Technology and the future of ASEAN jobs

The impact of AI on workers in ASEAN's six largest economies

September 2018

Executive summary

Over the next decade, innovations in digital technology will present vast opportunities to ASEAN economies to boost their productivity and prosperity. The more widespread adoption of existing technologies, coupled with advances in the use of artificial intelligence (AI) through software, hardware, and robotics, has the potential to transform business capabilities. As a youthful region (half the 630 million inhabitants are aged under 30) with an internationally competitive manufacturing sector and innovative enterprises, ASEAN is poised to take advantage. However, digital transformation will also mean that many of the region's workers face considerable upheaval.

6.6 million

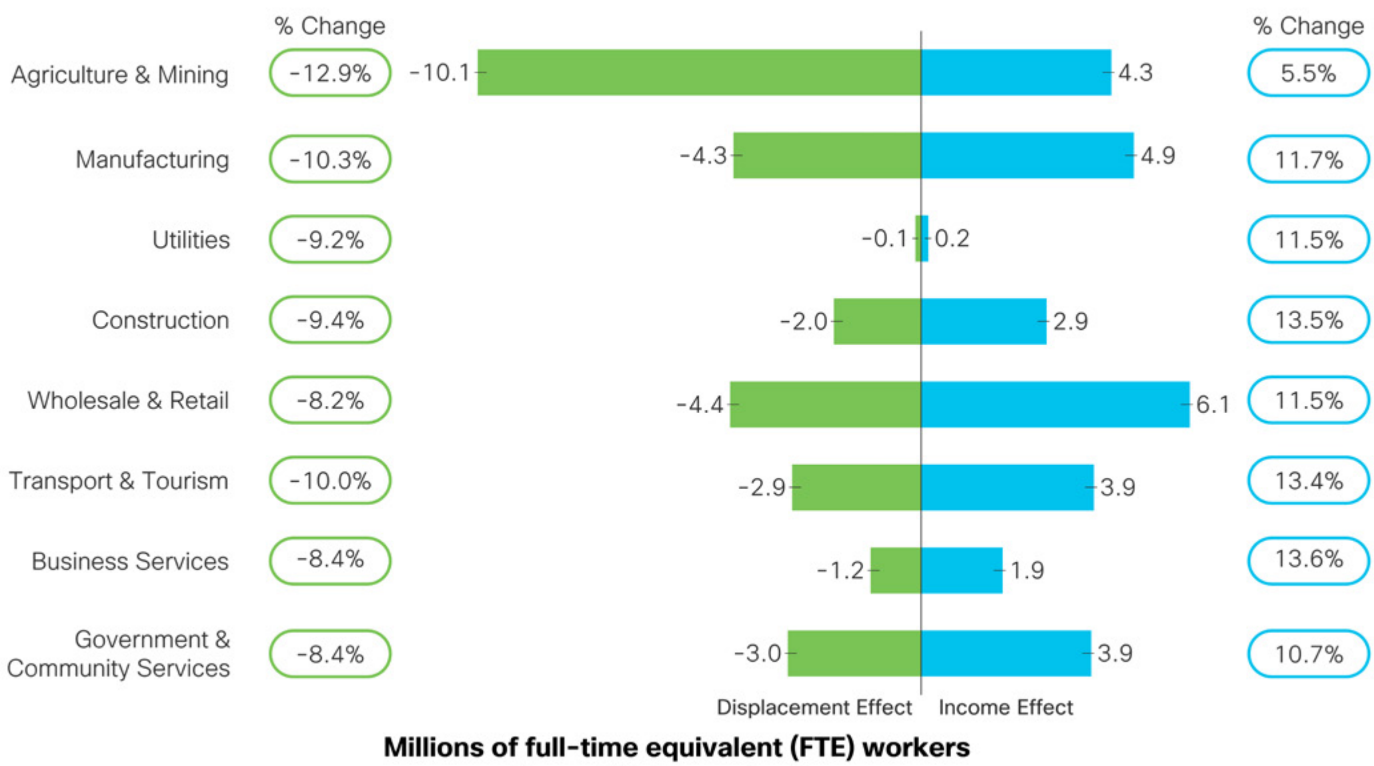
Number of jobs that will become redundant through more widespread adoption of technology by 2028

* Across the ASEAN-6 economies.

To better understand these opportunities and challenges, Cisco has worked with Oxford Economics to explore what the next decade of technological change will mean for ASEAN workers. We assembled a multidisciplinary team of experts from across the region to advise on the role technology will play in different industries and occupations. We then leveraged data on 433 occupations across 21 industries to model the impact of these technology adoption patterns on the 275 million full-time equivalent (FTE) workers employed in the six largest ASEAN economies (ASEAN-6) by 2028.

This is a dynamic model, which captures the many shifts in the labour market triggered by the adoption of new and existing technology over the coming decade. Technology will displace workers from some jobs, but it will also boost productivity growth, which in turn creates new demand for workers. Fig. 1 shows the projected changes according to these two dynamics for each industrial sector, both in absolute and relative terms, across the ASEAN-6 economies.

Fig. 1. Positive and negative impact of increased technology adoption, by industry sector
(ASEAN-6, number of workers (axis), percentage of workforce (labels), 2018-2028)



Source: Oxford Economics, Cisco

Our model finds that, by 2028, 28 million fewer workers across these economies – more than 10 percent of the current ASEAN-6 workforce – will be required to produce the same level of output as today. This constitutes substantial productivity gains from more widespread technology adoption, which will drive growth and create new

28 million

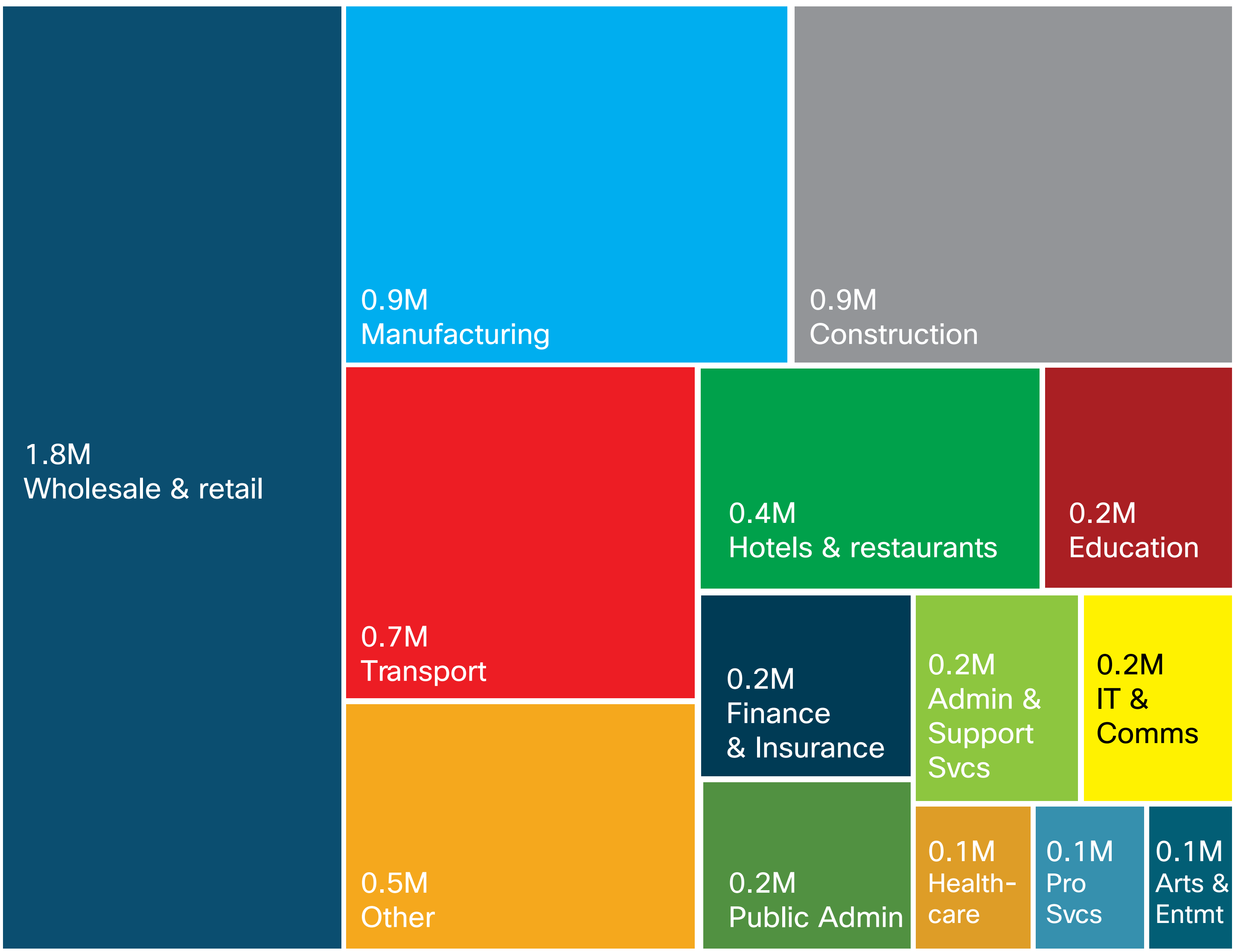
Fewer workers required in 2028 to produce the same level of output as today

* Across the ASEAN-6 economies.

demands for workers. Overall, the job landscape will look very different in 2028, because where the jobs are created is different to where the jobs are displaced. Our modelling identifies that, for some 6.6 million workers across the ASEAN-6 region, the new technology scenario will render their jobs redundant. Agriculture will be the major source of these redundancies, as new development – for example in global positioning systems, telematics and smart sensors – are deployed to greater effect. Overall, we find there will be 5.7 million net fewer FTE workers in the agriculture sector by 2028, across the six economies.

In contrast, many sectors will experience a net increase in their demand for jobs by 2028, because the rise in spending power through increased productivity more than offsets the jobs directly displaced by technology. As Fig. 2 illustrates, the sectors projected to see the greatest rise in demand for new workers are wholesale & retail (1.8 million new FTE jobs), manufacturing (0.9 million), construction (0.9 million), and transport (0.7 million).

Fig. 2. Jobs created by industry sector (2018-2028)

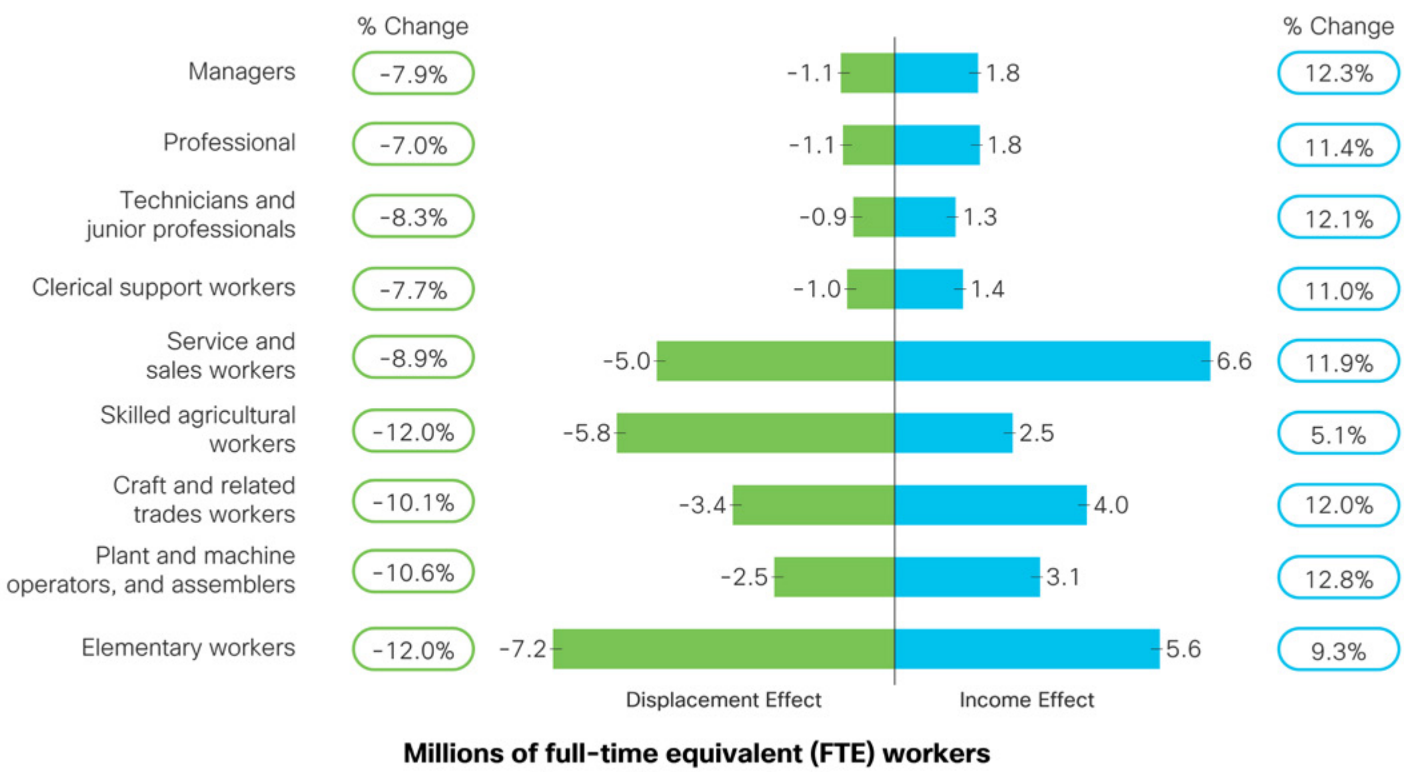


Source: Oxford Economics, Cisco

We also looked at the impact of technology adoption on different occupation types, constructing 433 unique "task profiles" as the basis for our modelling exercise. In relative terms, we predict that there will be greatest extra demand for managers and professionals (both up 4.4 percent), and the biggest fall in demand for skilled agricultural workers (down 6.9 percent) and elementary workers (down 2.7 percent) – see Fig. 3.

In absolute terms, we predict the biggest increase to come in service & sales occupations, with the creation of some 1.6 million net new FTE jobs. In terms of absolute job losses, we predict there will be 3.4 million net fewer skilled agriculture workers, and 1.6 million fewer elementary workers (such as labourers), across the ASEAN-6 by 2028.

Fig. 3. Positive and negative impact of increased technology adoption, by occupation type
(ASEAN-6, number of workers (axis), percentage of workforce (labels), 2018-2028)



Source: Oxford Economics, Cisco

Whether viewed in terms of industry sectors or occupation types, this technology-driven evolution of the ASEAN-6 labour market carries significant implications for both businesses and workers, as the skillsets demanded by employers change accordingly.

In reality, the 6.6 million redundant jobs identified by our model will lead to many more job moves, as the labour market gradually evolves around its new demands. But comparing the typical skillsets of workers doing jobs that will become redundant, with the skillsets of jobs that will be created in other parts of the economy under our new technology scenario, offers a window on the scale of the "reskilling challenge" that the six ASEAN economies will face.

Our analysis reveals that 41 percent of that 6.6 million cohort are "acutely lacking" the IT skills that new jobs will be demanding. Almost 30 percent lack the "interactive skills" that will be demanded by future vacancies – such as negotiation, persuasion, and customer service skills. Just over 25 percent also lack "foundational skills" – such as active learning, reading, and writing skills that are required to a much greater extent in ASEAN's future labour market.

Mitigating the negative impact of technological change may require massive policy changes from education systems, but there is no one size-fits-all solution. The nature of the ASEAN-6 skills challenge means responsibility will fall to an ecosystem of government departments, businesses, educational institutions, technology providers, and workers' groups, which will need to work collectively to provide workers with the necessary tools and skills for the transition.

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Introduction

1. Introduction

Across the ASEAN region's large and diverse economies, many businesses are pushing at the frontiers of digital transformation – while others are outdated in the global context, and ripe for change. Over the next decade, the more widespread adoption of existing technologies, plus rapid improvements in emerging technologies such as artificial intelligence (AI), networked computing and advanced robotics, will drive the real costs of automation down and create opportunities for economic growth.

It will also lead to wrenching changes for many members of the labour market, whose jobs are made redundant by technology. Yet very little empirical research exists on what that change will look like for workers – who will be affected, and what new skills they will need to adopt. This leaves policymakers and business leaders without guidance as to how best to prepare for the future.

Cisco assembled a multi-disciplinary team of experts to explore the implications of technological change for ASEAN workers. Our team of leaders from technology, education, non-profit, consulting, journalism, economics, regulatory policy and government sectors worked together to define the technology landscape for the six leading ASEAN economies: Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Vietnam. Their invaluable insights formed the basis for the "new technology scenario" developed and modelled by Oxford Economics, in order to predict the net impact on jobs in each of the ASEAN-6 countries by 2028.

The workers most vulnerable to displacement from technology are those whose responsibilities most overlap with emerging technological capabilities. In all, our modelling analysed 433 occupations across 21 industries. It identified up to 41 types of task that workers might be asked to perform, then assessed the impact of technology on each task – and in composite, each job – over the next decade. (For a step by step account of this approach, see Box 1.)

This study provides a rich evidence base for policymakers and other stakeholders seeking to prepare the ASEAN-6 workforces for the demands of the future. As well as exploring technology's impact on jobs, we analysed the skills many of today's workers will need to develop, if they are to find sustained employment under the new technology scenario. This assessment, spanning 35 skill categories, reveals the scale of the "reskilling challenge" that the ASEAN-6 economies face over the coming decade.

We will discuss this challenge at length in Chapter 5 of this report. Before that, however, we describe the negative and positive impact of our new technology scenario on the labour market of each ASEAN-6 country, analysing these impact both by industrial sector and occupation type. This allows us to give a detailed assessment, in Chapter 4, of what the overall impact of increased adoption of new and existing technology will be on jobs across the region over the coming decade.

Box 1:
How we built a model that predicts the future for ASEAN-6 jobs

In December 2017, Cisco and Oxford Economics published The AI Paradox: How Robots are Making Work More Human – a ground breaking study of the implications of technological change on the United States (US) labour market, and how workers would have to evolve to remain relevant. Cisco and Oxford Economics teamed up again to extend this analysis to the ASEAN region, working with a multi-disciplinary team of experts from the region to provide empirical foundations for an important dialogue on the future of jobs, and skills.

Here is how we carried out the study:

Step 1: Assemble our team of experts

To kickstart this project, we assembled a team of experts from across the ASEAN region, from a variety of backgrounds and specialisms, to provide technical insights into the technology applications that are most likely to transform businesses – plus local insights into the factors that might hasten or slow down that process.

Step 2: Build a detailed vision of ASEAN-6's future technology landscape

Using structured scenario-development techniques, we challenged our experts to consider three core drivers of technological progress: the ubiquity of data and ease of access to it ("generating data"); the power of algorithms and ability to analyse them ("making sense of data"); and the real-world application of those technologies in business ("making use of technology"). From these, we developed consensus assumptions of the impact of technology on each of the ASEAN-6 economies, across different industrial sectors.

Step 3: Analyse each occupation in terms of the tasks it demands

We assembled task profiles for 433 occupations, based on a 41-task typology produced by O*NET (see Appendix 7), then worked with our team of experts to consider the productivity implications of greater technology adoption on each of these tasks. Our experts considered the extent of technological progress, as well as the rate of business investment and other institutional, political and infrastructural factors in each of our ASEAN-6 economies.

Step 4: Construct a new labour market model for the ASEAN-6 countries

The main reason for a lack of research into the future of jobs in the region is a lack of labour market data. Oxford Economics constructed a bespoke ASEAN-6 labour market model, drawing on the best available labour market data and a system of imputations based on international comparators. For full details, see Appendix 4.

We fed our scenario assumptions through this model to simulate how technology will displace workers across our 433 occupations, based on their distinct task profiles, and to explore how technology will lead to the creation of new jobs – derived from an increase in demand for goods and services across the 21 industries. To model where jobs will be created, we leveraged Oxford Economics' global industry forecasts for the ASEAN-6 economies into the modelling apparatus. For more information on the model, please refer to Appendix 5.

Step 5: Consider the implications of our modelling for each ASEAN-6 country

After completing our quantitative analysis, we re-engaged our team of experts to reflect on what these challenges mean to policymakers, business leaders, technology firms and educators in the region. See Chapter 6 for our country-by-country summary.

The displacement effect of technology on ASEAN-6 jobs

2. The displacement effect of technology on ASEAN-6 jobs

Over the next decade, both existing and new technologies will be applied to business activity in increasingly innovative and diverse ways. From ASEAN's professional and financial services hubs to its agricultural sectors, and every industry in between, AI-enabled technologies are set to deliver substantial productivity gains. If these opportunities can be seized, substantial benefits await the ASEAN economy, and the prosperity of the region.

But for many workers, this shift will bring about significant life changes, as they are forced to adapt their skills or face the threat of redundancy. New technologies precipitate a shift in the nature of work, by altering the balance between man and machine in performing different tasks. The views which underpin our new technology scenario were developed as the consensus of a multi-disciplinary team of experts. For more information on the country-level assumptions we made, see Appendix 3.

Expert view:

Adoption of AI: Balancing Risk and Rewards

Kiran Karunakaran, Partner, Delta Partners

Any study attempting to quantify the impact of AI on the labour market will be closely scrutinized. The base set of assumptions input into the model can dramatically alter the outputs. This study has made many assumptions. However, the one requiring some deeper dialogue will be around the pace of adoption of AI, technology and digitization. Will the vast benefits of AI continue to propel the pace of AI adoption; or will the risks posed by AI limit its adoption?

In reality, well-proven AI technologies can unlock substantial value, although companies and governments alike are still unlikely to adopt them in their full potential. The adoption of AI is guided equally by both trust and risk. There are several low-hanging applications in many industries, where the underlying tasks would have required a substantial workforce to execute. Applications in the consumer space are already well-known, for example, Google's PageRank, Amazon's product recommendations and Netflix's content recommendations.

In these use-cases, the benefits of a correct recommendation in the right context is directly correlated to increased revenue and higher customer loyalty. On the other hand, a seemingly incorrect recommendation does not immediately lead to short-term commercial risk. Hence adoption of such technologies have progressed at rapid pace. This has become the default application right at the outset and the implications on employment and other social factors in the context of a recommendation engine is hardly, if ever, discussed.

As AI engines get more sophisticated and begin to approach technological singularity, many other use cases will line up to take the path that the 'recommendation AI' took. This might happen in industries where the level of skills required is quite easily 'machine learnt' and offers a significant cost and productivity upside.

Contact centers or Business Process Outsourcing (BPO) industries in ASEAN countries are good examples. In these industries, there is a clear case of rapid adoption in the host markets, which threatens jobs as they are typically outsourced for cost reasons. In today's political environment where some developed markets are moving towards a protectionist model, it is these industries, where the pace of adoption will be high, that pose a substantial risk to jobs in ASEAN. The Philippines is probably the market that will feel the effects of this the most followed by Thailand and to some extent Indonesia.

On the other hand, machine learning technologies are particularly equipped to solve complex optimization issues. It is in these situations that the upside far outweighs the risk of social displacement and therefore there is a clear case for governments to invest in driving adoption where the pace has been slow. Energy distribution, healthcare systems and food production are examples where the risk of adoption could be lower than the negative social consequences. This study highlights the risks, while presenting a modest view of the upside and poses the questions that need to be answered – and fast.

