Capturing Indonesia’s automation potential

Prospera and AlphaBeta Advisors

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Executive Summary

Automation is transforming the nature of work in Indonesia. Since 2000, machines have eliminated around 5.5 hours of repetitive and menial tasks from the average Indonesian working week, boosting economic productivity and enabling people to spend their time on more productive and rewarding tasks.

While Indonesian firms have been slower to automate than their global peers, almost three in 10 are now investing in technology like car assembly robots, agricultural tractors, and advanced point-of-sale systems. The Government’s Industry 4.0 strategy aims to accelerate this by incentivising technological investment and establishing a foundation of digital infrastructure and skills.

These automation efforts this century have produced real, tangible benefits for Indonesians, businesses and the economy. Automation accounted for almost one-quarter of Indonesia’s GDP growth between 2000 and 2015. Workers who were able to adapt to higher value, more complex tasks saw their incomes grow almost twice as quickly over the period as those whose work didn’t automate.

But there is more to be done. Indonesia’s labour force growth rate is slowing, which means that it will need to rely more heavily on productivity gains – like those that automation provides – to achieve its strong growth targets. Despite this, Indonesia’s rate of automation adoption lags that of its regional peers in the Philippines, Vietnam, Cambodia and Malaysia.

If Indonesia accelerates the pace of automation, to match that of ASEAN’s leading adopters, automation would add 2.1 percentage points to GDP growth on average every year until 2030. Growth would be 0.7 percentage points faster on average over the 11-year period than if Indonesia continued to automate at the current rate. By 2030, automation would lift average annual per capita income by almost Rp17 million or US$1210 (at current exchange rates). That is about Rp6 million or US$440 more than under the current rate of automation.

The stronger path of GDP growth would provide a significant contribution to Indonesia’s regional competitiveness as well as increasing prosperity at home.

But investing in automation is not enough. If workers are unable to adapt to automation, for example by becoming underemployed or unemployed as machines take over more of their tasks, these economic benefits could be lost. To date, the dividends of automation have not been evenly distributed, with older and low-skill workers not experiencing the same income growth as their tasks change. These workers are at risk of being left behind in the automation age.

Automation will only deliver additional jobs, higher value exports and quality work if Indonesian policymakers create the necessary enabling environment, and provide the right support for those impacted by the changing nature of work. The experience of other countries and an in-depth analysis of the Indonesian business environment highlights three interrelated policy areas that are critical to reaping the full benefits of automation:

- **Supporting businesses**: Building the enabling environment for automation by removing trade and investment restrictions, simplifying tax incentives, and establishing a regulatory approach for new, digital businesses.
- **Supporting workers**: Equipping the workforce with skills needed for automation by stimulating private sector investment in Indonesia’s technical and vocational education and training (TVET) sector, reforming labour laws, and engaging businesses.
- **Ensuring inclusion**: Supporting all Indonesians to participate in growth by helping women into technology industries; reviewing fiscal distribution and social protection policies; and engaging trade unions and other stakeholders in labour market reforms.
1 Automation is already transforming how Indonesians work

Automation, or the adoption of new technologies to take over some forms of labour, is changing the nature of work in Indonesia. At the same time, it is creating opportunities for growth and increased prosperity. Automation has supported productivity growth for firms and has reduced the need for workers to complete repetitive and routine tasks. This has created the potential for more time to be spent using technology, working with people, or exercising creative, problem solving and other uniquely human skills. Between 2000 and 2015, automation changed how the average Indonesian worker spends around 5.5 hours of their working week. This chapter explores how that happened and what it means for different types of workers and businesses.

1.1 The Indonesian economy is becoming more automated

Indonesia’s economic growth in the 21st century has been supported by investments from businesses to increase their levels of automation. In 2015, almost three in 10 Indonesian firms invested in automation technology to improve their productivity by delegating repetitive or routine tasks to machines.¹

Box 1: What is automation?

Automation is the adoption of new technologies to take over some forms of labour. Automation takes different forms across a large and complex economy such as Indonesia. Car manufacturers may use robots to perform physical tasks like lifting, painting and assembly. Retail stores may use software to monitor stock levels and make better purchasing decisions. While automation has recently become intertwined with artificial intelligence in public debates, it represents a much wider range of investments in software, machinery and equipment that firms make to replace existing types of work.

While the concept of automation is relatively simple, the variation of how it works in the real world makes it complex to measure. Companies respond to the incentives to automate in their own unique economic contexts. A country with a high underlying level of automation might have relatively few companies investing in automation in a given year relative to another country that is attempting to catch up. There is also no universal measure of uptake of automation. This report relies on a measure of new investments in automation as it is this growth in automation in an economy that drives growth in labour productivity.

Exhibit 1 sets out how automation can benefit workers, firms and the economy by improving productivity, boosting economic growth and improving the nature of tasks completed by workers.

Exhibit 1: Automation creates productivity gains for the Indonesian economy

1.2 Automation is changing the tasks performed by Indonesian workers

1.2.1 Jobs involve a mix of routine and non-routine tasks, and routine tasks are more readily automated

Jobs can be broken down into the specific tasks they involve. A customer service centre worker, for example, may be responsible for tasks such as answering calls, data entry and dispute resolution. A retail store worker’s tasks may include restocking shelves, cash handling, and helping customers.

Because some of these tasks are more readily automated than others, automation affects each job differently. Some fruit harvesters, for example, may be displaced by automated harvesting machines capable of performing most of the tasks in their jobs. Other farming jobs may be less affected; a highly skilled farmer who uses a tractor to prepare a field for sowing may still be needed to complete tasks like deciding when and where to plant, equipment maintenance, and record keeping.

Exhibit 2 shows how jobs may be analysed according to the types of tasks they involve, to understand how automation is changing the nature of work in Indonesia. Tasks are grouped into five main categories:

- **Routine physical.** These tasks involve repetitive and predictable physical work, for example a farmer sowing seeds across their fields.
- **Routine interpersonal.** These tasks involve predictable interactions with other people, for example a call centre worker reading a sales script.
- **Non-routine physical.** These tasks involve physical work that is not repetitive or predictable, for example a mechanic diagnosing and repairing problems with a car engine.
- **Non-routine interpersonal.** These tasks involve complex or creative interactions with other people, for example a carer bathing and feeding an elderly person.
- **Technological.** These are tasks that predominantly involve computers or other technological equipment, for example data entry and analysis.

Exhibit 2: The impact of automation is best understood by breaking the economy down into task groups

<table>
<thead>
<tr>
<th>Examples of occupations</th>
<th>Task group</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture workers</td>
<td>Routine physical</td>
<td>Repetitive and predictable physical work</td>
</tr>
<tr>
<td></td>
<td>Routine interpersonal</td>
<td>Predictable interactions with other people</td>
</tr>
<tr>
<td>Sales workers</td>
<td>Non-routine physical</td>
<td>Physical work that is not repetitive or predictable</td>
</tr>
<tr>
<td></td>
<td>Non-routine interpersonal</td>
<td>Complex or creative interactions with other people</td>
</tr>
<tr>
<td>Production labourers</td>
<td>Technological</td>
<td>Work predominantly involving machines</td>
</tr>
</tbody>
</table>

Source: Indonesian Family Life Survey (IFLS), AlphaBeta analysis
Routine physical and routine interpersonal tasks are more likely to be automated in the near term. They involve work that is repetitive and predictable, which makes them easier for machines to take on. This work is often less desirable for humans because it is dull or even dangerous. These tasks are referred to as “automatable tasks” throughout this report.

Non-routine physical and interpersonal tasks may be subject to some automation but this is less likely to occur in the near term in Indonesia, given the development of technology and the higher cost of automating these more complex tasks. Humans have an advantage in these types of creative, interpersonal or complex work.

Within the technological task group, advanced automation technologies like artificial intelligence may replace some basic IT functions. However, this effect will be far outweighed in the near term by the increase in IT work due to structural shifts in the Indonesian economy and the automation of routine tasks. Automation is also likely to create new, more complex technological tasks for Indonesians by introducing new sales channels, new data to be analysed, or new machines to be maintained.

Box 2: Why is task analysis useful?

This research looks at how automation changes the type of tasks that workers perform in the economy. This is useful because it allows us to understand the net impact of automation across the economy.

Automation involves the adoption of new technologies to replace some forms of labour. This can result in changes to what jobs we do. That is, it can mean that some workers change jobs once their old forms of work become more automated. Previous studies on the future of work in Indonesia have looked at the impact of automation by assessing how workers will move between jobs and industries. This has often involved using American or international data on how susceptible different jobs are to automation.

However, automation also changes how we do our jobs. New technologies can complement existing workers and allow them to take on more complex work or increase how much they are able to produce per week. In fact, our analysis suggests that the majority of the change that automation has brought to Indonesian work this century has been within jobs. To capture the impact of these changes, we need to look deeper than changes to jobs and industries and examine changes to the nature of work done within jobs. Task analysis enables us to do this and so captures the full impact of automation.

