation factors are calculated as results of global inventories of emission and resources characterized through impact assessment methods. These inventories are built after several modelling choices and assumptions, which may increase uncertainty in the assessment. Nonetheless, normalisation makes it easier to make comparisons between impact scores of different impact categories.

Figure 10. Impact results for the SMEP target countries in South Asia (normalised relative contribution)



abstract impact scores for every impact category into relative contributions of the production stages or activities to a reference situation, providing a better understanding of impact magnitude.

The analysis used two system boundaries approaches to map the environmental burden. The first considered only the manufacturing activity inside the plant, and this approach is called gate-to-gate system boundary. The second adopted the supply chain perspective, from raw material production to the manufacturing process at the plant. This approach provides a broader view by including upstream processes from the supply chain, called the cradle-to-gate system boundary. The analysis does not include downstream[22] processes starting from the plant gate to end-use or grave given the scope of the study, which is manufacturing exports. Figure 10 and Figure 11 present the relative contribution of categories to the overall impact of the exports in the manufacturing sectors from the SMEP target countries located in South Asia and SSA.

From Figure 10 and Figure 11, the exports in the manufacturing sectors, when considering a gate-to-gate system boundary, have a significant contribution in terms of impact to the ozone formation and ecotoxicity categories. This outcome relates to the nitrogen oxides, non-methane volatile compounds (NMVOC), and heavy metal emissions to air from manufacturing processes. In the cradle-to-gate system boundary, the exports in the manufacturing sectors significantly contribute to water consumption, freshwater eutrophication, and land-use changes. These impacts result from agricultural activities since these manufacturing sectors (e.g., textiles or food and beverages sectors) rely on renewable raw materials. Figure 12 and Figure 13 present the normalised relative contribution of manufacturing sectors in the

22 Downstream lies at the export destination.

Figure 11. Impact results for the SMEP target countries in SSA (normalised relative contribution)

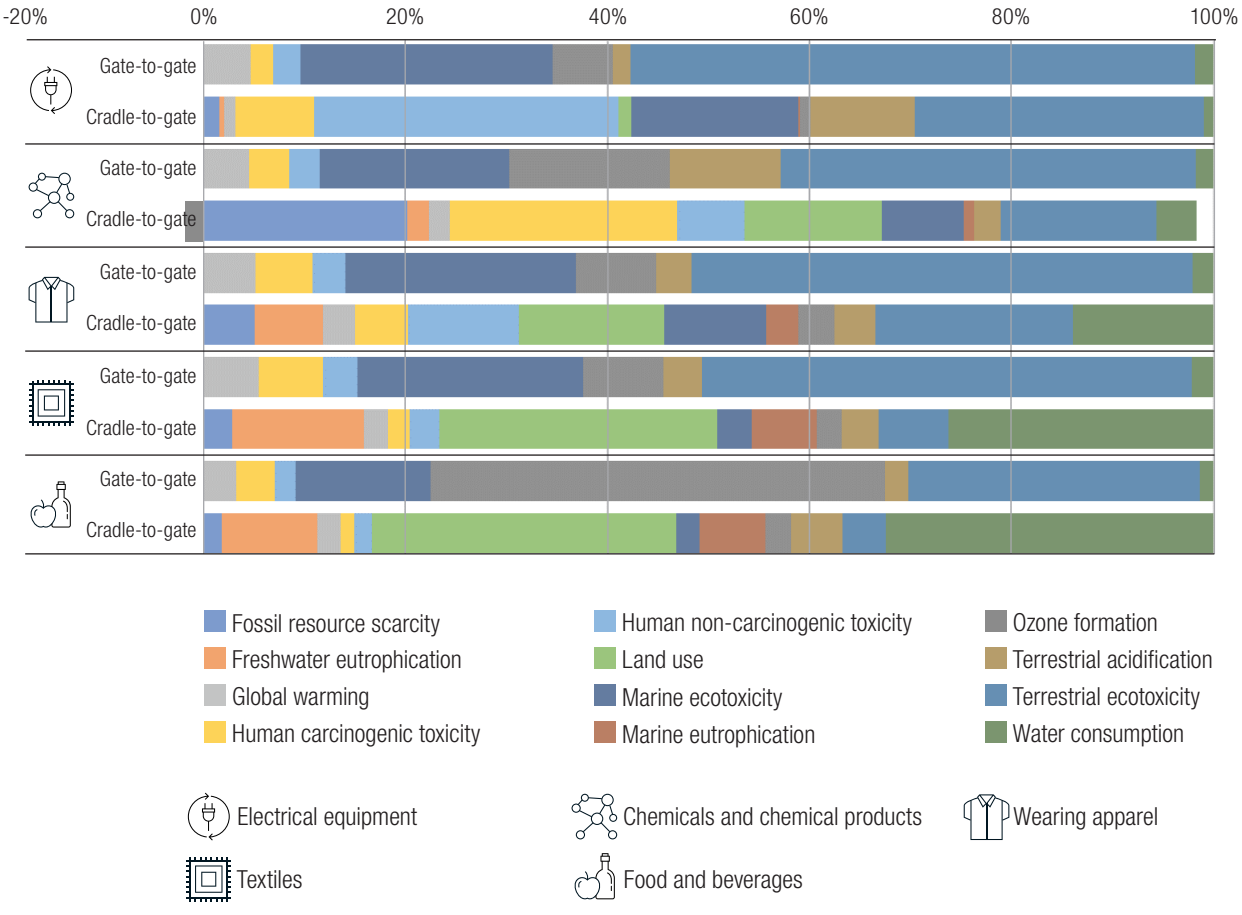
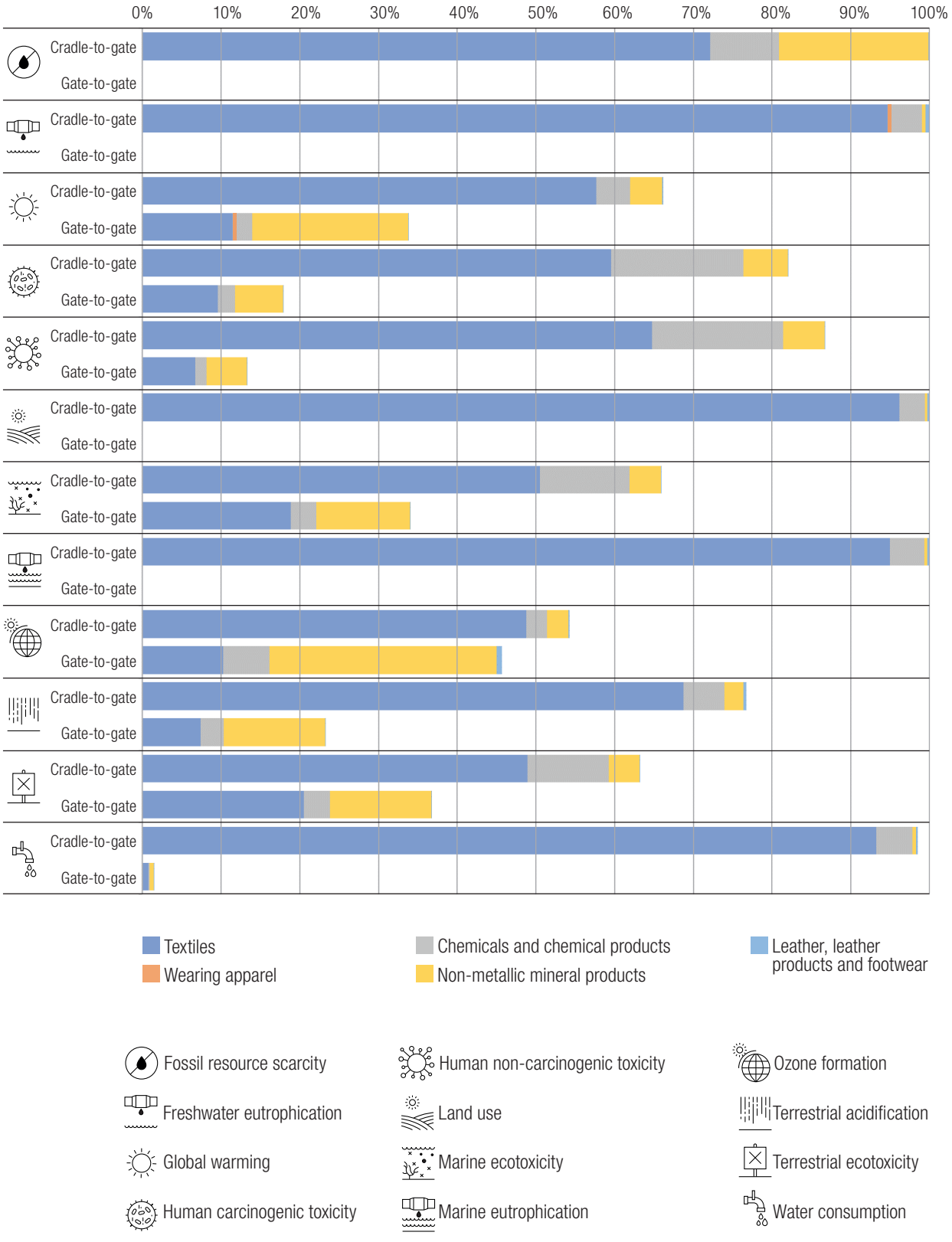


Figure 12. Impact results for the SMEP target countries in South Asia (normalised relative contribution)



SMEP countries in South Asia and SSA, respectively.

In South Asia, Figure 12 shows expressive participation of the textiles sector in all the impact categories, considering both the cradle-to-gate and the gate-to-gate system boundaries. The textile industry has long been considered one of the most polluting industries in the world. This impact is mainly related to the use of harmful chemicals, high consumption of water and energy, and the generation of large quantities of solid and gaseous wastes (Roy Choudhury, 2014). The SEI-York study (O'Neill et al., 2020) found that textiles were the industries most commonly associated with pollution by stakeholders in Bangladesh and generated the most significant number of articles in the literature review. Figure 12 also shows non-metallic mineral products, and chemical and chemical products appear as relevant sectors. The non-metallic mineral products sector significantly impacts the environment (Binder, 2001), mainly due to the high energy consumption and high rate of fossil fuel usage and global warming emissions (Hu and Kavan, 2014). Regarding the chemical industry, it is recognized as one of the most potent sources of environmental pollution, and its environmental impacts are well documented (Beschkov, 2009), involving many persistent, bioaccumulative or hazard emissions (OECD, 2001), not bypassing damages originating from the exhaustion of natural resources (Beschkov, 2009).

In SSA, Figure 13 shows the importance of the food and beverages sector, especially when considering the cradle-to-gate system boundary. In terms of products, processes, and company size, the food and beverages sector is a very diverse sector, but in general, it has the most relevant environmental impacts on energy use, water consumption, solid waste, and wastewater (Dri et al., 2018). The chemicals & chemical products sector is also relevant regarding environmental impacts on fossil resource scarcity and human carcinogenic toxicity. When considering the gate-to-gate system boundary, this sector contributes to ecotoxicity categories and ozone formation.

2. Health impacts

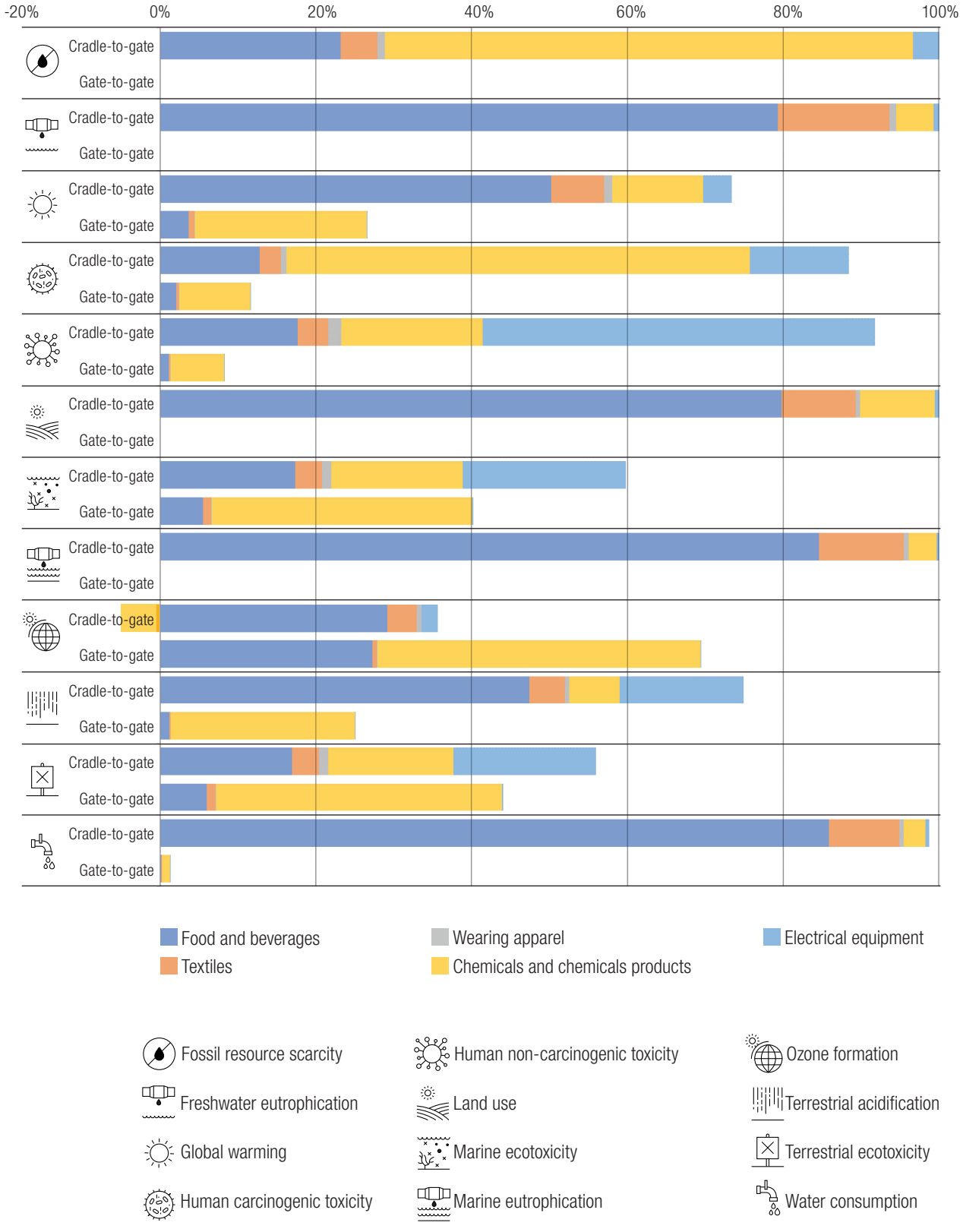
Manufacturing is often seen as a pathway to more significant economic growth. However, polluting activities are increasingly prevalent in lower- and middle-income countries, where environmental and public health protections are limited, and there are few resources to implement sustainable practices.

Negative health impacts on the human body start from the air pollution one inhales to the water one drinks and the soil used to grow crops that one eats. Manufacturing production without environmental control can cause these health impacts. For example, tannery effluent contains large amounts of pollutants, such as salt, lime sludge, sulphides, and acids. The tanning process stabilises the collagen or protein fibres in skins so that they stop biodegrading — otherwise, the leather would rot right in the closet. People who work and live near tanneries can suffer exposure to toxic chemicals used to process and dye the leather. Arsenic, a common tannery chemical, has long been associated with lung cancer in workers exposed to it regularly. Studies of leather-tannery workers in Sweden and Italy found cancer risks between 20-50 per cent above those expected (Mikoczy and Hagmar, 2005).

The impacts on human health from the food and beverages sector arise by producing or consuming agricultural products and not directly by land degradation or aquifer depletion. However, some environmental changes directly affect the quality of human health, such as a rise in temperature, which causes thermal stresses, respiratory problems and deterioration of aquatic ecosystems leading to waterborne diseases (Masood et al., 2014).

The textile production industry is one of the oldest and most technologically complex of all manufacturing sectors. With escalating demand for textile products, textile mills and their wastewater have increased proportionally, causing a significant pollution problem, especially in developing countries. Many chemicals used in the textile industry cause environmental and

Figure 13. Impact results for the SMEP target countries in SSA (normalised relative contribution)



health problems[23] associated with water pollution caused by the discharge of untreated effluent and those because of toxic chemicals, especially during processing. Among the many chemicals in textile wastewater, dyes are considered key pollutants. Textile effluent is a cause of a significant amount of environmental degradation and human illnesses. About 40 per cent of globally used colourants contain organically bound chlorine, a known carcinogen (Khan and Malik, 2014).

The significant changes in health conditions and the emergence of new diseases require understanding and call for new solutions in implementing environmental and health policies for manufacturing activities, especially in the SMEP target countries. The linkages between manufacturing-sourced pollution and related human health impacts constitute an area that needs further research, especially concerning SSA and South Asia, where quantitative assessments are limited in literature (O'Neill et al., 2020).

23 The dyes used in textile industries are potential health hazards as they may be converted to toxic and/or carcinogenic products under anaerobic conditions. Inhaling dust produced during cotton, flax, or hemp handling causes byssinosis, which is a respiratory syndrome. The noise level resulting from the machines used in the textile industry, especially from the dry processes, may violate the limit allowed by the law and cause hearing problems. The use of dyestuffs and pigments may cause a number of adverse effects to health. Health effects may be exerted directly at the site of application (e.g., affecting the workers) and later in the life cycle (e.g., affecting the consumers) (Khan and Malik, 2014).

C. Regional Trade Agreements and public environmental governance

This subsection analyses the Regional Trade Agreements (RTAs)[24] ratified by the thirteen SMEP target countries, exploring how they consider aspects of pollution caused by exports of manufactured goods. It is essential to bring Article XX of the General Agreement on Tariffs and Trade (GATT) 1947. This article lists ten general exceptions to the GATT objectives, including protecting human, animal or plant life, health, and compliance with law and regulations. Therefore, the World Trade Organisation (WTO) members may establish general exceptions to international trade rules due to meaningful considerations such as human and non-human life, the conservation of exhaustible natural resources, and compliance with the law.

There are sixteen RTAs in place for the SMEP target countries linked to regional or international organisations. Amongst the identified and analysed RTAs, there is no expressed mention of the pollution related to the export of manufactured goods. Agreements, such as the Global system of trade preferences (GSTP), Protocol on Trade Negotiations (PTN), are strictly about trade, bringing no mention of environmental issues. However, in most analysed agreements, it is possible to use other provisions to control or reduce pollution. These provisions are here being considered as environmental provisions.

The GATT exceptions to trade rules is the primary mechanism adopted by RTAs to address environmental issues in South Asia and SSA. In South Asia, they are the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC), the Developing 8 Organization for Economic Cooperation (D-8), the South Asian Free Trade Area (SAFTA) and Economic Cooperation Organization Trade Agreement (ECOTA). In SSA, they are the Economic Community of West African States (ECOWAS), the West African Economic and Monetary Union (WAEMU), and the Southern African Development Community (SADC).

The agreements that deal with regional development

24 Annex 3 presents the ratified trade agreements by the SMEP target countries. It also shows the nature of environmental provisions that might be present in the RTAs.

and cooperation, known as "*deep*" RTAs (Mattoo et al., 2020), are secondary mechanisms to address environmental issues in the SMEP target countries. They include environmental provisions in a broader sense. Although these agreements do not expressly mention the pollution caused by the export of manufactured goods, the environmental provisions establish rights and obligations for member states to protect the environment. For example, in this category are the African Continental Free Trade Area (AfCFTA), the Common Market for Eastern and Southern Africa (COMESA), and the East African Community (EAC). Therefore, States parties to RTAs, which have provisions related to the general exceptions of Article XX of the GATT, may take the necessary and exceptional measures to limit trade for the protection of life. In the case of deep RTAs with environmental provisions in their texts, although there is no specific mention of the trade-environment nexus when ratifying these agreements, states assume obligations regarding protecting the environment front of the international community and law. Besides, if a state party has ratified a Multilateral Environmental Agreement (MEA), therefore, it has assumed obligations in the face of the respective MEA. GATT considers the compliance to this MEA by the state member as a general exception to international trade, which means this state may adopt and enforce policies for environmental protection[25].

Concerning Public Environmental Governance (PEG), literature offers a diversity of analytical frameworks for its understanding. Environmental governance can be defined as the exercise of power in the decision-making process about natural resources and the environment. PEG presence on RTAs is still minimal. Relevant values for PEG, such as democracy, human rights, gender equality, and the rule of law, sometimes are present in preambles and other programmatic provisions of the RTAs, but it is still limited or absent in the rest of the RTAs texts.

Regarding environmental provisions, RTAs focused only on trade have narrower perspectives when compared with deep RTAs. Nevertheless, even in this case, PEG remains very limited. Therefore, the interplay (Young, 2011) between the international trade regime and MEAs (Brandi et al., 2020; Kelly, 2003; Sarmiento Erazo, 2018) is essential because obligations in the MEAs are applicable to trade relations. For example, public participation and civic engagement in the trade-environment nexus is absent of the sixteen RTAs analysed for the SMEP target countries. Even recent RTAs, such as AfCFTA, do not deepen this relevant element of PEG. Although PEG is very limited in the sixteen RTAs ratified by SMEP target countries, there are many opportunities to improve the PEG approach to RTAs, including designing future agreements.

There are no approaches or mentions in the identified agreements texts to specific sectors or lists of products tariffs reductions. Therefore, based on the data in the sixteen RTAs analysed, there is no expressed mention about controlling or reducing the pollution related to the export of manufactured goods. Nevertheless, research findings show that international and regional trade regimes have environmental provisions dealing with this thematic through a general exception to trade rules or cooperation in the environment. Besides, MEAs, as legally binding instruments, may be used to prevent, control, and reduce pollution of the export of manufactured goods. However, this information can occasionally be found in other mechanisms of transparency and dissemination, such as, for example, on websites, annexes, protocols, or other documents that do not compose the legal-normative text of the RTAs.

25 More information is presented in Annex 4 about the MEAs that SMEP target countries have ratified.

SECTION II. CASE STUDIES

With the globalisation of trade and manufacturing industries, SMEP target countries have been experiencing industrialisation in recent years. Notwithstanding its capacity to enable economic growth, if the growing manufacturing sector is pollution-intensive, it can negatively impact the local environment and health. This report has investigated the role of manufacturing trade in driving pollution in SSA and South Asia countries. A process-based LCA is conducted, to quantify the local impacts of manufactured goods exports.

The LCA analysis allows a better understanding of which economic activities drive a more significant pollution share in the supply chain. It also identifies the pollutants that make these activities stand out in terms of environmental impacts. LCA results, combined with public and private governance analysis, provides recommendations for each case study country.

A. Case study countries and sector selection

The four case study countries are Bangladesh, Pakistan, Kenya, and the United Republic of Tanzania. These countries are already under analysis by other SMEP programme's activities. This report uses their outcomes to increase local understanding of manufacturing sectors and their pollution management and control in the case studies, which could be replicated to other SMEP target countries.

Sector selection for each country follows three criteria, and they carry the same weight to define the sector. They are:

- Economic Impacts considers the most important products exported between 2015-2019 by each of the target countries.
- IO-LCA Impacts considers potential damages on ecosystems (i.e., environmental impact) and human health (i.e., health impact).
- Secondary data availability considers access to the private sector information about pollution management and control.

Table 2 presents the most relevant sector for each criterion, and the sector with more representation is selected.

Table 2. Selection criteria table and selected sectors for case study analysis in target countries

Region	SMEP Target Country	Economic Impacts	IO-LCA Impacts				Secondary Data Availability	Selected Sector
			Environmental Impact		Health Impact			
			Cradle to Gate	Gate to Gate	Cradle to Gate	Gate to Gate		
South Asia	Bangladesh	Wearing apparel Textiles	Textiles	Textiles Chemicals and chemical products	Textiles	Textiles Chemicals and chemical products	Textiles	**Textiles**
South Asia	Pakistan	Textiles Wearing apparel	Textiles	Textiles Non-metallic mineral products	Textiles	Textiles Non-metallic mineral products	Textiles	**Textiles**
Sub-Saharan Africa	Kenya	Food and beverages Chemicals and chemical products	Food and beverages Chemicals and chemical products	Chemicals and chemical products	Food and beverages Chemicals and chemical products	Food and beverages Chemicals and chemical products	Food and beverages	**Food and beverages**
Sub-Saharan Africa	United Republic of Tanzania	Basic metals Food and beverages	Food and beverages Chemicals and chemical products	Chemicals and chemical products	Food and beverages Electrical machinery and apparatus	Food and beverages Chemicals and chemical products	Food and beverages	**Food and beverages**

B. Sub-Saharan Africa

International trade is an important economic driver for African countries as continental export and import capacity has grown with trade openings (Moussa, 2016). This report uses two case studies located in Sub-Saharan Africa, Kenya and the United Republic of Tanzania.

1. Kenya

The industrialisation has been on the governmental agenda for Kenya since 1963, the year of its independence. However, Kenya has not yet developed a robust manufacturing sector, and its economy is strongly dependent on agriculture, accounting for 34 per cent of its GDP, while manufacturing accounts for less than 10 per cent (KAM, 2018; Karcher et al., 2020). The food and beverage sector (see Table 2) ratifies the strong connection between agriculture and local development in Kenya.

a. Environmental law and governance for manufacturing pollution control

The information about the bilateral trade agreements (BTAs) signed by Kenya is minimal. So far, the research has found only one BTA text available online. The Economic Partnership Agreement (EPA) between Kenya and the United Kingdom of Great Britain and Northern Ireland, as a Member of the East African Community (EAC). Signed in December 2020, its entry in force was in March 2021.

The EPA is a comprehensive deep trade agreement open for any EAC state member accession. It has many innovative provisions that may inspire the creation of environmental provisions in future BTAs. The EPA approaches the trade-pollution-environment nexus in different parts. The parties recognise that trade and economic cooperation shall promote sustainable development in the preamble, including advancements to poverty eradication (United Kingdom of Great Britain and Northern Ireland, 2020).

The EPA follows Article XX of GATT concerning the general exceptions to trade rules. It also highlights the interplay with the MEAs and International Laws. As a deep BTA, there are broader environmental provisions applied to all sectors of trade cooperation. Water, waste, pollution control, protection, management, and environmental policies regarding trade are subjects of the EPA approaches. There are also specific provisions for the fisheries and agricultural sectors, manufacturing included[26].

Concerning governance, the EPA considers the complexity of trade and cooperation rules and recognises that mistakes may happen. The EPA comprises provisions dealing with failures and corrections mechanisms. Access to information and relationship with the business communities are ensured, including participation in different levels. Public participation in the Committee that oversees the EPA is guaranteed too. It expressly mentions civil society organisations and the academic community, which is also innovative compared to other agreements. Despite this complete set of environmental provisions, it establishes that parties shall conclude negotiations in the next five years for a specific BTA for the trade, environmental and sustainable development matters. The EPA is a comprehensive agreement that directly deals with the pollution related to trade between Kenya and the United Kingdom of Great Britain and Northern Ireland.

Regarding environmental governance gaps in Kenya´s BTAs, the main issue is transparency and information disclosure. There is no information about which agreements Kenya has signed on the official state websites. The Ministry of Industrialization, Trade and Enterprise Development, for instance, has news about the EPA, but not the agreement text, which is available online only on the United Kingdom of Great Britain and Northern Ireland website. There is a database of ratified treaties in the Ministry of Foreign Affairs. However, there is no information about any BTA, and apparently, the database is outdated.

Kenyan Constitution ensures the right to information, and the Access to Information Act of 2016 establishes the duty for public information disclosure[27]. Literature suggests that access to information in Kenya is limited. Poor information management, insufficient infrastructure, and weak implementation capacity for public officials/bodies are challenges to ensure the

26 Articles 51.1 and 59.1 affirm the economic relevance of these sectors as sources of export earnings. Parties shall cooperate in industrial processes to achieve sustainable fisheries and agriculture.

