Discussion Paper

Automation and its impact on employment in the garment sector of Vietnam

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Background

The Fourth Industrial Revolution, especially with automation and artificial intelligence, will change the world of labour disruptively. It will greatly affect workers, especially in the labour-intensive manufacturing industries, such as textile and garment, footwear and electronics. According to the forecast of the German Smart Factories, automation of the industrial production process will be a step towards the creation of a social network of machines and factories communicating with each other through artificial intelligence—and this will be realized within the coming decade. This implies that many jobs will be lost along with many new jobs created.

Textile and garment production is considered a high-risk industry of the Fourth Industrial Revolution, with the garment sector a major concern for government, enterprises, trade unions and workers due to its high concentration of labour. This paper examines the degree of automation now and to be used in the near future in Vietnam's garment sector, assesses its impact on employment in the garment sector and makes recommendations for the government, employers, trade unions and workers to prepare for the coming transformation.

Research methods

The research for this paper is based on the following sources:

First, a survey questionnaire on the automation level of 66 major garment enterprises, of which 55 are independent suppliers in Hanoi, Hung Yen, Nam Dinh, Ho Chi Minh City, Binh Duong, Long An and Dong Nai provinces, and 11 are under the Vietnam National Textile and Garment Group—a large textile and garment corporation. And 40 of the 66 enterprises are large operations, in business for an average of 15.4 years and having a certain degree of automation already in their factories. All are producing for export and have an average labour force of 2,007 workers per enterprise. Among these 40 enterprises, 21 are foreign direct investment and 19 are domestic private ownership. Of them, 57.5 per cent are cut-make-trim operations, while 32.5 per cent are both cut-make-trim and free-on-board enterprises, and only 10 per cent incorporate cut-make-trim, free-on-board and original design manufacturing operations.

Second, 87 in-depth interviews were conducted with the enterprise management (including directors, deputy-directors in charge of technical management and heads of engineering departments), trade union representatives, technical workers, sewing workers and others at 24 large garment factories in Ho Chi Minh City, Binh Duong, Dong Nai, Long An, Nam Dinh, Hung Yen, Hanoi and Bac Ninh provinces.

Third, consultations with eight specialists from the Vietnam Textile and Apparel Institute, including heads of the information and training centre, the sewing consultancy and technology transfer centre, the fashion design centre and other related departments; one specialist from the Vietnam Textile and Garment Association; one from the Vietnam Textile and Garment Union; and two from the Ho Chi Minh City Textile Union and the Hanoi Textile Union (representing major employment centres in North and South Vietnam.

Report structure

Beyond this background and garment sector introduction, the paper is structured in three parts: Part I assesses the level of automation in the garment sector; Part II evaluates its impact on employment in the garment sector; and Part III identifies worker-related issues. Based on the analysis, the paper includes recommendations for a just transition of Vietnam's garment sector into the Fourth Industrial Revolution.

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1 In a meeting between the delegation of Vietnam National Assembly Economic Committee and representatives of the Smart Factories in Germany, April 2019.

2 "Free on board refers to operations that include the materials that enterprises buy as input in addition to their cut-make-trim component.

Terminology

The analysis uses three terms interchangeably—Fourth Industrial Revolution, Industry 4.0 and Technology 4.0, although each has a slight distinction. The Fourth Industrial Revolution refers to the qualitative change in the industrial production taking place for the fourth time in human society. The term goes beyond industry to encompass the agriculture and service sectors. Industry 4.0 refers to the industrial development of the Fourth Industrial Revolution, including the Internet of Things, to connect machines on a large scale (the Industry 4.0 term was first used in Germany around 2011 and then exported to other countries). Technology 4.0 is the technology of the Fourth Industrial Revolution. These terms are used interchangeably depending on the context, but all have the same implication (Industry 4.0 is typically used in the literature as a shorthand).

The terminology of job positions used in this research:

- **Manual workers:** low-skilled workers instructed or trained to operate machinery or other equipment.
- **Mechanical engineering workers:** people who possess knowledge about mechanical engineering and who specialize in the work of repairing and maintaining machinery and equipment.
- **Technicians:** people who possess knowledge in computer hardware and software, specializing in jobs related to software applications and who do basic hardware repair and maintenance.
- **Engineers:** highly skilled technicians, usually attaining at least a bachelor's degree.

A brief introduction to the garment sector of Vietnam

For many years, the textile and garment industry of Vietnam had the highest growth rate and was among the country's most important export sectors. From 2010 through 2015, the industry enjoyed a 15 per cent annual export growth rate—the second-most exporting sector after mobile telephone components. In 2016–2017, the industry continued to grow.[3] With all exports in 2017 reaching nearly $31.2 billion in value, the garment sector represented the bulk, at $24.7 billion, up 10.8 per cent from 2016.[4] In 2018, the export value of the textile and garment industry reached more than $36 billion, of which the garment sector represented more than $28 billion—an increase of more than 14 per cent from the previous year.[5] In 2019, the export turnover of the industry was reported at $39 billion.[6]

Vietnam is among the top-five countries with the largest volume of textile and garment exports in the world. In the next five to ten years, with Vietnam's two new free trade agreements, the Progressive and Comprehensive Trans-Pacific Partnership Agreement and the Vietnam–European Union Free Trade Agreement, the textile and garment industry in general and the garment sector in particular are predicted to continue their high annual growth rate. By 2021, the growth rate of the industry is expected to be an estimated 10–12 per cent.[7]

The industry comprises more than 7,000 enterprises, including 5,080 garment enterprises. Of the total enterprises, 60–65 per cent are cut-make-trim operations, 20–25 per cent are free-on-board and original equipment operations and only about 10 per cent are original design or original brand manufacturing (design, branding and distribution). The industry covers yarn, weaving, dyeing and garments, in which the garment sector accounts for the largest proportion, producing approximately 80 per cent of the total export of the industry. The development objective of the industry until 2030 focuses on increasing efficiency and quality instead of quantity.

The majority of garment enterprises are cut-make-trim production, which is low value added, with low labour skills and at the bottom of the global supply chains. The cut-make-trim operations are labour-intensive. The industry employs a total of 2.7 million workers, of which

3 See http://baochinhphu.vn/Kinh-te/Nganh-det-may-tren-da-tang-truong-cao-nhat-trong-5-nam/341677.vgp.

4 Interview with a senior specialist from the Vietnam Textile and Apparel Association.

5 ibid

6 ibid

7 ibid

2.4 million are in the garment sector, accounting for more than 88 per cent of the industry's total workforce. The garment sector is predominantly female, with more than 70 per cent of the workers women.[8]

Garment workers have to work long hours. According to the annual report 2019 by the ILO's Better Work Program[9] which assessed complicance of 331 garment enterprises in Vietnam, 77 percent of assessed factories do not comply with the monthly limit of 30 hour, and 69 percent do not comply with the annual limit of 300 hours

Between 2014 and 2018, the number of enterprises in the textile and garment industry increased by 16 per cent, the export turnover of the industry increased by 15 per cent while the number of workers in the industry increased by only 8.8 per cent.[10] Thus, the rate of labour increase has slowed in comparison with the increase in the number of enterprises as well as the export value of the industry over the past years.

