

How Industry 4.0 can boost Cambodia's economy after COVID-19: Opportunities for industrial upgrading and equitable development



About this report

A report prepared by Policy Links, IfM Engage, for the United Nations Development Programme (UNDP) Cambodia.

The views expressed here do not imply the expression of any opinion on the part of UNDP. Designations such as 'developed', 'industrialized' and 'developing' are intended for statistical convenience and do not necessarily express a judgement about the stage reached by a particular country or area in the development process. Any mention of firm names or commercial products does not constitute an endorsement by the authors or UNDP.

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Executive summary

Cambodia faces a dual challenge: swiftly navigating the disruptions caused by COVID-19, while enabling a resilient, sustainable and inclusive industrialization. In both cases, technology, and in particular Industry 4.0 technologies, can play an important role.

The COVID-19 pandemic has acted as a driver of industrial digitalization around the world, and Cambodia is no exception. Estimates based on firm surveys indicate that globally, in response to the challenges imposed by the pandemic, firms have accelerated the use of digital technologies in customer interactions by three years and sped up the rate at which they develop digital products and services by seven years.¹

The adoption of Industry 4.0 technologies can contribute to increasing firms' productivity, improving product quality, reducing waste and improving supply chain integration, as the firms consulted for this project recognize. When these technology-enabled improvements are permeated to most firms and sectors, Industry 4.0 adoption leads to increased national productivity and competitiveness.

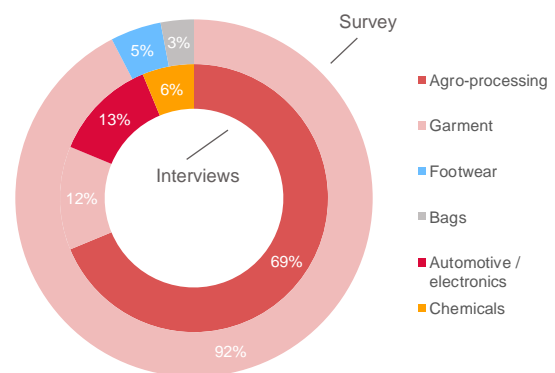
As COVID-19 has made apparent, technological change is happening—whether countries have a strategy or not. In a context of increasing global competition, the lack of strategic responses can therefore lead to the erosion of national competitiveness.

This is the second of a three-report series aimed at informing strategies and policies to support the adaptation and adoption of Industry 4.0 technologies in Cambodia. The focus of this report is on providing sectoral evidence on the opportunities and challenges of Industry 4.0 adaptation and adoption. It covers established manufacturing sectors, such as garment, textile, footwear and agro-processing; and more sophisticated industries emerging in the country, such as bicycles, electronics and automotive.

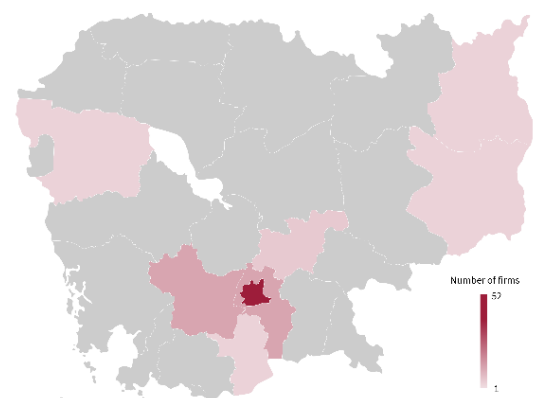
The study draws mainly upon primary data sources, including: key informant interviews, firm interviews and a firm survey conducted among 66 garment and footwear firms.

Profile of firms consulted (Includes survey and interviews)

- 82 manufacturing firms
- 6 manufacturing sub-sectors
- 17% domestic and 83% foreign firms
- 8 provinces/municipality



By manufacturing sub-sector



By region

¹ McKinsey & Company (2020). *How COVID-19 has pushed companies over the technology tipping point and transformed business forever.*

Impacts of COVID-19 on Cambodia's manufacturing sector

Cambodia's economy is estimated to have contracted by 3.1 percent in 2020, with garment and tourism being the hardest-hit sectors.² In comparison, more capital-intensive emerging industries, such as bicycles and electronics, have shown a faster recovery and stronger performance during the COVID-19 pandemic.

Impacts of COVID-19 in Cambodia's manufacturing sector

Four main impacts have been identified among the sectors examined:

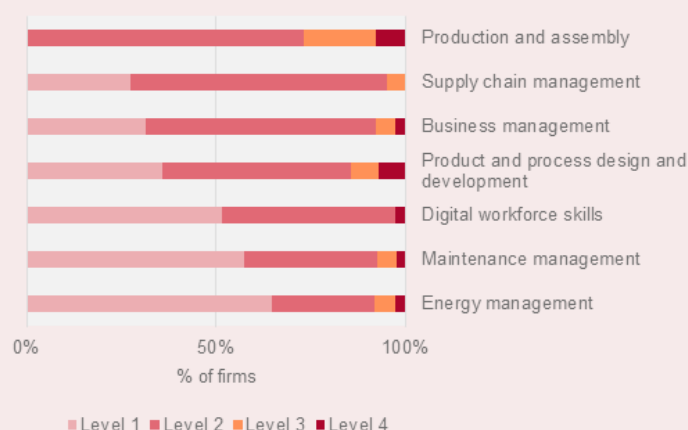
- **Supply disruptions.** In the garment sector these involved shortages of inputs and materials, such as fabric coming from China. In the agro-processing sector supply disruptions reported included food product inputs and packaging, particularly from neighbouring countries. Firms also reported difficulties accessing technical support.
- **Demand shocks.** Falls in the global demand for garments with negative impacts also seen in prices and payment terms. Mixed impacts on the agro-processing sector, with snack producers experiencing positive impacts on both sales and employment.
- **Delays in investment plans.** Firms across all of the industries examined reported delays in plans involving factory expansions and new project investments.
- **Loss of workers' livelihoods.** As a result of the affectations faced by firms, workers have been laid off, and some of those who managed to sustain their jobs have suffered reductions in their income and the number of working hours. Firms also reported issues related to restrictions in the movement of workers located abroad.

Industry 4.0 readiness and awareness

Firms operating in Cambodia are already adopting Industry 4.0 technologies. However, this is particularly true for larger firms. Insights from this study indicate that less than 10 percent of the firms operating in Cambodia are advanced adopters of digital technologies.

Higher levels of technology are reported in production and assembly activities, supply chain management, business management, and the design and development of products and processes. Specific garment production processes, where a degree of automation has been achieved, include: metal scanning, fabric spreading, heat embroidery print, fabric relaxation and fabric cutting.

Level of technology use by business function



Note: Level 1 – processes executed mainly manually; Level 2 – processes conducted with the assistance of digital tools; Level 3 – a degree of automation; Level 4 – processes fully automated.

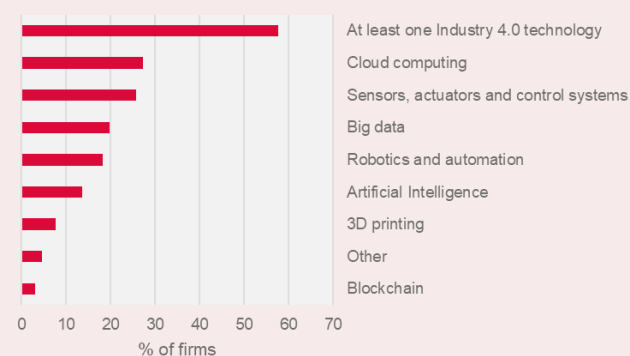
Source: UNDP Cambodia firm survey (2020). Number of observations = 66.

² ADB (2021). *Cambodia's Economy to Recover in 2021, Accelerate in 2022* — ADB.

In the agro-processing sector, applications of Industry 4.0 technologies include: the monitoring of production lines and crops; e-learning; and, because of the COVID-19 pandemic, access to remote expertise. In emerging industries, applications are mainly focused on the semi-automation of production processes and the collection and analysis of business data.

Although the adoption of Industry 4.0 technologies may not be extended across all business functions, over half of the firms surveyed are already using at least one type of Industry 4.0 technology. The top three technologies most commonly used are: cloud computing; sensors, actuators and control systems; and big data.

Industry 4.0 technologies used by firms



Source: UNDP Cambodia firm survey (2020). Number of observations = 66.

The challenges for Industry 4.0 adoption

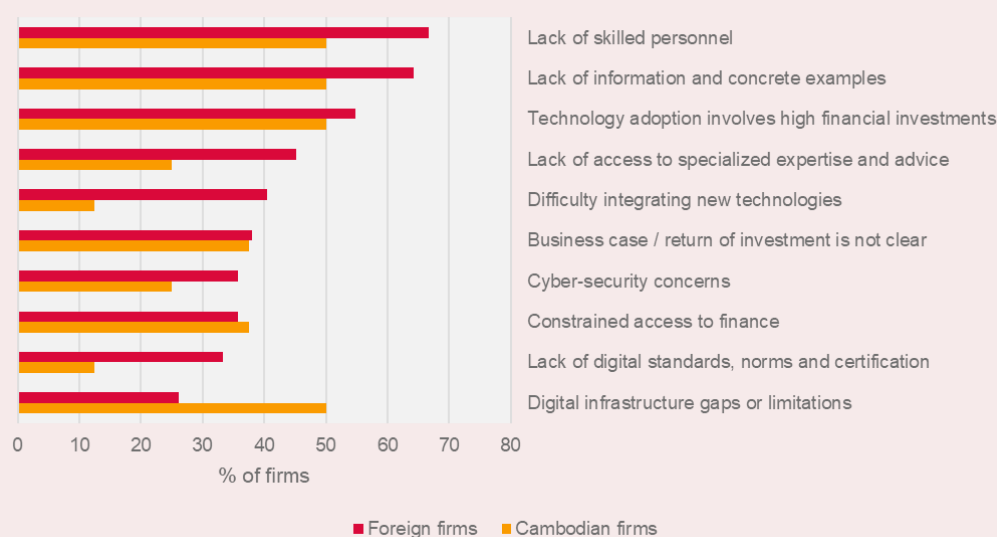
Despite the availability of Industry 4.0 technologies, barriers at firm and system level prevent firms from adopting them.

While many firms are already using Industry 4.0 technologies in Cambodia, there is significant scope to increase awareness of these technologies and their potential benefits, particularly among smaller, local and agro-processing firms, which are the

firms with lower rates of awareness and adoption.

Key barriers to the adoption of Industry 4.0 technologies identified by firms operating in Cambodia include: shortages of a skilled workforce; a lack of concrete examples of how digital technologies can benefit companies; high financial requirements; and a lack of access to specialized expertise and advice.

Top 10 barriers preventing firms from adopting Industry 4.0 technologies in Cambodia



Source: UNDP Cambodia firm survey (2020). Number of observations = 50.

Key sector-specific challenges

Key sector-specific challenges identified in this study include:

- **Garment.** Shortages of skilled labour for management, supervisory and technical positions; increasing regional competition; and increasingly stringent quality and sustainability requirements from global buyers.
- **Agro-processing.** High turnover rate of workers; high maintenance costs of digital technologies; dependence on imported inputs; limited availability of food safety, sanitary and phytosanitary support services; underused production capacity; and limited market information services.
- **Emerging industries.** Dependence on foreign expertise; limited backwards and forwards linkages; and the need to improve capabilities for remote supply chain management.

The opportunities for Cambodia

Digital technologies that are commonly grouped under the umbrella of Industry 4.0 are becoming cheaper, more widely available and easier to use. This means that even companies with limited resources and technological expertise have the potential to benefit from them.



GARMENT SECTOR

Cambodia has positioned itself as one of the main exporters of garment, textile and footwear (GTF) goods in the world. However, increasing quality, social and sustainability compliance demands from global buyers highlight the need to explore new drivers of competitiveness beyond low labour costs.

Stakeholder consultations suggest that specific opportunities for Cambodia exist to develop the accessories' supply chain and improve the sustainability of production processes. Addressing these opportunities will require better decision-making systems, improved supply chain management and better-trained workers. Technologies such as radio-frequency identification (RFID) and other advanced sensors, cloud-based supply chain management tools and data analytics, and augmented and virtual reality (AR/VR) can contribute to developing these capabilities.



AGRO- PROCESSING SECTOR

The inter-sectoral interactions involved in the agro-processing value chain, and the immediate opportunities to include local actors in the development of the sector, make it a priority for supporting the post-COVID-19 industrial recovery of Cambodia and for improving people's livelihoods.

Opportunities where Industry 4.0 adoption can contribute to the industrial upgrading and diversification of the agro-processing sector include: the application of RFID and blockchain technologies to improve food traceability; artificial intelligence (AI), sensors and drones and facilitating organic production; and AR/VR applications for training workers. Opportunities also exist to use combinations of these technologies in precision agriculture applications in order to improve overall farming productivity.



EMERGING INDUSTRIES

The future growth of emerging and new industries is important in the pursuit of more resilient industrial development in Cambodia. Emerging industries, such as bicycles and automotive components, have shown a faster recovery and stronger performance during the COVID-19 pandemic. Diversifying the manufacturing sector towards higher value-added activities would also help the country to benefit more from its participation in global value chains.

In emerging industries, opportunities exist to enhance the participation of firms based in Cambodia in regional value chains. This process can be supported through the adoption of supply chain management applications. Moreover, stakeholders highlighted opportunities for these industries to improve the environmental sustainability of production processes through digitally enabled energy and water management systems.

Industry 4.0 and jobs: new skills needed

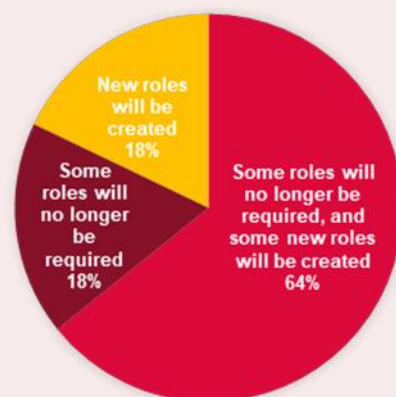
Earlier studies³ have highlighted the potential of Industry 4.0 technologies to create a massive displacement of jobs in the garment sector; however, evidence collected in this project suggests that it is unlikely to happen, at least in the near future.

Nonetheless, the adoption of Industry 4.0 technologies is likely to change the composition of employment. Increases in productivity, as well as the production and trade of new products and services, will create new job opportunities for those who have, or acquire, the relevant skills. In Cambodia 64 percent of the firms surveyed perceive that the adoption of Industry 4.0 technologies will involve the elimination of some roles but also lead to the creation of new ones.

Changes in roles and tasks will require fast and flexible responses from industry actors, but also from government and development partners, in order to avoid deepening the existing social and economic inequalities.

Half of the firms surveyed expressed having a plan to retrain their staff in the next five years, while insights from the interviews indicate that some firms are already retraining their workers as a result of the adoption of new technologies. However, not all companies seem to be responding at the same pace to these changes. Smaller and local companies are lagging behind.

Expected impact of the adoption of Industry 4.0 technologies on roles



Source: UNDP Cambodia firm survey (2020). Number of observations = 56.

³ International Labour Organization (2017). *ASEAN in transformation*.

Policy options for an inclusive and sustainable digital transformation

The creation of the Ministry of Industry, Science, Technology and Innovation (MISTI) and the launch of Cambodia's Digital Economy and Society Policy Framework 2021-2035 evidence the increased interest in technology and innovation in Cambodia, and provide an opportunity to give cohesion to the country's innovation policy landscape.

Although improvements in digital and broader infrastructure have been made in recent years, further and more focalized efforts are needed to ensure that Cambodian firms can participate in the benefits of Industry 4.0 technologies and facilitate the upskilling and reskilling of employees with low and high levels of skills.

Industry 4.0 adoption may also involve risks, and government and development partners can play a key role in implementing mitigation strategies to reduce the potentially negative effects of Industry 4.0 adoption and in ensuring that no one will be left behind in the industrial transformation journey.

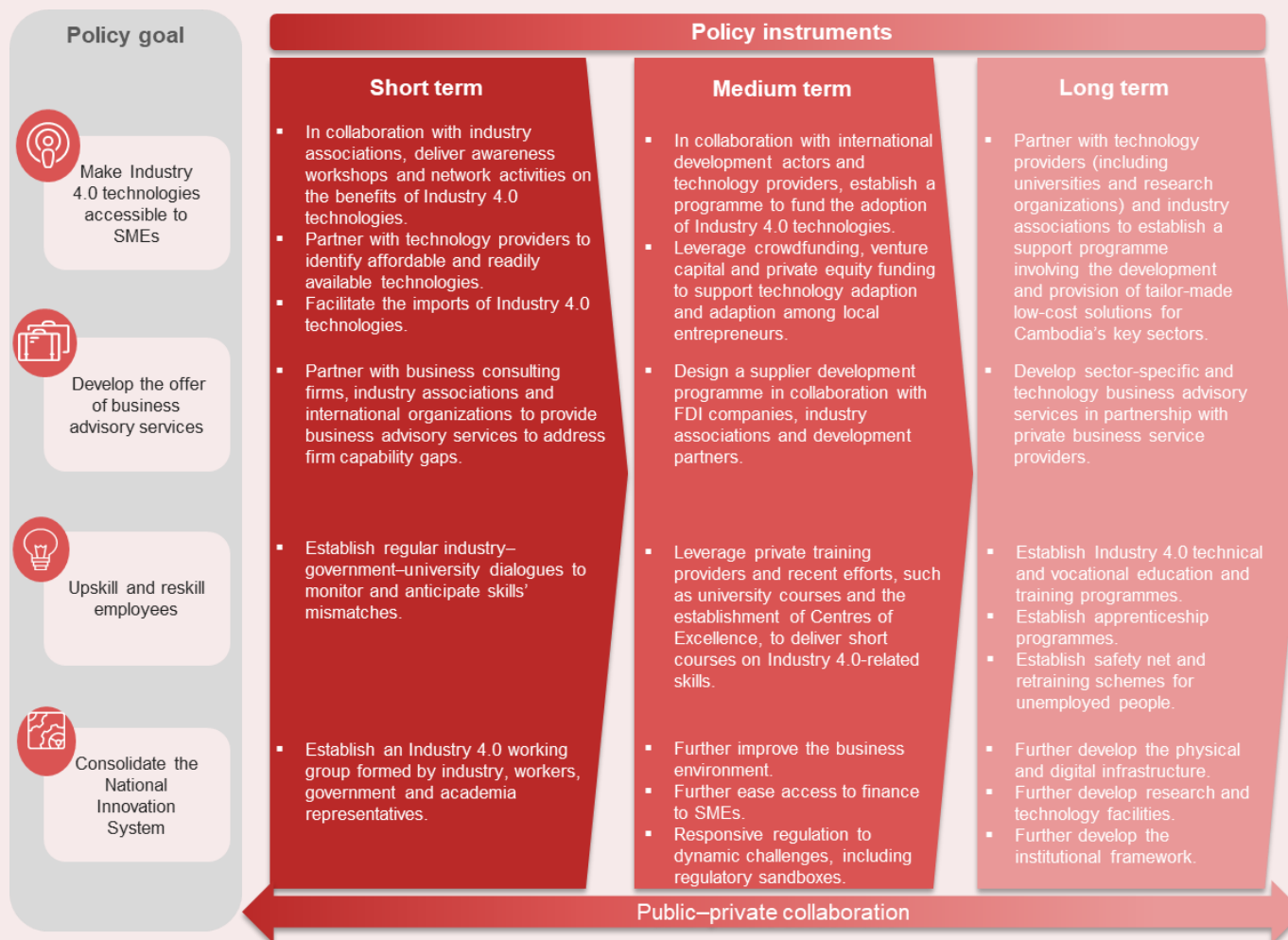
This report identifies four key areas of policy action to support the adaptation and adoption of Industry 4.0 technologies in Cambodia in the short, medium and long terms:

- i. Make Industry 4.0 technologies accessible to SMEs
- ii. Develop the offer of business advisory services
- iii. Upskill and reskill employees
- iv. Further develop the National Innovation System

The role of the private sector. International experience has demonstrated the importance of the active participation of the private sector in the design, delivery and funding of innovation support programmes. Business consulting firms, private training providers, foreign companies and industry associations are key actors in advancing local firms' managerial, production and innovation capabilities. The growing local base of software developers can also play an essential role in adapting and developing tailor-made low-cost Industry 4.0 solutions. In addition, through crowdfunding, venture, and equity capital, the private sector can contribute to funding the development of a local base of entrepreneurs to adapt and develop technology solutions that respond to the specific needs of Cambodian firms.

The next phases of this project will involve the review of international effective practices and the design of implementation roadmaps in collaboration with industry, government, academia and other development actors.

Four key areas of policy action to support the adaptation and adoption of Industry 4.0 technologies in Cambodia



Source: The authors, based on the findings of this report.