1.2.2 Indonesian workers have automated almost 16% of their tasks in the past 15 years

To understand how automation is already changing the tasks that Indonesians perform at work, this report analysed data from the longitudinal Indonesian Family Life Survey to examine how people from across the Indonesian economy – farmers, teachers, taxi drivers and textile workers – have been spending their work hours in the 15 years since 2000. The analysis considered workers across 80 occupations in nine broad sectors.

The analysis found a substantial shift in the types of tasks performed during that period: by 2015, Indonesian workers spent 16% less of their time – or 5.5 hours less per week – on routine and physical tasks (Exhibit 3). Instead, those hours were reallocated to more complex tasks requiring creative, interpersonal and technological skills.

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3 Further details on the data and methodology are provided in the Appendix.
Exhibit 3: Indonesian workers are spending more time on more complex tasks

<table>
<thead>
<tr>
<th>Change in types of tasks performed by Indonesian workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average share of time spent on task group, %</td>
</tr>
<tr>
<td>Non-routine physical</td>
</tr>
<tr>
<td>Non-routine interpersonal</td>
</tr>
<tr>
<td>Technological</td>
</tr>
<tr>
<td>Routine physical</td>
</tr>
<tr>
<td>Routine interpersonal</td>
</tr>
<tr>
<td>2000</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>47</td>
</tr>
<tr>
<td>42</td>
</tr>
</tbody>
</table>

IFLS, National Labour Force Survey (SAKERNAS), AlphaBeta analysis

In the year 2000, automatable work such as a farmer tilling her field, a textiles worker sewing a dress or an office assistant drafting written records took up 31 hours (89%) of a typical 35 hour work week. The share of such work declined to 25.5 hours per week, or 73%, by 2015.

These work hours have been reallocated to technological work and non-routine physical, interpersonal tasks. In 2000, these complex tasks comprised only 4 hours (11%) of the typical Indonesian work week. This rose to 9.5 hours (27%) by 2015. For an individual worker, this may mean that they are able to spend more time maintaining machinery, talking to customers, or emailing with suppliers.

1.2.3 Task change has been relatively consistent across occupations and key cohorts of workers

The shift in time worked from automatable tasks to more complex tasks from 2000 to 2015 was relatively consistent across major occupation groups (Exhibit 4).

- **Agricultural workers** (26% of the Indonesian workforce) spent 6 hours less per week on routine physical tasks such as tilling fields and instead used that time on farm planning and supplier liaison.
- **Sales workers** (22% of the workforce) delegated 4 hours per week of their most mundane work to new point-of-sale and retail technology, allowing them to spend more time using interpersonal skills to meet consumer needs.

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4 Time changes throughout this report are based on a 35 hour work week for simplicity and ease of comparison. Actual average hours varied between occupations and industries throughout this period. At the economy level, the average hours worked per week were between 38 and 39.

5 Measured as a share of total hours worked in 2014 using data from SAKERNAS.
• **Production labourers** (32% of the workforce) reallocated 3 hours per week that were previously spent on manual labour to more complex production tasks such as operating and maintaining advanced machinery.

Exhibit 4: The shift of hours towards less automatable work is consistent across major occupation groups

<table>
<thead>
<tr>
<th>Major occupation group</th>
<th>Task composition of work</th>
<th>Change from 2000 to 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Full-time hours per week</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Automatable</td>
<td>More complex</td>
</tr>
<tr>
<td>Agricultural workers</td>
<td>2000 34 1</td>
<td>2015 28 7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sales workers</td>
<td>2000 31 4</td>
<td>2015 27 8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production labourers</td>
<td>2000 28 7</td>
<td>2015 25 10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: IFLS, SAKERNAS, AlphaBeta analysis

Note: This analysis assumes a full-time work week of 35 hours for simplicity. Figures are rounded to the nearest hour. Automatable tasks comprise routine physical and routine interpersonal work while more complex tasks comprise non-routine physical, non-routine interpersonal and technological work.

Automation affected the tasks performed by men and women similarly, both shifting around 16% of their time that was previously spent on routine work to more complex tasks in the 15 years to 2015. By that year, men and women alike spent around 10% of the working week on each of non-routine physical and interpersonal tasks and 7% on technological work. This is shown in Exhibit 5.

Workers in Indonesia’s informal sector – including shop keepers, domestic workers and smallholder farmers who together comprise more than 60% of the nation’s workforce – were impacted slightly more by automation than those in the formal sector. In 2000, informal workers spent 93% of their working hours on automatable tasks, and the remaining 7% on more complex physical and interpersonal tasks. By 2015, informal workers were spending 22% of the work week on more complex tasks, with a steep decline on the amount of time spent on routine physical tasks (from 57% of their time to 42%).

For comparison, workers in banking, government, retail, education and other formal economy jobs spent about 31% of the week on more complex tasks in 2015, up from 18% in 2000. Informal workers are beginning to catch up to formal workers as their work increasingly automates. This may reflect a structural shift that is moving workers from agriculture to industry and services, and the rise of gig economy jobs through platforms such as Go-Jek and Grab.
Exhibit 5: The trend towards more complex tasks is consistent for men and women and informal and formal workers

**Change in types of tasks performed, by gender and informality of work**

<table>
<thead>
<tr>
<th>Task Type</th>
<th>Formal</th>
<th>Informal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-routine physical</td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td>2000</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>2015</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Non-routine interpersonal</td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td>2000</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>2015</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Routine physical</td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td>2000</td>
<td>51</td>
<td>48</td>
</tr>
<tr>
<td>2015</td>
<td>38</td>
<td>37</td>
</tr>
<tr>
<td>Routine interpersonal</td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td>2000</td>
<td>36</td>
<td>42</td>
</tr>
<tr>
<td>2015</td>
<td>36</td>
<td>37</td>
</tr>
</tbody>
</table>

Source: IFLS, SAKERNAS, AlphaBeta analysis

1.3 **Automation is improving business productivity and worker incomes**

1.3.1 **Automation is helping businesses and the economy grow**

Automation is a key part of Indonesia’s Industry 4.0 strategy and related plans to sustain strong economic growth. As previously described in Exhibit 1, it changes the nature of work and so creates opportunities for growth for firms, workers and the economy. Indonesian businesses invest in automation because it improves their productivity. Exhibit 6 shows that automation improved Indonesia’s output per hour worked by around Rp9500 from 2000 to 2015. This contribution represented 42% of the total increase in labour productivity over this period.

The other 58% of labour productivity growth, or around Rp13000 per hour worked, came from causes other than automation. Some of these causes are firm specific, such as the efficiency of operational processes, the effectiveness of management decisions, and workplace morale. Other sources of labour productivity growth are based on economy-wide factors such as the level of education and skills in the workforce and investment in enabling infrastructure such as roads and telecommunications.

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Exhibit 6: Automation contributed 42% of labour productivity growth 2000-2015

2015 labour productivity by source

<table>
<thead>
<tr>
<th>Real output per hour, 2019 '000 IDR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000 GDP per hour worked</td>
</tr>
<tr>
<td>35.4</td>
</tr>
</tbody>
</table>

% of growth: 42% - Growth due to automation; 58% - Other productivity growth

Source: IFLS, Statistics Indonesia (BPS), SAKERNAS, World Bank Enterprise Surveys, AlphaBeta analysis

Businesses that successfully harnessed this productivity growth were able to grow in size, increase profits, or introduce new products and services. Some manufacturing companies such as Astra Daihatsu have introduced advanced automation of assembly lines, freeing up labour for more complex tasks such as quality assurance and resources for new products such as small low cost cars (see case study). Larger mining firms are increasingly introducing automation technologies to make extraction more efficient and reduce the need for workers to operate in hazardous environments.

Meanwhile, Indonesia is also seeing the growth of a range of online services companies – including the “unicorn” startups Traveloka, Tokopedia, Bukalapak and Go-Jek – that rely on automation of communications, commerce and analysis. Go-Jek and Tokopedia have a particular focus on connecting micro, small and medium enterprises to new markets. This speaks to the potential of automation to stimulate inclusive growth, especially given the predominance of SMEs in Indonesia.

Case Study 1: Astra Daihatsu uses automation to increase scale and capacity for innovation

Indonesian companies that invest in automation gain opportunities to increase market share and become more profitable. For Astra Daihatsu Motor (ADM), opening a state-of-the-art Karawang production plant in 2013 has more than doubled its production capacity and boosted sales, employment and R&D.

ADM is a large Indonesian automotive firm and the local production base for Daihatsu and Toyota. It has production facilities in Sunter (North Jakarta) and Karawang (West Java). The Karawang production plant was intended to increase ADM’s production capacity and its offerings in the Indonesian market. It is one of Indonesia’s leaders in automation within the automotive industry with robots taking on many repetitive tasks such as pressing and welding. With the Karawang plant, ADM produced around 550,000 cars in 2018.