The research for this paper assessed the degree of automation in the garment sector of Vietnam. Regarding automation in the textile and garment industry, the yarn, weaving and dyeing sectors are likely to become automated more quickly than the garment sector. This is because the manufacturing process in these sectors is more homogeneous and the work skills are simple and repetitive. According to experts in the textile and garment industry, automating the garment sector will be more difficult because many of its stages require skilful human hands, such as stitching product details in a curve; aligning colours, patterns and designs; and ensuring the subtleness of the stitching and aesthetics of the product.

Moreover, the garment sector is a fashion industry with a tendency of individualization, and production is usually of a small quantity for each design to suit specific needs of consumers. Another factor that has not encouraged the shift is the estimation of comparative advantage of investment in automation in matching with the benefits gained through a small quantity of production while the purchase price in the world market is becoming cheaper.

Garment enterprises in Vietnam have started to care about investing in new technologies to improve productivity and quality. However, the proportion of enterprises that have enough capital to invest in automation technology is not large. Therefore, most enterprises have chosen a step-by-step strategy of investment by selecting which stages of production to automate first so that the capacity of automatic machinery and equipment is fully utilized, based on the skills of the labour, financial and production abilities as well as potential orders from buyers.

As indicated in the development goal of Vietnam's textile and garment industry until 2030, the industry is projected "to be one among the key export-oriented industries and to be able to meet increasing domestic consumption needs as well as to create more jobs for society."[11] This is challenging because although opportunities of job quality improvement are clearly possible within Industry 4.0, job creation and related issues may be more difficult, particularly with the current low-skilled and untrained workforce.

8 ibid.

9 https://betterwork.org/wp-content/uploads/2019/06/BWV_Annual-Report-2019_EN_v4.pdf

10 Bùi, 2014.

11 Decision No. 3218/QĐ-BCT dated 11/4/2014 of Minister of Industry and Trade.

Part I: Automation in the garment sector

This section assesses the automation of the garment sector in Vietnam via Industries 1.0, 2.0, 3.0 and 4.0. Among the stages in the process of garment-making, automation has centred more on cutting, sewing buttonholes, attaching buttons to the fabric, designing, washing and grinding jeans. Sewing is the most difficult stage for automation, but if it can be automated, the employment of workers will be greatly affected because sewing workers often account for a large proportion of the workforce in a production line, at 85–96 per cent, and in a garment factory, at 45–70 per cent. The proportion depends on the size of the factory, purchasing orders, technology level and management efficiency. Thus, the automation of the sewing stage (if it it occurs) will transform the whole garment sector of Vietnam (for this paper, the sewing machines used in the garment sector illustrate the disruption that Industry 4.0 will usher in).

Based on product categories, the country's garment enterprises can be categorized into two groups: fashion products and basic products. According to garment experts, production managers and technicians in the garment sector responding to our survey, sewing basic garments are easier to automate than sewing fashion garments, because basic products have the same design and seams and are produced in large volume. Fashion garments often have unique characteristics with special designs for different users. Fashion garments require high aesthetics, especially plaid fabrics, decorative patterns and frills, which require special skills for the assembly of materials to ensure the aesthetics of the fabric. Therefore, the use of automatic machinery and equipment in cutting and sewing may not guarantee the product quality. Fashion garments require subtle seams, and the processing of many details of the product need the hands of skilful workers. What is more, the cycle of fashion garments is shortened due to the demand for new styles as they relate to weather change, regional differences, religion and other factors, all of which contribute to rendering automation more difficult.

Garment enterprises in Vietnam are willing to accept any orders from buyers or customers, whether it is fashion products or basic products. To date, there has been no survey to identify the percentage of fashion product enterprises among the total garment enterprises; nor the percentage of fashion products of the total apparel market; nor have there been any studies on the percentages of fashion products or basic products made in an enterprise. The degree of automation for fashion products and basic products differs. Knowing these percentages is crucial for assessing the automation capability and possible job decline in the garment sector.

Garment enterprises making both fashion and basic products look at automation in terms of increasing productivity and ensuring product quality while reducing the lead time and meeting delivery targets. Under the current circumstances, a large-scale investment in automation is not an optimal choice for a majority of the country's garment enterprises, partly due to lack of capital but, more importantly, any investment in automation must take into account the quantitative factor of the production. If the quantity of production is small, the investment in automatic machinery and equipment will not be beneficial because the investment cost is high. And when the product design changes, the automatic machinery and equipment may no longer be relevant. Moreover, the country's low-cost workforce is still considered a comparative advantage for enterprises.

Most of the country's garment factories use the electromechanical machinery and equipment that were introduced during Industry 2.0, accounting for 90–95 per cent of all machinery and equipment in an enterprise currently in use. The machinery and equipment of Industry 1.0 are no longer in use in the garment sector.

First and Second Industrial Revolutions

The First Industrial Revolution, or Industry 1.0, ushered in the use of mechanical tools and equipment, together with steam power, to support people in manufacturing and producing. Industry 1.0 freed a part of human labour—a transition from only human labour to the use of supportive mechanical machines and equipment; but production in Industry 1.0 was still largely based on human muscle. The sewing machine of Industry 1.0, for instance, was based on human muscle.

Sewing machines of Industry 1.0
Source: *http://pricenow.com.ng/product/butterfly-butterfly-sewing-machine/?wmc-currency=USD*
https://suamaykhau.com/upload/images/sua-may-may-uy-tin.jpg

The advent of electrical power during Industry 2.0 upgraded the muscle-based and steam-powered mechanical machinery and equipment of Industry 1.0 to electromechanical machinery and equipment. Thanks to Industry 2.0, mass production factories were established, and economies of scale were enabled, with profits earned through a large quantity of products made in a shorter time than during Industrial 1.0.

At the end of the Industry 2.0 and with the innovations of Industry 3.0, electromechanical sewing machines were upgraded by attaching an electronic device to track the number of stitches and the number of products to assist managers in production management—the so-called "modern" sewing machine. In terms of human interaction with machines, the operating mechanism of these machines remained the same. Thus, the modern sewing machines with electronic devices, characterized by many enterprise managers respondents in our survey as machines of Industry 4.0, are still the machines of Industry 2.0. These sewing machines are quite popular in garment enterprises in Viet Nam today.