27 The act foresees exceptions cases too. Hence, perhaps there are state restrictions to the information about the BTAs. If there are no constraints, the management and availability of information are inadequate. Even with the support of local consultants, there was limited data, and they did not found information about the signed BTAs.

right to information (Article 19 and UNESCO, 2014). Therefore, the absence of information compromises transparency and accountability, which is an issue for local public environmental governance.

i. Kenyan environmental law and governance

Kenya Constitution, 2010, is one of the most advanced Constitutions in Africa. Human dignity is protected, and the environment is one dimension of human dignity. The environment is approached in three different provisions[28]. The right to a clean and healthy environment, obligations, and enforcement rules compose the constitutional framework for the environment.

The Environmental Management and Coordination Act (EMCA), 2015 (amendment), is the primary legal tool for environmental management and pollution control. It provides the legal basis, creates an institutional framework[29] for managing the environment, and establishes the National Environmental Tribunal and its proceedings, designing a comprehensive Judiciary system.

EMCA Second Schedule brings a list of activities that undertake a complete environmental impact assessment (EIA) and submit a report to the respective authority before obtaining any license. In the original 1999 text, processing and manufacturing industries were mentioned, including food and beverages. The 2015 amendment has specified that only the large plants need to fulfil EIA requirements. EMCA requires a separate license for industrial discharge. There is a legal obligation to inspect, audit and monitor the activity yearly. Compliance with the standards is mandatory, and violations are environmental offences. There are also provisions about restoration.

Kenya has a large set of sectoral environmental laws that deepens the trade-production-pollution nexus from a legal perspective. The Water Act, 2016, provides the regulation, management and development of water resources and water and sewerage services in line with the Constitution. The act establishes the right to clean and safe water in adequate quantities and reasonable sanitation standards (Republic of Kenya, 2010). The Climate Change Act, 2016, and the Sustainable Waste Management Bill, 2020, establish legal and institutional frameworks. Both Parliament Acts have similar structures. There are provisions about measures and actions; functions of stakeholders, including private entities; public participation and access to information; finance; monitoring and compliance. Policy coordination is present in both acts.

The National Environmental Policy (NEP) (Republic of Kenya, 2013) is the general policy that leads the environmental agenda in Kenya, adopting a rights-based approach. NEP sets goals, objectives, and principles for environmental management, including the fisheries and agricultural processing sectors. Table 3 summarises the trade-environment nexus provisions.

The Kenyan Constitution designs the institutional framework, limiting the number of Ministries to twenty-two. Considering that the environment is a cross-cutting issue, more than one Ministry may have power over environmental issues, increasing the chance of overlapping mandates. However, the primary Ministry responsible for the environment is the Ministry of Environment and Forestry. The principal agency responsible for implementing environmental policy is the National Environment Management Authority (NEMA). The EMCA created it in 1999, which attributes the powers of the authority for setting the standards, monitoring and enforcement. NEMA regulations have fixed environmental quality standards for water, waste, air, wetlands, controlled substances, noise, and EIA.

Kenya has a dedicated legal system for procedures and trials of environmental offences. The Constitution

28 Article 42, in the Fundamental Principles chapter, states the "Every person has the right to a clean and healthy environment". Article 69 sets environmental obligations for the Kenyan State, such as the "Sustainable exploitation, utilisation, management and conservation of the environment and natural resources". The State shall establish "systems of environmental impact assessment, environmental audit and monitoring of the environment", and "eliminate processes and activities that are likely to endanger the environment". Public participation is mandatory and shall be encouraged by the State. Besides, there are also obligations for any person concerning the environment. Kenya Constitution establishes the duty of every person to cooperate with authorities and "ensure ecologically sustainable development and use of natural resources" (Republic of Kenya, 2010). The enforcement of the Environmental Law is foreseen in article 70.

29 The Act has provisions on General Principles; conservation; environmental impact assessment (EIA); audit and monitoring; quality standards; restoration orders; inspection and environmental offences.

Table 3. NEP Environmental Statements for Trade

Provisions about the Trade-Environment nexus in the National Environmental Policy		
Mainstream environmental considerations into the National Trade Policy	Ensure that environmental issues are integrated into international and regional trade negotiations and nationalize resulting agreements	Promote and support capacity building in the field of trade and environment
	Promote and encourage the adaption, uptake, and implementation of international environmental and natural resources stewardship standards	Promote reduction of negative environmental footprints in production and trade practices

Source: Based on data from the Republic of Kenya (2013).

establishes the obligation to the Parliament to create courts with the status of High Courts with power to hear and dispute settlement about the environment. Public Complaints Committee and the National Environment Tribunal complete the institutional architecture for the Environmental Law enforcement (Mwenda and Kibutu, 2012). Therefore, Kenya has sound legal mechanisms, a clear legal orientation, and well-established environmental management systems[30] to control and reduce pollution in the food and beverage sector.

Environmental law in Kenya is well advanced. Institutional architecture and policies are comprehensive. Their design and powers are qualified to face environmental challenges. However, implementation, compliance and enforcement are weak, a significant concern for achieving sustainable production practices.

Regarding the institutional architecture, powers are complex, and overlapping roles remain.[31] For example, although well-articulated waste management policies exist, responsible organisations still face institutional challenges. Financial resources constraints have hindered the effective implementation of environmental policies (The World Bank, 2019a). A clear nationwide roadmap to eradicating pollution emerging from industrial solid wastes is yet to be established, limiting governance effectiveness[32] (Mungai et al., 2020). There are reports of inadequate implementation of transparency, accountability, fairness, and capability principles (Oduor, 2020); public participation (Mbithi et al., 2019; Walker et al., 2014); and communication (Karanja et al., 2018).

b. Private sector governance of the food and beverage manufacturing sector

Kenya has been pursuing industrialisation since it attained independence in 1963. Three policy regimes influenced this process: import substitution, market liberalisation and export orientation strategy (Chege et al., 2014; Ngui et al., 2016). The three of them were not successful. So far, policy reforms in 2000 have contributed to industrial development and trade, culminating in 2007 in enacting the National Industrial Policy (NIP).

The policy targeted industrialisation and placed Kenya globally competitive through export orientation strategies. The country defined reforms under three blueprints: Poverty Reduction, Economic Recovery for Wealth Creation, and Vision 2030[33] (Chege et al., 2014).

Proposed interventions focused on the external markets, and consequently, export-oriented strategies. In this sense, efforts were made to promote the development of special economic zones (SEZ), industrial parks, and industrial clusters (Khisa, 2016). So far, implementation has been a challenge attributed to a weak technical and managerial capacity, poor coordination, and inadequate funding (The World Bank, 2019a).

Along with NIP 2007 and Vision 2030, the "*Big Four*" (B4) is a government economic blueprint that seeks to foster inclusive economic growth, boosting the

30 According to data provided by the local consultant on Annex 2.

31 According to data provided by the local consultant on Annex 2.

32 According to data provided by the local consultant on Annex 2.

33 Vision 2030 described the pathway towards developing the country into a middle-income industrial nation by the year 2030, through expansion of the manufacturing sector (Karcher et al., 2020).

country's manufacturing sector with an emphasis on exported goods (KAM, 2018). The emphasis on inclusive growth is reflected in global and regional development commitments: the Sustainable Development Goals (SDGs), the Africa Agenda 2063, and the EAC Vision 2050 (KIPPRA, 2020).

During the 2018-2022 implementation period, four priority areas were identified: manufacturing, food and nutrition security, universal health coverage and affordable housing (AfDB, 2014a). Indeed, Vision 2030 and the B4 Agenda build on manufacturing to support economic growth, expand job creation, and foster industrial development (KAM, 2018). So far, the low and declining share of the manufacturing sector in the GDP represents a significant challenge for the country economic growth. Historically, its contribution to the GDP stagnated around 10 per cent, was about 8.1 per cent in 2017, and reduced to 7.5 per cent in 2019, showing signs of deindustrialisation[34] (KAM, 2021). This trend accelerated because of COVID-19, mainly due to the collapse of existing businesses. Table 4 highlights the Kenyan manufacturing sector strengths and constraints (AfDB, 2014a).

Until the mid-80s, the dominant manufacturing sector was textile in Kenya, when trade liberation saw cheap textile and second-hand clothes influx. In 2000, the African Growth and Opportunities Act (AGOA) enactment resulted in apparel exports increment. By this time, food processing[35] began to dominate manufacturing, accounting for one-third of total manufacturing output in 2010 (Chege et al., 2014). Hence, manufacturing is dominated by food and beverage companies, which account for over 35 per cent of the total manufacturing sector output in value[36] (AfDB, 2014a).

Initially, the food and beverages sector was dominated by subsidiaries of multinational corporations, mainly from Europe and North America. Production concentrates around the country´s three most important urban centres Nairobi, Mombasa, and Kisumu (AfDB, 2014a, 2014b). Many food and beverages manufacturing companies are privately owned and operate across the country as informal businesses. Prevailing in the sector, small enterprises (90 per cent) comprise 5,878 companies (AfDB, 2014a; Imungi, 2018). Most of the industrial raw materials are sourced from the domestic market, directly from agriculturally based outputs. An increase or a decrease in outputs will have significant implications for the sector due to climate change, significantly affecting agriculture (AfDB, 2014a).

In 2019, food and beverages exports accounted for 44 per cent of total exports in value, reducing 3.44 per cent compared to 2018 (KAM, 2021). Out of the total food and beverages exported, only 16 per cent is processed; the remaining is exported raw (MOIED, 2015). Export products are concentrated in meat, fish, fruit, vegetables, and oils and fats production, accounting for 58 per cent of food and beverages exports (AfDB, 2014a). Other food products account for 29 per cent, beverages 10 per cent, followed by dairy products and grain mill products, 1.9 per cent and 1.6 per cent respectively. The European Union, the United States of America, and the EAC are the most prominent exporting destinations (AfDB, 2014a). Therefore, the sector is considered a key driver to the country economic growth, with a direct and significant positive impact on the overall economy (KAM, 2018). This development trend can relate to Kenya's good logistics and connectivity (e.g., ports, road infrastructure, international airports, and railway lines). Kenya also has a good workforce scenario with a relatively affordable wage rate, reliable power scenario, and favourable legal and regulatory framework[37].

Industrialisation can indeed provide substantial opportunities for Kenya economic growth. However, it often comes with environmental degradation, natural resources depletion, and high pollution levels, usually associated with public health concerns and decreased industrial productivity (The World Bank, 2019a). Greening the sector is a considerable

34 The TEIFAs report – being developed through the SMEP programme – mentions that "the GDP has remained around 10 per cent and was approximately 8.4 per cent in 2017". According to KAM (2021), the manufacturing sector's contribution to GDP are 7.5 per cent in 2019 , 7.8 per cent in 2018, and 8.1 per cent in 2017.

35 In an African context, food processing involves drying, milling, curing, smoking and packaging (Dekeyser, 2019).

36 The food & beverage sector has seven sub-sectors: alcoholic beverages and spirits; bakers and millers; cocoa, chocolate and sugar confectionery; dairy products; juices/water/carbonated soft drinks; slaughtering, preparation and preservation of meat; tobacco and vegetable oils (KAM, 2018).

37 According to data provided by the local consultant on Annex 2.

Table 4. Strengths and constraints of the Kenyan manufacturing sector

Strengths	Constraints
Availability of well trained and skilled labour	Expensive and unreliable power supply
Availability of raw materials, especially in the food and beverages sector	Resource-based production patterns using low technology
Strong private sector industry associations	Limited access to finance, especially for small and medium enterprises (SMEs)
Strong public-private partnerships (PPP)	Limited value addition and product transformation
	Poorly developed infrastructure
	High cost of labour
	Low productivity compared to emerging economies
	A high number of burdensome regulations
	Multiple regulatory institutions with overlapping mandates leading to high administrative costs
	Limited market access

Source: Based on data from African Development Bank (2014).

challenge. Indeed, integrating sustainability into Kenya's development agenda is crucial if the country aspires to economic growth, poverty alleviation, and health improvement (Kaimuri, 2020).

Undeniably, Kenya has enacted a range of environmental policies and laws[38] and created an institutional framework. Nevertheless, it faces many constraints on its capacity to execute, monitor, and enforce those regulations. Those constraints are related to limited human and financial resources and limited technological know-how to implement environmental management and resource-efficient and cleaner production (RECP)[39] initiatives (The World Bank, 2019a).

Kenya's educational system comprises primary, secondary, and tertiary levels of education. Tertiary level institutions include universities and technical and vocational and education and training (TVET) institutions. Even though Kenya's education is considered reasonable compared to other African countries, providing the labour market with a relatively high skills workforce remains low (AfDB, 2014a). Integration, coordination and linkages between training institutions and industry are also considered weak in the country (Karcher et al., 2020).

i. Sustainability in the food and beverage manufacturing sector

Sustainability is a global issue that recently is gaining a place among businesses in Kenya. The Kenyan private sector[40] gradually recognizes the need to commit to sustainability. Major drivers pressuring food and beverages companies to pursue sustainability are the local government through environmental policies and legislation, international market and agencies, business associations, and consumers. International market pressures usually apply only to medium and large companies interested to access the external markets. For example, to export to the European Union and the United States of America, especially California, Kenyan companies must meet environmental solid regulations and standards (ITC, 2016; Owade, 2020). To ensure compliance with international market demands, most companies work

38 In Kenya counties have the responsibility for implementing environmental policies (The World Bank, 2019a).

39 RECP is part of National Industrialization Policy Framework. Section 4.8 Industrial Research, Development and Innovation: "Develop a National Resource Efficiency and Cleaner Production Policy, and the institutional framework" (Republic of Kenya, 2012, pg 35). Cleaner Production is the continuous application of preventive environmental strategies to processes, products and services to increase efficiency and reduce risks to humans and the environment (production efficiency, environmental management, human development).

40 Kenyan private sector, despite its growth over the years, is limited by infrastructure, security, regulatory and political challenges, which impede the sector from reaching its full potential (Kaimuri, 2020).

with the government, non-governmental organisations (NGOs), and other private organisations. There is an effort to provide financial and technical incentives[41].

Kenya has developed two eco-labelling initiatives at the regional level: the African Eco-labelling Mechanisms (AEM's)[42] and the ECO Mark Africa (ECO)[43].

The AEM is a project promoted by the German Corporation for International Cooperation (GIZ)[44]. The African Organisation for Standardisation (ARSO)[45] leads it in partnership with the African Roundtable on Sustainable Consumption and Production (ARSCP), the African Union, and the United Nations Environment Programme (UNEP) in three countries Ethiopia, Kenya and the United Republic of Tanzania. The ECO[46] started in 2010 and is registered under the European Union Intellectual Property Office. EMA establishes a recognition system for sustainability standards which functions as a quality assurance mechanism.

An improvement to access international markets. ECO signals to the market that products and services meet specific environmental and social standards. Businesses will be able to measure their performance while communicating the environmental credentials of their products.

Besides eco-labelling, cleaner production is an essential tool in promoting sustainable manufacturing in Kenya. The cleaner production impacts in Nairobi manufacturing companies resulted in reduced water consumption, costs of raw materials, occupational and safety expenses, waste discharge, energy consumption, and improved corporate image and staff morale (Njoroge et al., 2017).

Industrialisation through SEZs and Industrial Parks is gaining force in Kenya. The private sector is increasingly recognizing that SEZs and Industrial Parks provide an enabling environment for manufacturing through energy, water, telecommunications, transport, and waste management infrastructure (Khisa and Onyuka, 2018). In this sense, Khisa (2016) assessed the efficacy of Industrial Ecology and Industrial Symbiosis[47] in enhancing the environmental governance of the Athi River SEZ (Khisa, 2016). The Industrial Symbiosis was in its infancy. However, it has helped demonstrate the social inclusion dimension of green growth by creating decent green jobs (Khisa, 2016). Detailed investigation of the material flows revealed that some companies were already exchanging wastes and by-products. However, the Athi River SEZ's weak infrastructure for waste recovery and recycling slowed down symbiotic links among businesses. The main Industrial Symbiosis contributions were green jobs creation, lower GHG emissions, and lower production costs.

Bor (2021) determined the effects of Green Supply chain Management (GSCM)[48] practices on the performance of 187 food and beverages processing firms registered within the Kenya Association of Manufacturers (KAM), including environmental aspects, cost management, quality and operational performances (Bor, 2021). The research found out that the implementation of GSCM practices leads to better performance. Some of the identified environmental measures were reduced purchase of hazardous materials, carrying out supplier's environmental audits, conducting environmental awareness seminars, production processes designed to reduce waste, ensuring water conservation, product ecodesign, cleaner production practices, and use bio-degradable, reusable or recyclable packaging material. Those measures, when properly implemented, resulted in a higher environmental,

41 According to data provided by the local consultant on Annex 2.

42 See https://www.international-climate-initiative.com/en/details/project/african-ecolabelling-mechanism-09_I_131-20/.

43 See https://www.ecomarkafrica.org/.

44 See https://www.giz.de/en/worldwide/19720.html/.

45 See https://www.arso-oran.org/?page_id=5617/.

46 See https://euipo.europa.eu/eSearch/#details/trademarks/010395945/.

47 Industrial symbiosis was named through an analogy with the symbiotic relationship between two organisms in nature. Industrial symbiosis can look for the exchange of materials, by-products, waste and other resources between companies. This concept was first discussed in 1989, by Frosch and Gallopoulos, in the article "Strategies for Manufacturing". Industrial symbiosis can happen between co-located industries within an industrial districts, EPZ or SEZ or in a virtual way, when synergies happen between industries not co-located (Kincaid, 1999).

48 GSCM "is referred to as an incorporation of environment- friendly initiatives into every aspect of the supply chain encompassing sourcing, product design and development, manufacturing, transportation, packaging, storage, retrieval, disposal, and post-sales services including end-of-product life management" (Bor, 2021).

social and financial performance besides the superior quality of products (KAM, 2018).

ii. Sustainable enterprises initiatives

Food and beverages companies were selected from companies listed in the Nairobi Securities Exchange (NSE), and all the information presented was gathered from their website and published reports.

East African Breweries Limited (EABL), founded in 1922, is a regional leader in alcoholic beverages in East Africa, with brands ranging from beer and spirits to adult non-alcoholic drinks. Business is concentrated in three core markets of Kenya, Uganda and the United Republic of Tanzania and exports to more than ten countries across Africa and beyond. The company is committed to sustainability by adopting efficiency measures in operations, investment in renewable energy (i.e., biomass and solar energy), maintaining zero waste to landfill, and recovery, purification and reuse of water[49]. Currently, EABL treats 100 per cent of its wastewater. The company also invests in reforestation, granting its hole in reducing carbon footprint and curbing air pollution. In partnership with four local colleges, EABL implemented a scholarship programme enabling underprivileged students from farming communities to access higher education (EABL, 2020).

Seven SDGs are part of the company´s business sustainability strategy, promoting a positive place for alcohol in society, building thriving communities and reducing our environmental impact. Table 5 summaries of the SDGs covered.

Kapa Oil Refineries Ltd is a food manufacturing company founded in 1960. Its manufactures edible oils, margarine, baking powder, detergent powder, laundry and toilet soaps, and glycerine. This range of products is exported to over 18 African countries serving the COMESA, SADC markets, Asia, and the United Arabs Emirates. The company focus on products and services quality and performance. Between 2003 and 2012, KAPA was certified under Quality Management Systems (QMS)[50] and committed to the Code of Ethics for Business (KAPA, 2019). The code is based on the United Nations Global Compact principles from human rights, labour standards, environmental protection, and anti-corruption practices. Since 2014, Kapa has disclosed its Sustainability Report under the Global Reporting

49 Water efficiency was achieved through the reduction of water per litter of beer produced, from 4.3 to 2.6 litres (EABL, 2020).

50 ISO 9001:2000.

Table 5. SDGs included in the EABL business sustainability strategy

Sustainable Development Goal	EABL business strategy
SDG 1: No Poverty	Local sourcing of 80 per cent of raw material
SDG 2: Zero Hunger	Food security by an increase in the growth of crops to supply small farmers' demand
SDG 3: Good Health and Well-being	All employees are free from harm at work. Based on four pillars: prevention, culture, compliance, and capability
SDG 4: Quality Education	EABL Foundation's Skills for Life programme. 250 scholarships. Employment of hundreds through trainee programmes
SDG 6: Clean Water and Sanitation	Minimise water use throughout the value chain, reduced wastage and water p/l of beer produced
SDG 8: Decent Work and Economic Growth	EABL employs 1,600 East Africans directly and another two million people indirectly
SDG 12: Responsible Consumption and Production	Responsible consumption of alcohol campaign. Launched initiatives: Campaigns such as "Under 18 Asipewe and Utado?" (What will you do?) are designed to equip consumers with the knowledge they need to enjoy our products responsibly. We've also delivered training to thousands of retailers and consumers

Source: Based on data from EABL (2018).

Initiative (GRI) standards[51].

Kapa business activities, actions, decisions, and behaviour are guided by five core values: integrity, quality, accountability, respect, and responsibility. To ensure compliance with those values, the company created a platform where employees can raise concerns without fear of reprisal. Information remains confidential and anonymous. All incidents reported are investigated and reported to the ethics committee. Kapa is committed to sustainability in the whole value chain. In this sense, suppliers undergo a comprehensive due diligence process, in which facility and process are audited, to ensure that processes, operations and quality are in line with agreed standards.

Furthermore, it conducts periodical performance monitoring (KAPA, 2019). Kapa gradually is making progress towards realizing the SDGs and United Nations Global Compact aligned with its business operations. Seven of the SDGs are part of the corporate company strategy, as shown in Table 6.

51 The GRI Standards are a framework, that provides a common language for organizations to report on their sustainability impacts in a consistent and credible way. Reporting enhances global comparability and enables organizations to be transparent and accountable (https://www.globalreporting.org/).

In a path to comply with international market demands, a few Kenyan companies pursued Environmental Management System (EMS) certification under ISO 14001:2015 standards. According to a survey conducted in 2019 by the International Organisation for Standardisation (ISO), Kenya has 57 valid EMS certificates, among which eight were granted for food and beverages companies (ISO, 2019).

As Bor (2021) states, external motivators like international buyers and customer pressure, are key drivers to pressure companies to pursue EMS certification (Bor, 2021). Indeed, research conducted in Kenya on EMS certified companies recognized a positive relationship between green companies and organizational performance enhancement (Mwaura, 2015).

Committing to sustainability, the Nairobi Securities Exchange (NSE), with 63 listed companies, enrolled on the Sustainable Stock Exchange Initiative[52,53]. Under

52 Listed companies available at: https://www.nse.co.ke/listed-companies/list.html/.

53 Sustainable Stock Exchange Initiative is promoted by the United Nations Conference on Trade and Development (UNCTAD), the United Nations Global Compact, the United Nations Environment Program Finance Initiative (UNEP FI) and the Principles for Responsible Investment (PRI). It seeks corporate transparency and performance enhancement on ESG (environmental, social and corporate governance), sustainable investment and the achievement of the SDGs (https://sseinitiative.org/).

Table 6. SDGs covered by Kapa´s corporate company strategy

Sustainable Development Goal	Kapa´s corporate company strategy
SDG 1: No Poverty	Employment generation
SDG 2: Zero Hunger	Donation to children and elderly homes
SDG 3: Good Health and Well-being	Products compliance with World Health Organisation requirements
SDG 7: Affordable and Clean Energy	Energy efficiency and renewable energy sources (solar, biomass)
SDG 8: Decent Work and Economic Growth	Adoption of the National Minimum wage to all employees. To become an inclusive organisation
SDG 15: Life on Land	Protection of elephants, combat climate change, compliance with wastewater discharge standards, water use reduction, and E-waste management
SDG 16: Peace and Justice Strong Institutions	Conduct business with integrity, ethics, fight corruption and bribery

Source: Based on data from KAPA (2019).

the Initiative, listed companies commit to issuing a sustainability report annually. Those companies are distributed in 13 sectors. The manufacturing sector is represented by eight companies, out of which four are from the food and beverages sector. They are British American Tobacco Kenya Plc, East African Breweries Ltd, Mumias Sugar Co. Ltd and Unga Group Ltd. In 2018, NSE published its Corporate, Social & Responsibility (CSR) Policy containing the requirements for implementing and monitoring a CSRProgram in NSE[54] (NSE, 2018).

The Kenya Green Economy Strategy and Implementation Plan (GESIP) 2016–2030 has committed to investing US$ 23.5 billion in Kenya's green growth pathway. In this sense, in 2017, the Green Bonds Programme Kenya (GBPK) was launched to catalyse the market for green bonds[55]. The program seeks to accelerate using green bonds as a tool for Kenya to enter international and domestic capital markets and finance green infrastructure projects (NSE, 2018). Green bonds issuance entered into force in the 2018/19 fiscal year, making Kenya the first country in East and Central Africa to issue a green bond (NSE, 2019).

iii. Business associations / sectoral institutions initiatives

The KAM is an umbrella association for manufacturers that seeks to promote competitive and sustainable local manufacturing. KAM members are categorized into 14 sectors, among which is the food and beverage sector. The food and beverages sector is the largest manufacturing sector in KAM and constitutes 22 per cent of registered members.

Among the initiatives at KAM, the Kenya Industrial Transformation Program (KITP) provides a roadmap to enhance manufacturing, stimulate exports and subsequently transform the economy. Central pillars are infrastructure expansion, SME development, long term finance access, and improve manufacturing investments (MOIED, 2015). Another initiative is the Manufacturing SME Hub, created in 2019, offering SME incubation services, preparing them to take advantage of available markets, and overcoming challenges, such as lengthy standards and certifications processes and access to finance (KEPSA, 2020).

Since 2018, KAM publishes the Manufacturing Priority Agenda (MPA) every year, outlining actions to enhance manufacturing and investment growth. The agenda is based on five pillars: (i) competitiveness and level playing field for manufacturers, (ii) enhance market access, (iii) pro-industry policy and institutional framework, (iv) government-driven SME development, and (v) industrial resilience and sustainability. The fifth pillar mainly focuses on implementing a manufacturing sector resilience and sustainability strategy, green growth, and industry skills development (KAM, 2021, 2020).

The Kenyan Private Sector Alliance (KEPSA) is the private sector body that brings together over 500,000 businesses, including SMEs, from all sectors of the economy (KEPSA, 2020). KEPSA coordinates an institutionalised mechanism of engagement between government and private sectors called the Public-Private Dialogue (PPD) platform that seeks to join solutions, formulate and implement policies, laws, and strategies and knowledge sharing.

Under KEPSA, the private sector reports on its contribution to the achievement of SDGs in Kenya. Significant initiatives adopt market-based solutions, including green and circular approaches for growth and programmes to address youth, persons with disabilities, and women unemployment through access to productive opportunities. So far, many businesses are shifting from the linear economy model to a green and circular economy model. Besides, publicly listed companies incorporate sustainability reports as part of their annual report (KEPSA, 2020).

In 2018, the Kenya National Platform on Partnering for Green Growth and Global Goals (P4G) was established as a public-private partnership, fostering green and circular economy adoption, implementing SDGs, and the Paris Climate Agreement. In this line, Andersen et al. (2021) investigated how 27 manufacturing companies in Ruaraka industrial area, Nairobi, are experiencing a green and circular economic change (Andersen et al., 2021). The study

54 CSR is a business approach that contributes to sustainable development by delivering economic, social and environmental benefits for all stakeholders. The policy entered into force on 18th March 2018 (NSE, 2018).

55 A green bond is a type of debt instrument whose proceeds are exclusively earmarked to fund projects that deliver positive environmental benefits. Financially, green bonds are the same as vanilla bonds, offering comparable risk/reward profiles and following the same issuance procedures.

concluded that companies, with differences between them, are reaching a moderate to the medium stage of greening and that circularity is relatively widespread, as there are strong business incentives to go circular among companies.

Regarding small and medium enterprises (SME), KEPSA developed the SME Policy Index, which tracks the regulatory environment and enhances SME growth in Kenya (KEPSA, 2020).