The new scale supported by automation has allowed ADM to invest in R&D. The R&D facility at its Karawang plant has produced ADM’s second low-cost “green” car model in response to government incentives. Marketed as the Astra Daihatsu Sigra and Astra Toyota Calya, the car is proving popular with Indonesia’s burgeoning middle class and supporting ongoing growth for ADM.

ADM’s growth has also supported many new jobs in the Indonesian economy. Hundreds of thousands of workers participate in the production of ADM vehicles either directly or through suppliers. ADM management expects that its workforce will continue to expand and is taking steps to improve its talent pool through partnerships with vocational high schools and other means.
Productivity improvements at the firm level lead to GDP growth across the economy. Automation contributed around 24% of Indonesia’s GDP growth from 2000 to 2015, equivalent to Rp1700 trillion (Exhibit 7). The remainder was derived from other sources of productivity growth, such as skills and operational improvements, and labour force growth – that is, a net increase in the number of people in the workforce, leading to more hours being worked. Automation has been an important driver of Indonesia’s competitive economic performance so far this century.

Exhibit 7: Automation contributed 24% of GDP growth 2000-2015

1.3.2 Automation increases prosperity for workers who are able to adapt

Automation of the Indonesian economy has also benefitted some Indonesian workers. Those workers who have remained in employment and replace some dull or dangerous tasks with more complex work have experienced higher pay growth. Exhibit 8 compares the income growth of workers who experienced an increase in non-automatable tasks with that of workers who did not.

The incomes of workers whose jobs were unaffected by automation grew by 4% per year in the seven years to 2014. The incomes of workers whose tasks changed as they adapted to automation grew almost twice as quickly (7% per year). The implication is significant: workers who can convert automation into an opportunity to take on hours of more complex tasks appear to increase wages earned.

Task change from automation also appears to increase incomes of informal workers, relative to those whose work was not automated. This is a positive sign as it implies that the benefits of automation are felt not only by formal workers but also workers in the informal economy, who typically struggle with access to finance and are excluded from protections under the labour law.

Of course, not all workers will be able to make this transition on their own, and some may experience unemployment or underemployment as a result of automation. Some may also benefit less than others; automation leads to faster income growth on the whole but the gains may not be evenly distributed (Chapter 4). It is important that skills policy and other measures are used to maximise the ability of workers to increase the value of their labour through automation, and ensure that the gains to workers outweigh the costs of displacement.
Exhibit 8: Workers whose tasks are changing through automation are experiencing faster income growth

**Median annual growth in real income overall and for informal workers**

2007 to 2014, %

<table>
<thead>
<tr>
<th></th>
<th>No task change due to automation</th>
<th>Task change due to automation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All workers</strong></td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td><strong>Informal workers</strong></td>
<td>4</td>
<td>6</td>
</tr>
</tbody>
</table>

Source: IFLS, OECD, AlphaBeta analysis

Note: Informality is measured using the BPS Proxy 1 definition.

**Case Study 2: Automation has helped Go-Jek grow**

Automation can help businesses access new markets and create new jobs. This has been the experience of Go-Jek, which has grown into one of Indonesia’s massive “unicorn” startups through a model that uses automation to bring new opportunity to vulnerable workers in the services sector.

Go-Jek started in 2010 as an enterprise with a simple mission: to connect ojek drivers to customers needing ad hoc transport and delivery services. The firm acted as an intermediary to match drivers with customers, share demand information with drivers to inform their business decisions, and vouch for the safety of the parties involved.

This business model started with a relatively low level of automation. Customer service workers took phone requests from customers and then called driver after driver until they found someone available for each job. This process took an average of 20 minutes per job. Demand was so great that within a few years, there were 80 workers providing this critical matching service.

It was ultimately customer experience that prompted Go-Jek to automate. In 2015, Go-Jek introduced an app that brought matching times down from 20 minutes to under two seconds per job. This paved the way for the company’s ongoing success in an economy with increasing expectations of real-time, on-demand service.

The transition to an automated services platform supported rapid expansion in the volume and variety of services offered through Go-Jek. The platform now supports 2.5 million workers, including ojek drivers and other providers offering services from food to massage and home maintenance. As a gig economy platform, it offers flexible and accessible work that supports new workforce entrants, with around three quarters of these workers not previously employed. It also provides banking, insurance, and other protections that are often not available for informal workers.

While there is no longer a need for workers to call drivers and offer them jobs, Go-Jek’s expansion has led its customer service team to grow to 800 staff. These workers focus on managing complaints and working with customers and service providers to ensure that their needs are met – complex, creative and interpersonal work that humans excel at.
2 Indonesia is not capturing the full potential of automation

Automation is already happening in the Indonesian economy, and with substantial effect: it was responsible for almost one quarter of GDP growth from 2000 to 2015. However, Indonesia is underinvesting in this important driver of growth and is not capturing its full potential. Indonesian firms are not adopting automation technologies at the same rate as their peers. Increasing the rate of automation of Indonesia’s businesses could add around 0.7 percentage points to GDP growth every year until 2030. This chapter compares Indonesia’s update of automation with peers and describes the economic opportunity from accelerating automation.

2.1 Indonesia’s uptake of automation is lower than ASEAN peers

International comparisons suggest that Indonesia has more to gain from automation. In 2015, 28% of Indonesian companies reported that they were automating manual processes. This rate is below that of Indonesia’s regional peers, including Vietnam, Cambodia and Malaysia, where about 35% of companies invested in automation that year (Exhibit 9). The disparity is even greater with India and Bangladesh where around half of all companies increased their use of automation.

Exhibit 9: Indonesia has a low to moderate rate of automation relative to regional peers

<table>
<thead>
<tr>
<th>Automation and technology uptake in select ASEAN and other countries</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>% of surveyed firms reporting automation of manual processes or uptake of technology, c. 2015</td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>52</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>49</td>
</tr>
<tr>
<td>Philippines</td>
<td>41</td>
</tr>
<tr>
<td>Vietnam</td>
<td>36</td>
</tr>
<tr>
<td>Cambodia</td>
<td>35</td>
</tr>
<tr>
<td>Malaysia</td>
<td>34</td>
</tr>
<tr>
<td>Indonesia</td>
<td>28</td>
</tr>
<tr>
<td>Lao PDR</td>
<td>28</td>
</tr>
</tbody>
</table>

Source: World Bank Enterprise Surveys, AlphaBeta analysis

Note: Survey covered manufacturing and services firms. Thailand has been removed due to sample issues distorting data. Some countries’ results have been rescaled to address apparent differences in understanding of innovation. Some countries conducted the survey in years surrounding 2015.

Other measures of automation, such as comparisons of machinery imports and consumption relative to gross value added (GVA) by sector as well as stakeholder feedback, paint a similar picture. These sources consistently indicate that Indonesia has a low to moderate uptake of automation relative to its peers, and that more could be done to support Indonesian businesses to increase their utilisation of automation technology.
Industry stakeholders say there are significant barriers to automation that may be hindering greater adoption, including:

- **Limited access to finance and skills**: There is a general constraint on financial capital and technological skills in Indonesia, both of which are critical to enable automation; this constraint is particularly marked for smaller businesses.

- **Restrictions on foreign investment and labour**: These regulations constrain access to the finance, skills and technology needed to advance local R&D capability and reap the benefits of automation within Indonesia.

- **Social pressure to preserve existing jobs**: Businesses face substantial social and political pressure to preserve jobs. This disincentivises automation even where it could increase competitiveness and growth and ultimately create new employment.

- **Complex tax incentives**: It is difficult for firms to navigate overlapping tax incentives for training, sector development and mechanisation. The complexity of these incentives may also dampen the impact of new policy measures to support Industry 4.0.

- **Legal and administrative concerns**: Businesses seeking to automate face a range of business concerns including assurance of property rights, enforcement of contracts, confidence in the tax system and the ability to efficiently register, operate and dissolve companies. The labour law makes it difficult and expensive to make workforce changes to adjust to automation.

Some of the difference in automation uptake between countries is likely due to company characteristics. Indonesia has a small number of large, globalised firms, and a large number of smaller, informal businesses with relatively little participation in global trade. Exhibit 10 examines levels of automation in companies of varying sizes and trade orientation.

Smaller firms are less likely to engage in automation in Indonesia. Only 26% of small firms reported investing in automation technology in 2015 compared to 61% of large firms. Small businesses may lack the scale to justify expensive investments in automation and find barriers to automation such as access to skills and finance to be particularly acute.7

Trade orientation also influences the decision to automate. More globalised companies may be pushed to automate by international competition or influence from global corporate headquarters. They may also find it easier to overcome barriers to automation due to their scale, business models, and connection to international networks. In 2015, 45% of Indonesian companies participating in global value chains invested in automation compared to 28% across the board.

2.2 Accelerating automation could significantly increase GDP growth

Indonesia’s economic performance has long been underpinned by strong population growth providing new workers into the labour force. However, the growth of Indonesia’s labour force is forecast to moderate over the next decade. It will contribute a shrinking share of GDP growth, which will need to be replaced if Indonesia wants to meet its growth targets. Automation can support GDP growth in Indonesia by lifting productivity growth.