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Acronyms and abbreviations

AI	Artificial intelligence
APO	Asia Productivity Organization
AR	Augmented reality
ASEAN	Association of Southeast Asian Nations
CAD	Computer-aided design
CAGR	Compound annual growth rate
CALT	China Academy of Launch Vehicle Technology
CDRI	Cambodia Development Resource Institute
CGTI	Cambodian Garment Training Institute
CMT	Cut, make and trim
CNTAC	Chinese National Textile and Apparel Council
E&E	Electronic and electrical
ERP	Enterprise resource planning
EU	European Union
FDI	Foreign direct investment
GMAC	Garment Manufacturers Association in Cambodia
GTF	Garments, textiles and footwear
ICT	Information and communications technology
IfM	Institute for Manufacturing
JBAC	Japanese Business Association of Cambodia
JETRO	Japan External Trade Organization
MEF	Ministry of Economy and Finance
MISTI	Ministry of Industry, Science, Technology and Innovation
PPE	Personal protective equipment
RFID	Radio-frequency identification
SMEs	Small and medium-sized enterprises
SWOT	Strengths, weaknesses, opportunities and threats
UNDP	United Nations Development Programme
US	United States of America
VR	Virtual reality

Section 1. Introduction

This is the second of a three-report series aimed at informing strategies and policies to support the adaptation and adoption of Industry 4.0 technologies.

The *Scoping Report* provided the conceptual basis for the investigation, discussed the opportunities and challenges of Industry 4.0 for developing countries such as Cambodia, and provided cross-sectoral insights into Cambodia's readiness to adapt and adopt Industry 4.0.⁴ Building on this foundation, this second report provides sector-level evidence on Industry 4.0 readiness and the key constraints faced by businesses in Cambodia.

Over the last couple of decades Cambodia has undergone a significant expansion of its industrial base. Its manufacturing contribution to the economy grew from below 10 percent in the 1990s to over 16 percent in 2018. Garments, textiles, footwear and agro-processing are key sectors driving this expansion. Together, they account for 80 percent of manufacturing value added and 76 percent of the country's exports.⁵

This report examines specific opportunities and challenges in Cambodia for firms operating in these sectors, as well as in other manufacturing activities that are emerging in the country, such as bicycles, electronics and automotive.

The findings presented in this report build on a variety of sources of evidence compiled between May and October 2020 with the support of UNDP Cambodia (Box 1.1). As a result of COVID-19 travel restrictions, consultations were conducted both remotely

and in Cambodia by partners based in the country.

Box 1.1 Sources of evidence

- Interviews with key informants from 10 industry and research organizations;
- Interviews with 16 manufacturing firms from the industries studied;
- A survey⁽ⁱ⁾ conducted in 66 garment and footwear firms, which included questions designed to support this investigation;
- Literature review, including previous studies and industry association surveys;
- National and international statistical databases.

⁽ⁱ⁾ This survey was conducted as part of the UNDP project 'Garment and Footwear Industry Adaptation toward Automation Focusing on Youth Employment and Skills Development'.

The COVID-19 pandemic has accelerated industrial digitalization

Across the world the COVID-19 pandemic has led to profound supply and demand disruptions that are threatening the very survival of many firms and entire industry segments. As of 31 December 2020, the pandemic had cost at least 3 million lives and caused a global economic contraction estimated at 3.3 percent.⁶ Although the global economy is projected to recover and grow by 6 percent in 2021, it is also expected that, by the end of the same year, around 100 million people will have fallen into extreme poverty.⁷

Cambodia's economy is estimated to have contracted by 3.1 percent in 2020, with garment and tourism being the hardest-hit industries. However, the recovery of main trade partners is helping Cambodia to bounce back. According to projections of Cambodia's Ministry of Economy and Finance (MEF), the

⁴ UNDP (2020). *Adaptation and Adoption of Industry 4.0 in Cambodia*.

⁵ World Bank (2019). *World Development Indicators*; UN Comtrade Database.

⁶ IMF (2021). *World Economic Outlook April 2021*. Growth Projections; WHO (2021). *The impact of COVID-19 on global health goals*.

⁷ IMF (2021). *Op. cit.*; World Bank (2021). *The Global Economy: on Track for Strong but Uneven Growth as COVID-19 Still Weighs*.

national economy is expected to grow by 2.4 percent in 2021 and by 4.8 percent in 2022, supported by higher dynamism in both established and emerging industries.⁸ Nonetheless, actual growth rates are still subject to uncertainties. As we move forwards, emerging evidence suggests that digital technologies can play a crucial role in recovery.

Estimates based on firm surveys indicate that globally, in response to the challenges imposed by the pandemic, firms have accelerated the use of digital technologies in customer interactions by three years and sped up the rate at which they develop digital products and services by seven years. These acceleration rates have been even greater in the Asia-Pacific region.⁹

Firms around the world are increasingly experimenting with new digital solutions to better understand their supply chains, identify risks and take mitigating actions. They are also using digital tools to redesign factory layouts in order to make facilities COVID-19 secure. In addition, digital tools are enabling remote access to technical assistance and training, allowing industries to respond to travel and social distancing restrictions.¹⁰

Throughout the pandemic, the adoption of digital technologies such as AI, cloud computing and data analytics has helped companies not only to survive but also to thrive. A study conducted across 20 countries and 22 industries found that high-technology adopters outperformed their peers' revenue by 6 percent, on average.¹¹

Governments around the world are prioritizing industrial digitalization policies

Previous crises have taught us how more innovative firms tend to be more resilient to shocks.¹² As a result, governments around the world have prioritized policy responses to seize the opportunity that the digital transformation offers to citizens, businesses and governments. For example, the Republic of Korea announced a New Deal, which includes a Green New Deal and a Digital New Deal. The latter involves, among other measures: the investment of 13.4 trillion won (~US\$12.1 billion) by 2022 to strengthen the country's data, network and artificial intelligence ecosystem ('DNA') and create 330,000 jobs; investments in digital infrastructure; vouchers to adopt AI solutions for 600 SMEs; and a 1 trillion won (~US\$903 million) fund to invest in AI start-ups.¹³

In Singapore the existing 'Go Digital' programme is being promoted to help businesses embrace digitalization in order to overcome the challenges posed by the COVID-19 pandemic. This programme involves a diverse mix of support for SMEs, including: planning and self-assessment tools; foundational digital tools (Start Digital Pack); technical and project management advisory services; and grants for purchasing digital solutions. Singapore's Infocomm Media and Development Authority (IMDA) is also partnering with industry leaders to train

⁸ Cambodia's Ministry of Economy and Finance (2021). Cambodia's Economic Performance and Outlook 2021-2022. August 2021.

⁹ McKinsey & Company (2020). *How COVID-19 has pushed companies over the technology tipping point and transformed business forever.*

¹⁰ Industrie 4.0 Maturity Center (2020). *Industrie 4.0 & Covid-19. How to deal with digitalization strategies during the crisis?*

¹¹ Across 12 industries where technology acted as a performance differentiator, including: manufacturing

of consumer products, automotive, chemicals, energy and retail. IBM Institute for Business Value (2020). *Digital acceleration.*

¹² Santiago, F., Dachs, B. and Peters, B. (2020). *Foster recovery from COVID-19 through science, technology and innovation.*

¹³ The Republic of Korea Ministry of Economy and Finance (2020). *Korea's Health and Economic Response to Pandemic.*

and place 3,000 Singaporeans in jobs to support a digital recovery.¹⁴

While developed countries are better equipped to take advantage of digital technologies to respond to the challenges imposed by the COVID-19 pandemic, a variety of responses leveraging these technologies have also been deployed in developing countries.

In Thailand the Digital Economy Promotion Agency (DEPA) is providing digital transformation vouchers to help SMEs with the adoption of digital technologies.¹⁵ In India the Council of Scientific and Industrial Research (CSIR) launched *AarogyaPath*, an information management online platform providing real-time data and forecasts of supply and demand of critical medical supplies.¹⁶ In Brazil the National Service of Industrial Training (SENAI) opened up 100,000 places for free online courses in Industry 4.0 technologies.¹⁷

Development partners and international cooperation can also play a key role in supporting developing countries to harness Industry 4.0 technologies for a sustainable and inclusive recovery. A recent initiative launched by the Vietnamese Ministry of Science and Technology and Australia's Aus4Innovation programme for the adoption of artificial intelligence (AI) solutions illustrates this. As part of the Aus4Innovation programme, the Australian government is supporting the development and adoption of AI solutions in Viet Nam to assist economic recovery post-COVID-19. This initiative involves: short-term funding for innovative AI solutions; technical support for the implementation of Viet Nam's future AI

strategy; and training courses for stakeholders in the AI ecosystem.¹⁸

How can Cambodia leverage digital technologies for economic recovery and industrial development?

The Royal Government of Cambodia has recognized the role of digital technologies as drivers of economic diversification and growth in the fourth iteration of the Rectangular Strategy, its national medium-term development strategy. The creation of the Ministry of Industry, Science, Technology and Innovation (MISTI) evidences the increasing relevance of technology and innovation in the national policy agenda.

As discussed in our *Scoping Report* 'Adaptation and Adoption of Industry 4.0 in Cambodia', Industry 4.0 is underpinned by engineering systems that link the 'cyber' world (e.g. software, computational algorithms and wireless communication) with the 'physical' world (e.g. machines and human users).¹⁹

However, Industry 4.0 should not be understood as an 'ideal state' of full automation in which human labour is completely replaced by robotic processes. Industry 4.0 may be better understood as a journey, as a gradual transformation that requires a continuous accumulation of capabilities at firm, sector and national levels. The particular technologies and applications that are 'right' for a firm will depend on its particular position in the journey as much as the particular industry and segment of the value chain in which it operates.

The urgency to support the modernization of industries, particularly in developing countries such as Cambodia, cannot be understated. Technological change is happening—whether countries have a strategy or not. In a

¹⁴ Corsini, L. and Leal-Ayala, D. (2020). *The role of industrial digitalisation in post Covid-19 manufacturing recovery*.

¹⁵ depa (2021). *Recruitment of legal entities to receive promotion and support for digital coupons*.

¹⁶ Policy Links (2020). *Covid-19: International Manufacturing Policy Responses* (Update).

¹⁷ SENAI (2020). *SENAI opens more than 100 thousand free places in distance education courses on Industry 4.0*.

¹⁸ CSIRO (2020). *Australia kicks off new initiative assisting Vietnam to apply Artificial Intelligence in post COVID 19 economic recovery*.

¹⁹ See Section 1 of the *Scoping Report* for detailed discussions on the definition of Industry 4.0.

context of increasing global competition, the lack of strategic responses can therefore lead to the erosion of national competitiveness.

The role of technology in economic development is also well established in the academic and policy literature. As a country climbs the industrial development ladder, productivity gains from low-cost labour tend to decrease, real wages rise and countries need to find new sources of competitiveness.²⁰

However, as discussed in the *Scoping Report*,²¹ some preconditions are needed to seize the benefits of Industry 4.0 technologies. While the gains from the adoption of technologies are believed to be greater for adopters further away from the technological frontier, evidence has also shown that technology adoption is constrained by the lack of production and innovation capabilities and adequate institutions.²²

As new Industry 4.0 technologies and industrial solutions become cheaper, more widely available and easier to use, a key item in the policy agenda is to enable SMEs and

other less technologically sophisticated companies to benefit from Industry 4.0. As such, this second phase of the investigation has gathered evidence on the main barriers and opportunities to the adoption of Industry 4.0 in Cambodia and the policy options needed to address them.

The report is organized as follows:

- **Section 2** provides an awareness and readiness assessment of Industry 4.0 in Cambodia.
- **Section 3** identifies specific opportunities driven by Industry 4.0 in the garment, textile and footwear (GTF) sector.
- **Section 4** identifies opportunities in the agro-processing sector.
- **Section 5** identifies opportunities in emerging industries, including bicycle manufacturing, electronics and automotive.
- **Section 6** discusses policy options for supporting the adaptation and adoption of Industry 4.0 in Cambodia, highlighting the potential role of government, private sector as well as development partners.

²⁰ Cherif, R. and Hasanov, F. (2019). *The return of the policy that shall not be named: Principles of industrial policy*.

²¹ UNDP (2020). *Adaptation and Adoption of Industry 4.0 in Cambodia*.

²² Cirera, X. and Maloney, W. F. (2017). *The innovation paradox: Developing-country capabilities and the unrealized promise of technological catch-up*.

Section 2. Industry 4.0 in Cambodia: awareness and readiness

Key messages of this section

- Over half of the firms surveyed are already using at least one Industry 4.0 technology; however, there is scope to increase awareness of these technologies and their potential benefits, particularly among smaller and local firms.
- A lack of information on how digital technologies can benefit companies, shortages of a skilled workforce, dependency on foreign providers of technical services, and limited physical and digital infrastructure are among the key barriers that firms face when adopting Industry 4.0 technologies.
- The key benefits perceived from the adoption of Industry 4.0 technologies include: labour cost reductions; quality and sustainability improvements; and better supply chain integration and optimization.
- Although Industry 4.0 is perceived to be a labour-saving technology, firms also expect the adoption of these technologies to lead to the creation of new jobs.
- Skills and knowledge that are expected to be in high demand in the next five years include: specialized knowledge about manufacturing activities and processes; cyber-security; basic ICT knowledge; processing and analysing data obtained from machines; and programming and coding.

This section provides an assessment of the current state of Industry 4.0 technology adoption in selected manufacturing industries in Cambodia. It describes how aware firms are of the term 'Industry 4.0', which technologies they are already using, how they are using these technologies, and the barriers preventing firms from adopting them. The section also discusses the main motives for firms to adopt these technologies and their perception of the potential benefits and implications for jobs and skills.

The section draws upon key informant interviews conducted with representatives of 10 different industry and research organizations, 16 firm interviews and a firm survey conducted in 66 garment and footwear firms (Box 2.1).²³ Annex C provides a detailed list of the stakeholders interviewed who agreed to disclose their names.

As a result of COVID-19 travel restrictions, consultations were conducted remotely or by

local partners. Social distancing measures also meant that industry workshops could not be conducted; instead, key informant interviews with industry and firm representatives were conducted.

The firm survey was conducted by a local partner; however, it only covered garment and footwear firms. Efforts have been made to capture cross-sectoral views; however, given the availability of survey data, there is an emphasis on the garment, textile and footwear (GTF) sector in this section.

A suitable sampling framework for the agro-processing and emerging sub-sectors was not identified. Nonetheless, the fragmentation and dispersion of the agro-processing sub-sector, and the small number of firms operating in emerging industries, also meant that targeted interviews were better suited to capturing the heterogeneity of these firms than surveys of a random sample of firms.

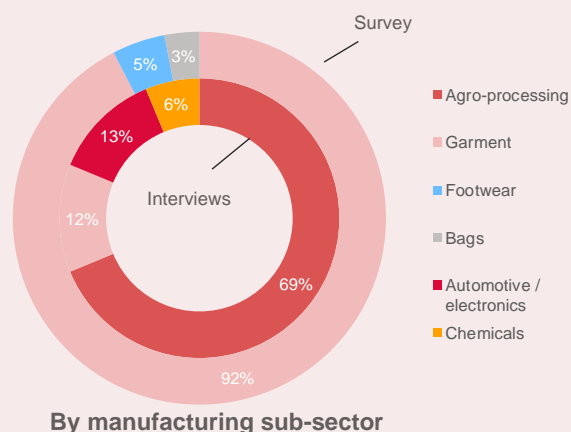
²³ As a collaboration with the UNDP project 'Garment and Footwear Industry Adaptation toward

Automation Focusing on Youth Employment and Skills Development'.

Topics covered during the consultations include:

- COVID-19 impacts
- Awareness of the term Industry 4.0
- The use of Industry 4.0 technologies
- Potential and observed benefits
- Major barriers
- Observed and expected impacts on employment
- Actors and services usually involved in technology transfer
- Key areas of support that are useful to firms.

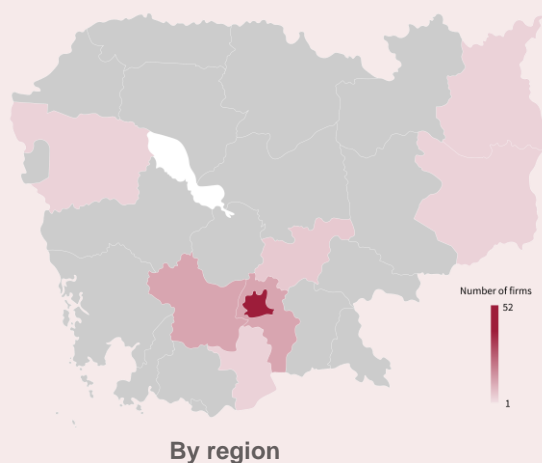
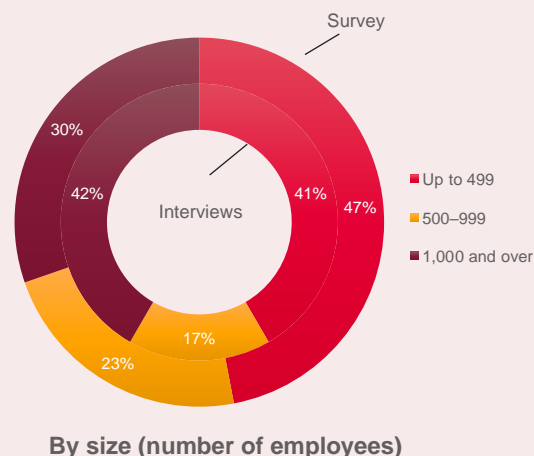
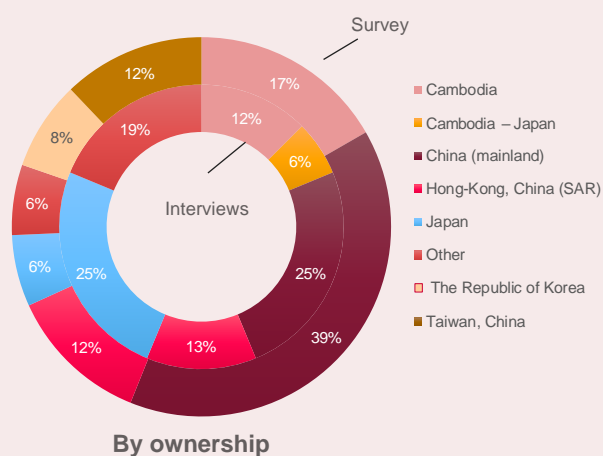
Box 2.1 Profile of firms consulted



Profile of firms consulted

(Includes survey and interviews)

- Number of firms: 82 (66 survey, 16 interviews)
- 6 manufacturing sub-sectors
- 17% domestic and 83% foreign firms
- 44% up to 499 employees
- 21% 500 – 999 employees
- 35% 1,000 employees and over
- 8 provinces/municipality



A total of 63% of the firms consulted were located in Phnom Penh, 18% in Kandal Province, 11% in Kampong Speu and the rest in five other Cambodian provinces.

The firm survey was conducted in four provinces, where most of the garment and footwear firms are located: Phnom Penh, Kampong Speu, Kandal and Takeo.

2.1 Awareness and readiness in Cambodia

From the firm survey that was conducted it was found that, although over half of the firms are already using at least one Industry 4.0 technology, most (83%) perceive themselves to have either a limited understanding of, or unfamiliarity with, the term 'Industry 4.0'. This may mean that although firms are becoming familiar with some Industry 4.0 technologies, these are being used in very specific

processes or business functions. As Figure 2.1 shows, Cambodian and smaller firms perceive themselves to have lower Industry 4.0 awareness than foreign and larger firms. Smaller firms also show lower rates of technology adoption, while Cambodian and foreign firms show similar rates of adoption (Box 2.2).

Figure 2.1 How aware are firms of the term 'Industry 4.0'?
(Cambodian Garment and Footwear Industry)



Source: UNDP Cambodia firm survey (2020). Number of observations = 66.

The Industry 4.0 technologies most commonly used by the firms surveyed include: cloud computing; sensors, actuators and control systems; and big data. Examples of cloud computing applications mentioned by the firms involve auto-cutting cloud applications and servers; applications of sensors, actuators and control systems being used for temperature controlling, metal scanning, auto-hanger systems and auto-cutting; and big data technology mainly being used in computer-aided design (CAD).

Depending on the business function, up to 7 percent of the firms surveyed report high levels of technology use, as defined in Annex

B. These findings from the garment and footwear firms confirm the results presented in our *Scoping Report*, where industry stakeholders identified that between 1 and 3 percent of firms in Cambodia have adopted advanced technologies. Higher levels of technology are reported in production and assembly activities, supply chain management, business management, and design and development of products and processes (Box 2.2). Specific production processes, where some degree of automation has been achieved, include: metal scanning, fabric spreading, heat embroidery print, fabric relaxation and fabric cutting.