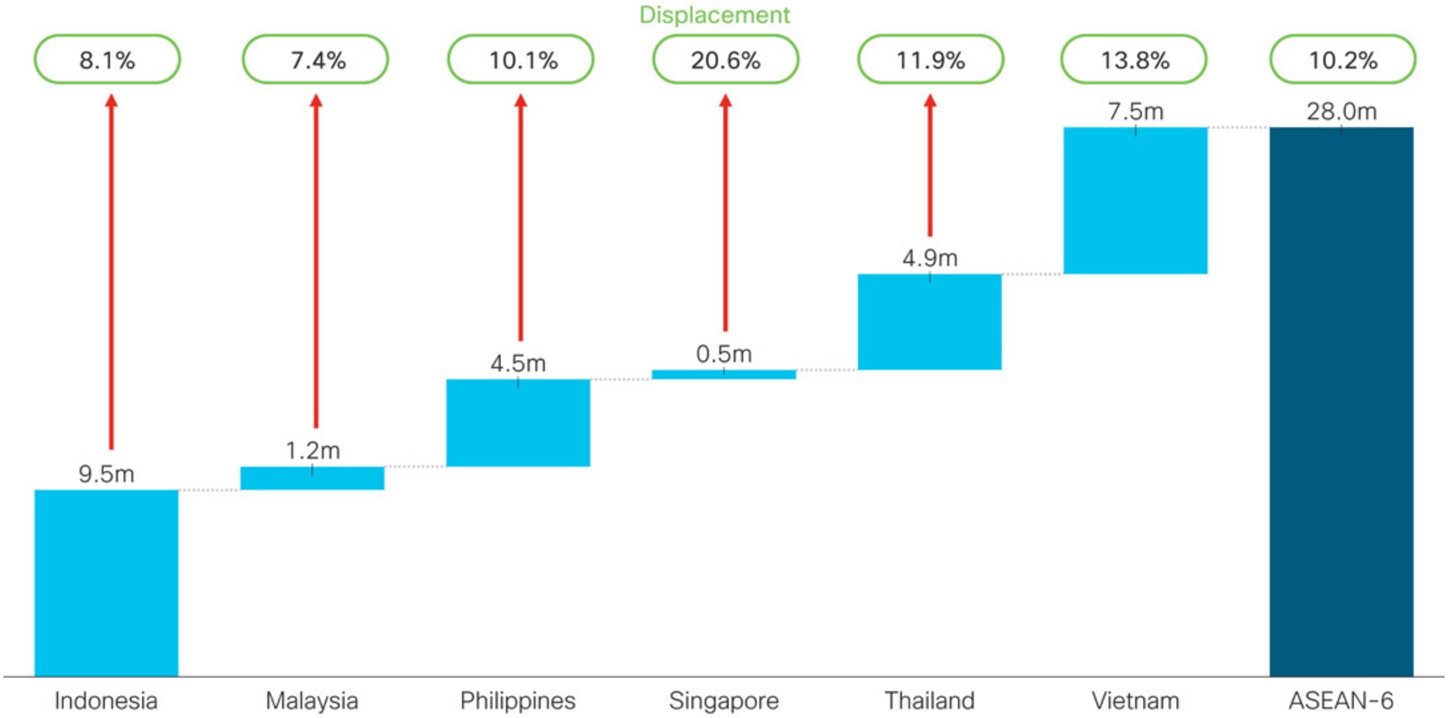
Do we have a higher moral imperative to maintain the quality of life for all people around the world? If the answer to this question is yes, then we will need to address the question of pace of adoption and manage it through the right balance of regulation, policy and enablement. If not, whole industries run the risk of being disrupted and the social implications could be dire.

In conclusion, the adoption of AI is expected to be measured since the benefits of AI will be weighed up against the determined social risk that AI technologies pose.

2.1 Displaced workers: a country perspective

Our model finds that, by 2028, 28 million fewer workers across these economies – more than 10 percent of the current ASEAN-6 workforce – will be required to produce the same level of output as today. The bulk of these "displaced workers" are located in ASEAN-6's largest labour markets, with 9.5 million based in Indonesia, 7.5 million in Vietnam, 4.9 million in Thailand, and 4.5 million in the Philippines (Fig. 4).

Fig. 4. Jobs that will be displaced under our new technology scenario, by country
(Number of workers (label), share of workforce (box) 2018-2028)



Displacement, millions of full-time equivalent (FTE) workers
Source: Oxford Economics, Cisco

While it is important to note that, under our new technology scenario, there will also be increased demand for workers offsetting this displacement effect (see Chapter 3), it is worthwhile exploring the reasons for the different levels of projected job displacement among the ASEAN-6 countries.

In relative terms, Singapore's labour market faces the largest degree of job displacement over the next decade, with almost 21 percent of its FTE workforce affected. Singapore is already close to the frontier of technological progress, so this is not "technology catch-up" (automation due to the adoption of existing technologies, the like of which might characterise other economies in the region). Rather, our team of experts acknowledged the exceptional enabling environment in Singapore for innovation and digital transformation, combined with a small geographical area and modern, upgradeable infrastructure, which means businesses there can readily take advantage of new innovations as they become available.

Vietnam and Thailand are next in line, with 14 percent and 12 percent of jobs displaced by technology, respectively. The drivers here are different to Singapore, in that many more Vietnamese and Thai workers are projected to be displaced from much-less productive, more monotonous jobs. Both economies see agriculture workers displaced in large numbers – mostly unskilled labourers in Vietnam, and skilled agricultural workers in Thailand.

Despite the sheer numbers displaced in Indonesia, Malaysia and the Philippines, the impact here is smaller as a share of the workforce. In Indonesia, our team of experts viewed that a slower pace of technological change was likely, dampened by expectations of institutional and political constraints to automation, as well as the abundance of cheap labour that will keep the price of workers competitive.

In Malaysia, concerns over labour market protection fed through to our model, while in the Philippines, high regard for the skills potential of the workforce was dampened by expectations of a challenging regulatory environment. Philippines' large, low-skilled rural population was also seen as a likely break on technological progress, since a cheaper supply of labour may make the widespread adoption of technology uneconomic for some time to come.

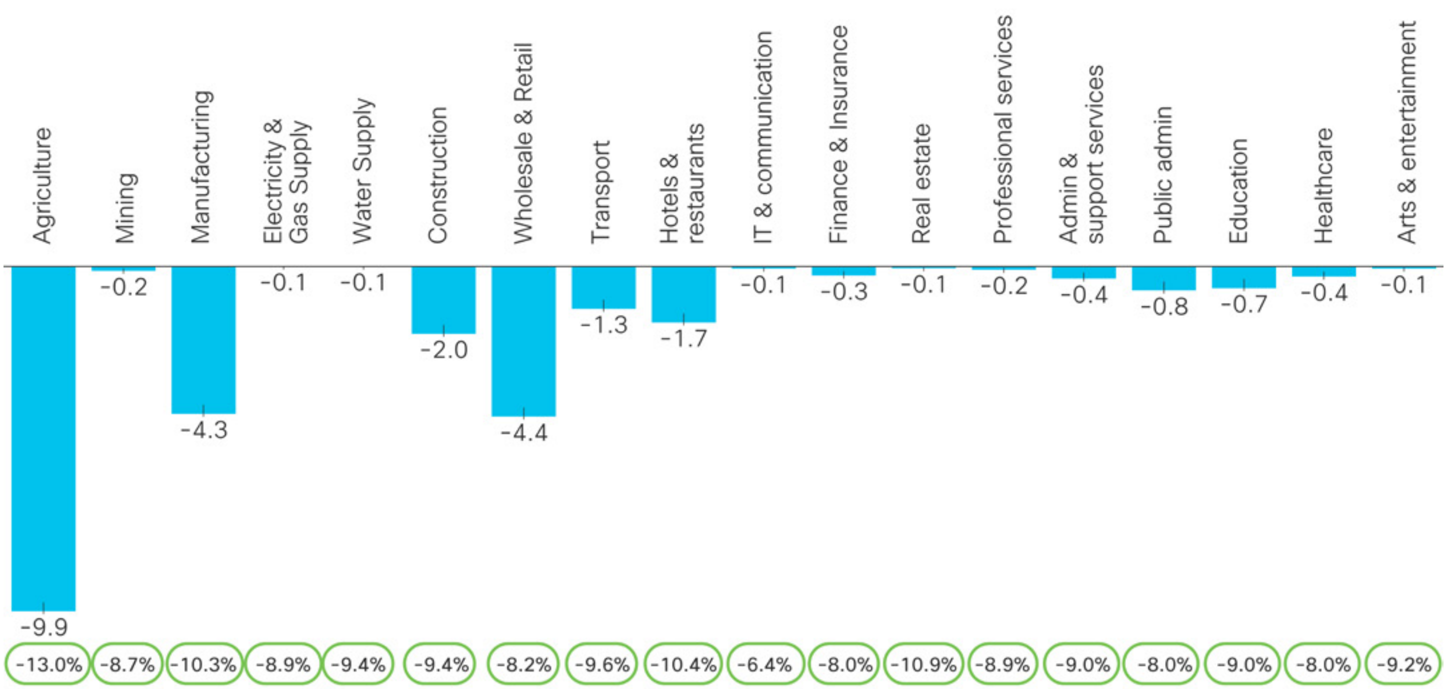
2.2 Displaced workers: an industry perspective

The varying employment impact across ASEAN-6 countries is partly driven by differences in the structure of their economies. Indonesia and Vietnam are heavily dependent on agriculture, which accounts for 13 and 17 percent of their respective GDPs. In contrast, more than half of the economies of Malaysia, Thailand, and the Philippines are in the services sector, with less than 10 percent in agriculture. However, their wage levels differ considerably, with GDP per capita more than three times larger in Malaysia than the Philippines (with Thailand in the middle).

Singapore stands out, with virtually no agricultural sector, but a very high level of GDP per capita, in an economy orientated towards professional services and advanced manufacturing.

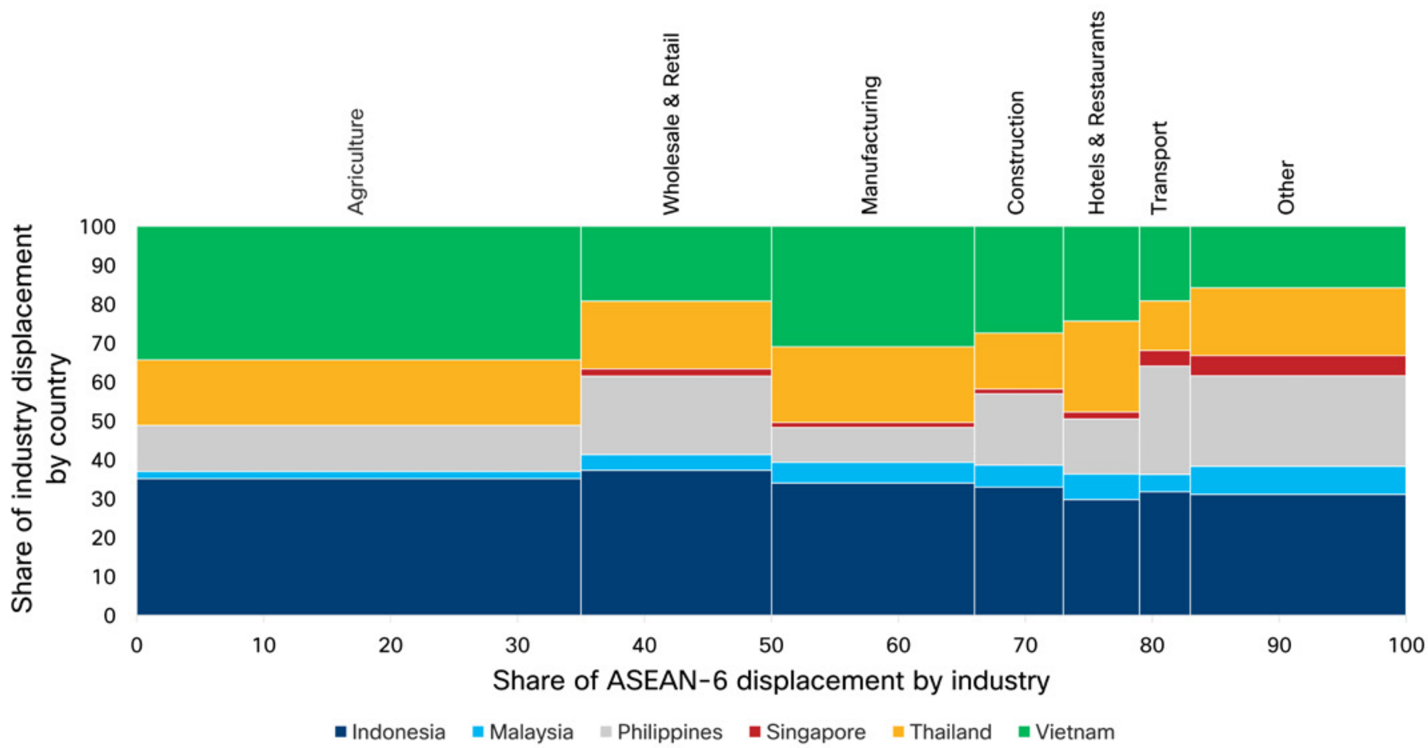
Across all ASEAN-6 economies, our model predicts that technological displacement will occur most intensively in the agriculture sector, affecting 13 percent of the workforce, which equates to around 10 million FTE jobs. In the manufacturing sector, also a major employer across the ASEAN-6, technology is projected to displace up to 10 percent of the workforce over the next decade, equating to over four million FTE jobs (Fig. 5).

Fig. 5. Technology-driven displacement of ASEAN-6 jobs, by industry
(ASEAN-6, number of workers (axis), percentage of workforce (labels), 2018-2028)



Millions of full-time equivalent (FTE) workers
Source: Oxford Economics, Cisco

Fig. 6. Proportion of displaced jobs by sector attributable to each ASEAN-6 country (2018-2028)



Source: Oxford Economics, Cisco

2.3 Displaced workers: an occupational perspective

Underlying each of these industry impact is the potential of technologies to outperform workers in the tasks they are paid to complete. Based on the unique task profile of each occupation, our analysis reveals that low-skilled service and agricultural workers will experience the largest displacement effect. Across the ASEAN-6, around 12 percent of elementary workers – encompassing cleaners, labourers, and low-skilled service workers – could be displaced by technology in the next 10 years. Skilled agricultural workers, including crop and livestock farmers, machine operators, and trades workers are next in line, with between 10 and 12 percent displaced (Fig. 7). For further insights into how technology affects the nature of work for particular occupations, see Box 2.

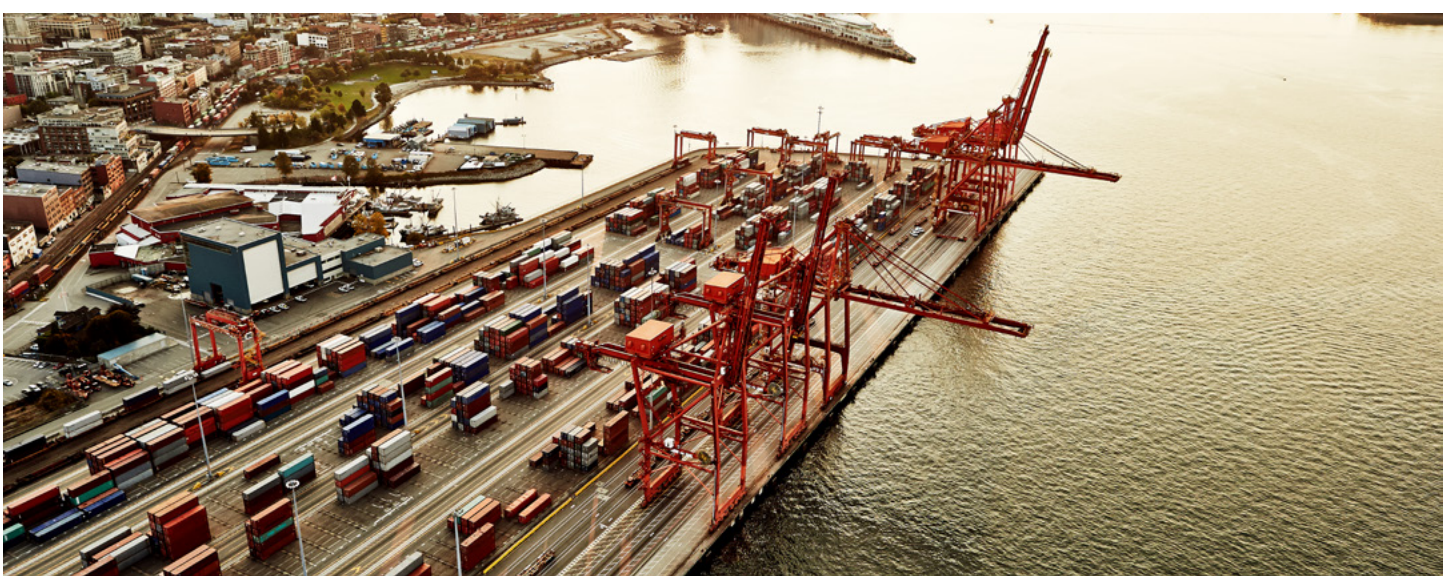
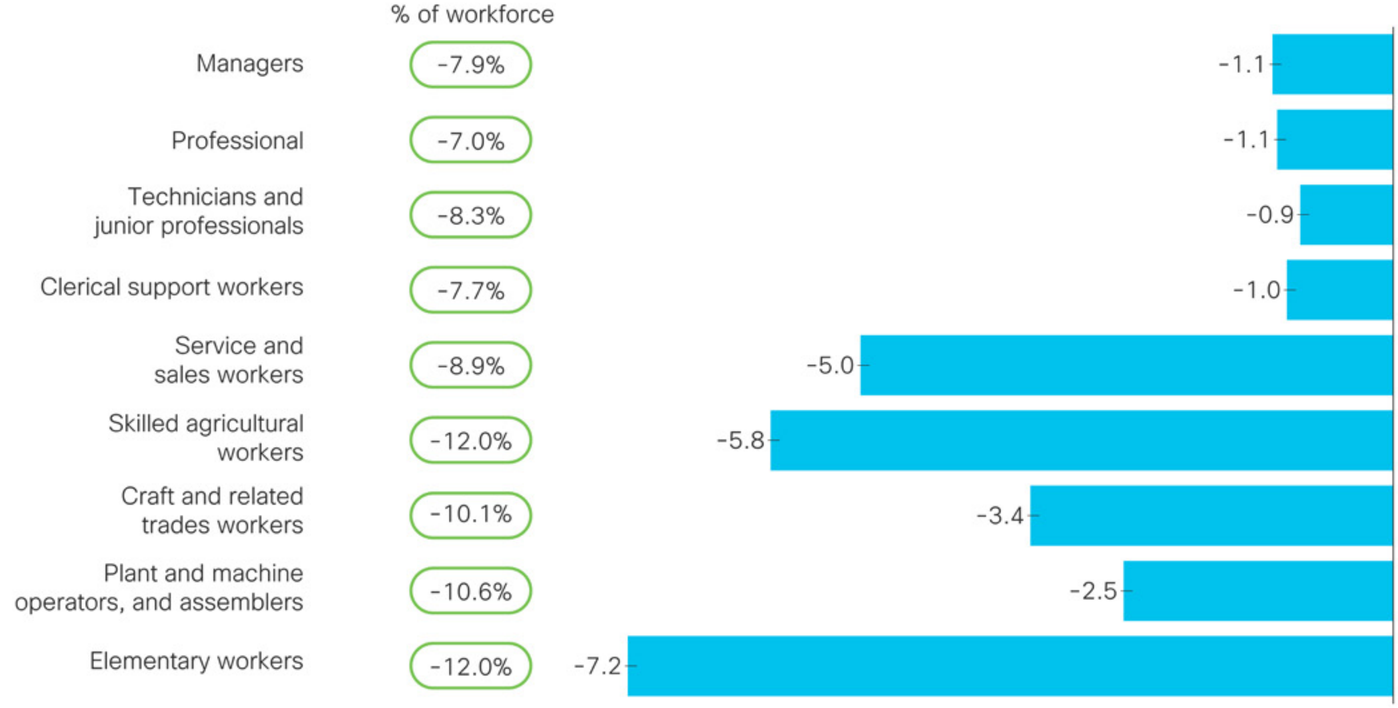


Fig. 7. Technology-driven displacement of ASEAN-6 workers, by occupation
(ASEAN-6, number of workers (axis), percentage of workforce (labels), 2018-2028)

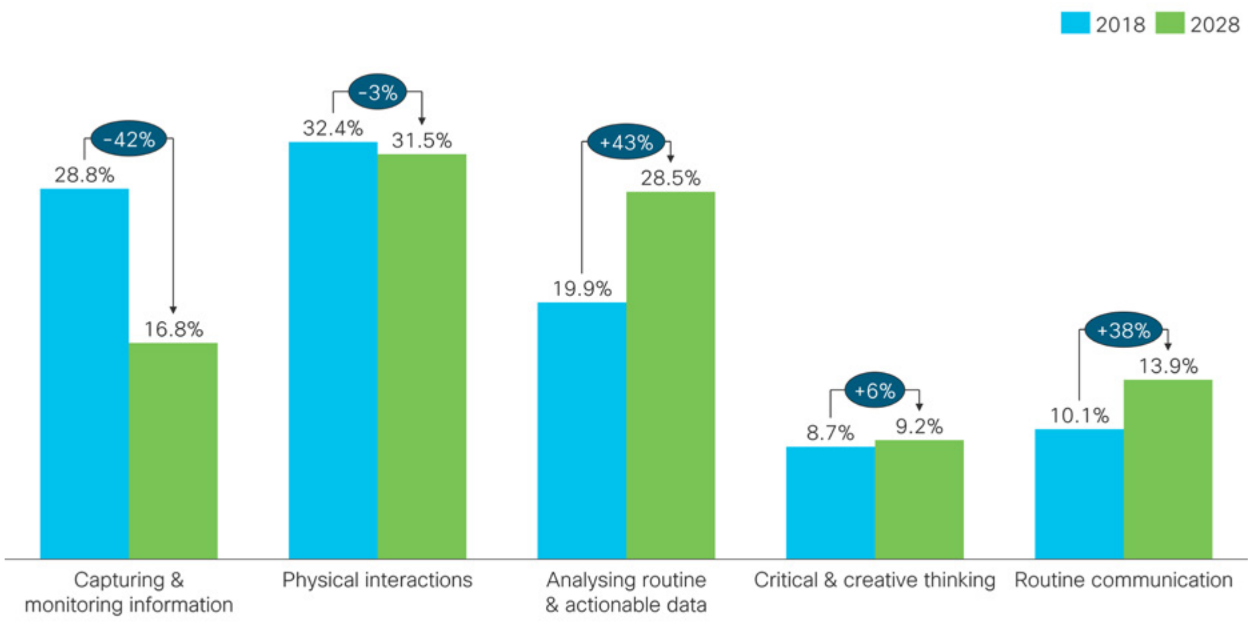


Millions of full-time equivalent (FTE) workers
Source: Oxford Economics, Cisco

Box 2:
How will new technologies change the nature of work?