If Indonesian companies continue to automate at the current pace, automation would add 1.4 percentage points to GDP growth on average between 2019 and 2030, contributing a total of Rp3200 trillion (Exhibit 11). This assumes that labour can be effectively reallocated. It represents around 30% of all GDP growth over the 11-year period (alongside labour force growth and other sources of productivity growth such as education) and raises average annual per capita income by Rp10.8 million in real terms by 2030.

If Indonesia can increase automation, it can accelerate GDP growth. The second scenario in Exhibit 11 assumes that Indonesia matches the automation rate of ASEAN leaders in each major sector of the economy (see Appendix for detailed methodology). Under these conditions, automation would add 2.1 percentage points to annual GDP growth on average over the next 11 years. Around Rp1800 trillion extra would be added to GDP in 2030 compared with the first scenario, for a total contribution of Rp5000 trillion. Average annual per capita income would be Rp16.9 million higher in real terms in 2030. That is Rp6.1 million more than if automation continues at its current pace.

The stronger path of GDP growth would provide a significant contribution to Indonesia’s regional competitiveness as well as increasing prosperity at home.

This forecast of the uplift in GDP growth from accelerating automation is conservative because it only estimates the gains to labour productivity from automation directly, and the contribution of other productivity growth to GDP is held constant. In fact, the investments in education and skills needed to increase the uptake of automation technology would likely lead to stronger productivity growth from other sources, generating further benefits for Indonesia.
Exhibit 11: Accelerating automation could significantly increase the GDP growth rate

<table>
<thead>
<tr>
<th>2030 GDP under current and accelerated automation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real 2019 IDR '000 trillions</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Current uptake of automation</th>
<th>Accelerated uptake of automation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019 GDP</td>
<td>16.0</td>
<td>16.0</td>
</tr>
<tr>
<td>Labour force growth</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Other productivity growth</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Growth due to automation</td>
<td>3.2</td>
<td>5.0</td>
</tr>
<tr>
<td>GDP growth rate 2019-2030 % p.a.</td>
<td>4.9%</td>
<td>5.5%</td>
</tr>
</tbody>
</table>

Source: IFLS, BPS, SAKERNAS, World Bank Enterprise Surveys, AlphaBeta analysis
3 Automation can only generate economic benefits if workers are able to transition

Productivity growth due to automation relies on technology increasing the output of workers by freeing up hours in the day. However, it is not enough to simply adopt automation technologies. The benefit of automation comes when workers successfully reallocate their time into new types of tasks. This relies on workers having the skills to take on alternative tasks, and business and government providing the necessary transition pathways. As this chapter shows, Indonesia will not achieve an economic return from its investment in automation unless transition is effective.

3.1 Reaping the benefits of automation requires reallocation of time savings

In theory, automation benefits the economy by allowing workers to complete their tasks more quickly, freeing up time for additional work. However, this outcome is not guaranteed – if workers lose a substantial number of hours due to automation and are not able to find new hours of work, they may experience job losses. These workers may be able to move to new roles and different sectors of the economy where demand is growing, but this transition can be challenging. There is a risk that some vulnerable or older workers may struggle to find new work and may enter unemployment.

Another less discussed risk from automation is underemployment, which refers to workers who gain hours in the week due to automation but see a decline in productive hours worked. It could occur where:

- Average weekly hours worked decrease. The labour productivity of a worker improves but their hours decline in proportion. They achieve more per hour but overall output is the same and wages decline.
- Average weekly hours are the same, but productive hours decline. A worker is paid for the same hours but does not use the time freed up by automation for productive work. They achieve the same average amount per hour worked and overall output is the same.

In both scenarios, output per worker remains the same and there is a missed opportunity to increase productive capacity using the hours saved by automation.

3.2 If labour is not reallocated, there will be an economic cost

If hours saved are not reallocated, then Indonesia’s Rp3200 trillion economic opportunity from automation could be lost. Automation has the potential to increase GDP by improving the economic output that people can achieve for each hour they work. If people end up working fewer hours in total, there is no overall benefit to GDP. This is demonstrated in Exhibit 12, which compares the GDP outcomes of the scenario in which the current rate of automation continues and all hours are reallocated (top), to a scenario based on the same rate of automation but in which the time savings are wasted (bottom).
Exhibit 12: Failure to reallocate labour offsets the GDP impact of time savings due to automation

2030 GDP under full and no reallocation of labour

<table>
<thead>
<tr>
<th></th>
<th>Real 2019 IDR ‘000 trillions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Full reallocation</strong></td>
<td></td>
</tr>
<tr>
<td>2019 GDP</td>
<td>16.0</td>
</tr>
<tr>
<td>Hours gained due to labour</td>
<td>5.0</td>
</tr>
<tr>
<td>market entry</td>
<td>3.0</td>
</tr>
<tr>
<td>Other productivity growth</td>
<td>2.6</td>
</tr>
<tr>
<td>Productivity growth from time</td>
<td>0.0</td>
</tr>
<tr>
<td>savings</td>
<td>0.5</td>
</tr>
<tr>
<td>2030 GDP</td>
<td>27.1</td>
</tr>
<tr>
<td>GDP growth rate 2019-2030</td>
<td>4.9%</td>
</tr>
<tr>
<td><strong>No reallocation</strong></td>
<td></td>
</tr>
<tr>
<td>2019 GDP</td>
<td>16.0</td>
</tr>
<tr>
<td>Hours gained due to labour</td>
<td>5.0</td>
</tr>
<tr>
<td>market entry</td>
<td>3.0</td>
</tr>
<tr>
<td>Other productivity growth</td>
<td>2.6</td>
</tr>
<tr>
<td>Productivity growth from time</td>
<td>2.6</td>
</tr>
<tr>
<td>savings</td>
<td>0.0</td>
</tr>
<tr>
<td>Hours lost due to failure to</td>
<td></td>
</tr>
<tr>
<td>reallocate</td>
<td></td>
</tr>
<tr>
<td>Productivity growth from higher</td>
<td></td>
</tr>
<tr>
<td>value work</td>
<td></td>
</tr>
<tr>
<td>2030 GDP</td>
<td>24.0</td>
</tr>
<tr>
<td>GDP growth rate 2019-2030</td>
<td>3.7%</td>
</tr>
</tbody>
</table>

Source: IFLS, BPS, SAKERNAS, World Bank Enterprise Surveys, AlphaBeta analysis

Note: Productivity gains due to automation are derived from hours of work saved and the potential to reallocate these hours to higher value work. This assumes that time savings are reinvested into activities that generate ~20% more per hour than automated activities. Numbers may not add due to rounding.

Under the full reallocation scenario, automation improves labour productivity, delivering Rp2600 trillion increase in GDP from time savings. In this outcome, these hours are reallocated to high-quality work comprising more complex tasks such as non-routine and technological work. Such work is estimated to be worth 20% more than automatable work (see Appendix) and the combined effect of full reallocation and higher value work creates the Rp3200 trillion opportunity and lifts the average GDP growth rate to 4.9%.

In the no reallocation scenario, time saved from automation still increases the value of labour productivity by Rp2600 trillion by 2030. However, there is an equivalent GDP decline due to lost productive hours per capita. These lost hours could occur through some combination of unemployment and underemployment as described above. All of the hours saved by automation drop out of the economy and do not contribute to greater production, and GDP growth falls by 1.2 percentage points (to 3.7%).

These scenarios show that the effect of automation on Indonesia’s GDP will depend substantially on how effectively the nation is able to reallocate labour. They demonstrate the policy opportunity to maximise automation’s return on investment: full labour reallocation would lead to a 2030 GDP that is around Rp3200 trillion (13%) higher than in the no reallocation scenario.

Investing in automation is not enough in and of itself. Rather, productivity growth through automation relies on lifting both firms and workers. Workers need the structural, regulatory and skills support to transition to new work for their own and the economy’s benefit.
3.3 Indonesia’s skills system is not prepared for this challenge

Indonesia’s skills system has been slow to respond to the demands of an expanding and automating economy. The system is leaving workers without the skills required to adapt to the type of complex, interpersonal and technological work that will take up an increasing proportion of their time. Unless this challenge is addressed, it is likely that labour saved by automation will not be optimally reallocated and that Indonesia will miss out on the full return from its automation investments.

Industry stakeholders report a mismatch between the breadth and quality of skills that they need and the skills pipeline from vocational and other educational institutions. Indonesia has increased its education investment over the past decade. However, government spending on education is still relatively low in per capita terms and there has not been a significant improvement in outcomes.

Indonesia devotes a similar proportion of its budget to education as peers such as Vietnam and Malaysia but has achieved worse educational outcomes in core subjects such as maths (Exhibit 13). Meanwhile, there is a sense among stakeholders that the Government has focussed on controlling skills supply rather than preparing the skills system to respond quickly to demand. This generates a structural inflexibility that hinders the suitability of graduates for positions available.