Sewing machines and modern sewing machines of Industry 2.0

Source (L-R):
Image from istockphoto / sergeyryzhov
Image from istockphoto / Liudmyla Liudmyla
Image from istockphoto / AnnaStills

Regarding the interaction between workers and machines, the machinery and equipment of Industry 1.0 and Industry 2.0 required a manual worker to operate and a mechanical engineering worker for repairing and maintenance. Each industrial revolution increased productivity and reduced the time of production per unit of product. Thanks to electrical energy, Industry 2.0 pushed production to a large scale, thereby creating a mass of jobs. While work in Industry 1.0 was manual, handmade, individual and using mechanical equipment, work in Industry 2.0 created mass jobs relying on electromechanical machines and equipment. The nature of work in both eras was the same: workers operating machinery and equipment. Without those workers, the machines and devices were just an inanimate object.

The quantity and quality of products of Industry 1.0 and Industry 2.0 were determined by the technique and skills of workers. High-skilled workers created good-quality products at high productivity. Low-skilled workers had low productivity and typically the products were of poor quality, unsatisfactory or defective.

There are many discussions on Industry 4.0 in Vietnam affecting the thinking of managers in the garment sector who are considering the application of new technology to increase productivity and product quality in shorter delivery time. It is certain that Industry 4.0 in the garment sector in Vietnam will develop based on Technology 4.0 of the global garment sector. Then, based on the affordability of capital and cost-benefit calculation, garment enterprises in Vietnam will look to make step-by-step investment in the new technology. The research and development of Technology 4.0 in the global garment sector is limited to basic products with mass production, and the global garment sector is in the early stage of Industry 4.0. Our survey reveals that Vietnam's garment sector is only at the beginning stage of investing in machinery and equipment of Industry 3.0, but is heading towards Industry 4.0.

Third Industrial Revolution

The Third Industrial Revolution, or Industry 3.0, is characterized by automatic machinery and equipment thanks to the advent of electronic computers. Industry 3.0 entails the use of electronic software to run machinery and equipment, called automatic programmed electronic devices, which means that automation combines hardware and software—a different type of automation compared with the previous industrial revolutions.

Image from istockphoto / Chernus

Image from istockphoto / surasak petchang

The machinery and equipment of Industry 3.0 still require two types of workers to operate (as in Industry 1.0 and Industry 2.0): a manual worker and a technician. But the Industry 3.0 technicians differ from the mechanical engineering and technical workers of the previous two eras in that they are knowledgeable about machinery and equipment in terms of repairs and maintenance and also about the software of computers that run the machinery and equipment appropriately. While Technology 1.0 and Technology 2.0 needed one technical worker for a machine and equipment, Technology 3.0 requires two technical workers (one for the machines and equipment, or the hardware, and one for the software but including the hardware of computers). If one technical worker can be in charge of both tasks, they are called a technician. The requirement of repairs and maintenance for technicians is only demanding at a basic level. Any machinery or equipment experiencing a large fault or malfunction will be returned to the supplier or discarded as equipment depreciation. Today's global economy of high competition demands higher quality of service, which means greater responsibility with the suppliers' warranty of machinery and equipment.

The skills of manual workers in Industry 3.0 also differ from the previous two eras in that the task of workers of Industry 3.0 is to prepare inputs and feed the machine. Industry 2.0 manual workers needed to be skillful enough to finish a good-quality product on time. Although manual workers are still required, the quality

of products of Industry 3.0 is determined by the machinery and equipment (whereas it was previously determined by the skill of the workers). The productivity of automatically programmed electronic devices is multiplied many times over that of electromechanical devices. With the machinery and equipment of Industry 3.0, there is no faulty product if the machinery is not faulty. Industry 3.0 machinery and equipment do not need skilful workers. With the computerized programmed electronic devices of Industry 3.0, technicians have a more important role than manual workers. Regarding the number of workers, a sewing machine in Industry 3.0 requires at least one technician and one manual worker, similar to the requirement in the previous two eras. The difference is that a manual worker operating the machinery and equipment previously could only operate on one machine at a time, while a manual worker operating Industry 3.0 machinery and equipment can work on several machines at the same time, depending on the product details, the capacity of the machines and the physical health of the worker.

Industry 3.0 is the revolution of automation of separate stages in the production process, with electronic machinery and equipment being programmed to work automatically. Industry 3.0 has laid the foundation for Industry 4.0 to automate the whole production process, which is run by a virtual control system. Work in Industry 3.0 involves hardware (operation and maintenance of machinery and equipment), software (computers and programs that run the machinery and equipment) and manual work.

Many Vietnamese enterprises have invested in Industry 3.0 machinery and equipment over the past five years, and some even began doing so in the early 2000s. Still, the rate of garment enterprises investing in Industry 3.0 machinery and equipment remains low, at about 10 per cent of the total enterprises in the garment sector, and mainly by large enterprises with adequate capital and stable orders. But most of them, however, have only made the investment in about 5–10 per cent of their total machinery and equipment.[12] In most modern enterprises, the level of Industry 3.0 investment may be 20 per cent.

Because investing in new technology requires a large amount of capital, most enterprises apply a gradual investment strategy to replace the old machinery and equipment. Depending on different types and origins, Industry 3.0 machinery and equipment usually cost 10 to 350 times more than Industry 2.0 machinery and equipment. The transfer of technology from Industry 2.0 to Industry 3.0 is not only about considering the cost but also customers' requests for product quality. The pressure of competition in the world market forces enterprises to consider investing in technological innovation so as to increase productivity. Our survey responses indicate that some enterprise managers have a long-term vision thanks to their awareness of the development trend and due to the increasing pressure from consumers and non-government organizations in the social and environmental fields, and their decision to invest in technological innovation derives from the demand of corporate social and environmental responsibility as well. In their opinion, the technology in Industry 3.0 has a high degree of accuracy, uniformity and stability of product quality for all products manufactured and is more environment-friendly than the technology of Industry 2.0. Therefore, it may be costly initially but it offers a solution to long-term development goals. The following box, for instance, highlights Viet Thang, a company that reflects how the drive to invest in Industry 3.0 automation derives from competition in terms of productivity and quality of products as much as the felt responsibility for the environment and the health of workers, in line with development trends.