The Kenya National Cleaner Production Centre (KNCPC) is a trust under the Ministry of Industrialization and Enterprise Development (MOIED), established in July 2000, as part of the global UNEP, United Nations Industrial Development Organization (UNIDO) and the National Cleaner Production Centre program. KNCPC provides advisory services in resource-efficient and cleaner production (RECP) to increase companies' productivity. It also provides companies with environmental management and pollution prevention courses and policy analysis and advice. In addition, KNCPC offers companies technical support, including companies' assessments, to ensure cleaner production.

iv. International initiatives

Kenya and the European Union have agreed on the Joint Cooperation Strategy 2018-2022, a mechanism to foster the SDGs implementation through strengthening policy dialogue, partnerships, budget support, and local implementation capacity. In this line, the European Union conducted a study to understand the potential of implementing a circular economy in Kenya (Karcher et al., 2020). The Solid Waste Management Bill (2019) and Vision 2030 were highlighted as contributors to a more circular economy transition.

The SWITCH Africa Green Programme[56] aims to assist micro, small and medium enterprises (MSME) in transitioning to an inclusive green economy based on sustainable consumption and production (SCP), RECP and Industrial symbiosis[57]. Around 134 MSMEs enrolled on the program. Results encompass resource efficiency, diversion of waste from landfills, water and raw material savings, carbon emissions reduction, green jobs creation, reduced operational costs, profits increase. It developed a platform where companies can access information on types of waste and by-products available for exchange (UNEP, 2021). Table 7 presents a summary of the programme´s outcomes.

RECP and Industrial symbiosis had positive outcomes by enhancing companies resource productivity and environmental performance. Management commitment was relevant in ensuring the programme success (UNEP, 2021). The European Union proposed the Green Deal Kenya recently under the Team Europe Initiative, supporting a post-COVID-19 green recovery. The initiative has five key areas of intervention circular economy transition support, smart agriculture, renewable energy, natural capital, and sustainable urbanisation (UNEP, 2021).

c. Exploring the potential environmental

56 Green Business Development Component of Phase I (2014-2019), is another EU and Kenya partnership.

57 In 2017, there were in Kenya 1.56 million licensed MSMEs and about 5.85 million unlicensed businesses. SMEs contribute around 34 per cent of the GDP in the economy and create employing 15 million Kenyans. The informal sector in Kenya compromises of 98 per cent of business, that contribute 80 per cent of jobs and three per cent of the GDP (Kaimuri, 2020).

Table 7. Outcomes from SWITCH Africa Green programme in Kenya

Type	Savings / Reduction
Water	231,092 m^3 annually
Wastewater	214,455 m^3 annually
Energy efficiency	21.2 GWh annually or 15.8 Gg of CO_{2eq}. annually.
Waste diverted from the dumpsites and exchanged, including Industrial symbiosis	50,833 tonnes
Economic impacts	US$ 234,060.00

Source: Based on data from UNEP (2021).

impacts of a relevant exported product

Figure 14 presents the normalised relative contribution of the impact categories included in the IO-LCA to the overall impact of the gate-to-gate and the cradle-to-gate scopes of Kenya's food and beverage sector. While ozone formation and terrestrial ecotoxicity are the primary impact categories at the plant level, land use and water consumption present the highest contribution at the supply chain level.

The most exported products for Kenya's food and beverage sector are vegetable and animal oils and fats, including crude palm oil (CPO). CPO corresponds to almost 24 per cent of the country´s exported quantities in the sector[58]. Therefore, the report conducts a process-based LCA to assess the potential environmental impacts of this product in terms of quantity. The analysis adopted a broader view and included upstream processes from the supply chain (e.g., cradle-to-gate system boundary). With more detailed inventories, the aim is better understand the main issues and the areas for action[59]. Figure 15 presents the normalised absolute contribution and associated environmental impacts of the stages during CPO production for export.

Figure 15 shows that palm fruit bunch production is the stage that mainly contributes to the impact results. Palm fruit bunch production significantly impacts marine ecotoxicity mainly due to the emissions from insecticide application and land use from farming activities. It causes a reduction in human non-carcinogenic toxicity due to the withdrawal of heavy metals from the soil by palm plants. To better understand the impact originating from each stage, especially those included in the plant level, Figure 16 shows the normalised relative contribution of CPO per production stage.

Apart from the chemical inputs, which are not necessarily produced in the country, the impacts related to direct emissions, water consumption, waste, and wastewater treatment can be directly associated with the local impact of exports manufacturing. Figure 16 shows that these stages can be predominantly associated with ecotoxicity, human toxicity, water consumption, and ozone formation, resulting in local damages to ecosystems and human health. Therefore, sustainable initiatives at a plant scale are desirable, including reducing water consumption, selecting environmentally preferable chemical inputs, and optimizing wastewater and waste treatment. The results highlight the relevance of adopting a green and circular economy strategy.

Finally, Table 8 presents the environmental load per type of impact category left behind for one tonne of exported CPO.

58 The reference product flows are considered as the product quantities exported in 2019, according to the ITC (2021.), in 6 digits codes.

59 Ecoinvent dataset is used as the basis for the inventory modelling, adapting electricity, water, waste, and wastewater to the national conditions.

Figure 14. Impact results for the food and beverage sector in Kenya (normalised relative contribution)

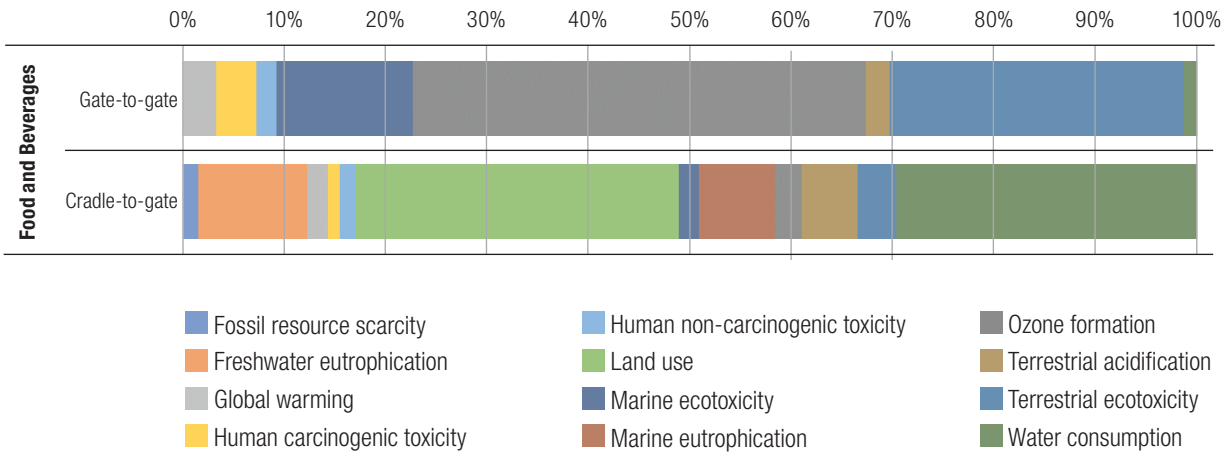


Figure 15. Impact results for exported crude palm oil in Kenya per production stage (normalised absolute contribution)

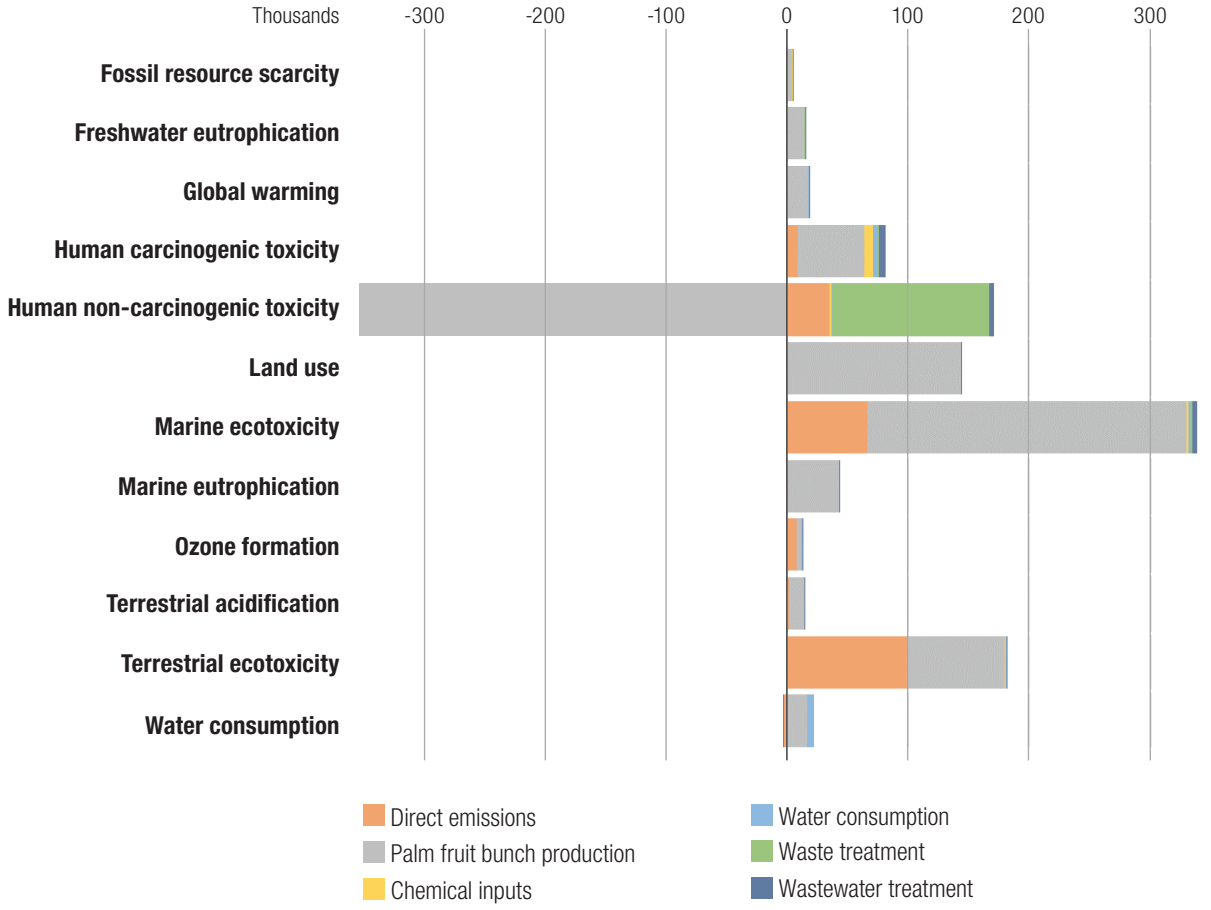


Figure 16. Impact results for exported crude palm oil in Kenya per production stage (normalised relative contribution)

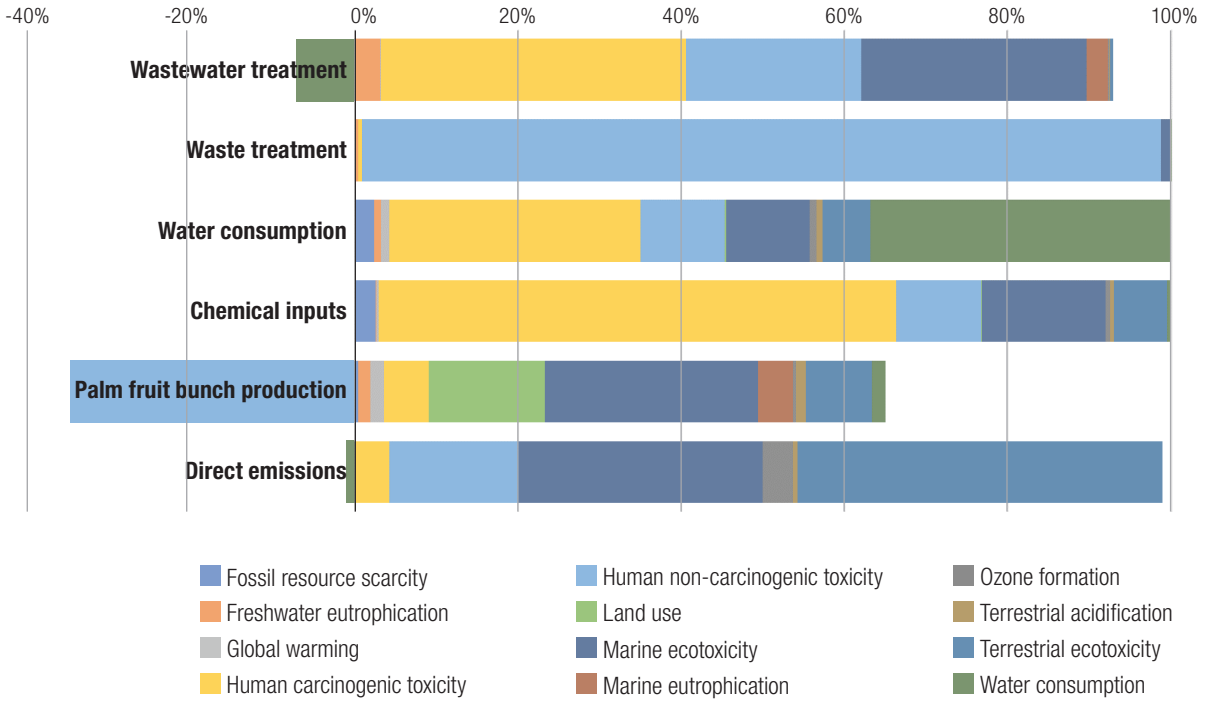


Table 8 shows that each tonne of CPO exported by Kenya requires 8,641.49 m^2 of land destined for palm fruit bunch production, which results in a change of land cover, directly affecting original habitats. Another example is that for each tonne of exported CPO, there are 997.50 kg 1,4-DCB of direct emissions from oil extraction potentially causing terrestrial ecotoxicity and 187.81 kg 1,4-DCB of waste treatment emissions causing human noncarcinogenic toxicity.

Table 8. Environmental burden per 1 tonne of exported crude palm oil

Impact category	Unit	Total	Direct emissions	Palm fruit bunch production	Chemical inputs	Water consumption	Waste treatment	Wastewater treatment
Fossil resource scarcity	kg oil_{eq}	43.96	0.00	38.28	2.77	2.73	0.02	0.16
Freshwater eutrophication	kg P_{eq}	0.10	0.00	0.09	0.00	0.00	0.00	0.00
Global warming	kg CO_{2eq}	1,395.23	9.91	1,371.43	2.37	10.45	0.24	0.83
Human carcinogenic toxicity	kg 1,4-DCB*	2.19	0.24	1.47	0.20	0.11	0.02	0.16
Human non-carcinogenic toxicity	kg 1,4-DCB	-264.75	50.77	-511.86	1.77	1.89	187.81	4.86
Land use	m^2a crop eq**	8,643.19	0.00	8,641.49	0.46	1.06	0.12	0.06
Marine ecotoxicity	kg 1,4-DCB	3.40	0.67	2.64	0.02	0.01	0.02	0.04
Marine eutrophication	kg N_{eq}	1.93	0.00	1.91	0.00	0.00	0.00	0.02
Ozone formation	kg $NO_{X\,eq}$	2.46	1.63	0.79	0.01	0.02	0.00	0.00
Terrestrial acidification	kg $SO_{2\,eq}$	5.59	0.53	4.99	0.02	0.04	0.00	0.01
Terrestrial ecotoxicity	kg 1,4-DCB	1,827.43	997.50	813.54	7.72	7.54	0.65	0.49
Water consumption	m^3	46.68	-6.37	43.71	0.14	12.10	0.00	-2.90

Notes: *Kilograms of 1,4 dichlorobenzene equivalents.
**Square meters multiplied by the years of agricultural land use equivalents.
Source: Based on data from process-based LCA.

2. The United Republic of Tanzania

The United Republic of Tanzania is one of the leading countries of the "*African growth miracle*" (Page, 2016). The country has continued industrialisation, especially in the food processing and textile and apparel sectors. The total value exported between 2015-2019 was US$ 3.2 billion. In 2018, the manufacturing sector share of GDP was around 8 per cent (CTCN, 2020).

a. Environmental law and governance for manufacturing pollution

The information about Tanzanian bilateral agreements is very scarce. The research has found only one BTA ratified by the United Republic of Tanzania signed with India in 1966, a significant trade partner. It is a concise trade agreement that does not mention specifically the pollution linked to the exports of manufactured goods. Nonetheless, this agreement follows a pattern[60]. Despite not using the name "*general exception*", the most-favoured-nation treatment is not applied in the case of Article XX of GATT expressly. Hence, the agreement fosters trade relations, but state parties may invoke the GATT rules. They may adopt measures to restrict trade to protect human and non-human lives by observing some conditions described in Article XX of GATT. Besides, the agreement affirms that it does not give any rights of non-compliance to international law. Therefore, all the obligations present in the conventions and treaties ratified by the United Republic of Tanzania remains.

The primary environmental governance gap is related to transparency and information disclosure[61]. The Access of Information Act was enacted in 2016, linked to the United Republic of Tanzania's Open Government Partnership (OGP) Action Plan (Mfikwa, 2018). Despite the existence of constitutional and legal rights, the act foresees exceptions to information disclosure[62]. If the information is about any environmental risk or compromises public safety seriously, exceptions do not apply. For Tanzanian BTAs, there is no information on the government website portals, such as the Ministry of Industry, Trade, and Investment and others. Even with the support of local consultants, there was no information about the trade agreements signed but one between the United Republic of Tanzania and India, which was available by the Indian government. Access to information and public participation in different Tanzanian scales of power is historically limited (Chaligha, 2014; Cooksey and Kikula, 2005; Gray and Khan, 2010; Kessy, 2008; Mfikwa, 2018; Pallangyo, 2007; Pazi, 2018; Ponte et al., 2020; The United Republic of Tanzania, 2012). Thus, the absence of clear information compromises transparency and accountability.

i. Tanzanian environmental law and governance

The Constitution of the United Republic of Tanzania establishes human dignity and law enforcement, amongst others, as essential elements, especially in Article 9. However, the protection of the environment is not present in the Constitution. Nevertheless, the Constitution does recognise the right to life as an expression of human dignity in Article 14. United Republic of Tanzania High Court Jurisprudence recognises the right to the environment as a dimension of the right to life (Boyd, 2011). Whereas Article 27 declares that the protection of natural resources is a duty of every person, the Constitution has little contribution to environmental laws and the control of pollution related to the exports of manufactured goods.

The primary law concerning the control of pollution is the Environmental Management Act (EMA), 2004. It is a comprehensive environmental law that provides a legal and institutional framework for environmental management[63]. It establishes the right to a clean, safe and healthy environment and the duty to safeguard and enhance the environment.

The EMA includes meaningful environmental law principles such as the precautionary principle, polluter pays principle, ecosystem integrity, public participation in the development policies, plans and processes for managing the environment, and access to justice. Along with others in Article 7, these principles offer environmental management guidance,

60 The Article 10 offers orientation to resolve a potential conflict between trade and life protection, as described in Section 1.

61 Article 18 of the Constitution guarantees the right to information.

62 One example is the break of commercial interests (Article 6 (2) f).

63 Article 4 declares that persons living in the country "shall have a right to clean, safe and healthy environment" (The United Republic of Tanzania, 2004). Article 6 declares that every person must safeguard and enhance the environment. This duty is followed by the responsibility to inform any conduct or phenomena that may affect the environment.

including pollution prevention and control. The act foresees that the Tanzanian government shall develop and approve national environmental quality standards for water, air, light, noise, and other environmental impacts. There is a legal obligation to comply with the Act, which prescribes Enforcement mechanisms and institutions. Manufacturing and processing industries need to carry out an EIA before obtaining the license for its activities.

The Water Resource Management Act. 2009, and The Water Supply and Sanitation Act, 2019, provide the legal and institutional frameworks for water resources management for water protection. The law recognises the water access right and establishes obligations against water pollution. There are criminal and administrative liabilities for those who contravene the law. For others sectors as waste and air, the EMA is the legal basis. It is an overarching environmental law that gives the structure and the paradigms for pollution prevention and control. Hence, the United Republic of Tanzania adopts a more centralised and general legal system than other countries where different environmental sectors have specific laws.

Regarding public environmental governance, the institutional architecture for pollution control and reduction is a complex system set up by the EMA. The Vice President´s Office (VPO) is responsible for the coordination of environmental management and policies[64]. Thus, there is no entirely devoted Ministry of Environment since the law assigns the VPO. However, environmental issues are also distributed at all specific sectoral ministries and regional authorities.

EMA also establishes two institutions with different but complementary responsibilities. The National Environmental Advisory Committee (NEAC) mandates advising the Vice-President in environmental matters and the National Environmental Management Council (NEMC), which has operational and enforcement roles. Besides the national level, local governments have the power to operate and enforce environmental laws.

The National Environmental Policy (NEP), 1997, is the overarching policy that guides the United Republic of Tanzania environmental regulatory framework and prescribes specific provisions for the industry-environment nexus. However, trade is not a particular concern.

The NEP brings EIA, economic-based instruments and sets up the need to develop other environmental laws, including environmental quality standards and education and public awareness dimensions. For the food and beverage sector, the following policies may also impact pollution control and reduction positively: (i) National Fisheries Policy, 2015; (ii) National Agriculture Policy, 2013; (iii) National Water Policy, 2002; and (iv) National Land Policy, 1995. There are also specific air, water, waste, noise, and EIA regulations, which provide compliance and enforcement mechanisms and regulate criminal and administrative offences. Notwithstanding the existence of these legal and policy frameworks, many challenges compromise their effectiveness and environmental governance. Table 9 presents the environmental governance challenges in the United Republic of Tanzania.

The Tanzanian legal and policy frameworks are not effectively addressing the challenges of environmental protection. For example, the legal framework is limited (The World Bank, 2019b) and based on the command-and-control approach (Pallangyo, 2007). Despite limited legal and policy frameworks, local constraints such as the absence of financial resources and inadequate enforcement infrastructure undermine their effectiveness leading to gaps between law and reality (Melyoki, 2005). Stein et al. (2011) analyses that the complexity of the water governance system in the United Republic of Tanzania is higher than suggested by formal policies (Stein et al., 2011). Gray and Khan (2010) acknowledge as critical areas for governance: (i) land management, (ii) industrial policy, and (iii) natural resource management. There is also a need to improve environmental governance and pollution control related to exports of the food and beverages sector.

64 The VPO has four Divisions, and one is dedicated to the environment. This Division has the following sections: Biological Diversity, Environmental Management of Pollution, and Environmental Assessment and Climate Change Management.

Table 9. Tanzanian environmental governance challenges

Institutional Capacities	Law and Policy		Social Process
Human resources	Absence of good governance guidance	Inadequate cross-sectoral policy planning	Low involvement and engagement of communities in the policy processes
Financial resources (implementation, monitoring, and evaluation)	Absence of comprehensive guidelines for formulating bylaws	Insufficient environmental information, data generation and accessibility	Public awareness of environmental issues
Enforcement infrastructure	Inadequate enforcement	Inadequate compliance	Public awareness of environmental law matters

Source: Based on data from the United Republic of Tanzania (2012) and data provided by local consultant on Annex 2.

b. Private sector governance of the food and beverage manufacturing sector

Following two decades of sustained growth, the United Republic of Tanzania formally graduated from a low-income country to a lower-middle-income country status in July 2020[65]. Industrialisation is crucial for realising its ambition to become a middle-income economy by 2025 (CTCN, 2020).

Policy regimes that influenced those decades were: the mixed economy (1961-66), the state-led import substitution (1967-85), the deindustrialisation and associated policy reforms (1986-95), and finally, the current development agenda, in which industrialisation is central in enhancing the country´s economic transformation (Wangwe et al., 2014). Hence, the United Republic of Tanzania is undergoing profound changes in its economic structure, as there is an ongoing national effort to boost industrial development, focusing mainly on supporting dominant sectors such as food processing, textile, and apparel (CTCN, 2020; Page, 2016). Those changes started in 1996, when the Sustainable Industrial Development Policy (SIDP) was launched, aiming to boost sustainable development for the industrial sector in the country (Msami and Wangwe, 2016). SIDP recognized the private sector's central role in the country's economic change, while the government ought to provide an enabling investment environment (Wangwe et al., 2014). The country's broad vision on the development set in Vision 2025 seeks, among others, to build a diversified economy through industrialisation.

Focusing on export-led economic growth, in 2002, the local government established the Export Processing Zones (EPZ) Act[66] (Kinyondo et al., 2016). In 2006, the Special Economic Zones (SEZ) Act set a strategy to achieve the Mini-Tiger Plan 2020[67]. The plan focuses on export promotion and private investment in foreign direct investments (FDI) and domestic direct investment (DDI). The study conducted by Kinyondo et al. (2016) examining the performance of SEZs revealed a lack of state capacity in the organisation and management of SEZs, resulting in minimum economic benefits (Kinyondo et al., 2016).

In 2010, the Integrated Industrial Development Strategy (IIDS) 2025 targeted building a competitive industrial sector. The Economic Zones Law defined the Export Processing Zones Authority (EPZA)[68] as the administrative body responsible for both programs, EPZ and SEZ (Dinh et al., 2013). The government also promoted the development of industrial clusters to accelerate industrialisation. Page (2016) explained that all those policies were needed to realize the United Republic of Tanzania's industrial development goals set in Vision 2025 (Page, 2016).

As noted, the United Republic of Tanzania government has taken actions to stimulate industrialisation over

65 https://www.worldbank.org/en/country/tanzania/overview/.

66 In 2006, the Export Processing Zones Authority (EPZA) was created (Page, 2016).

67 SEZs focus on investment promotion in specific industries, while EPZs focus on promoting exports (Wangwe et al., 2014).

68 The EPZA reports through the Ministry of Industry and Trade (MIT) (Dinh et al., 2013).

those years. Indeed, the United Republic of Tanzania's Five-Year Development Plan 2016–2021 (FYDP II) built three pillars industrialisation, human development, and implementation[69] (Kweka, 2018). The government understands the role of industrialisation and the private sector in building sustainable and inclusive economic growth. In 2018, the manufacturing sector share of GDP averaged about 8.05 per cent, compared to 7.7 per cent in 2017 (CTCN, 2020). As Page (2016) states, even considering that the number of manufacturing companies more than doubled between 2005 and 2010, the sector is still relatively small, heavily dependent on agriculture, specifically local agricultural goods processing (Page, 2016).

The manufacturing sector is dominated by private companies, accounting for 91 per cent of businesses. The most dynamic sub-sectors in output growth, export growth, production innovation, and product diversity are food products, plastic and rubber, chemicals, basic metalwork, and non-metallic mineral products (Msami and Wangwe, 2016). So far, the United Republic of Tanzania's manufacturing sector has been transformed due to changes in national policies, fluctuating domestic demands, and world market dynamics (Wangwe et al., 2014).

AfDB (2014b) and Wangwe et al. (2014) listed positive aspects and challenges faced by manufacturing companies in the United Republic of Tanzania (AfDB, 2014b; Wangwe et al., 2014). Among the positive aspects, quality of products, good management, marketing strategies, investment in human capital and innovation, access to financing opportunities, timely delivery, staff motivation, availability of raw materials, low labour costs compared to East Asia, and labour market efficiency. However, Table 10 presents the challenges faced by the manufacturing sectors. Particularly, transportation systems, human resources, and technology increase operation costs, making manufacturers unable to compete (JICA, 2019).

Wangwe et al. (2014) surveyed fifty emerging industrial companies in the United Republic of Tanzania (Wangwe et al., 2014). Companies' selection used four criteria: (i) new products, (ii) innovation, (iii) market share growth, and (iv) export growth. The most successful companies were in food processing, machinery and equipment, textiles, and basic metals.

The United Republic of Tanzania is experiencing rapid growth of manufactured exports compared to EAC (Page, 2016). Major manufacturing export destinations are Belgium, the Democratic Republic of the Congo, Rwanda, Uganda, and Kenya (ITC, 2021). The low penetration rate to export markets in Europe and North America is attributed to the high standards requirements (AfDB, 2014b). Major manufacturing export categories in the food and beverage sector are (i) manufacture of vegetable and animal oils and fats, such as sunflower and palm oil, (ii) manufacture of other food products, which includes miscellaneous edible preparations, and (iii) starches and starch products (ITC, 2021).