Exhibit 13: Indonesia devotes a similar budget proportion to education as ASEAN peers but with worse outcomes

Beyond the education sector, on-the-job training is relatively rare in Indonesia. For example, only around 8% of firms offer formal training programs for their staff. Many firms are reluctant to invest in training staff because of poor awareness of the benefits of vocational education and because the labour law discourages the appointment of permanent staff. The resulting casualisation and high turnover rates limit investment in professional development and learning. Anecdotal evidence suggests that only larger firms are delivering in-house and on-the-job training to address skills gaps.

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8 World Bank Enterprise Survey, 2015
4 The benefits of automation may not be evenly distributed

Automation creates an opportunity for workers to shift their labour up into more complex and more valuable tasks. However, not all workers are equally able to capitalise on this opportunity for growth. Some workers may exit employment, or shuttle from work that has been automated into other low quality work. This chapter focuses on the latter group of workers who experience worse outcomes from automation. These workers tend to be more vulnerable in general, for example because they are low-skilled, older or in the informal economy. Without policy intervention, automation could exacerbate existing inequality by leaving these cohorts behind.

4.1 Some cohorts of workers are experiencing stronger income growth from automation than others

While automation drives faster income growth across the Indonesian economy (see section 1.3.2), this benefit may not be evenly distributed across workers experiencing its effects. Exhibit 14 shows how automation’s effect on incomes changes depending on workers’ characteristics. Gender and job formality made little to no difference to individuals’ ability to benefit from automation on average. However, age and skill levels were strong predictors: low-skilled and older workers experienced lower rates of income growth than their peers.

Exhibit 14: Low skilled and older workers experience lower income growth related to automation

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Low skilled workers</th>
<th>Medium skilled workers</th>
<th>High skilled workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men Formal</td>
<td>7</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Women Formal</td>
<td>6</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Informal</td>
<td>1</td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>

Source: IFLS, OECD, AlphaBeta analysis
Note: High skilled workers comprise those with a Bachelors degree or Diploma; medium skilled those who have completed junior or senior high school; and low skilled those with an elementary school or adult education. Informality measured using BPS Proxy 1 definition.

Exhibit 15 shows the variable income effect of automation across a range of cohorts. While gender alone did not change income growth, gender in combination with other characteristics appears to have had an impact. Highly skilled women experienced the highest annual income growth (10% per year) of the cohorts examined. Other than these high skilled workers, each female cohort saw lower income growth than their male counterpart. Among those studied, women over the age of 50 were least able to turn automation into an income growth opportunity, with their real incomes declining 4% per year from 2007 to 2014. The variation in gender disparity at different skill levels points to the important role that skills can play in offsetting income disadvantage due to gender.
The distributional differences in income growth are no greater than those for workers not experiencing automation-related task change, but demonstrate that automation by itself will not reduce existing inequality in Indonesia. To ensure that automation’s dividends are well distributed, government and business will need to increase the skills resilience of the workforce and improve the social protection offered to older workers.

Exhibit 15: The income effect of automation varies significantly by cohort of workers

Median annual growth in real income by cohort

For workers experiencing automation-related task change 2007 - 2014, %

Source: IFLS, OECD, AlphaBeta analysis
Note: Bubble size represents size of cohort. High skilled workers comprise those with a Bachelors degree or Diploma; medium skilled those who have completed junior or senior high school; and low skilled those with an elementary school or adult education. Informality measured using BPS Proxy 1 definition.
5 Indonesia can generate inclusive growth from automation by addressing key policy priorities

The economic opportunity presented by automation cannot be taken for granted. Automation will only deliver additional jobs, higher value exports and quality work if Indonesian policymakers create the necessary enabling environment and provide the right support for those impacted by the changing nature of work.

To this end, the Government of Indonesia accurately assesses automation as an opportunity rather than a threat. The Government’s Roadmap for Industry 4.0 sets out the objective of bringing Indonesia into the world’s top ten economies by 2030 by boosting net exports, increasing labour productivity, and investing in technology R&D.9

International experience suggests that there are three major policy levers that can achieve this objective and reap the full benefit of automation (Exhibit 16): creating the enabling environment for automation; developing the workforce skills needed; and supporting workers to participate in growth. Importantly, addressing these areas of policy will require coordination across government, the private sector, and private training providers and community organisations.

Exhibit 16: Policy levers to maximise inclusive growth from automation

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5.1 Supporting business: creating the enabling environment for automation

The uptake of new technology by business is the first step to generating economic growth from automation. As such, Indonesia can increase the benefits of automation by supporting business to make these investments. Other countries have had success in increasing automation uptake by:

- **Reducing trade and investment restrictions.** In Thailand, removing restrictions on overseas investment helped to boost automation in the automotive industry. Thailand is now a leading exporter of cars in the region.\(^\text{10}\) In the past, trade and investment restrictions have been thought to protect the Indonesian workforce and support self-sufficiency. However, in the age of automation and Industry 4.0, they may be having the opposite effect. Indonesia should consider removing import restrictions on used capital goods, foreign investment including local content requirements, and skilled labour migration.

  This policy change would provide business with access to the technology, finance and skills they need to develop Industry 4.0, pursue “on-shoring” of advanced manufacturing, and enable collaboration with firms, universities, investors and policymakers around the world.

- **Supporting new, digital business models.** Singapore is a major exporter of electronics, machinery, pharmaceuticals, refined petroleum and more. This is attributed to its highly open and transparent business environment, few formal market access barriers, and intense competition in the Singaporean market. Singapore is now positioning itself as the digital gateway to Asia with world class IT infrastructure and a relatively open framework for digital investment.\(^\text{11}\)

  Meanwhile, Japan and South Korea have adopted regulation to support digital investment. They have reduced the complexity of rules surrounding businesses that operate online, for example by allowing data offshoring and aligning with international frameworks for data privacy. South Korea has also made direct investments in automation, leading to the highest robot density in the world. These measures combine to attract global investors to contribute to the digital economy in these countries.\(^\text{12}\)

  Indonesia has made significant strides in improving its business climate, including reducing the time that it takes to start and register a business, enhancing business confidence, and measures to reduce corruption. It could add to these reforms to further enable the operation of companies running digital platforms, fintech and the like.

**Case Study 3: TaniHub is enabling Indonesian farmers to improve productivity**

TaniGroup is helping to automate commerce and finance for some 25,000 Indonesian farmers through its ecommerce platform TaniHub and crowdfunding platform TaniFund.

TaniHub connects farmers with consumers, supermarkets, hotels and restaurants seeking fresh produce. It helps farmers forecast demand through analytical tools that estimate price movements for the next several quarters. This helps inform farmers’ planting decisions, boosting revenues by about 60% though increased production, sales volumes and prices.

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TaniHub farmers can also apply for microloans through the TaniFund crowd funding platform, allowing them to access the capital needed for investments in automation and growth. To reduce the risk to lenders, TaniFund loans are issued to small groups of farmers who are encouraged to keep one another accountable in their spending; collaborate on farming practices; and band together to cover unexpected shortfalls from any one farm.

Agriculture is a vital part of Indonesian economy, accounting for three in 10 jobs and more than 13% of GDP in 2017. However, most agricultural production is still small-scale and relatively low-productivity – 93% of all farmers are smallholders with an average farm size of 0.6 hectares. However, if agriculture does not automate and become more productive, then agricultural regions will not share in the benefits of increased wealth and standards of living.

Looking forward, Tanihub sees the potential for increased automation to help Indonesian farmers to overcome challenges of scale, profitability and resilience. For example, increased uptake of indoor farming technology would reduce risk from weather conditions while reducing distribution costs and shrinkage.

5.2 Supporting workers: developing the workforce skills needed for automation

The ability of future workers to adapt to automation by maintaining or increasing the value of their labour could drive economic gains of Rp3200 trillion by 2030. Developing a workforce that is skilled for an automated economy is critical to maximising the return on investments in automation technology.

Indonesia has invested heavily in education and is expanding the capacity of the country’s vocational schools. Nonetheless, an economic shift towards more technological and creative work threatens to add to existing skills gaps. The experience of other countries suggests that there is value in the following reforms, with a particular focus on engagement with industry:

- Delivering higher quality technical and vocational education and training (TVET) through partnerships with business. Malaysia involves industry in developing training curricula and standards. All skill standards and certification are coordinated by the National Vocational Training Council (NVTC) which comprises representatives from government and the private sector. Other initiatives include the SkillsMalaysia campaign to raise interest in TVET among employers and employees and the use of public funding through the Economic Transformation Program to spur quality training through private accredited centres.

The Indonesian Government is taking steps to better engage industry in TVET policy and program design, while leading firms are investing in partnerships with local vocational high schools to meet skills demand and boost training standards (see Case Study 4). Some also provide apprenticeships for students and contribute technical expertise to school- and workplace-based training.