12 Survey of 24 garment enterprises in seven provinces and cities nationwide.

Viet Thang company—A rare case of investing in machinery and equipment for environmental protection

Viet Thang (VitaJean) is an original design and original brand manufacturing company operating for 25 years in the production of primarily jeans for export (at 95 per cent). Around half of its machinery and equipment are considered "new" technology (Industry 3.0 machinery and equipment). The company began investing in new technology in 1993, with greater investment in the past five years. All stages of washing, grinding, dyeing, designing, spreading cloth, cutting and shipping use modern automatic Industry 3.0 machinery and equipment imported from Germany, Italy, Spain and Turkey. The company has started using chain connection and management software and checking the fabric from the source. When interviewed, the company director noted that in addition to increasing productivity and quality of its product, the investment in the Industry 3.0 machinery and equipment was also driven for the purpose of protecting the environment. The grinding machine, dry-dyeing machine and dry-washing machine that the company bought are all high-standard machines with a "closed" technology of waste treatment (smoke, dust, dyes and detergents are cleaned by the machine before being discharged into the environment) and use of solar energy. Smoke and dust from the grinding jeans, fabric dyes and laundry detergent are all cleaned by the machine before being discharged into the environment. It is this machinery and equipment that help the company perform better corporate social responsibility and respond to customers' requirements. "If thinking about immediate profits, the company will never dare to invest in such machinery because the cost of each machine is up to 7.7 billion dong, or even over 9 billion dong [equivalent to $350,000 to over $400,000]," the director admitted.

The next box summarizes how Industry 3.0 machinery and equipment operate in the sewing lines of Vietnamese garment enterprises.

Machinery and equipment of Industry 3.0

With the following computerized machines, the basic task of a garment worker is to serve a machine and let it perform the functions. One worker can be in charge of one, two, three or four machines at the same time, depending on the machines.

Automated electronic machines and devices are used for specific operations:

- fabric spreading and cutting;
- sewing (sewing collars, borderlines, embossed lines on the fabric, etc.), with software programmed to perform the sewing operation;
- knitting (buttons are available in the machine, and workers only need to put the fabric in the right position and the machine adjusts the buttons to knit into the fabric, which reduces operation by workers); and
- metal detecting (to locate any metal left in a finished product).

Automated machinery and equipment combine several stages:

- pocket-making (combines several stages, such as fabric cutting, sewing and attaching buttons; only one worker is required to operate this machine with much faster speed than operating each stage separately);
- checking packaged products (uses computer software to scan the product code for checking if packaged products meet the customer's requirements; combines inspection of several types at the same time, such as counting the number of products in a package, checking models, sizes and colours of products, and so on);
- folding each product;
- sewing decorative materials (such as pockets, patterns and labels);
- embroidering; and
- transferring unfinished products through stages of the production, beginning from the cutting to the final stage of packaging (it is designed scientifically with an appropriate slope to reduce thrust, save space and reduce labour).

For the Viet Thang company (see the previous box) and other original design manufacturing and original brand manufacturing enterprises, the possibility to apply the technology of Industry 4.0 is greater than it is for free-on-board and cut-make-trim enterprises because it can be easily applied with virtual reality, or augmented reality, in the design, marketing and other stages. For cut-make-trim enterprises, sewing is more difficult to automate. Global research and development on the technology for Industry 4.0 in sewing production lines is only beginning. Even so, among Vietnam's original design and original brand manufacturing enterprises, which account for only 10 per cent of all enterprises in the textile and garment industry, the number investing in new technology (still at only Industry 3.0 level), such as Viet Thang, can only be counted on two hands because the cost is prohibitively high at present.

Fourth Industrial Revolution

The Fourth Industrial Revolution, or Industry 4.0, links with Industry 3.0, which means that the stages of the production process in the garment sector, after being automated separately (Industry 3.0), will be connected to become an automatic production line (fully automatic manufacturing process). This will result from a combination of technologies, such as robots, artificial intelligence, the Internet of Things, 3D printing and others. This means that the technology of Industry 4.0 will no longer need manual workers to operate each machine and equipment separately as in the previous three eras. Rather, it will require high-skilled technicians. The number of technicians needed for a production line in Industry 4.0 will be reduced (compared to the previous third era) because they can be in charge of the whole production line instead of separate stages. These technicians will need to be highly skilled to deal with complex problems throughout the whole automatic manufacturing process. Thus, Industry 4.0 is eliminating simple manual workers from the manufacturing process and requiring technicians or engineers with higher skills. Workers who cannot upskill to that level of technician are at risk of losing their job when the new technology is introduced.

Process of fully automatic production lines of Industry 4.0
Image from istockphoto / nd3000

Industry 4.0 is characterized by real and virtual systems. The real system includes connected machines and devices that are run entirely by the virtual system, which includes connected computers and software. Industry 4.0 is the revolution of process automation, and its associated work in the garment sector requires highly qualified technicians and engineers.

No garment enterprise in Vietnam has yet to invest in a complete automatic production line in the true sense of Industry 4.0, in which the production line is run by a virtual system that is operated by a contingent of engineers and no manual workers are needed in the factory. In the research interviews, a majority of the enterprise managers could not even imagine that the garment sector could be fully automated, especially the sewing stage, partly due to their understanding that the technology of complete automation in the garment sector does not yet exist and the technical requirements for sewing products make it impossible to automate the entire manufacturing process.

Almost all the interviewed enterprise managers have a misconception that the current computerized sewing machinery and equipment used in their factories (which are actually Industry 3.0 machinery and equipment) are those of Industry 4.0. For example, some managers think that the electromechanical sewing machines with an electronic board tracking the number of sewing products and the number of stitches (which are actually Technology 2.0) are those of Industry 4.0. From that perspective, they insisted, the garment sector cannot be automated fully because there will always be a need for manual workers.

Technology of a fully automatic sewing of Industry 4.0

Technological advancement in the world has proven that the production line in the garment sector could be completely automatic. Among all stages of production in the garment sector, sewing is seen as the most difficult stage for automation due to the sewing curves and because the fabric often shrinks or skews, especially with soft and thin fabrics. But two American software companies, Softwear Automation in Atlanta, Georgia and Sewbo in Seattle, have each designed a fully automatic sewing robot, called Sewbots and Sewbo, respectively, that are capable of curve sewing.

Sewbots applies the technology of robots' dexterity by making them as skilful as humans. Sewbots technology involves an extremely high-resolution camera installed at the tip of the sewing needle to monitor the movement of yarns in the fabric and software to track the movement of the fabric so that, in case of skewed fabric, the software directs the robotic hand to return the fabric to the original flatness before pushing it again into the position for sewing. The Sewbots capacity is 3,300 units per day.

Sewbo applies the technology of technical processing by hardening the fabric by dipping it in a chemical to thus easily insert the fabric into the sewing robot, and then dipping it again in warm water after sewing to dissolve the chemical and bring it back to the original state.

Source: See http://usa.chinadaily.com.cn/world/2017-07/25/content_30244657.htm

Fully automatic sewing technology is possible (as the previous box explains). Although, to date, this technology is only applicable to basic garments with simple design, such as T-shirts. A Chinese company has started investing in a fully automated sewing factory in the United States (see the following box). Making large-scale investment, however, is still an issue of investment efficiency in comparison with low labour costs in developing countries, which remains a comparative advantage for investors.