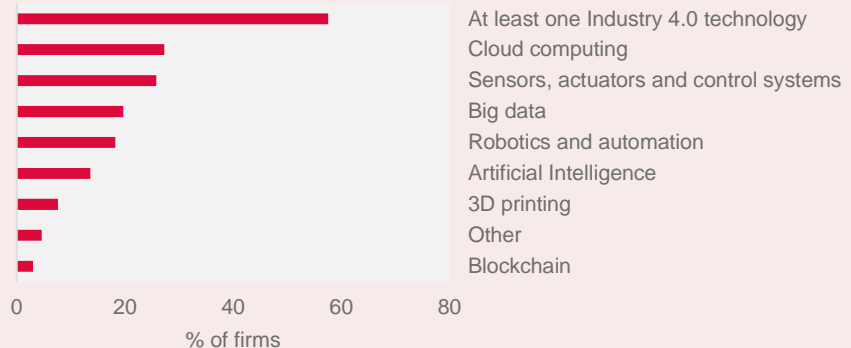
Box 2.2 Industry 4.0 readiness (Cambodian Garment and Footwear Industry)

Over half of the firms surveyed are **already using** at least one **Industry 4.0** technology.

Top 3 Industry 4.0 technologies used:

- Cloud computing
- Sensors, actuators and control systems
- Big data

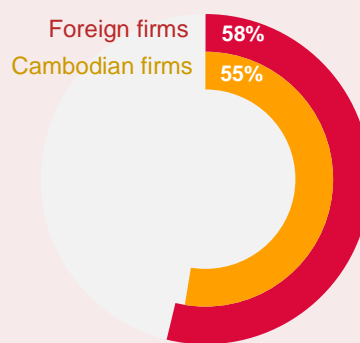
Which of the following technologies does your company currently use?



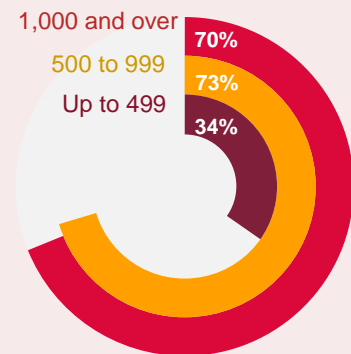
Foreign and Cambodian firms show **similar rates** of technology adoption.

Smaller firms, with fewer than five hundred employees, show **lower rates** of technology adoption.

Use of at least one Industry 4.0 technology



By ownership

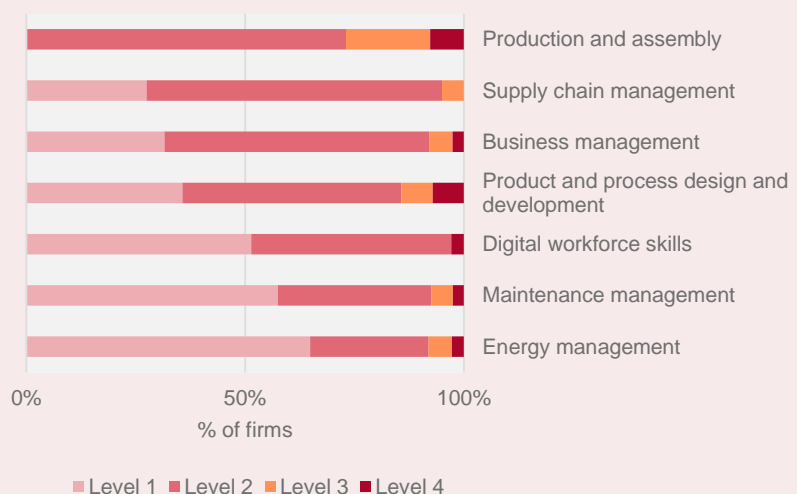


By firm size (number of employees)

Level of technology use by business function 1/

Higher levels of technology are used in:

- Production and assembly
- Supply chain management
- Business management
- Design and development



Source: UNDP Cambodia firm survey (2020). Number of observations = 66.

These findings on the rate and type of adoption of Industry 4.0 technologies are similar to those from a study conducted by the Japan External Trade Organization (JETRO) among 66 Japanese firms operating in Cambodia. The JETRO report found that, in 2019, 55.6 percent of the firms were using digital technologies, in comparison with 46.7 percent in 2018. Cloud computing was also the technology most frequently used among the firms studied.²⁴

While rates of adoption of Industry 4.0 technologies are still low in Cambodia, similar rates have been identified in other developing countries, particularly neighbouring countries such as Thailand and Viet Nam.²⁵ Even in countries leading the development and adoption of Industry 4.0 technologies, such as Germany, awareness and rates of adoption are still low, particularly among SMEs. A survey conducted among 4,500 businesses in Germany found that only 18 percent were familiar with the term Industry 4.0, and 4 percent had already implemented digitalized and networked production processes or had plans to begin doing so in the near future.²⁶

From the interviews conducted among agro-processing firms, other applications of

Industry 4.0 technologies include: the monitoring of production lines and crops; e-learning; and, because of the COVID-19 pandemic, access to remote expertise. Section 4.3 elaborates further on these and related applications. In the case of the firms operating in emerging industries, applications are mainly focused on the semi-automation of production processes and the collection and analysis of business data. Section 5.3 provides additional insights into the applications of Industry 4.0 technologies in emerging industries.

Insights from the firm interviews confirmed differences in awareness and readiness between smaller and larger firms across the different manufacturing sub-sectors analysed. Large firms, usually of foreign ownership, have access to information and financial resources to acquire new technologies, training and technical assistance from abroad. In contrast, smaller firms tend to acquire second-hand machinery and use training services and support from machinery and equipment vendors and local industry organizations. This was particularly apparent among the smaller firms interviewed in the agro-processing sector.

2.2 Barriers to technology adoption

As discussed in the *Scoping Report*, barriers at firm level, and the lack of contextual enablers, prevent firms from adopting Industry 4.0 technologies. Key barriers identified in the *Scoping Report* at firm level included: a lack of awareness of digital technologies and their benefits; the high-cost perception of technologies; aversion to the use of new technologies; skills gaps; and

limited access to technical services. Key contextual barriers identified included: limited, costly and unstable electricity supply and constrained access to capital and credit for local enterprises.

The most frequent barriers to technology adoption mentioned by the garment and footwear firms surveyed for this study are:

²⁴ JETRO (2020). *FY2019 Survey of Japanese Companies in Asia and Oceania*.

²⁵ Kupfer, D. et al. (2019). *A comparative analysis on digitalization in manufacturing industries*.

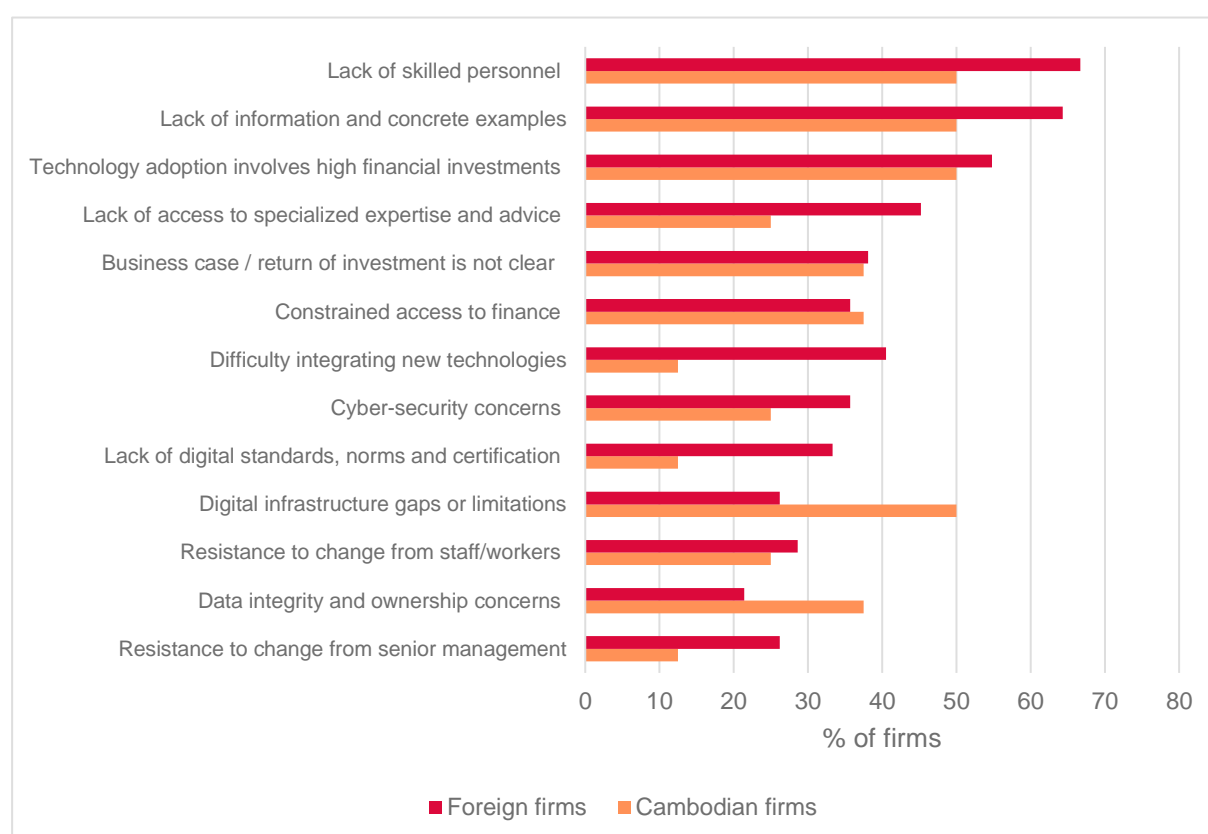
²⁶ Zentrum für Europäische (2015). *Industrie 4.0: Digitale (R)Evolution der Wirtschaft*.

- A lack of skilled personnel;
- A lack of information and concrete examples;
- A perception that the adoption of digital technologies involves high financial investments;
- A lack of access to specialized expertise and advice; and
- The business case or return of investment not being clear.

Overall, no significant differences were identified between larger and smaller firms

and between Cambodian and foreign-owned firms. The only exceptions were firms with between 250 and 1,000 employees, which more frequently expressed cyber-security concerns. Cambodian firms also less frequently reported technical barriers (for example, a lack of specialized expertise, difficulty integrating new technologies and a lack of standards) and more frequently reported those related to infrastructure and data management (Figure 2.2).

Figure 2.2 Main barriers keeping your company from adopting new digital technologies
(Cambodian Garment and Footwear Industry)



Source: UNDP Cambodia firm survey (2020). Number of observations = 50.

Insights from the interviews confirmed the survey findings. The interviews also helped to identify some additional barriers and provided a better understanding of the barriers captured in the survey. Agro-processing firms added the high turnover rate of workers and

high maintenance costs of digital technologies, such as drones, as relevant barriers. These firms also explained how technical service providers tend to be located in neighbouring countries, such as Malaysia, Viet Nam, Thailand and Singapore. Firms

operating in emerging industries highlighted the lack of business case since many processes are still labour-intensive.

These barriers are similar to those found in other countries. For example, in Indonesia²⁷ the key barriers identified were related to financial constraints, skilled-worker shortages, technical uncertainties, resistance to change and digital infrastructure gaps.

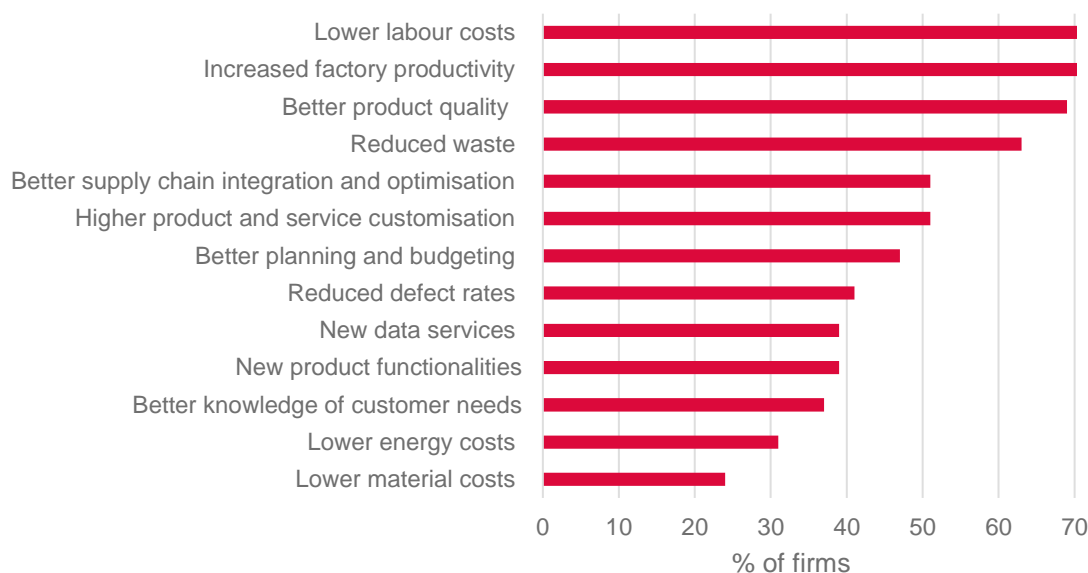
Skills shortages, high costs and uncertain returns on investment are common barriers identified in both developing and developed countries.²⁸ In Germany, skills shortages, a lack of firm strategies and a lack of standards are among the key barriers identified by firms in the adoption of Industry 4.0.²⁹ An inadequate institutional framework and data security concerns are barriers that were also identified in Thailand.³⁰

2.3 Benefits of the use of Industry 4.0 technologies

As discussed in the *Scoping Report*, Industry 4.0 technologies have the potential to boost productivity, improve labour safety, increase firms' efficiency and improve the variety and quality of the goods and services available for consumers.³¹ The firms surveyed for this study mentioned productivity improvements and requirements from headquarters and

buyers as being among the main reasons to adopt Industry 4.0 technologies. However, several other potential benefits are perceived following the adoption of these technologies, including: labour cost reductions, quality and sustainability improvements, and better supply chain integration and optimization (Figure 2.3).

Figure 2.3 What are the main benefits that could be obtained from the use of new digital technologies? (Cambodian Garment and Footwear Industry)



Source: UNDP Cambodia firm survey (2020). Number of observations = 51.

²⁷ Asian Development Bank (2020c). *Innovate Indonesia*.

²⁸ Orzes, G. et al. (2018). *Industry 4.0 Implementation barriers in small and medium sized enterprises*.

²⁹ Glass, R. et al. (2018). Identifying the barriers to Industrie 4.0.

³⁰ Orzes, G. et al. (2018). *Op. cit.*

³¹ UNDP (2020). *Op. cit.*

Perceptions of the benefits of Industry 4.0 technologies were shared across firms of different sizes and capital ownership; however, some differences were identified. Reduced waste was more frequently mentioned by larger firms (500 and over), while better supply chain integration was more frequently reported by medium-sized firms (500–999). In comparison with Cambodian firms, foreign firms mentioned more frequent data service, reduced defect rates and low energy costs. These findings are also likely to reflect the lower level of awareness of the benefits of new technologies among smaller and local firms.

From the firm interviews we identified additional benefits, including: remote supply chain management; facilitating the reporting of more timely data; monitoring breakdowns and maintenance of equipment; and obtaining better insights from the data. The next sections discuss further sector-specific benefits identified from the firm interviews.

2.4 Implications for jobs and skills

While some studies³⁵ have highlighted the potential of Industry 4.0 technologies to create a massive displacement of jobs in the garment sector, evidence collected in this project suggests that it is unlikely to happen, at least in the near future. The availability of a young workforce, as well as the existence of barriers to technology adoption, suggest that the economic case for embarking on more

Our findings on the benefits of Industry 4.0 technologies perceived by the firms are similar to those found in other contexts. In Indonesia³² the benefits identified include: increased productivity, energy efficiency, improved planning and budgeting, improved knowledge of customer needs and improved product quality. In Thailand, the main benefits identified by automotive firms include: improving production quality, reducing costs and improving efficiency.³³ From a firm survey conducted in Thailand, Viet Nam and Ghana, Industry 4.0 technologies were also identified as key drivers of sustainability, through enabling savings in the use of energy and resources and waste reduction.³⁴

A key difference between our findings and those from previous studies is the increasing emphasis on applying Industry 4.0 technologies in supply chain management. As discussed in Section 1, this trend is driven by the challenges posed by the COVID-19 pandemic.

extensive automation processes in Cambodia is still weak.

As Box 2.3 shows, there is increasing evidence that, globally, garment production processes will continue to be labour-intensive for at least the next decade. A quote by a stakeholder from the garment industry consulted for this study captures this well:

“Different job functions evolve with technology [...] we are so far from replacing humans.”
Interview, garment industry stakeholder, June 2020

³² Asian Development Bank (2020c). *Innovate Indonesia*.

³³ Meechamna, N. (2017). *Industry 4.0 strategies implementation and practices among automotive manufacturers in Thailand*.

³⁴ Kupfer, D. et al. (2019). *Op. cit.*

³⁵ International Labour Organization (2017). *ASEAN in transformation*.

Box 2.3 Garment industry: expected to continue to be labour-intensive in the next decade

A recent study published by the German Development Institute addressed the question of whether, considering digital automation trends, Sub-Saharan African (SSA) countries would be able to attract garment investments in the future, or whether firms would stay in China or relocate closer to consumers. Drawing upon the insights of interviews undertaken in Germany, China, Ethiopia and Madagascar, the study found that, while digital automation is likely to shape the future of the garment value chain, *“about 10–15 years remain to exploit labour cost advantages in the clothing industry before automation kicks in decisively”*.

Different case studies used in the study illustrate the persistence of a gap between what is technologically feasible and what is economically viable at scale. An example of these is the Adidas ‘smart factory’, established in Germany in 2016. The rationale for opening the ‘smart factory’ was: cutting down the time from design to delivery; allowing fully flexible mass customization; reducing inventories; and achieving cost savings in production. However, it ceased operations in 2019, and the technology used there was transferred to two main suppliers in Asia, where it can be applied more economically.

Source: Altenburg et al. (2020).

In Cambodia, Industry 4.0 is perceived as a labour-saving technology by most (78%) of the firms surveyed for this project; however, the industry stakeholders interviewed also highlighted that, while there may be opportunities to automate some processing and assembly tasks, most of the immediate opportunities from the adoption of Industry 4.0 technologies are likely to come from improvements in the collection and analysis of data.

Nonetheless, emerging evidence also suggests that the adoption of Industry 4.0 technologies is likely to change the composition of employment.³⁶ Increases in productivity, as well as the production and trade of new products and services, will create new job opportunities for those who have, or acquire, the relevant skills. In Cambodia, 64 percent of the firms surveyed perceive that the adoption of Industry 4.0

technologies will involve the elimination of some roles but also lead to the creation of new ones (Box 2.4). These changes in the roles and tasks will require fast and flexible responses from industry actors, but also from government and development partners, in order to avoid deepening the existing social and economic inequalities.

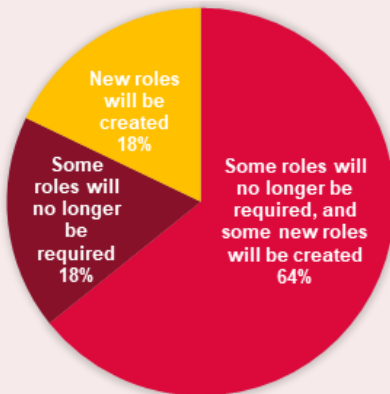
Half of the firms surveyed expressed having a plan to retrain their staff in the next five years, while insights from the interviews indicate that some firms are already retraining their workers as a result of the adoption of new technologies. However, not all companies seem to be responding to these changes at the same pace. A larger proportion of foreign and large firms (500 employees or more) mentioned having a retraining plan. Box 2.5 presents the case of the reskilling response of an agro-processing foreign firm.

³⁶ Fu, X.M. et al. (2021). Diffusion of industrial robotics and inclusive growth.

Box 2.4 Industry 4.0: implications for jobs (Cambodian Garment and Footwear Industry)

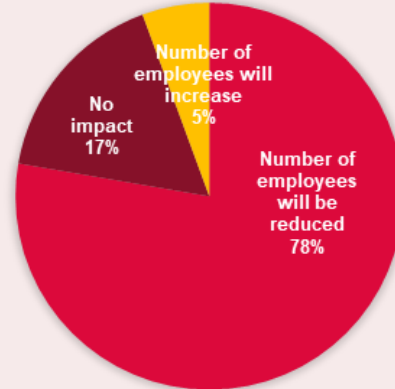
Industry 4.0 is perceived to be a labour-saving technology. However, it is also recognized that the **main impacts** on employment will involve the **elimination of some roles and the creation of new roles**.

