ASEAN IN TRANSFORMATION

TEXTILES, CLOTHING AND FOOTWEAR:
REFASHIONING THE FUTURE

ILO
International Labour Organization

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TEXTILES, CLOTHING AND FOOTWEAR: REFASHIONING THE FUTURE

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Jae-Hee Chang, Gary Rynhart and Phu Huynh

PREFACE

This paper, *ASEAN in transformation: Textiles, clothing and footwear – Refashioning the future* examines how technology is transforming the textile, clothing and footwear (TCF) sector in the Association of Southeast Asian Nations (ASEAN). The TCF sector is a significant contributor to employment and trade for a number of ASEAN Member States. In particular, the sector provides over 9 million jobs, particularly to young women.

The study highlights that the TCF sector is undergoing significant technological transformation, especially as multinational retailers and apparel brands aggressively innovate and pilot disruptive technologies such as 3D printing, robotics and automation which bring production to move closer to market. Trends in reshoring is already emerging in the footwear sector and will soon occur for the clothing sector upon introduction of automated sewing machines that enable automation of the most difficult part of apparel manufacturing. Moreover, players in ASEAN's TCF sector need to be mindful of the changing nature of production in China which remains the top TCF manufacturing country in the world. These movements will result in decline in export growth for the ASEAN region and ultimately affect the number of workers required.

ASEAN Member States that are heavily reliant on the TCF sector as a source for jobs and development require a critical review of their economic structure. In addition, a renewed focus on training and education and emphasis on the skills pipeline are crucial to enable TCF players to manufacture higher value products and remain competitive.

The findings of the paper are based on primary data collected from over 50 interviews and in-depth case studies conducted mainly in Cambodia, Thailand, and Viet Nam. Additional field wok was executed to examine China-ASEAN trends for the sector. In addition, initial findings of the fieldwork were consulted with over 50 apparel buyers and manufacturers at a business forum held by ILO Better Work in April 2016.
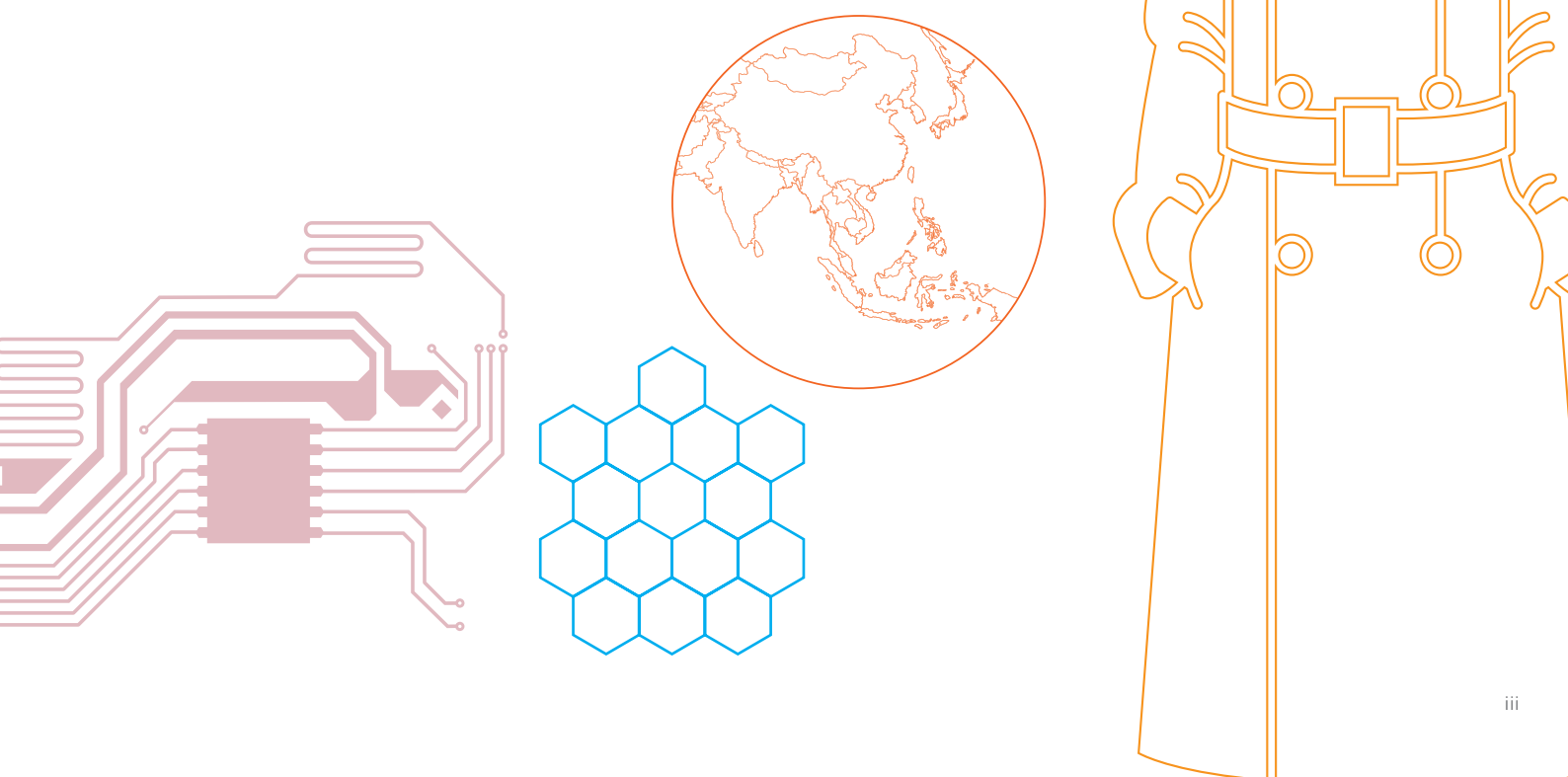
The paper forms part of the ILO Bureau for Employers' Activities (ACT/EMP) research project on the future of work and how technology is transforming jobs and enterprises in the ASEAN region. Drawing from numerous interviews and case studies, the research team examined current technological trends in ASEAN and how they impact enterprises and workers within five major labour-intensive and/or growth manufacturing and services sectors: automotive and auto parts; electronics and electrical parts; textile, clothing and footwear; business process outsourcing and retail.

The wider research effort has culminated into a collection of separate papers, of which this study forms a part, each providing an in-depth examination on different aspects of how technology affects the ASEAN region.

1. ***ASEAN in transformation: The future of jobs at risk of automation***
2. ***ASEAN in transformation: Perspectives of enterprises and students on future work***
3. ***ASEAN in transformation: Automotive and auto parts – Shifting gears***
4. ***ASEAN in transformation: Electrical and electronics – On and off the grid***
5. ***ASEAN in transformation: Textiles, clothing and footwear – Refashioning the future***

The key findings from this paper, and the abovementioned, are synthesized in a master document entitled, *ASEAN in transformation: How technology is changing jobs and enterprises*.

We hope this paper and its associated research provide enterprises, workers, their representative organizations, governments and other stakeholders with useful empirical evidence and a rich knowledge base from which they can initiate national level policy dialogues and actions to address the future of work. Finally, it is our hope that this research makes a constructive contribution to the ILO's on-going efforts related to the Centenary Initiative on the Future of Work, as well as the 16th ILO Asia-Pacific Regional Meeting, to be held in December 2016.

Deborah France-Massin
Director
Bureau for Employers' Activities
International Labour Office
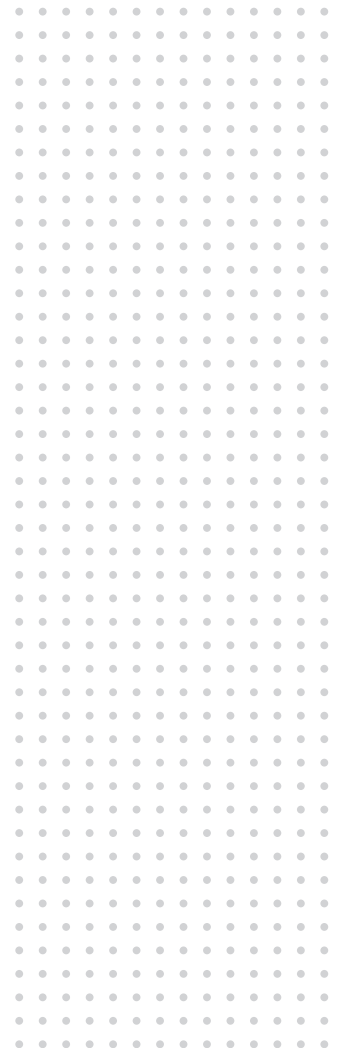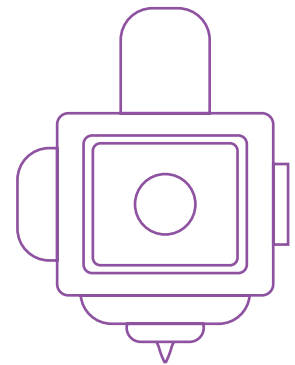
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ACKNOWLEDGEMENTS

ABOUT THE RESEARCH TEAM

ABOUT THE BUREAU FOR EMPLOYERS' ACTIVITIES

The Bureau for Employers' Activities (ACT/EMP) is the specialized unit within the International Labour Office that maintains direct and close relationships with employers' organizations. Employers' organizations advance the collective interests of employers at country and regional levels. ACT/EMP assists employers' organizations with becoming strong representative organizations that help to shape conducive business environments.
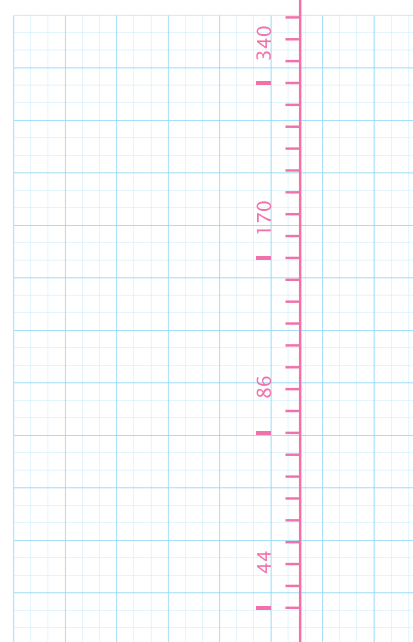
ABBREVIATIONS

ASEAN	Association of Southeast Asian Nations
ASM	automated sewing machine
CAD	computer-aided design
CPT	container port traffic
ISCO	International Standard Classification of Occupations
ISIC	International Standard Industrial Classification of All Economic Activities
R&D	research and development
SEZ	special economic zone
SITC	Standard International Trade Classification
STEM	science, technology, engineering and mathematics
TCF	textiles, clothing and footwear
TEU	twenty-foot equivalent units
TPP	Trans-Pacific Partnership
TVET	technical vocational education and training

EXECUTIVE SUMMARY

TCF is a highly competitive sector. In ASEAN, TCF is predominately shaped by large multinational brands and retailers, acting as a conduit for transitioning economies to shift from informal agricultural jobs to formal wage employment. It is also one of the most labour-intensive industries, assisting countries with moving into their secondary economic cycle. Collectively, TCF provides over 9 million jobs in ASEAN, mostly for young women.

Of all the sectors analysed in this research, the TCF sector seems to be the most vulnerable to the extensive technological displacement of workers. A number of technologies stand to disrupt this sector: 3D printing, body scanning technology, computer-aided design (CAD), wearable technology, nanotechnology, environmentally friendly manufacturing techniques, and lastly, robotic automation.

Combined, body scanning sensors and CAD not only provide the perfect fit to the consumer, but also permit extremely fast delivery, which is further accelerated through 3D printing. Because 3D printing does not require as much human input, it enables production to move closer to the markets in which products are sold. Indeed, there are early indications that the need for mass production footwear factories in ASEAN is dissipating. The footwear industry has begun using 3D printing techniques to open automated shoe factories in key destination markets. If these operations prove profitable, such automated shoe factories will no doubt reduce the need for ASEAN workers.

Recently, researchers successfully prototyped smart clothes, or apparel enhanced with electronic and digital capabilities (e.g., smart shoes that provide health metrics and measure distances travelled). Moreover, advancements in nanoparticle research have introduced nanoparticle-infused clothes that are waterproof, stain-proof, UV protecting and/or odourless. In addition, larger TCF brands are implementing more environmentally friendly manufacturing techniques to reduce the amount of water consumed, chemicals used and material waste produced. When the price point becomes favourable, an increasing number of consumers will demand these improved and sustainably manufactured goods *en masse.* Overall, these advanced technologies present a different kind of challenge for ASEAN: a lack of skilled talent.

Automated cutting machines are now becoming a widely available technology, and robots capable of sewing – called "sewbots" – will soon change the calculus of TCF production. Sewbots are unlikely to displace current workers in ASEAN garment factories, but more likely to be deployed in destination markets such as China, Europe and the United States. The disruptive impact on the sector in ASEAN could be very substantial, as robotic automation poses a significant threat of job displacement. The implications of technologically induced upheaval for the TCF sector in ASEAN are profound and likely to disproportionally affect female workers, who currently serve as the backbone of the TCF sector. The female share of TCF employment exceeds 70 per cent in Cambodia, Lao People's Democratic Republic, the Philippines, Thailand and Viet Nam. An additional concern for ASEAN's TCF sector is the continued and improved production growth of China's TCF activities: China currently produces more with less workers, and this production gap will increase as it deploys more automotive processes.

ASEAN's TCF workforce needs will drastically change. The region will encounter both a displacement of lower skilled workers and an increase in the demand for higher skilled technicians and engineers to serve niche apparel producers. Significant shares of TCF workers in ASEAN are at high risk of automation, from 64 per cent in Indonesia, 86 per cent in Viet Nam and 88 per cent in Cambodia. To remain competitive, industry players must accelerate partnerships with educational and training institutions to groom the next generation of TCF workers who have stronger technical qualifications, expertise and the ability to work seamlessly with multiple strands of emerging technologies.
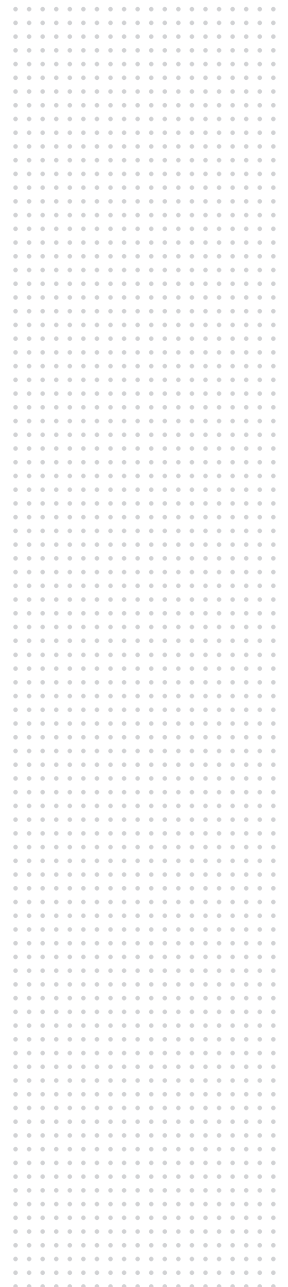
Illustration 1. ASEAN TCF overview

TCF is at the highest risk of automation
of the five sectors analysed

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TCF provides over
9 million jobs in ASEAN,
most of whom are
filled by young women

The female share of
TCF employment exceeds 70%
in Cambodia, Lao PDR,
the Philippines,
Thailand and Viet Nam

3D printing, body scanning technology,
computer-aided design, wearable technology,
nanotechnology, sustainable/environmentally friendly
manufacturing and robotic automation are disruptive
technologies globally
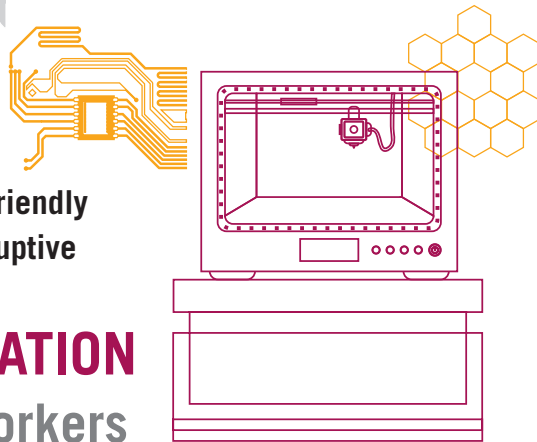
In ASEAN ROBOTIC AUTOMATION
forms the biggest threat to workers

Significant shares of
TCF salaried workers in ASEAN are at
high risk of automation, from
64% in Indonesia,
86% in Viet Nam and
88% in Cambodia

Sewbots
enable production
reshoring

The United States
sees immediate
savings from sewbots
if purchased in 2016

Savings of US$180,000
can be seen over 5 years

SECTOR OVERVIEW

1
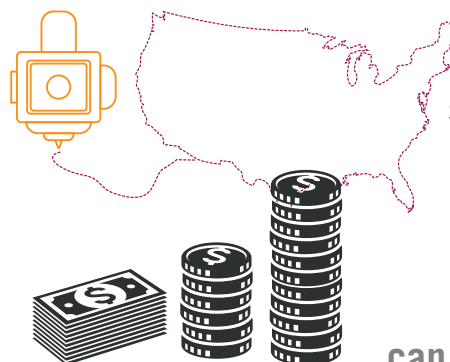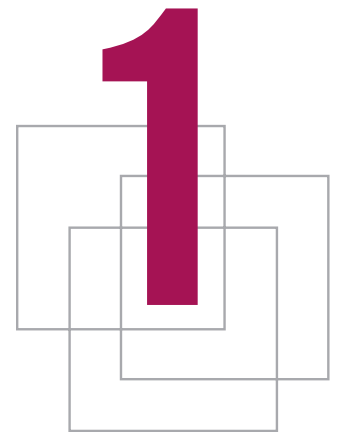
The textiles, clothing and footwear (TCF) sector is a highly competitive sector predominately shaped by large enterprises consisting of both multinational brands and retailers. Production moves from one country to another, depending on competitive labour cost, trade agreements and other factors.[1] Characterized as one of the first sectors a country adopts when transitioning to its secondary economic cycle and standing as one of the most labour-intensive industries, the TCF sector is a conduit for transitioning from informal agricultural jobs to formal wage employment.[2] TCF contributes significantly to poverty alleviation and economic growth for developing regions. The sector, collectively, provides over 9 million jobs in ASEAN, mostly for young women.