A Chinese company opens a fully automatic sewing factory in the United States

With the fully automatic technology now possible with Industry 4.0, the demand for intensive labour is no longer a requisite. In early 2018, Tianyuan Garment Company, based in Suzhou, China and which supplies Adidas, Armani and Reebok, began investing $20 million to build a sewing factory in Little Rock, Arkansas in the United States.[a] The company wanted to set up a manufacturing plant in the United States to be closer to customers and thus reduce its transportation costs and generate a larger profit.

In this project, 21 automatic production lines were installed. The 330 factory workers are actually robots provided by Softwear Automation, based in Atlanta. The company reportedly employs 400 engineers to control the 21 production lines. The company's sewing capacity is expected to be 800,000 shirts per day and 23 million shirts per year (equivalent to 28.75 working days per month).[b] The estimated time to make a shirt from cutting to a finished product will be 24–26 seconds. If the operation is at full capacity and full efficiency of connecting the stages, the sewing time will be reduced to 22 seconds per shirt. The personnel cost for each T-shirt will be an estimated 33 cents (no information was found during the desk review on whether operations had begun and reached these estimations).[c] In comparison, the sewing capacity of factory workers in the enterprises covered by our survey (in terms of the time to make a complete shirt) is 8–12 minutes, depending on the technology, management skills and worker productivity. Thus, the automatic technology of Industry 4.0 has a capacity to perform 18 to 33 times faster.

Source:
[a] see https://money.cnn.com/2016/11/30/technology/chinese-manufacturers-come-to-america/index.html;
[b] see www.therobotreport.com/chinese-factory-sets-arkansas-make-t-shirts-using-u-s-robots/;
[c] see http://usa.chinadaily.com.cn/world/2017-07/25/content_30244657.htm

The Tianyuan Garment Company (in China) is the first in the world to invest in a garment factory with the technology of Industry 4.0. This suggests a possible shift of production from Asia to the importing countries to thus be closer to consumers. However, the speed of this shift will depend on the speed of the research and development on the machinery and equipment, along with consideration of the cost of investment compared with the cost of labour. In addition, investors' decision to shift production will depend on the source of input materials. Also, it must consider the environmental and security impact for the government of the importing countries to decide whether to allow the establishment of factories in their territory.

Nonetheless, the garment sector is about fashion, and fashionable garment products will always need workers of some sort. Of course, they will need to be qualified and skilful workers rather than simple manual workers (like the porters of Industry 3.0 who only carry the fabric and insert into a machine). Hence, the shift of the whole garment production to importing countries may not take place as is currently predicted (see more discussion on this in Part III).

In addition to the fully automatic sewing technology, the garment sector has made progress in the application of fabric adhesive technology instead of sewing technology (see the following box). This technology will help the full automation of the garment sector become a reality

in the near future. For now, the technology, especially with respect to sewing, is mostly confined to experiments and test studies.[13] Although the Tianyuan Garment Company has invested in an automatic sewing factory according to online sources dating to 2017 and 2018 (mostly announcements of the investment), no reference to any success was found in the desk review. This could suggest that full automation of the sewing process may not yet prevail. Hence, whether Industry 4.0 technology (in sewing) will be introduced at an industrial scale within the next few years in Vietnam or elsewhere in the world seems unlikely.

The technology of pressing and gluing fabrics

The technology of pressing and sticking fabric to make garment products uses synthetic materials and coated fabric, hot air and ultrasonic energy to link pieces of fabric and then uses adhesives to link details. Because special equipment is required, this technology is now mainly used to produce water-resistant and chemical-resistant products for special needs such as rescue clothing, labour protective clothing, anti-epidemic prevention clothing, sportswear such as ski wear, sailing apparel, etc.

There are many factors that affect the quality of pressed and glued products such as: fabric material (some fabrics can withstand high temperatures but some fabrics are easily scorched at high temperatures), compatibility between the material and the tape, for example, the stretch fabric should choose the tape with good elasticity, the pressing condition (temperature, time, pressure) and the type of machine. Currently, there are many types of fabric-pressing-and-gluing machines on sale such as hot air pressing machines, ultrasonic sewing machines, ultrasonic welding machines, water power pressing machines, etc. The technology for pressing and gluing fabrics is used more commonly not only because of its comfort and for meeting high technical properties such as waterproofing, windproof, keeping warm and moisture but also for creating fashion products that meet the diverse needs of consumers around the world.

13 Küsters, Praß and Gloyam, 2017, pp. 214–221.

PART II: Impact of automation on employment in the garment sector

Part I explains that Vietnam's garment sector is at an early stage of transition from Technology 2.0 to Technology 3.0 and has not yet taken on Technology 4.0. Even so, the nature of work in the garment sector has changed. The number of workers needed to operate one machine has not changed, typically requiring at least two workers (a mechanical engineer worker or a technician and a manual worker) for one machine. But the capacity of Industry 3.0 machinery and equipment is much greater than the previous era technology, and the number of products manufactured is far greater while the demand for labour is much less. Because the country's garment sector has experienced a continuous annual growth rate in production, the number of workers losing jobs in the garment sector due to automation is low or unclear at present. Still, the current rate of labour mobility in the garment sector is high, at 8–10 per cent a year,[14] although it is because of poor wages and working conditions rather than automation.

The interviews with managers and technical workers about the change of labour when adopting Industry 3.0 machinery and equipment, indicate that labour productivity doubles or triples while the labour demand is reduced by two to six people, depending on the stage of production and type of machinery and equipment used.[15] This labour reduction is smaller than expected. But if output does not increase (which is not the case in Vietnam), the reduction of workers will be greater. For example, in Viet Thang Company, 98 workers were made redundant in the jeans grinding section after an Industry 3.0 automatic grinding machine run by software was installed. But those workers were transferred to other sections because the company had expanded production.

Even though enterprise owners believe that investing in the automation machinery and equipment can help them reduce the use of physical labour, the survey responses show that most of the enterprises are having a labour shortage and looking to recruit more workers to either replace those who have moved to a different sector or have retired or due to expansion of the enterprise. This matter was mentioned before.[16] Therefore, once investing in Industry 3.0 machinery and equipment begins, the workers not capable of handling the new production needs will be transferred to jobs still using more traditional machinery and equipment. To date, there has been no loss of jobs in Vietnam's garment sector due to automation.

The growth of Vietnam's garment sector is predicted to slow in about ten years' time.[17] That reality combined with whether the Industry 4.0 technology develops sufficiently over the next five to ten years and is embraced by the country's garment sector will lead to a reduction in the demand for labour and higher risk of job loss. Industry 4.0 technology does not need low-skilled workers or manual workers—these people will lose their jobs in the garment sector if they cannot upskill as technicians.