Expected impact on employment in your factory – roles



Number of observations = 56

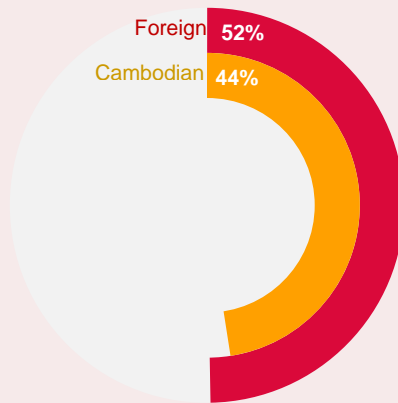
Expected impact on employment in your factory – number of employees



Number of observations = 54

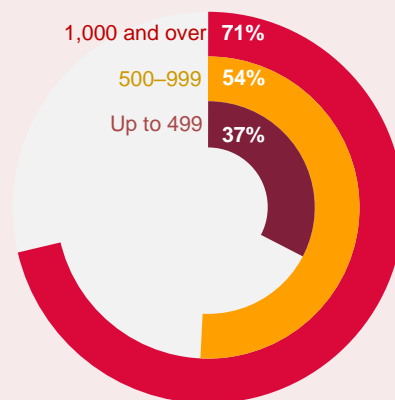
Approximately half of both foreign and Cambodian firms surveyed have retraining plans in technical skills such as machine maintenance, smart machines and quality control.

Does your company have any plans to retrain your current staff to meet skills' needs in the next five years?



By ownership

Number of observations = 57



By firm size (number of employees)

Number of observations = 57

Source: UNDP Cambodia firm survey (2020).

Box 2.5 Case study: automation and reskilling in an agro-processing company

A large foreign beverage company operating in Cambodia shared its experience of the automation of a production line. After three-year efforts and support from technology vendors from abroad, the company managed to successfully automate production lines in the manufacturing unit, relocating the excess headcounts to other areas where additional labour was required, for example, front-line sales representatives.

The company director interviewed explained that since new machines are usually imported from developed countries, these tend to be labour-saving. They explained that, as a result of the adoption of new digital technologies, future hiring is inclined towards more tech-savvy employees who can operate multiple machines at any one time. While less labour is required in the production area, the company is increasing the number of employees within sales and distribution functions.

For those employees in production that were no longer required, the company offered three options:

- Retrain and move to other departments where more people are needed;
- Scholarship covering education fees, with the possibility of being hired back when they graduate;
- Leave the company with the respective redundancy payment.

Source: Firm interview, July 2020.

Industry 4.0 adaptation and adoption requires a combination of specialized hard and soft skills. As described in Table 2.1, these include: managerial skills, production skills, digital skills, innovation skills and other soft skills.

Table 2.1 Skills needed for Industry 4.0 adaptation and adoption

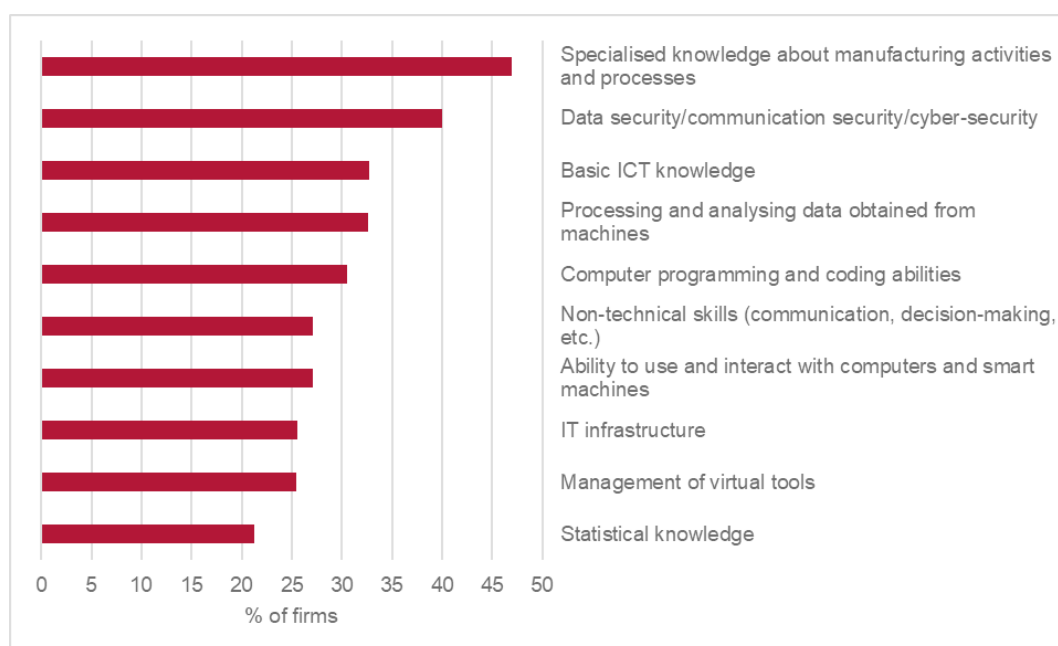
Digital skills	Other skills
<ul style="list-style-type: none">▪ Ability to manage human–machine interfaces (including occupational safety)▪ Ability to organize and coordinate interactions between virtual and physical machines in cyber-physical systems▪ Computer-aided design▪ Cyber-security▪ Data and information processing and analytics▪ Data communication and networks▪ Decision support systems▪ IT infrastructure design, installation and management▪ Logistics optimization systems▪ Management of virtual tools▪ Programming and coding▪ Smart maintenance	<p>Managerial skills</p> <ul style="list-style-type: none">▪ Decision-making▪ Leadership▪ Technology trend monitoring▪ Project management▪ Strategic thinking <p>Production skills</p> <ul style="list-style-type: none">▪ Lean manufacturing▪ Operations management▪ Quality management▪ Supply chain management <p>Innovation skills</p> <ul style="list-style-type: none">▪ Adaptability and ability to change▪ Creativity▪ Engineering and design▪ Entrepreneurial skills▪ Research skills <p>Other soft skills</p> <ul style="list-style-type: none">▪ Problem-solving▪ Ability to work in a team▪ Mindset for independent and lifelong learning▪ Communication skills▪ Time management▪ Ability to work in interdisciplinary environments

Source: ADB (2020); Kaur et al. (2020); Maisiri et al. (2019); Pejic-Bach et al. (2020).

The need to prepare for new skills needed is recognized by the firms surveyed (Figure 2.4). According to them, skills and knowledge that are expected to be in high demand in the next five years include the following:

- Specialized knowledge of manufacturing activities and processes
- Cyber-security
- Basic ICT knowledge
- Processing and analysing data obtained from machines
- Programming and coding

Figure 2.4 From the following list of skills, what are the main needs of your factory in the next five years? (Cambodian Garment and Footwear Industry)



Source: UNDP Cambodia firm survey (2020). Number of observations = 55.

Section 3. Opportunities in the garment, textile and footwear sector

Key messages of this section

- Cambodia has positioned itself as one of the main exporters of garment, textile and footwear (GTF) goods in the world. However, increasing quality and social and sustainability compliance demands from global buyers highlight the need to explore new drivers of competitiveness beyond low labour costs.
- The COVID-19 pandemic has imposed new challenges, including disruptions in the supply of raw materials and drops in demand and prices. These negative impacts have been intensified by the partial withdrawal of Cambodia's duty-free, quota-free access to the European Union market.
- Despite this challenging landscape, the stakeholders consulted identify industrial upgrading opportunities for Cambodia's GTF sector, including: increasing the production of more capital-intensive goods, such as travel goods and footwear; development of the accessories supply chain; and improving the sustainability of production processes.
- Specific Industry 4.0 technologies that could contribute to addressing these challenges and opportunities include: data analytics for improving decision-making; predictive maintenance for increasing efficiency; augmented reality (AR) and virtual reality (VR) applications for upskilling workers to perform new and more complex tasks; and radio-frequency identification (RFID) tags to improve supply chain management.

The garment, textile and footwear (GTF) sector is the most important manufacturing activity in Cambodia and the main source of exports. Despite being an established sector in the country, firms are mostly engaged in low-value-added segments of the value chain. This section examines the main challenges and opportunities faced by the GTF sector in Cambodia and how Industry 4.0 technologies could help to address them.

The section provides an overview of the sector in the context of global value chains

and describes the key strengths, weaknesses, opportunities and threats. It also provides a brief account of how the COVID-19 pandemic has impacted the GTF sector in the country. Lastly, it explains how firms are using Industry 4.0 technologies and how further adoption of these technologies could help firms to address current and emerging challenges, as well as taking advantage of industrial upgrading opportunities.

3.1 Sector overview

In 2018 the GTF sector contributed to 65.5 percent of Cambodia's manufacturing output, 39.6 percent of manufacturing employment and 66 percent of total merchandise exports.³⁷ The sector is dominated by foreign-owned firms, which represent 90 percent of the total, mainly from Southeast and East Asian countries, such as China (mainland); Taiwan, China; Hong Kong, China; Singapore; Malaysia; and the Republic of Korea.³⁸

Different comparative advantages have attracted foreign direct investment (FDI) into Cambodia's GTF sector, including: preferential access to markets such as the United States (US), the European Union (EU) and Japan; competitive labour cost; and investment incentives.³⁹ These investments have allowed the country to emerge as a significant player in world exports of GTF goods. In 2016 it was the 8th leading exporter of apparel, with a global market share of 2.6 percent, the 22nd largest exporter of textiles (market share of 0.9%) and the 15th largest exporter of leather and footwear (market share of 1.2%).⁴⁰ The three main destination markets for Cambodia's GTF exports are the EU (43%), the US (26%) and Japan (9%), with a combined share of 78 percent of the total.⁴¹

The GTF sector has experienced significant growth in the last decade. Between 2000 and 2019, Cambodia's GTF exports increased from US\$1.4 billion to US\$14.8 billion.⁴² Despite this remarkable process, Cambodia's participation in the GTF value chain is mainly limited to assembly functions. Approximately 60 percent of the firms operate on a 'cut, make and trim' (CMT) basis, whereby the producing firm takes orders from buyers, who provide the design and either specify or source inputs.⁴³ As Cambodia gains experience in the GTF value chain, it can move from low-cost commodities to higher-value-added fashion goods that warrant higher returns.

The firms interviewed for the study suggest that there is scope for upgrading the product mix within the GTF value chains. For the leather and footwear value chains, the more complex products with potentially higher returns include travelling goods. For the textile value chain, the more complex products are printed and dyed fabric, as well as fabric parts such as embroidery and labels and badges. For the garment value chain, opportunities lie not only in higher-value finished products, such as specialized sportswear, but also accessories and parts, such as zippers or slide fasteners.

3.1.1 Strengths, weaknesses, opportunities and threats of the GTF sector

Based on consultations with key stakeholders in Cambodia, complemented by the review of previous studies and industry statistics, the key challenges identified for the industrial upgrading of Cambodia's GTF sector include:

a costly and unstable electricity supply; shortages of skilled labour, particularly in management, supervisory and technical positions; increasing regional competition;

³⁷ NIS (2019). *National Accounts*; ILO (2019). *The Footwear Sector - New Opportunities for Cambodia?*

³⁸ GMAC (2021). *Members Directory*.

³⁹ Hossain, Z. (2010). *Report on Cambodia textile and garment industry*; EuroCham Cambodia (2018). *Garment industry in Cambodia*; ASEAN Briefing

(2018). *Cambodia's Garment Manufacturing Industry*.

⁴⁰ BACI-CEPII 2018 Version.

⁴¹ ILO (2019). *Op. cit.*

⁴² UN Comtrade.

⁴³ Balchin, N. and Calabrese, L. (2019). *Comparative country study of the development of textile and garment sectors*.

and growing quality and sustainability demands from global buyers.

The productivity of the GTF sector in Cambodia is lower than that of other GTF-exporting countries within the region.⁴⁴ Ongoing efforts to improve workers' skills are likely to contribute to narrowing this gap. The Cambodian Garment Training Institute (CGTI) is an example of a relevant initiative helping to improve the skills of middle managers. It was established in 2016 by the Garment Manufacturers Association in Cambodia (GMAC), in partnership with TaF.tc International Pte Ltd, in response to skills shortages faced by the garment industry.

CGTI is the result of international collaboration with TaF.tc International Pte Ltd, the international arm of the Textile and Fashion Industry Training Centre (TaF.tc), based in Singapore. In the first years of its operations, training courses were delivered by Singaporean instructors from TaF.tc. However, CGTI's approach was to develop local capacity by 'training the trainers'. Currently, 75 percent of the training can be delivered by instructors based in Cambodia.⁴⁵

CGTI's training offer includes long-term training programmes and short-term courses customized to the industry's needs. Additionally, CGTI runs the 'Train & Place' programme, which offers university graduates a scholarship to join a three-month full-time diploma (certified by TaF.tc). After successful completion of their diploma, they are guaranteed a job in a middle management or supervisory role.⁴⁶

Recent trends in the international markets pose additional challenges for upgrading the GTF sector in Cambodia. Higher prices of fabrics and an increasing supply from major producers, such as China, Viet Nam and Bangladesh, resulted in reductions in garment purchase prices in the 2000s, especially in the US market.⁴⁷ Garment products for the US market are mostly produced for segments in the lower price range, where competition over prices is higher and profit margins are smaller. A common strategy pursued by manufacturers to survive in this challenging landscape is to minimize costs through the use of simple designs and specifications, albeit locking themselves in the production of low-value-added products.⁴⁸

Although this negative trend in purchase prices reverted in 2015, the economic crisis caused by the COVID-19 pandemic, and the resultant lower household purchasing power, are likely to create additional downwards price pressures.⁴⁹ Signs of this negative trend were already experienced in the first months of the virus outbreak, as discussed in Section 3.2.

Increased demand from global buyers is another market trend that is raising barriers to entry into new production segments and making it more difficult for Cambodia to maintain competitiveness in the segments of the global value chain already present in the country. Compliance with labour and environmental standards, flexibility with production schemes, reduced lead times and increased responsibility over the

⁴⁴ UNCTAD (2013). Cambodia. Sector-specific investment strategy and action plan; International Labour Organisation (2016). Cambodian garment and footwear prices.

⁴⁵ Interviews with GMAC stakeholders.

⁴⁶ [CGTI Website](#).

⁴⁷ ILO (2016). *Trends in Cambodian garment and footwear prices and their implications for wages and working condition*.

⁴⁸ Natsuda, K., Goto, K. and Thoburn, J. (2010). Challenges to the Cambodian garment industry.

⁴⁹ U.S. Bureau of Labor Statistics (2021). [Import Price Index by Locality of Origin](#). Apparel Manufacturing for Association of Southeast Asian Nations.

manufacturing process are becoming more important than competitive labour costs.⁵⁰

Despite the challenges that the international configuration of the GFT value chain impose on the vertical integration of local firms in Cambodia, and those specific to the local context, there are a small number of Cambodian firms providing inputs such as embroidery, thread, elastic bands, labels, hangers, draw-strings, screen printing, poly bags, paper cartons, buttons, laundry and washing.⁵¹ In addition, there are around a thousand cottage garment factories in Phnom Penh that supply to the formal sector in Cambodia, Thailand and Myanmar under subcontracting schemes. These are family

businesses owning between five and twelve sewing machines.⁵²

Adaptation and adoption of Industry 4.0 technologies may open up opportunities for new production segments and diversify the sector in terms of both products and markets. The Japanese market, for example, demands higher-quality products, and these requirements are mirrored in some involvement in improving the technical capacities of local manufacturers, usually sending Japanese technicians to train Cambodian employees.⁵³ Table 3.1 summarizes the strengths, weaknesses, opportunities and threats of the GTF sector in Cambodia.

Table 3.1 Strengths, weaknesses, opportunities and threats of the GTF sector

Strengths	Weaknesses
<p><i>Institutional framework</i></p> <ul style="list-style-type: none"> Good country-level relationships with key actors of the value chain. High-level capabilities among government officials. Flexible regulation for foreign investments. Fiscal incentives. <p><i>Innovation</i></p> <ul style="list-style-type: none"> GMAC is working with the Ministry of Industry, Science, Technology and Innovation (MISTI) to formulate industrial standards and related systems for development of the textiles industry. The Ministry of Economy and Finance (MEF) has announced the development of a five-year plan (2020–2025) to increase the value added of the sector and improve its productivity. <p><i>Skills</i></p> <ul style="list-style-type: none"> The Cambodian Garment Training Institute is well recognized among industry actors. Collaboration with the Ministry of Labour and Vocational Training and textile colleges from China to train workers and local management talent. Support received from the Skills Development Fund. 	<p><i>Infrastructure</i></p> <ul style="list-style-type: none"> Limited physical infrastructure. High electricity costs. <p><i>Production</i></p> <ul style="list-style-type: none"> Dependence on imported inputs, mainly from China. Lower productivity than other exporting countries within the region. <p><i>Skills</i></p> <ul style="list-style-type: none"> Skilled-workforce shortages, particularly in digital technologies. Dependence on foreign technicians. A lack of service providers in the country.
Opportunities	Threats
<p><i>Markets</i></p> <ul style="list-style-type: none"> Diversification towards footwear and travel goods, which are more capital-intensive. Diversification towards US, UK and ASEAN markets. <p><i>Production</i></p> <ul style="list-style-type: none"> Development of the accessories supply chain. The use of technologies to improve the environmental sustainability of the industry. The use of technologies to compensate for the increase in wages. 	<p><i>Markets</i></p> <ul style="list-style-type: none"> Increasing trade preferences of neighbouring countries. Neighbouring countries are strengthening their production capacity. Lower production costs and better infrastructure in neighbouring countries. Partial withdrawal of preferential access to the EU market. Increasing demand from global buyers. Higher prices of fabrics.

Source: Consultations with key stakeholders and previous studies (ILO, 2015, 2016; *Khmer Times*, 2020b; Natsuda et al., 2010; UNCTAD, 2013).

⁵⁰ UNCTAD (2013). *Op. cit.*; ILO (2016). *Op. cit.*

⁵¹ Balchin, N. and Calabrese, L. (2019). *Op. cit.*

⁵² Hossain, Z. (2010). *Op. cit.*

⁵³ Natsuda, K., Goto, K. and Thoburn, J. (2010). *Op. cit.*

3.2 COVID-19 impacts on the GTF sector

The GTF industry has been among those hit hardest by the COVID-19 pandemic. In Cambodia, as in other contexts, the garment industry has experienced a 'double hit'. The first was the 'supply hit', felt even before the disease arrived in the country. Since over 60 percent of Cambodia's textile imports come from China,⁵⁴ as early as February garment factories were reporting shortages of supplies, primarily because of the closure of factories in China. Some Cambodian manufacturers decided to suspend operations. Then a more significant 'demand hit' occurred, as orders from clients in Europe and the US dried up.

Interviewees also reported drops in prices, where buyers were taking advantage of the reduction in orders. According to data from a survey conducted by the GMAC in June 2020, 45 percent of the factories reported that buyers were offering lower prices. Based on this data, buyers' payment terms for new orders also seemed to harden, since 35 percent of the factories reported longer payment terms than those agreed before the pandemic.⁵⁵

While imports from both the EU and the US have plummeted, falls have been larger in the EU, as Figure 3.1 shows. During the first half of 2020, the fall of EU imports from Cambodia showed rates similar to those observed by imports from other ASEAN countries. However, during the second half of the year, the EU's decision to partially withdraw Cambodia's duty-free, quota-free access of GTF goods became effective (12 August

2020), which has further reduced the EU's imports from Cambodia.

Although some companies have been involved in producing personal protective equipment (PPE) and face coverings, these activities do not seem to be compensating for the large losses in the usual orders. Nonetheless, a rise in exports to the US market seems to be balancing some of the losses,⁵⁶ as is also the case in other neighbouring countries, such as Myanmar and Viet Nam.

These negative impacts on the factories have inevitably affected workers' livelihoods. According to the GMAC, as of July 2020, 400 garment factories had suspended operations, laying off 150,000 workers, representing approximately 15 percent of the country's garment workers.⁵⁷ In response to the impacts on workers of the GTF and tourism sectors, the Royal Government of Cambodia has introduced a furlough scheme. Through this scheme the government provides a monthly contribution of US\$40 towards employees' salaries.⁵⁸

A survey conducted by ILO Better Factories Cambodia also revealed that even those employees who are continuing to work are experiencing negative impacts on their incomes. From a sample of 375 workers surveyed in May and June 2020, ILO Better Factories Cambodia found that 49 percent experienced a reduction in income, while 41 percent reported working fewer hours.⁵⁹

⁵⁴ The World Bank (2020c). *World Integrated Trade Solution*.