Globally, TCF is monopolized by China, who takes an unrivalled position. It accounts for over 31 per cent of global textile exports, 37 per cent of clothing exports and over 39 per cent of footwear exports.[3] China aside, a number of ASEAN countries, including Indonesia and Viet Nam, join the world's top rankings for TCF exports. In 2014, Viet Nam made an impressive mark by becoming the world's third largest footwear exporter (world market share: 7.6 per cent) and fifth largest textile and garment exporter of the world.[4] Figure 1 highlights the sector's success in Viet Nam, with export figures adding up to US$36.9 billion. Cambodia, while not yet a global leader, is also experiencing very high growth in TCF, which accounted for over 87 per cent of the country's total manufactured exports in 2014.[5]

Figure 1. **Exports of TCF (current US$ billions), selected ASEAN Member States, 1995-2014**
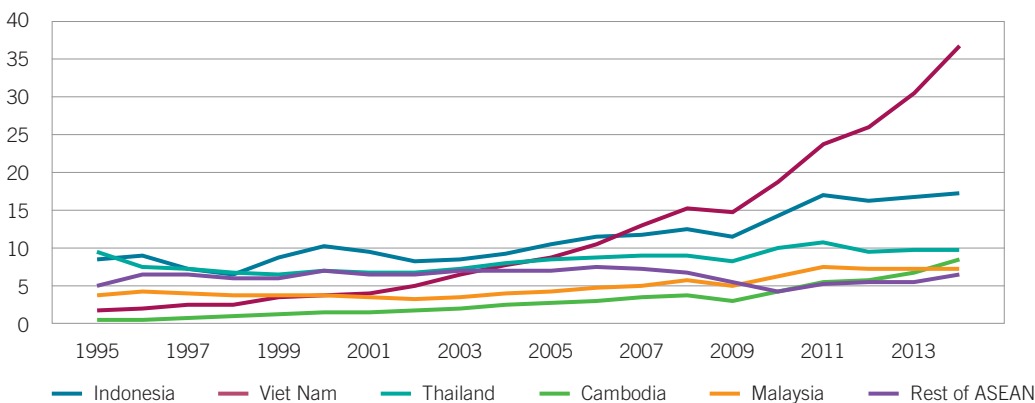
Note: TCF include products under the Standard International Trade Classification (SITC), Rev.4 Divisions 26, 65, 84 and 85.
Source: UNCTAD, 2016.

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[1]   ILO, 2014a.

[2]   It is theorized that economies go through three "cycles", or phases of economic activity: the extraction of raw materials (primary), manufacturing (secondary) and lastly, services (tertiary).

[3]   UNCTAD, 2016.

[4]   UNCTAD, 2016, VIETRADE, 2014.

[5]   UNCTAD, 2016.

The main markets for ASEAN's TCF exports are Europe and the United States, with notable demand from China and Japan as well. ASEAN's total TCF exports to the United States and Europe accounted for 32 per cent and 22 per cent of total export value in 2014, respectively. Moreover, the United States was the largest market for Viet Nam's TCF, representing over 39 per cent of the country's export value in 2014.[6] In the meantime, for Indonesia, the United States consisted of 30 per cent of the country's TCF exports while Europe represented 22 per cent of the export share in 2014.

Figure 2 illustrates ASEAN's total TCF employment among selected Member States. The sector's total employment in Indonesia was approximately 3.7 million in 2014, accounting for almost 25 per cent of total manufacturing workers. Total employment in the sector in Viet Nam was 2.6 million in 2013, accounting for 36 per cent of total manufacturing employment. TCF in Cambodia accounted for 749,000 workers and almost 60 per cent of total manufacturing employment in 2012.

Figure 2. Total employment in the manufacture of TCF (thousands) and share of total manufacturing employment (per cent), selected ASEAN Member States, latest available year
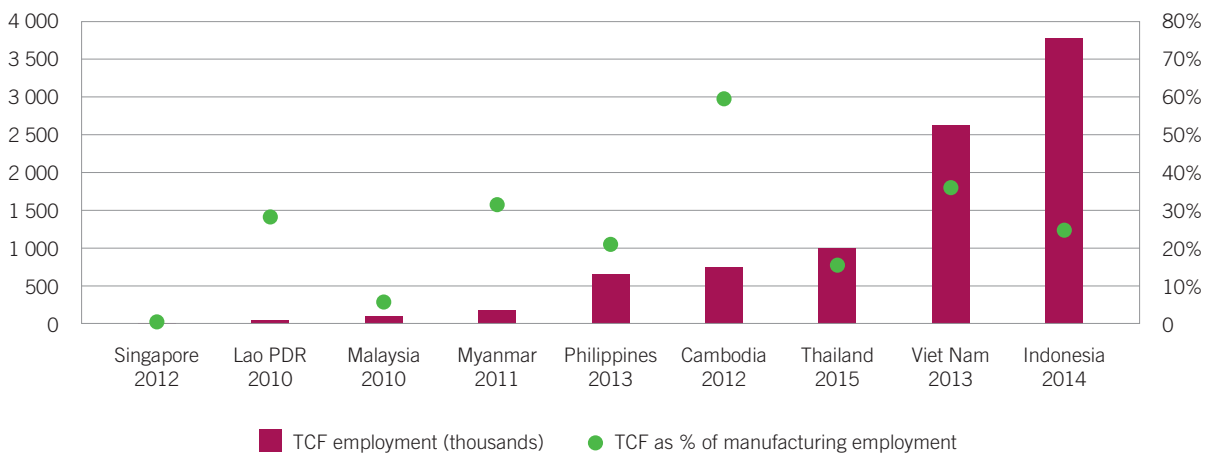
Note: TCF include products under the International Standard Industrial Classification of All Economic Activities (ISIC), Rev.4 Divisions 13 ('Manufacture of textiles'), 14 ('Manufacture of wearing apparel') and 15 ('Manufacture of leather and related products'). Total manufacturing refers to ISIC, Rev.4, divisions 10-33.

Source: ASEAN, 2015; ILO estimates from official labour force surveys (various years).

Notably, the sector employs a high concentration of women (see figure 3). Female participation is over 70 per cent for five ASEAN countries: Cambodia (81 per cent), the Lao People's Democratic Republic (86 per cent), the Philippines (71 per cent), Thailand (76 per cent), and Viet Nam (77 per cent). The average age for six ASEAN countries where the sector has a strong presence is 31 years, with Cambodia having the most youthful workforce of 25 years.[7] The workforce is also largely characterized by low productivity and low education levels.

[6] Ibid.

[7] Huynh, 2015.

Figure 3. Total employment (thousands) in manufacture of TCF by gender, selected ASEAN Member States, latest available year
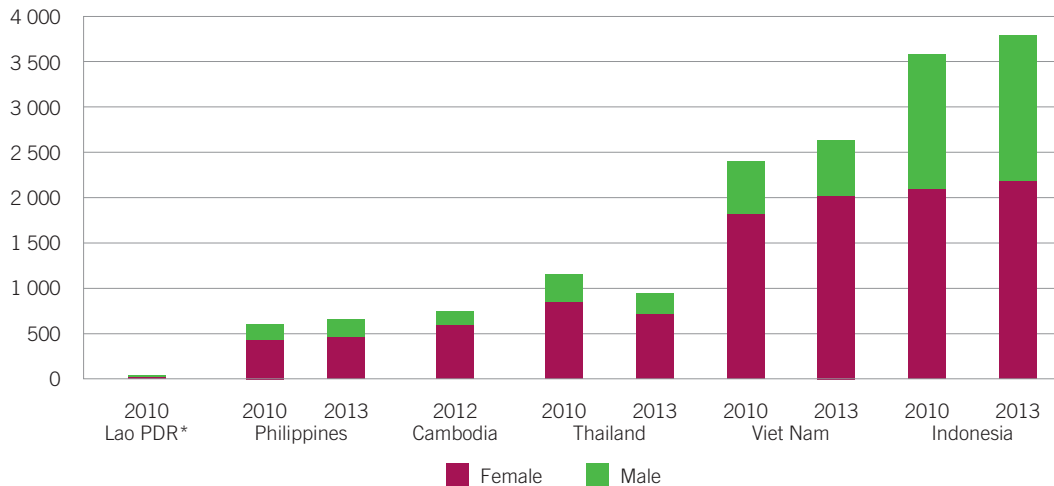
Note: As the figure demonstrates, total employment in Lao PDR's TCF manufacturing sector is relatively small compared to other ASEAN Member States, with 38,000 female and 6,000 male workers reported for the latest available year.

Source: Huynh, 2015.

The growth in ASEAN's TCF can be attributed to a number of factors. Primarily, strong competition among players led to the offshoring of retailers and brands to ASEAN.[8] Growth was further fuelled by waves of preferential trade agreements that promoted global free trade. The most recent example of such an agreement is the Trans-Pacific Partnership (TPP), which – if passed – will provide Viet Nam with tariff-free access to the United States. Additionally, ASEAN's abundant, low-cost, young workforce was especially attractive for the clothing sector, where labour costs was reported to comprise over 60 per cent of total production costs in some instances.[9] Moreover, internal changes within China – such as rising labour costs and demographic changes – resulted in a climate less suited to certain types of TCF production, generating some operational relocation to ASEAN.[10]

Today, the TCF sector represents a key segment for ASEAN manufacturing. However, most Member States are leaning towards less labour-intensive production and the sector's prominence in overall manufacturing is declining as wages increase, as living standards rise and as businesses move to more productive activities.[11] Recent incidences of political instability could also make the region less attractive for TCF manufacturers. As such, a conscious decision needs to be made by ASEAN governments and stakeholders on whether to maintain the TCF sector as an engine for growth or to seek opportunities in other sectors.

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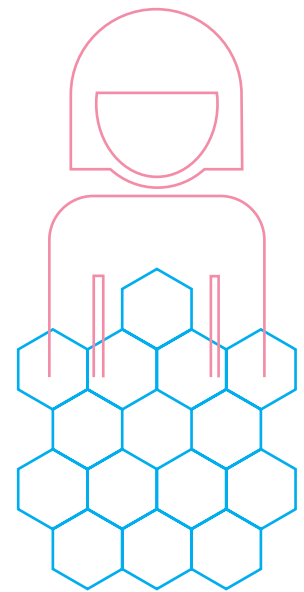
[8]   Large retailers, for example, are Marks and Spencer, Target and Wal-Mart. Clothing brands that are fashion-oriented for example are H&M, Gap and Zara. Footwear brands include the likes of Adidas, Nike and Reebok.

[9]   Gereffi and Memedovic, 2003. Other available research suggests that labour cost can be lower. For example, AT Kearney (2011) indicates that in China, labour consists of about 35 per cent of total cost.

[10]   As young Chinese become better educated and the service sector grows in China, they are seeking alternative jobs. Cut-and-sew operations are the first part of textile production to relocate; they are highly mobile given the simplicity of factories and low capital investment.

[11]   Myanmar would be an exception to this trend. As an economy starting to grow and offering the lowest labour cost in ASEAN, Myanmar could see large growth.

A critical consideration to take into account when making this decision is technological advancements that are transforming TCF production worldwide. Research shows that technology could potentially make the popular formula of offshored production devised by retailers and brands in search of low-cost labour less profitable. At the same time, efforts to increase technology transfer in the region could assist in weathering current weaknesses of ASEAN's TCF sector such as low productivity, rising labour costs and increasing labour disputes.

This chapter looks at the regional and global changes in technology impacting the economics of the TCF sector in the ASEAN region. The main findings are based on expert commentaries, interviews with over 50 industry leaders in the TCF sector, eight company site visits and consultations from multinational manufacturers and brands.[12]

1.1 The disruptors

Today's production for the TCF sector is complex, involving multiple actors of various sizes in geographically dispersed locations. Production includes numerous steps and activities which must be performed in a limited time frame to meet fast-changing and seasonal consumer demand. In addition, the sector is largely divided into (1) high-value production comprising of factories that use advanced technology and higher skilled workers and (2) low-end production relying on low-cost labour and operated under a business model that results in narrow margins.[13] Technological advancements in the TCF sector occurs at various levels of the supply chain and in both high and low value production. It is largely driven by consumer needs and environmental concerns.

> Lean manufacturing is being achieved through technological improvements to assist manufacturers offset labour cost increases with cost savings in other segments such as reduced defects and usage of excess raw material, reduced manufacturing lead times and production cycle time and minimized inventory levels. Companies like Zara use lean techniques to stay ahead of their competitors in the fast fashion industry.
>
> Source: UK Essays, 2016.
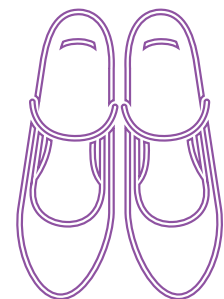
Fast fashion – a production model that has been in existence for about two decades – uses modern technology to keep pace with consumer's on-demand lifestyles by combining short production and distribution lead time and offering highly fashionable design. Enterprises like Zara have invested in a number of in-house technological capabilities such as a high-tech equipment that enables factories to adjust for changes in production volume.[14] Additionally, electronic ordering devices are used by store managers to transmit orders directly to Zara's headquarters. This real time information flow helps shift production capacity as needed and brings flexibility to manufacturing.

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[12] The interviews were conducted in the first quarter of 2016.

[13] High value products would include for example high performance footwear geared to fully support the foot and body movements typical of the sport in question. This type of footwear is characterized by ongoing and intensive technological development aimed at weight reduction, durability, stability and flexibility, comfort and foot or ankle support.

[14] Cheng, 2015.

Product customization technology, such as additive manufacturing, body scanners and computer-aided design (CAD). Consumers nowadays are not only fashion conscious, but also increasingly looking for the perfect fit. They seek TCF products that support their individual biomechanics through customization.[15] This trend is further propelled by higher consumer purchasing power, especially in primary export markets to which ASEAN delivers.

Footwear brands like Converse, Nike, Adidas, Vans, Shoes of Prey, Ferragamo and Manolo Blahnik have all incorporated product customization into their online retail business model, giving customers the ability to directly participate in the design of shoes they buy and wear.[16] Additional technology breakthrough for customization is happening at great speed in the footwear sector as a result of 3D printing or additive manufacturing which allows for automated improvements in the perfect fit of footwear.[17] Moreover, widespread implementation of this additive technology has potential dramatic impacts on the sector's current production model since manufacturing becomes increasingly possible at the point of sales (i.e., proximity of the consumer) rather than having to rely on outsourced production and assembly.

Take the German sportswear manufacturer, Adidas.[18] Adidas predominately sources from ASEAN. Collectively, Cambodia, Indonesia, the Philippines and Viet Nam represent 55 per cent of the company's overall source market.[19] In 2016, Adidas successfully tested a fully automated shoe factory (also known as "Speedfactory") using 3D technology and robotics in Germany. Adidas plans to open the second Speedfactory in the United States in 2017.[20] Speedfactory is part of Adidas' efforts to individualize sportswear and react quicker to consumer needs by bringing manufacturing closer to its clients and speeding up delivery.[21] While time will tell if Speedfactory is widely successful, its profitability could usher a new trend of footwear companies using advanced manufacturing techniques to produce goods closer to point of sale.

> 3D printing and robotic technology will help us set the scene for large-scale commercial production so each consumer can locally get what they want, when they want it, faster than ever. Speedfactory was set-up to propel a network of automated production which brings cutting-edge technology to cities around the world.
>
> Gerd Manz, Vice President of Technology Innovation, Adidas
>
> Source: Sport Techie, 2015.

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[15]   For example, custom suits made to fit the client's body shape and athletic shoes that provide optimal fit and support.

[16]   Nike, 2016; Adidas, 2016a; Shoes of Prey, 2016. Shoes of Prey is a retail brand that enables shoppers to design their own shoes online. Customers use a 3D designer to choose the shape, colour, height and material of their shoes.

[17]   3D printing is a machining process that lays out thin layers of materials to build three dimensional product in the exact form of a digital model. The accurate 3D measurement of the customer's feet is combined with height, weight and activities they engage.

[18]   Adidas is a German multinational company designing and manufacturing sports shoes, clothing and accessories. It is the largest sportswear manufacturer in Europe and the second biggest in the world.

[19]   Adidas, 2015.

[20]   Poltz, 2016.

[21]   Reuters, 2015.

"[Digital printing] helps lower our costs, gives us a lot more options because you can take a white fabric and offer the consumer a lot more options. It's more sustainable and enables much shorter lead times instead of asking a tier two mill to do an overall print for you."

John McNamara, Head of Global Sourcing, Adidas

Source: Just-style, 2015.

The clothing sector has also been able to take advantage of CAD for pattern making, body scanning for measurements, and digital printing for assistance with accurate and rapid production.[22] Body scanning technology is an especially attractive technology, as it customizes clothes in ways that Internet ordering and off-the-shelf purchases cannot accomplish. Body scanning will only become more commonplace.

