The Automatability of Occupations in Malaysia: Automatability Profiles of Occupations on the 2017/2018 Critical Occupations List

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OVERVIEW

Digitization, automation, and Industry 4.0 are changing the world of work in Malaysia. New technologies – cloud computing, 3D printing, blockchain, the Internet of Things to name just a few – are transforming how work is done. These technologies and their predecessors have already shifted the composition of the Malaysian workforce away from tasks that involve repetitive work to tasks that require creative thinking, social intelligence, and the ability to adapt to new situations. The forces of digitization, automation, and Industry 4.0 will increasingly take over even the dynamic, interpersonal tasks that computers have traditionally struggled to automate.

These forces are likely to have a significant impact on the Malaysian economy: half of all jobs in Malaysia are at high risk of automation. This report provides an overview of the potential for automation in Malaysia. The report examines the technical potential for the automation of jobs in Malaysia, estimating how many jobs could be automated given existing technologies. This methodology shows that 50 percent of the Malaysian workforce is at high risk of automation, 25 percent is at medium risk, and another 25 percent is at high risk. The share of jobs at high risk of automation in Malaysia is similar to that estimated for the United States.

However, there are several constraints to automation that will hinder and slow the expansion of automation in Malaysia. Cost, as well as legislation, regulations, and norms are likely to hinder the adoption of automation technologies in some cases. In other cases, automation will affect the types of jobs that workers do but will not eliminate their occupations entirely.

Occupations that appear on Malaysia's 2017/2018 Critical Occupations List are subject to these constraints to automation. The report focuses on the 58 occupations appearing on the 2017/2018 Critical Occupations List. Understanding the automatability of these occupations, which have been shown to be both in shortage and also strategic to Malaysia's economic development, is particularly important because automation may be a potential mechanism to fill the shortages identified. Evidence gathered for this report shows that constraints to automation remain even for occupations that would be technologically feasible to automate. In fact, in the case of each of the 58 occupations on the Critical Occupations List, cost and the lack of penetration of technology beyond top-tier firms are constraints on automatability. The table below summarizes the findings of the report for the COL occupations.

The automatability of occupations on the 2017/2018 Critical Occupations List

Masco code	Masco title	Probability of automation	Evidence of constraints to automation								
			Depth of technological penetration			Cost			Legal, regulatory, normative		
			Yes	Mix	No	Yes	Mix	No	Yes	Mix	No
2411	Accountants	96%	○	●	○	○	●	○	○	●	○
8189	Stationary Plant and Machine Operators Not Elsewhere Classified	92%	○	●	○	○	●	○	○	○	●
3114	Electronics Engineering Technicians	84%	○	●	○	●	○	○	○	○	●
3151	Aircraft Technicians	84%	●	○	○	●	○	○	○	●	○
3113	Electrical Engineering Technicians	82%	●	○	○	●	○	○	○	●	○
8141	Rubber Products Machine Operators	82%	○	●	○	○	●	○	○	○	●
3321	Insurance Agents	66%	○	●	○	○	●	○	○	●	○
7412	Electrical Mechanics and Fitters	64%	●	○	○	●	○	○	○	●	○
3323	Buyers	64%	●	○	○	○	●	○	○	●	○
7233	Agricultural and Industrial Machinery Mechanics and Repairers	62%	●	○	○	●	○	○	○	○	●
1324	Supply, Distribution and Related Managers	59%	●	○	○	○	●	○	○	○	●
3257	Environmental and Occupational Health Inspectors and Associates	53%	●	○	○	○	●	○	○	●	○
2514	Applications Programmers	48%	○	●	○	○	●	○	○	○	●
3115	Mechanical Engineering Technicians	48%	●	○	○	●	○	○	○	○	●
2413	Financial Analysts	46%	○	●	○	○	●	○	○	●	○
8332	Heavy Truck and Lorry Drivers	41%	●	○	○	○	●	○	●	○	○
3322	Commercial Sales Agents	39%	○	●	○	○	●	○	○	○	●
1214	Business Services Managers	35%	●	○	○	●	○	○	○	○	●
1219	Business Services and Administration Managers Not Elsewhere Classified	35%	●	○	○	●	○	○	○	○	●
3119	Physical and Engineering Science Technicians Not Elsewhere Classified	34%	●	○	○	●	○	○	○	○	●
2114	Geologists and Geophysicists	32%	●	○	○	●	○	○	○	○	●
2173	Aircraft Pilots and Related Professionals	25%	○	●	○	○	●	○	●	○	○
1213	Policy and Planning Managers	25%	●	○	○	○	●	○	○	●	○
2523	Computer Network Professionals	21%	●	○	○	○	●	○	○	○	●
2432	Public Relations Professionals	18%	●	○	○	●	○	○	○	○	●
3123	Construction Supervisors	17%	●	○	○	●	○	○	○	●	○