⁵⁵ The World Bank (2020a). *Cambodia Economic Update. November 2020*.

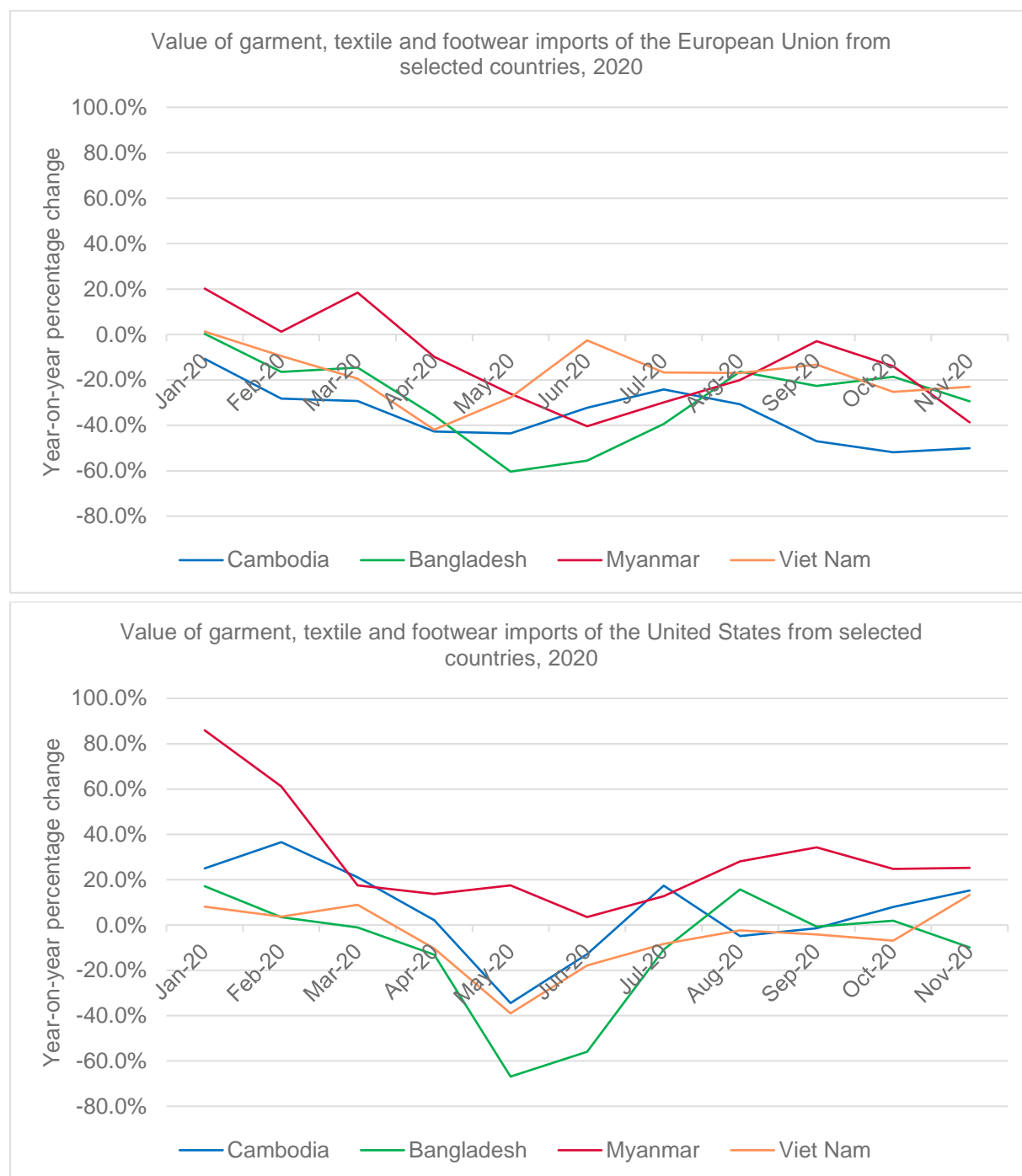
⁵⁶ Asian Development Bank (2020). *ADB Revises Cambodia's 2020 Economic Forecast Upward*.

⁵⁷ The World Bank (2020a). *Op. cit.*

⁵⁸ EuroCham (2020). Recent Announcements by the Royal Government; Ministry of Labour and Vocational Training (2020). Notification on the payment of allowances to garment and tourism workers.

⁵⁹ ILO (2020). *The supply chain ripple effect: How COVID-19 is affecting garment workers*.

Figure 3.1 European Union garment, textile and footwear imports have been more affected than imports from the US



Note: Harmonized Schedule commodity codes 61, 62, 64, 65, 66.

Source: Eurostat; US Census Bureau.

3.3 Industry 4.0: opportunities for upgrading and diversification

Based on the SWOT analysis presented in the previous section, recent technology trends and firms' insights on the actual and potential use of Industry 4.0 technologies, key opportunities were identified, including:

- Improving decision-making
- Increasing productivity
- Increasing efficiency
- New business models/customization
- Production diversification
- Improving supply chain visibility and resilience/market diversification
- Improving environmental sustainability

A variety of technologies can be applied to address these opportunities, for example:

- Data analytics can help to produce better data insights and thus improve decision-making;

- Semi-automation of simple production tasks can contribute to productivity increases;
- Connected enterprise resource planning (ERP) and predictive maintenance can improve business efficiency;
- Computer-aided design (CAD) and e-commerce platforms can be applied for massive customization;
- Augmented reality (AR) and virtual reality (VR) applications can help with upskilling workers to perform new and more complex tasks;
- Cloud-based production tracking systems and radio-frequency identification (RFID) tags can be applied to improve supply chain management; and
- Energy, water and waste management solutions can contribute to improvements in business environmental sustainability (Table 3.2).

Table 3.2 Industry 4.0 applications: opportunities for the GTF sector

Opportunity	Examples of technology applications
Improving decision-making	<ul style="list-style-type: none"> ▪ Data analytics
Increasing productivity	<ul style="list-style-type: none"> ▪ Application of sensors in product quality ▪ Auto-cutters ▪ Automated hanger systems ▪ Fabric spreading machines ▪ Semi-automated sewing machines
Increasing efficiency	<ul style="list-style-type: none"> ▪ Connected enterprise resource planning (ERP) ▪ Predictive maintenance
Enabling new customization-based business models	<ul style="list-style-type: none"> ▪ 3D design and prototyping ▪ Computer-aided design (CAD) ▪ E-commerce platforms
Skills for production diversification	<ul style="list-style-type: none"> ▪ Augmented reality (AR) and virtual reality (VR) applications for training workers
Improving supply chain visibility and resilience for market diversification	<ul style="list-style-type: none"> ▪ Cloud-based production tracking systems ▪ Radio-frequency identification (RFID) tags
Improving environmental sustainability	<ul style="list-style-type: none"> ▪ Blockchain applications for greenhouse emission monitoring ▪ Digital dyeing and printing ▪ Energy, water and waste management solutions

Source: Consultations with key stakeholders and Altenburg et al. (2020); Castañeda-Navarrete et al. (2021); National Confederation of Industry, CNI (2017). *Industria 2027* sectoral reports.

The firms interviewed for this project are already using several Industry 4.0 applications, including: auto-cutters, automated hanger systems, barcode systems, fabric spreading machines, production planning systems and RFID

applications for production tracking and supply chain management. Box 3.1 presents examples of how these technology applications are being used by garment firms in Cambodia.

Box 3.1 How is Industry 4.0 changing the garment sector?

In the last decade Industry 4.0 applications have become more accessible and opened up opportunities for different sectors, including garment manufacturing. These include improvements in business areas such as: production control; supply chain visibility and traceability; workers' safety; and environmental sustainability.

Dakota Garment Group is a garment company with factories in Cambodia, Dongguan and Myanmar, and headquarters in Hong Kong, China. In 2013 Dakota started using an RFID application for real-time production monitoring (Figure 3.2). Thanks to the adoption of this RFID application, they were able to monitor real-time production status and stopped recording hand-written production data, saving both time and money.

Dakota, like other companies established in Cambodia, has also adopted other Industry 4.0 applications, including: production planning systems, computer hanger systems and auto-cutting machines. As a result of this technology adoption, Dakota reports improvements in efficiency and productivity and an increase by 60 percent in the overall output in 2018.

Although some of these technology applications may be considered labour-saving, the garment stakeholders interviewed emphasized that rather than replacing human labour, the use of technology is complementing and increasing the efficiency and productivity of workers. In addition, applications such as auto-cutters also reduce the exposure of employees to workplace hazards.

Industry 4.0 applications are also helping firms to become more sustainable. For example, 3D sampling and virtual prototyping help with reducing material waste, while improving accuracy and accelerating product development.

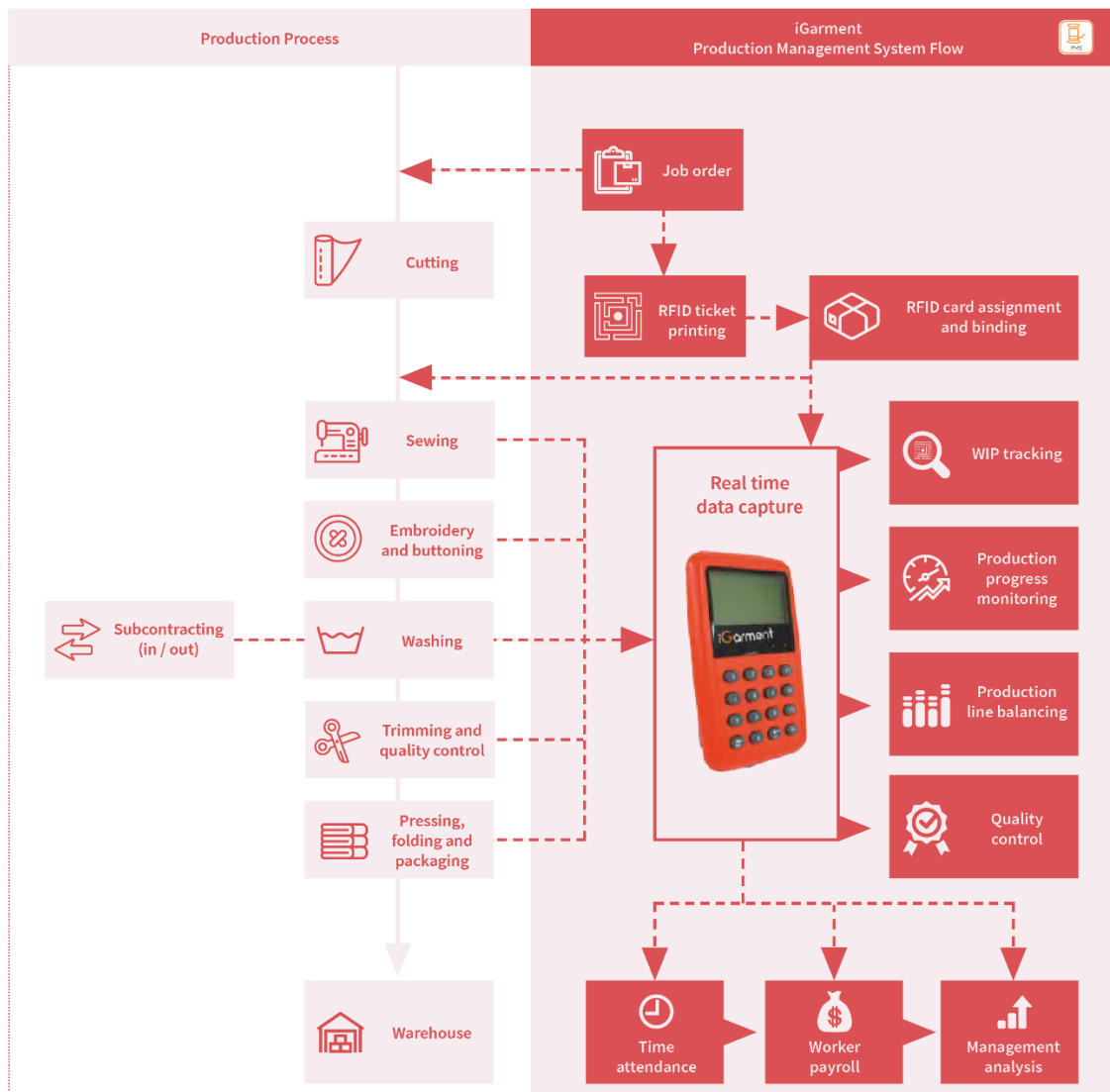
Computer hanger system used by Dakota Garment Group



Source: Dakota Garment Group.

Source: Interviews with key industry stakeholders, May–September 2020; Dakota (2019). *Sustainability Report*; iGarment (2021). *Success Stories. Dakotal Industrial Co., Ltd*; Justin Allen Group (n.d.). *Experience Vertical Textiles*.

Figure 3.2 Example of a production management system used in the garment sector



Source / Copyright: iGarment (n.d.). *iGarment Production Management System*.

Section 4. Opportunities in the agro-processing sector

Key messages of this section

- Increasing the value added of the agro-processing sector is key to supporting the post-COVID-19 industrial recovery of Cambodia because of its linkages to other sectors and the importance of agriculture as a livelihood.
- The impacts of COVID-19 on Cambodia's agro-processing sector provide a mixed picture, with some firms coping better than others. Three key types of disruption were identified in the interviews that were conducted: disruptions in the supply of inputs, impacts on sales and delays of investment plans.
- Opportunities identified by the stakeholders consulted include: improving supply chain management; delivering agricultural services; making efficiency and productivity improvements; increasing domestic production of inputs; deepening integration into regional value chains; increasing participation in domestic and international markets; and improving the environmental sustainability of production.
- Industry 4.0 applications that could contribute to industrial upgrading and diversification include: data analytics to obtain a better understanding and forecast customer needs; radio-frequency identification (RFID) and blockchain technologies to improve food safety traceability; artificial intelligence (AI), sensors and drones to monitor organic production; augmented reality/virtual reality (AR/VR) applications to train workers; and automated quality control systems to increase the domestic production of inputs.

The agro-processing sector is the second most important manufacturing activity in Cambodia. In addition, its linkages to the agriculture sector make it one of the most important sources of livelihoods and with high potential to contribute to the economy and well-being outcomes of both rural and urban households. This section examines the main challenges and opportunities faced by the agro-processing sector in Cambodia and how Industry 4.0 technologies could help to address them.

The section provides an overview of the sector in the context of global value chains and describes the key strengths, weaknesses, opportunities and threats. It also examines the differentiated impacts of the COVID-19 pandemic on the sector and how mobility restrictions due to the pandemic have also driven an increase in the adoption of digital technologies. Lastly, the section describes how firms are using Industry 4.0 technologies and how further adoption of these technologies could help firms to take advantage of industrial upgrading and diversification opportunities.

4.1 Sector overview

The agro-processing sector contributed to 14.7 percent of Cambodia's manufacturing value added in 2018 and approximately 5 percent of Cambodia's goods exports in 2019, taking into account both agricultural products and food and beverages (the more processed form).⁶⁰ Rice is the single most important crop in Cambodia. Other relevant agricultural products include: cassava, maize, fish and seafood, rubber, sugar cane and vegetables.⁶¹ The main destinations of food exports include China, France, Viet Nam, the US and the EU.⁶²

According to the most recent official data, there are more than 32,000 establishments processing agricultural products in Cambodia, employing over 80,000 people.⁶³ The sector is dominated by micro, small and medium enterprises, many of which are informal businesses. However, large firms make the largest contribution to value added and employment. Medium and large firms include rice millers, soft drinks and beer manufacturers, in addition to speciality food exporters.⁶⁴

The agro-processing industry has had a limited role in the growth of the manufacturing sector in Cambodia, since most crops (rice, cassava, maize, cashews, cattle, rubber and soy beans) are exported unprocessed to neighbouring countries.⁶⁵ Rice-processing firms are an exception. These firms have been established in recent years as a result of the 'Promotion of Paddy Production and Rice Export' policy implemented by the Royal Government of Cambodia in 2010.⁶⁶

Agriculture is the main livelihood for a third of Cambodia's population.⁶⁷ Considering inter-sectoral dependence, agriculture can also provide a useful base for industrial development if production linkages between agriculture and industry are successfully created. Within Southeast Asia, this has been observed in Thailand and Malaysia, which established strong positions in specific agro-processing value chains and created large home-based multinationals in the process.

4.1.2 Strengths, weaknesses, opportunities and threats of the agro-processing sector

Based on consultations with key stakeholders in Cambodia, complemented by the review of previous studies and industry statistics, the main challenges identified in relation to the industrial upgrading of Cambodia's agro-processing sector include: limited physical infrastructure; constrained access to finance to SMEs; limited awareness of new technologies and their benefits; dependency on imported inputs; inadequate regulatory

frameworks; limited food safety, sanitary and phytosanitary support services; and shortages of skilled workers.

The key stakeholders consulted also recognized several advantages of Cambodia's agro-processing sector, including: a strategic location in the ASEAN region; preferential access to key markets;

⁶⁰ National Institute of Statistics (2019). *National Accounts*; UN Comtrade Database.

⁶¹ FAOStat.

⁶² The World Bank (2020c). *World Integrated Trade Solution*.

⁶³ National Institute of Statistics (2012). *Economic Census of Cambodia 2011*. Kingdom of Cambodia.

⁶⁴ EuroCham (2017). Agriculture and agro-processing sector in Cambodia.

⁶⁵ Australian Aid – The World Bank Group (2015). *Cambodian agriculture in transition: opportunities and risks*.

⁶⁶ Ibid.

⁶⁷ ILO (2019). ILOSTAT.

favourable weather; and suitable land for agriculture.

Product upgrading, or moving into more sophisticated product lines, is an essential opportunity for the creation and capture of higher value added in agro-food value chains. For agricultural production, product upgrading can be achieved through diversification of crops. An example mentioned by the firms interviewed is organic farm produce, a growing global market. The value of the global organic food market was estimated at €97 billion in 2018 (~US\$115 billion), with a 55 percent increase in the number of organic producers since 2009; yet only 0.2 percent of the cultivated land in Cambodia practises organic farming.⁶⁸

There is also scope for expanding and diversifying the production of processed foods, including: rice-flour products (rice flour, rice noodles, egg-roll wrappers and edible rice paper, rice-flour cakes and dumplings); liquid rice-based products (rice bran oil, rice-based alcoholic beverages, rice vinegar, rice milk, rice syrup); rice-based convenience foods (puffed rice, rice crackers, canned rice products, quick-cooking packaged rice); rice starch; wild rice stems; rubber-based industrial products (conveyor belts, rubber rollers, adhesives, etc.); automotive products (fan belts, radiator hoses, etc.); medical products (surgical gloves); dried chips and pelletized cassava for animal feed; and fruit-based products.

Additional opportunities identified by the stakeholders consulted include process and functional upgrading transitions. Process upgrading involves the introduction of new technologies in the production system or the restructuring of existing systems, while functional upgrading involves the entry of a

firm into a new, higher-value-added function or level in the value chain. Opportunities mentioned by stakeholders include: the adoption of smart agriculture technologies; improving food safety traceability; cold chain storage; providing agricultural services (testing, certification, insurance finance); and increasing domestic production of inputs (food inputs and packaging materials).

The National Cassava Policy 2020–2025 may create additional opportunities to increase the value added of cassava exports and to improve the livelihoods of smallholder farmers. The aim of this policy is to promote innovation across all the segments of the cassava value chain, including: supporting climate-smart agriculture, promoting cassava processing and facilitating trade.⁶⁹

The stakeholders consulted, in addition to previous studies, have identified scope to diversify export destinations towards new markets, including: Australia, Indonesia, the Republic of Korea, Malaysia, Japan and Taiwan, China. The China-Cambodia Free Trade Agreement signed on 12 October 2020 is also expected to facilitate exports to this country.

One of the key challenges mentioned by local firms is to compete with imported products that are perceived to be of higher quality than local products. This situation highlights the need for business advisory services. This type of support would help local firms to better understand and address buyers' demands, both in Cambodia and abroad.

Table 4.1 summarizes the strengths, weaknesses, opportunities and threats of the agro-processing sector in Cambodia.

⁶⁸ Willer, H. et al. (eds) (2020). *The World of Organic Agriculture: Statistics and Emerging Trends 2020*.

⁶⁹ UNDP Cambodia (2020). *Cassava as the Kingdom's Strategic Move for Agribusiness Development*.