There is scope to build on these existing efforts. Engaging business will be key to addressing Indonesia’s skills challenge as it is fundamentally a problem of matching skills supply with industry demand. The Government can improve the quality and range of industry partnerships and promote on-the-job training, apprenticeships and industry-school programs through subsidies and other incentives. These reforms would offer a significant opportunity to simultaneously tap into industry resources, improve the quality of training and better align training with the needs of industry in a digital economy for technical, analytical and soft skills.

- **Removing investment restrictions on education and training providers.** For example, Vietnam reduced restrictions on the role that foreign providers can play in delivering training. It has seen increased quality of training and an improved supply of the skills that its economy needs. Vietnam is now seeking to further simplify the regulation of education and training providers.\(^{15}\)

Training institutes, universities and private providers from Indonesia and overseas have shown interest in investing in Indonesia’s skills system. However, international TVET providers are currently limited to 49% ownership of Indonesian educational institutions. International universities must operate only on a not-for-profit basis and must prioritise employment of local faculty and staff. Enabling greater private sector investment in education and training, including for overseas organisations, will help to improve quality and access.\(^{16}\)

Such changes would need to be accompanied by oversight and regulation of quality to ensure that new and existing providers were delivering high standards of training. This is particularly important due to information asymmetry in the market for training, where students know less about the quality of the product to be offered than the providers and have little ability to bargain for improvements.

- **Improving coordination and administration of the TVET sector:** The Philippines has a single lead agency for TVET that is mandated to provide relevant, accessible, high quality and efficient technical education and skills development. The private sector provides 80% of university education and TVET. TVET enrolments are higher than countries at similar development levels, particularly for young women.\(^{17}\)

Indonesia has multiple ministries with overlapping mandates for the TVET sector which leads to duplicated processes, wasted resources, limited coordination and variable TVET quality across different regions. There is scope to reduce complexity and harmonise regulations and standards, which will free up resources to focus on quality and student needs and outcomes. Appointing a single Minister for TVET with lead responsibility for the sector may improve coordination and leadership as TVET faces ever increasing demands from business and workers.

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**Case Study 4: Investment in skills is critical for businesses like Toyota to become more automated**

Industry has a key role in ensuring current and future workers have the right skills to succeed in a more automated economy. The partnership between Toyota and Indonesia’s technical and vocational education and training (TVET) system is one example: its Toyota Institute Academy takes outstanding vocational high school (SMK) students from around the country and aims to have 1000 graduates by 2026.

The academy offers free accommodation and tuition to extend access to this opportunity to students from different socioeconomic backgrounds. It combines a standard SMK curriculum with specialised learning in automotive production. Toyota provides equipment and parts used in its manufacturing processes, and brings in current employees to provide technical training and ensure that the academy’s lessons are up to date with

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manufacturing advances. This focus on practical learning helps to provide the capabilities that Toyota needs while also improving students’ outcomes.

The Toyota Institute Academy aims to equip graduates with not only technical specifics, but also soft skills that are necessary in modern production environments throughout Indonesia. Manufacturing firms have reported a shortage of these skills, which are sometimes described as ‘industrial culture’ and include a strong work ethic, teamwork, creative problem solving and resiliency.

Other medium and large firms are making similar investments in TVET. Some run their own training academies while others contribute knowledge and equipment to SMKs in their area. Often, there is a spillover effect where the firms train more graduates than they need as part of their corporate social responsibility efforts. This means that the training programs are able to increase the quality of skills accessible by the sponsor firm as well as other employers in the area.

The Toyota Institute Academy demonstrates several factors that will be important to Indonesia’s development into a more automated economy: the fostering of skills that are difficult to automate but critical to success; industry engagement in the design and implementation of TVET; and the connection of early career education to life-long and on-the-job training.

5.3 Ensuring inclusion: supporting all Indonesians to participate in growth

The benefits of automation are not evenly distributed. Some vulnerable cohorts may experience underemployment or unemployment following automation in their industries. Meanwhile, income growth for workers who adapt to automation varies depending on their characteristics (Exhibit 15). Automation also tends to occur faster in urban and major economic regions.

To fully realise the potential of automation, policymakers must be mindful of the distributional impacts of automation. Policy measures taken in neighbouring countries to ensure that automation leads to inclusive growth include:

- **Supporting female workers.** Female workers are about as likely to experience task change due to automation as male workers. However, women are less likely to participate in the workforce and some cohorts of older or less skilled women may struggle to adapt to this change. The Indonesian Government can support women to be more resilient to automation and to create economic opportunity from the changes that it brings.

As the Indonesian economy becomes more automated, there are likely to be significant opportunities in science, technology, engineering and maths (STEM) occupations. Indonesia has high numbers of female students enrolled in STEM subjects but this has not translated to higher employment in these fields. South Korea has established a research fund for female students in technology related industries and also has programs to provide field experience for women in STEM. Japan has increased the number of positions open to female science and engineering professionals to inspire female students to choose STEM careers.

To improve female participation in the workforce in general, labour market reforms that allow greater flexibility such as part-time work may benefit women with family responsibilities. They would also better reflect the more flexible nature of business models in the automation age.

- **Using automation technology to support workers with disability:** China is using online tools to support increased employment of people with disability. Working with private internet

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companies, China is expanding disability employment services to include TVET, job matching, and other employment consulting support.20

While not the focus of this report, there is evidence that technology will create new opportunities for workers with disability. By taking over some manual tasks, automation may allow workers with disability to fill roles that were not previously accessible to them.

Targeting government support to jobseekers with disability will boost economic participation and take advantage of this opportunity. Measures to achieve this include disability employment programs; early intervention in education to support those with additional learning needs; and incentives for businesses employing people with a disability.

- **Further enhancing Indonesia’s social protection policies:** Even with the above measures, some workers may struggle to transition to new work. Targeted support is likely to be needed for cohorts such as older and low skilled workers. For example, subsidies to education providers can increase training access for disadvantaged and low-skilled groups; temporary unemployment benefits support workers who are transitioning between roles; and new benefits could be introduced for older workers facing redundancy. The Government could also extend the coverage of its healthcare security and employment security programs to informal workers and other vulnerable groups.

### Box 3: Other measures to enhance economic gains from automation

Some other measures that the Indonesian Government could consider to enhance the value of automation to the economy include:

**Supporting automation**

- **Simplifying tax incentives and providing better coordinated government support for automation:** The Government has introduced a Super Tax Deduction to increase the incentive for investment in innovation, R&D, and technical and vocational education and training (TVET). This step reflects the Government’s intent to reduce the cost of automation to business. However, tax incentives alone won’t be enough – Indonesia already has a range of complex tax incentives that are relatively underutilised. These need to be combined with trade and investment reform, better coordinated government support, and consistent messaging that Indonesia is open for business for firms wishing to automate.

  Firms also appreciate policy consistency and certainty. Committing to a freeze on tax incentives would send a strong message that the government is committed to long term stability and business confidence. Tax uncertainty is a significant influence on business decisions, and economic stability is valued above the impact of tax incentives in foreign investors’ decisions; 80% of investors in Thailand and Vietnam report that they would have made their investments even without tax incentives.21

- **Reducing costs for small and medium enterprises (SMEs) so they have the capital to automate:** Indonesia’s private sector is dominated by SMEs which, compared to large firms, are less able to absorb risks and access the capital required to invest in automation. This means that Indonesia’s largest group of employers is less likely to tap the potential of automation to benefit workers and firms alike.

  In addition to subsidising finance for SMEs, the Government could reduce the cost of doing business including regulatory and trade barriers and labour costs. Labour costs such as severance pay and restrictions on outsourcing and part-time work place a particularly heavy burden on SMEs seeking to

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expand and automate. Reducing these costs will significantly enhance the ability of SMEs to access capital and contribute to automation in Indonesia.

Supporting workers

- **Reforming labour laws to permit greater flexibility and support for training:** Indonesia’s current labour laws and regulations incentivise casualised or informal labour, which discourages investment in skills and training. Businesses are reluctant to offer permanent positions due to regulatory impediments such as the high severance costs. At the same time, there are restrictions on outsourcing and an absence of provisions for part-time work.

  Allowing more flexible employment arrangements could encourage more permanent employment contracts, which would in turn encourage businesses to invest in training and upskilling their staff. The Government could also consider relaxing or removing foreign labour restrictions that currently limit firms’ ability to train employees by drawing on global expertise. These restrictions similarly deprive Indonesian educational institutions of available teacher talent.

- **Promoting the importance of TVET:** There is a need to build awareness of the importance of skills and training in Indonesia amongst both employers and the workforce. The Government can promote the value of TVET qualifications, demonstrate the employment outcomes achieved by graduates, and advertise the role of education throughout workers’ careers with approaches such as lifetime learning. These approaches would increase knowledge of the role of TVET in the community and improve the ability of workers to respond to the role transitions and process changes involved with automation.

- **Encouraging lifelong learning.** Singapore’s “SkillsFuture” initiative grants lifetime credits to all citizens aged 25 and over to pay for training courses. Older workers can use credits accumulated over a lifetime to upgrade their skills and adapt to changing requirements. Meanwhile, Thailand is providing Massive Open Online Courses for the public in education and other settings while also delivering 10,000 free Wi-Fi hotspots.