69 FYDP II is a product of FYDP I and the National Strategy for Growth and Reduction of Policy (Kweka, 2018).

Table 10. Manufacturing sector challenges in the United Republic of Tanzania

Categories	Challenges
Technical	Unreliable power supply, outdated equipment, lack of skilled workforce, poor transport infrastructure, inefficient trade logistics*, high transportation costs, inadequate communication infrastructure, and low level of technology
Administrative	Ineffective policies, poor enforcement of laws, and complex legal and institutional frameworks
Financial	Difficulties in accessing financial resources and high cost of capital
Market	International market competition
Policy	Tax laws, government bylaws, environmental legislation, and lack of skilled human resources

Notes: *"*The efficiency of the port of Dar es Salaam is the most acute problem affecting the country's trade logistics and is a major barrier to success in export production*" (Page, 2016).

Source: Based on data from Wangwe et al. (2014) and African Development Bank (2014b).

The Confederation of Tanzania Industries (CTI) groups its members into 14 broad categories, including food processing and beverages[70] (CTCN, 2020).

Table 11 shows the proportion of food and beverage and tobacco MSMEs and large companies concerning the mainland's total manufacturing establishments.

Table 11 indicates that food manufacturing companies account for 40 per cent of all the manufacturing companies in the United Republic of Tanzania. Among them, 90 per cent are micro-size, 8.9 per cent are small-size, 0.18 per cent are medium-size businesses, and 0.3 per cent are large companies. Food manufacturing, wearing apparel that accounts for almost 27 per cent of the market, and furniture manufacturing for almost 14 per cent, together account for more than 80 per cent of the total manufacturing production in the United Republic of Tanzania.

Regarding the number of employees, food manufacturing prevails, with 45,299 employees, accounting for 36.7 per cent of the total positions, wearing apparel with 28,795 employees (e.g., 23.3 per cent), and furniture manufacturing with around 21,000 employees (JICA, 2019). Men dominate the food manufacturing workforce, and women correspond to 20 per cent of positions. However, they dominate the workforce in textiles, wearing apparel and cigarettes companies, accounting for 76 per cent, 57 per cent, and 41 per cent, respectively (JICA, 2019).

Initially, the food and beverages manufacturing in the United Republic of Tanzania were government-owned. In the early 2000s, the private sector started moving into these sector operations (FBA, 2019). Privatisation resulted in efficiency improvement and investments in the industry. Two giants emerged, the Bakhresa Group and the Mohamed Enterprises Group. They are the country's largest and most diversified food industry operators, covering milling, beverages, bakery and other industries. Privatisation and sector opening up to other players increased international companies in the United Republic of Tanzania, like Coca-Cola, PepsiCo and AB-InBev.

Finally, graduation courses are satisfactory concerning education, training, and skills, but there is a scarcity of practical qualifications and work skills (AfDB, 2014b). Vocational Education Training (VET) centres,

70 In Kenya the food and beverage sector is one whole sector that has seven sub-sectors, among which manufacture of tobacco products (KAM, 2018). In United Republic of Tanzania, they are three separate manufacturing sub-sectors (CTCN, 2020).

Table 11. Food, beverages, and tobacco manufacturing companies in the United Republic of Tanzania

Manufacturing Activity	Business per Category					
	Number of employees				Total	Share of the total manufacturing sector (%)
	Micro (1-4)	Small (5-49)	Medium (50-99)	Large (100+)		
Food Products Processing*	17,849	1,755	35	60	19,699	40
Beverages**	14	35	8	19	76	0.154
Tobacco Products***	3	7	0	4	14	0.028
Manufacturing sectors total	41,920	6,907	170	247	49,244	100

Notes: *Food sub-sector includes: dairy products, canning and preserving fruits and vegetables, canning fish and similar foods, manufacturing animal and vegetable oils, grain milling, baking, sugar and confectionery, animal feeds (AfDB, 2014b).

**Beverage sub-sector includes distilling ethyl alcohol, distilling, rectifying, blending spirits, wines, ciders and beer (AfDB, 2014b).

***Tobacco sub-sector includes cigarettes, tobacco, and other tobacco products (AfDB, 2014b).

Source: Based on data from CTCN (2020).

technical schools, and training colleges provide training courses[71]. According to Kweka (2018), over 80 per cent of companies have no difficulty finding low-skilled workers (Kweka, 2018). However, finding medium-skilled workers is challenging, and finding local high-skilled workers appear to be impossible.

i. Sustainability in the food and beverage manufacturing sector

The United Republic of Tanzania is a country with valuable natural resources. However, as the country grows, environmental challenges became significant and widespread. According to (The World Bank, 2019b), four key forces underly the country's environmental degradation: (i) rapid population growth, (ii) economic growth, (iii) increasing urbanization rate, and (iv) climate variability and change. These forces are responsible for three negative trends loss of ecosystems, competing demands for land and water, and environmental pollution.

As the country pursues industrialisation and access to international markets, it is expected to increase associated negative environmental impacts, exacerbated by its high vulnerability to climate change[72]. Awareness of those impacts has increased, but gaps in data and information persist (The World Bank, 2019b). As an example, little is known, at the national level, about water resources quality. There is a lack of monitoring, and due to limited data availability quantifying industrial pollution is a challenge (The World Bank, 2019b). The WB funded the Industrial Pollution Projection System(IPPS) to address this gap, which estimates the amounts and types of pollutants generated by industrial activities. Table 12 presents the results for the food and beverage sector in the United Republic of Tanzania.

Table 12 reveals that biological oxygen demand (BOD), a measure of organic water pollution, is prevalent in the food products effluent, particularly in dairy. Air pollutants prevail in vegetable and animal oils. Yet, an analysis of industrial pollution revealed that pollution is concentrated in a few country areas, particularly in Dar es Salaam, as 88 per cent of industrial pollution is generated there, indicating the high concentration of industries in this area (The World Bank, 2019b).

As Ruteri (2009) states, local companies perform inefficiently compared to multinational food companies (Ruteri, 2009). Each supply chain company operates individually and seeks to optimize its profit rather than the entire supply network. Therefore, hindering local companies from growing and improving technical know-how, research and development, capital, and managerial and physical infrastructures. However, this reality is changing. Global markets, through international buyers, are pressuring large companies and MSMEs towards sustainable manufacturing. These buyers set up

71 According to data provided by the local consultant on Annex 2.

72 According to United Republic of Tanzania local consultant, due climate change's impacts on raw materials availability, beer manufacturers are importing raw materials needed in beer production.

Table 12. Pollutants generated by the Tanzanian food and beverage sector

			Industrial Pollution*				
ISIC	**ISIC description**	**Share of Employment**	**SO_2**	**PM10**	**BOD**	**Toxic Chemicals**	**Toxic Metals**
1040	Vegetable and animal oils, fats	5.02	16.8	24.5	2.58	5.14	1.45
1072	Sugar	4.18	4.98	0.24	13.50	0.61	0.04
1104	Soft drinks, mineral waters	6.15	3.35	0.11	11.7	0.61	1.18
1050	Dairy products	1.38	0.04	0.00	18.8	0.22	0.00

Notes: *All figures shown represent percentages. ISIC = International Standard Industrial Classification, BOD = biological oxygen demand, PM10 = particles that have aerodynamic diameters less than or equal to 10 microns (µm), SO_2 = sulphur dioxide.

Source: Based on data from The World Bank (2019b).

conditions and standards to which local companies must comply. In addition, they provide support and incentives, including affordable loans to implement sustainable measures and access to global markets with better prices. In this sense, through legislation, international buyers and local community/consumers, financial institutions, and local government drive local companies towards sustainability. Nevertheless, local companies still consider legislation compliance and the adoption of environmental initiatives as a burden due to the additional investment needed to implement sustainable manufacturing[73].

ii. Sustainable enterprises initiatives

Food and beverage companies were selected from the NSE and the Cleaner Production Centre of Tanzania (CPCT) case studies reports. In addition, websites from companies and their published reports provided additional information.

Nyanza Bottling Company Limited (NBCL), founded in 1986, is one of the largest Coca-Cola franchises in East Africa and is engaged in bottling and distributing soft drink products in the United Republic of Tanzania´s Lake Zone. This privately-owned company is a significant employer and driver of economic growth in the region (NBCL, 2011). Under the Kyoto Protocol, NBCL proposed a Clean Development Mechanism (CDM) project, approved in 2012, involving the company moving towards renewable energy sources by installing a biomass-fired boiler. Until 2014, greenhouse gases (GHG) emission reductions achieved 9,197 tCO_{2eq}[74] (EWW Consultancy, 2015). NBCL also implemented RECP measures. Table 13 presents the results.

The measures were undertaken from new technologies, creating an effluent treatment plant, material substitution, and worker training. The company implemented most of the RECP measures suggested, which besides the environmental results, enabled improvement in corporate social responsibilities. As a result, NBCL gained recognition awards, such as Wastewater Management Award, Water Use Management and Energy Efficiency Award.

An example of the growing food processing industry in the United Republic of Tanzania is vegetable oil, specifically sunflower oil. The sunflower was introduced during colonialism and is considered one of the most valuable vegetable oils in the international market (Larsson, 2018). According to Zeng (2016), the United Republic of Tanzania has excellent potential in sunflower oil seeds, considered a key sector for industrial development (Zeng, 2016). Among oilseeds companies in the United Republic of Tanzania, Bidco Africa[75] considers sustainability measures in its activities. The company has an environmental

73 According to data provided by the local consultant on Annex 2.

74 The reduction of greenhouse gas (GHG) emissions by fuel switch from Residual Fuel Oil (RFO) to biomass (cotton seed husk, sawdust, coffee husk, rice husk and maize husk), supplying all energy demand.

75 https://www.bidcoafrica.com/sustainability/.

Table 13. Results from RECP adoption in NBCL

Results	Resources	First Year	Second Year
Reductions	Water consumption	10 per cent	39 per cent
	Wastewater generation	10 per cent	29 per cent
	Electricity consumption	39 per cent	67 per cent
	Air pollution	39 per cen	67 per cent
	CO_2 intensity	33 per cent	58 per cent
	BOD levels	23 to 17 mg/l	-
Increases	Energy productivity	50 per cent	137 per cent
	Resource productivity*	5 per cent	2 per cent

Notes: *Resource productivity measures how much product output can be produced per unit of resource use.
Source: Based on data from the CPCT (2021).

management policy, an environmental management system; however, it appears not to be EMS certified. Among actions highlighted, the company lists compliance with NEMA standards, self-generation of power and steam through a cogeneration plant, use of biomass (i.e., cashew nut shells, macadamia shells, sawdust, and coffee husks) as fuel, operating an effluent treatment plant, and air emissions control[76]. Regarding social responsibility, the company invests in girl's education through supporting two foundations: Tony Elumelu Foundation and Starehe Girls Education Fund.

Tanzania Breweries Limited (TBL) is the oldest and largest brewer in the United Republic of Tanzania. Founded in 1993, TBL is engaged in producing, distributing, and selling malt beer, non-alcoholic malt beverages, and alcoholic fruit beverages. Since 2010, TBL has been adopting RECP measures. Results achieved encompass a 44 per cent reduction in total energy consumption, 50 per cent reduction in carbon dioxide (CO_2) emissions, 39 per cent reduction of solid waste generation, and 42 per cent reduction of wastewater generation (CPCT, 2021).

In a path to comply with international market demands, Tanzanian companies pursued EMS certification under ISO 14001:2015 standards. According to a survey conducted in 2019 by the ISO, the United Republic of Tanzania has only 30 valid EMS certificates, among which two were granted for food and beverages companies (ISO, 2019).

Mangula and Lyakurwa (2013) identified factors hindering EMS implementation in Tanzanian companies (Mangula and Lyakurwa, 2013). They lack top management commitment, which creates difficulty in dealing with environmental issues. Other hindering factors are maintaining continuous improvement, long and lasting results after implementation, lack of environmental experts, implementation costs, and low employee participation[77].

Committing to sustainability, the Dar es Salaam Stock Exchange Limited (DSE), with 28 listed companies in 2016, voluntarily enrolled on the United Nations Sustainable Stock Exchange Initiative[78]. Those 28 companies cover five sectors, among which the manufacturing sector represents eight companies. Five of these companies are from the food and beverage and tobacco segments: Tanzania Cigarette Company, East African Breweries Limited, JATU PLC, Tanzania Breweries PLC, and TATEPA Tea.

iii. Business associations / sectoral institutions initiatives

The manufacture of food products and beverages has a high potential for reducing pollution and increasing productivity by applying resource efficiency and cleaner production initiatives, industrial symbiosis, and promoting a circular economy (Wangwe et al., 2014).

The CPCT established in 1995 promotes RECP measures in the manufacturing sector by implementing initiatives and projects. Its central role is to assist companies to lower costs through reduced energy, water and materials usage and reduced pollution. In this sense, CPCT provides policy advice on environmental management and conducts in-plant assessments, industry capacitation, and government professional training (UNEP, 2001). However, it does not effectively reach most MSMEs in the food and beverage sector[79].

iv. International initiatives

The "*Project on Strengthening Manufacturing Enterprises through Quality and Productivity Improvement*" is being implemented since 2013 by the Ministry of Industry and Trade (MIT) in collaboration with the Japan International Cooperation Agency (JICA, 2019). In its second phase (2017-2021), the project supports the manufacturing sector in technical and capacity building. The Plan focuses on disseminating the Framework for Quality and Productivity Improvement (KAIZEN) and establishing sustainable KAIZEN training programs (MIT and JICA, 2020).

The UNIDO Industrial Upgrading and Modernization Program (IUMP) seeks to contribute to African countries economic growth and facilitate regional integration (UNIDO, 2013). In the United Republic of Tanzania, the IUMP pilot project was launched

76 The use of by-products for energy generation is an example of industrial symbiosis adoption in the country.

77 According to data provided by local consultant on Annex 2, despite having EMS certification, there is no assurance that manufacturing practices of local companies do reflect conditions set in the certificate.

78 https://www.dse.co.tz/listed-companies/.

79 According to data provided by the local consultant on Annex 2.

in 2012 in a partnership between UNIDO and the Massachusetts Institute of Technology. The focus is to increase competitiveness by improving industrial output and market access facilitation at national, regional, and international levels. As a direct result of IUMP, nineteen enterprises in food processing increased, on average, 38 per cent of local sales, two enterprises doubled their exports, performance improvement through material loss reduction at the processing process resulting in US$ 1 million in savings. Besides, it trained 50 national experts on industrial upgrading methodologies.

c. Exploring the potential environmental impacts of a relevant exported product

Figure 17 presents the normalised relative contribution of the impact categories included in the IO-LCA to the overall impact of the gate-to-gate and the cradle-to-gate scopes of the food and beverage sector in the United Republic of Tanzania. Like the Kenyan food and beverage sector, ozone formation and terrestrial ecotoxicity are the primary impact categories at the plant level. However, ozone formation impacts are more relevant in the United Republic of Tanzania than in Kenya due to greater participation in vegetable oils and fats processing. Land use presents the highest contribution at the supply chain level, followed by water consumption and freshwater eutrophication.

The most exported products for the food and beverages sector in the United Republic of Tanzania, as in Kenya, are products from vegetable and animal oils and fats, of which sunflower oil cake is the most important product in terms of exported quantities. It corresponds to about 45 per cent of the country's exports in the sector[80].

The report conducts a process-based LCA to assess the potential environmental impacts of sunflower oil cake production in terms of quantity, including upstream processes from the supply chain (e.g., cradle-to-gate system boundary). More detailed inventories help understand the main environmental issues related to sunflower oil cake exports and the better-prioritised areas for action[81]. Figure 18 shows the normalised absolute contribution and associated environmental impacts of sunflower oil cake production stages for export.

Figure 18 shows that sunflower production is the stage that primarily contributes to the impact results. It has a significant impact on marine ecotoxicity mainly due to the emissions from the application of herbicides and human noncarcinogenic toxicity due to heavy metal emissions from fertilizer and pesticide use. Transport impacts marine ecotoxicity and human noncarcinogenic toxicity, mainly originating from heavy metal emissions from brake wear. To better understand the impact originating from each stage, especially those included in the plant level,

80 The reference product flows are considered as the product quantities exported in 2019, according to the ITC (2021.), in 6 digits codes.

81 A dataset from the World Food Life Cycle Assessment Database (WFLDB) is used as the basis for the inventory modelling, adapting electricity, water, waste, and wastewater to the national particular conditions.

Figure 17. Impact results for the food and beverage sector in the United Republic of Tanzania (normalised relative contribution)

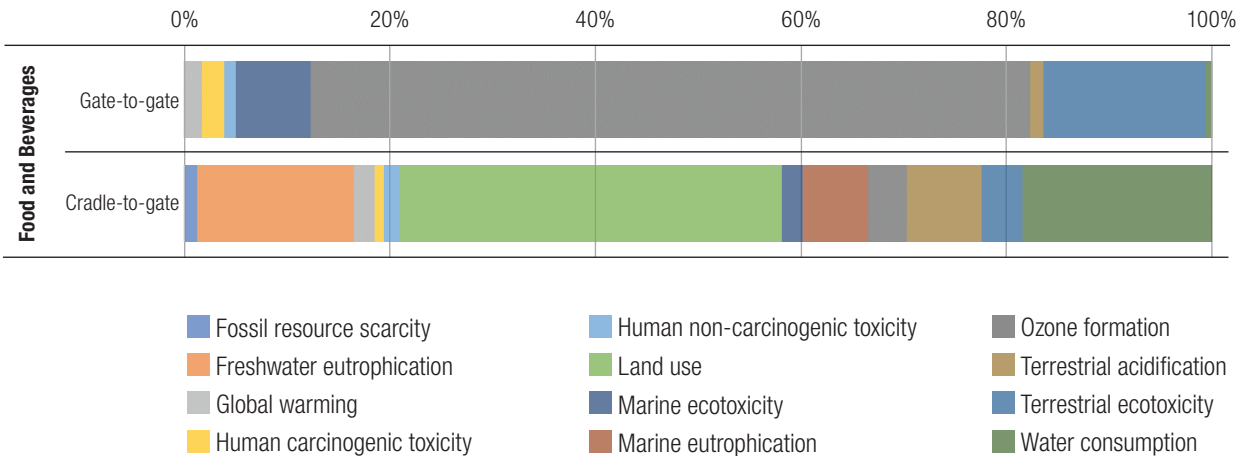


Figure 18. Impact results for exported sunflower oil cake in the United Republic of Tanzania per production stage (normalised absolute contribution)

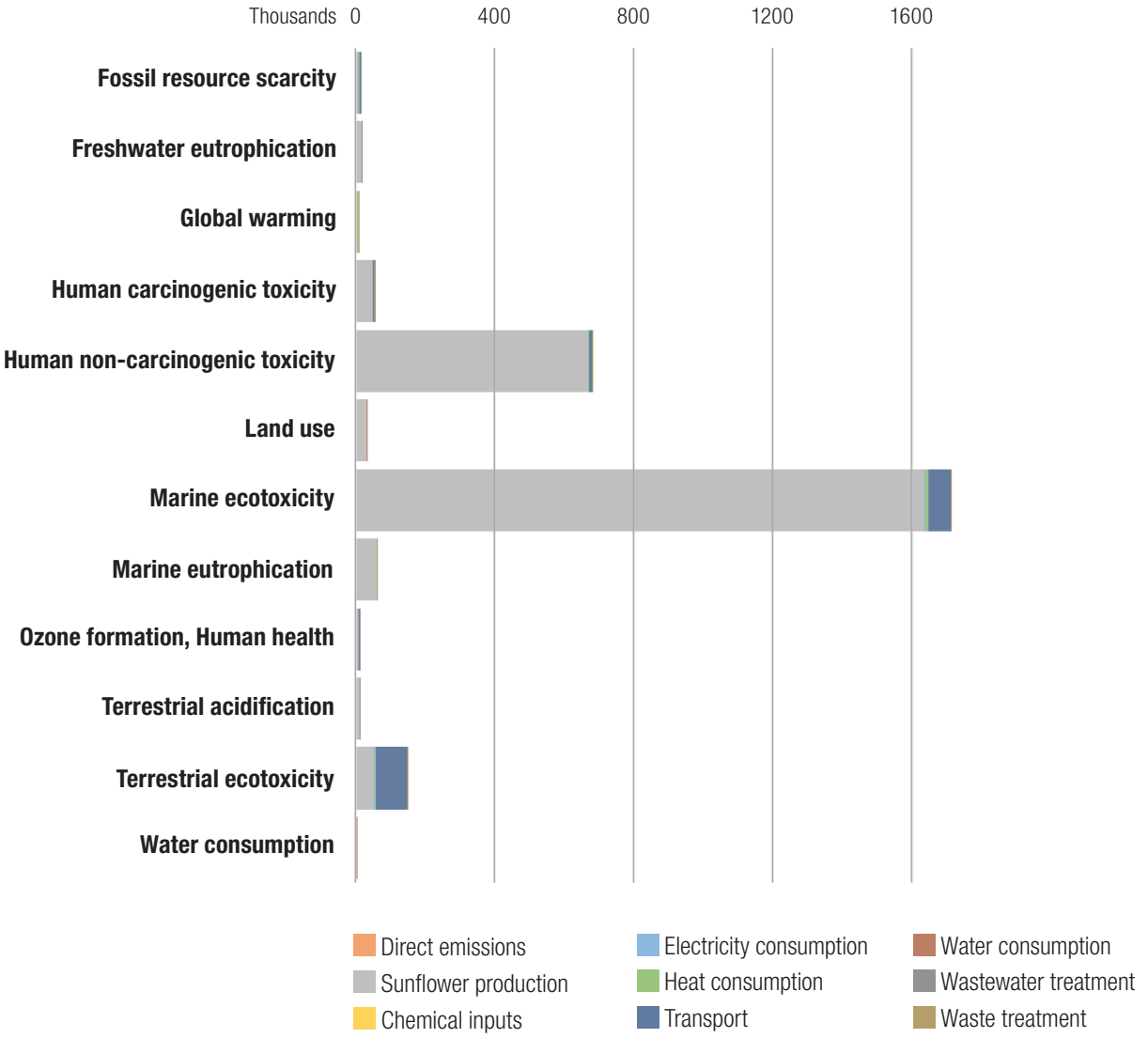
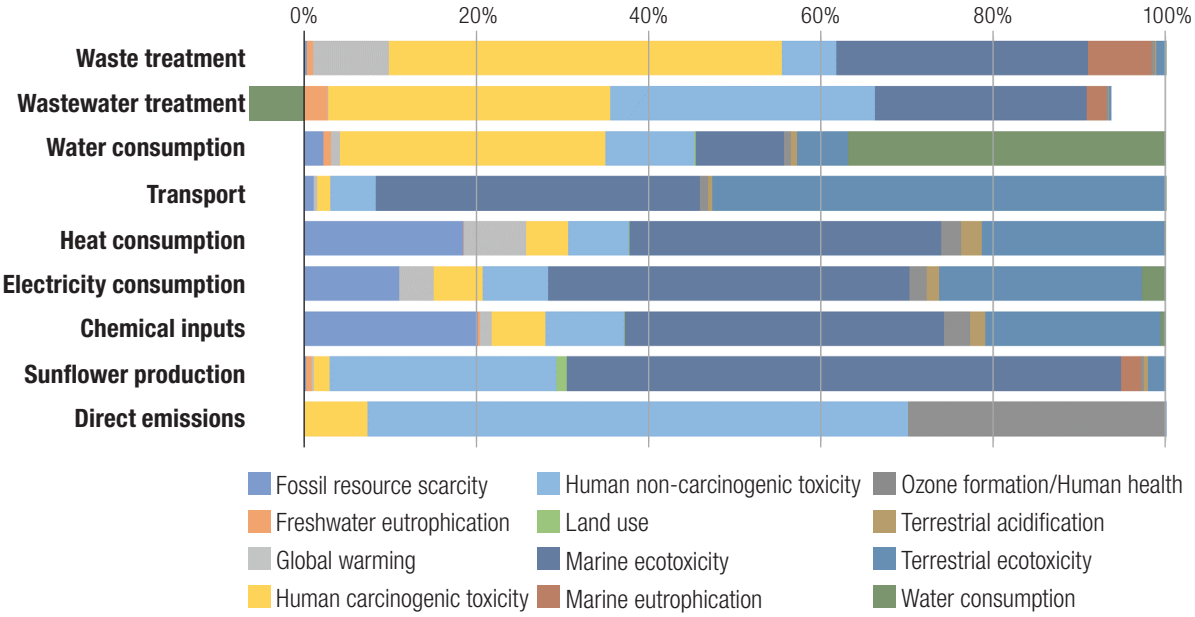


Figure 19 shows the normalised relative contribution of sunflower oil cake per production stage.

Similarly to Kenya, local impacts of manufacturing exports are direct emissions, electricity, heat and water consumption, waste and wastewater treatment. Figure 19 shows that these stages can be predominantly associated with ecotoxicity, human toxicity, water consumption, fossil resource scarcity, and ozone formation, resulting in local damages to ecosystems and human health. Therefore, improving the performance of the manufacturing activity at the plant is applicable, including strategies for reducing energy and water consumption, optimizing transport, and selecting environmentally preferable chemical inputs. Wastewater and waste treatment are also important areas for improvement. The results corroborate the importance of the Tanzanian food and beverage companies' measures, which went from new technologies, adopting effluent treatment plants, material substitution, and training of workers. Despite not effectively reaching most MSMEs in the food and beverage sector, the CPCT has an essential role in promoting RECP measures to reduce energy and water consumption in the United Republic of Tanzania.

Figure 19. Impact results for exported sunflower oil cake in the United Republic of Tanzania per production stage (normalised relative contribution)



Finally, Table 14 presents the local environmental load per type of impact category left behind for one tonne of exported sunflower oil cake.

Table 14 shows that for each tonne of sunflower oil cake exported by the United Republic of Tanzania, there are 1.87 kg N_{eq} destined to marine ecosystems. Nutrients are transported from air to soil, from soil to air, and soil to water due to leaching and run-offs, resulting in eutrophication and loss of local biodiversity. Another example is that for each tonne of sunflower oil cake exported, there are 623.14 kg 1,4-DCB of emissions from transport causing terrestrial ecotoxicity.

Table 14. Environmental burden per 1 tonne of exported sunflower oil cake

Impact category	Unit	Total	Direct emissions	Sunflower production	Chemical inputs	Electricity consumption	Heat consumption	Transport	Water consumption	Water-waste treatment	Waste treatment
Fossil resource scarcity	kg oil_{eq}	84.71	0.00	37.87	0.59	9.40	24.32	12.42	0.09	0.02	0.00
Freshwater eutrophication	kg P_{eq}	0.07	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Global warming	kg CO_{2eq}	431.41	0.00	286.86	0.32	27.45	77.49	38.71	0.34	0.09	0.15
Human carcinogenic toxicity	kg 1,4-DCB	1.00	0.00	0.90	0.00	0.01	0.02	0.05	0.00	0.02	0.00
Human non-carcinogenic toxicity	kg 1,4-DCB	680.26	0.45	667.54	0.04	0.98	1.42	8.94	0.06	0.83	0.00
Land use	m^2a crop eq	1,299.59	0.00	1,298.81	0.01	0.14	0.31	0.27	0.03	0.01	0.00
Marine ecotoxicity	kg 1,4-DCB	11.85	0.00	11.31	0.00	0.04	0.05	0.44	0.00	0.00	0.00
Marine eutrophication	kg N_{eq}	1.87	0.00	1.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ozone formation	kg NO_{Xeq}	1.50	0.03	1.15	0.00	0.04	0.06	0.22	0.00	0.00	0.00
Terrestrial acidification	kg SO_{2eq}	3.44	0.00	3.03	0.00	0.05	0.13	0.22	0.00	0.00	0.00
Terrestrial ecotoxicity	kg 1,4-DCB	1,033.45	0.00	358.76	0.63	21.11	29.51	623.14	0.24	0.05	0.00
Water consumption	m^3	2.94	0.00	2.15	0.01	0.65	0.04	0.01	0.39	-0.31	0.00

Source: Prepared by i17 based on data from process-based LCA.

C. South Asia

Over the past few years, South Asia has sustained robust growth that has economically lifted many living in poverty and made notable strides in health and education. In fact, between 2013 and 2016, growth in South Asia countries increased from 6.2 per cent to 7.5 per cent, while growth rates of other developing nations remained flat or even turned negative. In the coming years, the World Bank expects countries in South Asia to continue this growth trajectory, estimated at 6.7 per cent in 2021 (The World Bank, 2021).