For instance, Brooks Brothers, an early industry adopter of body scanners, indicates that their cost declined by 60 per cent from 2001 to 2010.[23] The efficiency and continuous cost reduction of such mass customization technology – if accelerated with additional innovation like 3D printing, computerized production and automated packing – will transform manufacturing as well as the supply chain and logistics which surround it. The economics for brands and retailers to place local manufacturing centres closer to major markets will become stronger, making next day delivery possible for consumers. Because of this potential to please consumers in ways previously not possible, big players are re-evaluating their supply chain to cope with faster product design, personalization and production cycles.[24] ASEAN factories that form part of the current off-shored supplier model will increasingly be less needed.

Brooks Brothers introduced customized suits using body scanning machines at their New York retail store in 2001. Using 16 sensors, the body scanner produces 600,000 to 700,000 data points accurate to two-tenths of a millimetre. Brooks Brothers continues to work with large electronic companies like Intel to improve accuracy and perfect the made to measure experience to improve customer satisfaction.

Source: Crease, 2010; Intel, 2016.

Wearable technology, nanotechnology and more sustainable, environmentally friendly manufacturing techniques. Advancements in these technologies are taking TCF to new frontiers. The merging of clothing and footwear sector with electronics is resulting in an emergence of smart clothes that combine medical, fitness and wellness features to monitor heart rate, calories burned and other biometric data. Indeed, market experts predict that wearable electronics business will increase from US$20 billion in 2015 to US$70 billion in 2025.[25] Furthermore, the textile industry is now enhancing consumer experiences by applying nanotechnology to clothes. There now exists nanoparticles that can render clothing odour-free,

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[22]   Bhatia and Asai, 2007. CAD involves the product development process (from designer first sketch to final sample approval ready for production) which has always been the most time-consuming phase in a product cycle.

[23]   Crease, 2010.

[24]   Kaltenbrunner, 2014.

[25]   Harrop et al., 2015.
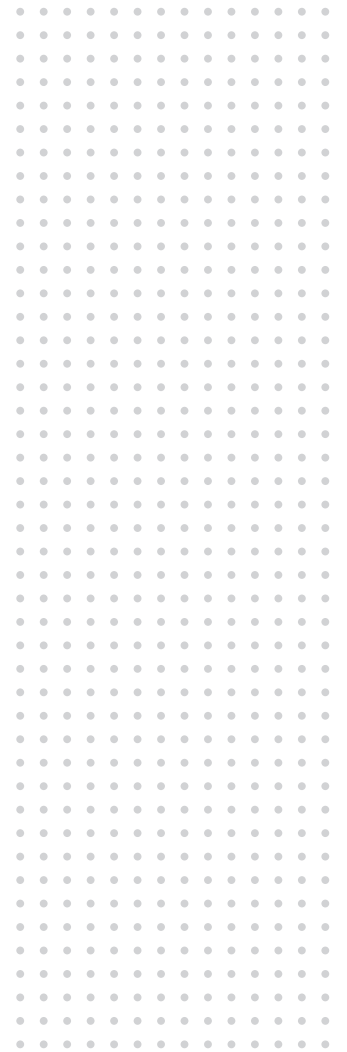
waterproof, UV-blocking or antistatic.[26] With smart textile and wearable technology penetrating the sector, the lines between apparel and technology are blurring while increasing the need for different industries – apparel, electronics, and science – to work together.

Another technology demonstrated increasingly in ASEAN TCF factories is non-sewing (stitchless) technology, or seamless technology. Seamless technology involves a special type of glue that fuses layers of fabric together. Reports show that seamless methods reduce production time by 25 to 35 per cent less than cut-and-sew methods and reduce the labour input required.[27] The end result is a clothing piece that is sew-free, or seamless. For special functionality clothing, such as sports or active outdoor wear, a complete light-weight, waterproof clothing is possible because there are no seams to lock in moisture once the clothing comes in contact with rain or water.

Significant steps are taken to introduce more sustainable, environmentally friendly manufacturing techniques. Consumer and enterprise consciousness is increasing with regards to environmental sustainability and zero-waste products. TCF is well-known for its high consumption of material, water and energy to produce, pack, and ship merchandise across the globe. The cotton required for a single t-shirt consumes up to 2,700 litres of water; dyeing and printing requires vast amounts of water and chemicals and releases volatile agents; and footwear manufacturing uses difficult-to-recycle, petroleum-based material and hazardous chemicals.[28]

Advances have been made to reduce such waste, with knit technology standing as an exemplary case. First pioneered by Nike ("Flyknit") and Adidas ("Primeknit") in 2012, the computer-controlled knitted technology enables a shoe piece to be produced using a single thread.[29] It relies on precise yarn measurement rather than cut-and-glued bulk materials. Reportedly, Nike's Flyknit running shoe is made with 80 per cent less waste than the typical Nike design.[30] If this becomes widespread, knit technology will quickly reduce material, labour and overhead costs. Like 3D printing, efficient zero-waste production allows manufacturing to be localized, cutting global shipping time and increasing production for knitted footwear in strategic markets.[31]

Overview of Nike's supply chain footprint in ASEAN

In 2014, over 150 factories in 14 countries composed Nike's footwear production. Viet Nam and Indonesia collectively manufactured over 67 per cent of the company's shoes (China produced 28 per cent). For clothing, over 430 factories primarily located in a number of ASEAN countries including Indonesia, Malaysia and Viet Nam supplied the company.

Source: Soni, 2014.

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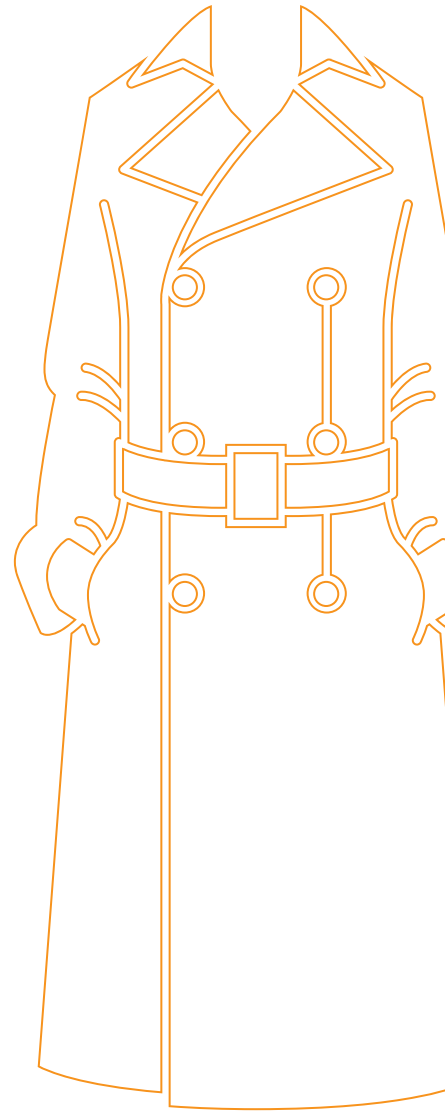
[26] NANOBusiness, 2015.

[27] Sakthivel, 2007.

[28] WWF, 2013.

[29] The price for knit technology varies from US$5,000 to US$18,000 for small-scale production that knits the shoes upper (Alibaba, 2016).

[30] Nike, 2013.

[31] Tsui, 2014.

Other green manufacturing efforts relate to integrating biodegradable materials, non-harmful chemicals and water-saving processes during production. Overall, these trends will pressure manufacturers to equip their facilities with such technologies to improve efficiency and compliance. This will, in turn, create a demand for skilled operators, engineers and others with relevant skills.

For example in 2010 Levi's developed the industry's first "waterless" jeans (called Water<Less) that involves a set of manufacturing process that reduce up to 96 per cent of the water used.[32] Similar eco-friendly production processes have been initiated by numerous actors in the industry. Recognizing reputational risks connected to TCF production and the growing number of environmentally conscious consumers who check for carbon or water footprint of their favourite pair of jeans or sneakers, clothing and footwear brands are stepping up to incorporate modern technology and working with their suppliers to achieve sustainable manufacturing.

> "What's different about the Water<Less collection is that we're still using the same materials and techniques to create finishes for our jeans but we've substantially reduced water's role in the equation."
>
> Carl Chiara, Director of Brand Concepts and Special Projects, Levi's.
>
> Source: GreenBiz, 2010.

The interviews conducted show that ASEAN suppliers are also stepping up efforts to make the workpace greener and safer. In addition, they are responding to consumers worldwide who are demanding for enhanced corporate responsiblility and reduced exposure of factory workers to occupational risks. Suppliers throughout the region have started to address these concerns through better compliance with national labour laws and improved working conditions by utilizing technology that provides worker protections and reduces enviromental waste.

> "Biodegradable plastics are used for some of shoes and shoelaces. The shoe volume for our 'Superstar' brand is very high, and hence it was advised that we use biodegradable and recycled material inside shoes. For the rubber, we also use 5 per cent recycled rubber."
>
> Adidas, Indonesia, ILO interview, 2016.

> "We have deployed a technology to reduce chemical waste when mixing chemicals and eliminated manual labour in that process. So it is done automatically using the machine which produces aerosol and morphine. As a result, the chemical mixing process is safer as there is no direct contact with people."
>
> ECCO Tannery, Indonesia, ILO interview, 2016.

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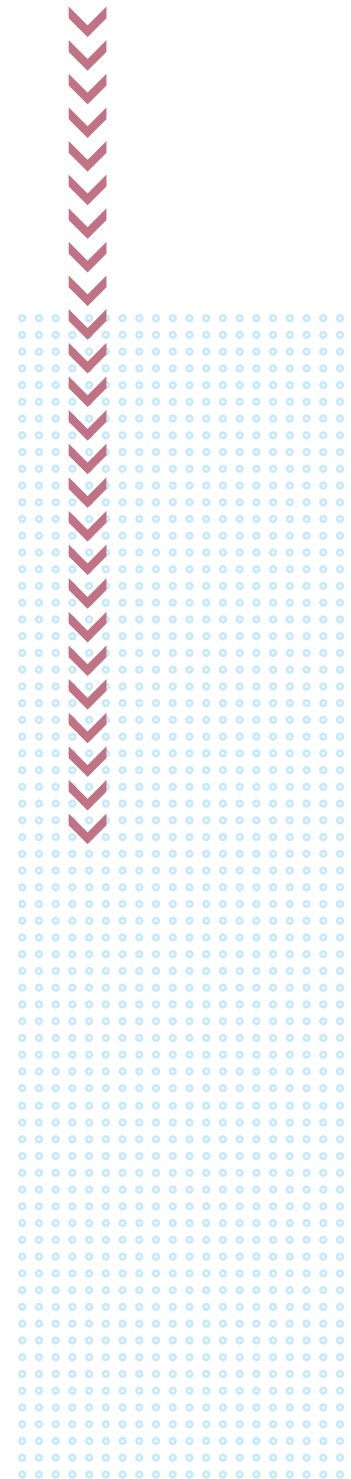
[32]   GreenBiz, 2010.

Computerized TCF manufacturing processes, namely automated cutting machines and sewbots.
In clothing and footwear, automated cutting machines are increasingly prevalent in ASEAN
factories. Hung Wah Garment Manufacturing (Cambodia) – which adopts technology based on
requirements specified by vendors – invested in automated garment machines which eventually
eliminated manual labour from the cutting process.[33] Adidas (Indonesia) also mentioned
automated cutting as a key innovation strategy, and targets are set to lower manual cutting down
to 30 per cent.

For another foreign-owned apparel manufacturer in Viet Nam, the investment of automated
cutting machines was made in 2015. One machine replaced 15 workers in the cutting section,
and the estimated time to reach a break-even point for investment was 18 months. If strategies
such as this are more widely implemented, production will fundamentally change. Workers'
main responsibilities would entail managing three to four cutting machines and ensuring the
machines' smooth operation. This would require increased level of concentration from workers
and result in enhanced productivity.[34]

In addition to increasing productivity through reduced time and labour input, automated cutting
"deskills" the task, as manual cutters – who are considered relatively higher skilled workers
at factories – are no longer needed. With automated cutting, only non-trained operators are
required and there is reduced need for higher skilled workers.[35] Other examples of improved
productivity through automated cutting have been cited in factories within Myanmar, a country
currently looking into the TCF sector as a first step to climb the development ladder.[36]

"In the past, the sewing department needed to re-cut fabric by hand. The Smart Myanmar
team [a technical project] advised us to make the cutting department to [be operated
by machines] strictly follow the orders. The result was unbelievable. There is no longer
re-cutting in the sewing department. It saved us approximately US$3,600 (Bt13,000)
a year: 65.4 per cent on material costs and 34.6 per cent on labour costs."

Thet Su Zin Win, Director, Maple Trading (Myanmar)

Source: Kyaw, 2016.

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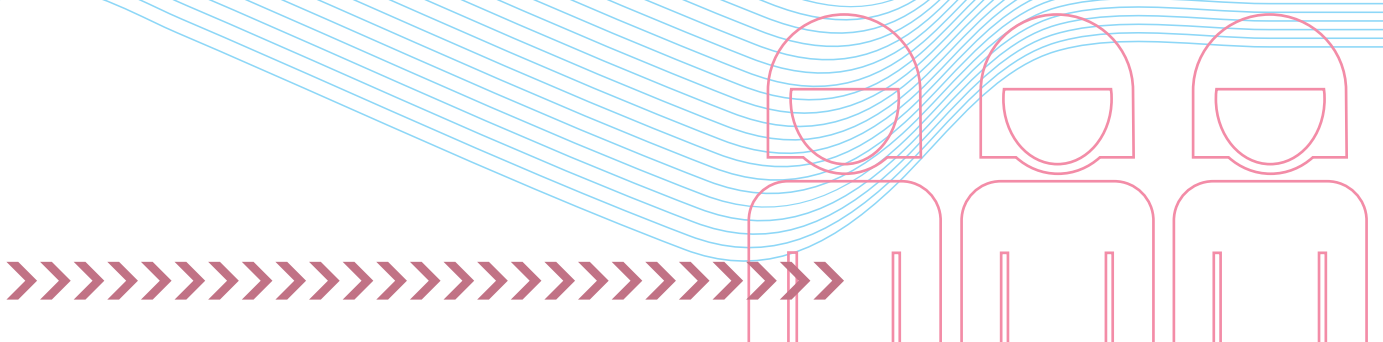
[33]   Hung Wah supplies for brands such as H&M, Adidas, A&F, among others. Cutting is a garment manufacturing operation that can be fully automated (Byrne, 1995).

[34]   ILO interview conducted with foreign-owned apparel company in Viet Nam that prefers to remain anonymous. April 2016.

[35]   Tukatech, Automated fabric cutting machine (Tukatech, 2016).

[36]   Kyaw, 2016.

Box 1. Is clothing manufacturing in Myanmar set to grow?

Myanmar is increasingly noted as a growing market for apparel manufacturing in South-East Asia. Countries such as Cambodia, China and Viet Nam have been more traditional sourcing markets for international buyers, but as wages rise in these countries and others (such as Bangladesh), they are continually seen as high risk. Contrastingly, Myanmar's low-wage, low-skilled workforce and its incorporation into the European Unions' Generalised System of Preferences makes the country an attractive location for clothing manufacturing today. For example, as of February 2016, both H&M and Adidas have manufacturing plants in Myanmar, operating 16 and six plants, respectively.[37]

In 2012, average monthly wages in Myanmar's clothing sector were estimated to be US$60 (including overtime), lower than Bangladesh's basic rate of US$68 and far lower than China and other ASEAN Member States.[38] Currently, the majority of inputs (such as fabric or buttons) are imported to Myanmar, as the country does not have the capability to produce these inputs. This means that manufacturing in Myanmar is on a "cut, make and pack" basis, and manufacturers are only paid for the assembly of the garments as opposed to the full value of the final product.[39]

The main product types exported from Myanmar include high-tech sportswear, formal shirts and suits. Continued development of the input supply will serve to raise the overall production and export value of the sector. In 2014, the export value for the sector stood at US$500 million, based on steady growth since 2003. This is miniscule in comparison to the dominant regional player, China, whose exports stood at US$153 billion.[40]

Myanmar's Garment Manufacturing Association predicts that by 2020 the clothing industry will generate US$12 billion in export value and create 1.5 million jobs. This project was made largely due to the influx of foreign direct investment, the sector's inclusion under the governments' National Export Strategy (2015-2019) and considerable assistance from donors such as the European Union.[41]

Will Myanmar be able to meet these growth targets and profit from using the clothing sector to move up the development ladder as others in the region and globally have done so in the past? Or would Myanmar need to pursue a different growth strategy, given current and forthcoming technological innovations in the TCF sector that could change today's economics of apparel manufacturing? One thing is clear: Production needs and the way of producing will not stay static, and all economies need to be prepared for change.

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[37] Adidas, 2016c; H&M, 2016.

[38] ILO, 2015b.

[39] Barrie, 2016.

[40] ILO, 2015b.

[41] The Nation, 2016.

Computer aided applications such as CAD are slowly coming into ASEAN factories. CAD is a relatively old design technology that offers significant reduction in lead times and labour cost for generating new styles and modifying existing ones through a computerized system.[42] The technology provides cost-effective and sustainable ways of creating samples and reducing waste time, and it facilitates greater speed-to-market. In developed economies, close to 100 per cent of all advanced clothing industries have adopted these applications.[43] However, industry experts say that CAD is relatively new to the supplier side. In ASEAN, apparel technology solution providers like Tukatech revealed that Viet Nam has been the top ASEAN market for CAD for the past ten years with Thailand and Indonesia positioned as 2nd and 3rd.[44] Tukatech's competitor also indicated the same sales pattern for CAD.[45] Essentially, technologies like CAD would move ASEAN's TCF sector up the value chain with better designed and enhanced quality apparel produced by medium-skilled workers.[46]

Numerous reports from 2015 highlight the entire configuration of apparel manufacturing could potentially be redefined through what are known as "sewbots". In 2015, Softwear Automation Inc. launched LOWRY, a robot built with machine vision and computing technologies that automates fabric handling.[47] Working in parallel with LOWRY, Softwear Automation will introduce an automated sewing machine (ASM) that can run on a continuous basis without a human operator by end of 2016. Innovative technology at the sewing stage is pushing apparel production to what seemed impossible in the past – sewing robots automating the more difficult and labour-intensive tasks in garment making.