14 According to the survey responses.

15 According to the survey findings.

16 Lee, 2019.

17 Interviews with experts in the textile and garment industry.

Labour demand in the garment sector through the industrial revolutions

	Industry 1.0	Industry 2.0	Industry 3.0	Industry 4.0
Technological characteristics	Mechanical or steam-powered machinery and equipment	Electromechanical machinery and equipment.	Automated programmed electronic device machinery and equipment (automation of separate stages in the production process).	Automatic production line or fully automatic manufacturing process.
Labour need	Mechanical engineering workers and manual workers.	Electrical and mechanical engineering workers and manual workers.	Computer technicians (also doing small maintenance of machinery and equipment) and manual workers.	Highly skilled computer technicians (or engineers) taking care of both hardware and software and managing both real production and the virtual system of the manufacturing process.
Determinants of product quality and quantity	Workers' skills (which is the decisive factor for productivity and quality of products). Basically, the working speed is slow.	Workers' skills (which is the decisive factor for having products produced quickly and without error). Products made by different workers have certain differences due to different levels of skill. The quantity and quality of products depend on the workmanship.	Products are made by machinery and equipment, so all products are the same in quality. Quantity and quality of products depend on the capacity and scientific nature of the machine and equipment. If the speed of manual workers does not keep up with the speed of machinery and equipment, it will affect the productivity as designed of the machinery and equipment.	Products are made by machinery and equipment, so all products are the same in quality. Quantity and quality of products depend on the capacity and science of the machines and equipment in the entire production line.

Source: Author's analysis and synthesis from the survey responses and desk review findings.

The transition in technology used in the garment sector over the different eras will change the demand for labour and the skill requirement for both technicians and manual workers, as the following table explains.

Requirements for garment worker skills through the industrial revolutions

Requirement for manual workers	
Industry 1.0	**Industry 2.0**
Workers need vocational training and to have work experience so as to make products of good quality.	Workers need vocational training and to have work experience so as to make products of good quality.
Industry 3.0	**Industry 4.0**
Workers do not need vocational training. The only action of workers is to put the raw material into the machinery (for example, putting cloth into automatic programmed sewing machines), which operates on their own. Manual workers need to have quick hands and quick eyes, otherwise the capacity of the machine will not be optimized. There is no need for skilled workers but only manual (muscle-based) workers, like porters, who have good health to keep up with the speed of the machine, and also a strict discipline regarding regulations of technical specifications.	No need for manual workers.

Requirement for technicians	
Industry 1.0	**Industry 2.0**
Need mechanical workers, trained in mechanical expertise, who are skilful and qualified to repair and maintain mechanical machinery and equipment.	Need electrical and mechanical engineering workers, trained in mechanical and electrical expertise, who are skilful and qualified to repair and maintain electromechanical machinery and equipment.
Industry 3.0	**Industry 4.0**
Need software technicians who can maintain the machinery and equipment or need two technicians (one for machinery and equipment hardware and one for the computer program software to run the machinery and equipment), who are trained in mechanical and electronic engineering, are able to operate machinery and equipment by software so as to produce products that meet the designed technical requirements for the product, are able to identify errors in the operation of the machinery and equipment and are able to make small repairs and maintenance on the hardware of the machinery and equipment. The manufacturer and supplier of the machinery and equipment are responsible for warranty and overhaul.	Need highly skilled technicians (engineers) who manage both real production and virtual systems, who are trained in electronics and mechanical engineering, are able to manage the whole line, are able to use computer software to operate the whole production line to meet the technical requirements of products, are able to detect errors in the whole production line and are able to make small repairs and maintain the hardware of the machinery and equipment. The manufacturers and suppliers of the machinery and equipment are responsible for the warranty and major repairs.

Source: Author's analysis and synthesis from the survey responses and desk review findings.

Training for adaptation in the garment sector

Industry 3.0 and Industry 4.0 demand that workers improve their knowledge, skills and qualifications, especially concerning computers, programming and controlling the devices and the production line in a virtual system as well as the ability to solve problems in the whole system. The Industry 3.0 automation process of the garment sector is thus presenting manual workers with two choices: (i) become a technician or (ii) remain a simple manual worker with limited skill. And Industry 4.0 will present garment workers with two choices: (i) job loss or (ii) become a highly skilled technician (or engineer). Realistically, becoming a high-skilled technician is unlikely because it is difficult to train a manual worker for this type of work in a short time. If manual workers cannot adapt, they will be forced to change their job.

This study did not include small enterprises, which represent a large number in the country's garment sector. But the survey responses suggest that small enterprises, while unable to afford the capital to invest in Technology 3.0, can possibly exist by subcontracting for large enterprises. However, when machines replace manual workers in Industry 4.0, the product quality and productivity will be at high levels. Without capital, subcontracting enterprises will likely not survive. If this happens, job loss will occur for a large part of the labour force working in these small garment enterprises.

Training technicians and manual workers for Technology 3.0

The training of technicians and manual workers for operating Industry 3.0 machinery and equipment varies greatly. For technicians, the training subjects and training time needed far outweigh what is needed for manual workers. Because the skills of manual workers with of Technology 3.0 are reduced and the main action is to insert material into machinery and equipment, the training time needed is only one to two days or one week at the most. Technicians must have basic knowledge of the garment sector, stages of production, production details and materials, knowledge of computers and design applications and then the time to practise at a factory. Thus, training time can be up to four years for newcomers and about two years for experienced technicians (with one to two years of experience in the garment sector). Therefore, it is likely that it will be difficult for manual workers to switch to a technician.

Source: Based on interviews with managers and technical workers in garment enterprises.

PART III: Problems faced by garment workers due to technology transformation

New jobs and lost jobs

With the real and virtual systems in producing and manufacturing that Industry 4.0 will herald, it is certain that the jobs of manual garment workers will be lost. Until then, the transition from Industry 2.0 to Industry 3.0 machinery and equipment (which is only beginning in Vietnam) will not introduce job loss as long as the growth of the garment sector remains.

A good point made in the survey responses is that Industry 4.0 will create new jobs in the garment sector, including: simulation work; sample design on 3D models; evaluation and analysis of models in a digital space; preventive maintenance; data analysis and statistics work to identify potential risks of equipment failure so as to have a reasonable maintenance plan; improvement of operational efficiency to prevent risks affecting the automatic assembly line (digital maintenance); supply chain management or monitoring and managing the flow of goods and services; e-commerce; programming robots; and jobs related to artificial intelligence in controlling production processes, product quality, product progress and product mistake identification. But these are all jobs that require considerable skills, which means manual workers could not crossover into this work without intensive training.