South Asia has experienced fast economic growth in the 21st century compared to the 90s. South Asia countries new economic reforms were essential to promote the extent and pace of industrialisation (UNCTAD and Asian Development Bank, 2015). The SMEP target countries in South Asia are Bangladesh, Nepal, and Pakistan, of which this report uses two of them as case studies, Bangladesh and Pakistan.

1. Bangladesh

Bangladesh has emerged as a leading textile product manufacturer and has become a frontrunner in South Asia. As the trade deficit decreased, the growth in remittances grew strongly by 9.6 per cent in 2019 to a record US$ 16.4 billion. This economic growth has been supported mainly by textile and wearing apparel products, the country's leading exported goods (Rasel et al., 2020; Restiani, 2016). Export-led industrialisation is an important activity to transform Bangladesh from a lower-middle-income country into a middle-income nation by 2024 (Belal et al., 2015).

a. Environmental law and governance for manufacturing pollution control

Bangladesh has thirty-five BTAs in force. In general, Bangladesh BTAs approach to environmental provisions follow the international pattern of RTAs. On the one hand, agreements including environmental provisions were signed with Indonesia, the Islamic Republic of Iran, Uganda, and the United States of America. On the other hand, the agreements signed with Algeria, Thailand, and United Arab Emirates, for instance, do not mention any environmental concerns.

Concerning law and regulations interplay, some agreements, such as China, expressly mention their relationship to other laws and regulations in both countries, including environmental laws. Malaysia, Kenya, the United States of America, and Uzbekistan agreements cite compliance with conventions and treaties. Few agreements deal with tariff product concession in their texts. For example, that is the case of China, the Republic of Korea, and the United Arab Emirates. In all cases of product list, textiles and jute are present. The majority of the agreements do not bring any product list. Examples are the United States of America, Kenya, and Senegal.

There are three highlights on the trade-environment nexus in Bangladesh BTAs. The European Union's Cooperation Agreement framework, 2001, comprehends cooperation in all sectors, including trade. One of the agreement's objectives is "*to pursue equilibrium between policies for sustainable economic growth, social development and protection and conservation of the natural environment*" (Ministry of Commerce People's Republic of Bangladesh, 2019). The second highlight is the United States of America BTA, 2013. The preamble recognises the relevance of environmental protection (Ministry of Commerce People's Republic of Bangladesh, 2019). Also, this agreement is the only one that acknowledges the importance of public participation. The third highlight is the bilateral agreement with Uzbekistan. It is also an economic and trade cooperation agreement. It establishes that both countries, based on economic, trade and technological cooperation, shall improve ties in many sectors, including environmental protection. The agreement provides an opportunity platform to strengthen trade and technological cooperation related to the environmental sector.

Most of Bangladesh's BTAs approaches environmental issues through general exceptions of Article XX of GATT. The analysed Bangladesh BTAs shows no expressed mention about controlling or reducing the pollution related to the export of manufactured goods. Another possibility to control the pollution related to the manufactured exports is compliance with other international laws. Hence, there is room for improvement, especially bringing mutually supportive policy orientation towards sustainability practices, public participation, and achievement of SDGs to future BTAs.

i. Bangladeshi environmental law and governance

Bangladeshi Constitution dates from 1972 and guarantees respect for the human dignity and worth of the human person. In 2011, the 15th Amendment incorporated Article 18A, the constitutional obligation to protect, preserve, safeguard, and improve natural resources. Therefore, in promoting economic development to improve living standards, Bangladesh "*shall endeavour to protect and improve the environment*" (Ministry of Commerce People's Republic of Bangladesh, 2019). Hence, environmental protection is an expression of human dignity that the textiles and wearing apparel sector shall respect.

The primary general environmental law is the National Conservation Act, 1995. It aims to conserve the environment, improve environmental standards, control pollution, and establishes criminal offences. Article 6A, inserted in 2002, affirms that on the advice of the Director-General, the government may issue a ban on or impose strict conditions to the production, import, trade, and use of any harmful goods. However, for direct export or indirect use to produce exported goods, the restriction is not applicable.

Specific sectoral environmental law supports the general National Conservation Act to control pollution in the sector. Bangladesh Water Act 2013 sets rights and duties on different water bodies, including preferential uses in water stress. This act also describes offences and procedures in case of violations and transgressions to the law.

The institutional architecture for controlling pollution is complex due to the transversality of environmental issues. In April 2021, there are thirty-nine Ministries in Bangladesh, plus President and Prime Minister Offices and Governmental Cabinet. The primary institution responsible for the environment is the Ministry of Environment, Forests and Climate Change, which comprises four institutions. Enforcement and the fight against pollution lay mainly on the Department of the Environment (DoE), with offices in divisional cities and 22 districts. The legislation does not directly mention the DoE's powers. However, the law text describes the powers of the Director-General. Hence, it is possible to infer the mandate of the DoE through its Director-General. Coordination, inspection, monitoring and issuing direction or ordinance to prevent, control, and mitigate environmental pollution are amongst the Director-General's powers. Although the Ministry of the Environment, Climate Change and Forests is the leading agency, the mandate overlapping with other governmental institutions may be a problem because agencies have little or no coordination.

The Environment Conservation Rules, 1997, is the administrative regulation of the National Conservation Act. It provides regulations for issuing the environmental clearance certificate of industries according to their industrial site and its impact on the environment. The act classifies the garment industry as Orange-B category, the third most rigorous, on a scale of four. Certificate issuance requires documents such as an initial environmental examination of the industrial unit, including the process flow diagram, layout Plan showing the location of an effluent treatment plant, and the plant's blueprint. It is also needed the EMP report and the non-objection certificate from the local authority. The Rules also set environmental standards for air, water, sound, waste, and other environmental elements. No compliance is subject to penalties, and there is a system to calculate their amount. DoE regularly publishes the list of non-compliant organisations. Therefore, Bangladesh has a sound overarching environmental regulatory framework that guides the textile and apparel manufacturing sector.

The New National Environment Policy of Bangladesh dates from 2018. It became the overarching environmental policy in the country. It emphasises preventive and corrective measures (Rahman, 2021), seeking to keep the equilibrium in the development-environment nexus. The New National Environment Policy also highlights the importance of achieving the SDGs and recognises the polluter pays principle and reduce, reuse, and recycle (3Rs) principle. It includes provisions about the industrial development sector to ensure sustainable development by considering environmental conservation, pollution control, biodiversity conservation, and tackling the adverse impact of climate change.

The 8th Five Years National Plan – July 2020 to June 2025 – mainstreams climate change, water conservation, energy management and other environmental issues into national planning.. It establishes environmental strategies and targets. The plan predicts environmental, institutional, and fiscal reforms for this period. Hence, Bangladesh has a comprehensive set of sectoral environmental policies that rule industrial water pollution and soil contamination (Moazzem and Radia, 2016).

Environmental Court Act, from 2000, establishes specifics courts for hearing and trial offences relating to environmental pollution in every district. Bangladesh Supreme Court has been quite active in environmental issues. Remarkable progress is the 2019 decision that provided legal personality to all rivers in the country. Then, Bangladesh is the third country globally, alongside New Zealand and Colombia, to adopt one of the most progressive advancements in environmental legislation. Notwithstanding legal, administrative, and judicial systems to protect the environment, governance gaps and social, political, and economic issues may undermine governance effectiveness.

Mittal et al. (2015) appoint two barriers to urban environmental governance in Bangladesh. The lack of accountability and continuity in public governance. As a result, the ruling authorities indicate many officials, leading to a personal and partisan governance model[82]. The revolving door mechanism (i.e., the change of persons in different departments and industries) is frequent. The second barrier concerns how informal power plays or vested interests may negatively affect law implementation and effectiveness. This process is described "*as the ability of powerful individuals or groups to pursue their personal and specific interests over and above the greater good of the society, often through treating Law as a marketable commodity. In other words, they inappropriately influence law development or implementation to gain access to power or financial resources*" (Mittal et al., 2015).

Literature also evidences the limits of institutional capacities. Lack of human, technical and financial resources are barriers to effective governance, including the court system (The World Bank, 2018a). Disclosure of information, however, is facilitated by the Right to Know Act, 2009.

In this scenario, social movements play critical roles. Public interest litigation is mostly on NGOs, such as Bangladesh Environmental Movement (BAPA) and the Bangladesh Environmental Lawyers Association (BELA). Nevertheless, public participation and access to justice are limited. There is no direct access to the court by people. If someone intends to file a case, it is necessary to present the arguments for the Director-General. After its acceptance, the DoE analyses the case and creates a report to the court. In case of delay or omission, then the case is open by the court. Therefore, there is not a completely independent judiciary power. An independent institution, such as Public Prosecution Office, with a specific mandate on environmental issues, is missing. In addition, knowledge of Environmental Law amongst the judiciary is limited (Ullah, 2016).

b. Private sector governance

The textile and wearing apparel manufacturing sector, known as the Ready-Made Garment (RMG) sector, is Bangladesh's largest manufacturing and export sector (Ahmed, 2017). This lower-middle-income country aims to become a middle-income nation by 2024, which will probably be achieved through export-led industrialisation (Belal et al., 2015). Indeed, the RMG sector has been a crucial driver for boosting economic growth (Rasel et al., 2020; Restiani, 2016).

In 2018, the RMG sector accounted for 84 per cent of the country total exports and 11 per cent of the national GDP (BGMEA, 2020). Composed of around 7,179 companies, the RMG sector is responsible for 4.1 million direct jobs and 5 million indirect jobs (Restiani, 2016; Salam and Senasu, 2019). Bangladesh is the world's second-largest RMG exporter behind China (Hossain et al., 2019; Selim, 2018). Major export destinations are North America and Europe, while the Australian market is gaining a place. Bangladesh textile industries mainly produce knit and woven garments, while apparel industries major export products are trousers, knit shirts, jackets, t-shirts and sweaters (Hossain et al., 2019; Rasel et al., 2020).

As a result of RMG companies expansion, the apparels accessories and packaging industries have thrived on the same path (Ahmed, 2017). The development of this industry reduced the dependence on imported inputs and increased the share of domestic value addition in exports of knit and woven garments (Ahmed, 2017). Some factors reinforce the RMG sector growth, such as competitive price based on low labour wage and energy costs, industry's capacity, quality of products at competitive prices, suppliers' capability (i.e., good quality products and ability to meet large orders), terminal handling and customs improvements, assurance of market access by international agreements and granted preferences, and supporting industrial policies (Hossain et al., 2019; Restiani, 2016).

82 Personalisation may open doors to political capture, leading to a potential conflict of interests. Specifically, to the prevention of industrial pollution.

This successful trajectory has been accompanied by the deterioration and depletion of the natural environment. Local economic growth came at the expense of significant environmental and social damages. Environmental damages include eco-systems degradation (e.g., wetlands, rivers, soil, coastal, and marine estuaries), air, soil, sound, and water pollution (e.g., waste load and effluent discharge from factories). Social damages involve pollution driven pressure exerted on the health and livelihood of workers and the poor and vulnerable population (Belal et al., 2015; Khan, 2017).

The RMG sector has contributed heavily to what (Belal et al., 2015) refer to as a water pollution disaster, especially in the Dhaka industrial area, contaminating crops and fish with toxic wastewater, directly impacting the local community's health. As a result, the economic growth led by the RMG sector relies on *"[…] exporting pollution from wealthy developed countries to the backyard of the most economically destitute countries like Bangladesh"* (Salam and Senasu, 2019). Thus, workforce exploitation, social degradation, and environmental pollution are by-products of RMG development[83]. Belal et al. (2015) summarized key factors contributing to Bangladesh achieving such a state of environmental degradation (Belal et al., 2015). They are the lack of enforcement of environmental regulations and standards, a non-compliance culture, weak institutional mechanisms, bureaucracy, centralisation and non-participatory working style, and resistance to reform and change.

Regarding the ecological footprint, the RMG sector operations within the plant (e.g., gate-to-gate system boundary) shows that wet processing has the most significant footprint[84]. This result can be explained by the fact that the dyeing, washing and finishing phases require large amounts of clean water and, consequently, are responsible for generating large volumes of wastewater, often discharged directly into rivers without any treatment (The World Bank, 2014). Figure 20 presents the ecological footprint per type of manufacturing stage in the RMG sector.

The RMG sector in Bangladesh has some distinct advantages. However, it also faces significant challenges such as safety issues, inadequate incentives for expansion, inefficient infrastructure[85], standards compliance, lack of investment in new technologies, insufficiently skilled workforce[86], corruption, and weak law enforcement (Berg et al., 2011; Hossain et al., 2019; Rasel et al., 2020). F. Rahman (2020) also mentioned the minimum wage increase, the dependence on liquified natural gas import, and the climb in electricity tariff as competitive advantage loss in the global market (F. Rahman, 2020).

Berg et al. (2011), Hossain et al. (2019), and Rasel et al. (2020) mentioned the heavy country dependency on imported raw materials, creating sourcing risks and lengthening lead-time (Berg et al., 2011; Hossain et al., 2019; Rasel et al., 2020). For instance, China and India are Bangladesh leading suppliers of cotton fibre. China also sources equipment and machinery, explaining the disruption of the RMG supply chain when Covid-19 spread over China (M. Rahman, 2020).

Hossain et a. (2019) emphasised the increasingly global market competition, mainly from South Asian and South-East Asian countries, Viet Nam, India, and Myanmar, the reduced labour productivity compared to these competing countries, and the impact of the recent wage increase in Bangladesh (Hossain et al., 2019). However, the RMG sector has started investing in new technologies. For example, using lasers by the denim factories to make "*greener*" denim allowed increased production rate and reduced risks of accidents to workers (Rasel et al., 2020). Many factories moved from a semi-automatic to an automatic production system, increasing speed and productivity. This technological enhancement created tensions among workers as they may become replaceable.

Labour and social standards compliance are other significant challenges for the sector. It covers a wide range of matters: labour standards compliance, fair

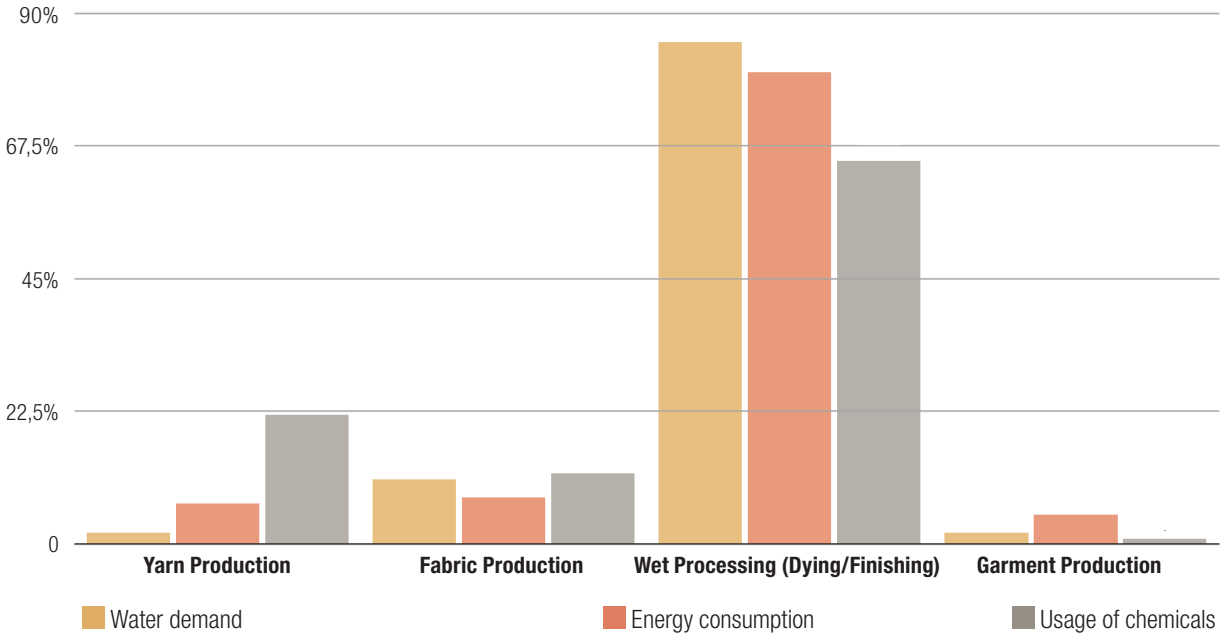
83 Bangladesh ranks amongst the lowest in the global Environmental Performance Index (Khan, 2017).

84 The ecological footprint accounting measures the demand on and supply of nature. On the demand side, it measures the ecological assets that a given population or product requires to produce the natural resources it consumes and to absorb its waste, especially carbon emissions. On the supply side, a city, state, or nation's if left unharvested, can also serve to absorb the waste we generate, especially our carbon emissions from burning fossil fuel (https://www.footprintnetwork.org/our-work/ecological-footprint/).

85 Transportation system, utility and energy supply, information technology, communication system.

86 Worker education: the sector relies on foreign employees particularly in middle management.

Figure 20. Ecological footprint of the RMG sector in Bangladesh



Source: Based on data from The World Bank (2014).

labour practices, working conditions, health and safety issues, child labour, forced labour, right to free association, among others (Khan and Molla, 2014). Recent events, such as the Tazreen Factory[87] in 2012 and the Rana Plaza[88] collapse in 2013, have attracted negative international attention, affecting market demand. However, those accidents initiated positive changes within the industry. Among those changes, welfare-enhancing, improvement in labour and social standards compliance, working conditions, women empowerment, wages level increase, gender inequality, and child labour reduction (Ahmed, 2017; Berg et al., 2011; JICA, 2012). Despite the advances, gaps still exist. Even with an increase in wages, Ahmed (2017) argued that the minimum wage is not satisfactory, as it is still low compared to the International Labour Organization (ILO) terms (Ahmed, 2017).

i. Sustainability in the RMG sector

Sustainable manufacturing practices are gaining a place in Bangladesh due to pressures from international market access, buyer´s requirements, community pressure, customer awareness, and government regulations. RMG companies, particularly the large ones, are gradually discovering the social, environmental, and economic benefits of such practices (Hossain et al., 2019; Moktadir et al., 2018).

International buyers and funding agencies are concerned about the environmental and social impacts of RMG manufacturing practices, requiring companies committed to sustainability. A mindset change that is already happening would help the sector gain a competitive edge over the global market (Hossain et al., 2019). For instance, as of 2020, RMG companies had more than 140 units certified under the Leadership in Energy and Environmental Design (LEED), and more than 500 factories were in the process to achieve a green factory status (BGMEA, 2020). In September 2018, there were 70 LEED-certified buildings and 312 application submissions (Hossain et al., 2019). These certified companies (i.e., buildings and surroundings) use renewable energy

87 On November 24, 2012, the deadliest factory fire in the country's history broke out at Ashulia, on the outskirts of Dhaka, killing at least 112 people and leaving over 200 injured. The blaze was believed to have been caused by a short circuit. Workers were trapped inside the building, as all exit routes to the outside were locked.

88 The eight-storey Rana Plaza factory building near Dhaka collapsed on 24 April with an unknown number inside. The authorities say about 2,500 people were injured in the accident and 2,437 people were rescued.

sources, have effluent and sewerage treatment plants in operation, and adopt many other practices, as demonstrated in Table 15.

This "*green revolution*" is not a reality among the whole RMG companies. Business reluctance to take responsibility for the environmental impact of manufacturing activities and the low willingness to meet environmental standards still exist, particularly considering SME enterprises. This reluctance can be attributed to the lack of political will, business responsibility, and costs (Sakamoto et al., 2019). As Belal et al. (2015) explain, most enterprises perceive that "*pollution abatement technologies 'requires huge investment*" (Belal et al., 2015). For example, even though some companies have effluent treatment plants, they are neither functional nor operational as it involves a considerable operational cost. Incurring

Table 15. LEED Certified Green RMG Companies

Factory Name Date certified Category	Water efficiency	Energy and atmosphere	Materials and resources
Remi Holdings Ltd **July 2016** **Platinum**	100 per cent reduction in potable landscape water use 40 per cent reduction in baseline indoor water use 50 per cent reduction in wastewater generation	40 per cent improvement on baseline building performance rating 9 per cent onsite renewable energy 35 per cent green power purchase	20 per cent recycled content building materials 20 per cent regionally extracted, harvested, recovered, or manufactured materials 50 per cent FSC-certified wood products 75 per cent diversion of construction and demolition debris 10 per cent salvaged, refurbished, or reused building materials 2.5 per cent rapidly renewable materials
Tarasima Apparels Ltd **July 2016** **Platinum**	30 per cent reduction in indoor potable water use 100 per cent reduction in potable landscape water use	79 Energy Star Performance Rating 12 per cent or 100 per cent onsite renewable energy or offsite renewable energy 80 per cent of total energy consumption is system-level metered	60 per cent sustainable purchasing of ongoing consumables 40 per cent sustainable purchasing of electric equipment 50 per cent reuse, recycle or compost of ongoing consumables 75 per cent reuse or recycle of durable goods 50 per cent sustainable purchasing of facility alterations and additions 90 per cent sustainable purchasing of reduced mercury lamps 70 per cent diversion of waste from facility alteration and additions 25 per cent sustainable food and beverage purchasing

Table 15. LEED Certified Green RMG Companies (cont.)

Factory Name Date certified Category	Water efficiency	Energy and atmosphere	Materials and resources
Plummy Fashions Ltd **September 2015** **Platinum**	100 per cent reduction in potable landscape water use 40 per cent reduction in baseline indoor water use 50 per cent reduction in wastewater generation	42 per cent improvement on baseline building performance rating 13 per cent onsite renewable energy 35 per cent green power purchase	20 per cent recycled content building materials 20 per cent regionally extracted, harvested, recovered, or manufactured materials 50 per cent FSC-certified wood products 75 per cent diversion of construction and demolition debris
AR Jeans **March 2018** **Platinum**	100 per cent reduction in potable landscape water use 40 per cent reduction in baseline indoor water use 50 per cent reduction in wastewater generation	44 per cent improvement on baseline building performance rating 5 per cent onsite renewable energy 35 per cent green power purchase	20 per cent recycled content building materials 20 per cent regionally extracted, harvested, recovered, or manufactured materials 50 per cent FSC-certified wood products 75 per cent diversion of construction and demolition debris
Vintage Denim Studio Ltd **May 2012** **Platinum**	100 per cent reduction in potable landscape water use 40 per cent reduction in baseline indoor water use 50 per cent reduction in wastewater generation	44 per cent improvement on baseline building performance rating 9 per cent onsite renewable energy	20 per cent recycled content building materials 20 per cent regionally extracted, harvested, recovered, or manufactured materials 75 per cent diversion of construction and demolition debris
Green textile Limited Unit **April 2018** **Platinum**	50 per cent reduction in potable landscape water use 35 per cent reduction in baseline indoor water use 50 per cent reduction in wastewater generation	36 per cent improvement on baseline building performance rating 13 per cent onsite renewable energy 35 per cent green power purchase	20 per cent recycled content building materials 20 per cent regionally extracted, harvested, recovered, or manufactured materials 50 per cent FSC-certified wood products 75 per cent diversion of construction and demolition debris
Columbia Washing **November 2016** **Platinum**	100 per cent reduction in potable landscape water use 40 per cent reduction in baseline indoor water use 50 per cent reduction in wastewater generation	36 per cent improvement on baseline building performance rating 3 per cent onsite renewable energy 35 per cent green power purchase	20 per cent recycled content building materials 20 per cent regionally extracted, harvested, recovered, or manufactured materials 50 per cent FSC-certified wood products 75 per cent diversion of construction and demolition debris

such costs could raise the prospect of Bangladesh losing market share to other developing countries with weaker and less strict regulations (Belal et al., 2015).

Despite environmental policies and laws in Bangladesh, business non-compliance is widespread (Belal et al., 2015). Legislation compliance failure results from lacking political will, implementation costs, absence of monitoring systems, lack of enforcement, weak and ineffective agencies, lack of human resources with skills and knowledge to enforce the laws (Belal et al., 2015; Sakamoto et al., 2019).

Hoque and Clarke (2013) study documented the adoption of pollution prevention practices in Chittagong, Bangladesh (Hoque and Clarke, 2013). The study revealed that compared to developed countries, those practices are underutilized. Companies are missing opportunities to cut costs, improve efficiency, improve employment conditions, reduce environmental impacts, and improve community relations. The lack of awareness about environmental and health consequences of industrial pollution was appointed one of the main reasons (Hoque and Clarke, 2013).

Belal et al. (2015), based on interviews conducted with 32 stakeholders, out of which 13 were corporate managers, highlighted the unwillingness to take responsibility for the environmental impact of their activities: "*[…] environment is a very important issue. [However] it is not one of our major concerns*"; "*As a citizen of the country, I would like to ensure the environmental safety of the country. But in business, I have to trade this off against profitability; […] We are businessmen. Very rarely do owners have a long-term view towards these issues*" (Belal et al., 2015). These statements ratify that local business continues, with some exceptions, driven by profit maximization and capital accumulation. As a result, they increase the responsibility of international fashion brands on their environmental and social impacts abroad. The pressure exerted by those brands has been an essential driver for RMG companies in Bangladesh to change to more sustainable practices. An example of such pressure is EMS certification. According to a survey conducted in 2019 by ISO, Bangladesh has 210 valid EMS certificates, among which 48 were granted for RMG companies, almost 23 per cent of total certifications (ISO, 2019). A massive difference in comparison to other sectors.

As in many export-oriented sectors, international brands pressure plays a significant role in pushing RMG companies to pursue EMS certification (Sakamoto et al., 2019). Indeed, international buyers require that Bangladesh export companies comply with their local environmental regulations, importing countries or organisations' regulations, buyers' code of conduct, and other international standards. Those buyers periodically audit the supplier company. Sometimes the buyers or international agencies provide technical assistance, but not the financial assistance needed to implement environmental initiatives[89]. It is worth mentioning that the number of MSME companies is decreasing from around 6,000 in 2012-13 to 3,856 in 2018 (BGMEA, 2020). Closing down MSME is attributed to the fact that they are not technically and financially capable of complying with international brands requirements. Those brands are discouraging subcontracting, and as a result, large factories are increasing their production capacity to supply international demand (Moazzem and Radia, 2016). According to Selim (2018), besides the international pressure, gradually, a growing number of RMG companies are discovering the "*win-win*" situation achieved through greener production practices, even in a highly cost-competitive environment (Selim, 2018).

ii. Sustainable enterprises initiatives

The Bangladesh Garment Manufacturers and Exporters Association (BGEMEA) has developed a list of 108 green companies[90]. Information presented was gathered from companies' websites and their published reports.

Cute Dress Industry Limited, a circular knitted apparel manufacturing company located in Dhaka, was founded in 2003[91]. Currently, it exports to more than 30 brands in Europe. This eco-friendly industry is LEED Certified as a Platinum category under United States of America Green Building Council standard. It is one of the top 20 green factories in the world. The company published its first Sustainability Report in 2019, is committed to the SDGs and comply with national and international codes of conduct. Major certifications acquired are LEED, AMFORI[92] (social

89 According to data provided by the local consultant on Annex 2.
90 See Annex 7.
91 Source: https://www.cutedress.net/.
92 https://www.amfori.org/content/about-amfori/.

responsibility), ACCORD on Fire and Building Safety[93], Sustainable Raw Material, Global Organic Textile Standard[94], Organic 100 Content Standard, Reach compliance[95] (European Union), Global Recycled Standard, Programme for the Endorsement of Forest Certification (PEFC), Forest Stewardship Council (FSC) and Oeko-Tex. Environmental actions taken include energy and water efficiency, CO_2 emissions reduction, and waste management.

Echotex Ltd is an RMG manufacturing company located in Gazipur and founded in 2008[96]. Echotex is LEED Certified in the Platinum category, under United States of America Green Building Council standard. Other certifications include EMS, Occupational Health and Safety Assessment[97] (OHSAS), QMS, Global Organic Textile Standard and Oeko- Tex.