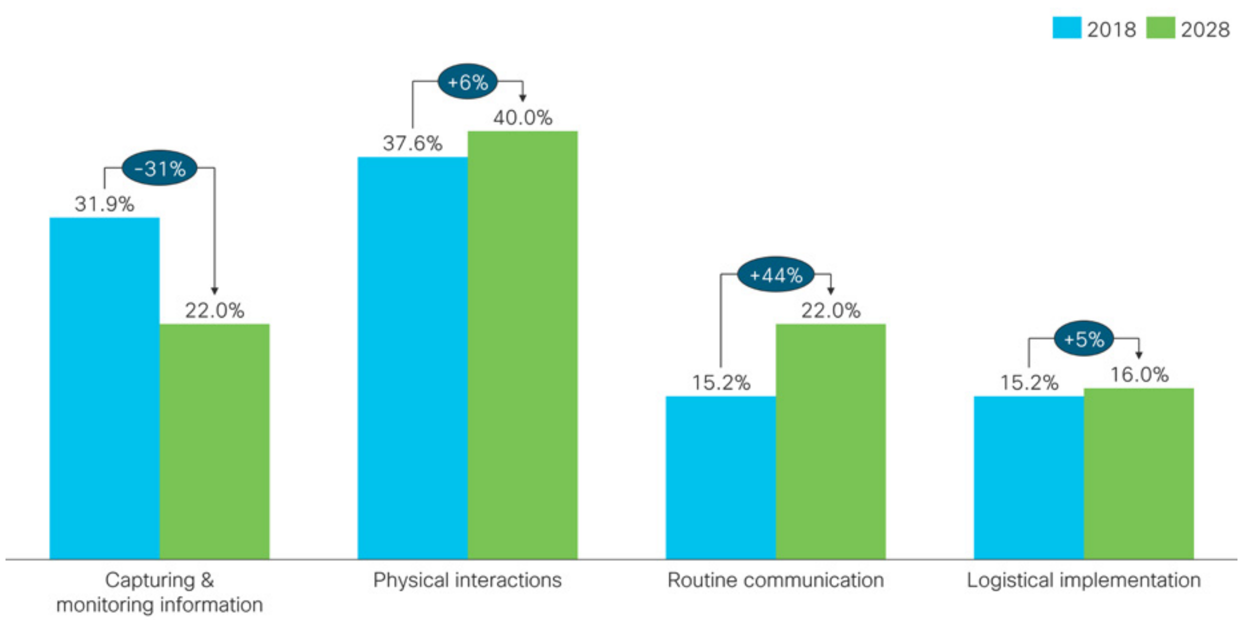
We constructed 433 unique occupational task profiles as the basis for our modelling exercise. Each of them contains the tasks deemed “important” to performing that job. Some more complex occupations require a balance of multiple important tasks. Others are more straightforward and require fewer. There are no occupations that are entirely dependent on a single task, and thus, the displacement effect is determined in part by the make-up of a given occupation. Fig. 8-11 illustrate how our assumptions about technology adoption feed into the model. They represent the extent to which applied technologies will take work away from humans in the various tasks that are important to any given occupation. To illustrate, we selected a basket of occupations reflecting the breadth of the labour market. It includes farm labourers and building caretakers, two of the occupations most at risk of disruption, as well as primary school teachers and software developers, which are less vulnerable to disruption.

Fig. 8. Reduction in labour effort required to perform task (Farm Labourer)



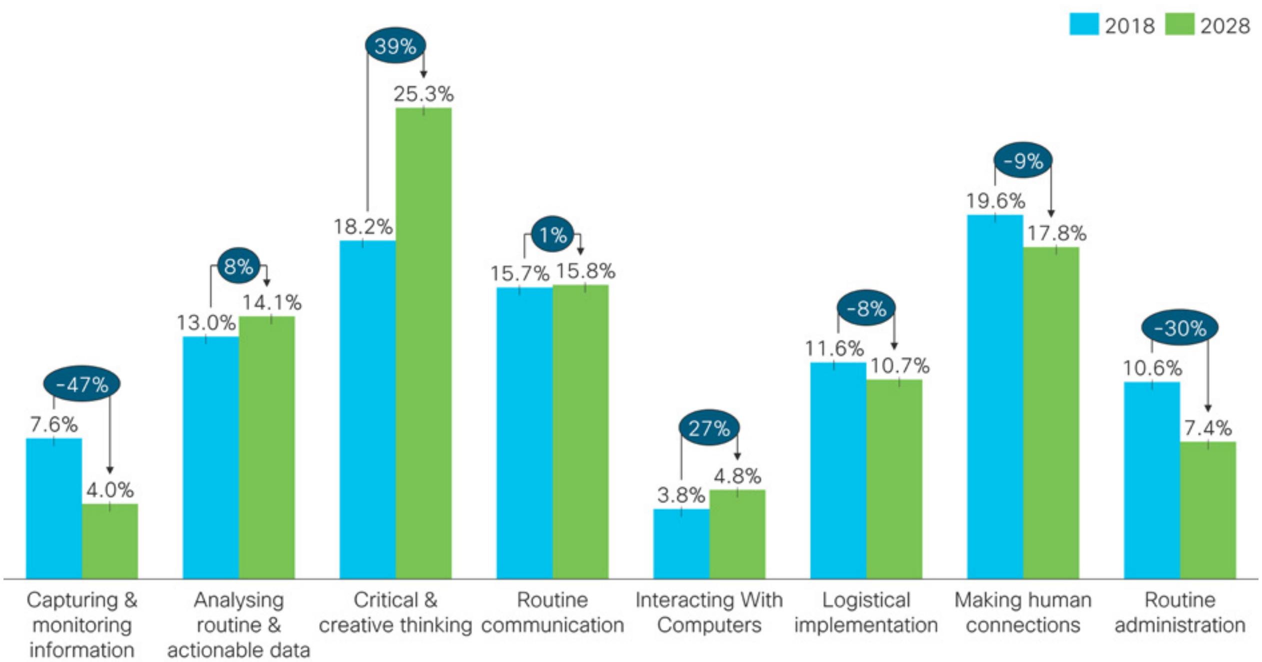
Source: Oxford Economics, Cisco

Fig. 9. Reduction in labour effort required to perform task (Building Caretaker)



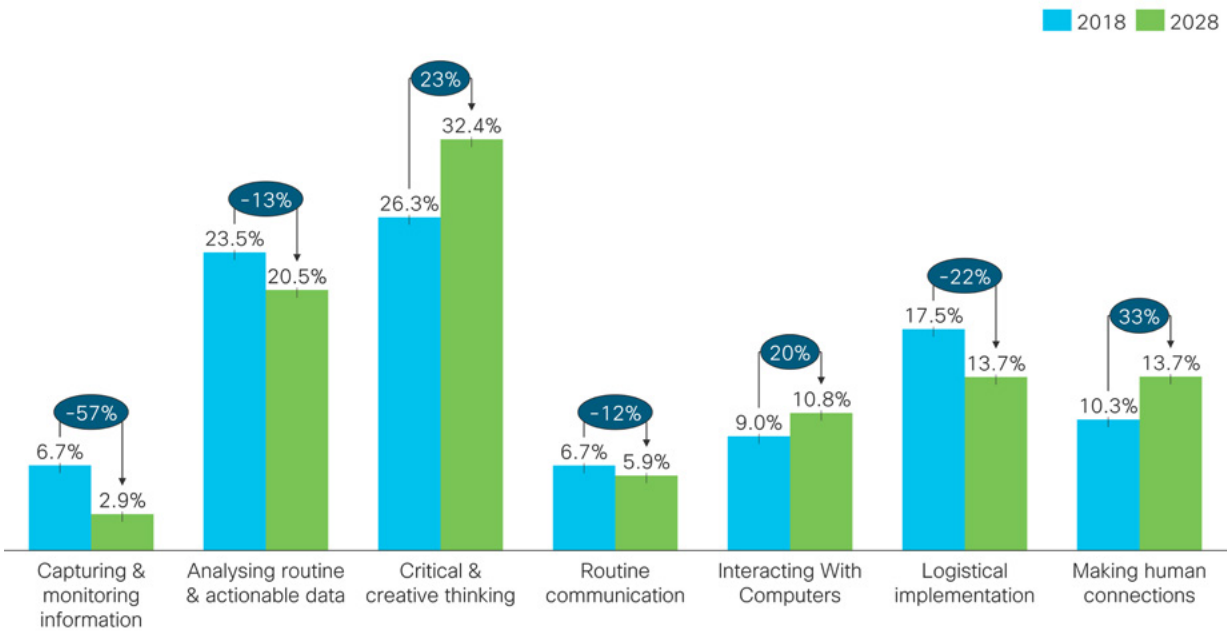
Source: Oxford Economics, Cisco

Fig. 10. Reduction in labour effort required to perform task (Primary School Teacher)



Source: Oxford Economics, Cisco

Fig. 11. Reduction in labour effort required to perform task (Software Developer)



Source: Oxford Economics, Cisco

Expert view:

The responsible adoption of AI

By Darryn Lim, Director, Policy – APAC, BSA | The Software Alliance

Artificial Intelligence improves lives, solves problems, and impact every sector. Its use has led to improvements in healthcare, advances in education, more robust accessibility tools, stronger cybersecurity, and increased business competitiveness. With the potential to generate substantial economic growth as a trillion-dollar accelerator, AI enables governments to provide better, more responsive services. A flexible policy framework that facilitates responsible AI innovation is necessary to enable successful deployment of AI products and services.

BSA | The Software Alliance has identified five key pillars for responsible AI innovation:

1. Confidence and trust in AI systems

Organisations creating and using AI must be responsible stewards of customer data and explain how AI systems work, using AI to reduce bias in decision-making and increase inclusion. Increased understanding and promotion of trust in the use of AI technologies can be facilitated by adhering to the following principles: fairness, accuracy, data provenance, explainability, and responsibility.

2. Sound data innovation policy

The exponential increase in data, combined with increases in remote computing power and development of more sophisticated algorithms, has fuelled AI innovation and applications. Governments should foster data-friendly policies that enable innovation in the way data is used. In addition, they should make their own data available in machine-readable formats to improve access to trainable data. In addition, data innovation policies should also promote the adoption of cloud computing, which will enable companies and governments to harness large amounts of computing power and scale intelligent opportunities everywhere.

3. Cybersecurity and privacy protection

As AI and other digital technologies create a globally connected economy, so governments must be vigilant in addressing increased security and privacy risks. Cybersecurity policies should adopt approaches that are aligned with internationally recognised standards: risk-based, outcome-focused, and technology-neutral; market driven where possible; flexible and adaptable to encourage innovation; and rooted in public-private collaboration.

4. Research and development

Investment in education, research, and technological development will be integral to continued development of AI technologies and global economic growth. These efforts should include long-term public sector investment that could unlock new insights, as well as investments in workforce training and development.

5. Workforce development

The increasing use of, and demand for, technology is creating new types of jobs that require an evolving set of skills in every sector of the economy. Private and public sectors, as well as academia, must work together to implement policies that will prepare the next generation for jobs of the future, and help the current workforce transition to new job environments. Here are five key strategies for governments and the private sector to encourage and develop an AI-ready workforce:

- Improve access to science, technology, engineering and mathematics (STEM) education;
- Create alternative pathways into the evolving workforce;
- Expand workforce retraining;
- Broaden access to technology;
- Promote a responsible immigration policy.

Expert view:

The advent of artificial intelligence and digitalisation

By Foo Suan Yong, Senior Expert, ASEAN+3 Macroeconomic Research Office, AMRO

Is the advent of artificial intelligence (AI) and digitalization, or technology more broadly, boon or bane for emerging countries in ASEAN and other regions? AI extracts much more of the information "out there" than humans have done, creates knowledge out of that information, and is then used to make decisions in a wide range of areas – from macroeconomic management and prudential supervisory work in the public sector, to identifying business opportunities and translating good ideas into commercially-viable solutions in the private sector.

While this is positive, AI's increasing pervasiveness also creates stiff challenges and risks – and technology is moving more quickly than solutions to these challenges can be devised. This confronts countries across different stages of economic development and technology catch-up. It raises challenges for different sectors of the economy, and poses difficult challenges at the very macro level, in terms of growth transition, inflation dynamics changes, and cyber security concerns.

Let's start by looking at sectors.

In Cambodia, for which the textiles, clothing and footwear (TCF) sector accounts for about 90% of its manufactured exports, automation threatens many of the more-than-600,000 jobs held by workers who are working hard and struggling to move on from sewing machines to much newer, more advanced, but also more technology-intensive, machines. Currently, there are limits on the extent to which the TCF sector can be automated or disrupted by technology, because of low wages and the relatively unstructured nature of the work. But graduation from basic automation to advanced AI will surely come, and developing economies have limited time to adapt.

The Philippines has increasingly used AI in its services-centred growth model. Much of this is in business process outsourcing (BPO), which accounts for some 40% of exports and more than one million jobs, with wages three-to-five times higher than the national average. But robotics threatens to replace simple operators, and there is a need to go from simple call centre services to a broader set of more complex services. The country also needs to branch out into knowledge process outsourcing, encompassing higher-value-added activities ranging from fraud analytics and project management to research and development. In all these, developing and applying AI is a requirement, not a "good to have".

Even in larger or more-advanced ASEAN or East Asian economies, AI and other forms of technology are making it more difficult to become competitive. Rapid technological advancements have raised the bar for basic manufacturing, and for moving up global value chains (GVCs). With manufacturing processes and products becoming more high-tech, emerging market economies are finding it tougher to join and be competitive in GVCs. This challenges countries from Korea and Singapore, to Indonesia and Vietnam – for products ranging from high-end consumer electronics, to basic textiles and garments.

Indeed, even in the relatively high-tech automobile sector, where advanced or large economies have advantages, the challenge is formidable. Production is becoming more capital- and technology-intensive. Deployment of technologies such as industrial robots and, Internet-of-Things (IoT) in factories, and new techniques such as 3D printing, is gathering pace.

End-products are changing: vehicles are becoming more sophisticated, with many more features and greater use of digital technology. And demand for labour is shrinking: workers who can retain their jobs need to have skills which were not thought of in the past.

The services sector offers rich opportunities. Travel and tourism is a prime example, with East Asian countries from Japan and China to Thailand and Vietnam having made headway in combining technology, (semi-)skilled human capital, and infrastructure; and balancing the pace of technology adoption with the priority of job creation.

Outcomes have been encouraging. China and the larger ASEAN economies have done well in using tourism to spur growth, and lift incomes. But what has not been done nearly enough is using AI to identify sources of demand, improve channels for reaching out to would-be tourists, and deliver services which form customized experiences for increasingly affluent and discerning tourists.

How technology will create new jobs across the region

3. How technology will create new jobs across the region

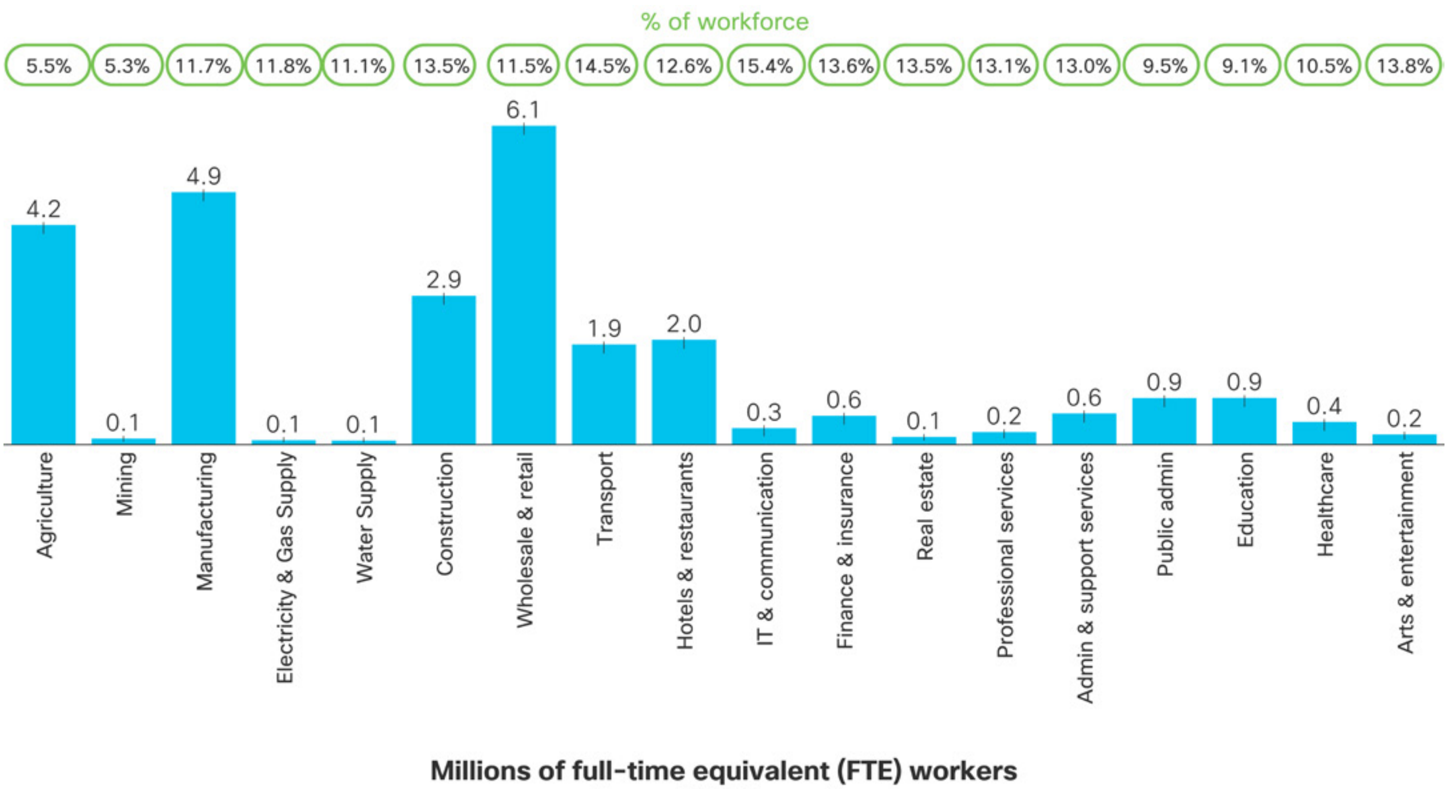
As technological innovations are more widely adopted over the coming years, labour productivity will be enhanced across all ASEAN-6 economies. This means that, while technology displaces some workers from the jobs they are doing, it also boosts economic growth which, in turn, creates demand for more jobs. New technologies cut the costs of production, which lowers the prices of goods and services, and raises the spending power of the population (this is known as "the income effect").

We used Oxford Economics industry forecasts to identify where this demand for new workers will be located within each of our ASEAN-6 economies. Just as the displacement effect will filter through all levels of occupations in different ways, the income effect will create demand for more jobs across the breadth of the economy too.

3.1 Jobs created: an industry perspective

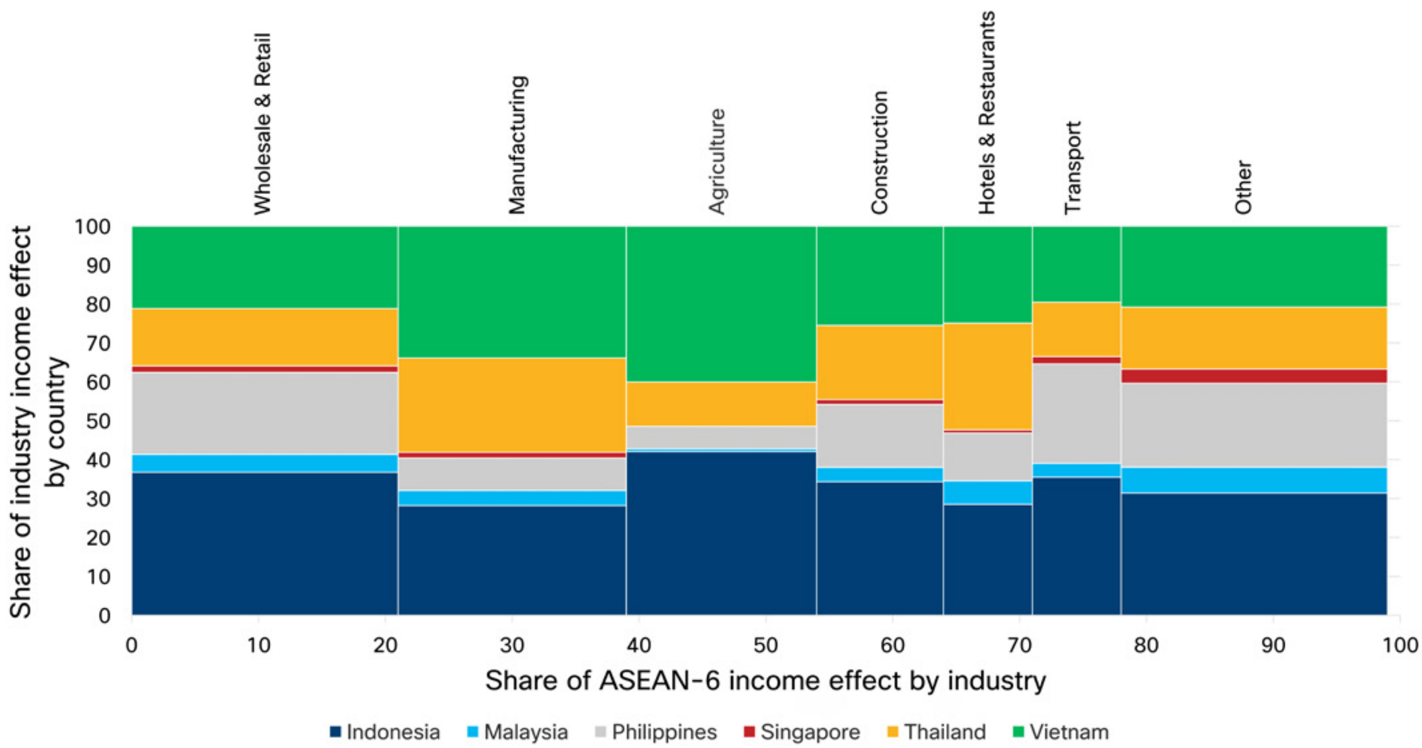
Across the ASEAN-6, the sectors we predict will see the highest gross increase in job demand are wholesale & retail, manufacturing, and agriculture, with a combined gain of more than 15 million jobs (Fig. 12). This is a reflection of where rising levels of real disposable income that arise from technological change are most likely to be spent. Other sectors, such as construction, transport and hotels & restaurants (tourism) also see major increases, totalling almost seven million new jobs between them. In relative terms, however, the IT sector, finance, and the arts rank among the most prolific job creators. The income effect alone implies a more than 15 percent rise in employment in the IT sector under our scenario.

Fig. 12. Gross impact of the income effect on jobs, by industry
(ASEAN-6, number of workers (axis), percentage of workforce (labels), 2018-2028)



Source: Oxford Economics

Fig. 13. Proportion of jobs created by sector attributable to each ASEAN-6 country (2018-2028)

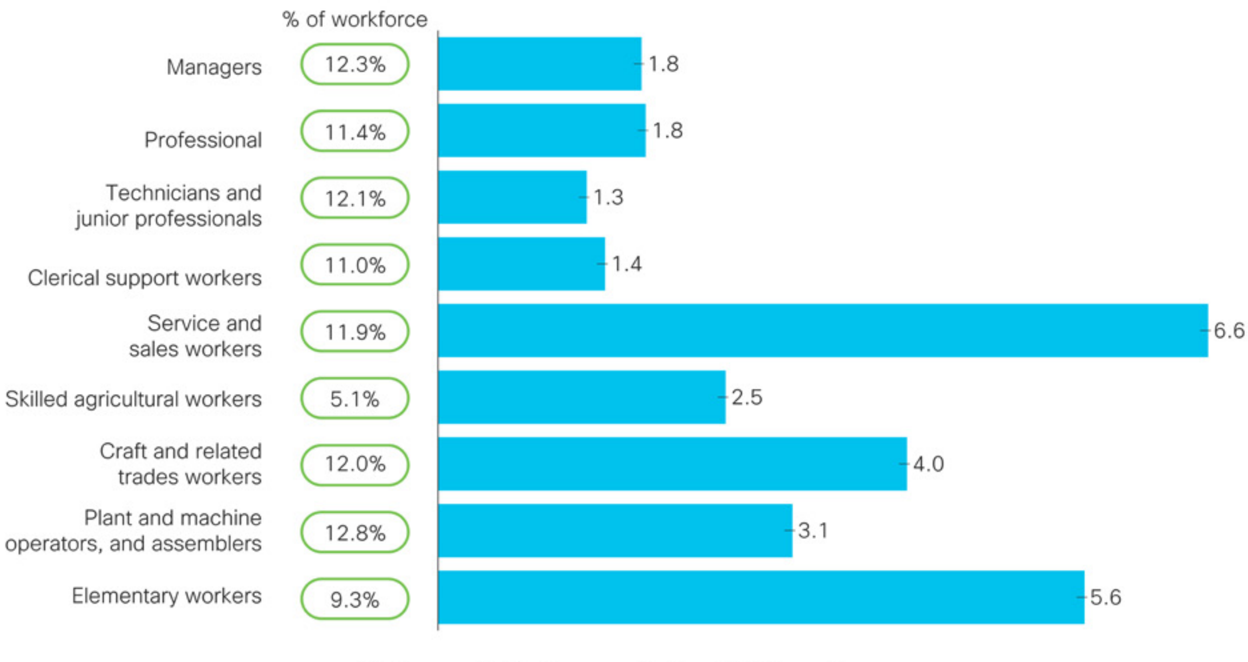


Source: Oxford Economics

3.2 Jobs created: an occupational perspective

The demand for workers is derived from the demand for goods and services, and the creation of new ASEAN-6 jobs will follow spending patterns. At the occupational level, this translates into a boom in service and sales workers, who account for over 60 percent of employment in the wholesale & retail sector elementary workers, who are largely employed in agriculture and construction; and trades workers and machine operators, who are fundamental to the manufacturing sector.