Polarization of skills in Industry 3.0 and the risk of unemployment for manual workers in Industry 4.0

Both Industry 3.0 and Industry 4.0 are creating skills polarization in the garment sector between highly skilled people (technicians and engineers) and low-skilled people (manual workers). In Industry 3.0, manual workers are not required to be as skilful as in Industry 2.0 (they just feed materials into sewing machines, embroidery machines and others as quickly as possible). But technicians in the latter technology are required to have command of the software, which did not exist previously. The skill polarization will be far greater once the production line is fully automatic (actually, there will be no need for manual workers). Workers with no qualifications, no computer training, no knowledge of the garment sector and no capability to acquire new knowledge or skills for controlling and managing automation chains will be at high risk of losing their job in the times of Industry 4.0. In that coming era, skilful manual workers may keep their job in the garment sector by working for enterprises that produce fashion garments and unique handmade products to satisfy an individual expectation of consumers. But a large number of manual workers will be unable to adapt to the new jobs. Perhaps this is why a study by the International Labour Organization[18] led to the prediction that 86 per cent of the garment and footwear workers (who are manual workers) in Vietnam are at high risk of losing their jobs in the transformation to Industry 4.0.

Widening wage gap

The polarization of skills in Industry 3.0 is associated with the widening wage gap between technical workers and manual workers, thereby exacerbating the gap between rich and poor workers. Although our survey shows that in the process of moving from Industry 2.0 to Industry 3.0 that manual workers did not experience a pay cut, technicians who are newly recruited to operate Technology 3.0 are often paid far more due to their higher level of skill than the mechanical engineering workers of Industry 2.0. Our survey also indicates that the wages of mechanical engineering workers (Industry 2.0 technicians) are only one and half times higher than that of manual workers while the salaries of Industry 3.0 technicians can be two to four times higher than that of manual workers.

More male workers than female workers in Industry 3.0 and Industry 4.0

Through the observation of factories and the interviews with factory managers, we found that the percentage of male workers who operate Industry 3.0 machinery

[18] Chang, Rynhart and Huynh, 2016.

and equipment to be larger than for female workers. Does Industry 3.0 present a higher risk of job loss for female workers? The factory managers and technical supervisors explained that more male students study information technology and programming than female students, who, they speculated, are more inclined to fashion design. Also, they posited, male workers seem to be faster and stronger than their female co-workers and that seems to make men better able to keep pace with the capacity of the automatic programmed machines. The respondents also claimed that women are more concerned with the work–life balance (without citing any definitive basis), so they are more limited than men in terms of having time for higher education. However, the respondents also said that as the country moves deeper into Industry 3.0 technology and especially into Industry 4.0 technology the number of women who choose to learn programming may increase.

Sharing economy is projected to increase in Industry 4.0

It appears that with Industry 4.0, the Internet-based service industry, or the so-called "sharing economy", will grow (see the following box). It is likely that garment workers who lose their jobs will join this economy. Our survey indicates that many garment workers are already making extra money to supplement their expenditures through e-commerce or working as Uber or Grab drivers. The skills requirement for workers in the sharing economy ranges from online marketing and the ability to analyse and assess consumers' and customers' needs to building the confidence of consumers or customers to help them come to a decision on buying goods or using the service.

Employment in the sharing economy is regarded as informal employment because it is too new to be covered by current labour laws. Thus, Industry 4.0 will likely lead to an increase in informal employment if nothing is done to formalize this type of working arrangement. Formalizing the sharing economy should be a goal.

The sharing economy presents many issues for workers, such as zero-hour work (work done on demand), doing several jobs at a time (which leads to overload), no sick leave benefit, no accident compensation, no trade union rights, no dialogue, no collective bargaining and no organization to represent and protect workers when problems arise related to their rights. The Vietnamese labour laws do not yet cover workers in the sharing economy, and as a result, there is no legal basis for the protection of such workers.

Sharing economy

The sharing economy is a business model with goods and services exchanged based on platforms often accessed via mobile telephones or computers. The sharing economy connects people who have assets or services (for example, an apartment, a car, a service, a skill to do a specific job) and are willing to share it with consumers and users. In the sharing economy, many jobs are created, such as Uber or Grab drivers; online salespersons; platform-based delivery workers or messenger workers; "click" workers who work on computers, receiving work and returning results to customers with just a click; and shoppers who walk throughout grocery and food stalls, collecting and delivering goods to customers on demand. With the Internet and digital applications, people can participate in the sharing economy with their available capabilities and resources. Automation, artificial intelligence, the Internet of Things and 3D printing are gradually infiltrating the manufacturing sector and creating growth without creating jobs. The workforce in the manufacturing sector likely will have to shift to other sectors, especially the sharing economy, which has been developing in many fields. Many terms are used to describe this economy, such as access economy, on-demand economy, circular economy, cooperative economy and gig economy. In Vietnam, the term "sharing economy" is most popularly used.

Assessment on shifting garment production to importing countries

The global supply chain in the garment sector concentrates production in developing countries, of which Asia is a centre, with manufacturing and assembly located mainly in Bangladesh, Cambodia, China (although it is farther up the supply chain), Myanmar and Vietnam. The coming Industry 4.0 is escalating the prospect that full automation without manual workers in the garment sector will allow enterprises to move production to the currently importing countries to be closer to consumers and reduce the transportation costs.

A 2018 study by McKinsey & Company[19] confirmed that globally "simple garments will be fully automated, affecting an 80 per cent labour reduction by 2025", which will be followed by a relocation of production from countries in the South (such as Vietnam) to the periphery of the industrialized world. The study's interviews with garment enterprise managers in Vietnam indicate no such shift as of yet. And if it ever happens, the managers believe that such a shift will take longer than the timeline of 2025 predicted by McKinsey & Company.

Many enterprise managers in Vietnam said that their brand companies require them to invest in new technology to create smart factories for ensuring a uniform-quality product and to secure delivery deadlines. This suggests that brand companies have not yet planned to erect a factory in their country and will still work with an outsourcing strategy. Therefore, the ability to move, if any, will depend on decisions by manufacturing enterprises. This possibility is not high in Vietnam, where enterprises cannot secure enough capital for investment nor have confidence in their production capacity, management skills and market stability to move their factories to the importing countries. Foreign-invested enterprises have enough capital, but our survey finds no sign of shifting because the low labour cost in Vietnam is still an advantage, along with other incentives for attracting foreign direct investment. Additionally, most input materials for the garment sector are imported from other Asian countries (at more than 50 per cent from China, 18 per cent from the Republic of Korea and 15 per cent from Taiwan).[20] This will hinder any geographical shifting because even though the relocation of factories to importing countries would cut the cost of transportation of finished products, there would still be transportation costs for the input materials from Asia to Europe and the United States. And then there are issues related to erecting new factories in importing countries, such as land clearing, investment licenses and taxes.