Echotex was the first RMG company in Bangladesh to treat 100 per cent of its wastewater to a standard above the legal requirements, receiving the highest government's recognition, the National Environmental Award 2010. Under the IFC PaCT programme, Echotex significantly reduced water consumption in dying by implementing the latest available technology (i.e., 45-50 thousand litres of water used per tonne of fabric). The rainwater harvesting project on the roof of its buildings contributed to groundwater extraction reduction. In addition, the company invested in water reuse (i.e., 70-80 per cent reuse). It installed LED to increase energy efficiency, energy-efficient sewing machines, and soft starter in motor operation, significantly reducing energy requirements and heat recovery. H&M has chosen Echotex to pilot a solar energy programme to install photovoltaic panels on top of the factory buildings.

According to a similar set of rules, other export-oriented RMG companies, like Remi Holdings Limited, Plummy Fashion, and Kaniz Fashion, have exported to countries through different global supply chains.

One example of buyer´s pressure is the Codes of Conduct (CoCs) or compliance standards related to social and environmental aspects (Khan and Molla, 2014; Selim, 2018). For example, the CoCs of C&A and H&M Code of Conduct imply:

- C&A requires suppliers to prevent chemical substances and waste to reach the environment without treatment, a sustainable production process, compliance with all national standards and laws, among other requirements. C&A offers technical support to suppliers to comply with the ethical, social and environmental requirements. C&A periodically audits suppliers.

- H&M requires suppliers and other business partners to prioritize employees' safety, a healthy working environment, and compliance with applicable environmental regulations and sustainable production processes.

Comparing those codes of conduct, C&A prioritises the environment, while H&M employees' safety, which can be attributed to the 2013 Rana Plaza factory collapse (Selim, 2018).

iii. Business associations / sectoral institutions initiatives

In Bangladesh, four trade associations represent the RMG exporting sector. They are the BGMEA[98], the Bangladesh Textile Mills Association[99] (BTMA), the Bangladesh Knitwear Manufacturers & Exporters Association[100] (BKMEA), and the Bangladesh Garments Accessories, Packaging Manufacturers & Exporters Association[101] (BGAPMEA). Among them, BGMEA is the one that is getting more involved in sustainability initiatives in partnership with other institutions. One recent initiative, launched in 2017, is The Circular Fashion Partnership, led by Global Fashion Agenda (GFA), in alliance with Reverse Resources, BGMEA and P4G, which aims to achieve a long-term transition to a circular fashion system. This initiative intends to develop a circular model that captures and directs the post-production fashion waste stream into the production system through the collaboration between fashion brands, textile and garment manufacturers, and recyclers, becoming a new fashion product[102]. In 2020, the GFA and Reverse Resources started to develop, with a small number of factories, circular economy pilot projects (BGMEA, 2020).

93 https://bangladeshaccord.org/.
94 https://global-standard.org/.
95 https://www.reach-compliance.eu/.
96 https://www.echotex.com/new-index/.
97 ISO 45001-2018.
98 See https://www.bgmea.com.bd/.
99 See https://www.btmadhaka.com/.
100 See https://bkmea.com/.
101 See https://www.bgapmea.org/.
102 See http://www.globalfashionagenda.com/circular-fashion-partnership/.

Regarding climate change, even though being one of the lowest carbon emitters globally, Bangladesh is one of the most vulnerable countries (Hutfilter et al., 2019). In this sense, in 2019, BGMEA signed the United Nations Fashion Industry Charter for Climate Action with the United Nations Framework Convention on Climate Change (UNFCCC), a series of principles addressing climate change by the textile, clothing, and fashion industries. The initiative establishes a 30 per cent GHGs emission reduction target by 2030, compared to the business as usual (BAU) level. In addition, BGMEA committed to setting a decarbonisation pathway for the fashion industry, drawing on the Science-Based Target Initiative methodologies[103].

In December 2020, BGMEA launched the program "*Go Human, Go Green*" with seven pledges to help the RMG sector align with the SDGs, which are:

- Pledge to Workers Education;
- Pledge to Early Childhood Learning of Workers' Children;
- Pledge to Mental Health ("*Moner Bondhu*", a platform which provides care for mental health and well-being service);
- Pledge to Sustainability (contribution of the RMG sector to national SDG achievement);
- Pledge to Culture Export of Bangladesh;
- Pledge to Workers Health; and
- Pledge to Industry Innovation and Efficiency.

Still, in 2020, BGMEA published its Sustainability Report, under the GRI standards, as part of the Promotion of Social and Environmental Standards (PSES) programme. As a service provider, BGMEA data disclosure mainly was for the RMG sector.

BGMEA, with the government of Bangladesh, is also part of the Water Resources Group 2030, a public, private, civil society partnership hosted by the World Bank[104]. This initiative seeks the sustainable management of water resources through collaborative actions.

BKMEA launched in 2015 the Green Industry Development (GID) Cell, which provides consultancy for the knit industries in services like LEED certification, chemical management, safety and storing system, water and waste management, among others[105]. BKMEA is also working with the Asian Development Bank (ADB), WB, JICA, UNIDO, Bangladesh Rural Advancement Committee (BRAC), Ministry of Finance and other national and international organisations. Actions taken include productivity enhancement, social compliance improvement, promotion of workers welfare through centralized daycare and healthcare centres, training program to raise workers and mid-level management productivity, organization of trade missions and fairs locally and abroad.

Education, training and skills development are a gap in the RMG sector (Ahmed, 2017). Textile education can be divided into three levels (a) entry-level, (b) mid-level & (c) high-level. Although many public and private textile education institutions have been created as a private sector's demand, outcomes cannot meet market expectations as education quality has not been assured (Siddique, 2017).

Following this market demand, the Skills for Employment Investment Program (SEIP) Project, a partnership with the ADB, the Swiss Agency for Development and Cooperation (SDC), the Ministry of Finance, BKMEA and BGMEA, started in 2014 to promote skills development at mid-level and worker-level (BGMEA, 2020). From April 2015 to December 2018, 23,411 workers received training[106].

Child labour has been a significant concern in Bangladesh. BGMEA, ILO and UNICEF launched two programmes, the Placement of Child Workers in School, and the Elimination of Child Labour, to tackle this problem (BGMEA, 2020). According to the ILO, the number of factories using child labour in the RMG sector has been reduced from 43 per cent in 1995 to less than 4 per cent in 2019. Former child workers that received informal education were admitted to the school system and received vocational training (International Labour Organization (ILO), 2019).

Dhaka Stock Exchange (DSE) with 308 companies and Chittagong Stock Exchange (CSE) with 288 companies have voluntarily committed to the Sustainable Stock Exchange initiative promoted by the UNCTAD, the United Nations Global Compact,

103 See https://unfccc.int/climate-action/sectoral-engagement/global-climate-action-in-fashion/about-the-fashion-industry-charter-for-climate-action/.
104 See https://www.2030wrg.org/bangladesh/.
105 See https://bkmea.com/department/gid-cell/.
106 See https://bkmea.com/projects/seip/.

the UNEP FI and the PRI. In 2018, DSE published the Guidance on Sustainability Reporting to support the GRI Standards. In the same year, CSE published the Corporate Governance Code, according to which companies must comply with the four pillars of corporate governance: fairness, accountability, transparency, and responsibility.

iv. International initiatives

The Partnership for Cleaner Textiles (PACT), launched in 2013 by the IFC in partnership with NGOs, government, brands, textile factories, and the BGMEA, supports the textile value chain to achieve sustainable production and introduced the cleaner production concept. PaCT first and second phases involved more than 400 RMG companies[107]. As a result, the initiative minimised natural resources consumption and environmental impacts and maximised energy, water, and resource efficiency[108].

German Federal Ministry for Economic Cooperation and Development (BMZ), in association with the Ministry of Commerce, BGMEA and BKMEA, adopted the Promotion of Social and Environmental Standards (PSES) project in the industry (Genzmer, 2015; F. Rahman, 2020). PSES looks to promote sustainable growth, improve social and environmental legislation and standards compliance, workers' rights, including provisions for persons with disabilities. Table 16 bshows the main results between 2009 and 2019.

PSES results are significant progress both in environmental and social matters in Bangladesh. More recently, these advancements are moving towards meeting the 2030 Agenda (F. Rahman, 2020).

The Partnership for Sustainable Textiles is another German initiative[109]. Launched in 2014, companies, business associations, NGOs, and the German government improve working and environmental conditions in the textile supply chain (BMZ, 2019). The Partnership builds on three pillars: individual responsibility, collective engagement, and mutual support. Primary objectives include transparency in the supply chain, banning toxic and hazardous chemicals, safe substitutes, promoting living wages[110], and freedom of association. So far, participating companies publicly report progress and adopt standards based on international principles and guidelines. In Asia, participating countries include Pakistan, China, Cambodia, and Myanmar.

Concerning process certifications, Eco Passport is standardised testing and certification by Oeko-Tex[111], Hohenstein, where chemicals and dyes undergo testing to ensure sustainable production along the textile supply chain (OEKO-TEX, 2021). OEKO-TEX currently has three institutes operating in Bangladesh: Chattogram, Dhaka, Narayangonj.

As for product certification, the Green Button Initiative is the first state-owned global label for sustainably

107 See https://www.textilepact.net/.

108 According to data provided by the local consultant on Annex 2.

109 Germany is the world's second largest importer of T&A products, accounting for 9 per cent of global imports (BMZ, 2019).

110 The living wage is the amount of income determined to provide a decent standard of living.

111 German certification body.

Table 16. PSES Results between 2009 and 2019

PSES Results (2009-2019)	
Social Results	**Environmental Results**
1,000 factories improvements in working conditions 270 inspectors trained in cooperation with the ILO 17,000 managers and workers received training in social standards and fire safety 2,100 people trained on vocational qualification in garment and textile 270,000 workers, mainly female made aware of their rights 300 people with disabilities received support in finding a job	300 factories significantly improved their environmental standards: properly functioning wastewater systems, chemicals management, energy consumption, climate-adapted buildings, waste management, environmental management systems. 70 advisors trained in environmental management

produced RMG. The German government set the criteria for the label award. Accredited independent auditing bodies monitor its compliance, and Hohenstein ensures that the audit process is credible and reliable. The company is audited and must fulfil human rights, social and environmental responsibilities based on set criteria (BMZ, 2019).

The Responsible Sourcing Initiative (RSI) is a joint initiative, created in 2010, between the WB, the Natural Resources Defence Council (NRDC), and the IFC in collaboration with the Bangladesh government, international brands, and the private sector aiming to improve the environment and people's health by ensuring the adoption of cleaner production measures by the RMG supply chain (The World Bank, 2014). Results showed that implementing low-cost measures such as housekeeping (e.g., eliminating water leaks) and water reuse could reduce consumption and treatment costs.

After the Rana Plaza incident to ensure safety in the RMG sector, three safety agreements were established: ACCORD on Fire and Building Safety supported by European brands, Alliance for Bangladesh Workers Safety supported by North American brands, and the National Initiative, a partnership among international brands, the local government, ILO, BGMEA and BKMEA (Ahmed, 2017). As a result, there were many fire and electrical safety inspections, and those who could not invest in safety repairs and meet recommended safety standards were closed (BGMEA, 2020). Complaints about these safety agreements included the costs associated with required retrofitting options, which often are more expensive than available local sources, and the arbitrary decision regarding safety and security standards from a Western point of view ignoring local specificities (Ahmed, 2017).

c. Exploring the potential environmental impacts of a relevant exported product

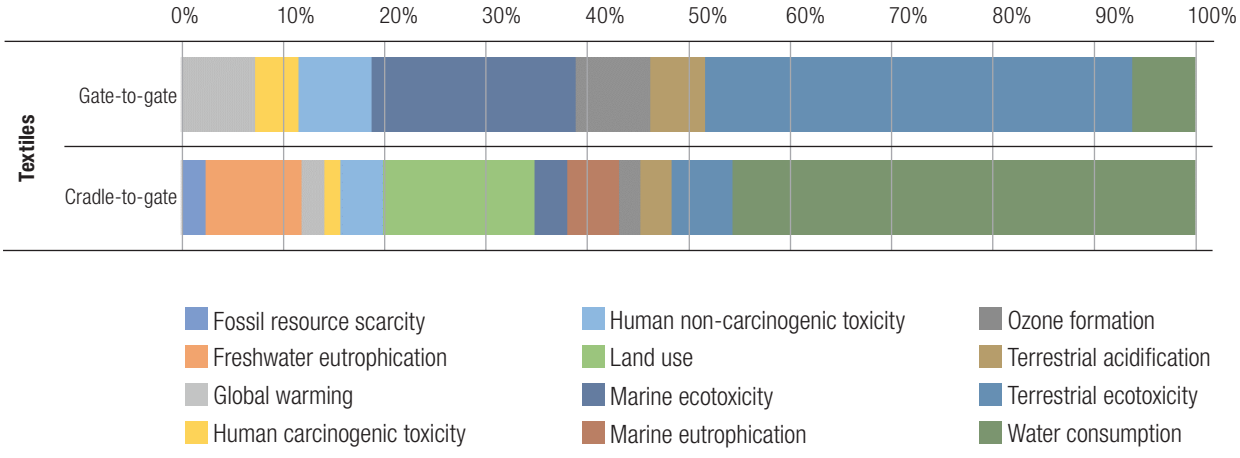
Figure 21 presents the normalised relative contribution of the impact categories included in the IO-LCA to the overall impact of the gate-to-gate and the cradle-to-gate scopes of the textile sector in Bangladesh. While terrestrial and marine ecotoxicities are the primary impact categories at the plant level, water consumption presents the highest contribution at the supply chain level, followed by land use and freshwater eutrophication.

The most exported products for the textile sector in Bangladesh are products related to the preparation and spinning of textile fibres, of which jute yarn is the most important product in terms of exported quantities. It corresponds to more than 84 per cent of the country's exports in the sector.[112].

Like previous case studies, the report conducts a process-based LCA to assess the potential environmental impacts of jute yarn production regarding quantity, including upstream processes

112 The reference product flows are considered as the product quantities exported in 2019, according to the ITC (2021.), in 6 digits codes.

Figure 21. Impact results for the textile sector in Bangladesh (normalised relative contribution)



from the supply chain (e.g., cradle-to-gate system boundary). Local inventories help understand the main environmental issues related to its exports and the better-prioritised areas for action[113]. Figure 22 shows the absolute contribution and associated environmental impacts of the stages in jute yarn production for export.

Sizing[114] represents the largest single group of chemicals used in the textile industry, and most of them are responsible for environmental impacts related to human non-carcinogenic toxicity. Size recovery, therefore, presents one of the most significant opportunities for operational cost and toxicity levels reductions.

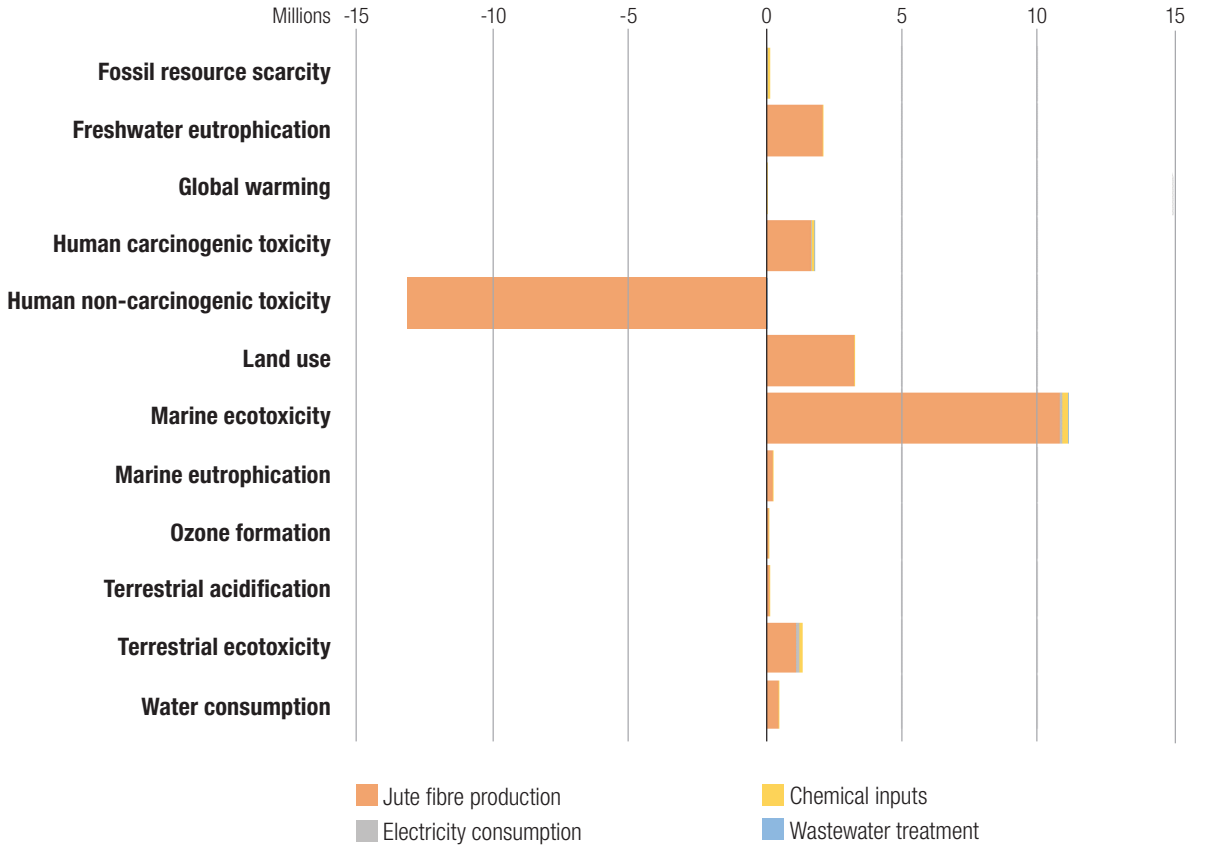
Figure 22 shows jute fibre production as the stage that primarily contributes to local environmental impacts. The most significant impacts are land use and marine ecotoxicity from fertilizer and pesticide use during jute plant cultivation. Jute fibre production causes a negative impact on human non-carcinogenic toxicity due to the withdrawal of heavy metals from the soil or water by plants. To better understand the impact originating from each stage, especially those included in the plant level, Figure 23 shows the normalised relative contribution of jute yarn per production stage.

Figure 23 shows that jute fibre exports impact marine and terrestrial ecotoxicity and human toxicity (e.g., carcinogenic and non-carcinogenic). These impacts result in local damages to ecosystems and

113 Ecoinvent dataset is used as the basis for the inventory modelling, adapting electricity, water, waste, and wastewater to the national conditions.

114 Sizing is a protective process. The process of applying a protective adhesive coating upon the yarns surface is called sizing. This is the most important operation to attain maximum weaving efficiency especially for blended and filament yarns. Sizing is called the heart of weaving. The most common chemical are starch, carboxymethyl cellulose (CMC), polyvinyl alcohol (PVOH), polyacrylic acid (PAA), polyvinyl acetate (PVAc), polyester (PET), and modified cellulose and starches.

Figure 22. Impact results for exported jute yarn in Bangladesh per production stage (normalised absolute contribution)



human health. Therefore, the results corroborate that sustainable initiatives at the plant scale are relevant and should include reducing electricity consumption, selecting environmentally preferable chemical inputs, and optimizing wastewater and waste treatment.

The process-based LCA identifies potential environmental impacts of exported jute fibre in terms of residual quantities during manufacturing activities left behind. Table 17 presents the local environmental load per type of impact category left behind for one tonne of exported jute yarn.

Table 17 shows that 2.77 kg P_{eq} is discharged to freshwater from jute fibre production for each tonne of jute yarn exported by Bangladesh. The discharge of nutrients into the soil or freshwater bodies causes an increasing nutrient uptake by autotrophic organisms such as cyanobacteria and algae and heterotrophic species such as fish and invertebrates, ultimately leading to a relative loss of local species. Another example is that for each tonne of exported jute yarn, 997.50 kg 1,4-DCB of direct emissions from oil extraction potentially causing terrestrial ecotoxicity and 187,81 kg 1,4-DCB of waste treatment emissions causing human non-carcinogenic toxicity are discharged.

Figure 23. Impact results for jute fibre exported in Bangladesh per production stage (normalised relative contribution)

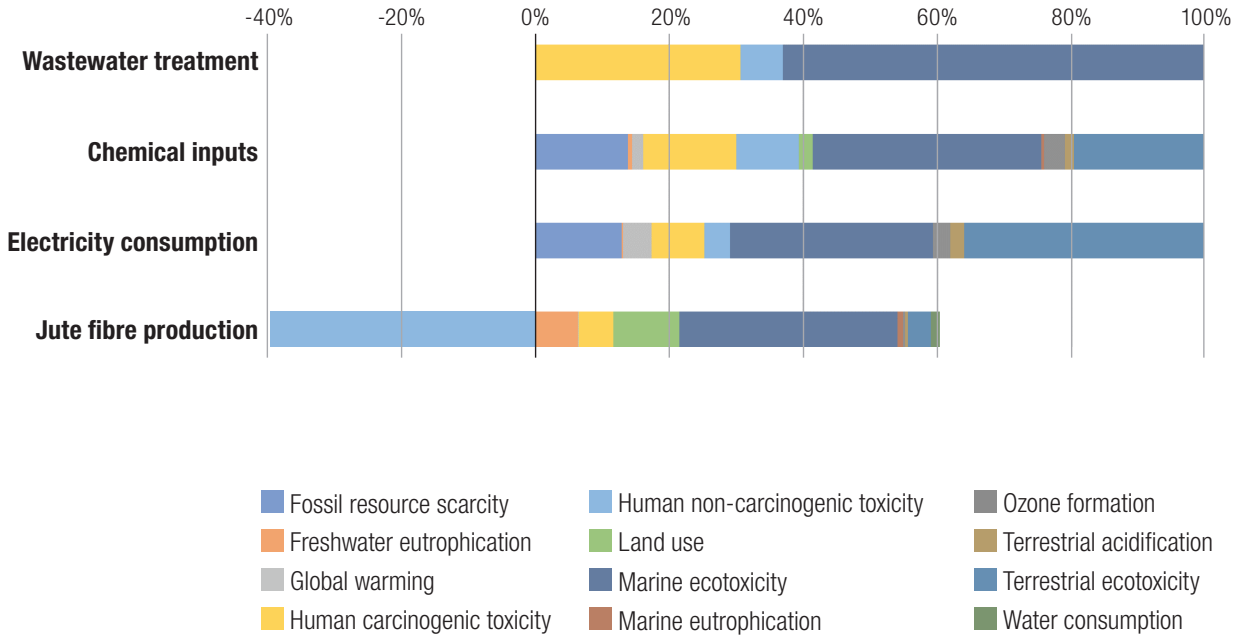


Table 17. Environmental burden per 1 tonne of exported jute yarn

Impact category	Unit	Total	Jute fibre production	Electricity consumption	Chemical inputs	Wastewater treatment
Fossil resource scarcity	kg oil_{eq}	663.23	331.62	79.09	94.53	157.99
Freshwater eutrophication	kg P_{eq}	5.53	2.77	2.76	0.00	0.00
Global warming	kg $CO_{2\,eq}$	2,110.49	1,055.24	648.12	251.90	155.23
Human carcinogenic toxicity	kg 1,4-DCB	20.12	10.06	9.45	0.16	0.45
Human non-carcinogenic toxicity	kg 1,4-DCB	-7,870.63	-3,935.31	-3,955.51	4.14	16.05
Land use	m^2a crop eq	81,590.52	40,795.26	40,641.99	0.82	152.45
Marine ecotoxicity	kg 1,4-DCB	46.32	23.16	22.52	0.23	0.41
Marine eutrophication	kg N_{eq}	4.79	2.40	2.37	0.00	0.02
Ozone formation	kg $NO_{X\,eq}$	11.40	5.70	4.56	0.41	0.73
Terrestrial acidification	kg $SO_{2\,eq}$	24.53	12.27	11.00	0.61	0.65
Terrestrial ecotoxicity	kg 1,4-DCB	5,696.23	2,848.12	2,340.33	275.14	232.64
Water consumption	m^3	510.70	255.35	253.72	0.48	1.15

Source: Based on data from process-based LCA.

2. Pakistan

Although raking in the lowest growth rates in 2019, Pakistan continues to benefit from increased investments from China, and the return of the Islamic Republic of Iran to international markets is expected to boost mutual trade. Additionally, the China-Pakistan Economic Corridor (CPEC), a 3,000-kilometre network of roads, railways, and oil and gas pipelines from Pakistan to China, is expected to bolster the Pakistani economy through 2030 (The World Bank, 2019c).

As described in their development agenda, industrialisation is the main activity for Pakistan's economic growth and poverty mitigation (Khan, 2016). After its independence in 1947 and the following 30 years (The World Bank, 2019c). Nowadays, the country is trying to achieve the title of an upper-middle-income country by 2047, probably through trade opening and regional integration besides other activities.

a. Environmental law and governance for manufacturing pollution control

Pakistan has nine BTAs in force and signed with the Islamic Republic of Iran, Malaysia, and Mauritius, adopting the same pattern of General Exceptions foreseen in Article XX of GATT. The agreements between Pakistan and the European Union and the United States of America, two major Pakistan trading partners, have dedicated provisions about the trade-environment nexus. With China, the agreement recognises environmental protection in the preamble. It contains provisions about sanitary measures in the animal trade.

Regarding the compliance with other legal instruments, including International Laws, all agreements, but one between Pakistan and Sri Lanka, mention the compliance obligation. In the Indonesian case, compliance with GATT and WTO rules is reinforced. Finally, the BTA with Afghanistan does not have any environmental or compliance to other law provisions.

Concerning the list of tariff concessions for Pakistan textile products, the following agreements have disclosed the list: China, Indonesia, the Islamic Republic of Iran, Malaysia, and Mauritius. Sri Lanka does have a list, but there are no concessions for textile products.

Amongst the nine BTAs, the most comprehensive is the cooperation agreement framework between Pakistan and the European Union, 2001. It applies to cooperation in all sectors, including trade. This agreement is similar to the Bangladesh-European Union agreement and recognises the environment-trade-development nexus, establishing human dignity as the basis for all cooperation sectors, including trade. The agreement has environmental provisions regarding environmental cooperation, such as attention and emphasis on preventing and controlling water, soil, air, and waste pollutions. Besides, the parties shall cooperate in the public sector reforms, legislation development, research, and technical assistance in the environmental sector.

i. Pakistani environmental law and governance

Pakistan Constitution dates from 1973. Like in other constitutions, human dignity is a central principle. It states that dignity is inviolable as a fundamental right. In its original text, there is no explicit mention of the environment. However, in 1994, jurisprudence from the Supreme Court recognised environment protection as a constitutional right, a dimension of the right to life (Alam, 2018). After this decision, Pakistan has approved environmental laws and policies such as the Pakistan Environmental Protection Act (PEPA), 1997, and the National Environmental Policy, 2005, constituting the country´s environmental law and policy frameworks.

In 2010, the 18th Amendment to the Constitution significantly shifted the environment's Pakistani legal and governance systems. This amendment did not include the environment in the list of shared powers amongst federal institutions and provinces. Thus, the power to enact environmental laws becomes mainly the responsibility of provincial legislative assemblies. After the Amendment, provinces may adopt or repeal the national environmental laws. In the case of repealing, provinces need to create their laws. Balochistan, Khyber Pakhtunkhwa, Punjab, and Sindh Provinces have exercised their powers. However, the national environmental laws and policies are still valid and in force in the following cases: Islamabad Capital Territory, Federal Administered Tribal Areas, and projects whose negative environmental impacts affect more than one province (Alam, 2018).

Concerning the executive authority power, the amendment also has meaningful modifications. In Pakistan, executive attributions are linked to legislative powers. Hence, the protection of the environment is

primarily a provincial government responsibility. Table 18 summarises provincial environmental laws and institutional architecture of governance applied to the textile sector in Pakistan.

Environmental laws and governance structures applicable to the textile sector depend on the environmental impacts' location and terrestrial extension. If the extension does not transcend provincial limits, then the provincial laws are applicable. If impacts transcend the limits, federal laws are applicable. The same if the impacts are within the limits of the capital or the federally administered tribal areas.