> "Our machines can run 24 hours straight – which is much longer than a traditional shift by a sewer… Additionally, the precision is much greater so there is less wasted product."
>
> KP Reddy, CEO, Softwear Automation
>
> Source: Barrie, 2015.

The deployment of sewbots could be disruptive. If the total cost of using sewbots proves more economical than sourcing from off-shored countries, with direct savings accumulated in shipping and duty and wider benefits of reduced reputational risk, a strong case can be made for reshoring garment production to places like California (the most populous state in the United States) rather than Ho Chi Minh, Viet Nam.[48] Given additional benefits of sewbots which

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[42] An expert commented that CAD has allowed pattern making to be done by a medium-skilled worker who receives two months training compared to the manual process, which would have engaged a high-skilled worker paid over US$125,000 per annum.

[43] Byrne, 1995.

[44] Tukatech's CAD product is named Tukacad.

[45] The ILO agreed to keep the company's name confidential.

[46] In this paper, we use the International Standard Classification of Occupations (ISCO) to define skills levels. Low skill occupations are defined as ISCO group 9 (elementary occupations), however we extend this to occupations that are labour-intensive and routine such as machine operators. High-skill occupations are defined as ISCO-08 major group 1 (legislators, senior officials and managers), major group 2 (professionals), and major group 3 (technicians and associate professionals), however for this paper, we extend high-skill occupations to cognitively intense and non-routine jobs. Medium-skill occupations include ISCO group 4 (clerks), 5 (service and sales workers), 6 (skilled agricultural and fishery workers), 7 (craft and related trade workers) and 8 (plant and machine operators and assemblers).

[47] Softwear Automation, 2016.

[48] Sewbots prove more economical including labour cost, overhead and other operational expenses. Large brands and retailers are sometimes associated with malpractices in their supply chain with regards to unfavourable working conditions.

include reduced human error, increased workplace safety, consistent quality and stability in output quantity, industry followers are cautioning that sewbots will "throw garment workers in low-cost countries out of a job".[49] In other words, sewbots could render ASEAN a geographic centre point of large-scale displacement of garment workers.

According to Softwear Automation, purchasing LOWRY and ASM together will cost about US$90,000 and the pair of robots could fully replace one sewer.[50] To better understand the disruptive nature of sewbots, we experimented with a couple of scenarios in three countries – China, Thailand and the United States – to determine if and when sewbots will become a profitable investment for apparel manufacturers.[51]

In the United States, clear results are seen in immediate investments made in 2016. In fact, by the end of five years of the machine's life, a saving of more than US$180,000 can be realized by replacing three sewers in the United States with the pair of sewbots. Moreover, if purchases are delayed until 2020, when the cost of technology is cheaper, sewbots could be more than four times cheaper than their human counterparts.[52] More needs to be investigated if the final price of using sewbots would increase the bottom line of US brands and retailers to reshore manufacturing, as producing in ASEAN could still be favourable due to considerably lower labour wages.[53] However, apparel production is not only about sewing of the cloth; it is also about textile, which is an industry that is reviving in the United States thanks to its modern technology and extensive material base.[54] And again, the sector's competitiveness lies in being able to deliver to consumers on time: a key benefit that is attached to sewbots.
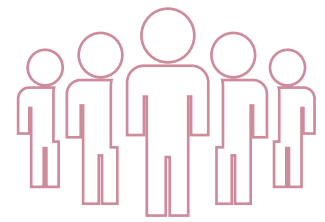
Parkdale, a US cotton spinning mill which closed down in the 1990s re-opened in 2010. There is a fundamental difference in the company's production after its revival: the factory produces 1.1 tonnes of yarn per week with 140 employees. That same production would have required over 2,000 people in 1980. Large-scale automation has been the key to the mill's revival.

"With all the challenges that we've had with cheap imports, we knew in order to survive we'd have to take technology as far as we could."

Anderson Warlick, CEO, Parkdale

Source: Clifford, 2013.

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[49]   The Economist, 2015.

[50]   The ILO clarified the cost structure with Softwear Automation through email communication. The life of the robots were also confirmed as approximately five years (dependent on machine maintenance).

[51]   China was chosen for the exercise as it remains the largest exporter for the TCF sector to developed economies. In addition, China has its own internal consumer base, which is by far the largest in the world and expanding. China's average nominal monthly wages were US$491 in 2013 (ILO, 2015a). Thailand was selected for the exercise as it is considered the most advanced TCF economy in ASEAN. Thailand's average nominal monthly wages (US$277 in 2013) and labour productivity (US$8,178) are the highest for manufacturing TCF in ASEAN (ILO, 2015a). United States was selected for the exercise due to its predominant position as the largest export market for ASEAN's TCF sector. The federal minimum wage per hour is US$7.25 in 2016, and the monthly minimum wage is calculated based on an eight-hour work day (US Department of Labor, 2016). The exercise assumes that LOWRY and ASM replace three workers considering that each sewer has an eight-hour shift.

[52]   We assume that technology will become cheaper and estimate a 5 per cent annual price reduction for sewbots.

[53]   For example, average apparel manufacturing labour cost in Cambodia is only 12 per cent of the US.

[54]   Clifford, 2013.

In both China and Thailand, sewbots are likely to be more economical if investments are made after 2020. Our estimates show that human labour can be up to 50 per cent more expensive than sewbots in China, and a break-even point could be reached in Thailand by 2025 (see figure 4).

Figure 4. Estimated cumulative technology costs of LOWRY and ASM and real wage costs of three sewing machine operators (US$), Thailand, 2017-26
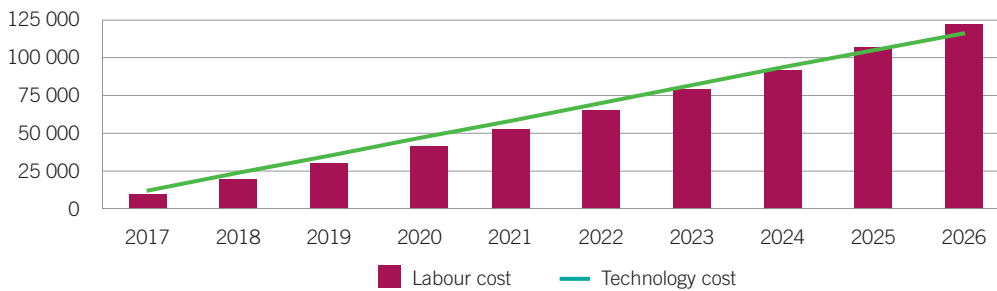
Note: Estimated technology costs in sewbots are based on 2016 prices for two units (US$90,000) with equal yearly installments at an annual interest rate of 5 per cent. Projected wage costs are based on average nominal monthly wages of three sewing machine operators in Thailand in 2015 (US$706.8), adjusted by historical inflation and real wage growth trends.

Source: Authors' estimates.

The key concern here is not in fact over ASEAN countries using sewbots, which is considered a longer-term possibility, but about sewbots entering the factory floors of China – ASEAN's largest competitor for apparel exports and ASEAN's increasingly important export destination. The estimates sketch out a favourable and tempting scenario for Chinese apparel factories to purchase sewbots. These purchases could enable the country to maintain, and even raise, its dominance in TCF manufacturing. China already exports more apparel with less workers and shows a huge appetite for robotics, consuming 25 per cent of the world's robots in 2014 with determination for more.[55] As such, China's decision to automate sewing and replace other labour-intensive processes with technology will impact ASEAN apparel factories, which may no longer be able to compete with China in "making for the world" and "making for China".
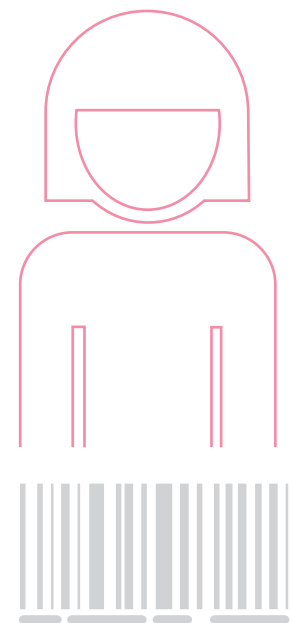
1.2 Forces at play

Technology transfer is made to increase labour productivity, product quality and reduce waste

Overall, the data show that major productivity gains can be made in ASEAN's TCF sector. Across the region, productivity gaps between TCF manufacturing and overall manufacturing remain wide (see figure 5). For example, take the Philippines and Thailand, where labour productivity in overall manufacturing is, respectively, 3.5 times and 2.7 times greater than the TCF sector. Differences within major TCF economies are also large. For example, Viet Nam's labour productivity for the TCF sector is alarmingly low: only 20 per cent of Thailand's.

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[55] IFR, 2016.

Figure 5. Labour productivity in TCF sector and manufacturing for selected ASEAN countries (current US$), latest available year

Cambodia 2012: Manufacturing $2 296, Manufacturing of TCF $1 848
Indonesia 2014: Manufacturing $11 623, Manufacturing of TCF $4 149
Philippines 2013: Manufacturing $17 634, Manufacturing of TCF $4 646
Thailand 2013: Manufacturing $21 512, Manufacturing of TCF $8 178
Viet Nam 2013: Manufacturing $4 112, Manufacturing of TCF $1 741

■ Manufacturing   ■ Manufacturing of TCF
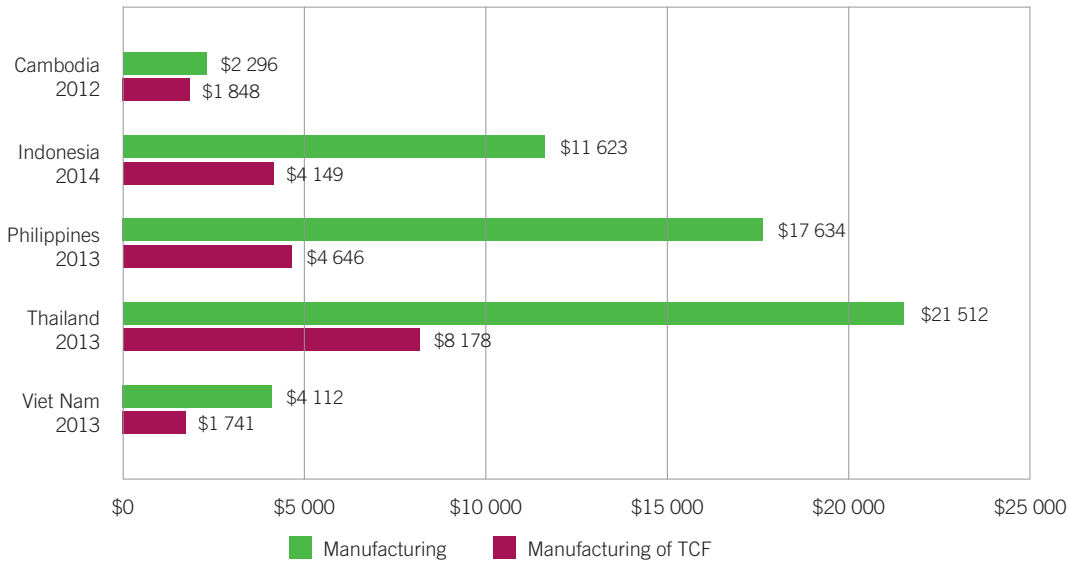
Source: Huynh, 2015.

Out-dated technology and a lack of machine maintenance have long held back ASEAN's TCF productivity. Indonesia's Ministry of Industry estimates 70 per cent of all machinery in use is out-dated (on average between 10 to 25 years old).[56] Viet Nam's TCF sector also struggles from old technology. Moreover, the low skills upon which many ASEAN countries rely limit their overall productivity.[57] These factors must be addressed going forward, as other forces at play are threatening ASEAN's TCF industries. The lack of local investment in R&D and upgrading technology may put the region in a challenging position, especially as other TCF players continually improve their processes. In the textile sector for example, Nan Yang Textile Group revealed that they invest in the latest automated technology that increases the speed of spinning to make fabric, resulting in enhanced productivity.[58] One study shows that labour productivity of spinning can differ by over 500 per cent depending on differences in technology, extent of automation and operational efficiency.[59]
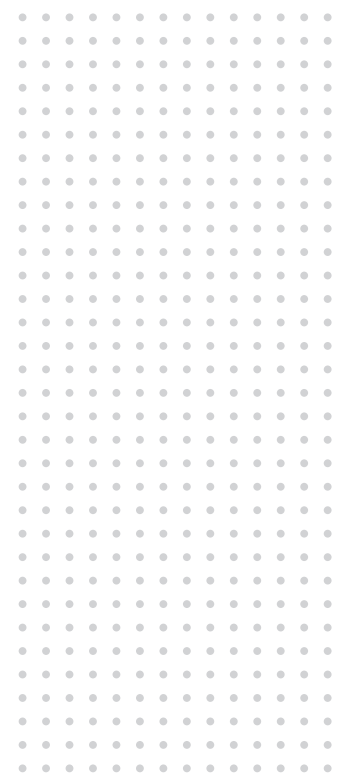
The three spinning mills of Nan Yang, consisting of 122,000 spindles, are equipped with modern spinning machineries from Switzerland, Germany, Japan and Italy.

Source: Nan Yang Textile Group, 2008.

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[56]   GBG, 2012.

[57]   Vietnam Chamber of Commerce and Industry, 2016.

[58]   Nan Yang Textile Group runs six factories in Thailand and Lao People's Democratic Republic. The group is made of 14 affiliated companies and employs 14,000 people. They specialize in yarn, fabric and apparel production.

[59]   Shanmuganandam and Mariappan, 2015.

Our research shows that innovation in TCF has largely been driven by major brands and transnational manufacturers investing targeted proportions of their returns into R&D. For example, in 2015 Adidas invested around 0.8 per cent of net sales in R&D (around 139 million euros).[60] Nike, while it does not publicly disclose R&D information, was included in the world's top 50 innovative companies in 2015, indicating heavy R&D investment.[61] Transnational apparel manufacturing such as Esquel is also known for investing millions in R&D, recruiting top-level engineers and making technology key to competitiveness.

While TCF industry leaders who source from ASEAN are spending millions on R&D and continuously introducing new and transformative technology, adoption of global innovation appears to be somewhat limited in ASEAN factories due to constraints in skills and economics, partly because the region largely trades on low-cost labour. However, global brands and transnational manufacturers that source or produce in the region are integrating incremental technological processes to improve efficiency and increase compliance with vendor requirements to meet product quality and environmental sustainability standards.

China matters: The big giant may accelerate automation

China remains the untouchable global giant for TCF, and its actions will influence ASEAN's TCF competitiveness. Despite the region's growing stature within TCF production and its lower wages, there are still a number of critical areas that makes China much more competitive.

First, China's extensive material base is unrivalled in Asia. Other countries in ASEAN cannot provide the full vertical supply chain and many import from China. Second, China has a long history of manufacturing and extensively investing in highly efficient and specialized ports, roads, bridges and services to support the movement of goods. Third, lower wages in ASEAN are not only offset by inferior infrastructure, but also worker productivity. Interviewees stressed that Chinese workers are higher skilled and more experienced.[62] Additionally, the major focus in China's TCF sector has been to sustain competitiveness through investment, individual training and lead time reduction. Finally, the growing middle class in China brings millions more individuals armed with new spending power that will increase net consumption. Alongside this, the proportion of income committed to discretionary and semi-necessity spending is predicted to rise by 13.4 per cent and 10.9 per cent a year until 2020, while mainstream consumers are expected to reach 51 per cent in 2020, up from 6 per cent in 2010.[63]

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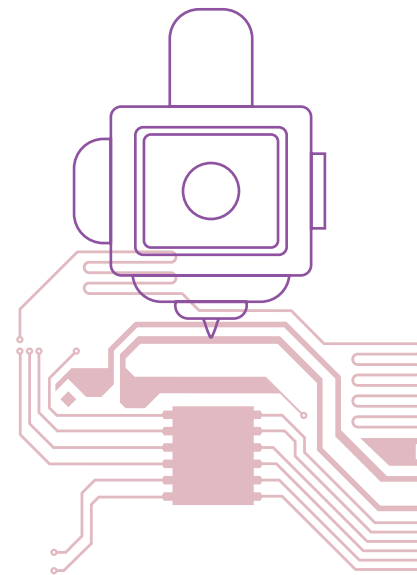
60   Adidas, 2016b.

61   Nike's R&D ranking was retrieved from The BCG, 2015.

62   Note that there is lack of reliable productivity data for China's TCF sector that could be directly compared to ASEAN countries.

63   McKinsey and Company, 2012. Mainstream consumers refers to consumers with incomes from US$16,000-34,000.

"If you look at top European machinery suppliers, maybe 80 per cent of sales are from China. There is a huge investment in this sector to help textile suppliers improve their efficiency and quality. So the textile side is no longer considered labour-intensive."

John Cheh, CEO, Esquel Group

Source: Fangqing, 2015.

Figure 6 compares China's exports with Viet Nam, ASEAN's leader in clothing and textile exports. Clearly, China has a powerful grip on the TCF sector. Moreover, statistics show that China has been able to increase exports despite declining number of workers employed in the TCF sector since 2008 (see figure 7). While numerous factors can be attributed to this trend, such as enhanced ability to produce higher-value products and a better trained workforce, a growing number of TCF manufacturers have cited technology as their new engine for growth.