Fig. 14. Gross impact of income effect on jobs, by occupation
(ASEAN-6, number of workers (axis), percentage of workforce (labels), 2018-2028)



Source: Oxford Economics, Cisco

As technology improves, productivity gains ripple through the economy, and we have modelled a snapshot of these positive changes from 2018-2028. In reality, this process happens continuously, with labour demand simultaneously rising for different occupations at different rates due to the income effect, just as the displacement effect (discussed in Chapter 2) reduces demand for workers at different rates across each industry and occupation.

In the real world, we will see businesses reducing their headcounts in some industries, just as they are hiring new recruits in others. Workers will constantly assess their options, and adapt to the demands of the labour market. In the next chapter, we illustrate how the twin forces of job displacement and job creation implied by our new technology scenario offset each other – and what this will mean for the future shape of the ASEAN-6 labour market.

Expert view:

How should regulatory and public policy be shaped in the new world?

By Seha Yatim, Policy Analyst, Access Partnership

There is a natural tendency for stakeholders to take a cautious approach to new technologies. This can, however, lead to some alarmist narratives which prevent sound policy-making. In fact, this Cisco and Oxford Economics ASEAN-6 study correctly demonstrates that AI will become a catalyst for job creation, by reducing manufacturing costs and providing workers with opportunities to move into jobs with higher functions and better salaries.

The emergence of new technologies like AI will not just eliminate or create jobs, it will change the way we work across society. The dominance of nine-to-five jobs may be eroded in favour of more part-time, freelance, contract, or job-share positions that are assisted by AI. Workers are also likely to work in many more jobs over the course of their careers.

These trends will have several policy implications – first and foremost, the need for new kinds of skilled workers. Collaboration between governments and industries is key to identifying these skills and how the workforce can acquire them. Once identified, upskilling workers requires investment and commitment. For example, government could develop a roadmap that provides a holistic strategy, from changing the way we educate in schools to developing and promoting the more flexible tertiary education that the more fluid workforce will need, or incentivising companies to train and retrain their staff.

Government will also need to rethink the concept of safety nets. As the share of part-time, freelance and self-employment grows, safety nets will need to be provided for this expanding group of workers. Policy-makers will need to decide how healthcare, insurance, and retirement benefits that are traditionally provided by employers can be extended to cover the new workforce.

Lastly, efforts to adapt operations to new economic models should be supported. We need to enable companies to make the right investments in technology, and to develop capabilities in their supply chains. This could come in the form of tax incentives, or regulatory "sandboxes" that allow companies to develop and implement new technologies before commercialising them. Pairing start-ups with multinational corporations could encourage them to learn from each other, as SMEs may benefit from operational expertise, while the multinational invests in innovative working practices, products, or services.

What will the new labour market look like?

4. What will the new labour market look like?

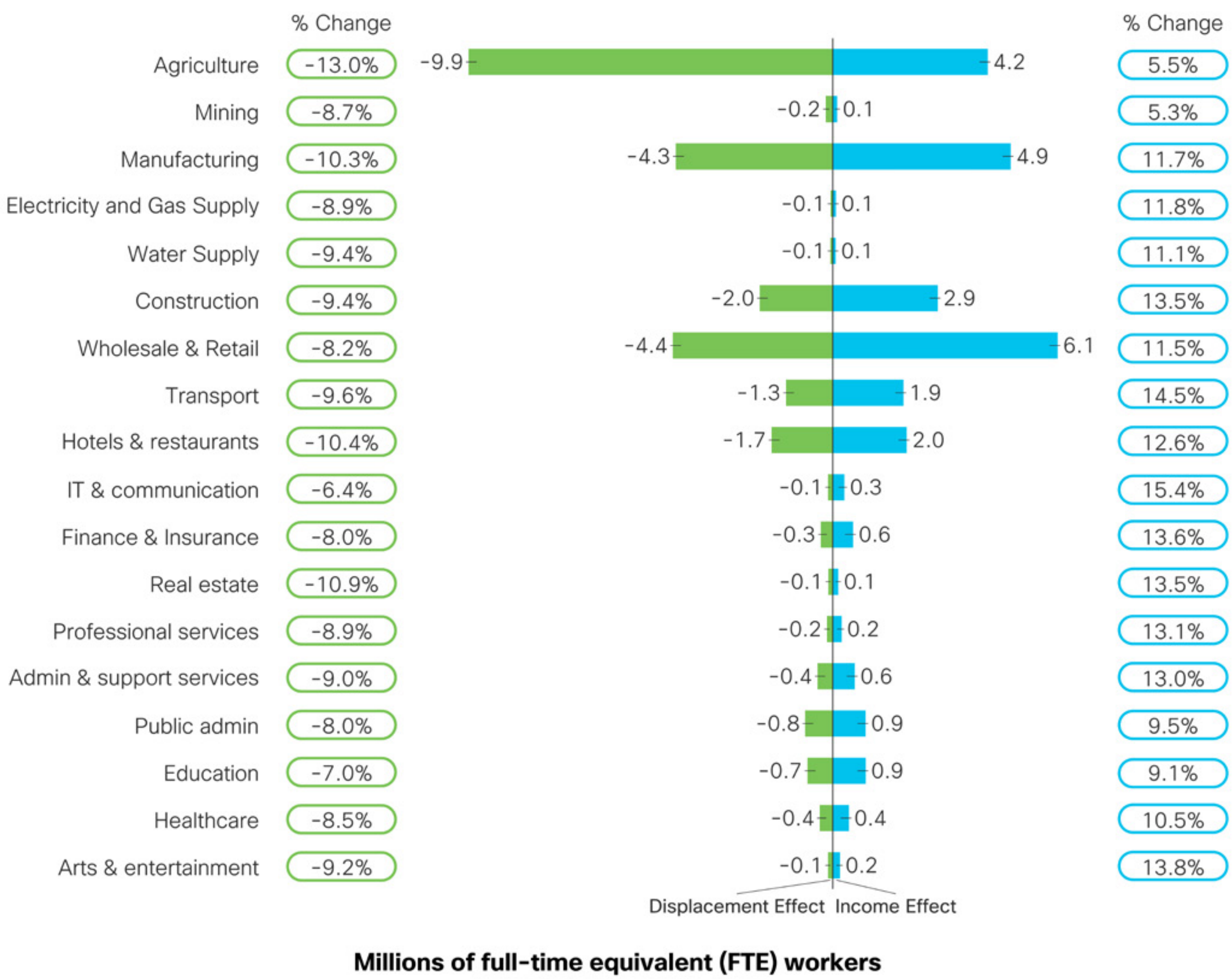
As technology frees up workers from some activities, it leads to new demands for workers to add value in others. We modelled the long run implications for these two trends to explore what they mean for the way ASEAN-6 labour markets will change shape, and the adjustments their workers will have to make.

Our 10-year technology scenario reveals that jobs will not likely be created in entirely the same places as they are displaced. The demand for labour to perform certain tasks, and therefore to work certain jobs, will be disrupted. Certain sectors of the economy will need to shrink their workforces, while others expand. In this chapter, we illustrate what that means for the new shape of the ASEAN-6 labour markets by 2028.

4.1 The overall impact on ASEAN-6 jobs, by industry

By combining the displacement and income effects of our new technology scenario, we are able to see what the overall impact on the ASEAN-6 labour markets will be. Fig. 15 illustrates these combined impact according to industrial sector – some of which will experience a net loss of jobs by 2028, others a net increase. Totalling up all the net losses, we find that 6.6 million current jobs across the ASEAN-6 will become redundant in our new technology scenario.

Fig. 15. Displacement vs income effects of new technology scenario, by industry sector
(ASEAN-6, number of workers (axis), percentage of workforce (labels), 2018-2028)

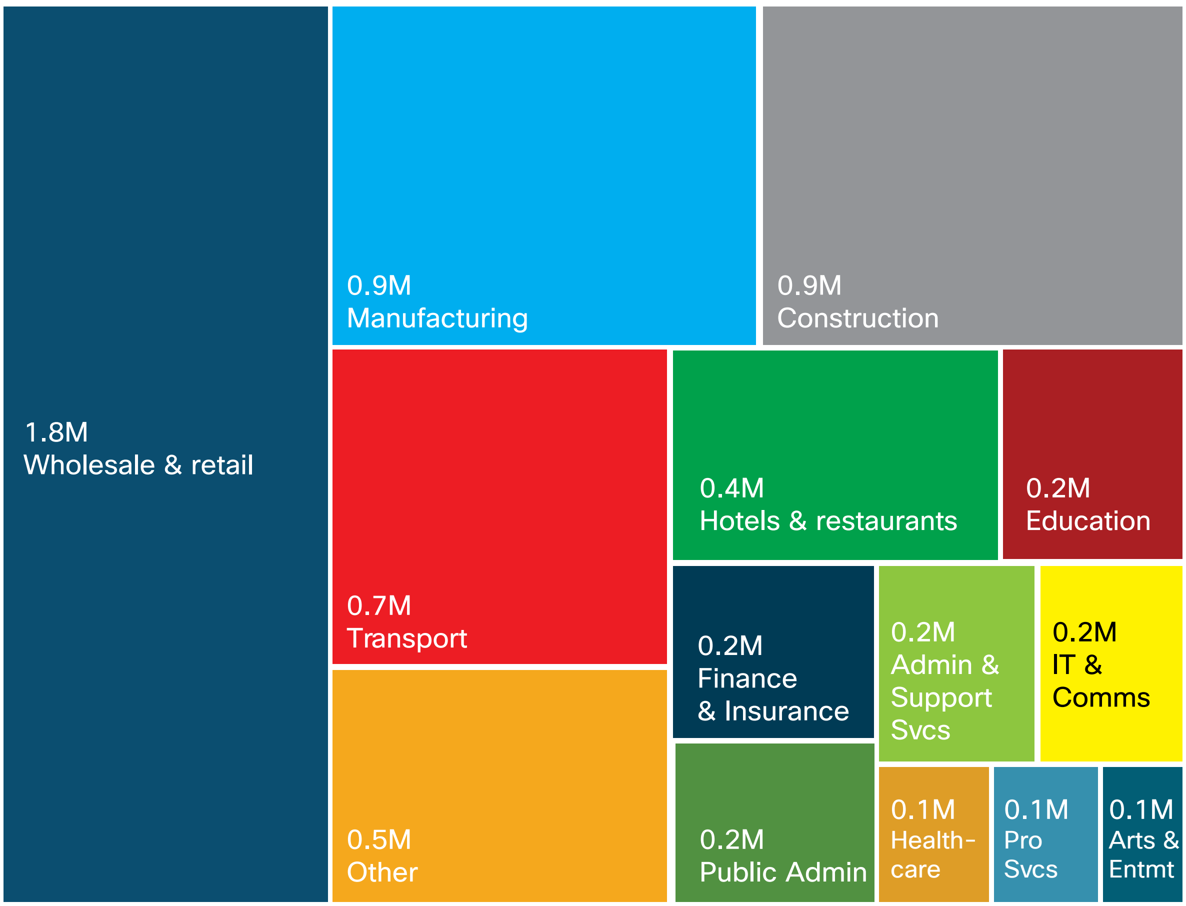


Source: Oxford Economics, Cisco

The agriculture sector will experience by far the largest net loss of jobs across ASEAN-6, as shown in Fig. 15. Some 5.7 million agricultural workers (7.5 percent of that sector's current workforce) will no longer be required and will be seeking a new occupation.

However, the net new jobs created under our new technology scenario will be spread across many sectors of the economy. In manufacturing and wholesale & retail, for example, large productivity gains are expected to be delivered via advanced robotics and artificial intelligence, meaning that the projected displacement of workers in these sectors is more than offset by demand for new jobs as a result of increased output.

Fig. 16. Vacancies by industry sector (2018-2028)



Source: Oxford Economics, Cisco

4.2 The overall impact on ASEAN-6 jobs, by occupation

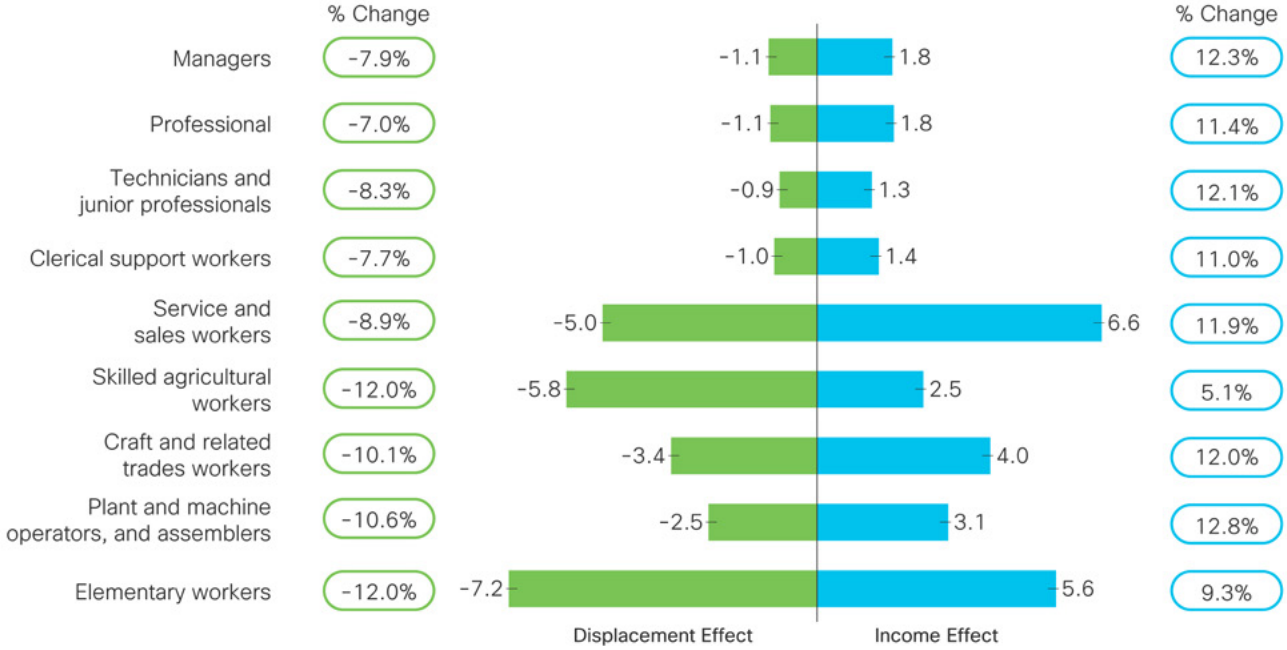
At the occupational level, our 10-year new technology scenario reveals that the burden of transition will fall most heavily on elementary workers and skilled agricultural workers. Fig. 17, illustrates how the competing effects of job creation and job displacement flowing from our technology scenario offset one another across nine occupation categories.

Overall, in relative terms, we predict that there will be greatest net increase in demand for managers and professionals[1] (both up 4.4 percent), and the biggest net fall in demand for skilled agricultural workers (down 6.9 percent) and elementary workers[2] (down 2.7 percent).

In absolute terms, we predict the biggest net increase to come in service & sales, with the creation of some 1.6 million net new FTE jobs. In terms of absolute job losses, we predict there will be 3.4 million net fewer skilled agriculture workers, and 1.6 million fewer elementary workers, across the ASEAN-6 by 2028.

[1] Professionals include accountants, lawyers and doctors.
[2] Elementary workers include cleaners, labourers, and low-skilled service workers

Fig. 17. Displacement vs income effects of new technology scenario, by occupation type
(ASEAN-6, number of workers (axis), percentage of workforce (labels), 2018-2028)

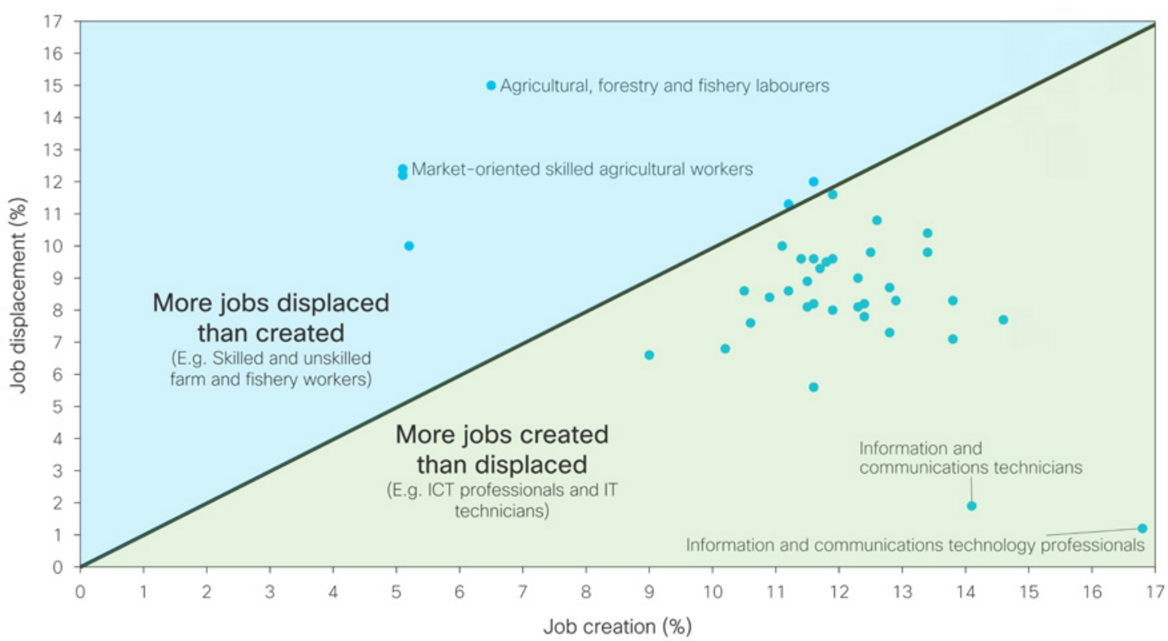


Millions of full-time equivalent (FTE) workers
Source: Oxford Economics, Cisco

Fig. 18 offers another way of looking at the net impact of our new technology scenario on ASEAN-6 occupations. The dots represent occupational categories, and those falling below the diagonal line will demand new workers in our 2028 scenario as the extent of new job creation outweighs the number of jobs being displaced. The dots furthest to the right are ICT professionals and IT technicians, for example.

Those occupational categories located above the diagonal line will see the greatest incidence of job redundancy, with the negative displacement effect outweighing the positive income effect in occupations such as skilled and unskilled farm and fishery workers.

Fig. 18. Net effect on employment by occupational group



Source: Oxford Economics, Cisco

Expert view:

For the tech hubs of the future, look to Asia's smaller cities

By Jeremy Wagstaff, Asia-based technology journalist, commentator and consultant

Much of the disruptive change in Southeast Asia over the past five years has been by adding formalised systems and layers to existing sectors – mainly in what is broadly known as mobile commerce (think Grab, Go-Jek, and Lazada). The investment has been concentrated in particular countries, sectors and companies.

However, in the long run, the real change in skills and work may come more from the backroads of Southeast Asia, tapping into a vibrant but hidden economy of online knowledge workers. According to data collected by Google last year, the majority of investments (92%) in Southeast Asia have targeted companies based in Singapore and Indonesia. In turn, most of that money ($9 billion, 73%) found its way to "unicorns" valued over $1 billion – while companies worth less attracted $3.3 billion.

These figures illustrates how slanted the overall picture is. Unicorns like Go-Jek, Grab, Lazada, Razer, Sea Ltd, Traveloka and Tokopedia are essentially platforms for retail selling (transport, consumer goods, travel etc.) that capitalise on inherent problems in the free flow of goods and people in Southeast Asia because of inadequate physical, financial or social infrastructure.

The more significant development in the long run when these platform players bring their services beyond major regional cities to the smaller cities is what I predict to be an interesting confluence of improved infrastructure and pent-up B2C and B2B demand. Companies and governments should focus their attention here – on building infrastructure, and tapping into these hubs of "quiet entrepreneurialism". These skill pools are going to help to even out, and possibly reverse, the trend of migration to the megacities.

99designs, an Australian crowdsourcing design company that provides a platform for graphic designers to submit their work and earn business, observed in 2012 that one city in Indonesia – central Java's Yogyakarta – consistently beat other cities for quality and contracts won. The young men and women in Yogyakarta were tapping into a deep well of artistry that stretches back hundreds of years, and can still be seen in carvings, batik, and other artwork around the city. Today, this trend has only increased: 95% of the Indonesian designers on the platform live outside Jakarta, and nearly 70% of them live outside the country's top five cities. This is not just an Indonesian phenomenon – the numbers are even higher in the Philippines and India, two other big contributors to 99designs.

Upwork, a provider of freelance services such as Ruby development and 3D rendering has lost count of services offered by freelancers in Yogyakarta and other "lesser" Indonesian cities such as Makassar and Medan. These freelancers are constantly motivated to take on new skills.

The implications are clear. As technologies emerge and develop more quickly, so companies will have to look elsewhere for skills. This benefits freelancers who can more-readily and rapidly identify what skills they should acquire, and position themselves, including skills such as blockchain, Google Cloud, ecommerce software volusion, risk management, and rapid prototyping. Such skills are increasingly found in Southeast Asia, where rates are significantly lower than those in the US by half or more.

This hidden economy is growing, and is impressively independent. But it could do with support. As mobile commerce companies expand beyond the big cities and bring improved transportation and better support services, governments, too, could lend a hand. Internet connectivity is still patchy in some parts, and a lot of those hoping to switch from a long commute to working at home often find it hard to get that first job. If those who do succeed can be encouraged to help build out these communities and share their skills, a whole new generation of home-based knowledge workers could lift towns such as Yogyakarta – and even further afield – to become technology hubs of the future.

Box 3:
Five key questions about the future ASEAN-6 labour market

Why does the agriculture sector account for most of the redundant workers?

The agriculture sector accounts for around 76 million jobs in the ASEAN-6 region. One third of those are labourers, which also happen to be the jobs most susceptible to technological displacement due to their focus on routine, codifiable tasks and physical effort. Under our scenario, jobs are displaced across the breadth of industry in different ways, but the impact on agriculture is so large that it plays a central role in the transition to the 2028 labour market.

Why do so many vacancies arise in wholesale & retail?