Despite the decentralisation of environmental matters, the federal level still has residual powers on the environment, such as international representation or national coordination. The Ministry of Climate Change is the primary ministry responsible for the environment (The National Information Technology Board of Pakistan Government, 2021). The PEPA gives the Pakistan Environmental Protection Agency (Pak-EPA) power to monitor and control environmental matters and establishes the Ministry of Climate Change functions. Pakistan has the following national policies: National Environment Policy (2005); National Drinking Water Policy (2006); National Sanitation Policy (2009); National Climate Change Policy (2012); and Framework for implementation of National Climate Change Policy (2014-2030).

The National Environmental Policy brings provisions concerning the trade-environment nexus. To avoid the negative impacts of trade liberalisation, the local government may use the subsequent strategies: certification of laboratories and business, capacity building, research on tariffs and subsidies for the specific sectors and, finally, to adopt measures dealing with the imports of goods and technologies could cause pollution. There are no mentions of the pollution related to the exports (Ministry of Environment Government of Pakistan, 2005).

Pak-EPA has the primary function of implementing and enforcing environmental laws and regulations and defining environmental quality standards. There are national standards for air, water, waste,

Table 18. Provincial environmental law and governance for the textile sector in Pakistan

Provinces	General Environmental Laws	Environmental Governance Structure	Environmental Quality Standards present in Rules and Regulations
Balochistan	Environmental Protection Act, 2014	Balochistan Environmental Protection Agency; Balochistan Environmental Protection Council, Environmental Tribunals	Air, EIA, hazardous waste, industrial gaseous emissions, noise, penalties, protection, tribunal rules, waste, and water
Khyber Pakhtunkhwa	Environmental Protection Act, 2014	KP Environmental Protection Council, KP Sustainable Development Fund and Board, KP Environmental Protection Agency, Environmental Magistrates and Environmental Protection Tribunals	Air, water, noise, and tribunal rules
Punjab	Environmental Protection (Amendment) Act, 2012	Environmental Protection Council, Sustainable Development Fund and Board, Environmental Protection Agency, Environmental Magistrates and Environmental Protection Tribunals	Drinking water, ambient air, industrial gaseous emissions, motor vehicle exhaust, noise, municipal and industrial effluents
Sindh	Environmental Protection Act, 2013	Environmental Protection Council, Sustainable Development Fund and Board, Environmental Protection Agency, Environmental Magistrates and Environmental Protection Tribunals	Air, water, and waste

Source: Based on data from Alam (2018) and provincial governments websites.

hazardous waste, and industrial noise in the textile sector. Despite these legal and policy frameworks, public environmental governance has many gaps and challenges to control pollution related to the exports of manufactured goods in the textile sector.

In the past ten years, Pakistan has changed its institutional environmental framework substantially. The institutional arrangements complexity may compromise its effectiveness. Decentralisation to regional or local scales has pros and cons in terms of environmental governance. Being close to where environmental problems occur facilitates their perception and fosters their locally adapted solution. Nevertheless, institutional mechanisms must follow decentralisation to ensure that the responsible scales have the necessary conditions to fulfil their obligations in controlling pollution in the textile sector.

There are institutional capacity constraints and gaps at the federal and provincial levels, such as human, financial and operational resources (Khan et al., 2020; The World Bank, 2019c). For example, there are nine environmental inspectors for the monitoring of 12,000 industries in Lahore[115]. There are not enough equipment or laboratories to conduct air and water tests. Thus, monitoring is limited, and Alam (2018) declares no monitoring and inspection practices in the textile sector of Faisalabad (Alam, 2018).

The Judiciary Power is a relevant stakeholder in Pakistani public environmental governance (Salman, 2012). Leading cases have improved the system, recognising constitutional rights and implementing provincial laws and regulations. However, institutional capacities are limited. Despite dedicated courts for hearing and judging environmental cases at both federal and provincial levels, Alam (2018) reports a decrease in cases and imposed fines in Punjab between 2012 and 2018 (Alam, 2018).

Although many NGOs work in environmental matters, resources and public participation are lacking (The World Bank, 2019c). Thus, accountability and transparency are limited, reducing policy implementation and effectiveness (Sohail et al., 2014; The World Bank, 2019c). Advancements exist; however, "*[…] the environmental governance mechanisms in Pakistan are still at an early stage, and enforcement is weak due to lack of capacity*" (Naureen, 2009).

115 According to data provided by the local consultant on Annex 2.

b. Private sector governance

Industrialisation is a foundation of Pakistan's development agenda to poverty alleviation and economic growth (Khan, 2016). In its first 30 years after Pakistan attained independence, it was considered an example of growth and development (The World Bank, 2019c). Nevertheless, this has changed as Pakistan's development become slow and uneven[116]. This lower-middle-income country aims to become an upper-middle-income country by the time it turns 100 years old, in 2047, which will probably be achieved through the business environment and education improvements, growing FDI, openness to trade, and regional integration (The World Bank, 2019c).

Amongst the industrial sectors, the textile manufacturing sector is the largest exporting sector in Pakistan, and the second-largest employment generator, accounting for about 40 per cent of the total labour force, Thus, being the leading contributor sector to the country's economy (Farooq, 2018; Pakistan Textile Journal, 2020; Samad et al., 2015). Between 2016 and 2017, the textile sector accounted for 61 per cent of total exports (Frederick and Daly, 2019). More recently, in 2020, its contribution was 57 per cent, representing almost 8.5 per cent of Pakistan´s GDP (Pakistan Textile Journal, 2020).

As the fourth leading cotton producer globally, local access to natural cotton fibre and related yarn and fabric materials contributed to Pakistan's integration into the Global Value Chain (GVC). As of 2016, Pakistan became the world's eighth-largest apparel exporter. Indeed, apparel exports share raised from 21 per cent in 2001 to 42 per cent in 2016. Trousers, knit shirts and sweaters/sweatshirts are the primary exported goods in Pakistan (Frederick and Daly, 2019; Lopez-Acevedo and Robertson, 2016). Major export destinations are the United States of America, the European Union, and China (Hamid et al., 2014).

Even being one of the world's largest cotton producers, Pakistan relies on cotton imports, attributed to the low-grade local cotton quality and outdated production technologies (Frederick and

116 Since the 1990s Pakistan suffered from political instability, dwindling foreign inflows and a deteriorating security situation due to geopolitical regional tensions following three cross-border wars (The World Bank, 2019c).

Daly, 2019). Production is concentrated in Karachi, Lahore, Faisalabad, Multan, Gujranwala, and Sialkot.

The textile sector in Pakistan can be characterized as an integrated sector, with high domestic ownership, a long history of producing cotton and relatively competitive labour prices (Frederick and Daly, 2019). However, the sector faces constraints such as government's poor industrial policy, supply chain gaps in critical inputs[117], underdeveloped energy infrastructure, high duties and taxes imposed on imported materials, security, country risk perception, lack of investment in human resources, lead times associated to imported inputs delays, and fragmented industry institutions. As a result of these hindering factors, FDI funding usually is below the levels of other competitor countries (Frederick and Daly, 2019; Hamid et al., 2014).

More recently, sector upgrading[118] allowed the country to diversify and access markets that pay higher price premiums (Frederick and Daly, 2019). The Punjab province, for instance, invested in the development of a model apparel cluster. Some Punjab cluster features include an uninterrupted power supply, common facilities such as an effluent treatment plant, a solid waste disposal facility, and a centre for skills development (Hamid et al., 2014). Nonetheless, many environmental and social challenges exist, particularly in the face of the global demand for environmentally friendly processes, products, and services. The sector expansion to foreign markets is connected to inefficient use of natural resources associated with environmental degradation and pollution (Khan, 2016). Pollution is estimated to cause around 340,000 deaths per year in Pakistan, a quarter of total annual deaths, over 70 per cent due to air pollution (The World Bank, 2018b). Besides air pollution, water pollution is a significant concern. Surface water and groundwater resources have deteriorated and became scarce due to population growth, industrialization, agriculture, and urbanization, representing a public health threat. As Ortolano et al. (2014) stated, if companies are not competitive on all dimensions, including environmental performance, the Pakistani textile sector cannot expand (Ortolano et al., 2014).

Besides environmental issues, textile companies are characterised by limited social upgrading, meaning a shortage of trained labour, a workforce traditionally skewed toward men and low female participation rates (Frederick and Daly, 2019). There are also safety and exploitation issues (Stotz, 2015). In 2012, two fires, Karachi and Lahore, together killed more than 280 workers. Both factories did not have fire extinguishers and emergency exits. Regarding worker exploitation, textile workers have the lowest wages compared to other sectors, discrimination against female workers is high, compulsory overtime work, and no permanent contracts. Short-term and temporary contracts are used, particularly for women (Lopez-Acevedo and Robertson, 2016).

Education, training, and skills development are also constraints faced by the sector. In this regard, Pakistan invested in specific education and training at all levels, such as universities and technical training institutes, for example, the Pakistan Readymade Garment Technical Training Institute (PRGTTI) (Frederick and Daly, 2019). In short, the textile workforce is characterised by a high number of informal workers, low wages[119] when compared with larger markets such as China, India, and others[120], relatively low percentage of female workers, and shortage of skilled and literate workers in some areas (Frederick and Daly, 2019).

Even though the textile sector is slightly more inclusive of female workers than other sectors in Pakistan, the high percentage of male workers persists. Cultural norms about women's suitability for factory work, security and safety issues, the lack of public transportation and insufficient child care, and lower education than men play a crucial role in this issue (Frederick and Daly, 2019). As Stotz (2015) pointed out, Pakistan's society is very traditional and religious, putting women at a disadvantage, directly affecting the kind of jobs women can get, their wages, the conditions they face at work, and employers' way treat them. In 2012, trying to improve women conditions, the Pakistan government reviewed the

117 Like, synthetic fibres and components not available in the local market that are subject to tariffs and taxes that increase costs, including cotton, which production has stagnated in recent years and fibres generated with low quality.

118 Process upgrades in the form of reduced lead times, investments in human capital, IT, R&D, energy supply, which allowed product upgrades (woven products with more sophisticated washes and finishes).

119 Workers in Pakistan are still paid on a piece-rate basis for each basis of apparel generated (Frederick and Daly, 2019).

120 Except by Bangladesh and Cambodia.

laws. However, they still lack implementation and enforcement (Stotz, 2015).

Regarding SMEs, they constitute a significant source of employment generation and poverty alleviation in Pakistan. In addition, they can act as a pioneer in developing new products and services (G. Syed et al., 2012). In 2015, there were 27,250 SMEs in the textile sector (Arshad and Arshad, 2019). Malik and Khaver (2020) highlighted constraints faced by SMEs that prevent them from entering a competitive export market (Malik and Khaver, 2021). They are the high cost of infrastructure, the inability to comply with international regulations and standards, and other conditions set by buyers. A study that applied questionnaires to 377 SMEs concluded that SMEs in the textile sector must reconfigure their internal resources and innovation capacities (Arshad and Arshad, 2019).

i. Sustainability in the textiles and wearing apparel manufacturing sector

Sustainability becomes a critical factor for textile and wearing apparel companies, and being an environment-friendly company, having an environmentally friendly process, manufacturing environmentally friendly products become a market differentiation, a competitive advantage for companies. Awareness of environmental issues has increased the demand for environment-friendly products and services from consumers and buyers internationally[121]. As Farooq (2018) states, sustainability will be a new quality that allows the consumers to make an informed choice (Farooq, 2018).

To cope with the international brands and consumers' demand for a sustainable manufacturing process and products, Pakistani companies started to commit to sustainability measures by complying with environmental regulations and implementing environmental management initiatives, tools, and instruments (Khan, 2016). To foster this change, in 2005, the National Environmental Policy included the promotion of cleaner production technologies and reduction, recycling and reuse of industrial solid and liquid waste, effective implementation of National Environmental Quality Standards (NEQS), self-monitoring rules and EMS certification.

As more rigorous regulations are applied, companies started looking for new technological methods to treat pollution. However, the high cost of technology acquisition and operation increases production costs, often forcing companies out of business. Gradually, companies realised that pollution prevention is necessary to overcome those costs and gain new markets (Shaikh, 2009).

ii. Sustainable enterprises initiatives

Pakistani companies, particularly those that export to foreign markets, comply with environmental regulations of importing countries, international brands standards and buyers CoC. Thus, they have gradually begun to adopt environmental management tools and products certifications[122]. Information presented was gathered from companies' websites and their published reports.

Lucky Textile Mills Limited is a textile company located in Karachi and founded in 1983. Its accredited certifications include Global Organic Textile Standards (GOTS), Organic Content Standard (OCS), Recycled Claim Standard (RCS), OEKO-TEX certification, STeP certification, Made In Green by OEKO-TEX, Detox To Zero by OEKO-TEX, EU Ecolabel, Quality Management System[123] (QMS), Testing and calibration laboratories[124], Cotton USA, Registrar Corp USFDA[125], Environmental Management System[126] (EMS), Business Social Compliance Initiative (BSCI), Worldwide Responsible Accredited Production[127] (WRAP), Fairtrade Cotton Standards, Business Environmental Performance Initiative (BEPI), Higg Index Sustainable Apparel Coalition, and ASDA Laboratory Certification[128]. Contribution towards sustainability includes national and local regulations compliance, 3Rs throughout the value chain, pollution prevention (P2), natural

121 According to data provided by the local consultant on Annex 2.

122 According to data provided by the local consultant on Annex 2 international companies are more likely to follow environmental standards, if only because they respond to a corporate headquarter that is located in Europe or North America, and hence is mandated to follow best sustainable practices.

123 ISO 9001:2015.

124 IEC/ISO 17025:2005.

125 https://www.registrarcorp.com/.

126 ISO 14001:2015.

127 WRAP is non-profit and independent organization focused on the apparel, sewn products and footwear. Wrap is the world's largest certification program for textile industries.

128 See https://luckytextilemills.biz/accrediation/.

resources conservation, energy and water savings, ETP implementation, plastic reduction in packing, hazardous waste management and reduction, toxic chemicals reduction, environmental objectives and targets set, wind power generation (e.g., 50 MW[129]), and EMS continuously improvement. It also includes employee safety, firefighting equipment, first aid procedures, evacuation drills, and personnel protective equipment (PPE) for workers.

Artistic Denim Mills Ltd is a textile and apparel company located in Karachi and founded in 1993. In 2019, the company received the Environment Excellence Award[130] to recognise its commitment to energy conservation and protect the overall environment for a greener Pakistan. Its accredited certifications include QMS, EMS, and OHSAS, WRAP, BSCI, Better Cotton Initiative (BCI), OEKO-TEX Standard, GOTS, RCS, OCS, LYCRA® Assured Mill, Global Recycled Standard (GRS), Customs-Trade Partnership Against Terrorism (C-TPAT), Supplier Ethical Data Exchange (SEDEX). The company invests in sustainability by adopting many initiatives throughout its vertical supply chain, as shown in Table 19.

129 Megawatt.

130 See https://www.admdenim.com/certifications.php/.

Table 19. Artistic Denim Mills Sustainability Initiatives

Initiatives	Description	Results
Better Cotton Initiative	100 per cent BCI cotton use	Reduced environmental impact. Improved economic development in cotton-producing areas. Ensure sustainability in the cotton supply chain
Organic Cotton	100 per cent Organic Cotton Fabrics certified from ONE CERT, GOTS & OCS	No use of genetically modified seeds. Builds soil in organic matter through crop rotation, intercropping & composting. Conserves water & uses rainwater more efficiently. Use soil balance, trap crops & insects to manage pests
Recycled Cotton	Recycling plant integrated with spinning; yarns are produced using consumer waste.	Reduction in the amount of energy, water, and dye used. Reduced disposal in a landfill. Reduced textile waste. Reduced CO_2 emissions
Recycled Denim	Denim produced by incorporating consumer waste	The denim jeans are sorted, run through a machine that shreds them into a raw fibre. The raw fibre is spun back into yarns for making new fabric
Lenzing Ecovero	Viscose fibres derived from sustainable wood and pulp from certified sources.	EU Ecolabel certified, meeting high environmental standards throughout the life cycle: raw material extraction to production, distribution and disposal
Lycra T400	50 per cent of the fibre made from recycled PET, a part from renewable sources such as plant-based material.	Made from recycled materials such as PET bottles. Contains plant-based sustainable materials. Less waste going to landfills. Renewable sourcing
ZDHC Program	Collaboration of brands, value chain committed to hazardous chemicals elimination.	Reduction in water use, waste generation, hazardous chemical, energy conservation, sustainable materials, supply chain management, health and safety, research and development

Style Textile and Apparel Co is located in Lahore and was established in 1992. The company is committed to international standards, such as EMS, OHSAS 18.001 and WRAP[131]. By adopting cleaner production, P2, and legislation standards compliance, the company decreased its carbon and water footprint, waste generation and energy consumption, which resulted in cost reduction and productivity improvement[132].

Nishat Mills Limited is located in Lahore and was founded in 2007[133]. The company has a production capacity of 1.2 million garments per month. Contribution towards sustainability[134] includes fully operational ETPs in all plants, sustainable fabric, 100 per cent green chemicals, and electricity consumption reduction[135]. In addition, it involves the use of renewable energy[136], waste to heat recovery plants, eco-friendly[137] washing machines, eco-friendly[138] curing ovens, green belts to reduce environmental pollution, environmental pollution monitoring through Pak-EPA approved facilities, water savings[139], and local community technical training. Future goals include EMS and QMS certifications, reducing paper waste and water consumption by installing water-efficient machines.

Sustainability is a central criterion to international brands decision-making process when selecting its suppliers. Among the factors contributing to this behavioural change, we can highlight CSR campaigns, compliance-conscious consumers, and the increase in the number of disasters in apparel factories (Lopez-Acevedo and Robertson, 2016). As an example, Levi's adopted strategies for reducing GHG emissions in its supply chain. Like C&A and H&M, other brands adopt CoCs and periodically audit the supplier company. However, compliance with these measures does not give suppliers or countries a competitive advantage since it is a minimum requirement for entering and remaining in the international market (Frederick, 2016).

Several international buyers like Target, Gap, Levi's, C&A, amongst others that extended their supply chains to Pakistan, usually purchase apparel from a small network of suppliers located throughout the country (Frederick and Daly, 2019). For example, Levi's and Target apparel suppliers are US Apparel & Textile, Nishat Mills, Interloop Limited, and Masood Textile Mills.

Samad et al. (2015) investigated the adoption of environmental management practices and regulations compliance by textile companies[140], attributed to international buyers' pressure (Samad et al., 2015). Results showed that companies adopt these practices. However, larger companies are more likely to adopt than medium-sized ones. This behaviour results from the pressure exerted by international buyers, and competitors, while medium companies are more likely to respond to community pressures. Large companies usually comply with regulations, such as EMS, ecolabels, and the use of certified chemicals and dyes. The pressure exerted by international buyers has been an essential driver for Pakistani companies to change their polluting activities[141].

The Pakistan Stock Exchange Limited[142] (PES) has 549 listed companies, among which 136 members are textile companies, divided under three categories: composite, weaving and spinning. Each year, PES publish a list of the top 25 companies. Qualified companies go through an assessment based on the highest marks obtained, considering ten specific criteria. Amongst those ten criteria, it includes CSR, reporting on SDGs achievement and reporting on diversity and inclusion. Out of the 2019 top 25 companies listed, only one textile company, Gadoon Textile Mills Limited[143], made it.

131 WRAP is non-profit and independent organization focused on the apparel, sewn products and footwear. Wrap is the world's largest certification program for textile industries.
132 See http://www.styletextile.com/.
133 Nishat Group is the largest corporate group of Pakistan, founded in 1951, present in textile, banking, dairy, power and hospitality sectors.
134 See https://www.nishatapparel.com.pk/.
135 From 36 kw to 18 kw per hour.
136 Eco-friendly solar panel generation system with an installed capacity of 1.26 MW.
137 50 per cent of energy savings.
138 Energy consumption reduction by up to 45 per cent.
139 95 per cent in spray booths, 50,000,00 gallons in 6 months by using laser machine.
140 Sixty textile-processing companies were surveyed, ten (6 large, 3 medium and 1 small) were selected as case studies. Selected companies produce home garments, bed sheets, terry towels and processed fabric.
141 According to data provided by the local consultant on Annex 2.
142 https://www.psx.com.pk/.
143 See http://gadoontextile.com/.

A breakdown by sector shows that certification among Pakistani companies is concentrated in regulated and export-oriented sectors but is rare or absent in polluting sectors. According to a survey conducted in 2019 by the ISO, Pakistan has 579 valid EMS certificates, among which 56 were granted for textiles or textile products companies (ISO, 2019). The pressure exerted by international brands has been an essential driver for Pakistani companies to pursue EMS certification. Indeed, exports play a significant role in EMS certification awareness in green supply chain management (Ortolano et al., 2014). Ikram et al. (2019), based on data from 211 Pakistani manufacturing companies, concluded that an EMS adoption contributes to improving the company's environmental performance and, consequently, long-term corporate sustainability (Ikram et al., 2019).

iii. Business associations / sectoral institutions initiatives

The textile sector in Pakistan has industry-specific actors (Frederick and Daly, 2019). At the government level, the most prominent is the Ministry of Textile Industry (MTI), a government agency charged with formulating the National Textile Policy and coordinating programmes and strategies for the entire sector (Frederick and Daly, 2019). The MTI has the support of local industry associations that provide the foundation for each stage of the value chain, for instance, the Pakistan Readymade Garment Manufacturer & Exporter Association (PRGMEA), the All Pakistan Textile Mill Association (APTMA) and the Pakistan Textile Exporters Association (PTEA), among others (see Table 20).

Among these local industry associations, APTPMA and the private sector have embraced cleaner production since 1994, under different public-private partnership arrangements and supported by the Netherlands Embassy (Khan, 2016). This initiative created two centres, the Cleaner Production Institute (CPI) and the National Cleaner Production

Table 20. Industrial associations in Pakistan

Name	Type	Established	Description
All Pakistan Textile Mills Association (APTMA)	Industry Association	1957	Largest trade association, representing textile spinning, weaving, and composite mill
All Pakistan Textile Processing Mills Association (APTPMA)	Industry Association	1990	Processing of textile products in dyeing, bleaching and printing. 372 members
Karachi Cotton Association (KCA)	Industry Association	1933	Cotton association for the whole of Pakistan
Ministry of Textile Industry (MIT)	Government Agency	1973	Formulates programs and strategies to bolster the competitiveness of the textile sector
Pakistan Cotton Ginners Association	Industry Association	1958	The industry association for cotton ginners, representing more than 1,200 members
Pakistan Hosiery Manufacturers Association (PHMA)	Industry Association	1960	Represents the hosiery and knitwear industry
Pakistan Readymade Garments, Manufacturers & Exporters Association (PRGMEA)	Industry Association	1981	Assists manufacturers and exporters to promote trade environment
Pakistan Textile Exporters Association (PTEA)	Industry Association	1985	Advocates for textile exporters and communicates with government

Source: Frederick and Daly (2019).

Centre Foundation (NCPC) in Pakistan (Khan, 2016; Ortolano et al., 2014). Both centres provide assessments, environmental and energy audits, and technical assistance in adopting cleaner production measures[144] (Ortolano et al., 2014). There are also two local programmes (Khan, 2016; Ortolano et al., 2014):

- Cleaner Technology Programme for Textile (CTP-Textile) aims to make textile companies environmentally friendly focused on capacity building to comply with international environmental standards. Some CTP-Textile actions included assisting in implementing EMS, designing plants, supervising construction, and commissioning wastewater treatment plants.
- The programme for Industrial Sustainable Development[145] (PISD) aims to enable Pakistan's major industrial sectors and industrial parks to comply with national and international environmental requirements, adopt best energy efficiency practices, and industrial parks to implement a sustainability framework for achieving the SDGs. PISD established demonstration projects in resource conservation, cleaner technologies, energy efficiency, EMS certification, CRS, and wastewater treatment plants. Among its partners are CPI, EKN, APTPMA, Punjab Industrial Estates Development & Management Company, and Korangi Association of Trade and Industry (Ullah, 2013). Table 21 show the results of PISD Phase I, which received an investment of US$ 1.4 million[146].

One hundred fifty textile companies[147] enrolled in PISD´s Phase I, and savings surpassed investments by almost threefold (Rafiq, 2011). Phase II suggested a sustainability framework for industrial parks development, considering local conditions and best international practices. Cleaner production measures incentivised local industries to achieve partial compliance with NEQS and get a direct financial return[148].

Table 21. Sector contribution under PISD Phase I

Textile Companies	Savings
Gas consumption	78 per cent
Electricity consumption	9.6 per cent
CO_2 emissions	40 per cent
Water consumption	3.5 per cent
Operational cost	US$ 3.6 million

Source: Based on data from Rafiq (2011)

CPI and NCPC have undertaken many efforts to launch and diffuse cleaner production measures in Pakistan (Ortolano et al., 2014). However, external and internal barriers still exist, such as limited access to funding, weak environmental regulations and enforcement, lack of cleaner production experts covering management and technical staff, and government incentives for cleaner production measures (Khan, 2016). To overcome the high capital costs associated with investments in cleaner technologies, Khan (2016) suggested developing local technologies instead of importing (Khan, 2016).

In turn, Ortolano et al. (2014) conducted a survey that evaluated the adoption of cleaner production measures on the Pakistani textile and leather sectors and compliance with the NEQS and EMS certification. Among the interviewed enterprises, over 90 per cent indicated economic benefits due to the adoption of cleaner production measures, notably, decreased energy, water, and material use (Ortolano et al., 2014). Considering SME enterprises, owners and managers were not aware of the potential of cleaner production measures to improve product quality and competitiveness. SMEs usually face no pressure to meet environmental regulations. Many of them were unaware of NEQS existence and had never contacted Pak-EPA.

In contrast, large companies understood the links between cleaner production, NEQS, EMS certification, and potential product quality and

144 According to data provided by the local consultant on Annex 2, in Pakistan, the idea of CP has got companies attention as it is a cost-efficient way of meeting environmental and legislative requirements.

145 The PISD has two phases: Phase I (2007-2010) and Phase II (2010-2013).

146 Total investment was PKR 117 million. Lowest exchange rate in 2010 for 1 PKR: 0.0116 US$, Highest exchange rate in 2010: 0.012 US$, Average exchange rate in 2010: 0.0117 US$.

147 Source: http://www.pisd.org.pk/PISD_IIPresentation.aspx. PISD I: Case studies.

148 According to data provided by the local consultant on Annex 2.

competitiveness improvements. Indeed, the adoption of cleaner production, EMS certification and regulatory compliance are standard requirements of international buyers. Increased demand for the green supply chain is putting pressure on Pakistani companies. Even though some companies do not export directly, they are part of the local export supply chain.

Based on audits conducted, Naqvi et al. (2020) analysed the effectiveness of cleaner production measures for minimizing water consumption, energy conservation, and wastewater pollution reduction in 21 textile processing units in Lahore (Naqvi et al., 2020). The study identified weak areas and suggested the most feasible cleaner production best techniques. Results revealed that 67 per cent of companies achieved a 10-30 per cent reduction in wastewater pollution, all achieved less than 4 per cent reduction in water consumption and an 80 per cent increase in energy efficiency. The success of cleaner production initiatives in Pakistan has attracted the government, NGOs, and international development agencies to take similar steps to facilitate and promote cleaner production measures[149].

iv. International initiatives

The Global Trade Supplier Finance (GTSF) Programme is an initiative conducted by the IFC, providing short-term financing to SME suppliers selling at the local or international markets. One example is the partnership between IFC and Levi Strauss & Co., which developed a monitoring system for rating its suppliers' environmental and social performance since 2014. Better environmental and social practices equal lower risks, which equal lower interest rates. Under this partnership, suppliers were able to improve their environmental and social standards. US Apparel and Textiles is located in Lahore, supplying denim to Levi Strauss & Co., employing more than 15,000 people and producing over 28 million metres of fabric and 22 million garments annually (IFC, 2018). The company joined the GTSF programme in 2015. Significant achievements include improving safety, restructuring the compliance department, adopting health and safety training programmes, installing a water treatment plant, water savings, water recycling, and energy conservation. Management was able to understand that both sustainability and profitability are essential and can walk together. This leap in sustainability performance resulted in a 10 per cent annual reduction in the cost of working capital, environmental standards and, worker wellbeing improvement (IFC, 2018).