Figure 6. Export value of TCF products (current US$ billions), China and Viet Nam, 1995-2014
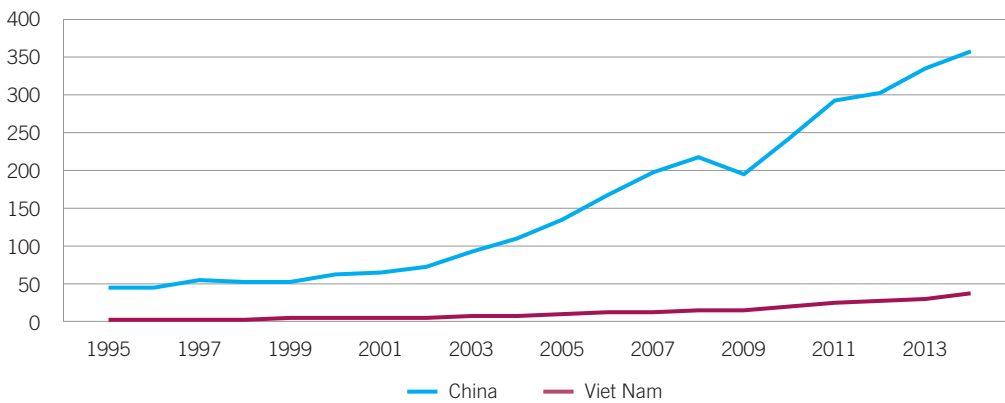
Note: TCF include products under the SITC, Rev.3, Divisions 26, 65, 84 and 85.
Source: UNCTAD, 2016.
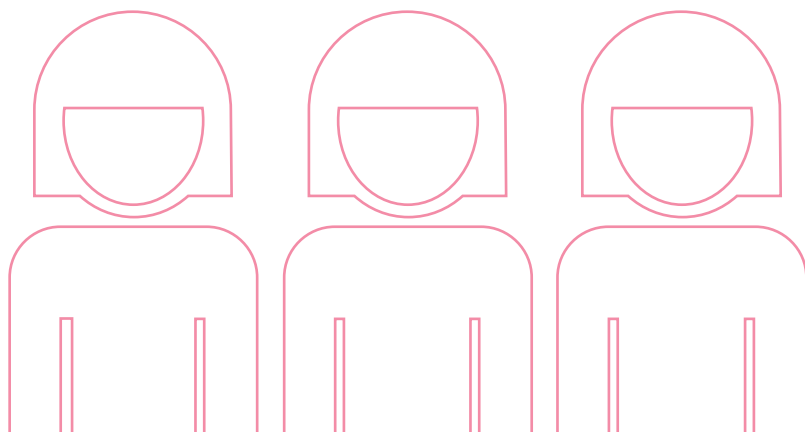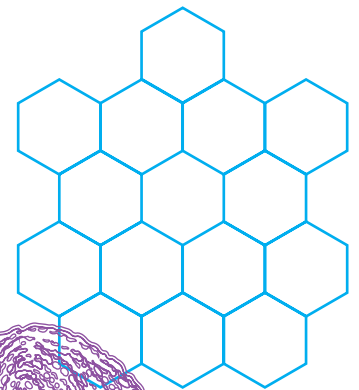
Figure 7. Employment in the apparel sector and sub-sectors (thousands), China, 1998-2015
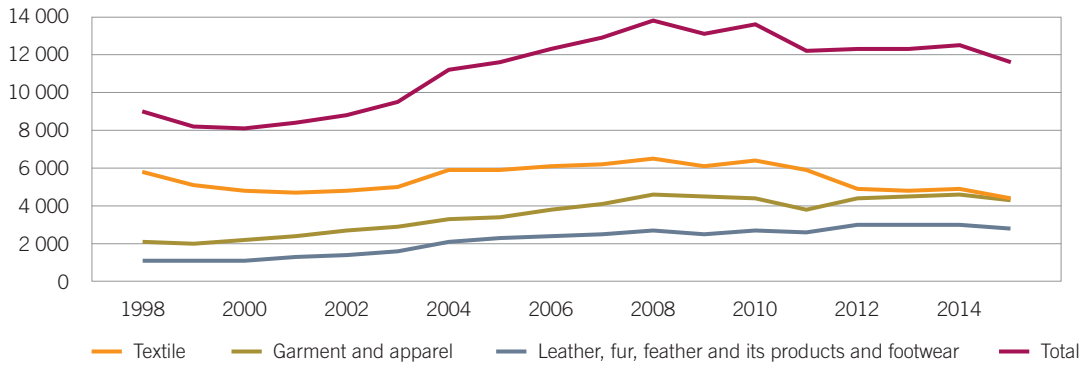
Note: Employment in the apparel sector and subsectors refers to the number of people employed in urban units.

Source: National Bureau of Statistics of China, 2016.

Thus, the major force at play here is not that China is a TCF leader; it is the fact that China is aggressively trying to improve its standing, with technology forming a critical component of maintaining competitiveness. Moreover, with the central government eager to push China's manufacturing sector up the value chain and looks to shift from "made in China" to "created in China", indigenous innovation is spurring.

For example, Bealead Automatic Machine Co., a Chinese-based automation company interviewed, devised a system that increases the efficiency and reduces the labour component of the duck feather filling process into jackets, partnering with North Face, Montcler and Adidas. The automated feather filling machine reduces the number of workers from five to two. The two workers left require training to operate with the machine and an additional technician is required to maintain the machine. In this particular case, investment in a single automated feather filling machine costs US$33,000. With worker wage in China at US$491, the company is able to recover the investment made in about one-and-a-half years.[64]

If other enterprises in China are making similar investments, particularly through sewbots, an uncertain future awaits ASEAN apparel makers. ASEAN will need to rigorously follow China's movements and continually evaluate how the region should use TCF as a vehicle for growth.

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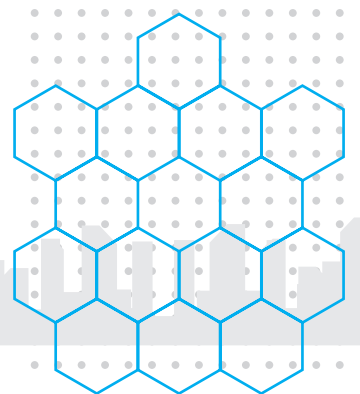
[64] China's average nominal monthly wages was US$491 in 2013 (ILO, 2015a). Average nominal wages from 2013 to 2016 were adjusted based on historical real wage growth and average inflation rates. The calculation was done assuming that the company pays for the automated feather filling machine over the course of five years at an annual interest rate of 5 per cent. Investment recovery is non-inclusive of technician wage and installation requirements.

> **Box 2.** **Technology developments in China's textile sector**
>
> A textile and clothing manufacturer in China reported to Aljazeera in 2015 that technology is becoming a critical component of maintaining competitiveness in the industry as it increases productivity and reduces labour costs. The company employs about 5,000 to 6,000 workers during peak operations and generates between US$113 million to US$129 million in sales annually. They developed a digital printer [invested US$ 500,000] which prints 30 metre lengths of cloth in one minute. The printer reduced the workload of eight people down to three and allows sales of US$161 million to be achieved with maximum 300 workers – roughly 20 times more productivity per capita.
>
> Source: Middlehurst, 2015.

TCF manufacturers can still chase the cheaper needle

Increasing labour costs labour costs in the region reduces the appeal of apparel manufacturing in ASEAN. Interviewees stated that their factories are considering strategies to reduce dependence on human labour through new machinery. However, local suppliers expressed that financial and resource constraints make it challenging to incorporate technology.

> Rather than shifting to Africa to take advantage of lower labour costs, the future will be driven by innovative technology such as 3D printing, which Puma is already using for prototype shoes.
>
> Source: Thomasson, 2014.
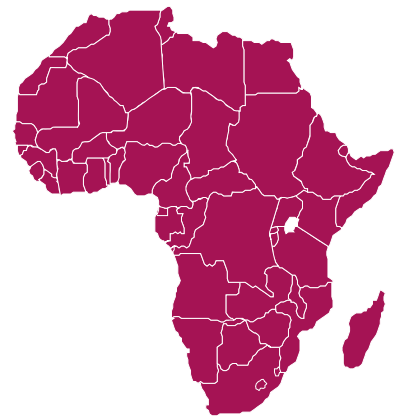
Therefore, if labour cost becomes too high in ASEAN, this could trigger transnational apparel manufacturers to move out of the region in search of new low-cost production sites. While it is difficult to strike the right balance for sourcing locations because criteria such as cost, quality, compliance, speed, productivity and risk need careful measurement, some industry leaders – albeit with mixed opinions – are suggesting expanding into Africa. The continent is seen to have the ingredients that can make it a global force in apparel exports. It has abundant, low-cost labour as well as natural resources like cotton, water, energy and land.[65] As aforementioned, raw material supply is considered one of ASEAN's core weaknesses. For instance, in 2013, Viet Nam's domestic cotton production satisfied only 1 per cent of the industry.[66] However, Africa comes with its challenges such as poor infrastructure, corruption and red tape. If movements to Africa are accelerated with government policy to attract investment, build regional value chains and continent-wide free trade agreements, the ASEAN TCF sector could lose its competitiveness and reduce in size.

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[65] Just-style, 2016.

[66] EOS intelligence, 2015.

Mass customization coming at grand scale

Advances in mass customization technology could also make ASEAN factories redundant. Currently, body-scanning technology is limited to upper mid-range products for which consumers pay a price premium. What is yet to come is mass customization offered by large retailers such as Wal-Mart, Tesco or Carrefour at no additional cost. However, technology exists to make large-scale retail customization a reality.[67] Once a cost-effective combination of technologies is achieved for 3D body scanners, computerized pattern making, computerized size grading, computerized spreading, computerized cutting, fast-turn sewing, computerized packing and localized production, the time between consumer purchase and delivery will be drastically reduced, offering enormous efficiency.

> "Custom-made clothing is going to be a big thing. Consumers will be able to scan their own body at home and send a scan to their favourite brand and make custom clothing from it. This I definitely see happening by 2030."
>
> Roger Lee, CEO, TAL Apparel Group
>
> Source: Just-style, 2014.

Figure 8. Flow chart for mass customization
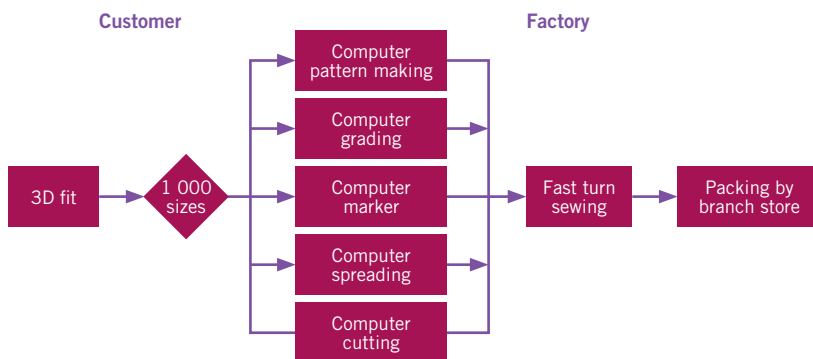
While it is difficult to foresee if 2025 will bring an optimized merger of existing technologies, the potential impact is clearly disruptive for entire actors of the sector, including ASEAN factories who supply to transnational manufacturers, brands and retailers. In order to remain relevant in this scenario, ASEAN factories will need to quickly upgrade technology and team up with retailers and brands that have a bigger consumer base in ASEAN, since localized production (intraregional trade) is a precondition to mass customization success. At the same time, export flow from ASEAN towards Europe and the United States will decline if these technologies trigger nearshoring or reshoring. Ultimately, mass customization could considerably impact the sector's prominence in ASEAN. The number of TCF factories and people employed will decline unless sales (or production demand) within ASEAN is sufficient to recover anticipated export losses.

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[67]   Based on commentaries provided to the ILO by industry leaders.

IMPACT ON ENTERPRISES

2.1 Effects on operations

Technology-driven production can become widespread in ASEAN, but today there are noted differences in adoption

Our fieldwork shows mixed results regarding technology upgrading in ASEAN TCF factories. While respondents agree that technology enhances operation at all levels, the expensive capital investments may prove unprofitable, especially because the sector generates thin profit margins. A long-term agreement would have to be made with buyers purchasing large quantities of stock produced. The fieldwork also reveals insufficient skills to manage advanced technology. Some interviewees stressed that factories could not adopt automation because they did not have adequate workers who could operate and maintain new machinery.

Despite these constraints, ASEAN suppliers need to keep in mind both the export market and domestic market. Consumers are becoming more sophisticated with their apparel selection. With this comes a vendor requirement that is ever more demanding. Embracing technology is one way ASEAN can maintain a competitive position and produce higher end apparel. Such movement was noted in Thailand, which is considered the higher end producer of ASEAN. ECCO (Thailand) revealed that they are introducing new technology to make shoes that have quick drying feature suitable for European countries.[68]

Localized production in major markets and heightened need to target domestic consumption

"In our 2015 benchmarking study, 53 per cent of members said they source from the United States. Meanwhile, 39 per cent of members expect to increase sourcing from the US in the next two years, with 80 per cent of those already sourcing from the US expecting to do more...There is an interest in making it [apparel] in America especially when it comes to 'smart' apparel and accessories and technical textiles, as well as samples and products that need to hit the market immediately."

Julia Hughes, President, United States Fashion Industry Association

Source: Barrie, 2016.

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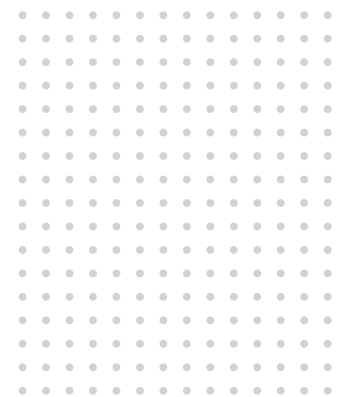
[68]   ECCO provides comfort footwear for men, women and kids. ECCO Thailand has been operating for more than 20 years.

Deloitte's 2015-16 survey of apparel, general merchandise and retailers identified a diverse set of sourcing pressures related to cost, quality and speed to market. For apparel, the biggest pressures included demand for increased speed to market, rising labour costs, availability of production facilities and evolving product trends causing shifts in consumer demand.[69] As aforementioned, 3D printing, body scanning and sewbots help bring manufacturing closer to markets and de-link, to a great extent, production cost and wages.[70]

How can ASEAN apparel factories prepare for the forthcoming changes? One strategy would be to reduce dependence on exports and to focus on local and regional markets. ASEAN's domestic consumption and disposable income from a young, fashion-oriented population is growing. In Indonesia alone, the consumer class is growing by 5 million every year – a market size nearly equivalent to Singapore's population.[71]

A number of surveys also highlight a key advantage ASEAN manufacturers could reap: strong consumer preference to buy local brands.[72] However, our research shows that most local apparel suppliers do not have their own brands. Rather, they simply fill orders from outside buyers. Overall, ASEAN apparel makers can weather forthcoming changes in global apparel manufacturing by serving domestic and regional markets. In doing so, they need to track the changing lifestyles of ASEAN consumers and produce apparel that meets their needs.

2.2 Effects on skills

Technology means both deskilling and upskilling of operations

There is a dearth of technicians and engineers who can operate, service and maintain the new TCF technologies in the ASEAN region. As commented by an interviewee who has served the industry for more than 30 years, "the almost complete lack of qualified garment and textile industry engineers and the fact that ASEAN does not have a single qualified tertiary engineering institution is a sad reality, especially for a region that is dependent on apparel exports."

In the immediate term, industry experts stress that better skilled production line workers are needed. In addition, skilled engineers are required not just from a simple line efficiency perspective, but also from a holistic sustainability perspective. As demands to be efficient from both labour and environment perspectives increase, qualified personnel are needed to guide these required changes.

Modern technology such as automated cutting and CAD will increase the demand for skilled workers knowledgeable in operating new machines and computer software. To produce higher value products that meet heightened consumer demands from export markets, ASEAN TCF makers will need to work more closely with other sectors such as electronics, material science and medical science.

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[69] Deloitte, 2015.

[70] This happens either through reshoring or nearshoring. There is already growing evidence of nearshoring – the movement of production to lower cost countries closer to market. Expansion in areas such as Central America for the US market and Turkey and Portugal for the European market is developing and a trend observed by a number of actors. One company interviewed is seeing the fastest level of growth in Turkey and Portugal. The advantage is their proximity to market and reduced lead time.

[71] McKinsey and Company, 2013.

[72] Ibid.

Higher education outcomes set the young ASEAN generation apart from previous ones, especially the growing share of ASEAN women in tertiary education. Given this trend, the TCF sector is unlikely to attract better educated female workers. Indeed, the ILO student survey confirms women students desire to work in human health or social work rather than manufacturing.[73] While the apparel sector provides an income stream for many young female workers in the region, as stressed by one interviewee, "as soon as they have an option, they will not choose to be in an apparel factory". In more advanced ASEAN countries such as Thailand, apparel employers are already flagging challenges with filling factory lines and considering technology as an operational solution.

Manufacturers are deskilling operations through automation, achieving the same production with less workers. Deskilling manufacturing is also critical to achieve better quality and to reduce a learning curve that takes up to several weeks, even months, to achieve expected levels. TCF suppliers mentioned that modern technology is in particular replacing medium-skilled or high-skilled workers who may require six to nine months of training. To summarize, deskilling reduces manual labour, training time and worker turnover and increases overall product quality.