The wholesale & retail sectors are expected to see considerable productivity gains from technology, with the move to online commerce eating away at the need for sales staff on the shop floor. Automated checkouts are being integrated into supermarkets, while intelligent robots can now more efficiently pick and distribute products in a warehouse. However, our whole-of-labour-market approach identifies how the scale of the productivity gains throughout the economy leads to a considerable boost to the real disposable income of consumers. We anticipate a large portion of that disposable income to be spent in retail, driving up demand for workers in that sector – albeit in a more technology-orientated (and productive) context.

Why is employment in the transport sector growing?

Employment in the transport sector is predicted to grow by around five percent as a direct result of our scenario. In Singapore, however, where autonomous vehicles are expected to become increasingly prevalent, we anticipate a net reduction in transport employment of more than seven percent under our scenario assumptions. The expectations for autonomous vehicles are much lower in other ASEAN-6 economies, due in part to infrastructural constraints and a more challenging geographical terrain, as well as the fact that consumers there cannot afford them in large enough numbers to make them viable. In these much larger economies, the rise in disposable income from our technology scenario is predicted to lead to an increase in money spent in the transport sector, which pushes up demand for workers there.

Why is there a large net increase in managers?

The rise in managers is a compositional effect, driven by the growth of sectors that tend to employ more managers. The balance of the labour market is shifting away from agriculture, which is currently still highly labour intensive outside Singapore, towards the wholesale & retail, transport and tourism sectors, which include many more small and medium sized enterprises and have a much higher manager-to-worker ratio.

Why is the construction sector recruiting so many workers?

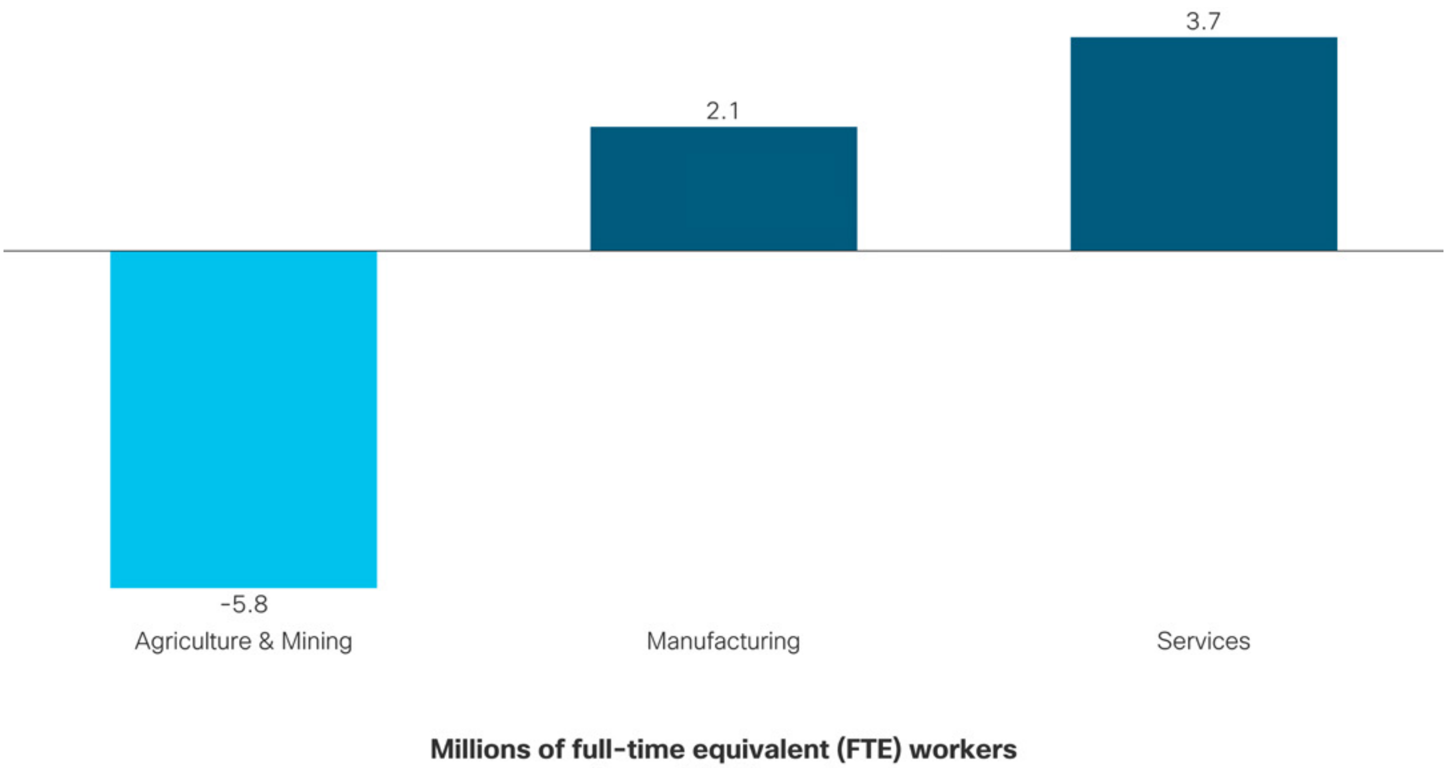
Drone technology, smart machines and new operating software will deliver considerable productivity gains for the construction sector across the ASEAN region. However, the income effect through our technology scenario is also expected to fuel an increase in construction spending, which will be enough to offset the labour displacement effect. Overall, we forecast the sector to expand its numbers of labourers and building tradespeople by four percent.

4.3 Why our model breaks the traditional development path

Across the ASEAN-6 region, the size and nature of low-skilled work in the agriculture sector means it is the most susceptible to technological displacement. The shift in workers implied by our technology scenario is in keeping with historical trends and, indeed, our scenario represents an acceleration of the migration of workers into cities, rather than a cessation of it.

However, our technology scenario suggests a shift in the traditional path to non-agrarian employment for these workers. Developing economies have traditionally seen employment shift out of low-value agricultural jobs into low-value manufacturing as a stepping stone to higher-value production and service sector jobs, as the economy develops. In our future scenario, however, only 40 percent of new jobs are created in the manufacturing sector, while the rest appear in services (see Fig. 19). Developing ASEAN economies, unlike many countries that became advanced economies in the 20th century, must increasingly leapfrog the manufacturing sector to secure service sector employment. In many cases, this will represent a more difficult transition.

Fig. 19. Workers leapfrogging the manufacturing sector[3]
(Net change in workers in 2028 labour market forecast, ASEAN-6)



Source: Oxford Economics

The takeaway vision from this 10-year forecast is of an ASEAN-6 labour market tasked with higher value and more rewarding work than it is today. But as technological change alters the nature of work and the shape of the labour market, workers will have to make a transition. For many, that transition will require a considerable effort to retrain and upgrade existing skillsets. In the next chapter, we explore the skills challenges facing workers in ASEAN-6 countries, as they adapt to the needs of the future economy.

[3] *"Manufacturing" captures the following sectors; Manufacturing, Electricity and Gas Supply, Water Supply, Construction and Transport*

The reskilling challenge

5. The reskilling challenge

Governments, businesses, and workers have a shared stake in ensuring the ASEAN-6 workforce is ready for the demands of the future economy. The changing shape of the labour market means workers do not have all the skills required to take advantage of future growth sectors. A major reskilling challenge lies ahead if countries are to make best use of their workforces under our new technology scenario. In this chapter, we quantify the precise nature of this challenge for the ASEAN-6.

5.1 The deepening skills mismatch

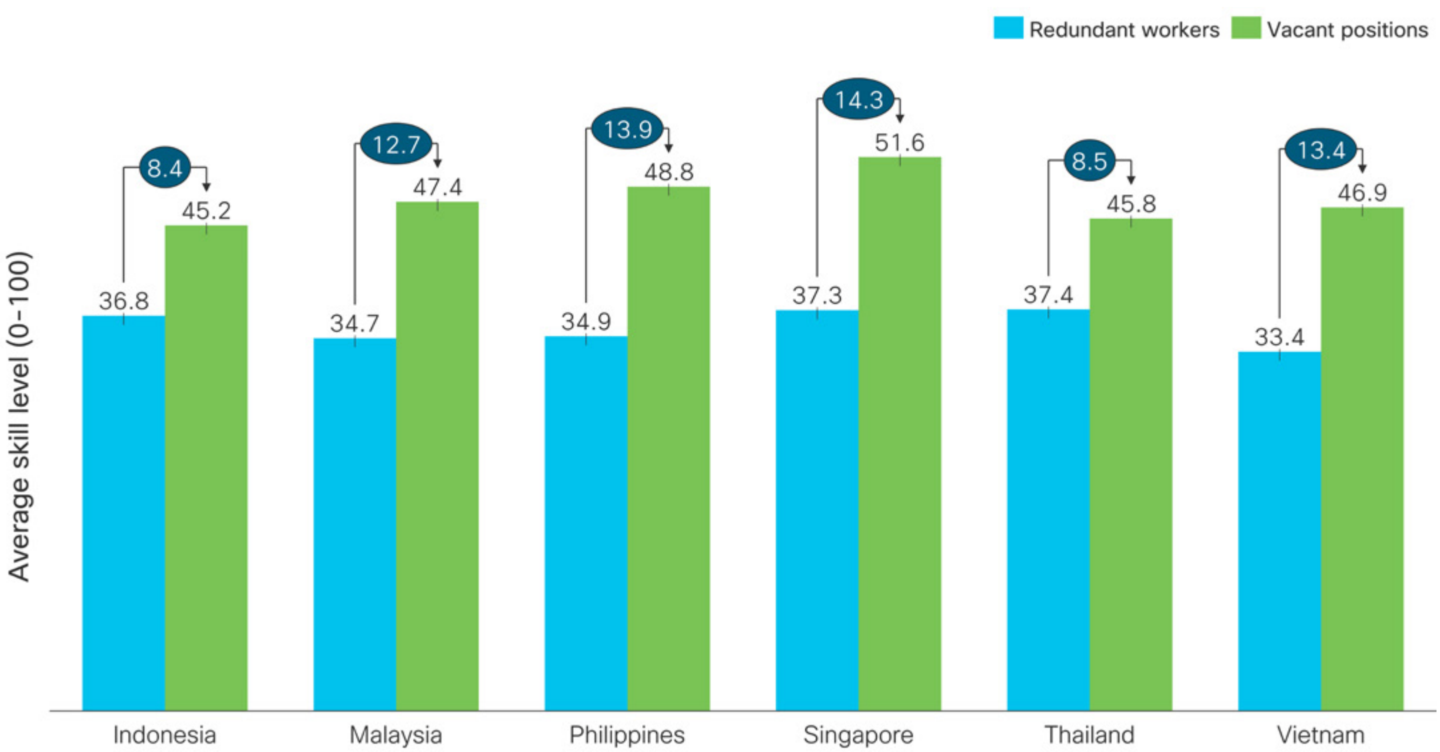
In a rapidly changing economy, with a large and youthful workforce, ASEAN-6 policymakers know there are many workforce challenges ahead. Technological change carries implications for all workers over the next decade: the majority will be required to familiarise themselves with new devices and software applications; many will be required to fundamentally change the nature of their job.

Our modelling shows that the general stock of skills in the labour market will have to rise significantly to accommodate the demands of the new technology scenario. We focused our skills analysis on those jobs at the margins of change: the 6.6 million jobs that we project will become redundant across ASEAN-6 by 2028. As a measure of the coming economy-wide mismatch, comparing the skills demanded by these redundant jobs with those required by the net new jobs being created in other sectors offers a window on the scale of the challenge. Fig. 20, illustrates the extent of the skills mismatch that we project will emerge across each of our six ASEAN economies.

Note: in reality, of course, redundant workers will not take the newly created positions directly. Rather, a range of more appropriately skilled candidates in nearby industries and occupations will compete for these positions, leaving vacancies in their wake that will slowly cascade through the labour market. The 6.6 million vacancies to be filled in our scenario will therefore lead to many more job moves, as the labour market evolves around its new demands.

Fig. 20. Skills mismatch by country

(Skills of redundant workers vs skills needed in vacant positions)



Source: Oxford Economics, Cisco

Expert view:

Sustaining an inclusive society and a competitive economy:

The Singapore experience

By Dr Soon Joo Gog, Chief Futurist & Chief Research Officer, SkillsFuture Singapore

"Learning for a new world" is the title of the final chapter of the book Learning For Life, published in 2014 to commemorate 50 years of Singapore's workforce development efforts. The chapter documents a new milestone in Singapore's commitment towards lifelong learning, as the nation entered the era of digital economy and launched the SkillsFuture movement.

Investment in education and training is a long-standing policy commitment and practice in Singapore. The outcome envisioned is that of a sustainable competitive economy, where citizens continue to enjoy a high quality of living despite economic changes.

Underpinning the SkillsFuture movement is the fundamental commitment of an inclusive society that all citizens have equal opportunities to fulfil their aspirations to become masters of their crafts. SkillsFuture is most pertinent when Singapore is bracing for the next phase of economic restructuring, and where every industry is going through a transformation. This transformation entails the adoption of digital technologies, rethinking business models, redesigning products and services, and accessing global markets.

SkillsFuture adopts a dynamic skills ecosystem approach, leveraging the tripartite partnership of businesses, the labour movement, and the government to ensure a ready and skilled workforce that can meet the needs of a new economy. This skills ecosystem comprises the following plans:

- Empowering individuals to make informed choices on career and learning. Pre skilling, re-skilling and deep-skilling opportunities are readily accessible to citizens via community workshops, online learning, workplace learning, and professional community learning.
- Engaging employers to plan and develop their skills stock. In each of the Industry Transformation Map, business transformation plan and the corresponding skills requirements are identified and make available to all stakeholders. Employers are engaged to review the changing skills needs and talent requirements.
- Engaging education and learning providers in the lifelong learning agenda. In October 2017, the 12 Institutes of Higher Learning jointly launched the SkillsFuture Series, which identified eight priority skills areas needed by the Singapore economy for the next five years. Digital skills ranging from basic to advanced levels feature prominently in the SkillsFuture Series.
- Leveraging on applied research and development to support the twin goals of skills development and business solution design. Research institutes from A-STAR, plus various university and polytechnic centres of excellence, partner enterprises to undertake applied research and development in creating business solutions and training the incumbent workforce in the application of new workplace solutions.

The Singapore government offers training grants and SkillsFuture Credit to support individuals and enterprises to pursue skill training. In 2017, the training participation rate hit a new high of 47.9%, compared to 35% in 2015. As of February 2018, over 285,000 Singaporeans have used the SkillsFuture Credit, amounting to S$ 40 million in expenditure.

5.2 How do the ASEAN-6 countries compare?

Despite its already highly-skilled workforce, our analysis suggests it is Singapore that faces the biggest skills challenge. This is due to the rate of digital transformation taking place under our scenario assumptions, which significantly outpaces other countries in the region. For example, a more supportive environment for IoT and robotics investment will lead to a much greater displacement of production workers and labourers in Singapore. Our scenario sees these low-skilled positions less affected in the other ASEAN-6 countries over the next decade. At the same time, the majority of new job opportunities in Singapore is likely to be created in highly-skilled managerial and professional roles, reflecting the growth areas of the economy. Thus, a considerable uplift is required in the overall skills composition of that workforce.

Workers in the Philippines, Vietnam and Malaysia face the next most significant skills challenge. This is driven by a particularly low existing skillset amongst those workers losing their jobs under our scenario, as well as the needs of a rapidly changing economy. In these three countries, we project a shift in demand towards the wholesale & retail sector that will create opportunities for workers, but these positions require a different skillset from other sectors. These include a greater incidence of managerial and decision-making roles, customer services, and negotiation, and this provokes a mismatch in complex, "softer" skillsets.

Thailand and Indonesia face a smaller skills challenge, reflecting the relatively minor differences in skillsets between the workers made redundant under our scenario, and the new vacancies created. There are new jobs created in high-skilled IT and professional roles, but to a lesser extent than in the other countries, due to expectations of a more limited environment for automation and digitalisation. Also, new job opportunities are skewed further towards manufacturing, heavy industry, and transport. The skills transition is consequently less severe than for other labour markets that are shifting more predominantly into service sectors.

5.3 Where will skills fall short?

The skills mismatches caused across the ASEAN-6 countries by our technology scenario present a range of challenges. We analysed the nature of those challenges across 35 skills categories to provide insights for policymakers and other stakeholders as to how they might be addressed. For a detailed taxonomy of these skills, refer to Appendix 7. We explored two perspectives on the skills challenge to help define it:

- Firstly, we looked at the most severe shortcomings of those workers leaving redundant jobs in the context of the skills demanded by vacant positions. This angle typically highlights those skills that might require more formal, or longer-term training to address.
- Secondly, we looked at the broader skills challenges facing the wider workforce. This angle focuses on the aggregate stock of skills embodied in those workers losing redundant jobs and the aggregate stock of skills new positions will demand. It reflects the number of vacancies requiring a skills upgrade of any size, and typically highlights skills that might require less formal, on-the-job training solutions.

5.3.1 In which skills are the challenges most acute?

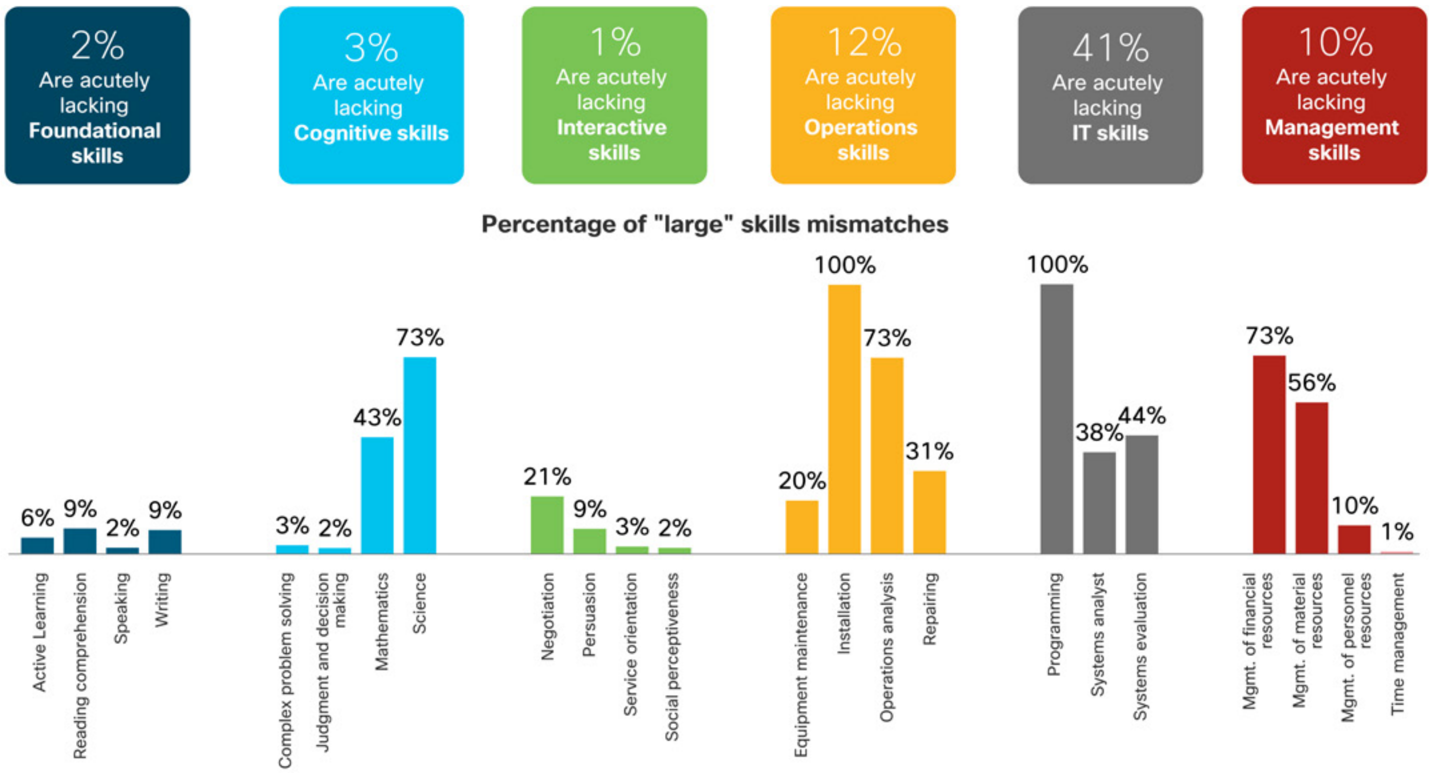
IT skills stand out as a major challenge. IT-related occupations are growing, but the workforce is currently acutely lacking the necessary skills. Around 41 percent of ASEAN-6 workers leaving redundant jobs have what we classify as an "acute" skills mismatch with vacant positions in the broader category of IT skills[4]. That is not to say a redundant farm labourer will move into a software developer role, but is a reflection of the aggregate skills mismatch this scenario creates. The IT skills challenge is not exclusively a problem of recruiting highly-specialised programmers, however; it spreads across all sectors of the economy in the future. Whilst the ICT sector accounts for more than one third of the vacancies requiring advanced programming skills, it is the source of only 6 percent of vacancies requiring the wider suite of IT skills (including more basic and intermediate level programming).

[4] Skills mismatches are divided into large, medium and small categories. A large skills mismatch is defined by a difference of more than 25 skills points between a redundant worker and a vacant position. This is only calculated for skills considered important to the vacant position. Skills points are calculated based on ONET data and the number of workers the skill applies to.

Similarly, acute skills challenges are revealed across the region in other skills too. There is a significant mismatch between the skills of ASEAN-6's redundant workers and the needs of new vacancies in installation skills, mathematics, science, operations analysis and management, too (see Fig. 21). These challenges are not straightforward to address, as they often imply years of formal training or experience to bridge the gap.

Fig. 21. Acute skills shortfalls emerge in niche, technical areas

Incidence of large skills mismatches between redundant workers and vacancies, by skill, ASEAN aggregate



Source: Oxford Economics, Cisco

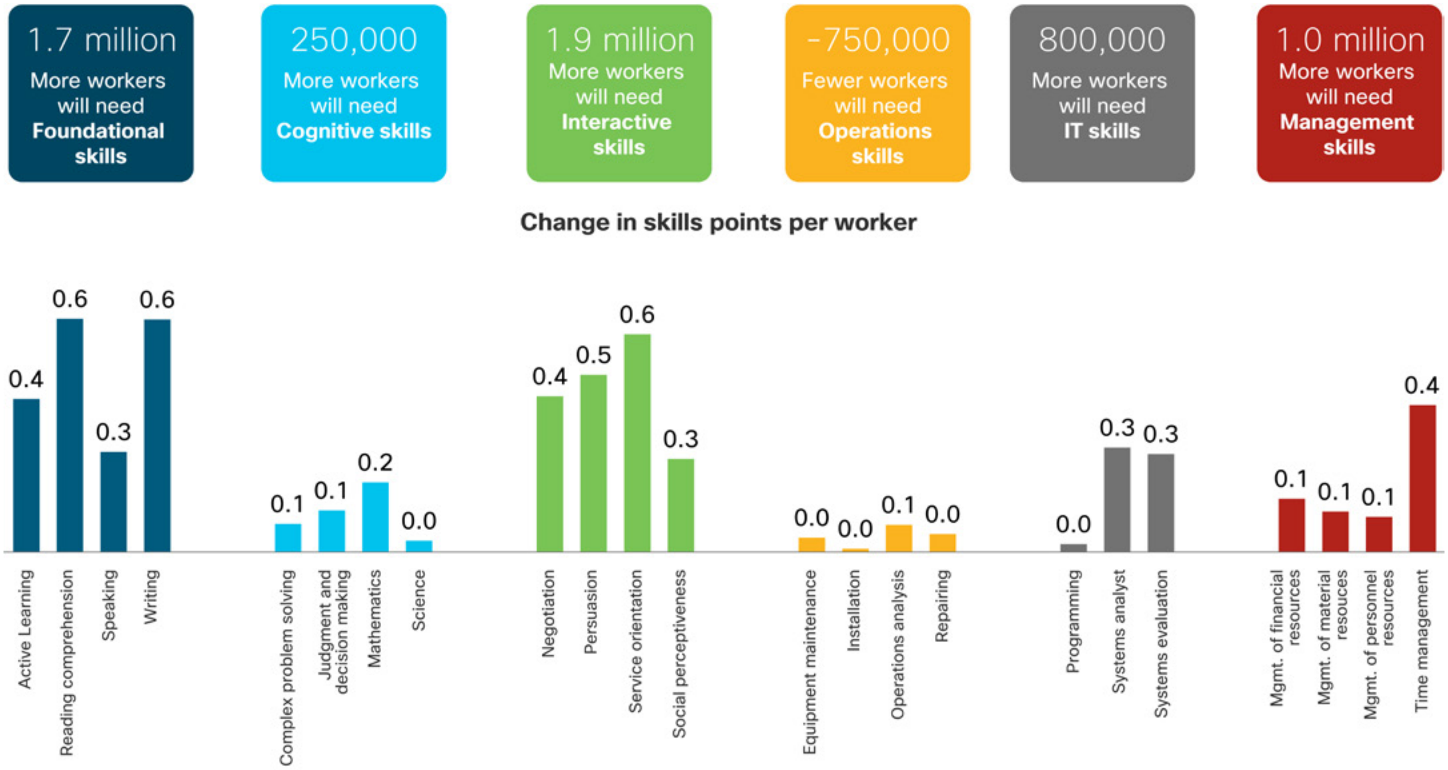
5.3.2 What are the broader skills challenges to be faced?