Table 4.1 Strengths, weaknesses, opportunities and threats of the agro-processing sector

Strengths	Weaknesses
<p><i>Markets</i></p> <ul style="list-style-type: none"> ▪ Strategic location in the ASEAN region. ▪ The Generalised Scheme of Preferences (GSP) makes Cambodia attractive as an overseas base to access key markets. ▪ Growing international reputation and branding of Cambodian premium fragrant rice. <p><i>Innovation</i></p> <ul style="list-style-type: none"> ▪ Successful experiences of companies partnering with international organizations such as the Asia Productivity Organization (APO) to achieve certification and comply with standards. ▪ The capability to develop digital technology applications for agriculture. <p><i>Production</i></p> <ul style="list-style-type: none"> ▪ Increasing production of vegetables and other high-quality products. ▪ Growing agricultural productivity. ▪ Favourable weather and suitable land for agriculture. <p><i>Institutional framework</i></p> <ul style="list-style-type: none"> ▪ Rubber Quality Certification Directive. ▪ National Cassava Policy 2020–2025. ▪ Tax incentives. <p><i>Skills</i></p> <ul style="list-style-type: none"> ▪ Young and increasingly skilled labour force. ▪ Efforts to educate and train engineers. ▪ People have become skilled in using digital technologies without formal training. ▪ The capacity of some firms to provide in-house training. 	<p><i>Infrastructure</i></p> <ul style="list-style-type: none"> ▪ Inadequate logistics infrastructure and channels. ▪ Instability and high cost of electricity supply. ▪ High cost of water supply. ▪ Inadequate irrigation infrastructure. <p><i>Markets</i></p> <ul style="list-style-type: none"> ▪ Costly exporting procedures that require significant paperwork. ▪ Constrained access to finance for SME agro-processors. ▪ Limited market information services. ▪ Limited experience in international marketing, export distribution channels and end markets. <p><i>Innovation</i></p> <ul style="list-style-type: none"> ▪ Limited awareness of new technologies and their benefits. ▪ Dependence on imported technology. <p><i>Production</i></p> <ul style="list-style-type: none"> ▪ Dependence on imported inputs. ▪ Limited food safety, sanitary and phytosanitary support services. ▪ Inadequate supply chain management. ▪ Underused rice-milling capacity. ▪ Limited cold chain and storage facility. <p><i>Institutional framework</i></p> <ul style="list-style-type: none"> ▪ Need to improve cross-border logistics. ▪ Weak linkages between producers and traders. ▪ Limited trust between local farmers and foreign firms. ▪ Unclear policy guidance for foreign investors. <p><i>Skills</i></p> <ul style="list-style-type: none"> ▪ Shortage of talent, including: mechatronic engineers, food science specialists, machine operators, accountants. ▪ Dependence on foreign engineers for technical and maintenance services.
Opportunities	Threats
<p><i>Markets</i></p> <ul style="list-style-type: none"> ▪ China-Cambodia Free Trade Agreement. ▪ Explore new international markets (Australia, Indonesia, the Republic of Korea, Malaysia, Japan and Taiwan). ▪ Integration into regional value chains. <p><i>Innovation</i></p> <ul style="list-style-type: none"> ▪ Plans of technical service providers to open offices in Cambodia in the near future. ▪ Increasing availability of digital technologies. ▪ Industry 4.0 applications for data management. <p><i>Production</i></p> <ul style="list-style-type: none"> ▪ Use of alternative energies. ▪ Organic production. ▪ Expanding and diversifying the production of processed foods (rice-based products; rubber-based industrial and medical products; fruit-derived products). Improve food safety traceability. ▪ Agricultural services (testing, certification, insurance finance). ▪ Cold chain storage. ▪ Smart agriculture. ▪ Increase domestic production of inputs, including packaging. <p><i>Institutional framework</i></p> <ul style="list-style-type: none"> ▪ Enhance coordination across ministries and between ministries, private sector and development partners. 	<p><i>Markets</i></p> <ul style="list-style-type: none"> ▪ Export routes highly dependent on Thailand and Viet Nam. ▪ Competition from imported products, particularly from neighbouring countries (Thailand and Viet Nam), which are perceived to be of higher quality than local products. ▪ Price volatility. ▪ Protected markets (e.g. Japan and the Republic of Korea for rice). <p><i>Skills</i></p> <ul style="list-style-type: none"> ▪ Adoption of new technologies without skills development could increase dependence on foreign talent.

Source: Consultations with key stakeholders and previous studies (Australian Aid – The World Bank Group, 2015; EuroCham, 2017; Royal Government of Cambodia, 2019; The World Bank, 2018; UNDP Cambodia, 2019).

4.2 COVID-19 impacts on the agro-processing sector

The impacts of COVID-19 on Cambodia's agro-processing sector provide a mixed picture. Some firms have faced sales decreases, while others have experienced positive impacts on both sales and employment. Three key types of disruption were identified in the interviews that were conducted: disruptions in the supply of inputs, impacts on sales, and delays in investment plans.

Most of the firms interviewed reported disruptions in the supply of imported inputs, mainly food products and packaging. Since borders were closed with Thailand, Singapore and Viet Nam, some of the firms opted to ship the necessary inputs. Some firms also mentioned issues sourcing spare parts and maintenance services.

A survey conducted among 144 firms from different sectors, between 18 April and 15 May 2020, found that around half of food-processing firms were expecting revenue reductions.⁷⁰ Most of these firms are Cambodian-owned or family-owned. In addition, approximately 40 percent of the firms reported having laid off their employees.

From the interviews conducted, we found that, while some firms faced decreases in their sales (up to 40%), others, mainly snack producers, reported sales increases (up to 20%). Sales increases were reported to have positive impacts on employment levels. Delivery services of food products also reported positive impacts. In addition, despite the challenges faced by rice mills (the pandemic, the EU safeguard measures on Cambodia's milled rice exports and floods),⁷¹ rice-milled exports increased 11.4 percent in 2020 in comparison with the previous year.⁷²

Delays in investments were also reported, such as the case of the Cambodia National Agricultural Industrial Park. The aim of the Agricultural Industrial Park, a project promoted by private, public and international actors, is to improve food safety in Cambodia through the adoption of new technologies.⁷³

In response to these disruptions, the government allocated US\$50 million through the Rural Development Bank (RDB) to provide loans with low interest rates (5% for working capital and 5.5% for investment capital) to support SMEs along the entire agro-processing value chain.⁷⁴

⁷⁰ UNIDO (2020). *Impacts of COVID-19 on the Private Sector*. Survey report. Cambodia.

⁷¹ The World Bank (2020a). *Cambodia Economic Update. Restrained Recovery*.

⁷² Cambodia Rice Federation (2021). *Export statistics. By Metric Tons*.

⁷³ HunTy (2020). *Cambodia National Agricultural Industry Park*. Project Executive Summary.

⁷⁴ Khmer Times (2020). *Millions of dollars of loans dished out*; RDB (2020). *SMAES Loans under the Royal Government's Special Financing Programme*.

4.3 Industry 4.0: opportunities for upgrading and diversification

Based on the SWOT analysis presented in the previous section, recent technology trends and firms' insights on the actual and potential use of Industry 4.0 technologies, key opportunities were identified, including:

- Improving supply chain management, including food safety traceability
- Improving productivity
- Improving efficiency
- Delivering agricultural services
- Increasing organic production
- Increasing domestic production of inputs
- Deepening integration into regional value chains
- Increasing participation in domestic and international markets
- Improving the environmental sustainability of production (Table 4.2).

Table 4.2 Industry 4.0 applications: opportunities for the agro-processing sector

Opportunity	Examples of technology applications
Improving supply chain management, including food safety traceability	<ul style="list-style-type: none"> ▪ Digital traceability control systems ▪ Radio-frequency identification (RFID) ▪ Blockchain technology to improve transparency along the value chain
Improving productivity	<ul style="list-style-type: none"> ▪ E-learning platforms ▪ AR/VR applications for accessing remote expertise and training workers
Improving efficiency	<ul style="list-style-type: none"> ▪ Predictive maintenance ▪ Cloud and data analytics to improve production and management processes
Delivering agricultural services (testing, certification, insurance finance)	<ul style="list-style-type: none"> ▪ Data analytics for better understanding/forecasting customer needs ▪ Blockchain applications in standards
Increasing organic production	<ul style="list-style-type: none"> ▪ AI, sensors and drones for monitoring crops (humidity, pests, soil quality, etc.) ▪ Blockchain applications in contracts and standards
Increasing domestic production of inputs	<ul style="list-style-type: none"> ▪ Automated quality control systems ▪ Smart packaging
Improving integration into regional value chains	<ul style="list-style-type: none"> ▪ Remote management from headquarters
Increasing participation in domestic and international markets	<ul style="list-style-type: none"> ▪ Data analytics for better understanding/forecasting customer needs ▪ E-commerce platforms
Improving the environmental sustainability of production	<ul style="list-style-type: none"> ▪ Optimization applications to reduce waste

Source: Consultations with key stakeholders and CNI (2017). *Indústria 2027* sectoral reports; SpecEngineering (2020); Te Velde et al. (2020).

The agro-processing firms interviewed for this project are already using several Industry 4.0 applications, including: monitoring of production lines, e-learning and access to remote expertise. Several applications of Industry 4.0 technologies were also identified

in the agriculture production segment of the value chain, including: drones to spray pesticides; applications to monitor water and temperature and prevent pests; supply chain management; and small-scale delivery systems.

Figure 4.1 Industry 4.0 applications are being used in Cambodia to monitor production lines



Source: Company visit. Pictures taken by YUAN Jiahuan.

As discussed in Section 1, the COVID-19 pandemic is acting as a driver of industrial digitalization. During the interviews several stakeholders mentioned an increase in the use of digital technologies, including:

online sales channels; supply chain management systems; e-learning; and access to remote technical assistance (Box 4.1).

Box 4.1 COVID-19 as a driver of industrial digitalization

Across the world, the COVID-19 pandemic is driving profound changes in the way we communicate, work and live. On the industrial front, COVID-19 is accelerating a number of digitalization trends. According to the interviews conducted with key industry stakeholders, increasing use of digital technologies was observed in response to the challenges posed by COVID-19. Examples include: online sales channels; supply chain management systems; e-learning; and access to remote technical assistance.

An agro-processing company interviewed for the study is exploring the use of augmented reality (AR) for training and accessing remote expertise. COVID-19 has accelerated the adoption of this technology. They explained how the technology has been on the market for several years and is affordable. However, before COVID-19 there was less of an incentive for the original equipment manufacturer (OEM). OEMs tend to prefer travelling and visiting the customer onsite, which was no longer an option during the pandemic. The company expected to start using this technology solution by the end of 2020.

Source: Firm interview, July 2020.

Figure 4.2 presents examples of technology applications already being used or to be adopted in the near future by the companies we interviewed.

Figure 4.2 How is Industry 4.0 changing the agro-processing sector?

	<p>Monitoring production</p> <p>Production line information systems are tools that gather real-time data on the availability, performance and quality of production lines, including downtimes and machine breakdowns. This technology solution also categorizes data and provides key performance indicators, through a graphic user interface, useful for operators and managers. Two of the agro-processing companies we interviewed reported using similar systems to monitor their production lines in Cambodia.</p>
	<p>Ensuring food safety</p> <p>Safety and compliance with regulation and standards is particularly relevant for food products manufacturing. Specialized enterprise resource planning systems (ERP) can help firms to improve their transparency and traceability throughout their production process. ERP systems also help companies with standards compliance. Common features of these systems include: inventory tracking, quality audits, customizable reports and equipment performance monitoring. One of the agro-processing companies we interviewed is already exploring the adoption of this application. This company also emphasized the availability of open source management systems such as odoo.</p>
	<p>Upskilling employees</p> <p>A multinational company operating in Cambodia is using a learning experience platform (LXP) to upskill their over 85,000 employees across the world. This solution leverages artificial intelligence for independent learning with the advantage of offering a personalized and user-friendly experience. In addition, it can provide data for managerial decision-making. In Cambodia, the company has used digital learning solutions for supply chain training. They are also exploring the use of augmented and virtual reality learning applications.</p>

Source: Interviews with key industry stakeholders, May–September 2020; Aptean (2021). [Website](#); Filtered (n.d.). [Website](#); Lineview Solutions (2021). [Website](#).

Section 5. Opportunities in emerging industries

Key messages of this section

- Industries involving relatively more capital-intensive production processes have emerged in Cambodia in the last decade. This includes: footwear, bicycles, automotive, and electrical and electronic products.
- Emerging industries, such as bicycles and electronics, have shown a faster recovery and stronger performance during the COVID-19 pandemic. The main affectations reported by the firms interviewed include: sales decreases; delays in investment plans; and restrictions in the movements of workers located abroad.
- Five key opportunity areas were identified from the applications of Industry 4.0 technologies in emerging manufacturing industries:
 - i. Increasing productivity through technology applications on workforce development.
 - ii. Increasing efficiency through better collection and analysis of data.
 - iii. Developing new products and business models, such as e-bikes and related services.
 - iv. Improving participation in regional value chains through the technology applications on supply chain management.
 - v. Improving the environmental sustainability of production processes through energy and water management systems.

Economic diversification is important in the pursuit of more resilient industrial development. Entering into higher-value-added global chains would allow Cambodia to create better jobs; however, successful integration will require decisive efforts to upskill the workforce and improve production and innovation enablers, such as infrastructure and regulation. During the last decade, Cambodia's manufacturing sector has observed the growing participation of relatively more capital-intensive industries, including: footwear, transport equipment, and electrical and electronic products.

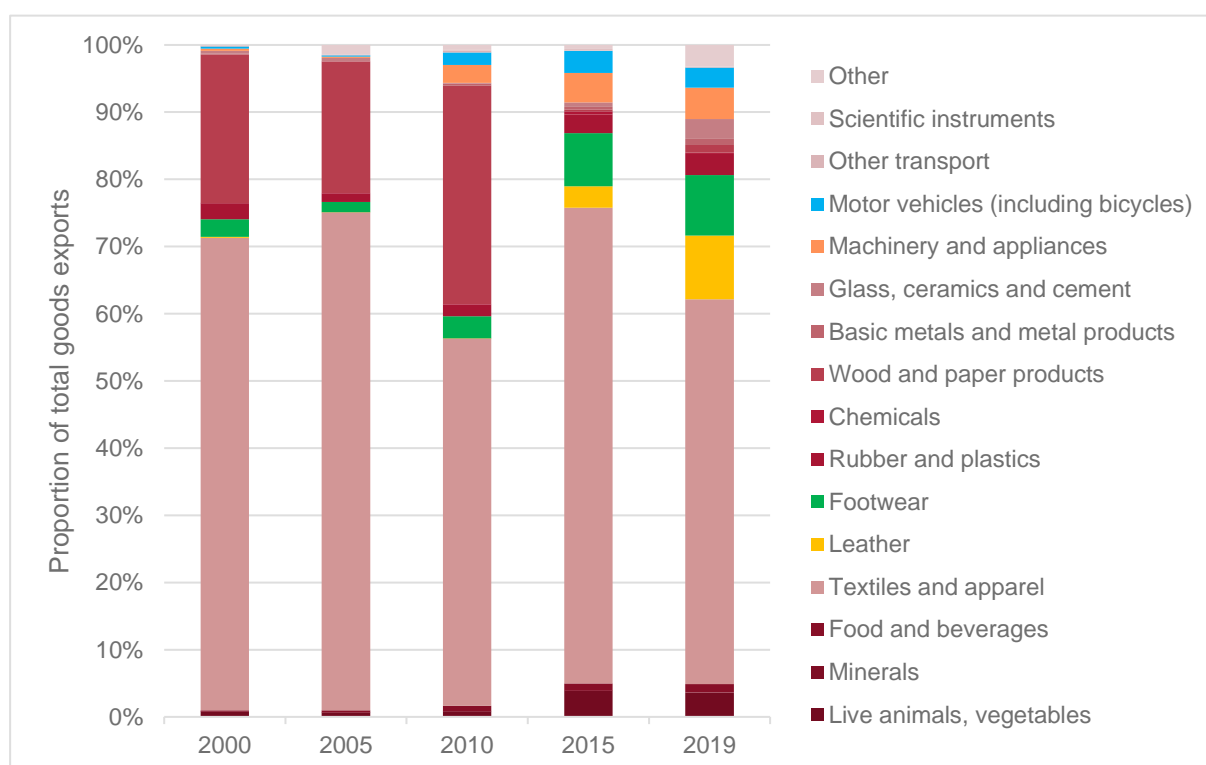
This section examines the main challenges and opportunities faced by these emerging industries and how Industry 4.0 technologies could help to address them and help Cambodia to benefit more from participation in global value chains. The section provides an overview of the recent performance of the emerging industries and describes the key strengths, weaknesses, opportunities and threats. It also examines how the COVID-19 pandemic has impacted these industries. The section concludes by describing how the firms consulted are using Industry 4.0 technologies, and how further adoption of these technologies could help firms to become more competitive.

5.1 Emerging industries overview

Different manufacturing industries have emerged in Cambodia in the last two decades. As Figure 5.1 shows, although apparel and textiles still represent the main manufacturing industries in terms of their contribution to exports, production and employment, industries involving more

sophisticated production processes have increased their contribution to the economy. Emerging industries that experienced significant growth in exports from 2000 to 2019 include: footwear, bicycle assembly, automotive, and electrical and electronic products.

Figure 5.1 Cambodia's exports of goods by product, 2000–2019



Source: Based on UN Comtrade Database.

Footwear is one of the industries that has experienced higher growth in Cambodia in the last decade. Between 2000 and 2019 the contribution of footwear to total exports grew from 2.6 to 9 percent, while the contribution of apparel and textile exports decreased from 70.3 to 57.3 percent. The EU and the US are the main destination markets. Footwear production tends to be less technology-intensive than other emerging industries, such as transport equipment or electronics; however, it usually involves more complex

processes than garment production. In comparison with garments, the footwear industry tends to have higher quality requirements, requires higher and longer-term investment and has more stable orders.⁷⁵

The transport equipment and electronic and electrical (E&E) industries have shown significant growth in Cambodia since 2005.⁷⁶ The growth of the transport equipment industry has mainly been driven by the

⁷⁵ International Labour Organization (2019). *The Footwear Sector – New Opportunities for Cambodia?*

⁷⁶ Ven Seyhah and Hing Vutha (2019). *Cambodia in the Electronic and Electrical Global Value Chains.*

establishment of Taiwanese bicycle assembly factories. Between 2005 and 2019 bicycle exports grew at a compound annual growth rate (CAGR) of 20.1 percent. The main destination markets include the EU, the US, India, Japan and the Republic of Korea.⁷⁷ Cambodia is the second largest bicycle exporter to Europe.⁷⁸

Exports of motor vehicle parts also saw a significant increase between 2005 and 2019, a CAGR of 58.4 percent.⁷⁹ Some of the motor vehicle parts produced in Cambodia are electronic and electrical components, an activity that has also seen significant growth in the last decade. Between 2005 and 2019 Cambodia's exports of electric and electronic

components and products increased by 40.8 percent (CAGR).⁸⁰

The growth of the E&E industry has mainly been driven by the investments of Japanese firms, following the 'Thailand Plus One Strategy', which involves including new production locations in order to mitigate risks. Japanese firms represent over 60 percent of total foreign investment in the E&E industry, while the main destination markets include: China, Belgium, the US, Japan, Thailand and the Philippines. Top E&E investments in Cambodia include: motor assembly, wire cables, lamps and lights, consumer electronics and computers, and office equipment.⁸¹

5.1.1 Strengths, weaknesses, opportunities and threats of emerging industries

The strengths and weaknesses perceived by stakeholders of emerging manufacturing industries are similar to those perceived by stakeholders of the garment and agro-processing industries. Key strengths include: a strategic location, investment incentives, preferential market access and competitive labour costs. In contrast, weaknesses include: limited logistics (physical) infrastructure, high cost and unstable electricity, the need for improvements in the regulatory framework, shortages of a skilled workforce and limited access to technical expertise.

While competition from neighbouring countries and the potential loss of preferential access threaten to undermine the competitiveness of Cambodia's industries, there is also scope to improve the country's participation in global value chains through improving production capabilities and enabling better integration within the ASEAN region.

Table 5.1 summarizes the strengths, weaknesses, opportunities and threats of emerging manufacturing industries in Cambodia.

⁷⁷ UN Comtrade Database.

⁷⁸ Asian Development Bank (2014). *Cambodia: Diversifying beyond garments and tourism*.

⁷⁹ UN Comtrade Database.

⁸⁰ Ibid.