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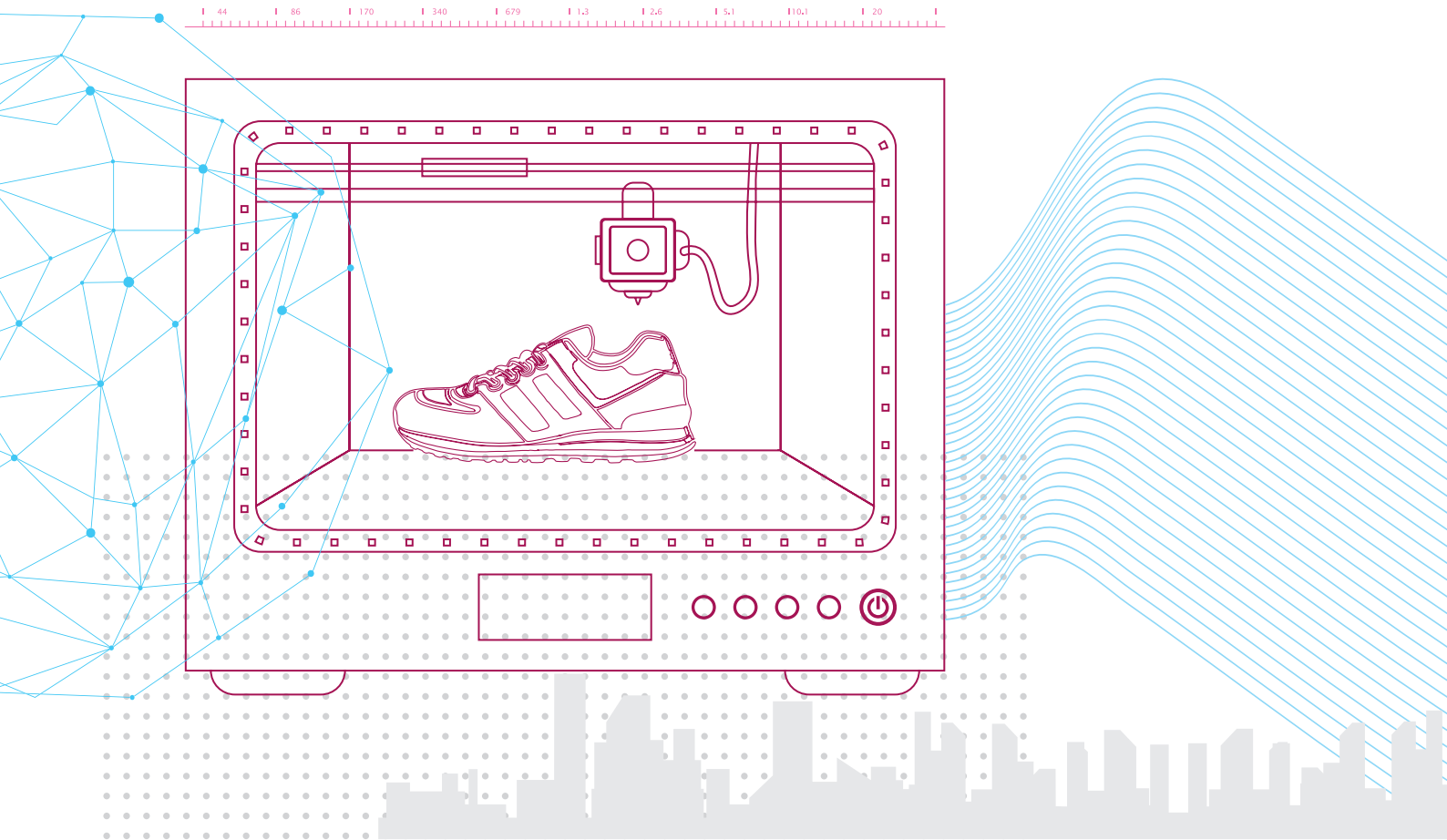
[73]   A 10 ASEAN country student survey with over 2,700 responses was carried out in 2015 by the ILO. The survey paper, *ASEAN in transformation: Perspectives of enterprises and workers on future work* is available as an accompanied paper to this research project.

IMPACT ON PEOPLE

3

Our interviews reveals that when technology is introduced and workers become redundant in ASEAN's TCF factories, they are absorbed and retrained in other departments. Because technology upgrades in ASEAN has thus far been incremental and small-scale, reskilling and re-profiling workers will remain a common practice.

> "If we have a process that was done by three to four people, then we see the need for automation. However, we take into consideration that due to automation the excess labour doesn't get laid off. We collect all the excess manpower and then set up another manual process which implies increased capacity. By having one more line, we have more capacity. Actually, none of the people lose their job due to technology. We relocate them to the new line which is developed."
>
> Adidas, Indonesia, ILO interview, 2016.

However, when technologies such as additive manufacturing, the Internet of Things, big data analytics and automation (sewbots) improve and become combined, ASEAN's TCF sector will look very different. Unless considerable strength in productivity and quality is constructed, millions of jobs could be at risk. For some countries like Cambodia, where TCF production dominates an undiversified manufacturing sector and makes up around 60 per cent of manufacturing employment, the impact will be felt more strongly than others.

An ILO assessment of automation risk of jobs in ASEAN provides an indication of the sector's vulnerability.[74] Estimates indicate that significant shares of TCF sector's wage workers are at high risk of automation, ranging from 64 per cent in Indonesia, 86 per cent in Viet Nam and 88 per cent in Cambodia. In fact, for most countries examined, the TCF sector showed the highest automation risk compared to other manufacturing sectors.[75] Such results suggest that the TCF sector predominately consists of repetitive and mundane jobs that are replaceable by programmed machinery and engineering advancements.

All of the above accumulates into an uncertain outlook for ASEAN's young workers, predominantly women who often look at TCF as a first step in career building. The sector may no longer have the capacity to absorb large numbers of low-skilled workers who are typically recruited from rural areas or farms. Rather, ASEAN factories are likely to turn to graduates from reputable vocational training institutions to fill higher skilled jobs. Such recruitment will provide factories with higher skilled workers who can work with modern technology and consumer needs.

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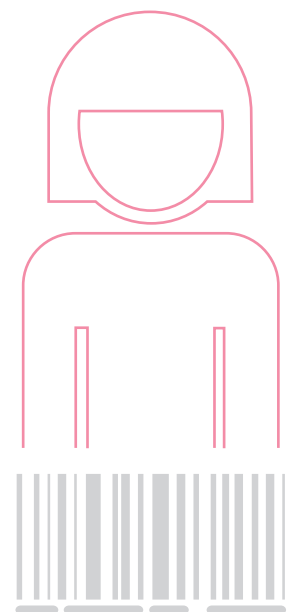
[74]   Chang and Huynh, 2016.

[75]   The exception is the Philippines, which showed greater automation risk for the electronics and computer sector.

LOOKING AHEAD

4

The economics of offshoring will be less attractive: Reduction of ASEAN's TCF sector labour force is inevitable

- In the short term, as leading brands and retailers experiment and pilot disruptive technologies such as 3D printing and automated sewing, ASEAN's export growth to Europe and the United States will incrementally decline. Additionally, China's determination to equip factories with the latest machineries could slowly reduce ASEAN's global market share.

- Selected ASEAN countries will reap some benefits through preferential trade agreements like Viet Nam's case with the TPP. This will boost export demand and create even more jobs. While the sector will continue to be associated with growth in the immediate term, we expect a plateau to be reached at a quicker rate than anticipated due to technological disruptions.

- In the medium term, the region is likely to experience a noticeable decline in export growth. During this time, a number of key disruptors are expected to feed off each other and hit economies of scale, reaching a level of sophistication that allows them to achieve extremely delicate sewing with precision, quality, flexibility and speed. These technologies will hasten multinational brands and retailers to bring production closer to markets to reduce lead time and meet consumer demands.

- Ultimately, ASEAN's TCF sector will be forced to downsize at a pace that challenges development strategy planned by certain Member States. ASEAN's export-led TCF sector will no longer be able to offer jobs to millions who are looking for formal employment opportunities.

- It is imperative for countries that are heavily reliant on the TCF sector to strategize economic diversification and foster additional growth sectors to avoid considerable setbacks in development.

The TCF sector will enter into an intense competition for higher skills

- We expect ASEAN's TCF sector to focus on upgrading production with low-cost automation technologies that will initially assist operators rather than replace them in the immediate term. As labour costs continue to rise and as technology becomes cheaper, more and more factories will introduce mechanized processes. As a result, the region will encounter some displacement of low-skilled workers while increasing the demand for higher skilled technicians and engineers.
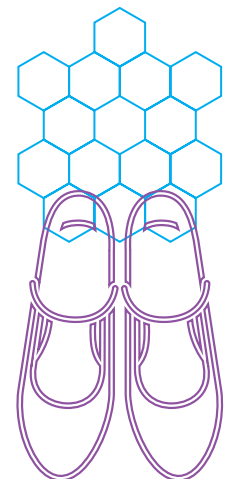
- Eventually, the workforce needs of the region's TCF factories will drastically change. The industry will likely consist of niche apparel producers who will enter fierce competition with other sectors – such as automotive and electronics – to recruit competent designers, engineers and technicians. Ultimately, the sector's pursuit for low-skilled, low-educated workers will wane.

- Moreover, ASEAN's booming middle class will need to be catered to. Increased domestic purchasing power will be associated with enhanced demands for customization, wearable technology and other needs on par with those of global consumers in today's developed markets.

- To remain competitive, industry players must accelerate partnerships with educational and training institutions to groom the next generation of TCF workers who have stronger technical qualifications and expertise and the ability to work seamlessly with multiple strands of emerging technologies.
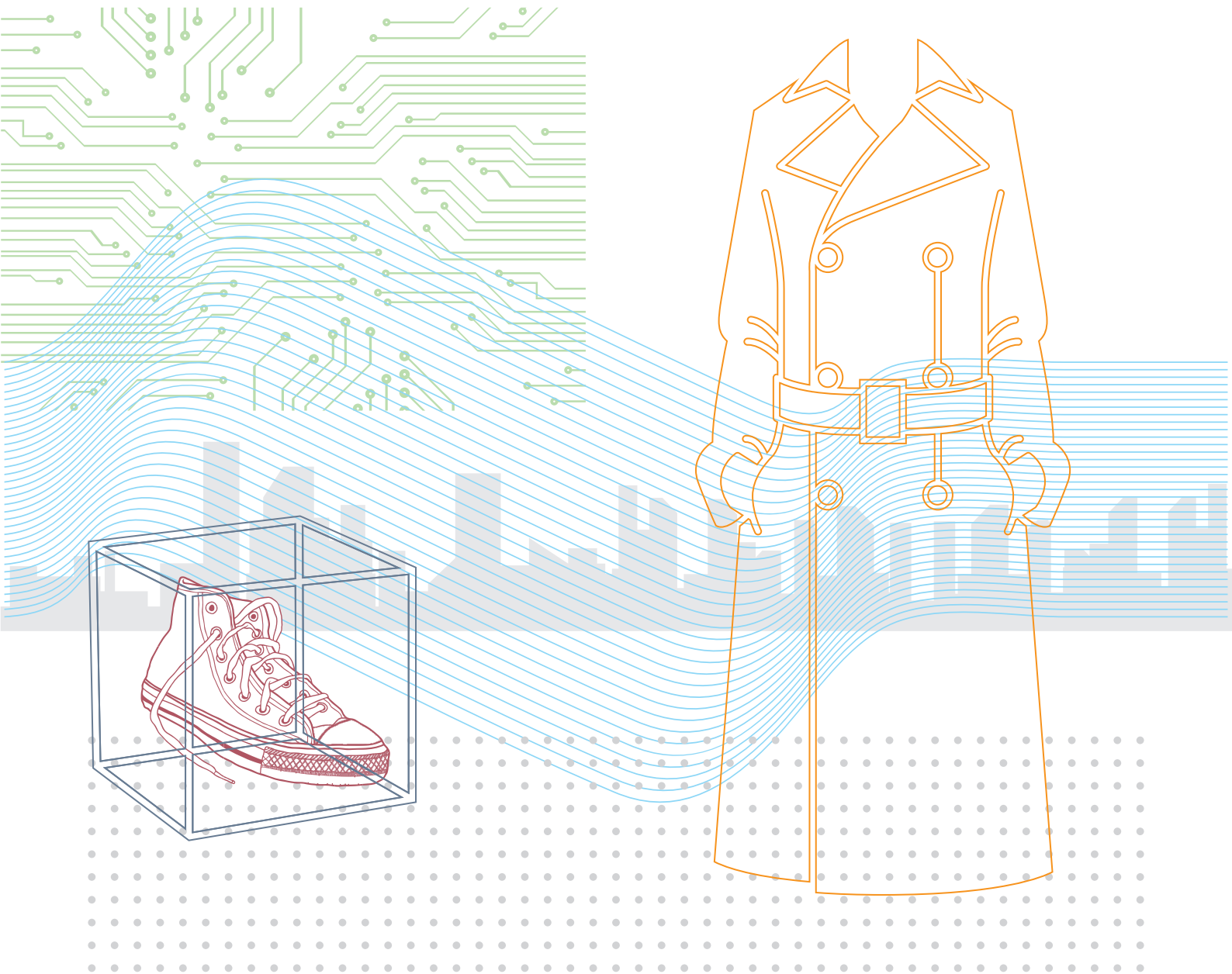
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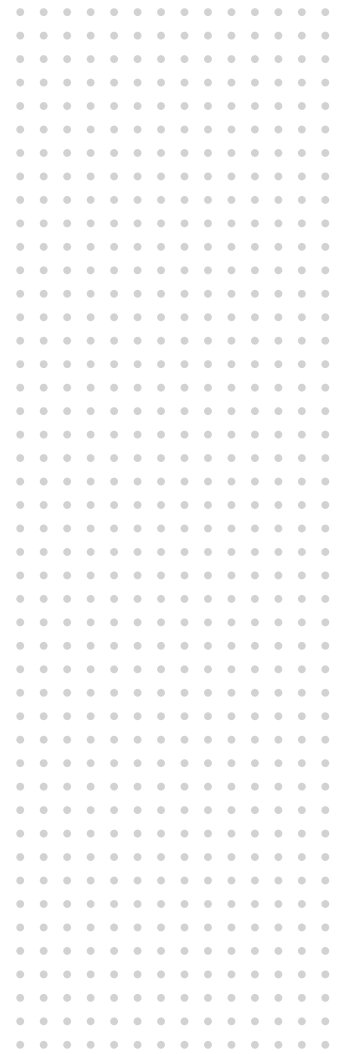
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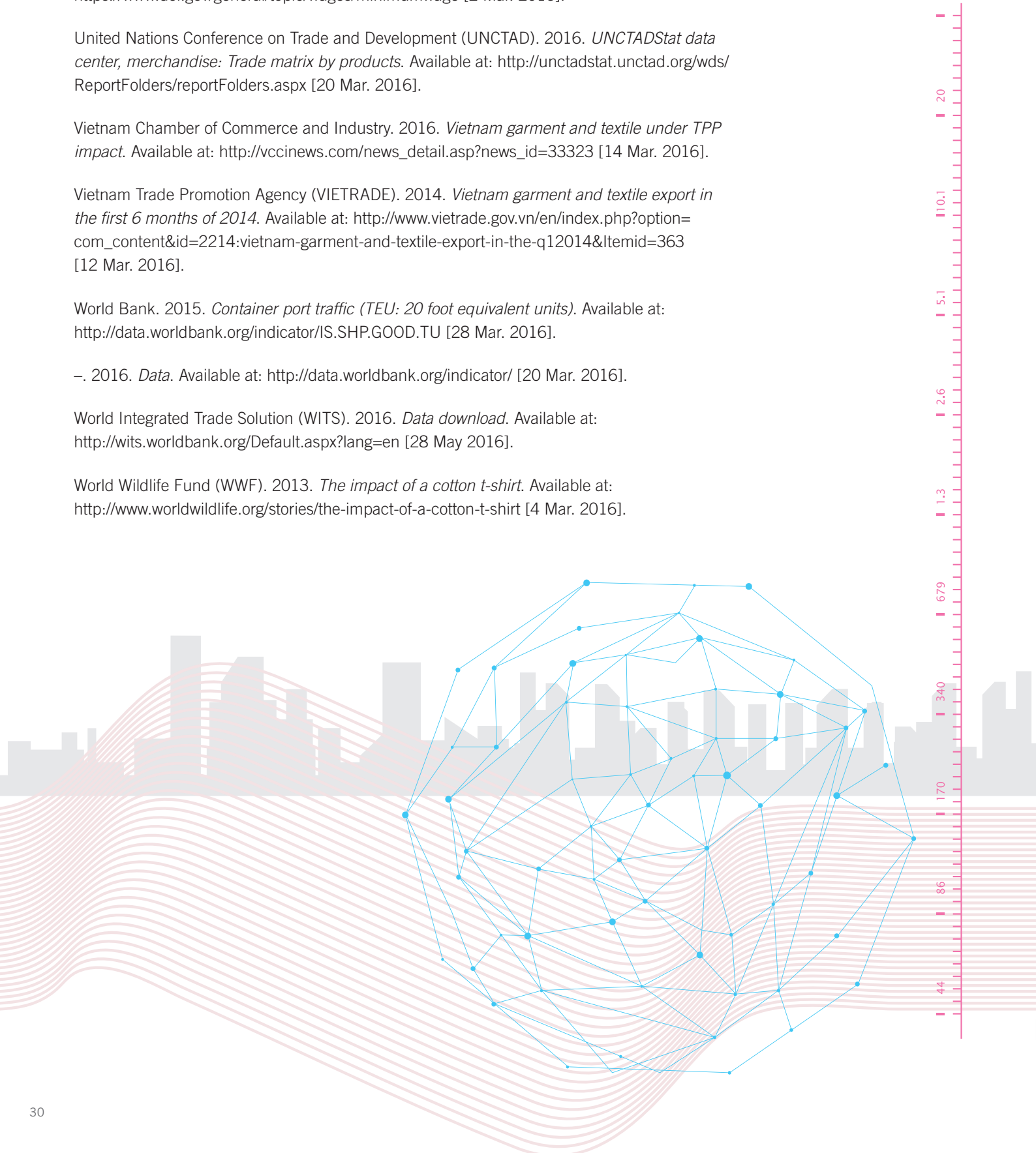
APPENDIX The impact of technology in the apparel sector: A focus on China

## 1 Overview of China's apparel sector

When China opened its economy to the world in 1978 and established its special economic zones (SEZ), it was perfectly suited to the apparel industry. The zones provided economically liberal policies, and an abundant labour force was available to take up the manufacturing jobs that more developed countries no longer wanted. Millions of internal migrants moved to urban areas in hopes of employment and bettering lives for both themselves and their families. This led to vast job creation for the population, a booming apparel industry and contributed to China's economic growth.