Our modelling scenario suggests just under 30 percent of workers leaving redundant jobs across the six major ASEAN economies are lacking in the "interactive" skills new vacancies will demand. This represents 1.9 million workers, lacking in such skills as negotiation, persuasion and service orientation. Additionally, 1.7 million of the workers are lacking in the "foundational" skills that form part of new roles. These include active learning, reading and writing skills (see Fig. 22).

This perspective highlights how, despite the disruption being technology-based in nature, the ASEAN-6 workforce's most significant challenge is to upgrade its softer, foundational and interactive skillset. Fulfilling these skills challenges will require a different approach to delivering the more technical, acute skills identified above. It might require a greater commitment to on-the-job training, more flexible online courses and experience, to complement or substitute for formal classroom education.

Fig. 22. A structural lack of softer skills must be overcome

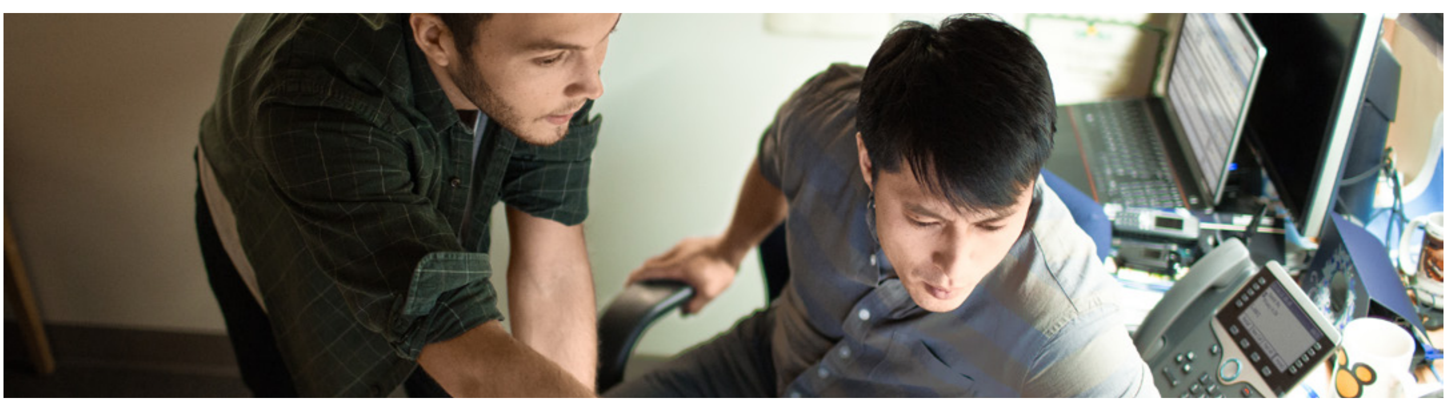
Overall size of skills mismatch in "skills points" per worker, by skill category, ASEAN aggregate



Source: Oxford Economics, Cisco

This analysis demonstrates how the skills challenge facing the ASEAN-6 labour markets is multifaceted. The extent of the challenge in each country will be determined by the rate of technological transformation taking place. This will depend not only on what is technically possible over the next decade, but by the investment climate and the institutional and infrastructural constraints that characterise different industries and economies. It will also depend on where the growth areas in the economy will be – and, ultimately, how well-equipped today's workforce, and the many young men and women entering the labour market over the next decade, will be with the skills that the future economy demands.

There is no one-size-fits-all solution to such a skills challenge, and the responsibility for meeting it will fall to a number of different parties. In the final chapter, we reflect on the major considerations that should shape ASEAN-6 policymakers' and other stakeholders' approach to this challenge.



Expert view:

Disruption from AI and automation will demand tighter education partnership with industry

By Marcus Lim, Director, Education, Asia Pacific, Cisco

The advent of AI and automation has determined that – on top of typical jobs and industries – the educational sector is also undergoing rapid change. In January 2018, Singapore celebrated its primary school students scoring second place in a global literacy test (the Progress in International Reading Literacy Study, or PIRLS). However, few people realised that two weeks before the PIRLS achievement made national headlines, Alibaba and Microsoft, made a testing achievement of their own: beating another highly regarded literacy test, the Stanford Question Answering Dataset. The only difference? This time, instead of primary school students, AI bots took the exam.

In 2017, Professor Noriko Arai of the National Institute of Informatics in Japan designed the Todai Robot to compete with human students at the highly prestigious and extremely competitive University of Tokyo entrance examination. The Todai Robot received a higher score in the exam than 80% of extraordinarily intelligent and competent Japanese students.

These results beg the question: if AI bots can outperform so many of our students in academic activities, is our current education system still sufficient to keep humans ahead of machines? Does it make sense for students to continue going through the current form of education at all?

But while the Todai Robot's achievements are impressive, Professor Arai noted that Todai does not actually "understand" the tasks it performs, even though it executes those tasks exceptionally.

We know that any tasks that can be procedurised or codified – including reading literacy – can be programmed into and performed by AI bots. Thus, if our education systems continue to predominantly focus on didactic, rote, and content-based approaches to learning, our future generations will eventually be rendered obsolete, as this type of learning can more easily and cheaply be programmed into AI bots instead.

Rather than this old model of education, we must shift the foundation of our learning systems toward active, authentic, experiential, and action-based approaches that teach our students skills of analysis, design, innovation, critical thinking, problem solving, communication, and making meaning out of content. These are the outcomes that the industry increasingly expects from educational systems, and this is how we ensure that students and future workers are set up to direct these AI bots, rather than being replaced or directed themselves.

Societal evolution fuelled by digital disruption will also contribute to the changing role of education into a value-based necessity of economic development and class equity for our future generations. Governmental institutions alone will not be able to address the impending challenges.

Industry will be required to take on a far larger role. It needs to serve as both a consumer of, and contributor to, this new educational landscape, driving a much-needed revamp in assessment and certification framework, increasing advisory and consultation, and refining hiring policies. While we must address the challenge of reskilling our workers with the necessary proficiencies to succeed in today's economy, it is equally if not more critical for industry and government to work together to reduce the graduate skills mismatch before students enter the workforce, and avoid further compounding the reskilling challenge.

On that note, Cisco's strategy is based around harnessing the power of the digital revolution to enable people and societies to thrive in the digital economy through global problem solving. Global Problem Solvers are people who innovate as technologists, think as entrepreneurs, to create, innovate, and collaborate, and act as agents of social change to connect with and inspire others, treating challenges as opportunities waiting to be explored.

Cisco's goal is to positively impact 1 billion lives by 2025, by equipping citizens with digital skills through our comprehensive range of educational initiatives. We are partnering with more than 11,400 learning institutions in 180 countries through the Cisco Networking Academy to impart technical training and professional skills development to prepare students for entry-level jobs, career transitions and professional certifications.

We also actively participate in workshops on building future-proof institutional digital infrastructure systems and services to transform the learning experiences of students, educators and administrators for years to come.

Reflections for the future

6. Reflections for the future

The scale and complexity of the technology-led shifts facing ASEAN labour markets over the coming decade mean that responses developed in isolation are unlikely to be successful. Instead, long-term strategies to mitigate the negative consequences of job displacement will require some form of collective approach – from an ecosystem of government departments, businesses, educational institutions, technology providers and workers' groups.

The precise implications for each country, occupation, and industrial sector vary considerably, and are unlikely to be well understood by the relevant workforces. Therefore, programmes that build public awareness of the issues at hand, and enable cross party opportunities for discussion, should be considered. Heightened understanding of the shifting labour market may increase the prospects of correct strategic decisions being made, and accepted, by all those involved.

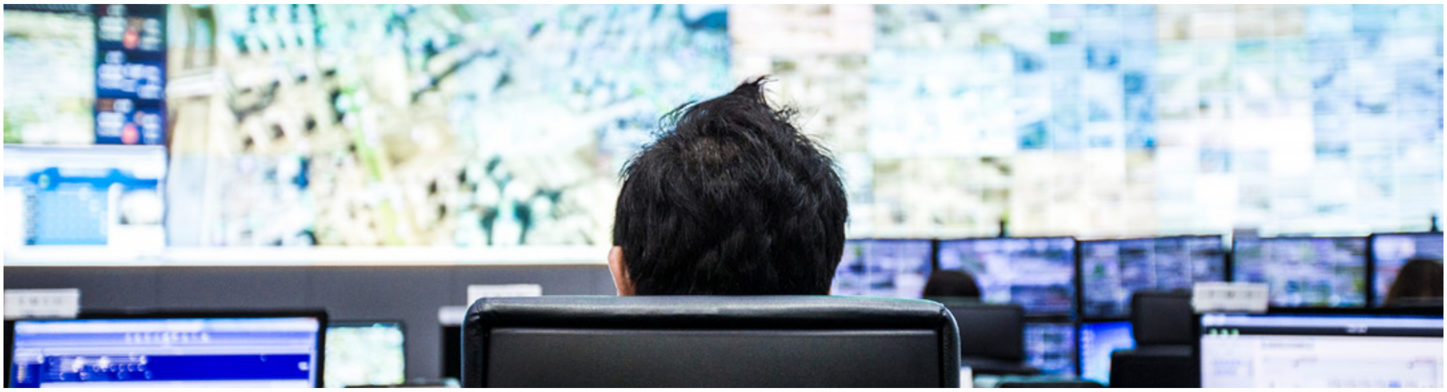
It is important to highlight the role of technology in generating greater productivity across all six ASEAN economies, and hence new opportunities for workers. In time, this may lead to many workers undertaking fewer routine administrative and routine communication tasks, and spending more time thinking and working more creatively, within a labour market tasked with generating higher value from more rewarding work.

However, this can only occur if workers are given – and accept – the opportunity to upgrade their existing skillsets or retrain, in order to develop their existing roles or take on new jobs. This is true whatever the current skills makeup of an economy. Indeed, relative to the size of its total workforce, and despite its already highly-skilled worker profile, Singapore faces the greatest skills challenge, according to our model, because the majority of new jobs there will be created in highly-skilled professional and managerial roles.

The prevalence of acute skills shortages, particularly in technical skills and IT, across all six ASEAN economies explored in this study, reflects a strong need for formal training and education to produce a larger number of specialist workers. In addition, we foresee widespread demand for workers to transition into jobs that require softer, customer-oriented or interactive skillsets. This will require a range of training approaches, including greater commitment to on the-job training, more flexible online courses, and work experience schemes, to complement (or even substitute for) a formal school and tertiary education.

In all cases, governments, businesses, institutions, and individuals will need to work together to smooth the transition to these new, digitally-led economies and labour forces. A successful transition will see economies benefiting more quickly from the opportunities that technology brings and will ease the pain of transition for those workers whose jobs will be displaced.

We now offer a more detailed summary of the 2028 jobs landscape for each ASEAN-6 country, starting with Indonesia (see Appendix 1).



Expert view:

Re-imagining the future of work and empowering youth

By Sumitra Pasupathy, Country Director of Ashoka Singapore and Malaysia

Technology and globalisation are affecting all industries and organisations, in two key ways. Jobs are being disrupted through automation, thereby transforming the existing skills that are required. In parallel, jobs are being created, with potentially new skillsets required.

It is estimated that 65% of children entering primary school today will have jobs that do not yet exist, and for which their education will fail to prepare them, exacerbating skills gaps and unemployment or underemployment. Today's active workforce of 3 billion people is also not able to adjust promptly, due to under-developed adult training and skilling systems. Simply incorporating e-learning in the classroom, or teaching skills such as coding, is far from sufficient. The risk remains that "we are in danger of educating a generation of children to become not very good at jobs that robots will do better".

Humans have several critical competitive advantages over machines: problem solving, creative thinking, innovation, judgment, and empathy, to name a few. Workers whose core purpose is critical and creative thinking, and making human connections, will thrive: these workers define themselves by their ability to use and work creatively with technology, rather than compete with it.

We are expected to live and work longer. With steadily increasing life expectancy, the majority of children born in rich countries today can expect to live to more than a 100. Our traditional lens sees life in three stages: education, followed by a 40-year career, ending in retirement. But this life model will not be relevant in the future. We will not be able to afford to retire at the age our parents did; in fact, we will need to work for potentially a 60-year stretch, testing our mental and physical fitness, as well as our passion for work and living.

We need to find ways to thrive in a different world. The OECD's Education 2030 framework recognises that societies are changing rapidly and profoundly, with significant challenges that are environmental (climate change and resource depletion), economic (new paradigms in value and wealth with the advent of technology), and social (socio-political and demographic shifts, widening inequality, threats of conflict). It will require a different type of young person and future adult to deal with this disruption, and the very nature of work and human thriving in this system will shift. Education cannot be just about developing abstract skills: it must also be about learning to live in new and better ways, and to take charge and shape the future.

"Changemaking skills" are critical for the future. Although literacy and technical skills remain important, our interviewees consistently identified a diverse range of skills that would be critical for our next generation to thrive in a vastly different future:

- Agency, self-direction, responsibility: the ability to find one's own voice, empowered to create change with new ideas and solutions.
- Changemaking and problem solving: the ability to constantly change and adapt, and problem solve with creativity and resourcefulness.
- Empathy: the ability to understand and respond to the perspective of others.
- Resilience and adaptability: the ability to take on problems, take risks, persevere through setbacks, and to be resourceful.
- Sophisticated teamwork and collaboration: building the next generation of connectors and weavers who can bring multi-disciplinary ideas and insights together, and can bring people together across a diverse ecosystem.
- "Learning to learn" and "growth" mindset: it is not a pre-requisite to have a specific knowledge or skill, but rather to have a growth and learning mindset for life.
- Attitudes and values: OECD 2030 identifies motivation, trust, respect for diversity, and virtue as some important values.
- Wellbeing and thriving: healthy inner-relationships with ourselves, including authenticity and the ability to create trust and safe spaces.

This article is an extract of a larger research paper, with the same title, written by A.T. Kearney/Ashoka Innovators for the Public.

Appendices

Appendix 1: Detailed country profiles

Indonesia

The 2028 technology landscape for Indonesia

Our team of experts developed a 10-year modelling scenario in which Indonesia is home to a vibrant digital economy, with start-ups engaged in digital enterprises and companies pursuing technological innovation. But the large role of the public sector in the economy, plus geographical constraints and political pushback regarding the rapid adoption of disruptive, labour displacing technologies, stifles automation.

Under this scenario, there will be ...

Jobs displaced

The three sectors in line for most displacement are:

1. **Agriculture:** 3.5m displaced (10.4 percent of workforce)
2. **Wholesale & retail:** 1.6m displaced (6.6 percent of workforce)
3. **Manufacturing:** 1.5m displaced (8.4 percent of workforce)

Jobs created

The three sectors in line for the most job creation are:

1. **Wholesale & retail:** 2.3m jobs created (9.2 percent of workforce)
2. **Agriculture:** 1.8m jobs created (5.3 percent of workforce)
3. **Manufacturing:** 1.4m jobs created (7.9 percent of workforce)

2 million existing roles will disappear from the labour market, pushing workers into other industries and occupations.

Occupation	Agriculture & Mining	Manufacturing	Utilities	Construction	Wholesale & Retail	Transport & Tourism	Business Services	Government & Community Services	Total
Managers	-699	6,227	155	8,680	15,393	8,615	16,451	14,191	69,013
Professionals	-582	3,149	61	3,866	1,725	2,442	19,260	86,148	116,069
Technicians and junior professionals	-2,969	5,061	637	8,096	13,327	10,344	39,471	20,184	94,150
Clerical support workers	-1,168	13,760	1,975	9,021	25,621	32,806	64,413	52,398	198,826
Service and sales workers	-4,551	3,191	-192	752	460,475	66,261	14,196	52,274	592,405
Skilled agricultural workers	-1,483,344	-	-	-	-	-	-	-	-1,483,344
Craft and related trades workers	-25,874	-92,853	931	136,151	20,840	2,392	3,093	31,904	76,585
Plant and machine operators, and assemblers	-15,421	-11,791	344	3,883	5,086	163,283	3,220	7,691	156,294
Elementary workers	-238,595	-14,709	1,949	155,905	86,743	70,778	15,652	102,278	180,001
Total	-1,773,203	-87,964	5,861	326,353	629,209	356,921	175,754	367,069	-0

More than 1.7 million agricultural jobs are predicted to be made redundant

62 percent of job vacancies will emerge in construction, transport and retail

Malaysia

The 2028 technology landscape for Malaysia

Our team of experts developed a 10-year modelling scenario in which Malaysia has excellent high-speed Internet connectivity and data infrastructure. Malaysia 2028 has achieved fairly advanced automation of low-value, routine and hazardous work, but labour regulations slow the business case for more widespread automation. IoT development is relatively nascent, and lacking a deep developer ecosystem.

Under this scenario, there will be ...

Jobs displaced

The three sectors in line for most displacement are:

1. **Manufacturing:** 230k displaced (8.2 percent of workforce)
2. **Agriculture:** 180k displaced (11 percent of the workforce)
3. **Wholesale & retail:** 175k displaced (6.3 percent of workforce)

Jobs created

The three sectors in line for the most job creation are:

1. **Wholesale & retail:** 280k jobs created (9.9 percent of workforce)
2. **Manufacturing:** 185k jobs created (6.7 percent of workforce)
3. **Hotels & restaurants:** 120k jobs created (8.3 percent of workforce)

250,000 existing roles will disappear from the labour market, pushing workers into other industries and occupations.

Occupation	Agriculture & Mining	Manufacturing	Utilities	Construction	Wholesale & Retail	Transport & Tourism	Business Services	Government & Community Services	Total
Managers	-1,739	-256	36	155	5,810	1,341	4,768	1,117	11,233
Professionals	-1,697	3,117	-54	496	2,573	1,978	17,771	26,948	51,132
Technicians and junior professionals	-2,060	-2,144	-539	67	9,169	1,785	11,081	6,591	23,950
Clerical support workers	-1,608	497	-36	1,040	8,809	3,694	6,907	4,806	24,110
Service and sales workers	-1,732	35	-117	-139	62,859	10,648	6,931	1,102	79,587
Skilled agricultural workers	-68,239	-162	-	-	47	6	210	-24	-68,162
Craft and related trades workers	-1,867	-15,008	-196	-5,963	8,548	-73	499	-192	-14,251
Plant and machine operators, and assemblers	-8,579	-24,527	-707	-1,233	1,992	3,971	184	-619	-29,518
Elementary workers	-74,413	-2,369	-904	-1,509	3,359	355	669	-3,269	-78,081
Total	-161,933	-40,817	-2,518	-7,085	103,167	23,705	49,019	36,462	-0

The transition out of agriculture, leapfrogs manufacturing and shifts straight into services

...Opportunities are not limited to retail: 20 percent of vacancies will be created in higher-value business services

The Philippines

The 2028 technology landscape for the Philippines

Our panel of experts developed a 10-year modelling scenario in which the Philippines is benefiting from an advanced cloud-based mobile broadband infrastructure. Outward facing industries targeting the export market have integrated some advanced technologies, including AI into decision making and supply chain capabilities, but domestic industry is much further behind the curve. The regulatory environment is slow to adapt and there is popular resistance to rapid technological change that affects jobs.

Under this scenario, there will be ...

Jobs displaced

The three sectors in line for most displacement are:

1. **Agriculture:** 1.2m displaced (12.4 percent of workforce)
2. **Wholesale & retail:** 880k displaced (8.5 percent of workforce)
3. **Manufacturing:** 380k displaced (10 percent of workforce)

Jobs created

The three sectors in line for the most job creation are:

1. **Wholesale & retail:** 1.3m jobs created (12.5 percent of workforce)
2. **Transport:** 490k jobs created (13.2 percent of workforce)
3. **Construction:** 460k jobs created (11.9 percent of workforce)

1.1 million existing roles will disappear from the labour market, pushing workers into other industries and occupations.

Occupation	Agriculture & Mining	Manufacturing	Utilities	Construction	Wholesale & Retail	Transport & Tourism	Business Services	Government & Community Services	Total
Managers	-14,435	14,362	422	3,464	226,945	113,105	18,786	17,170	379,819
Professionals	-303	5,408	615	3,236	4,275	1,560	23,443	28,338	66,572
Technicians and junior professionals	-818	4,639	576	2,265	8,157	2,602	19,890	9,246	46,557
Clerical support workers	-717	-46	172	524	3,409	3,848	51,914	3,406	62,511
Service and sales workers	-1,162	890	9	60	130,698	-3,564	48,099	24,339	199,368
Skilled agricultural workers	-420,747	59	-	-	-	-	11	-73	-420,749
Craft and related trades workers	-604	578	1,418	44,022	12,077	668	2,849	4,726	65,734
Plant and machine operators, and assemblers	-6,261	6,548	105	670	2,266	24,618	1,000	916	29,863
Elementary workers	-498,309	-8,208	-37	43,699	26,054	6,827	1,675	-1,376	-429,674
Total	-943,356	24,230	3,280	97,940	413,882	149,664	167,667	86,693	0

One-third of vacancies emerge in managerial positions, particularly retail management, reflecting the structural shift across industries to smaller enterprises

Singapore

The 2028 technology landscape for Singapore

Our panel of experts developed a 10-year modelling scenario in which Singapore sits at the cutting edge of technological innovation, globally. It has modern and upgradeable infrastructure, a supportive regulatory framework and a strong investment environment. Singapore has become a world leader in IoT-enabled logistics and supply chain optimisation. Semi-autonomous vehicles are commonplace and financial services heavily invested in AI and analytics.

Under this scenario, there will be ...

Jobs displaced

The three sectors in line for most displacement are:

1. **Wholesale & retail:** 80k displaced (19.8 percent of workforce)
2. **Manufacturing:** 55k displaced (22.1 percent of workforce)
3. **Transport:** 50k displaced (23.8 percent of workforce)

Jobs created

The three sectors in line for the most job creation are:

1. **Wholesale & retail:** 100k jobs created (24.6 percent of workforce)
2. **Manufacturing:** 70k jobs created (28.2 percent of workforce)
3. **Finance & Insurance:** 60k jobs created (27.6 percent of workforce)

85,000 existing roles will disappear from the labour market, pushing workers into other industries and occupations.