⁸¹ Ven Seyhah and Hing Vutha (2019). *Op. cit.*

Table 5.1 Strengths, weaknesses, opportunities and threats of emerging manufacturing industries

Strengths	Weaknesses
<p><i>Markets</i></p> <ul style="list-style-type: none"> ▪ Strategic location to supply ASEAN countries. ▪ Increasing FDI flows. ▪ Preferential market access. ▪ Rapid growth of light industries. <p><i>Skills</i></p> <ul style="list-style-type: none"> ▪ Increasing efforts to train local engineers. ▪ 'Intuitive' use of digital technologies, such as smartphones. ▪ Competitive labour costs. <p><i>Regulatory framework</i></p> <ul style="list-style-type: none"> ▪ Political stability. ▪ Government incentives for foreign investments. ▪ Special economic zones. 	<p><i>Infrastructure</i></p> <ul style="list-style-type: none"> ▪ Limited logistics capacity and physical infrastructure. ▪ High cost and unstable electricity. <p><i>Production</i></p> <ul style="list-style-type: none"> ▪ Limited backwards and forwards linkages. <p><i>Regulatory framework</i></p> <ul style="list-style-type: none"> ▪ Need to improve/issue compliance with regional standards. ▪ Less support than other manufacturing industries, such as garments. <p><i>Skills</i></p> <ul style="list-style-type: none"> ▪ Dependence on foreign engineers. ▪ The need to improve the quality of basic education. ▪ Limited access to repair and maintenance services. ▪ Low productivity.
Opportunities	Threats
<p><i>Markets</i></p> <ul style="list-style-type: none"> ▪ Scope for improving regional integration. <p><i>Infrastructure</i></p> <ul style="list-style-type: none"> ▪ Developing digital communication infrastructure will create opportunities for remote operations management. <p><i>Production</i></p> <ul style="list-style-type: none"> ▪ Local production of basic imported inputs such as cardboard and packaging boxes. ▪ Increase linkages with FDI firms. <p><i>Skills</i></p> <ul style="list-style-type: none"> ▪ Having a pool of local engineers would be advantageous to attracting foreign investment. ▪ The use of digital technologies for skill development (e.g. virtual and augmented reality). 	<p><i>Markets</i></p> <ul style="list-style-type: none"> ▪ Neighbours with stronger production and innovation capabilities. ▪ Potential loss of preferential access to key markets (as a least developed country). ▪ International and regional trade tensions.

Source: Consultations with key stakeholders and previous studies (Asian Development Bank, 2014; Royal Government of Cambodia, 2019; Ven Seyhah and Hing Vutha, 2019).

5.2 COVID-19 impacts on emerging industries

Emerging industries, such as bicycles and automotive components, have shown the strongest performance and a faster recovery during the COVID-19 pandemic.⁸² While garments and footwear exports declined, exports of bicycles grew 31.6 percent, and exports of electrical parts and vehicle parts and accessories grew 14.4 percent during the first nine months of 2020.⁸³ Additionally, FDI inflows were registered in the footwear, electronics and vehicle accessories industries during the first half of 2020.⁸⁴

The main affectations reported by the firms interviewed (automotive/electronics and chemicals) include decreases in sales, delays

in investment plans and restrictions in the movement of workers from their factories located in Thailand. Non-significant disruptions to the procurement of inputs and delivery of products were reported. However, the footwear firms faced similar disruptions to the garment industry, with some reports of factories closing, according to the industry stakeholders interviewed.

For the producers of electronic components for the automotive industry, the largest drops in sales were observed in April, while strong signs of recovery were reported in September. These companies expect to return to the production levels observed before the COVID-19 pandemic.

5.3 Industry 4.0: opportunities for upgrading and diversification

Industry 4.0 applications already in use by the firms interviewed include: AI applications to collect and analyse large amounts of data; semi-automated machines to perform tasks such as cutting and pressing; and automatic assembly machines for production processes that cannot be handled manually.

Five key opportunity areas were identified in relation to the applications of Industry 4.0 technologies in emerging manufacturing industries:

- i. Increasing productivity through technology applications on workforce development;

- ii. Increasing efficiency through better collection and analysis of data;
- iii. Developing new products and business models, for example, leveraging the experience in bicycles assembly and expanding capabilities in related markets such as e-bikes and linked digital-enabled services;
- iv. Improving participation in regional value chains through the technology applications on supply chain management;
- v. Improving the environmental sustainability of production processes through energy and water management systems (Table 5.2).

⁸² Asian Development Bank (2020). *Asian Development Outlook 2020. Wellness in worrying times*.

⁸³ The World Bank (2020a). *Cambodia Economic Update. Restrained Recovery*.

⁸⁴ Ibid.

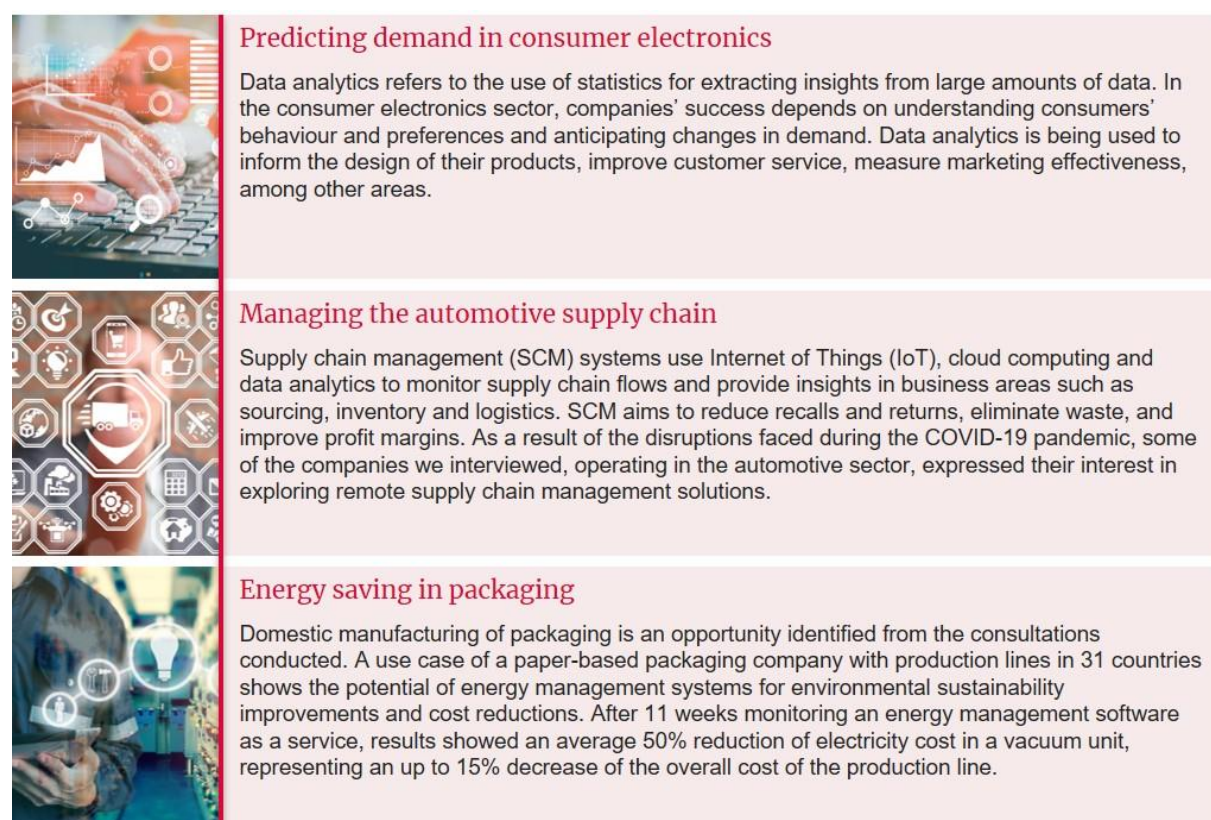
Table 5.2 Industry 4.0 applications: opportunities for emerging manufacturing industries

Opportunity	Examples of technology applications
Increasing productivity	<ul style="list-style-type: none"> ▪ E-learning platforms ▪ AR/VR applications for accessing remote expertise
Increasing efficiency	<ul style="list-style-type: none"> ▪ Predictive maintenance ▪ Cloud and data analytics to improve production and management processes
Developing new products and business models	<ul style="list-style-type: none"> ▪ E-bikes and related digital-enabled services
Improving participation in regional value chains	<ul style="list-style-type: none"> ▪ Remote supply chain management ▪ Data analytics for better understanding/forecasting customer needs
Improving environmental sustainability of production	<ul style="list-style-type: none"> ▪ Energy and water management systems

Source: Consultations with key stakeholders and BikeEurope (2020).

Figure 5.2 presents examples of how Industry 4.0 solutions could be used in those more capital-intensive industries that have experienced significant growth in Cambodia in the last two decades, such as electronics and automotive components; and packaging, an industry that has potential for growth and linkages to other sectors, including agro-processing.

Figure 5.2 How is Industry 4.0 changing emerging industries?



Source: Interviews with key industry stakeholders, May–September 2020; Brandwatch (2017). *Report: Three Data-driven Directions Shaping Consumer Electronics*; GENPACT (2016). *Consumer electronics major uses predictive analytics to boost sales by \$60 million*. Case study; PAT Research (n.d.). *Top 15 Supply Chain Management Software*; Wattics (n.d.). *Smurfit Kappa*. Case study.

Section 6. Policy options for Industry 4.0 adaptation and adoption

The COVID-19 pandemic is accelerating a number of digitalization trends. In doing so, it is revealing more opportunities for Cambodia's industrial upgrading and diversification. However, in order to leverage these opportunities, government and development actors will need to join industry efforts to strengthen the national innovation ecosystem and to improve production and innovation capabilities among local firms.

This section discusses a variety of policy instruments that could be implemented to support the inclusive adoption of Industry 4.0

technologies. It describes different technology transfer mechanisms and how these could be supported, including a case study that illustrates a mix of policies involved in supporting the technology upgrade and development of a button cluster in China. The section also presents insights from consultations on the support measures that firms regard as being most useful; and it discusses the potential risks involved in the adoption of Industry 4.0 technologies and the mitigation strategies that may help to address them. The section concludes by synthesizing useful mechanisms that will be examined in more detail in the next stages of the project.

6.1 How does technology adoption occur in Cambodia?

In Cambodia, inwards foreign direct investment and the import of machinery and equipment are the main channels for technology adoption. Some of the firms mentioned having enjoyed fiscal incentives to import machinery; however, firms also highlighted the need to extend this type of incentive to IT equipment.

Firms tend to rely on technology vendors and their headquarters to adopt new technologies. Other organizations also play an important role in providing training and helping companies to comply with standards and certification, including: industry associations, such as the Garment Manufacturers Association in Cambodia (GMAC) and the Cambodia Rice Federation; consulting firms; and international organizations, such as the Asian Productivity Organization (APO).

Among the firms studied, differences were observed across industries and between foreign and domestic firms. Garment firms seemed to be better informed about Industry 4.0 technologies and regarded the Cambodian Garment Training Institute (CGTI) as a useful resource for upskilling their workforce, as discussed in Section 3. Some of the agro-processing firms consulted use second-hand machines acquired from neighbouring countries.

Foreign firms seemed to be better equipped than domestic ones to adopt new technologies and train their workers. Foreign firms usually obtain support through industry associations and research organizations of their country of origin, either based in Cambodia or at home, such as the Chinese National Textile and Apparel Council (CNTAC) and the China Academy of Launch Vehicle Technology (CALT).

6.2 What kind of support do firms regard as most useful?

Support for the adoption of Industry 4.0 technologies that firms regard as being most useful include:

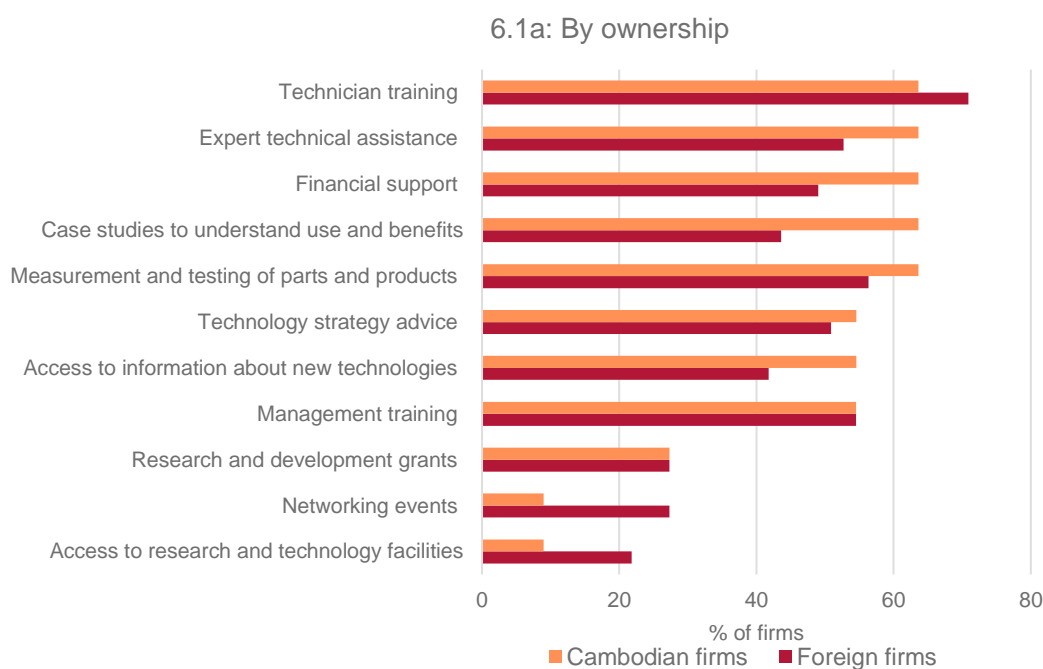
- Technician training and apprenticeship programmes
- Expert technical assistance
- Financial support
- Case studies to understand better use and benefits
- Measurement and testing services

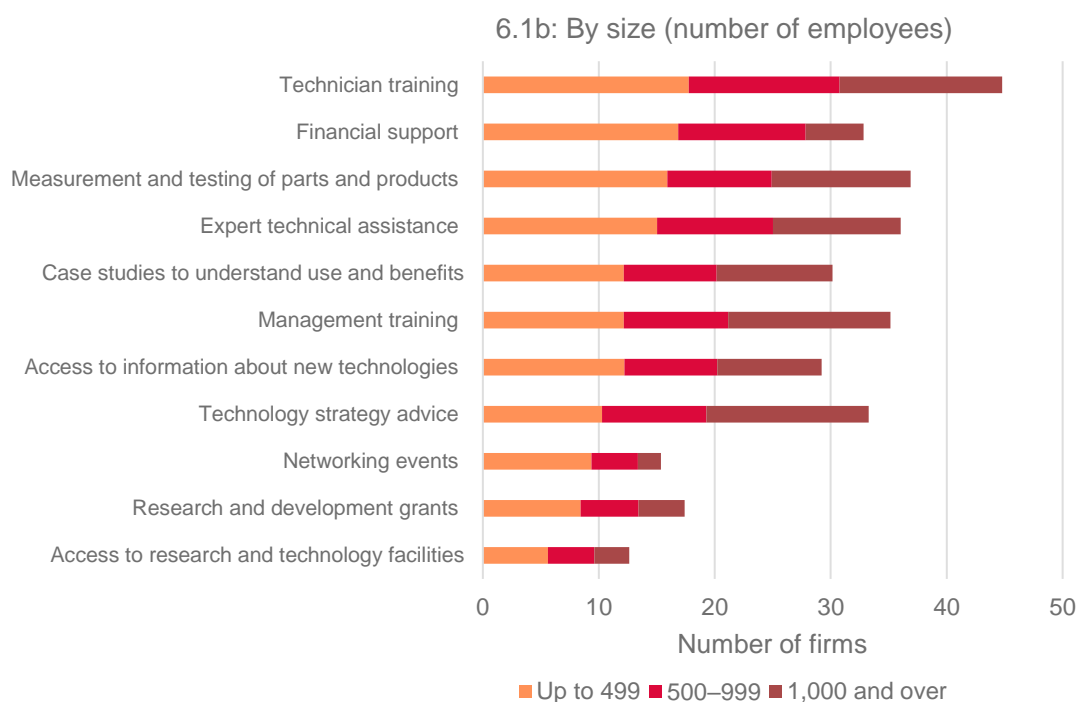
From the survey conducted among GTF firms, differences in their responses regarding the most useful support measures were observed between foreign and domestic firms and between larger and smaller firms. In comparison with foreign firms, a larger proportion of Cambodian firms mentioned case studies and access to information about new technologies, financial support and access to expert technical assistance as

being among the most useful support measures in the adoption of Industry 4.0 technologies. Similarly, a larger proportion of smaller firms regarded financial support and networking activities as the most useful type of support (Figures 6.1a and 6.1b).

Insights from the interviews confirmed a greater need for case studies and access to information about new technologies among smaller firms. Firms' perceptions of the support needed for the adoption of Industry 4.0 technologies were similar across sectors. Nonetheless, considering the fragmentation of the agro-processing sector, greater efforts will be needed to support the needs of this sector, in terms of both technology services and infrastructure. Insights from the interviews also indicate that broader business advisory services are needed among agro-processing SMEs, particularly those related to market intelligence.

Figure 6.1 What kind of support would be most useful to help your company adopt Industry 4.0 technologies? (Cambodian Garment and Footwear Industry)





Source: UNDP Cambodia firm survey (2020). Number of observations = 54.

6.3 Technology transfer mechanisms

Industry 4.0 technologies are becoming cheaper, more widely available and easier to use; however, barriers at firm and system level (as discussed in Section 2) are preventing firms from adopting these technologies. In order to overcome these barriers, a variety of policy instruments to facilitate technology transfer could be implemented.

As Table 6.1 summarizes, technology transfer can take place through different

mechanisms, including: information exchange; labour mobility; imports of capital goods and technical services; collaborative and contract research; spin-offs from research and technology organizations; licensing; joint ventures; and foreign direct investment. Government and development actors may utilize different policy instruments to build absorptive capacity among local firms and to ensure that spillover effects actually occur from joint ventures and foreign direct investments.

Table 6.1 Typology of technology transfer mechanisms

Mechanism	Source of knowledge	Potential benefits	Policy instruments
Information exchange	Firms, research and technology organizations	<ul style="list-style-type: none"> ▪ Access to information on technologies 	Networking activities, collaboration agreements, special economic zones and cluster initiatives
Labour mobility	Firms, research and technology organizations	<ul style="list-style-type: none"> ▪ Access to information on technologies ▪ Skills development 	Internships, mobility fellowships, incentives to attract diaspora population
Imports of capital goods and technical services	Technology vendors and technology service providers	<ul style="list-style-type: none"> ▪ Access to technology and related services ▪ Knowledge spillovers 	Facilitation of import procedures, selective reduction of tariffs
Collaborative and contract research	Research and technology organizations	<ul style="list-style-type: none"> ▪ Co-development of technology ▪ Shared risks and costs ▪ Access to technology and related services 	Establishment of technology organizations
Spin-offs	Firms, research and technology organizations	<ul style="list-style-type: none"> ▪ Commercialization of research outcomes 	Incubation services
Licensing	Firms, research and technology organizations	<ul style="list-style-type: none"> ▪ Access to technology and related services 	Establishment of technology organizations
Joint ventures and foreign direct investment	Foreign firms	<ul style="list-style-type: none"> ▪ Skills development ▪ Knowledge spillovers (mainly vertical) ▪ Access to higher-quality intermediate inputs 	Mapping of domestic capabilities; business advisory services; training; special economic zones; and improvements in infrastructure and the regulatory framework

Source: Reisman (2005); Upstill and Spurling (2020); Upstill and Symington (2002); UNCTAD (2014); UNESCAP (2015).

International experience has shown that technology transfer is a complex process that requires a combination of policy instruments. Box 6.1 presents the case of Qiaotou's button cluster, describing how the coordination of efforts between government, entrepreneurs and technology organizations helped firms to improve their production capabilities and strengthened the regional innovation ecosystem.

Box 6.1 Technology transfer and the development of Qiaotou's button cluster

Qiaotou's button cluster, located in the province of Zhejiang in Eastern China, is a remarkable case illustrating how the coordination of efforts between government, entrepreneurs and technology organizations helped firms to evolve from importing to producing and designing buttons.

In the 1980s garment producers in China used to purchase buttons from abroad, mainly from Italy, which is world-famous for its designs. As production costs were increasing, Italian button firms responded by outsourcing their production activities to Qiaotou, targeting the growing Chinese demand. Italian firms supplied novel Qiaotou manufacturers with designs, machinery and linkages to raw material suppliers.

Staff from China were trained in Italy to produce buttons and on inventory and quality-control methods. However, at this stage, raw materials, machinery and equipment continued to be imported and Qiaotou's manufacturers focused on the lower-value-added segments of the value chain.

It was in the 1990s that the government of Yongjia decided to deploy efforts to govern and upgrade button production. These efforts involved developing an information channel that included industrial conferences to connect the button firms, special industrial zones in the county and incubation facilities for new firms. They also mapped and identified the missing components of the button value chain.

An industrial park was built in Qiaotou to provide firms with adequate physical and digital infrastructure. The local government also collaborated with technical universities to support training delivery, standards compliance, design and R&D activities. An industrial science and technology innovation centre was established in collaboration with Lanzhou Technical University, located in Gansu province in north-western China, to provide technology information and skills development support for button manufacturing firms in Qiaotou.