Employment in the apparel sector followed this trend until 2008 when numbers began to see gradual decreases (see figure 7). In 2008, China introduced and implemented stronger regulation of its labour laws, which afforded greater rights to workers. Thus, from 2008 to 2009, labour costs increased by almost 10 per cent (see figure 9). These changes, coupled with the changing demographic of the modern workforce and cheaper options from alternative regions, provide potential insights into why total employment reduced within the sector.

Figure 9. **Average manufacturing wage (in Chinese yuan renminbi) and annual growth (percentage) in China, 2003-14**
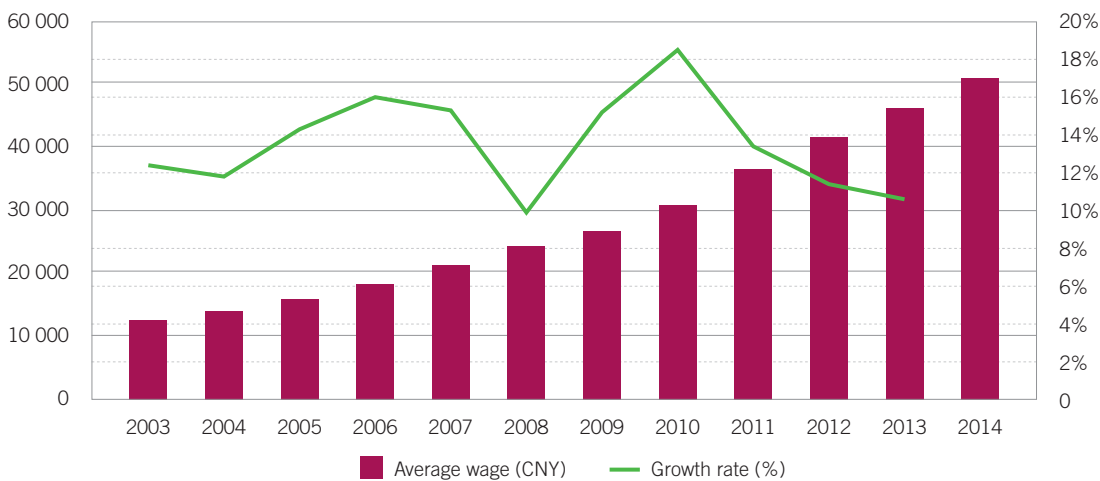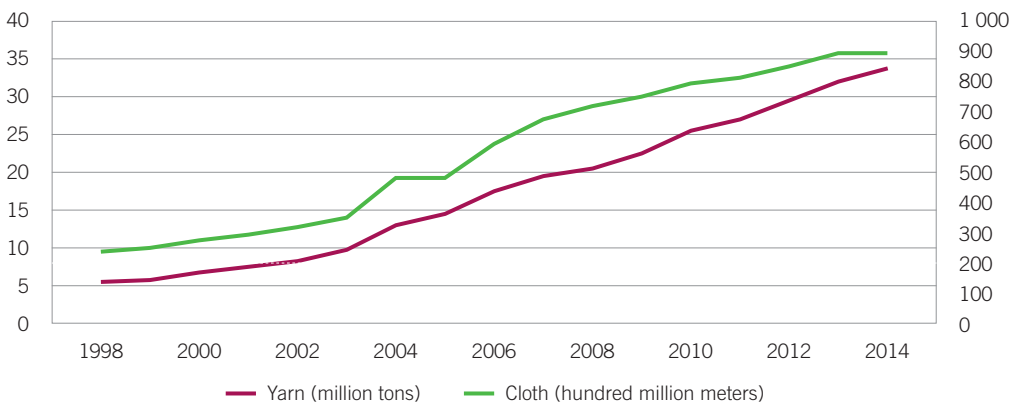

Source: National Bureau of Statistics of China, 2016.
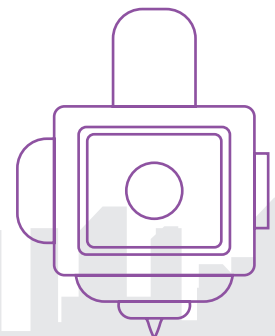
Over this period, China established itself as the top textile producing country in the world, with a range of product capabilities and production quantities that remain unrivalled to date. In 2014, Chinese primary yarn and cloth out stood at 33.8 million tonnes and 89.3 billion metres respectively (see figure 10) and has experienced year on year increases since 1998. The sector comprised of 20,821 enterprises, with domestic wholesales of 3.1 trillion Chinese yuan renminbi (CNY) and exported a total of US$287 billion of clothing and textile products to 212 different countries worldwide.[76]

Figure 10. **Total output of yarn (million tonnes) and cloth (hundred million metres), 1998-2014**

Note: Primary y-axis includes the output of yarn (expressed in million tonnes); secondary y-axis includes the output of cloth (expressed in hundred million metres).

Source: National Bureau of Statistics of China, 2016.

When assessing the Chinese apparel system, the size and intricacies of the country's economic and social differences must be assessed and understood. China is a large country, with many provinces containing differing cultures, languages and economic power. In manufacturing and industrial processes, certain provinces and municipalities house the bulk of production for specific industries and their subsectors, and others support these provinces.

In the textiles sector, 50 product-manufacturing clusters within China now exist. The vast majority of garment production, over 70 per cent, comes from the provinces of Fujian, Guangdong, Jiangsu, Shandong and Zhejiang – highlighted in figure 11.[77]

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[76]   Number represents enterprises above a total size as define by the National Bureau of Statistics of China. National Bureau of Statistics of China, 2016; WITS, 2016.

[77]   CNGA, 2016.

Figure 11. Regional production of yarn in China (100,000 tonnes), 2013

2013

Regional output of yarn production

0-3	4-7	8-11	12-15	16+

Measured in 100 000 tonnes

Source: National Bureau of Statistics of China, 2016.
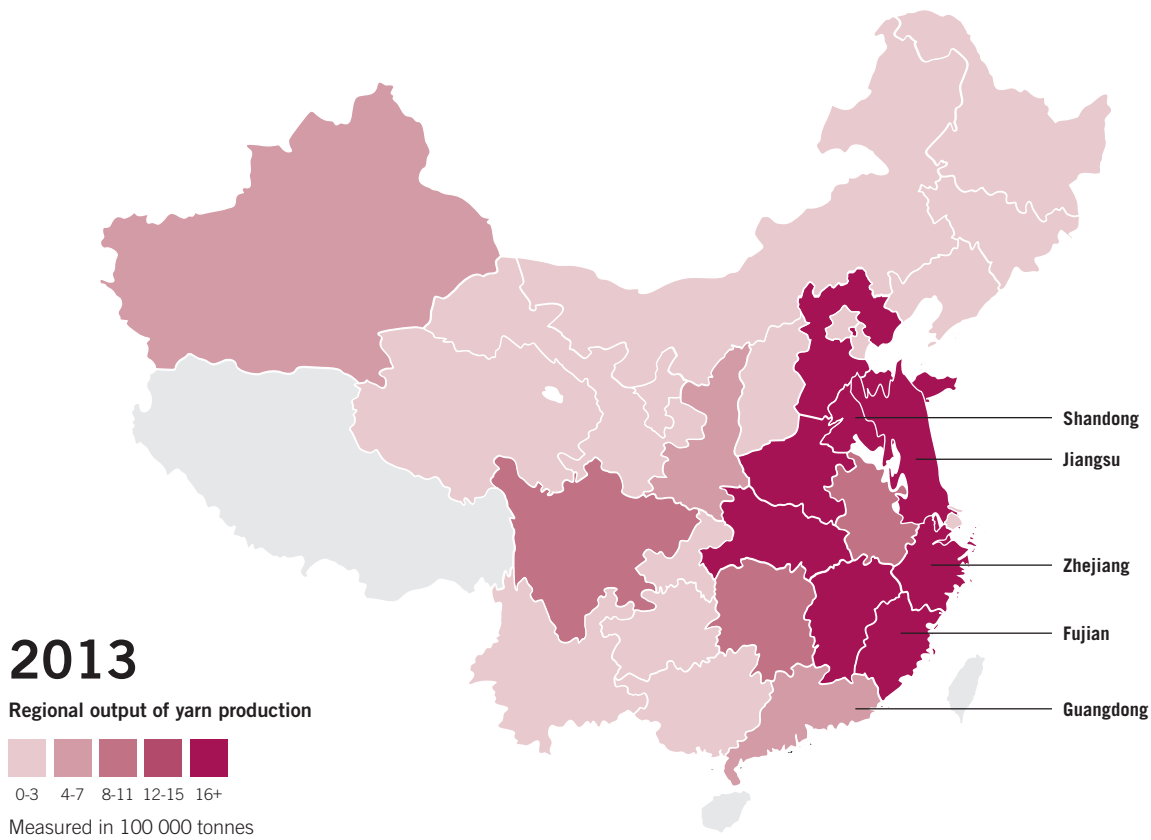
2 Trends, movements and analysis of the ASEAN and Chinese systems

2.1 General trends

Most production for raw textile materials has been concentrated (and remains concentrated) in China's eastern regions (see figure 12). The industry is well established in these areas, especially weaving, as this production involves large machinery that is difficult to relocate. From 2000 to 2014, the central and eastern provinces have seen continued and increased cloth production and output. As for the northern and central regions, production has noticeably been lost over this same time period.

Figure 12. Regional production of cloth in China (percentage of total output), 2000-14

2000

2010

2014

Regional output of cloth production

0-1 2-3 4-5 6-7 8-9 10-11 12-13 14-15 16+

Measured in per cent of total output

Shandong

Jiangsu

Zhejiang

Fujian

Guangdong
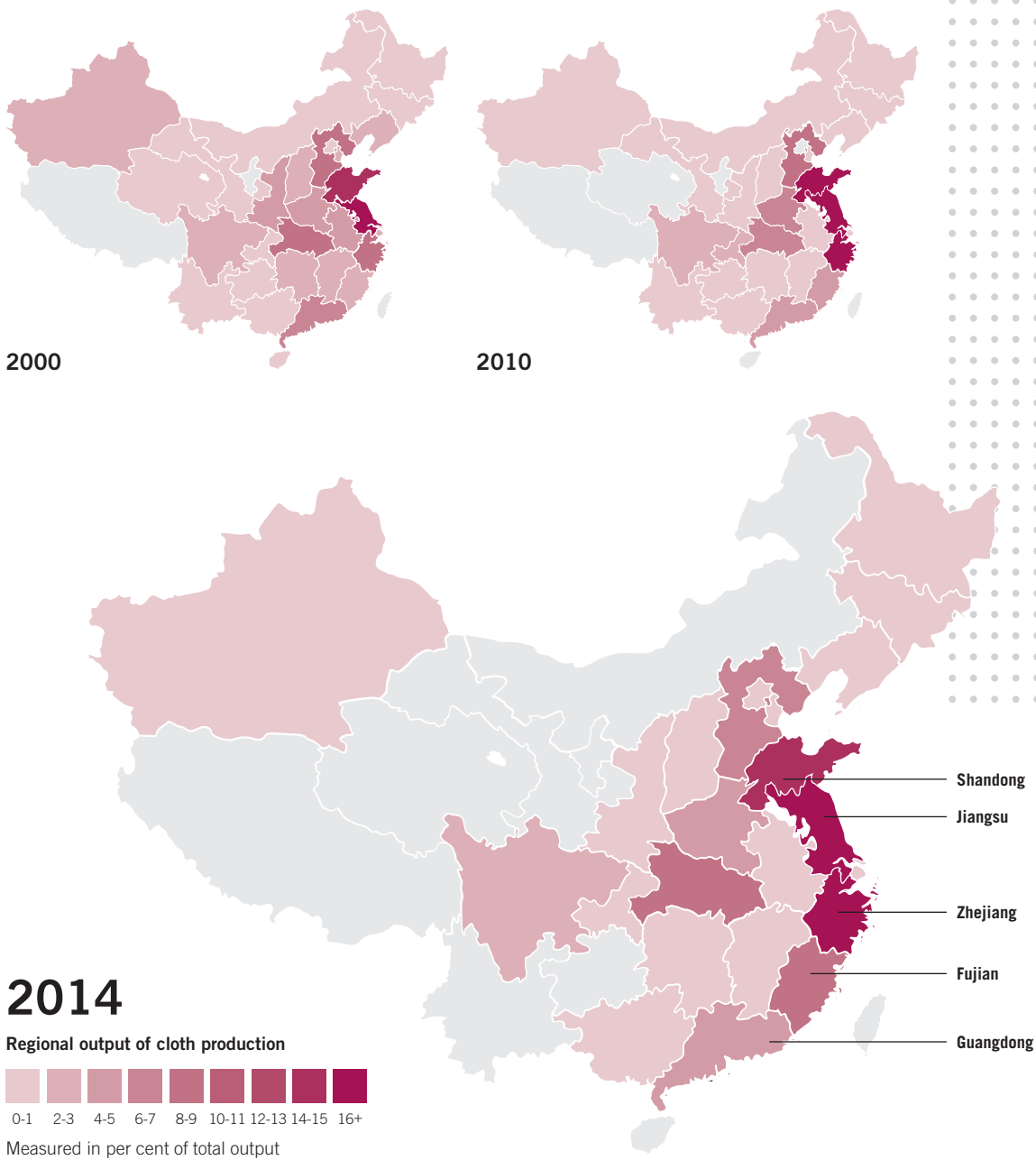
Source: National Bureau of Statistics of China, 2016.

With labour costs increasing in China, countries in the ASEAN region are being looked at as the next frontier of low-cost, available labour, compensating for China's labour shortages in the sector (see figure 13 for average monthly wage comparison between ASEAN and China). While China still has the largest available workforce, demographic changes and wage rises are making it increasingly less accessible, thereby increasing ASEAN's attractiveness.

Figure 13. Average monthly wages (US$), selected ASEAN Member States and China, latest available year
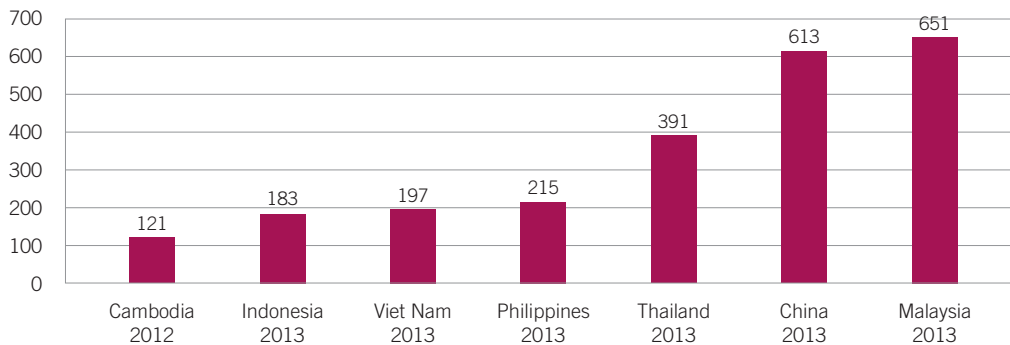
Source: ILO, 2014b.

Foreign direct investment in ASEAN manufacturing has reflected this, building on the previous developments of both foreign-owned and domestically owned industries. The investment impact can be observed in the increasing levels of textile export value. Cambodia and Viet Nam have experienced very high growth rates for apparel exports. Viet Nam now leads the way and is the fastest growing market in the region – exporting two times more than its closest ASEAN competitor, Indonesia, at US$36.9 billion in 2014.

The rise of Viet Nam can be seen in figure 1. In 2014, Viet Nam accounted for approximtely 40 per cent of ASEAN textile exports (in US$), up from approximately 9 per cent in 2000. Viet Nam has secured itself as the major contributor to trade value for the region.

Despite this exponential rise in its textile and clothing output, when compared to China, Viet Nam's export value is less than 10 per cent of the value of China's in 2014. It should be noted that this does not represent total unit output, but rather US$. China contains considerable levels of industrial textiles and high value added goods. The gap between the two is large, and based on historic data, China shows little signs of reduction in growth rates.

2.2 Advantages and disadvantages to China

Despite aspects of ASEAN growing in stature within apparel production and ASEAN's lower production costs, the Chinese system allows it to maintain competitiveness in a number of key areas.

Advantages

- **Vertical supply chain**
  China's extensive material base is unrivalled in Asia and the Pacific, granting it a great advantage. Other countries in ASEAN cannot provide the same full vertical supply chain as China, and in fact, many ASEAN countries import raw materials from China. Even though China is moving and accelerating parts of its production to countries such as Viet Nam, a potential member of the TPP, not all countries will be able to enjoy this because of the overall trade environment. For example, legislation requires all yarn to be produced in the country of export, and several countries will not have this resource capacity and therefore, will not be able to benefit from some of China's relocation efforts.

- **Solid infrastructure**

  Given China's long history of manufacturing and extensive investments in highly efficient and highly specialized ports, roads, and bridges, China's transportation infrastructure is one of its key competitive edges. For a number of interviewees operating enterprises in China, their familiarity with China's practices and established infrastructure is enough for them to remain within the country. The northern, western and southern regions of China stand as the most likely and favoured areas of relocation over other ASEAN countries.