Occupation	Agriculture & Mining	Manufacturing	Utilities	Construction	Wholesale & Retail	Transport & Tourism	Business Services	Government & Community Services	Total
Managers	-3	4,273	210	4,427	7,608	-1,802	2,467	557	17,737
Professionals	-6	7,311	253	1,718	3,685	158	6,454	1,665	21,238
Technicians and junior professionals	-14	3,844	-2	1,862	3,285	-3,361	-3,142	-3,898	-1,426
Clerical support workers	-4	624	-0	839	-425	-3,600	-3,629	-2,353	-8,548
Service and sales workers	-0	533	8	132	5,824	-3,498	-1,713	118	1,404
Skilled agricultural workers	-473	-	-	-	-	-	-	-	-473
Craft and related trades workers	-3	32	-44	1,221	-177	-622	-1,336	-361	-1,290
Plant and machine operators, and assemblers	-10	-1,081	-87	277	-881	-9,544	-1,750	-463	-13,538
Elementary workers	-8	-449	-132	342	817	-6,922	-5,842	-2,911	-15,104
Total	-521	15,087	205	10,819	19,736	-29,190	-8,490	-7,646	-0

Together, more than 25 percent of jobs in craft, production and labourer occupations will be automated by technology

Almost 60 percent of job opportunities will be in managerial and professional occupations

Thailand

The 2028 technology landscape for Thailand

Our panel of experts developed a 10-year modelling scenario in which Thailand has taken advantage of a lack of legacy infrastructure to establish a cloud intensive, 5G broadband network in major cities. Thailand 2028 is also regionally competitive in analytics, with a young, digital savvy workforce and a supportive government policy. AI is partially integrated into business functions through the cloud, but not to the same extent as in Singapore and Malaysia with regards to automating decision making, recruitment and operational decisions.

Under this scenario, there will be ...

Jobs displaced

The three sectors in line for most displacement are:

1. **Agriculture:** 1.7m displaced (14.5 percent of workforce)
2. **Manufacturing:** 840k displaced (11.6 percent of workforce)
3. **Wholesale & retail:** 760k displaced (10.4 percent of workforce)

Jobs created

The three sectors in line for the most job creation are:

1. **Manufacturing:** 1.2m jobs created (16.3 percent of workforce)
2. **Wholesale & retail:** 910k jobs created (12.4 percent of workforce)
3. **Hotels & restaurants:** 550k jobs created (17.4 percent of workforce)

1.3 million existing roles will disappear from the labour market, pushing workers into other industries and occupations.

Occupation	Agriculture & Mining	Manufacturing	Utilities	Construction	Wholesale & Retail	Transport & Tourism	Business Services	Government & Community Services	Total
Managers	-690	19,525	1,063	28,718	10,025	13,495	20,050	- 81	92,105
Professionals	-259	23,127	1,956	6,419	5,371	6,425	38,204	14,155	95,398
Technicians and junior professionals	-459	27,039	2,010	8,759	8,860	9,779	50,131	8,816	114,936
Clerical support workers	-342	20,833	1,512	3,911	4,349	19,168	25,397	-3,239	71,589
Service and sales workers	-928	9,001	329	447	96,329	134,832	22,436	2,248	264,695
Skilled agricultural workers	-1,056,408	491	183	-	92	804	1,137	-1,146	- 1,054,847
Craft and related trades workers	-1,186	107,047	2,680	133,123	12,825	4,255	5,938	1,222	265,904
Plant and machine operators, and assemblers	-12,314	114,047	732	12,144	20	64,834	4,133	-6,179	177,417
Elementary workers	-120,901	20,692	1,198	65,663	9,682	15,906	5,792	-25,229	27,196
Total	-1,193,486	341,803	11,662	259,184	147,553	269,498	173,219	-9,433	-0

More than 1.7 million agricultural jobs are predicted to be made redundant

62 percent of job vacancies will emerge in construction, transport and retail

Vietnam

The 2028 technology landscape for Vietnam

Our panel of experts developed a 10-year modelling scenario in which Vietnam benefits from a vibrant mobile economy, driven by a large, young, digital savvy workforce. High levels of investment in advanced infrastructure mean 5G connectivity is established in the cities and most rural areas are covered by Internet services. State-of-the-art IoT technologies support export manufacturing and logistics. Data localisation policies have proven a real impediment to advanced use of the cloud, distributed computing and AI development. But the prevalence of cheap and abundant labour means domestic economy is operating on dated practices.

Under this scenario, there will be …

Jobs displaced

The three sectors in line for most displacement are:

1. **Agriculture:** 3.4m displaced (17.1 percent of workforce)
2. **Manufacturing:** 1.3m displaced (13.2 percent of workforce)
3. **Wholesale & retail:** 840k displaced (10.9 percent of workforce)

Jobs created

The three sectors in line for the most job creation are:

1. **Manufacturing:** 1.7m jobs created (8.5 percent of workforce)
2. **Wholesale & retail:** 1.6m jobs created (16.4 percent of workforce)
3. **Hotels & restaurants:** 1.3m jobs created (16.8 percent of workforce)

1.8 million existing roles will disappear from the labour market, pushing workers into other industries and occupations

Occupation	Agriculture & Mining	Manufacturing	Utilities	Construction	Wholesale & Retail	Transport & Tourism	Business Services	Government & Community Services	Total
Managers	132	5,181	727	2,922	6,217	3,151	7,252	25,943	51,526
Professionals	2,413	43,071	4,922	18,125	34,922	19,209	79,434	149,087	351,183
Technicians and junior professionals	508	16,616	2,681	6,370	15,396	7,846	22,418	57,925	129,761
Clerical support workers	1,145	24,264	1,471	2,817	7,562	12,796	14,248	28,847	93,149
Service and sales workers	-1,961	10,965	211	723	334,736	77,973	14,154	62,606	499,407
Skilled agricultural workers	-335,304	108	-	-	-	46	174	312	-334,664
Craft and related trades workers	95	101,617	1,627	100,989	19,599	1,201	3,474	15,561	244,163
Plant and machine operators, and assemblers	-3,400	107,713	1,027	4,847	7,249	83,584	2,123	1,721	204,866
Elementary workers	-1,373,620	8,446	1,671	46,081	31,650	20,367	4,359	21,656	-1,239,391
Total	-1,709,992	317,981	14,338	182,874	457,332	226,174	147,637	363,657	-0

Over 90 percent of redundant jobs occur in agriculture alone

Appendix 2: Glossary of terms

ASEAN-6: The six largest economies in the ASEAN region: Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam.

Displaced worker: A Full Time Equivalent (FTE) unit of labour displaced by technology under our 2028 scenario assumptions, based on their occupational task profile.

Redundant job: A job that exists in our 2018 labour market, but is no longer required in 2028 under our technology scenario. Redundant jobs occur when the displacement of jobs outweighs the creation of jobs in any given sector of the labour market.

Vacancy: A job that exists in our 2028 scenario that did not exist in the 2018 baseline. Vacancies occur when the creation of jobs in a given sector of the labour market outweighs the numbers of jobs displaced.

Income effect: The creation of new demand for workers as a result of our 2028 technology scenario. Technology leads to productivity gains, which drives down prices and boosts real income, which is spent on new goods and services and demands new workers.

Labour market model: Oxford Economics' unique ASEAN-6 labour market model, which enables the translation of qualitative scenario assumptions into quantitative jobs impact.

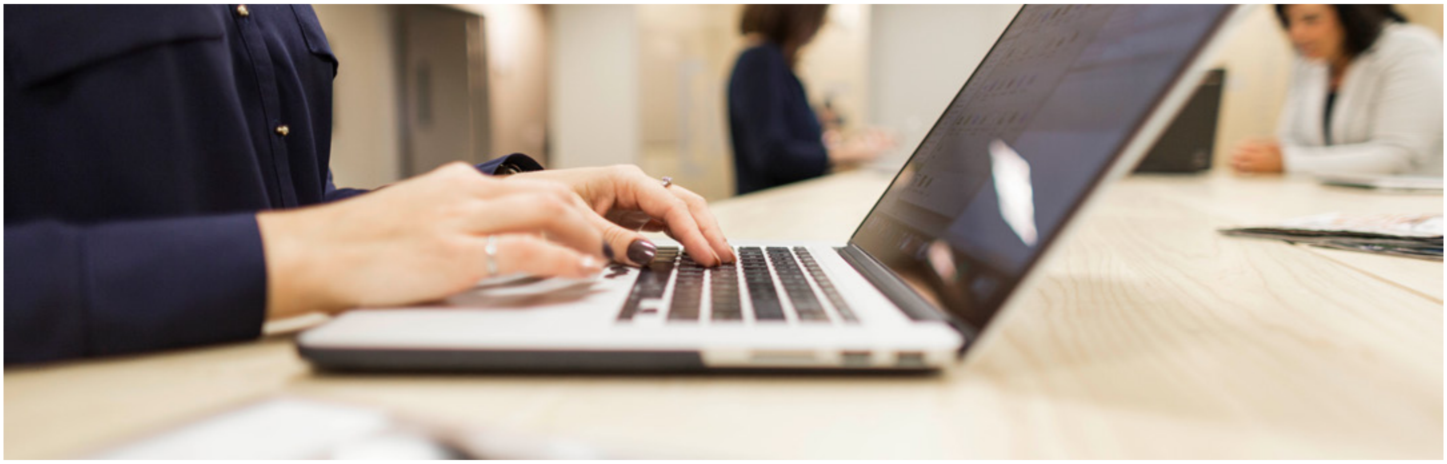
New technology scenario: A set of scenario assumptions, developed with our multi-disciplinary team of experts in a series of structured workshops.

Task profile: A profile of the tasks that constitute each of the 433 occupations in the ASEAN-6 labour market. The profile includes only those tasks deemed "important" to performing an occupation and weights the tasks according to the relative time they take up. Data on tasks is derived from the O*NET database (see Appendix 7).

Skills mismatch: An assessment of the differences between the skillset of redundant workers in our 2028 scenario and the available vacancies. It is not assumed redundant workers will move straight into the vacancies, rather there will be many jobs moves as the labour market evolves, but this provides a window into the reskilling challenge the wider labour market faces.

Foundational skills: A category of skills required by certain occupations, including reading comprehension, writing, speaking and active learning.

Interactive skills: A category of skills required by certain occupations, including negotiation, persuasion and service orientation.



Appendix 3: Modelling assumptions

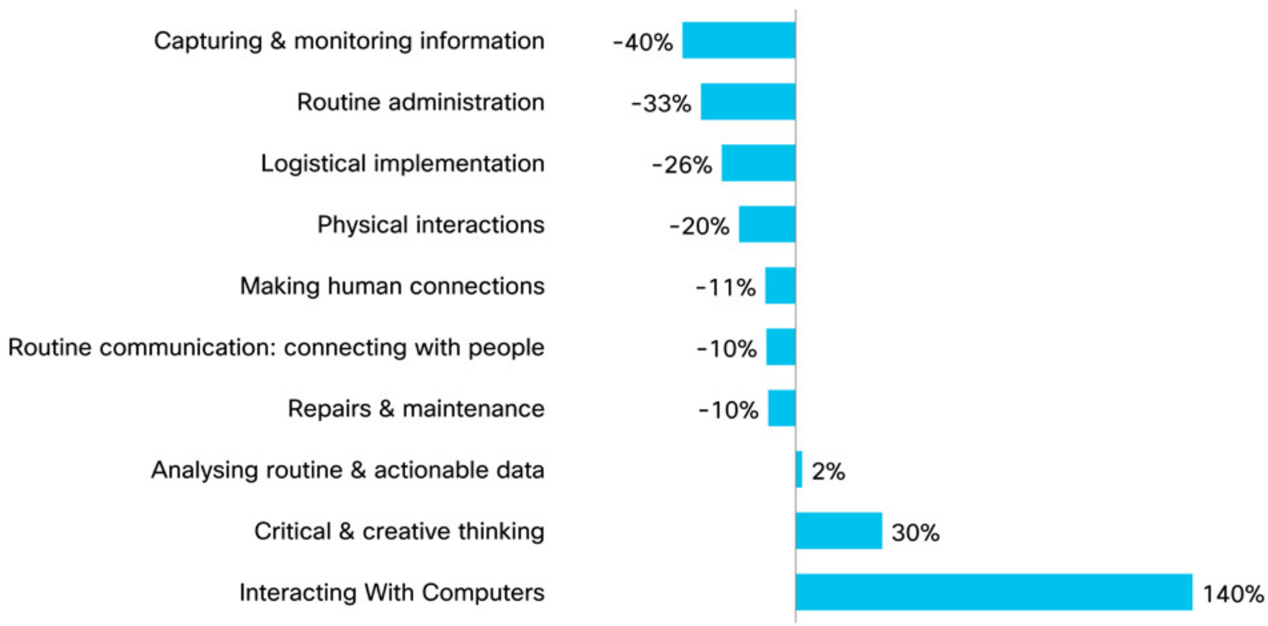
Cisco and Oxford Economics assembled a team of experts from across the ASEAN region to engage in an interactive workshop and develop a detailed hypothesis about the likely progress of technology over the coming decade. Our team included thought leaders from the technology, education, non-profit, consulting, journalism, economics, regulatory policy and government sectors. We worked together to define the technology landscape for the six leading ASEAN economies: Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Vietnam.

Participants were tasked to form a collective judgement on the future capabilities of a range of technologies, including artificial intelligence, advanced robotics and IoT, and how they would change the nature of work. They were asked: "To what extent will businesses become more productive at performing certain tasks, such that fewer workers will be needed to produce the same output?"

They considered the extent of technological progress, as well as the rate of business investment, and other institutional, political and infrastructural challenges that defined the context in each of our ASEAN-6 economies. This helped us formulate a set of consistent task-based productivity assumptions across 41 workplace tasks and each of our ASEAN-6 economies that are a key input to our labour market modelling framework.

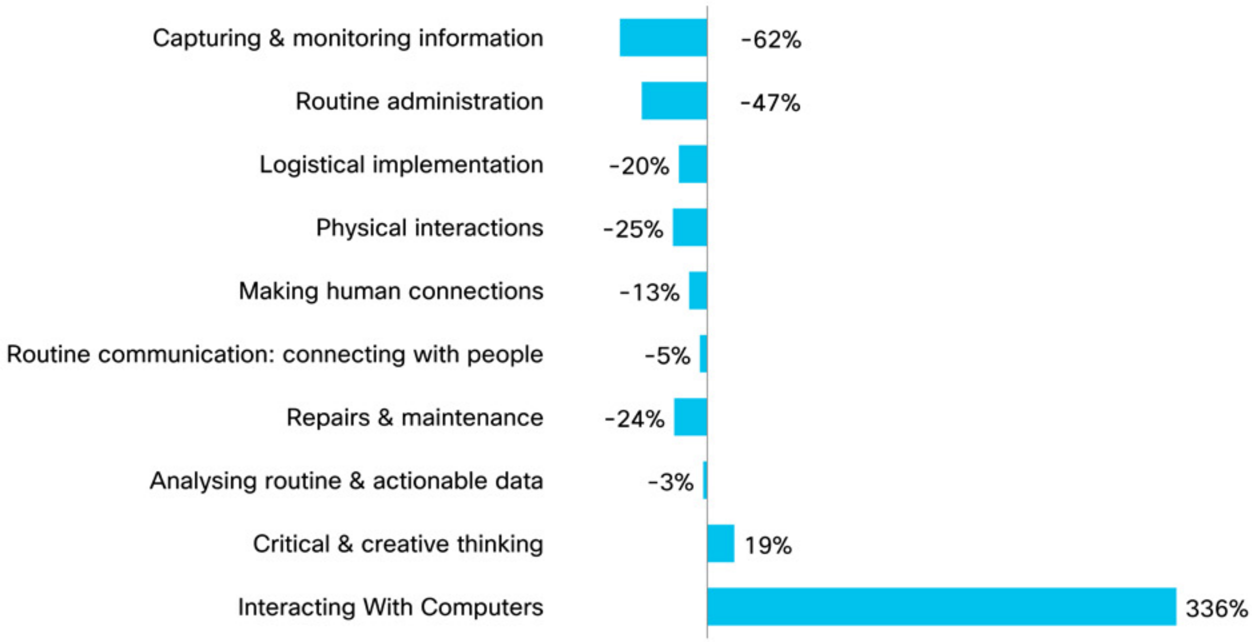
Below is a summary of the results from this interactive workshop, aggregating the 41 workplace tasks into 10 task clusters. The participants provided a high and low range of estimates. In this report we feature the high scenario estimations to more openly explore the dynamics underneath.

Indonesia (Displacement effect by task cluster, high scenario)



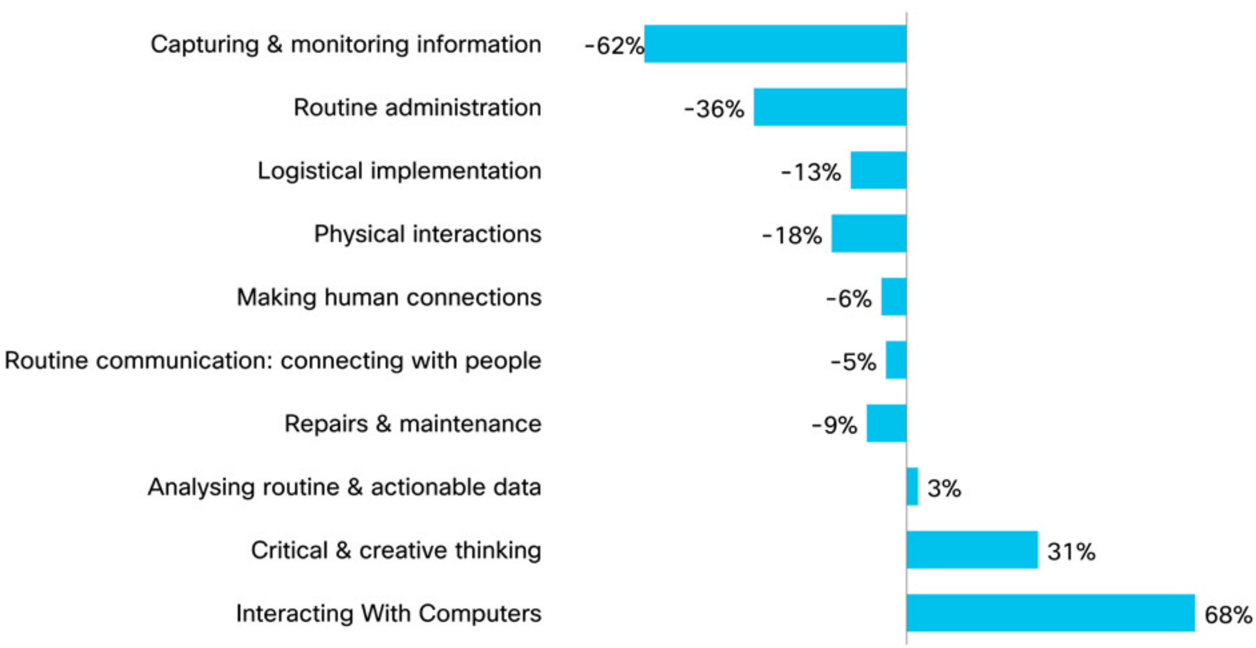
Source: Oxford Economics, Cisco

Malaysia (Displacement effect by task cluster, high scenario)



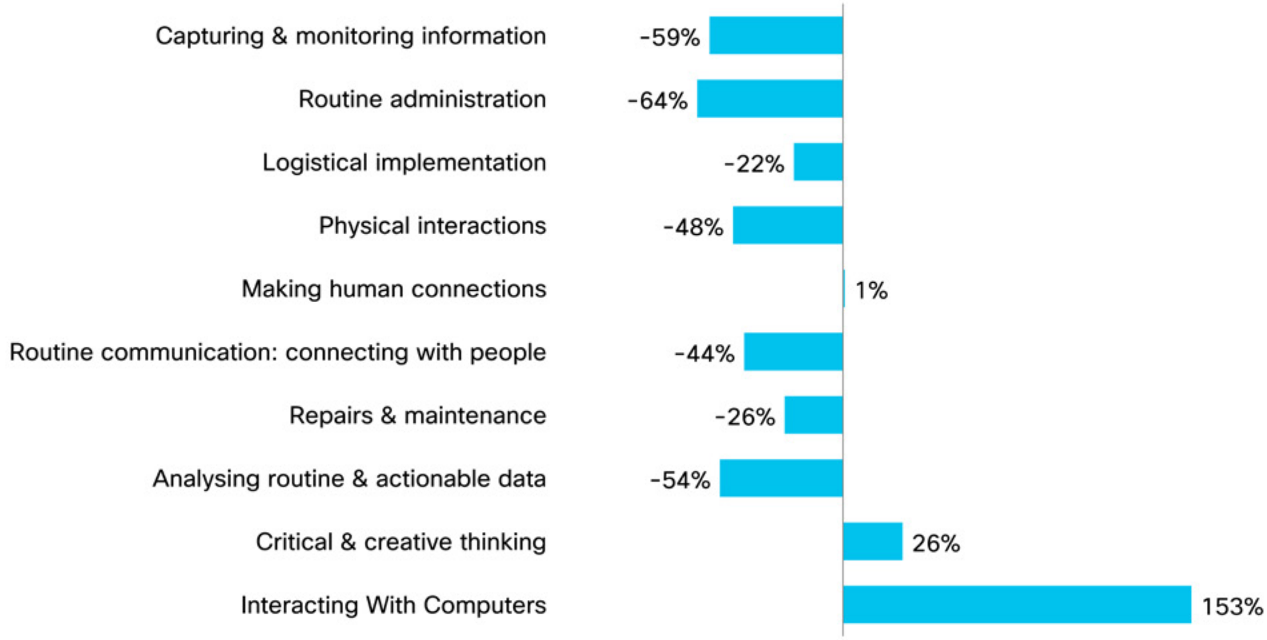
Source: Oxford Economics, Cisco

The Philippines (Displacement effect by task cluster, high scenario)



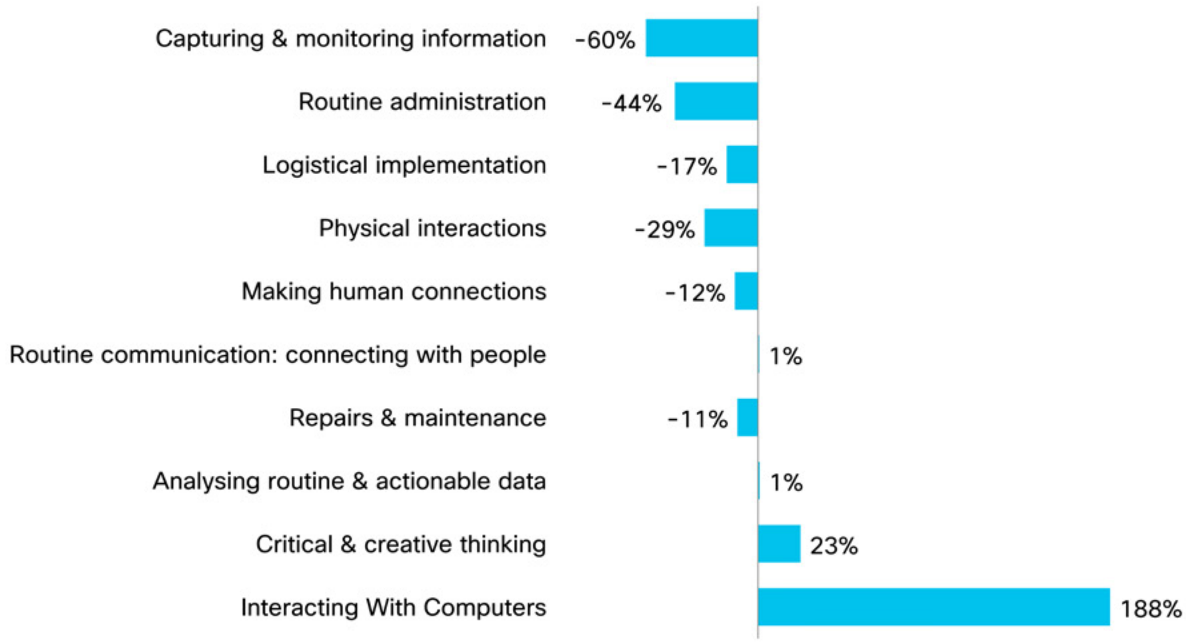
Source: Oxford Economics, Cisco

Singapore (Displacement effect by task cluster, high scenario)