In 2016, a study conducted by the National Productivity Organization (NPO), the CPI and the IFC interviewed 61 textile spinning mills and 58 textile processing companies. Water pollution and the dependency on groundwater are significant concerns among those companies, as only 1 per cent of wastewater receives treatment before discharge, and 90 per cent of the water consumed comes from onsite groundwater pumping. The study suggested different opportunities to implement cleaner production measures to improve maintenance, process operation, and infrastructure. Constraints and barriers that limit the implementation of these measures include the lack of awareness among top management and staff about cleaner production opportunities, a complete legal framework, incentives for environmental considerations, capital access to invest in more efficient technologies, lack of skills among employees, local cleaner production technology availability, and service providers. The conclusions were that investments in more efficient energy and water technologies could reduce consumption and costs (NPO and CPI, 2016).

A more recent study from 2019 appointed opportunities to reduce the environmental footprint while improving competitiveness for Punjab companies, the second largest and the most industrialised province in Pakistan[150] (The World Bank, 2019d). Punjab companies contribute significantly to resources consumption and pollution. As many manufacturing units are located within residential areas, pollution impacts community health. Suggested measures went through firm-level investments in RECP and investments in industrial symbiosis, eco-industrial

149 According to data provided by the local consultant on Annex 2.

150 Punjab is particularly affected by pollution. Punjab province represented in 2015/16, nearly 60 per cent of Pakistan national industrial value added (The World Bank, 2019d).

parks[151] (EIP) and circular economy development in industrial parks. So far, industries focus has been on reactive end-of-pipe approaches. Preventive approaches and sustainability leverage are still underexploited. Despite the potential to implement RECP in the country, many initiatives have not passed the pilot stage (Khan, 2016; The World Bank, 2019c). The World Bank (2019c) attributed this to the lack of incentives, awareness about available technologies, technical capacity to implement them, access to finance, access to clean technology services and equipment (The World Bank, 2019c).

As Bangladesh, Pakistan is part of the Partnership for Sustainable Textiles, launched in 2014 by the German government. Another initiative is the Green Button, a German certification label for produced textiles in Pakistan that became available in 2019 (BMZ, 2019).

In 2021, BMZ and the Pakistani government launched the project "*Improvement of labour, social and environmental standards in the Pakistan textile industry*"[152]. The project has three main objectives: (i) cooperation improvement between government and private sector to promote sustainability in the production process; (ii) strengthening the capacity of responsible state actors for monitoring compliance with labour and environmental legislation and (iii) the development of tools for improving resource efficiency and chemical management training to increase sustainable production.

c. Exploring the potential environmental impacts of a relevant exported product

Figure 24 presents the normalised relative contribution of the impact categories included in the IO-LCA to the overall impact of the textile sector in Pakistan. Similar to what occurs in Bangladesh, terrestrial and marine ecotoxicities are the primary impact categories at the plant level (i.e., gate-to-gate system boundary), and water consumption presents the highest contribution at the supply chain level (i.e., cradle-to-gate system boundary), followed by land use and freshwater eutrophication.

The most exported products for the textile sector in Pakistan are woven cotton products (e.g., toilet linen, kitchen linen, bed linen, table linen, wadding, sacks, and bags for packaging). They correspond to more than 30 per cent of exports in the sector[153]. Hence, the process-based LCA replicates previous analysis to assess the potential environmental impacts of woven cotton products regarding quantity, including upstream processes from the supply chain (e.g., cradle-to-gate system boundary). Inventory modelling used an ecoinvent dataset and literature inventories to help understand the main environmental issues related to its exports and the better-prioritised areas for action. Figure 25 shows the absolute contribution and associated environmental impacts per production stage of woven cotton products manufactured for export.

Figure 25 shows woven cotton production as the stage that primarily contributes to the impact results. It has a significant impact on marine ecotoxicity mainly due to the fertilizer and pesticide use during seed-cotton production and land occupation. Pollution in coastal waters is quickly becoming a noticeable problem in coastal areas of Pakistan. Untreated domestic and industrial sources are the prominent contributor of pollution through direct and indirect wastes discharge and effluents in the adjacent coastal waters. The emissions from fertilizer and pesticide use during seed-cotton production also influence human noncarcinogenic toxicity. Batch dyeing is crucial for marine ecotoxicity and human carcinogenic toxicity

151 An EIP is defined as a community of manufacturing and service businesses located together on a common property. Member businesses seek enhanced environmental, economic, and social performance through collaboration in managing environmental and resource issues. By working together, the community of businesses seeks a collective benefit that is greater than the sum of individual benefits each company would realize by only optimizing its individual performance. This concept was first introduced in the United States of America, in the 90s, looking for a possible way to apply the Industrial Ecology principles to industrial activities and to improve community welfare. Since them, several EIP initiatives are being developed worldwide, in developed and in developing countries (Elabras Veiga, 2007; Erkman and Van Hezik, 2016; Massard G., Jacquat O., 2014). In China, this concept was introduced in the 90s together with the Circular Economy concept, as a possible way to overcome environmental damage and at the same time to improve industrial and community economic and social welfare. China launched a national EIP demonstration program through legislation, invested in capacity building (Chiu and Yong, 2004).

152 See https://www.giz.de/en/worldwide/93600.html/.

153 The reference product flows are considered as the product quantities exported in 2019, according to the ITC (2021.), in 6 digits codes.

Figure 24. Impact results for the textile sector in Pakistan (normalised relative contribution).

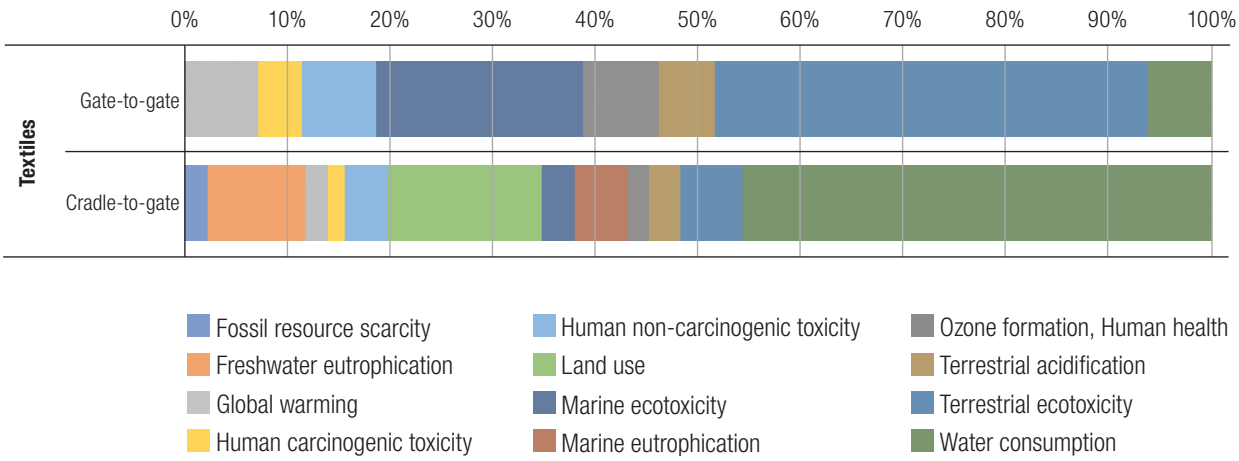
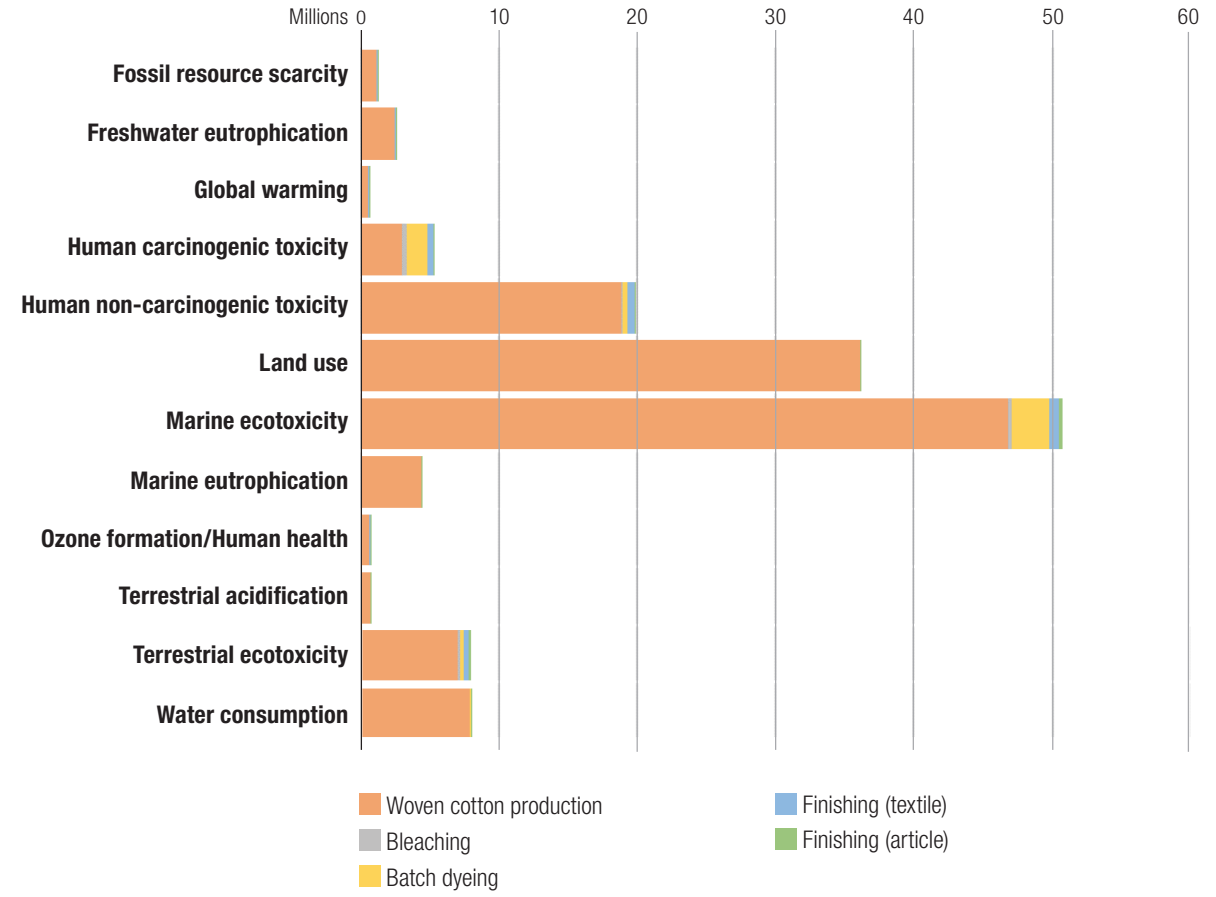


Figure 25. Impact results for exported woven cotton products in Pakistan per production stage (normalised absolute contribution)



due to toxic emissions from wastewater disposal during textile production.

To better understand the impact originating from each stage, especially those at the plant level, Figure 26 shows the normalised relative contribution of woven cotton products per manufacturing stage.

At the plant level, weaving, bleaching, batch dyeing, and finishing are stages that can be predominantly associated with ecotoxicity and human toxicity. These impacts result in local damages to ecosystems and human health. Therefore, improving the performance of manufacturing activities at the plant is pertinent, including sustainable strategies in all the required processes. Table 22 presents the local environmental load per type of impact category left behind for one tonne of exported woven cotton products.

Table 22 shows that for each tonne of woven cotton products exported by Pakistan, 5,579.39 m^3 of water is consumed due to cotton production. Another example is that for each tonne of woven cotton, 7.37 kg 1,4-DCB corresponds to batch dyeing emissions, causing marine ecotoxicity. These toxic emissions, via fate and exposure, affect species and disease incidences in the local environment.

Figure 26. Impact results for exported woven cotton products in Pakistan per production stage (normalised relative contribution)

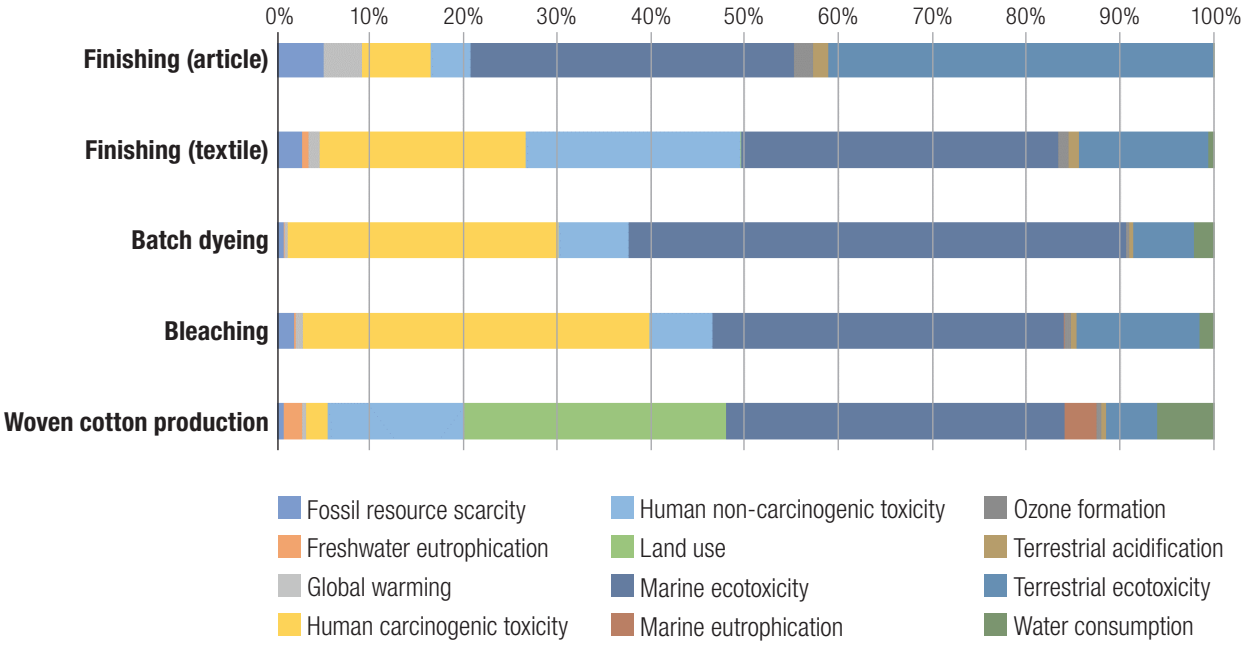


Table 22. Environmental burden per 1 tonne of exported woven cotton products

Impact category	Unit	Total	Woven cotton production	Bleaching	Batch dyeing	Finishing (textile)	Finishing (garments)
Fossil resource scarcity	kg oil $_{eq}$	3,390.31	2,987.81	41.07	118.52	170.03	72.87
Freshwater eutrophication	kg P $_{eq}$	4.37	4.33	0.00	0.01	0.03	0.00
Global warming	kg CO_{2eq}	13,647.51	12,074.87	137.32	383.79	583.67	467.87
Human carcinogenic toxicity	kg 1,4-DCB	39.25	22.41	2.17	10.75	3.63	0.29
Human non-carcinogenic toxicity	kg 1,4-DCB	7,847.49	7,462.07	21.12	150.17	205.16	8.97
Land use	m^2a crop eq	590,982.47	590,913.77	5.72	29.64	30.91	2.43
Marine ecotoxicity	kg 1,4-DCB	138.83	128.03	0.82	7.37	2.09	0.51
Marine eutrophication	kg N $_{eq}$	54.07	54.06	0.00	0.00	0.00	0.00
Ozone formation	kg $NO_{X\,eq}$	38.10	34.91	0.31	0.95	1.35	0.58
Terrestrial acidification	kg $SO_{2\,eq}$	83.14	76.66	0.55	2.13	2.82	0.99
Terrestrial ecotoxicity	kg 1,4-DCB	22,087.12	19,424.98	288.46	909.13	855.23	609.32
Water consumption	m^3	5,676.13	5,579.39	8.73	76.93	10.46	0.61

Source: Based on data from process-based LCA.

SECTION III. KEY CONSIDERATIONS AND RECOMMENDATIONS FOR SMEP TARGET COUNTRIES

Trade and consumer demand have driven growth in the manufacturing industries of SMEP target countries. While environmental and health burdens can be associated with this growth, sustainable production and trade practices are not fully adopted in developing countries. In this sense, building productive capacities is a crucial strategy to help foster the necessary structural transformation while promoting inclusive growth and achieve sustainable development in SMEP target countries. Both public institutions, NGOs and private sector are the centrepiece of this structural transformation and greatly influence the achievement of this goal.

Besides accounting for the economic aspects, companies must consider their environmental and social performance in planning and coordinating sustainable business practices in their decision-making process. Integrating environmental thinking into business daily practices is challenging for companies.

The case study analysis provides recommendations for SMEP target countries based on experiences from Kenya, the United Republic of Tanzania, Bangladesh, and Pakistan. The goal is to boost the transition to more sustainable manufacturing in these countries. Even though at different stages, the four countries are building diversified economies throughout industrialisation, focusing on export-led economic growth. Businesses, particularly export-oriented large companies, move towards sustainability to comply with the law and international market requirements. Hence, companies are implementing environmental management initiatives and tools, pursuing certifications, complying with labour standards. These companies rely on local MSMEs and are pressuring them to adopt sustainability measures in the supply chain.

A. Environmental law and public governance

The analysis shows that most RTAs and BTAs have environmental provisions valid for pollution control through a general exception to trade rules, cooperation in the environment, or the interplay with other legal tools, including MEAs.

The case study countries are in different stages of Environmental Law and Public Governance. Albeit in different levels of legal development, all four case study countries have legal and policy frameworks to control and reduce pollution within economic and related trade activities. However, implementation and effectiveness are the main gaps concerning Law and Governance. These four countries face institutional capacities and financial resources limits that compromise policy implementation and effectiveness. For example, in Kenya, the legal framework ensures information disclosure and public participation. However, information about the BTAs is not available. In Bangladesh and Pakistan, social movements and NGOs played essential roles in leading judicial cases, evidencing the relevance of public participation when institutional capacities are limited.

1. Recommendations for law and public environmental governance in SMEP target countries

Design of future RTAs and BTAs: countries shall consider at least the general exceptions of the international trade regime and the interplay with the ratified MEAs. Provisions that create legal bridges with national environmental law and technical cooperation in the environment sector are welcomed. The most comprehensive analysed BTA is the EPA Kenya-United Kingdom of Great Britain and Northern Ireland, which has specific provisions to control pollution. To recognise the trade-environment nexus in the legal text expressly may call the stakeholders attention to the problem, enhancing their perception of the necessary action.

Public Environmental Governance principles for RTAs and BTAs: policy coherence and coordination, interplay, transparency, accountability are governance principles that countries shall consider in the negotiation and implementation of RTAs and BTAs. For example, RTAs and BTAs should promote interactions amongst the Ministries of Environment and other local environmental agencies responsible for pollution control before and during the negotiations, such as the EPA Kenya-United Kingdom of Great Britain and Northern Ireland.

Environmental information disclosure, especially regarding the BTAs: clear information is essential for environmental rights. Information about the implementation of the agreements should

be collected and available online in a database. Bangladesh and Pakistan are good examples, and they disclose information about their BTAs in contrast with Kenya and the United Republic of Tanzania.

Strengthening institutional capacities for law enforcement: all case studies show the need to strengthen institutional capacities and enhance local infrastructure and financial resources for environmental regulation enforcement. International assistance and cooperation shall be promoted, including through RTAS and BTAs. Environmental economic instruments shall be encouraged. They may offer new income sources to finance improvements in local infrastructure and increase institutional capacities. Kenya and Pakistan, for instance, have provisions about the economic instruments in their environmental policies. However, they are underused.

Developing governance mechanisms to tackle informal activities: as SEI-York's previous report concludes, informality plays an essential role in manufacturing pollution. Research is needed to develop methodologies and mechanisms to assist stakeholders in tackling informal activities, including informality's illegal and criminal dimensions.

Focus on social sciences and categories, such as culture, politics, power, poverty, gender: SEI-York report highlights the importance of social sciences research to improve human behaviour on the trade-environment nexus. In addition, there is a need to understand social and political dynamics in SMEP target countries. Social and Human Sciences research is essential to understand how categories such as symbolic meanings, power asymmetries, class, race, and gender may influence the effectiveness of pollution control measures. They are relevant to understand the cultural roots and pathways of human behaviour in transitions for sustainability.

Public participation and strengthening of social movements and NGOs: are crucial for pollution control and legal and policy effectiveness. Public participation is present and, to some extent, implemented in Kenya and South Asia countries legislation. They have positive examples of public interest litigation by NGOs in implementing environmental legal and policy frameworks. United Republic of Tanzania context for the third sector is challenging, making international cooperation more critical to tackle this challenge.

To raise awareness for the trade-environment nexus: complex problems require complex thinking. Therefore, interdisciplinary education is relevant for shifting the way people look at the trade-environment nexus. Academia and Education sectors have essential roles, especially regarding technology transfer relater to cleaner production measures.

B. Private sector governance

International companies embrace the idea that sustainable manufacturing is a path with no return, going beyond legal compliance, command and control initiatives, and end of pipe solutions. Moving to pollution prevention and making the difference, seeing environmental management initiatives and tools as a business strategy is crucial for creating and sustaining a competitive advantage based on circularity principles. It is no longer simply incorporating sustainability into business activities but conceiving and planning its future, considering a broad set of factors related to sustainability.

1. Recommendations for private sector governance in SMEP target countries

Green manufacturing guidelines: Green manufacturing guidelines must be accessible for the different manufacturing sectors and companies. They must consider the local environmental regulations, manufacturing sector specificities, international treaties, environmental and labour standards, cleaner production measures, and local technologies.

Eco-industrial parks (EIP): none of the four case studies has EIPs. SMEP target countries can benefit from the EIP concept, especially in converting existing industrial districts, export producing zones or special economic zones, thus with existing industries fully in operation (i.e., brownfields sites), or they can be planned entirely from scratch in greenfield sites (Elabras Veiga and Magrini, 2009; Magrini and Elabras-Veiga, 2018). In this sense, following China example, which has more than 100 EIPs in place, SMEP target countries should invest in capacity building and regulation fostering EIP development.

Industrial symbiosis: this is a concept critical to circular economy transition. The National Industrial Symbiosis Programme (NISP) is the world ongoing major industrial symbiosis programme and gaining

momentum in other countries[154]. For example, industrial symbiosis is at its earlier stages but happening in the United Republic of Tanzania. The SMEP target countries shall invest in capacity building, regulation, policies fostering industrial symbiosis and EIP implementation.

Environmental Management System (EMS) certification: case studies show that EMS certification is being pursued in the four countries, however, with different degrees of success. The literature points out the lack of knowledge and implementation costs as barriers to certification. Besides being costly, various SMEs consider environmental protection a burden in the SMEP target countries, have low environmental awareness, and do not know about it. China presents the same problems. Hence, two Chinese EIPs support financially and technically local SMEs to obtain EMS certification and adopt cleaner production measures[155]. More than 400 companies passed the EMS certification (Erkman and Van Hezik, 2016). SMEP target countries could use large local companies, in partnership with business associations, to contribute with technical and financial support to help SMEs obtaining certification and implement cleaner production measures[156].

Resource Efficient and Cleaner Production (RECP) measures: these practices are being promoted in the four case study countries since the 90s. Companies can access and understand simple practices and measures, such as housekeeping and change to inputs, resulting in significant economic, environmental, and environmental changes social gains. However, the manufacturing sectors perceive the lack of knowledge and implementing costs of RECP strategies as barriers to their application. Tackling these barriers requires investments in capacity-building courses and cleaner production guidelines for the different manufacturing sectors.

Circular Economy[157]: out of the four case studies, only Bangladesh has a circular economy pilot project active, and Kenya has been fostering the implementation of the circular economy concept more prominently. As a result, these two countries present higher pollution reductions for their relevant exported product (see Figure 16 and Figure 23) amongst case studies.

Circular economy goes along with other environmental management instruments, such as RECP measures, eco-efficiency, reverse logistics, ecodesign[158], LCA, EIP, and Industrial symbiosis. Thus, it contributes not only to pollution reduction effectiveness but also to achieve the SDGs. In this sense, a key recommendation is to create training courses on circular economy and identify opportunities for circularity across selected manufacturing sectors.

Adopting circularity can reduce the pressure exerted by manufacturing on the environment by lowering extraction and use of raw material, water and energy, minimization of waste, effluent, and air emissions generation. Circularity can also foster the better social performance of manufacturing businesses through job creation, community development, community welfare enhancement, improvements in human health (i.e., less pollution), labour conditions improvements, accidents reduction. Adopting sustainable manufacturing practices increases brand and reputation value, product quality, productivity, revenues, and market share. Finally, adopting

154 NISP was a private sector initiative, started in 2005, in the United Kingdom of Great Britain and Northern Ireland. As a result of its success, went national and currently in being adopted by many countries.

155 The two Chinese EIPs are the Tianjin Economic-Technological Development Area (TEDA) and the Dalian Development Area (DDA).

156 To obtain certification, the company must comply with all environmental regulation and systematically pursue a continual improvement of processes within the EMS, undergoing environmental audits.

157 Circular Economy is based on the principles of designing out waste and pollution, keeping products and materials in use, circulating in the economy, and regenerating natural systems. CE concept was first introduced in 1989 in the book "Economics of Natural Resources and the Environment" (Pearce and Turner, 1989). More recently, in 2010 the Ellen Mac Arthur Foundation revived it by publishing several guides and manuals.

158 The European Union ended on June 21st, 2021 a public consultation on a legislative proposal, on the Sustainable Products legislative Initiative (SPI) responding to the objectives of the Green Deal (EU, COM (2019) 640 final) and the Circular Economy Action Plan (CEAP, COM (2020) 98 final). SPI aims to make products fit for a climate neutral, resource efficient and circular economy, reduce waste and ensure that the performance of frontrunners in sustainability progressively becomes the norm. For more information see https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12567-Sustainable-products-initiative/public-consultation_en.

circular economy guidelines can increase legislation compliance, stimulating sustainable innovation and increasing environmental awareness.

In short, these benefits are incentives for companies and for local governments moving towards sustainability. The adoption of these initiatives, however, is not easy. Its success relies on integration and cooperation by the public and private sectors through more cooperative environmental management for sustainable development.

C. Life Cycle Assessment

The LCA approaches performed in this study enabled identifying the most relevant export-oriented manufacturing sectors regarding environmental and health impacts for the SMEP target countries, particularly for the four case study countries (i.e., Kenya, United Republic of Tanzania, Bangladesh, and Pakistan).

1. Key considerations

IO-LCA inventory model: it is essential to create or update IO-LCA databases for the SMEP target countries since EXIOBASE present them aggregated as "RoW"[159]. Updated databases would benefit researchers, policymakers, and standard-setting organizations. Apart from the broad geographical representativeness, the base year for the EXIOBASE version is 2011. Hence, updating the database can improve local data quality. Nonetheless, using a single database provides consistency to the results. The completeness of EXIOBASE is a common characteristic of input-output databases, which strengths the outcomes.

Export data: the quality of the inventory model could be improved if there were more complete data available for the analysed sectors. Creating a local database for SMEP target countries is pivotal to increasing the understanding of trade-environment governance. One limiting factor for the LCA was that not all data available in monetary units were also available in physical units or part of the data on export quantities was not available in mass units, which prevented its use in the IO-LCA modelling.

Process-based LCA: future development of regionalized datasets could be helpful, as the lack of them, especially for Kenya and the United Republic of Tanzania, caused adaptations during the inventory modelling. These adaptations make these adjusted inventories and their associated results more distant from reality and subject to more significant uncertainty. Despite providing more breadth than depth, the results of process-based LCA in the four case studies make available a blueprint of environmental impacts related to exported goods. These blueprints contain enough information to allow local governments to define target sectors or regions for implementing pollution prevention strategies (e.g., RCPE measures).

To access the SMEP Trade and Pollution Dashboard use this QRcode or this link:
http://bit.ly/SMEP_UNCTAD/.

159 RoW stands for "rest of the world". This aggregation can cause potentially significant differences in environmental and socioeconomic impact calculations.

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