- **Manufacturing productivity**

  Low-cost labour in ASEAN is not only offset by inferior infrastructure, but also lower worker productivity. Chinese workers are higher skilled and more experienced. Moreover, ramping up operations to Chinese levels is difficult to achieve quickly.

- **High value-added products remain**

  Low cost, easily movable operations and products are the first to be relocated. However, products that are of higher value often require greater initial investment and a more skilled workforce. As a result, they are more difficult to relocate and likely to remain in China where a skilled, experienced labour force exists with factories that can facilitate production. Developments that allow greater customization with lower volume orders require more complex production processes. These will stay in China because higher margins are made and investing in improved process and the requisite labour is economically viable. Consumers are now demanding unique products that they themselves designed, and China is equipped with the manufacturing ecosystem to process these orders.

- **Large, stable labour pool in central and west China**

  China has the largest human population in the world. Therefore, to treat it as one labour system is to discount the complexities of its economic distributions and differences. Wages differ considerably between provinces, and as a result, this makes moving production away from the east, the region with the highest wages, compelling. More available labour pools at lower costs in China's inner provinces make it cost effective for enterprises.

- **China's domestic market**

  China's middle class is expanding, and with this expansion attends growing spending power and increasing net consumption. The proportion of income committed to discretionary and semi-necessity spending is predicted to rise by 13.4 per cent and 10.9 per cent every year until 2020. Consumers with incomes between US$16,000 and US$34,000 are expected to reach 51 per cent in 2020, up from 6 per cent in 2010.[78]

  The total sales of wholesale garments reached CNY417 billion in 2014, a 108 per cent (or CNY450 billion) increase from 2010.[79] This indicates the growing strength of the domestic apparel market in China. Manufacturing in China avoids unwanted import costs, and as a result, it is common by textile manufacturers to maintain operations in-country.

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[78] McKinsey and Company, 2012.

[79] National Bureau of Statistics of China, 2016.

Disadvantages

Internal changes within China have resulted in a climate less suited to certain types of textile and clothing production. There are a number of areas that are encouraging a move away from China and allowing only the most competitive firms to remain active.

> "These are good jobs for people who have no options, but as soon as they have an option they will not choose to be in an apparel factory."
>
> Head of Social and Environmental Sustainability, Global Apparel Company, Dusseldorf, ILO interview, 2016.

- **Demographic changes and labour shortages**
  Within the manufacturing sector and in particular, the apparel sector, China is experiencing a labour shortage. This has come as a result of changing worker and generational expectations. The younger generations are better educated and have aspirations to achieve more than the tedium of the factory line whilst alterative jobs, created by the growth of the service sector, are now available in other industries.

- **Rising production costs**
  Alongside rising average manufacturing wages in China, which increased by 66 per cent since 2010 and reached CNY51,369 in 2014, energy, land and water costs have also increased significantly, forcing many to consider investments in technology and automation. Additionally, with China's strengthening of its social and environmental regulations, as well as increasing the costs of failure, non-compliant enterprises are facing further pressure to invest or close.

- **Decreasing government support**
  China's economic transition has been marked by a distinct shift in mindset from the Government to move the Chinese manufacturing industry up the value chain. This is highlighted by the implementation of "Made in China 2025", a move to develop goods of higher quality and value. The apparel industry usually represents the first stage in a country's manufacturing lifecycle, and for China, at least for the lower end goods, the Government is decreasing their support. As a result, permits have been reportedly harder to come by and government incentives less forthcoming.
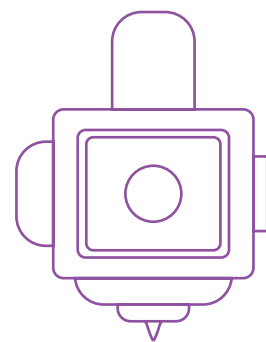
2.3 Advantages and disadvantages to ASEAN

Advantages

- **Favourable labour conditions**
  China now has some of the highest wages in the region. Labour costs in ASEAN countries are significantly lower (see figure 13). This is a major advantage to ASEAN apparel players and movements from China to countries like Cambodia and Viet Nam have been made.

- **Government support and incentives**

  In a push to drive investment into their countries, create jobs and benefit local and national economies, ASEAN governments have developed systems of incentives for establishing manufacturing enterprises. For example, incentives may come in the form of tax breaks.[80] Economic zones have also been established throughout the region, including industrial parks and SEZs, models that have successfully transformed China's economy.

- **Trans-Pacific Partnership**

  Although not yet enforced, the TPP agreement is a factor of significant consideration for brands and suppliers. While some expressed concern about its political timeframe, most were clear that many brands and suppliers are positioning themselves within the region with the expectation of its passing. The potential trade benefits of the TPP make Viet Nam and Malaysia favourable options for relocation. Viet Nam is currently the most likely to benefit from manufacturing relocation, and the TPP adds greater clout to its manufacturing credentials.

- **Enterprises want maximum flexibility**

  Given the uncertainty of the global economy and the fragility of the political system in countries around the world, a number of interviewees stressed the importance of developing a portfolio of production such that if operations in a particularly areas require either short-term closure or long-term relocation, negative impacts are reduced.

Disadvantages

- **Shallow supply base**

  One disadvantage of ASEAN is its lack of a material supply chain. Raw materials have to be imported from China, and because timely delivery is not always ensured, the potential for delays problematize productivity and increases lead time. This is not to say that relocation has not occurred. Cutting and sewing has successfully relocated to ASEAN because of its simplistic factory design and low capital investment. Textile weaving, on the other hand, requires high amounts of raw materials. Therefore, it is expected that it will be a long time before textile weaving moves to ASEAN from China.

- **Poor infrastructure and expensive basic needs**

  Some ASEAN countries lack basic infrastructure required for supply delivery. Road conditions may be poor and ports may have low capacity. For example, China's port capacity is far superior to that of ASEAN, with container port traffic (CPT) in 2013 at 174 million twenty-food equivalent units (TEUs) compared to 8 million TEUs in Viet Nam, while Myanmar and Cambodia are essentially landlocked with CPT at 233,005 and 274,886 TEUs, respectively.[81] The distance between factories and ports is also an issue in a number of countries: The longer it takes for port container to reach the factory, the higher the lead team and the lower the distribution productivity.

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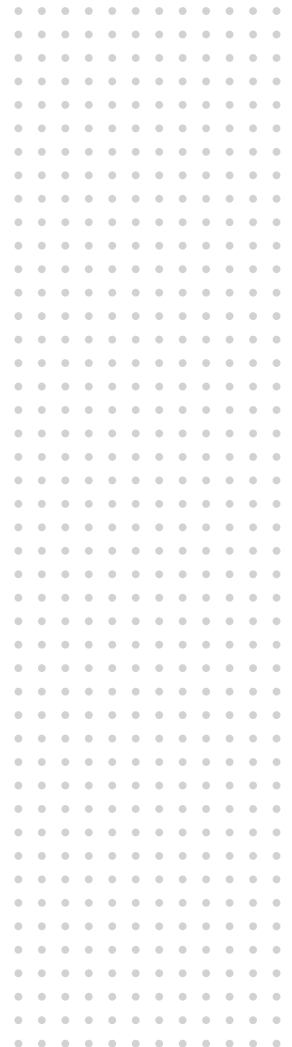
80   ASEAN, 2016.

81   World Bank, 2015.

- **Comparatively shallow labour pool**
  When China rose in manufacturing, it possessed a large population ready to be employed and activated as manufacturing workers. Numerous enterprises could enter the apparel market because there was such a plentiful supply of human capital. Comparatively, ASEAN does not have China's abundant labour pool, therefore making the competition among enterprises quite intense. While hiring enough workers was not an issue for Chinese enterprises who first relocated operations to ASEAN, those who wish to relocate operations currently will certainly face challenges. As ASEAN's available labour pool decreases, the competition will drive up labour costs. This makes future relocation less attractive.

- **Political instability and poor working conditions**
  The political instability in some ASEAN countries discourages foreign-owned enterprises from investing or sourcing from ASEAN in the long term. Therefore some foreign enterprises that choose to source from ASEAN often stick to a short-term plan, focusing on fast, immediate profits to be made. This lack of long-term investment ends up hurting ASEAN suppliers, and later, workers.

  Moreover, working conditions and their effects on a brand's reputation are of increasing concern for consumers. China has well known, trusted suppliers and improving regulations. As a result, brands perceive China as a lower risk location for manufacturing.
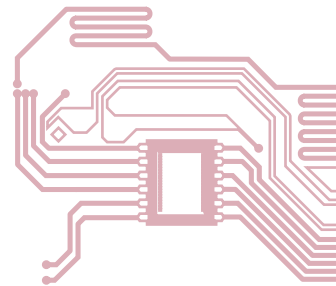
3 Key findings

- **Labour costs are a key consideration**
  Low-cost labour is a key consideration for moving apparel operations from China to ASEAN. Labour makes up a large proportion of total cost for the apparel sector, and rising wages in China have meant that suppliers are incurring greater costs of production. For the vast majority of manufacturers engaged, rising costs are the key factor when making a decision both to relocate and where to relocate. This is particularly the case for the lower cost, lower skilled apparel production, where workers can be swiftly trained and factory set-up and relocations are not capital intensive. China has many compelling factors to its production, but for many enterprises, it is becoming less competitive due to rising labour cost. While it has been able to maintain its industrial hold for a long time with its high levels of production and infrastructure, the continued wage increases are forcing decision makers to develop future strategies involving lower cost regions and invest in efficiency developments.

- **China will remain the primary production site and movement will take time**
  While rising labour costs push enterprises to look outside of China, China still remains the primary sourcing country for many brands. This will continue, at least, in the medium term. Brands and suppliers are neither implementing aggressive expansion plans nor conducting large-scale closure. In China, a natural transition is occurring in which larger, more efficient factories are forcing smaller and weaker players out. These smaller apparel enterprises are being consolidated or closed, and their replacements are established in other destinations. However, fully moving operations takes considerable time. Therefore, industries players will remain in China for the foreseeable future.

- **Large-scale automation is not yet compelling**
  While some localized examples do exist, there is a lack of new, widespread automation occurring within the apparel industry in China. The spinning and weaving process of textile production is already highly automated. On the other hand, finishing, packaging and washing currently require manual labour and opportunities exist for automation.

> "We are not just addressing productivity but also trying to deskill. One of the challenges in our industry is [what people call] skilled labour. Sometimes it takes up to six to nine months to train a worker, so the more we could use templates or attachments to deskill the operations, the faster the learning curve we would allow the worker."
>
> CFO, Textile Supplier, Hong Kong (China), ILO interview, 2016.

However, cutting and sewing – the production processes with the greatest labour component – has seen little deployment of automation to date. For the majority of actors, technologies such as ASMs are not commercially viable. Therefore, manufacturers are likely to invest once they hear about improvements in the company's bottom line.

There are some localized examples of template installation and some actors working towards other forms efficiency developments, such as reducing lead time, investing in management, deskilling tasks, reducing training times, reducing waste and improving worker turnover.

- **Automation uptake will vary among subsectors**
  Automation and its different incarnations within subsectors complicate how one understands transformation in TCF as a whole. For example, specific types of footwear (especially synthetics) can be automated to create customized shoes via additive manufacturing. In the clothing sector, ASMs represent an automated manufacturing process. One interviewee spoke to "changes in [the] binding process" for sports footwear, which uses glues and woven tops, which permit greater automation. Thus, this variety within the TCF subsectors make full-market understandings challenging and should be an area of further research.

- **"Nearshoring" is becoming more pervasive**
  There is a growing trend for "nearshoring" – the movement of production from lower cost countries closer to market. For example, operations have been moved to Central America for markets in the United States, and a similar trend can be seen in movement to Portugal and Turkey to serve a larger European market. This proximity to market can reduce lead time considerably.

- **ASEAN benefits from the TPP if it's passed**

  There is considerable interest in the TPP's passing, and brands and suppliers have begun aligning their operations around the TPP. For example, operations have to be "yarn forward", meaning countries should benefit from the relocation of more parts of the production process.[82] Due to the favourable trade environment, Viet Nam's apparel manufacturers will especially benefit from the TPP's passing. However, others remain cautious and do not consider it wise to base future business strategies around an uncertainty (especially because the results of the United States' presidential election will impact the speed of the TPP's passing). The TPP also contains strict regulations on the processes of item production. In theory, the TPP can lead to major benefits for trade and operations, in practice it may be more of a challenge.
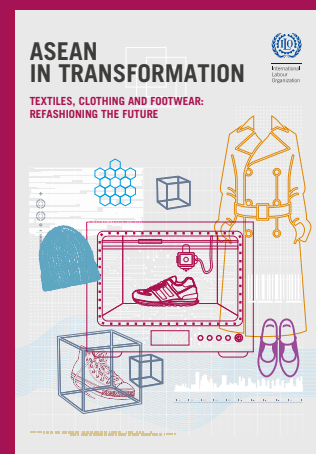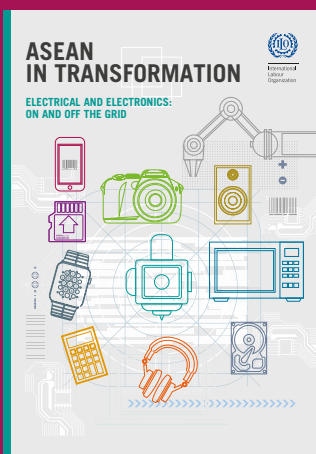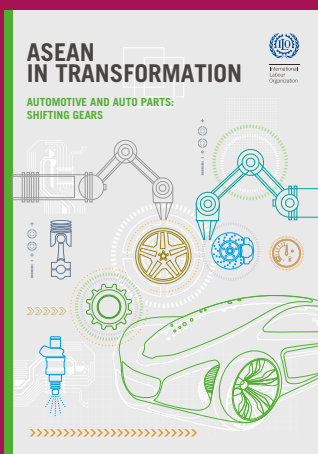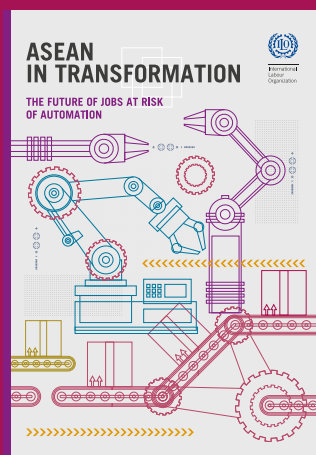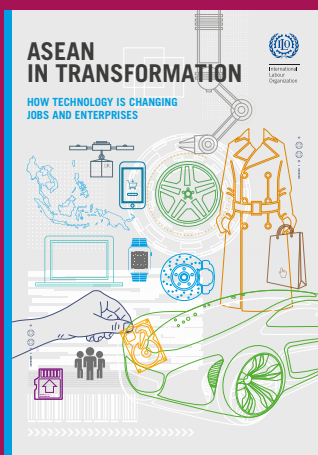
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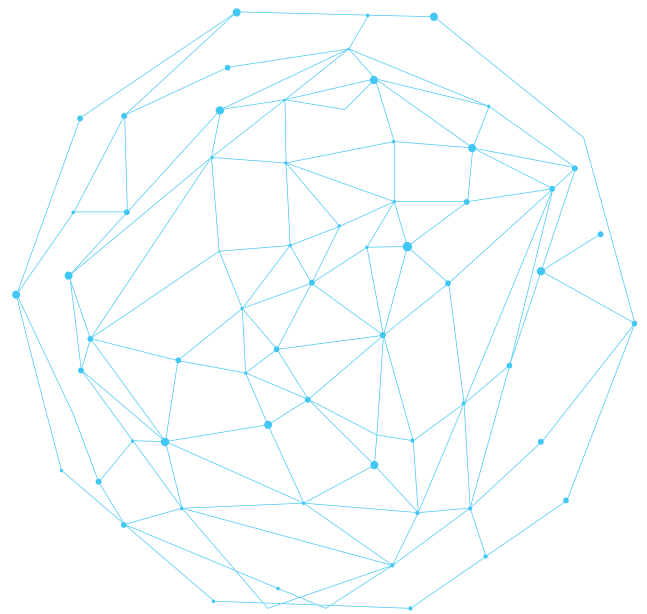
[82] "Yarn forward", which requires the TPP nation to use a TPP member-produced yarn in textiles in order to receive duty-free access.

ASEAN in transformation: Textiles, clothing and footwear – Refashioning the future

This paper examines the impact of technology and related implications for enterprises and their employment needs in the textiles, clothing and footwear sector in the ASEAN Member States. The main findings of this paper are available in *ASEAN in transformation: How technology is changing jobs and enterprises*, which offers a comprehensive compilation of transformative impacts of technological advancements penetrating five labour-intensive and/or growth sectors in the ASEAN region.

The paper uncovers that the sector is undergoing significant technological transformation, especially as multinational retailers and apparel brands aggressively innovate and pilot disruptive technologies such as 3D printing, robotics and automation that enable production to move closer to market. Trends in "re-shoring" are already emerging in the footwear sector and will soon occur for the clothing sector upon introduction of automated sewing machines that enable automation of the most difficult part of apparel manufacturing. Moreover, players in ASEAN's TCF sector need to be mindful of the changing nature of production in China which remains the top TCF manufacturing country in the world. These movements will result in decline in export growth for the ASEAN region and ultimately have an effect the number of workers required.

ASEAN Member States that are heavily reliant on the TCF sector as a source of jobs and development require a critical review of their economic structure. In addition, a renewed focus on training and education and emphasis on the skills pipeline are crucial to enable TCF players to manufacture higher value products and remain competitive.