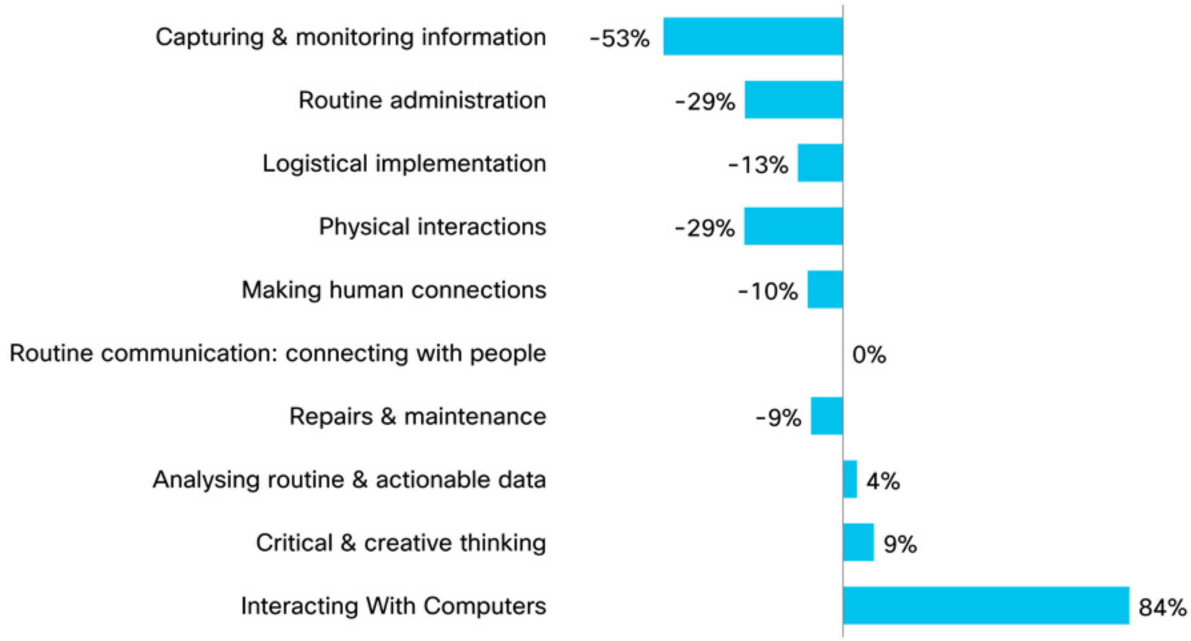
Source: Oxford Economics, Cisco

Thailand (Displacement effect by task cluster, high scenario)



Source: Oxford Economics, Cisco

Vietnam (Displacement effect by task cluster, high scenario)



Source: Oxford Economics, Cisco

Appendix 4: Creating ASEAN SIC-SOC matrices

Our modelling approach relies on granular labour market data for all six ASEAN labour markets, detailing employment across 433 occupations and 21 industries. This level of granularity is not available via national statistics offices. Therefore a robust, consistent imputation approach was used to develop the detailed industry-occupation employment (SIC-SOC) matrices.

To ensure international comparisons, we organised employment data according to the International Standard of Occupations (ISCO) 08 and the International Standard Industrial Classification of All Economic Activities (ISIC) Rev.4. The process followed two key steps. Firstly, official national employment statistics were collected at the most granular level of occupational/industry breakdown that is available. Secondly, these employment statistics were disaggregated to the required level of granularity using information from proxy countries.

The first stage of this process was to establish the high-level employment structure across industries and broad occupational categories[5] for each of the six countries. Data for the latest year available[6] was obtained from the ILO, and where not available was collected from the country's national statistics office/ministry of labour[7].

We disaggregated the 1-digit SIC-SOC matrix (10 occupations) to 2-digit SOC categories (40 occupations)[8]. Employment data split by industry and 2 digit occupation was available for the Philippines from the microdata of their labour force survey. For the other five countries, an imputation approach using a proxy country was required. Within data constraints, the choice of proxy was determined according to similarity of economic characteristics, stage of development and geographical proximity. For Indonesia, Malaysia, Thailand and Vietnam, the Philippines was used as a proxy country to disaggregate their respective employment matrices into 2 digit occupation categories. For Singapore, Hong Kong was used as a proxy country. This ensures that the core structure of the employment matrix for each country is determined almost entirely by official ASEAN statistics.

The same imputation approach was repeated to disaggregate employment into 3 digit occupation codes and subsequently 4 digit occupation codes. The choice of proxy country was significantly limited due to constraints in the availability of detailed labour market data[9]. The 3 digit occupation proxy was an average of the employment distribution in Croatia, Latvia, Romania, the United Kingdom and Australia. The 4-digit occupation proxy was an average of the employment distribution in Croatia, Latvia, the United Kingdom and Australia.

The outcome from this consistent imputation approach was a detailed headcount SIC-SOC matrix for all six of the ASEAN countries in the study. To reflect differences in working hours across occupations, these matrices were converted into full-time equivalent employment assuming a standard working week of 40 hours[10]. These matrices represent today's labour market equilibrium that will be used as the starting point for modelling the impact of technological change (as described in Appendix 5).

[5] 1 digit ISCO 08 (10 categories).
[6] Either 2016 or 2017.
[7] Data for Singapore was obtained from the Singaporean Ministry of Manpower. Employment data was combined across a few industries so Oxford Economics' gross value added shares were used to distribute employment across these industries.
[8] 2 digit ISCO 08.
[9] European national statistics offices were contacted to collect detailed employment matrices.
[10] Data on hours by occupation and industry was only available by 1 digit ISCO (2 digit for the Philippines) so each 4 digit ISCO within each 1 digit ISCO category was assumed to work the same hours.

Appendix 5: Modelling the labour market impact

Our modelling framework is designed to explore the implications of technological change on the shape of each of the ASEAN-6 labour markets. It is based on a long-term assumption of equilibrium employment and therefore does not attempt to forecast fluctuations in the rate of unemployment. Our model makes use of granular industry-occupation employment matrices, as described in Appendix 4, which represent today's labour market equilibrium. This is combined with data from O*NET on the nature of occupations, providing a comprehensive account of the skills (35 categories) and workplaces tasks[11] (41 categories) for each job, as well as other characteristics[12]. Our scenario projections represent a shift in the structure of the labour market compared to today's equilibrium. Our approach involves a sequence of two modelling exercises, which we set out below.

1. Modelling the static displacement effect

The displacement effect was derived from consensus expert judgements in an interactive workshop, as described in Box 1. The workshop produced quantitative assumptions about the extent to which technology would make us more productive in the future in producing the equivalent of today's level of output. In doing so, it would "displace" workers from performing specific tasks that are more amenable to automation. These "task changes" were mapped to occupations based on the task-profiles of 433 occupations[13] in the ASEAN-6 labour markets, which were produced using O*NET data.

The task profile of a given occupation[14] (*o*) provides an estimate of the share of working time spent completing each workplace task (*t*). It is calculated using the relative importance (*IM*) of each workplace task, only including tasks that are deemed important for that occupation. The importance score is derived from O*NET data, which gives each task for each occupation a score from 1-5. We normalise this score on a 0-100 scale and label all tasks with a score greater than or equal to 50 as "important" to a given occupation. By way of context, the 433 occupations involve an average of 23 "important" tasks. Cleaners, for example, have six important tasks to complete, whilst conference and event planners have 35. The estimated share of working time spent on task 1 for occupation *o* is therefore as follows;

$$1)\ T_{o1} = \frac{IM_{o1}}{\sum_{t=1}^{41} IM_{ot}}\ where\ IM_{ot} \geq 50$$

Our expert panel produced task-specific assumptions about the change in FTE employment required to perform each task. This resulted in a new occupational task profile, where β_t is the static displacement effect for task t.

$$(2)\ T_{o1}^{d} = \frac{IM_{o1}(1+\beta_1)}{\sum_{t=1}^{41} IM_{ot}(1+\beta_t)}\ where\ IM_{ot} \geq 50$$

The implied impact on FTE employment from the displacement effect was calculated for each occupation (ΔEmp_o^d)

based on the gross reduction in FTE hours required to complete each task under the technology scenario, compared to baseline (3). The labour market-wide impact was calculated as the sum of the occupational effects (4).

$$(3)\ \Delta Emp_o^d = Emp_o^d - Emp_o^{2018} \quad \text{where } Emp_o^d = \sum_{t=1}^{41} T_{ot}(1+\beta_t)\, Emp_o^{2018}$$
$$(4)\ \Delta Emp^D = \sum \Delta Emp_o^d$$

[11] *Referred to as Generalised Work Activities in O*NET*

[12] *All O*NET data is mapped from US Standard Occupation Classifications to ISCO 08 in order to be incorporated with the industry-occupation employment matrices for each ASEAN country.*

[13] *4 digit occupations in the International Standard Classification of Occupations 2008*

[14] *O*NET data is not industry specific, therefore the displacement effect is the same across industries for a particular occupations*

Whilst the expert panel dictated that most tasks would be subject to productivity gains over the next decade, i.e. a negative displacement effect, some tasks would see an increase in demand for workers as a necessary corollary of achieving those productivity gains. An example is that workers would have to 'interact more with computers', in order to achieve technology-based productivity gains in other tasks, such as 'inspecting equipment'. These "positive displacements" are interpreted differently to negative displacements. They are interpreted solely as a change in the task-composition of an occupation, which results in a rise in aggregate hours the worker spends on that task at the expense of other tasks, such that the net FTE employment for the occupation is unchanged. Therefore, the total displacement effect for each individual occupation is always non-positive. For interacting with computers specifically, an additional assumption is imposed, stating that this task becomes important for more jobs, based on an adjustment in the *importance threshold* for this task[15].

2. Modelling the income effect

The income effect occurs as a result of increased demand for goods and services and offsets the displacement effect on employment. Where that demand falls, i.e. how people spend their extra income – is independent of where technology is generating productivity gains. To estimate the income effect, we took GVA growth forecasts for all of the six ASEAN countries in 2028 from the Oxford Economics Global Industry Model and derived the implications for individual occupations using the industry-occupation employment matrices, set out in Appendix 4.

In the real world, the displacement and income effect occur in parallel. However, technically we estimated the displacement effect of our technology scenario first. We take the post-displacement employment for occupation *o* in industry *i* (Emp_{io}^{d}), then apply the GVA forecast for industry *i* (ΔGVA_i)[16] and sum across all industries to estimate the net change in employment level for occupation *o* (ΔEmp_o^{ie}).

$$(5)\quad \Delta Emp_o^{ie} = \sum_{i=1}^{19} \Delta GVA_i * Emp_{io}^{d}$$

The aggregate income effect on FTE employment was calculated as the sum of all occupational impact and, for modelling purposes, was constrained in FTE employment terms to equal the aggregate displacement effect, as expressed in (6). In fact, the income effect exceeded the displacement effect, but the residual is presumed to be driven by other, non-technology related productivity gains that are correlated to digitalisation.

$$(6)\quad \Delta Emp^{I} = \Delta Emp^{D}$$

[15] *Importance threshold is lower to 25 (out of 100)*
[16] *% growth in GVA over the next 10 years (2018-2028)*

Appendix 6: Analysing the skills mismatch

A core element of our modelling framework is to elucidate the skills challenges that must be overcome for the ASEAN region to reap the full rewards that technological change offers. Due to data limitations[17], we were unable to produce an ASEAN version of the Oxford Economics Skills Matching Model used in the original US AI Paradox report. Instead, our analysis of the skills challenges ahead focused on a rigorous comparison of the skills profile of those workers in redundant jobs with that required in vacant positions.

Country Level Skills Mismatch

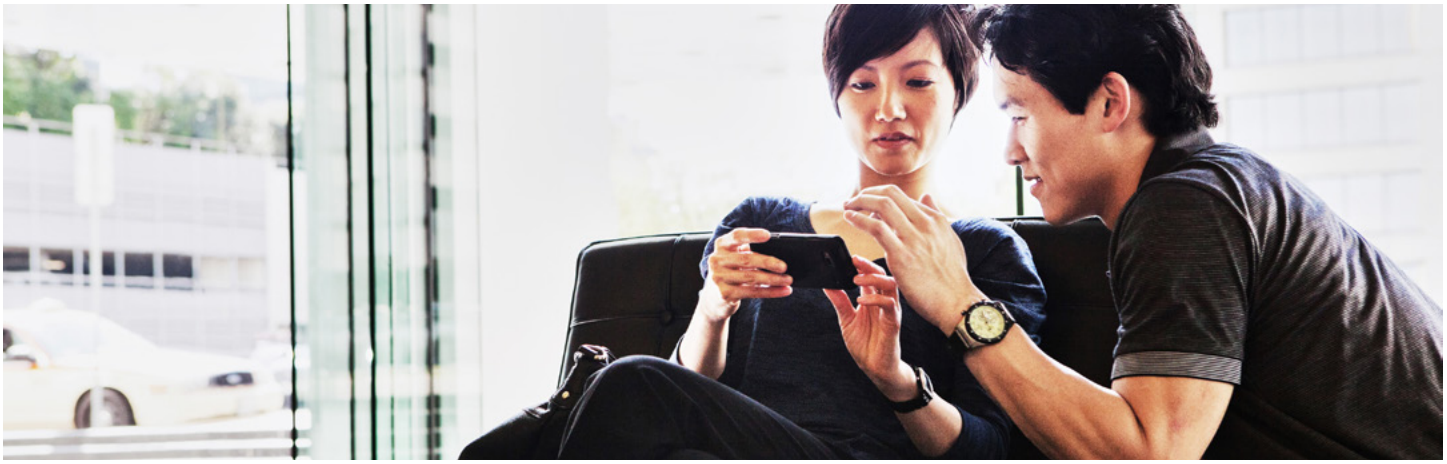
The aggregate country-level skills mismatch is calculated by comparing the average skill profile required in vacant positions to that possessed by the workers leaving redundant jobs. For each vacant position, a weighted average skills level is calculated, weighted by the respective importance scores of each skill deemed important[18] to that job. The skill level of vacancy, v, across skills, s, is as follows;

$$Skill_v = \frac{\sum_{s=1}^{35} LV_v^s * IM_v^s}{\sum_{s=1}^{35} IM_v^s} \; where \; IM_v^s \geq 50$$

By comparison, no such importance criteria applies to workers leaving a redundant job, so their skill level across the full spectrum of skills provides an indication of their proficiency. The skill level of these workers, r, across skills, s, is as follows;

$$Skill_r = \frac{\sum_{s=1}^{35} LV_r^s * IM_r^s}{\sum_{s=1}^{35} IM_r^s}$$

The aggregate national skill level of all vacant positions in a country is the weighted average of the skill level in each vacant position, weighted by the number of vacancies in each job. Similarly, the aggregate national skill level of all workers from redundant jobs in a country is the weighted average of the skill level in each redundant position, weighted by the number of redundancies in each job. The difference between the aggregate skill level of vacancies and redundancies provides a high-level insight into the scale of the skills mismatch facing each country.



[17] *The Skills Matching Model relies on detailed household longitudinal surveys which identify the movements between occupations and industries that have been made historically in the respective country. Such data was available for the USA, but not for the six ASEAN countries in this study.*
[18] *Importance score >=50*

We approached the skills challenge from two perspectives:

1. The most severe skills shortfalls

This perspective seeks to provide insight into the steepness of the learning curve between redundant workers and vacant positions. For each skill, we identify all vacant positions for which that skill is deemed important. A pairwise comparison between the skill level of the vacant position and a redundant position for the respective skill is undertaken. If the difference is greater than 25 skill points[19] then the mismatch between the vacancy and the redundancy for the respective skill is considered a "large mismatch". This process is iterated across all vacancies and all redundancies, such that all relevant pairwise comparisons had been made to produce a matrix of mismatches classified as either "large" or "small". This matrix is weighted by the number of vacancies and redundancies in each job to produce an aggregate share of the number of mismatches classified as "large".

2. Broad Skills Mismatch

The broad skills mismatch focuses on the aggregate stock of skills embodied in tomorrow's redundant worker and the aggregate stock of skills new vacancies will demand. It reflects the frequency with which a mismatch between redundancies and vacancies must be overcome.

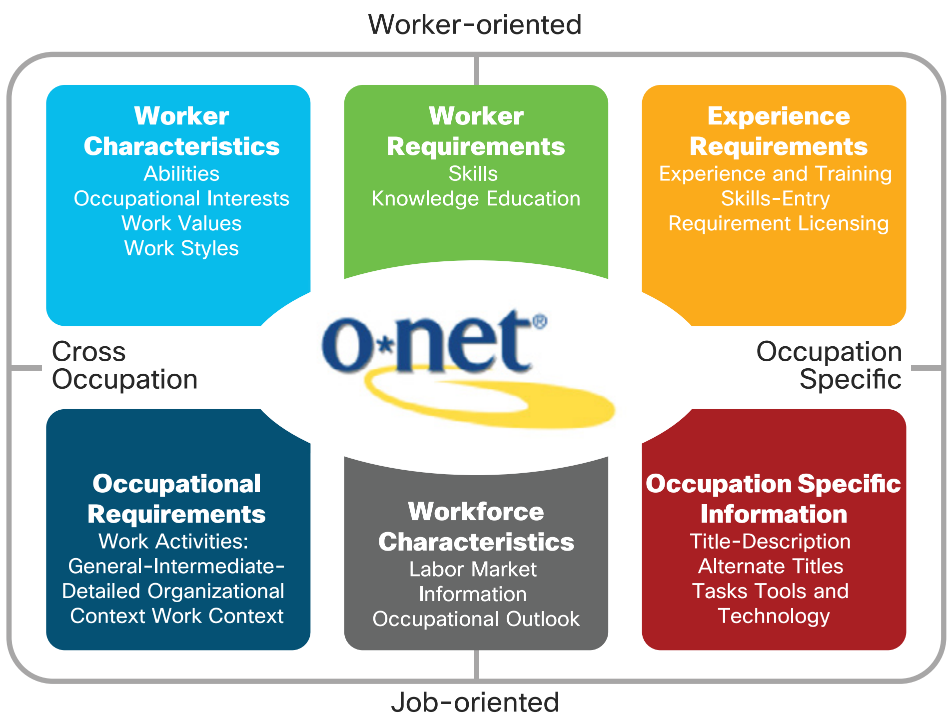
For each skill, the stock of skill points required by new vacancies[20] is compared to the stock of skill points embodied by workers leaving redundant jobs. This difference is divided by the size of the workforce in each country in 2018 to produce the average change in skills points per worker. Doing so, enables consistent cross-country comparisons to be made.

*[19] Equivalent to a 1 point change on the 1-5 likert scale used in the data collection survey by O*NET*
[20] Only includes vacancies for whom the skill is deemed important to the role.

Appendix 7: What is O*NET and how did we use it?

The US O*NET program is a comprehensive system for collecting and disseminating information on occupational and worker characteristics, sponsored by the US Department of Labor and Employment and Training Administration. At the cente of the program is the O*NET database, which contains information on hundreds of standardised and occupation-specific descriptors for over 1000 different occupations. All of these data are structured according to the O*NET "content model", which defines the key features of an occupation as a standardised set of variables called "descriptors". The descriptors are meant to provide an exhaustive list of all the worker characteristics, worker requirements and occupation requirements for any given occupation. Information is organised across six "domains" which comprise both worker-oriented characteristics and job-oriented characteristics. Please see table below for illustration of the "content model".

Much of the information is collected via self-reported assessments by existing employees using standardised questionnaire surveys and is supplemented by professional assessments by job evaluation analysts. These data collection methods are undertaken on an ongoing basis, enabling information to be updated regularly, and has created a rich time-series database of occupation-specific descriptors spanning almost 20 years. All data was mapped into international occupation codes (ISCO) using the publicly available crosswalks from O*NET and the US Bureau of Labour Statistics.



Specific details on skills and work activities

For this paper, the core data used from the O*NET database were the "Skills" and "Generalized Work Activities" sections. For both of these elements of the database, the "Importance" and "Level" of each skill or characteristic is recorded. The former reflects the degree of importance a particular descriptor has to the occupation and is scored from one ("not important") to 5 ("extremely important"). The latter reflects the degree to which a particular descriptor is required to perform the occupation. It is scored according to a 0-7 scale with reference points (or "level anchors") to help respondents place a value on that range.

The descriptors included in both of these sections are meant to be exhaustive and mutually exclusive. For example, the 35 skill descriptors should provide a comprehensive list of all the skills that might be required by a worker in any given occupation in the US. The table below presents the typology used for the "Skills" and "Generalized Work Activities" sections of the O*NET database.

Fig. 23. Skills typology[21]

Category	Descriptor
Cognitive Skills	Complex Problem Solving
	Critical Thinking
	Judgement and Decision Making
	Mathematics
	Science
Foundational Skills	Active Learning
	Active Listening
	Learning Strategies
	Monitoring
	Reading Comprehension
	Speaking
	Writing
Interactive Skills	Coordination
	Instructing
	Negotiation
	Persuasion
	Service Orientation
	Social Perceptiveness
IT Skills	Programming
	Systems Analysis
	Systems Evaluation
	Technology Design
Operations Skills	Equipment Maintenance
	Equipment Selection
	Installation
	Operation and Control
	Operation Monitoring
	Operations Analysis
	Quality Control Analysis
	Repairing
	Troubleshooting
Resource Management Skills	Time Management
	Management of Financial Resources
	Management of Material Resources
	Management of Personnel Resources

*[21] The categories used in this report differ to those used by O*NET.*

Fig. 24. Work Activities (tasks) typology [22]

Category	Descriptor
Analysing Routine and Actionable Data	Analysing Data or Information
	Controlling Machines and Processes
	Estimating the Quantifiable Characteristics of Products, Events, or Information
	Evaluating Information to Determine Compliance with Standards
	Identifying Objects, Actions, and Events
	Processing Information
Capturing and Monitoring Information	Drafting, Laying Out, and Specifying Technical Devices, Parts, and Equipment
	Getting Information
	Inspecting Equipment, Structures, or Material
	Monitor Processes, Materials, or Surroundings
	Monitoring and Controlling Resources
Critical and Creative Thinking	Interpreting the Meaning of Information for Others
	Judging the Qualities of Things, Services, or People
	Making Decisions and Solving Problems
	Thinking Creatively
	Updating and Using Relevant Knowledge
Interacting with Computers	Interacting with Computers
Logistical Implementation	Coordinating the Work and Activities of Others
	Developing Objectives and Strategies
	Organizing, Planning, and Prioritizing Work
	Staffing Organizational Units
Making Human Connections	Assisting and Caring for Others
	Developing and Building Teams
	Establishing and Maintaining Interpersonal Relationships
	Guiding, Directing, and Motivating Subordinates
	Performing for or Working Directly with the Public
	Provide Consultation and Advice to Others
	Resolving Conflicts and Negotiating with Others
	Selling or Influencing Others
Physical Interactions	Handling and Moving Objects
	Operating Vehicles, Mechanized Devices, or Equipment

[22] *The categories used in this report differ to those used by O*NET.*

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