Ensuring inclusion

- **Ensuring fiscal distribution policies remain effective across regions:** In Indonesia, major economic zones and urban areas tend to benefit more from automation that other regions. Indonesia can use its fiscal equalisation policies to counteract this effect. For instance, redistribution through the Village Fund should be reviewed to ensure that all regions share in the benefits of a more automated economy.

- **Engaging trade unions in labour market reforms:** The union movement has an important role to play in ensuring that all workers benefit from automation. This involves improving conditions for all workers and not just those operating under traditional employer-employee contracted models. Labour law reform supported by the unions would better reflect changing workplace structures, generate more employment options, and also support vulnerable workers.

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Appendix: Methodology

1  Estimating the timeshares of tasks in the Indonesian economy

1.1  About the data

The Indonesian Family and Life Survey (IFLS) is an ongoing longitudinal survey conducted by the RAND Corporation. The survey sample of over 30,000 individuals in 13 provinces (of 27 total) is representative of about 83% of the Indonesian population. IFLS captures a broad range of information on employment, including occupation, industry, and status; educational attainment; and demographic characteristics such as age and gender. Importantly for the purposes of this report, the 2007 and 2014 surveys asked participants to identify the frequency with which they perform certain tasks at work, the number of hours that they work each week and the number of weeks that they work a year.

The National Labour Force Survey (SAKERNAS), conducted by Indonesia’s national statistics agency Badan Pusat Statistik (BPS) captures occupation, industry, gender, hours worked and wages among other information. SAKERNAS was used to weight task information from IFLS for this report so that it is representative of the whole country.

1.2  About the approach

First, we calculate timeshares from frequency scores. We use a regression to fit hours (and thus timeshares) from frequency scores for technological, physical and interpersonal tasks at the occupational level. Specifically, we calculate the coefficient that minimises differences from actual hours worked per occupation using the equation:

\[ T_j = \beta_j (F_{j,t} + F_{j,m} + F_{j,i}) + e_i \]

where:

- \( F_{j,t} \) is the average frequency score for performing a task per occupation
- \( T_j \) is the average weekly hours worked per occupation
- \( \beta_j \) is the coefficient for a given task type by occupation

Second, we calculate the share of routine and non-routine work for physical and interpersonal tasks. IFLS captures information about the frequency with which workers ‘intensely concentrate’ in their jobs. We use this as a proxy for more complex, as opposed to more automatable, hours of work across the physical and interpersonal categories and describe this as non-routine. We weight the shares downward to reflect the fact that there are other factors besides complexity that cause a worker to intensely concentrate and these may be automatable. For example, the detailed work of hand sewing may require intense concentration but is automatable. Overall, the shares of routine versus non-routine work align with 2006 World Values Survey where 12% of Indonesian respondents (n = 1,200) reported that the tasks they perform at work are more non-routine than routine.24

Finally, we weight occupational timeshares by total hours worked by occupation using SAKERNAS data. This allows us to convert proportions of the working week spent to determine economy-wide timeshares and changes in these timeshares. These shares are extrapolated to 2000 and 2015 to estimate the impact of automation over this period.

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24 The World Values Survey is a survey conducted by a network of social scientists coordinated by a central body - the World Values Survey Association. It is established as a non-profit organization seated in Stockholm, Sweden, with a constitution and mission statement.
2 Analysing the impact of automation-related task change on income, including by select cohorts

This section of the analysis makes use of the longitudinal nature of IFLS. We begin with workers who reported receiving an income (wages or profits) in both 2007 and 2014 (n=10,165). We then identify those workers whose tasks are changing in response to automation by whether they reported an increase in the frequency of technological tasks or intense concentration in their jobs (N = 4,500).

Income figures are adjusted using the Indonesian CPI Index from 2007 and 2014 to strip out the effects of inflation. The percentage change in income between 2007 and 2014 is then calculated. Finally, we calculate the median income change by cohorts. We begin with those impacted by automation compared to those who are not, and then drill down further by characteristics such as age, skill level, gender and job formality.

3 Valuing hours of more complex work relative to automatable work

In order to value the productivity gains from automation, we calculate the ‘wage premium’ of wages earned for more complex tasks above those earned from automatable work. We begin by calculating average hourly earnings, hours worked and worker age by occupation from SAKERNAS data. We then match this to 2014 occupation timeshare data for our five task groups. For each occupation i, the expected hourly wage is assumed to be a function of time spent on automatable/non-automatable tasks and the age of workers (proxy for experience). The function for an occupation i is as follows:

\[ Wage_i = \alpha + \beta_1 HoursTSNonAutomatable_i + \beta_2 Age_i + \beta_3 Age_i^2 + e_i \]

where:
- \( HoursTSNonAutomatable_i \) is the share of hours spent per week on more complex tasks
- \( Age_i \) is the average age for workers in the occupation

An ordinary least squares regression is used to estimate the value of coefficients. Expected wages are calculated for a worker performing 100% of a given task type, assuming that the worker is of the overall average worker age and working the total average weekly hours:

\[ Wage^{NonAutomatable} = \alpha + \beta_2 Age + \beta_3 Age^2, \quad Wage^{Automatable} = \alpha + \beta_2 Age + \beta_3 Age^2 \]

We find the wage premium per hour of more complex (non-automatable) work over each hour of automatable work using the following equation:

\[ premium = \frac{Wage^{NonAutomatable}}{Wage^{Automatable}} - 1 \]

The results of this analysis show that the income share of more complex (non-automatable) work relative to the total time spent on such work is substantially higher than the ratio of automatable work. They suggest that more complex work pays a wage premium of around 20 per cent compared to automatable work.

4 Comparing uptake of automation by country

4.1 About the data

The World Bank Enterprise Survey is a survey of manufacturing and services firms that attempts to capture the experience of 155 thousand private sector firms in 148 countries. The surveys aim to capture a representative sample of firm level data on performance, competition, innovation, investment, and the business environment, including corruption, infrastructure and access to finance.
The survey has been conducted twice in Indonesia, in 2009 and 2015. Data from select ASEAN and regional peers was also used. The 2015 Indonesian data used in this research covered around 1300 firms stratified by region, size and industry. Industries covered included key manufacturing subsectors such as food, garments and textiles; retail; and other services. This research used the questions asking whether respondents had engaged in process innovation through automation of manual processes or uptake of technology.

Other metrics of uptake of automation were calculated for reference and comparison. These made use of:

- Compustat firm level data on financial performance, markets and other statistics.
- UN Comtrade data on international trade including imports of machinery by type, allowing the inference of sectors of use.
- Asian Development Bank Input Output tables estimating consumption of machinery by type by sector.
- World Bank estimates of sectoral Gross Value Added for manufacturing and services.

4.2 About the approach

This report compares the uptake of automation between Indonesian companies and between countries. This analysis helps to benchmark Indonesia’s performance in becoming more automated. It also informs the estimated economic gains under a scenario where Indonesia accelerates the uptake of automation.

As described in Section 1, there is no perfect metric for the uptake of automation because of the variety of factors that influence decisions to automate within a particular economy and the interaction of underlying and new automation. This analysis is concerned with new investments in automation technology, as opposed to underlying levels of automation, because it is these investments that lead to productivity increases and so economic growth.

The metric used is the proportion of companies in a given category (country or group of companies) that self-reported investments in automation or technology. This analysis draws on the World Bank Enterprise Survey, which asked manufacturing and services companies about these categories of investment. Technology investment was included alongside the specific question on process automation because of the different forms that automation takes across sectors. Automation of manual processes was underreported in services relative to manufacturing.

The most recent iteration of this survey in Indonesia was in 2015. The other countries studied conducted the survey either in 2015 or surrounding years. Most countries involved in the World Bank Enterprise Survey did not use the module that includes the questions on automation and so the available sample of countries is relatively limited. However, it contains most of Indonesia’s ASEAN peers and India and Bangladesh, as shown in this report.

The report also compares types of companies within Indonesia. The comparison of small, medium and large companies was derived from the size categories included in the survey. The comparison of all companies to companies involved in global value chains is based on company characteristics such as use of imported input materials, relationships with foreign parent companies, and reliance on exports.

Note that the data has been adjusted to account for the way that the survey was delivered. Respondents were only asked about automation if they reported that they had engaged in process innovation. This excluded companies who did not perceive themselves to be involved in innovation. Further, self-reporting of innovation and automation relies on subjective interpretations of these terms.
There appear to have been language and cultural issues affecting this self-reporting between countries.

Several other metrics for automation were considered such as data on machinery imports and consumption in manufacturing and agriculture. Our stakeholder consultation also included discussions on the extent of automation in Indonesia. These sources were relatively consistent in benchmarking Indonesia as a low to moderate performer in the uptake of automation. This gives us confidence in the use of the metric based on automation and technology investment.