While markets played a key role in driving Qiaotou's manufacturing activities, the Yongjia local government, in collaboration with the firms and technology organizations, played a critical role in the development of Qiaotou's button cluster.

Source: UNCTAD (2014).

6.4 Risks and mitigation strategies

The adoption of Industry 4.0 technologies has the potential to boost productivity, create higher-skilled jobs and open up opportunities for the economic inclusion of SMEs and less privileged groups. However, studies on the potential and observed impacts of the widespread deployment of these technologies are also raising concerns about the risks involved in Industry 4.0 transitions.

Massive job losses were one of the earliest concerns of these studies; however, more recent analysis on the observed impacts have found that, rather than massive job losses, a change in the composition of employment is taking place, biased towards higher-skilled workers.⁸⁵ Emerging evidence suggests that these changes are leading to increases in income inequality.⁸⁶

Other risks associated with the adoption of Industry 4.0 technologies include: the emergence of new safety and security hazards; a reduction in the importance of low wages as a driver of competitiveness; market and power concentration by the first technology adopters; and gender inequality as a result of women being disproportionately represented in low-skilled occupations.

As presented in Table 6.2, governments and development partners can implement different policy responses to address these potential risks, including:

- Adopting lifelong learning approaches in vocational training and education;
- Delivering safety-net schemes to those losing their jobs;
- Ensuring compliance with labour regulations;
- Adapting regulations and ensuring compliance with international standards to address new safety and health hazards;
- Promoting regional trade integration;
- Reformulating FDI attraction strategies based on international trends and prioritizing investments where linkages with local SMEs can be developed;
- Investing in physical and digital infrastructure;
- Providing SME support for the adoption of affordable Industry 4.0 technologies;
- Easing financial access to SMEs;
- Adopting gender-sensitive approaches in the design of upskilling and reskilling programmes, as well as in the design of other economic and social policies.

⁸⁵ Asian Development Bank (2020). *Innovate Indonesia. Unlocking growth through technological*

transformation. Manila: Ministry of Finance. Republic of Indonesia. ADB; Fu et al. (2021). *Op. cit.*

⁸⁶ Fu et al. (2021). *Op. cit.*

Table 6.2 Risks and mitigation strategies from the adoption of Industry 4.0 technologies

Risks	Mitigation strategies
<p><i>Income inequality</i> – Emerging evidence links automation with reductions in the share of labour income and increases in income inequality, particularly between high- and low-skilled employees.</p>	<ul style="list-style-type: none"> ▪ Adopting lifelong learning approaches in vocational training and education. ▪ Delivering safety-net schemes for those losing their jobs. ▪ Ensuring compliance with labour regulations.
<p><i>Job safety and security</i> – Increased physical hazards from new forms of human–machine interaction and exposure to new materials.</p> <p>Non-standard work arrangements, such as on-call work, zero-hours contracts, telework and self-employment increase insecurity for workers and affect their work–life balance.</p>	<ul style="list-style-type: none"> ▪ Adapting regulations and ensuring compliance with international standards to address new safety and health hazards. ▪ Promoting the use of technologies that help to better monitor and understand safety and health hazards. ▪ Promoting the use of technologies that reduce the need for humans to do physically hard, repetitive or dangerous work.
<p><i>Drivers of competitiveness</i> – Labour-saving technologies may reduce the relative importance of wage competitiveness, opening up opportunities for high-income economies to backshore production.</p>	<ul style="list-style-type: none"> ▪ Promoting regional trade integration. ▪ Reformulating FDI attraction strategies based on international trends and prioritizing investments where linkages with local SMEs can be developed. ▪ Developing programmes for workforce reskilling and upskilling. ▪ Investing in physical and digital infrastructure. ▪ Improving the business environment.
<p><i>Market and power concentration</i> – Firms with lower capabilities risk being excluded from digital transformation, increasing market and power concentration from large companies and global buyers.</p>	<ul style="list-style-type: none"> ▪ Providing SMEs support for the adoption of affordable Industry 4.0 technologies. ▪ Easing financial access to SMEs. ▪ Improving and enforcing competition regulation.
<p><i>Gender inequality</i> – Women are disproportionately represented in low-skilled occupations performing routine tasks, and thus they face higher risks of job automation than men.</p>	<ul style="list-style-type: none"> ▪ Adopting gender-sensitive approaches in the design of upskilling and reskilling programmes, as well as the design of other economic and social policies. ▪ Promoting campaigns to reduce structural discrimination. ▪ Improving sex-disaggregation data collection.

Source: Fu et al. (2021); UNDP Cambodia (2020); UNCTAD (2020); World Bank (2020b); ILO (2019); UNIDO (2019a); and Word Bank (2016).

6.5 Policy options for the adaptation and adoption of Industry 4.0 technologies

Firms operating in Cambodia are already adopting Industry 4.0 technologies; however, this is particularly true for larger and foreign firms. Although improvements to physical and digital infrastructure have been made in recent years, further and more focalized efforts are needed to ensure that SMEs can participate in the benefits of Industry 4.0 technologies and facilitate the upskilling and reskilling of low- and high-skilled employees.

Figure 6.2 summarizes four key areas of policy action identified in this report to support the adaptation and adoption of Industry 4.0 technologies:

- i. **Make Industry 4.0 technologies more accessible to SMEs.** In order to facilitate the digital journey of SMEs, government and development actors can join forces with industry associations and technology providers, to deliver awareness activities on the benefits of Industry 4.0 technologies. In the medium term, government and development partners could leverage crowdfunding, venture capital and private equity funding to support technology adaption and development among local entrepreneurs. Funding support targeted at SMEs would also help to reduce the burden of the costs involved in technology adoption. In the long term, once local capabilities have been further developed to adapt and develop Industry 4.0 technologies, the government could leverage this capability to deliver technology transfer programmes in collaboration with universities and research organizations, and to provide support for the development and provision of tailor-made low-cost solutions.
- ii. **Develop the offer of business advisory services.** Industry 4.0 adoption should go hand-in-hand with the development of essential managerial and production capabilities among SMEs. First steps in this direction can include, in the short term, leveraging the capacity among Cambodia-based business consulting firms, industry associations, and international organizations to provide business advisory services to address firm's capability gaps. In the medium term, the government could develop a supplier development programme, in established and emerging sectors, in collaboration with foreign companies, industry associations and development partners. In the long-term, the public and the private sector could collaborate in developing the offer of business advisory services, particularly sector-specific and technology business advisory services.
- iii. **Upskill and reskill employees.** As factors such as value chain remote management, sustainability, and social responsibility are increasingly driving competitiveness in export-oriented industries, further investments are needed to ensure that no one will be left behind in Cambodia's digitalization journey. Policy responses in this direction include: in the short term, establishing industry–government–university dialogues to monitor and anticipate skills mismatches; leveraging existing local capacity, both from private training providers and higher education institutions, to deliver training and education programmes that are relevant to firms; and, in the

long term, establishing technical and vocational education and training programmes, apprenticeships, and safety net and retraining schemes for those who may be impacted by changes in the skills and jobs demanded.

- iv. Consolidate the national innovation system.** While significant efforts have been deployed to improve the infrastructure and the institutional framework, a successful Industry 4.0 roll-out will need to continue these efforts and to develop a coherent national strategy for a sustainable and inclusive industrial development supported by the adoption of Industry 4.0 technologies. Activities in this direction include: in the short term, establishing an Industry 4.0 working group formed by industry, workers, government and academia representatives; further improving the business environment; adapting the regulation to the dynamic challenges, including developing regulatory sandboxes; and, in the long term, further developing research and technology facilities.

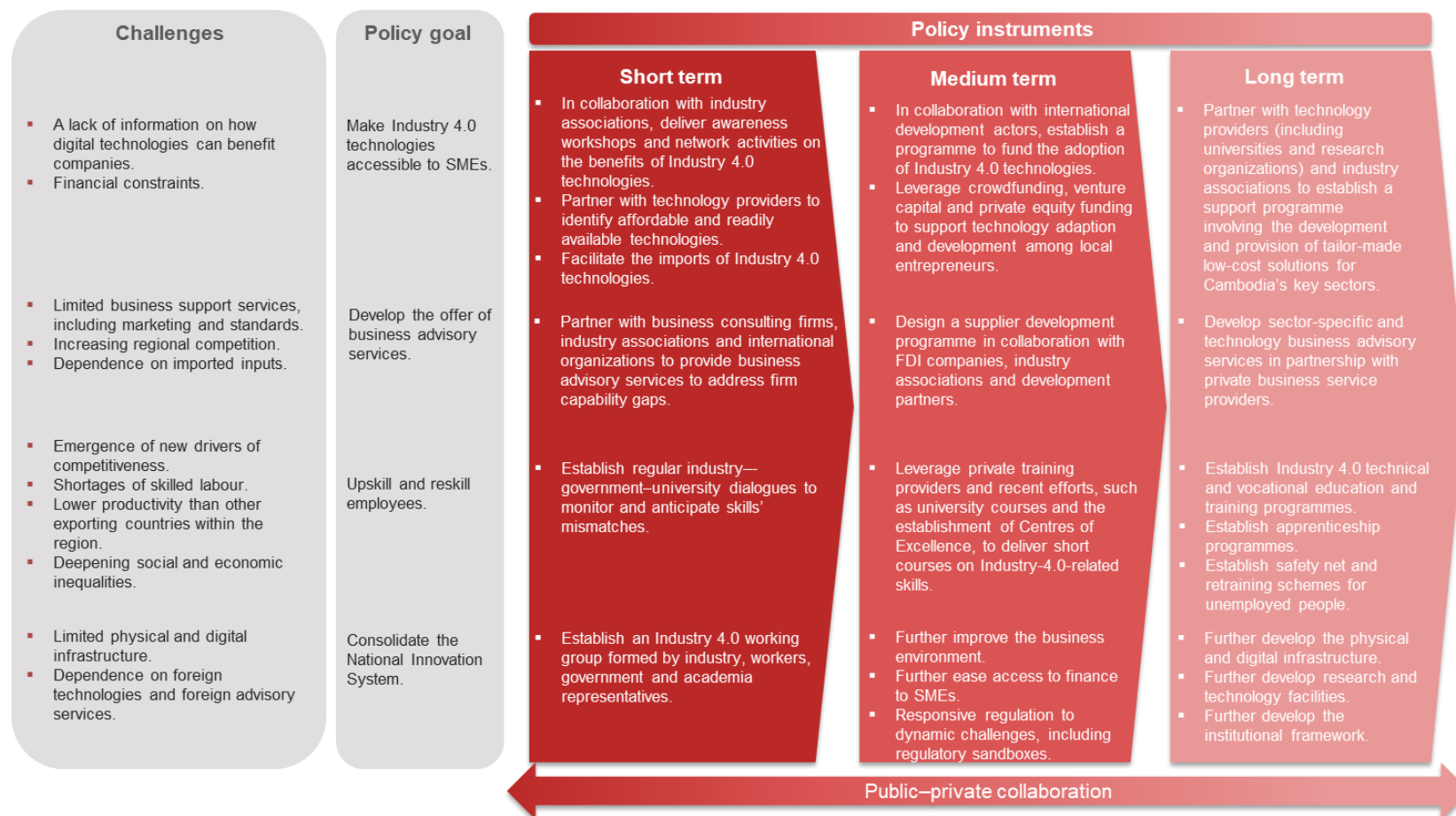
The role of the private sector. International experience has demonstrated the importance of the active participation of the private sector in the design, delivery and funding of innovation support programmes. As discussed above, business consulting firms, private training providers, foreign companies and industry associations are key actors in advancing local firms' managerial, production and innovation capabilities. The growing local base of software developers can also play an essential role in adapting and developing tailor-made low-cost Industry 4.0 solutions. In addition, through crowdfunding, venture and equity capital, the private sector can contribute to funding the development of a local base of entrepreneurs to adapt and

develop technology solutions that respond to the specific needs of Cambodian firms.

The next phases of this project will involve the review of international effective practices and the design of mechanisms for the Industry 4.0 roll-out. Policy recommendations will be prioritized, and implementation roadmaps will be developed in collaboration with government, industry and academia actors, as well as development partners (Annex A).

In addition to the private sector, a number of key government stakeholders identified during the consultations include: Ministry of Economy and Finance; Ministry of Industry, Science, Technology and Innovation; and Ministry of Posts and Telecommunications. Other public-sector organizations such as universities and particular divisions and agencies within the ministries listed above are likely to have an important role to play in Cambodia's roll-out of Industry 4.0 in order for it to be effective.

Figure 6.2 Policy options for the adaptation and adoption of Industry 4.0 technologies



Source: The authors, based on the findings of this report.

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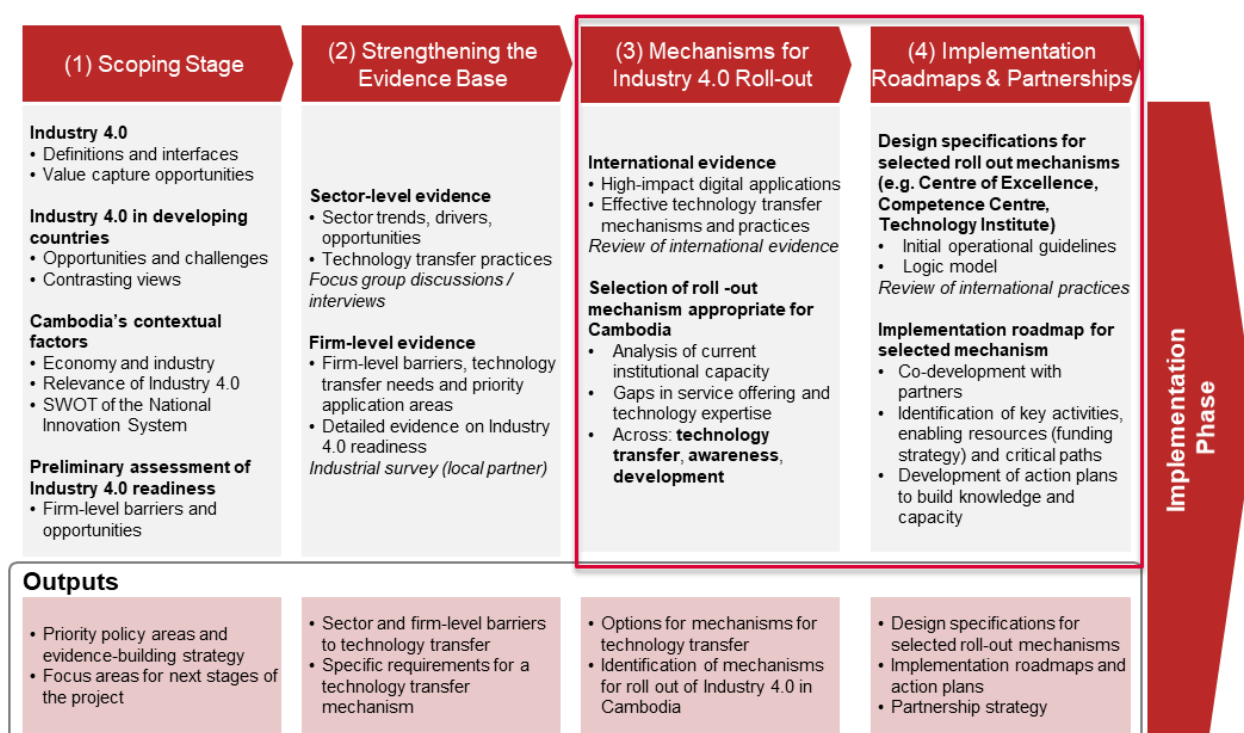
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Annex A. Next steps

Based on the evidence gathered during the first two stages of industry 4.0 roll-out initiative, the following activities are suggested for the subsequent stages:

- **Planning for implementation.** Review of international effective practices; and the selection and design of mechanisms for the Industry 4.0 roll-out.
- **Implementation roadmaps and partnerships.** Design specifications and implementation roadmaps for selected mechanisms, engaging with government, industry and academia actors, as well as development partners.

Four stages of industry 4.0 roll-out in Cambodia



Annex B. Levels of technology use

Area/level	Level 1	Level 2	Level 3	Level 4
Production and assembly	Mainly executed by workers.	Executed by workers with the assistance of equipment, machinery and computer-based systems.	A degree of automation. Workers' intervention is required for unplanned events.	Processes fully automated and integrated, which can be reconfigured when necessary. Data is exchanged across processes in real time.
Product and process design and development	Manual design of products and processes.	Use of computer-aided design (CAD) and other digital tools.	Most processes use digital modelling.	Use of digital tools and systems that allow the modelling and exchange of information across design, development, production, use and disposal. Virtual representations of products and processes (i.e. 'digital twins') are used.
Supply chain management (including procurement, inventory, dispatch)	Defined and executed by employees; processes are not formally defined.	Processes are completed by employees, with the support of digital tools.	Processes and systems are automated to a good degree. Employee intervention is required for unplanned events.	Automated processes and systems actively capturing, analysing and reacting to data.
Business management (including production planning, purchasing, sales management)	Mainly executed manually by employees.	Executed by employees with the assistance of computer-based systems.	Good degree of automation. Employee intervention is required for unplanned events.	Processes fully automated and integrated with those of the shop floor. Processes can be reconfigured when necessary.
Maintenance management (including scheduling of machine maintenance)	Manually executed and scheduled by workers.	Manually executed and scheduled by workers based on machine alerts.	Some machines are self-diagnosing, automatically sending information to the maintenance scheduling system.	Machines are mostly self-diagnosing, and the maintenance schedule adjusts itself based on real-time data inputs from the machine.
Energy management	Manually executed and scheduled by workers (e.g. machines are turned on and off manually).	Executed by employees with the assistance of computer-based systems.	Good degree of automation.	Fully automated, with real-time visibility of energy consumption across the facilities and self-optimizing systems.
Digital workforce skills	Employees have little or no experience with digital technologies.	Employees with digital skills in technology-focused areas of the business (e.g. IT systems).	Employees have digital and data analysis skills across several areas of the business.	Employees have advanced digital and analytics skills across most of the areas of the business.

Source: Policy Links, used in firm survey questionnaire.

Annex C. List of interviewees

Name	Organization
Mr. Blaise Kilian	EuroCham Cambodia
Mr. Chandy OT	Cambodia Beverage Company Co. Ltd
Mr. Channara NGOUN	Cambodia Footwear Association
Mr. Bun THAN	NVC Corporation Co. Ltd (Vital Premium Water)
Mr. Dat Pham	Heineken
Mr. Eng Mong	Lyly Kameda Co. Ltd
Mr. Go Fukada	Yamato Green Co. Ltd
Mr. Herman Leung	Dakota Garment Group
Mr. Enjoy HO	China Textile Association in Cambodia, China Chamber of Commerce, Garment Manufacturers Association in Cambodia
Mr. Hongjing LI	Hun Ty
Dr. Ken Loo	Garment Manufacturers Association in Cambodia (GMAC)
Mr. LIN Deen	Bamin
Mr. Masahiro Miyao	Japan External Trade Organization
Mr. Michel Cassagnes	EuroCham Cambodia
Mr. MingJun LIU	Holly Eco – Industrial (Cambodia), Co. Ltd
Mr. Raymond Tam	Justin Allen Group (JIIE WEI (Cambodia) Garment Factory)
Mr. Rendon Chan	Lywayway (Cambodia) Food Industry Co. Ltd
Mr. SE LALEN	HAK SE RICE MILL
Mr. Sopagna SEANG	Young Entrepreneurs Association of Cambodia
Dr. Sopheak SONG	Cambodia Development Resource Institute (CDRI)
Mr. Sovann HONG	NVC Corporation Co. Ltd (Vital Premium Water)
Mr. Takao Yagi	Japanese Business Association of Cambodia (JBAC)
Mr. Takayuki Kondo	Rohto-Mentholatum (Cambodia) Co. Ltd
Mr. Tassilo Brinzer	German Business Group in Cambodia (ADW), EuroCham Cambodia
Mr. Tetsuya Higa	Denso Cambodia Co. Ltd
Mr. Trevor Sworn	British Business Association of Cambodia
Mr. Vathana ROTH	Cambodia Development Resource Institute (CDRI)
Mr. XIE Leji	Viniton (Cambodia) Co. Ltd
Mr. Yasuhiro Wakatsuki	Lyly Kameda Co. Ltd
Mr. Yogo Kanda	Japanese Business Association of Cambodia (JBAC)



About us

Policy Links is a global not-for-profit innovation policy consultancy unit that works with governments to develop effective industrial innovation policies. We offer new evidence, insights and tools based on the latest academic thinking and international best practice in the areas of technology, manufacturing and innovation policy, with a track record of delivering high-impact projects in both developing and developed countries around the world.

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