Vietnam's garment sector has just entered Industry 3.0, while Industry 4.0 of the global garment sector is still taking shape. The shift of production closer to consumers and to meet the diverse, individualized and rapid needs of consumers can occur when 3D printing technology in the garment sector develops at a lower cost than the labour costs within producing countries (such as Vietnam). Based on our survey responses, we expect this will not take place in the next five to ten years, especially when the cost of Industry 3.0 machinery and equipment remains high (and even higher for the next generation of technology).

The large-scale unemployment of manual workers will occur when the garment industry enters the era of Industry 4.0. This means that many garment workers, especially women, who account for a large proportion of the sector's workforce, have more time to work in the garment sector in Vietnam than such workers have globally, before losing their jobs to automation. This period of time is important for Vietnam to consider policies for making a just transition to Industry 4.0 in the textile and garment industry.

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19 Andersson and others, 2018, p. 21.

20 See https://vietnambiz.vn/hon-mot-nua-nguyen-phu-lieu-nhap-khau-den-tu-trung-quoc-nganh-det-dang-yeu-o-dau-20190722163800079.htm; www.trungtamwto.vn/hiep-dinh-khac/13040-det-may-can-khai-thac-nguon-vai-tu-eu-han-quoc-de-tang-xuat-khau-vao-eu.

Conclusions and Recommendations

Our survey responses indicate that although Vietnam's garment sector has just started shifting to Technology 3.0, workers have already been impacted with job changes, skill changes and salary changes. But there will be great potential for job loss among manual workers in moving to Industry 4.0 technology if they are not able to adapt. The evolution of the sharing economy implies that workers suffering from job loss in the garment sector will likely move to this sector. The paper concludes with the following recommendations for a just transition to Industry 3.0 and eventually Industry 4.0 in the garment sector.

Trade unions

Trade unions need to raise awareness among workers on the technological change trends and the potential for lost jobs and new jobs that Industry 4.0 will encompass. They should advise workers on the need for improvement of their skills to help them decide on staying in the sector and adapting to the changes or moving to other industries when Industry 4.0 technology is introduced in the garment sector.

Grass-roots trade unions should be actively involved from the beginning when a technology renovation plan is designed in workplaces so as to include workers in any consideration of changes. The process of technological transformation and labour restructuring must be discussed in parallel with each other through dialogue and negotiation between trade unions and employers.

The sharing economy is new in Vietnam and has not yet been regulated in the labour legislation. And yet, the government promotes the sharing economy through the Prime Minister's Decision No. 999/QD-TTg of 2019, approving the Programme on Promoting the Sharing Economy Model in Vietnam. Therefore, trade unions need to proactively study the sharing economy to recognize issues and problems related to workers. They should propose legal regulations and participate in the development of a legal framework to protect workers and ensure social security in the sharing economy. Trade unions also need to organize workers in the sharing economy for their protection.

Employers

Employers should think strategically to prepare themselves for Industry 3.0 and Industry 4.0 and to consider moving from reliance on low value added to high value added in the garment supply chain if they want to maintain their position in the garment sector in the future.

The future level of automation is expected (based on the survey responses) to be lower with fashion products than basic products, especially due to relatively smaller orders in line with the nature of fashion demands. Enterprises should concentrate on the production of fashionable products of high quality. This would be good both for developing the garment sector and stabilizing employment for garment workers in Vietnam in the future.

Employers should discuss in advance with trade unions and workers any forthcoming changes at the workplace and together develop appropriate labour plans when moving into Industry 3.0 and then Industry 4.0 technology.

Employers should make plans to train workers to adapt to the new jobs in both Industry 3.0 and Industry 4.0 and ensure adequate social insurance for workers and support for workers in the event of job loss due to technology change.

Employers should consider creating an assistance fund for workers in the transition to Industry 3.0 and then Industry 4.0 to help them in changing jobs.

Government

To support enterprises in the technological shifts, the government should help them access information channels, such as technology fairs and technology forums, so they can catch up with the developments in the global garment sector. The current channels through which Vietnamese garment enterprises can learn about the technological developments are mainly through suppliers. But the information on technology may not be accurate or relevant, leading to a short lifetime of technology application or the ineffective application of

technology, thus wasting any related expenditure and affecting the competitiveness of enterprises.

In the context that overtime work in the garment sector in Vietnam is high and, worse, that employers are still lobbying to amend laws to increase the legal overtime limit, Industry 4.0 technology will be a solution to increasing productivity, reducing overtime work and improving working conditions. Vietnam needs to consider this factor to develop legislation on regulating working hours, along the lines of reducing physical labour and encouraging enterprises to seek out the advanced technologies and for the gradual modernization of technology without creating mass unemployment. Labour activists in many countries (such as the United Kingdom and the United States) have started to advocate for reduced working hours, from 40 hours a week to 32 hours or four days a week, to match with the application of new technology, while Vietnam still regulates 48 hours a week, excluding overtime.

To modernize the technology of the garment sector is to depend on foreign technology because Vietnam does not have enough resources to invest in the research and development of new technologies. In the Industry 4.0 era, the garment sector will become a sector growing without creating new jobs, which is a common characteristic of Industry 4.0 in other manufacturing sectors. The demand for labour will reduce. To achieve the goal of job creation, Vietnam needs to conduct research and identify and establish new industries for making investments for future development.

The government should research and propose a legal framework for the sharing economy to ensure that workers participating in it are protected from the risks at work and entitled to the social security system. The government should ensure equality between workers in the formal economy and the informal economy, both in law and practice.

The government should support the development of vocational training schools, in line with the technology transformation of the garment sector. It should develop programmes to assist workers to transition from a low-skill level to technician and that connect workers with enterprises to minimize the risk of job loss when the garment sector enters deeply into Industry 3.0 and Industry 4.0.

The government should develop new industries and supply incentives to attract workers, both women and men, into them, provide career orientation and help them to learn suitable skills for the new industries. In particular, the government needs to develop programs of supporting female workers to help them reduce their time for family work and children so as they have opportunities to participate in higher education for adaptation with job transition in Industry 3.0 and Industry 4.0.

Workers

Garment workers should actively search information about Industry 4.0 to plan for their future in the era of greater automation. On the basis of this information, they should improve their skills and qualifications to meet the requirements of the new technology.

Workers need to be attentive to the discipline expected to operate machines and equipment of Industry 3.0 due to the high productivity, mass production and high accuracy required. If workers do not comply with the technical procedures, they can damage the machinery and equipment, thus causing great loss to the enterprise and affecting their own employment.

Industry 3.0 and Industry 4.0 are creating jobs related to software, computers and automation. Female workers need to pay attention to this field and participate in learning to improve their knowledge and skills in information technology and automation to adapt to the job transitions in the digital age.

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