5 Evaluating potential gains due to automation

5.1 About the data

This analysis is based on Statistics Indonesia (BPS) time series on GDP, employment, hours and population. The 2000-2014 GDP time series is adopted to show GDP growth over this time period at the ISIC 2.0 sector level. The employment time series and SAKERNAS data was used to estimate hours worked across the nine ISIC 2.0 sectors. The employment time series provided the total employees per sector per year. SAKERNAS provided data on hours worked by individual workers which was aggregated to provide a sector level average of weekly hours. In conjunction, this data was used to estimate historical labour productivity growth.

BPS data was also used for the projection of employment by sector and labour force growth. The BPS Population Projection 2051-2045 data on population and dependency ratio by year was used to infer labour force growth across the economy. The historical employment series described above was used to estimate how this labour force growth would be distributed across the economy.

This section also brings together several pieces of analysis previously described:

- The task change analysis is used to estimate labour productivity growth due to automation.
- The uptake of automation analysis is used to estimate the impact were Indonesia to accelerate automation to meet ASEAN leading rates.
- The wage premium analysis was used to find the value of hours reallocated to more automatable work.

5.2 About the approach

First, we calculate total labour productivity growth from 2000 to 2015. These calculations are conducted at the sectoral level to capture variations in performance over time, and then the analysis is aggregated to the economy wide level at the last stage of estimating future GDP.

We use BPS GDP data to find annual gross value added (GVA) across the nine ISIC 2.0 sectors and inflate these figures to 2019 rupiah using sectoral implicit indices. We take historical employment figures and an estimate of weekly hours to estimate the total hours worked for each year in this period. We divide GDP by total hours per sector to find labour productivity in output per hour terms in 2019 rupiah.

From these figures, we can estimate cumulative and annual growth in labour productivity by sector from 2000 to 2015. There are some fluctuations in these estimates due to the nature of the original data, variability in market prices in sectors such as oil and gas, and other typical challenges in measuring labour productivity.

Second, we calculate labour productivity growth due to automation and to other causes from 2000 to 2015. We begin with the task change analysis described in section 1 of this appendix. That
analysis describes the hours of automatable work saved due to automation by sector from 2000 to 2015. The impact of this time saved on labour productivity comprises increased efficiency of output, or the ability of workers to produce the same output with fewer hours, and increased value of hours reallocated to new labour:

\[
\% \text{ growth}_{\text{automation}} = \% \text{ growth}_{\text{efficiency}} \times \% \text{ growth}_{\text{value}}
\]

\[
\% \text{ growth}_{\text{automation}} = \frac{\text{Hours}_{2000}}{\text{Hours}_{2000} - \text{Hours saved}_{2015}} \times \left(\frac{\text{Hours saved}_{2015}}{\text{Hours}_{2000}} \times \text{Premium} + 1\right)
\]

Where:

- \( \% \text{ growth}_{\text{automation}} \) is the cumulative labour productivity growth due to automation for a sector from 2000 to 2015.
- \( \% \text{ growth}_{\text{efficiency}} \) is the cumulative labour productivity growth due to increased efficiency of output.
- \( \% \text{ growth}_{\text{value}} \) is the cumulative labour productivity growth due to the increased value of hours reallocated to new labour.
- \( \text{Hours}_{2000} \) is the average weekly hours worked in 2000.
- \( \text{Hours saved}_{2015} \) is the hours of automatable work saved by automation from 2000 to 2015.
- \( \text{Premium} \) is the wage premium for hours of non-automatable work described above, which can be used as a proxy for the additional value created when hours saved by automation are reallocated to more complex, higher value work.

This analysis finds the proportion of total labour productivity growth from 2000 to 2015 that was due to automation. The residual is assumed to be due to other causes.

**Third, we project labour productivity growth from 2019 to 2030.** The scenarios under this analysis start from the present year and go out to 2030. We estimate what the productivity growth will be over this period by starting with the historical growth figures above. For our starting scenario, we project the same growth rates from 2000 to 2015 forward from 2015 to 2030 for total labour productivity growth, growth due to automation, and growth due to other causes.

We make adjustments for some sectors where the productivity growth from 2000 to 2015 was very high or very low. These projections are from 2015 to 2030. To find the growth rates from 2019 to 2030, we account for estimated productivity changes from 2015 to 2019.

**Fourth, we estimate changes in total hours worked per year per sector from 2019 to 2030.** Total hours worked per sector is a product of employment and average weekly hours per employee. Employment growth is driven by labour force growth and changes in sectoral workforce share. Labour force growth is estimated from BPS projections on population and dependency ratios. Once we know the total population and the ratio of the working age to the non-working age population, we are able to find the number of people in the working age population per year from 2019 to 2030. This allows us to

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25 Some sectors had negative total labour productivity growth under the estimates calculated from 2000 to 2015. However, labour productivity growth due to automation is estimated to be positive for these sectors during that period as we observe task changes towards more complex tasks, and these growth rates are projected forward to 2015-2030. This means that labour productivity growth due to other causes is estimated to be negative (because it is the residual between total and automation-driven growth). Instead of projecting these negative growth rates forward for 2015-2030, we assume that labour productivity growth from other causes will contribute the same proportion of total labour productivity growth in these sectors as it did across the whole economy from 2000 to 2015. The total labour productivity growth projection for these sectors is then the product of the growth rates due to automation and other causes.

Some other sectors had very high estimated total labour productivity growth from 2000 to 2015, which we assume will not continue. For these sectors, the total labour productivity growth rate from 2015 to 2030 is constrained to equal the economy wide total growth rate from 2000 to 2015. The automation component of labour productivity growth is calculated by projecting forward the historical growth rate. Growth in labour productivity due to other causes is then forecast as the difference between these two growth rates.
find labour force growth, which is applied to current employment to estimate the total number of employees in the economy each year from 2019 to 2030.

The share of these employees between sectors is changing due to structural adjustments, chiefly the departure of workers from agriculture to other sectors. This is accounted for by first finding the proportion of workers in each of the nine ISIC 2.0 sectors from 2000 to 2017 (when the employment series ends). The rate of change in these proportions is projected forward as a linear trend to 2030. These calculations provide us with employment by sector per year from 2019 to 2030.

Weekly hours worked are held constant from 2015 to 2030 in the starting scenario. This allows us to more easily isolate the expected impact of automation, given that its impacts on productivity are created by changes in the way that workers spend hours of work. Moreover, based on historical data any changes to average weekly hours are projected to be slight. These weekly hours figures are then used to find total hours worked per sector from 2019 to 2030.

**Fifth, we find GDP and GDP growth.** We now know 2019 labour productivity on an hours worked basis and total hours worked per sector from 2019 to 2030. We also have projections of how labour productivity will grow over the same period. We multiply the 2019 labour productivity figure by the projected growth rates to find labour productivity per year. We then multiply these output per hour figures by total hours worked to find projected GDP per sector and then GDP growth. These sectoral figures are built up to an economy wide level.

**Finally, we repeat the process across scenarios with different conditions.** The starting scenario calculated using the steps above assumes that the current rate of automation-led productivity growth will continue. This is based on an assumption that the uptake of automation by Indonesian companies will remain the same, leading to the same growth in opportunities for increased efficiency, and that workers will be able to reallocate their labour.

To capture the impact of policy decisions on the potential economic gains due to automation we vary these assumptions across three scenarios. The scenarios are:

- Starting scenario with current uptake of automation and full reallocation of labour. This is calculated based on the methodology above.
- Scenario with no reallocation of labour. Under this scenario, the current rate of uptake of automation is assumed, but no hours saved by automation are reallocated to other work. They drop out of the economy and offset the time savings due to automation.
- Accelerated automation. Under this scenario, the uptake of automation in agriculture, manufacturing, other industry and services catches up to the current rate of the ASEAN leader for each sector by 2025. Full reallocation of labour is assumed. In detail:
  - The proportions of companies investing in automation in services, manufacturing and at the aggregate level were compared to those sectors in the sample of ASEAN countries included in Exhibit 8. Agriculture firms were not included in the World Bank Enterprise Surveys so for this sector countries were instead compared on imports and consumption of agricultural machinery as a proportion of agricultural gross value added (GVA) (UN Comtrade, FAO).
  - The uptake of automation in the leading country for each of services, manufacturing and the aggregate economy was expressed as a proportion of Indonesia’s uptake of automation. This provided a multiplier needed to increase Indonesia’s uptake in that sector to the leading ASEAN rate. See Box 4 for a summary of the multipliers used. For example, the ASEAN leader in manufacturing has 1.7 times the proportion of companies investing in automation as Indonesia.
Uptake of automation affects labour productivity growth because it drives annual savings in hours of automatable work. By accelerating the rate of automation, we accelerate these annual time savings. We multiply this annual time savings rate for each sector by the relevant ASEAN multiplier described below. This becomes the annual savings rate for the sector from 2025 to 2030. Meanwhile, the annual rate accelerates from 2019 to meet this higher level in 2025. This provides an approximation of the time and productivity impact of increasing the uptake of automation to meet the relevant leading ASEAN peer.

<table>
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