2121	Mathematicians, Actuaries and Statisticians	15%	○	●	○	○	●	○	○	○	●
2144	Mechanical Engineers	13%	●	○	○	●	○	○	○	○	●
2152	Electronic Engineers	12%	●	○	○	●	○	○	○	●	○
2434	Information and Communications Technology (ICT) Sales Professionals	11%	○	●	○	○	●	○	○	○	●
2263	Environmental and Occupational Health and Hygiene Professionals	11%	○	●	○	●	○	○	○	●	○
2151	Electrical Engineers	10%	●	○	○	○	●	○	○	○	●
1121	Managing Directors and Chief Executives	9%	●	○	○	○	●	○	○	●	○
2512	Software Developers	9%	●	○	○	●	○	○	○	○	●
2519	Software and Applications Developers and Analysts Not Elsewhere Classified	9%	●	○	○	○	●	○	○	○	●
2146	Mining Engineers, Metallurgists and Related Professionals	9%	●	○	○	●	○	○	○	○	●
1323	Construction Managers	7%	●	○	○	●	○	○	○	○	●
1211	Finance Managers	7%	●	○	○	○	●	○	○	●	○
2113	Chemists	6%	●	○	○	○	●	○	○	○	●
1511	Information and Communications Technology Managers	4%	○	●	○	○	●	○	○	○	●
2171	Ships Engineers	4%	●	○	○	○	●	○	○	○	●
2149	Engineering Professionals (Excl. Electrotechnology) Not Elsewhere Classified	3%	●	○	○	●	○	○	○	●	○
2311	University and Higher Education Professional Teachers	3%	○	●	○	○	●	○	○	○	●
1321	Manufacturing Managers	3%	●	○	○	○	●	○	○	○	●
2521	Database Designers and Administrators	3%	○	●	○	○	●	○	○	○	●
2522	Systems Administrators	3%	○	●	○	○	●	○	○	○	●
3513	Computer Network and Systems Technicians	3%	●	○	○	○	●	○	○	○	●
2141	Industrial and Production Engineers	3%	●	○	○	●	○	○	○	●	○
2153	Telecommunications Engineers	3%	●	○	○	●	○	○	○	●	○
2142	Civil Engineers	2%	●	○	○	●	○	○	○	●	○
1223	Research and Development Managers	2%	○	●	○	○	●	○	○	○	●
2426	Research and Development Professionals	2%	●	○	○	●	○	○	○	○	●
2145	Chemical Engineers	2%	○	●	○	●	○	○	○	○	●
2182	Manufacturing Professionals	2%	●	○	○	○	●	○	○	○	●
3122	Manufacturing Supervisors	2%	○	●	○	○	●	○	○	○	●
1221	Sales and Marketing Managers	1%	○	●	○	○	●	○	○	○	●
2511	Systems Analysts	1%	○	●	○	○	●	○	○	○	●
2212	Specialist Medical Practitioners	0%	●	○	○	○	●	○	○	●	○

Source: World Bank based on Frey and Osborne (2017).

I. INTRODUCTION[1]

Digitization, automation, and Industry 4.0 are changing the world of work in Malaysia. New technologies – cloud computing, 3D printing, blockchain, the Internet of Things to name just a few – are transforming how work is done. These transformations extend from well-known examples like Grab, which helped kickstart the gig economy in Malaysia, to Hong Leong Bank's use of IBM's Watson to help the bank understand customer emotions. These technologies and their predecessors have already shifted the composition of the Malaysian workforce away from tasks that involve repetitive work to tasks that require creative thinking, social intelligence, and the ability to adapt to new situations. As TalentCorp lays outs in *Visioning Malaysia's Future of Work: A Framework for Action*, in this context Malaysia is faced with the dual tasks of keeping pace with rapid technological development and meeting the talent needs associated with global market demand.

The potential reach of these changes is significant. Estimates from countries around the world suggest that the jobs of a significant share of the workforce are at high risk of automation. These estimates judge that the forces behind automation like big data, artificial intelligence (AI), and machine learning will increasingly take over even the dynamic, interpersonal tasks that computers have traditionally struggled to automate. Overall, as one prominent research paper puts it, the automation of almost any task "is largely already technologically possible" (Frey and Osborne 2017).

However, the ultimate impact of digitization, automation, and Industry 4.0 on how people work is dependent on several factors beyond the technological potential for automation. First, firms decide to invest in new technologies based on their costs and benefits, not simply because they are available. In particular, large globally connected firms may be able to afford cutting-edge automation while SMEs continue to rely on labour-intensive technologies. Second, automation may not replace jobs but rather change the jobs that workers do. For instance, computers may replace the role of radiologists in identifying abnormalities in images, but leave radiologists more time to spend determining which radiological tests to order and consulting on diagnoses and treatment (Davenport and Dreyer 2018). Third, laws and regulations may inhibit swift adoption of automation technologies. Continuing the example of radiologists, reform of health insurance and health care legislation and rules will be necessary for AI to truly take off in radiology. Relatedly, norms or preferences may not shift immediately. For instance, though the technologies for e-commerce are well-established globally, less than one percent of retail sales are conducted via e-commerce in Malaysia (Chang and Huynh 2016). Fourth, the new technologies associated with automatability and the improved productivity implied by automation will themselves create new job opportunities and new job titles that cannot be foreseen today. For example, 28 new job titles emerged in Malaysia between 1998 and 2008 (ADB 2018).

This report examines the susceptibility of occupations in Malaysia to automation. The report examines the technical potential for the automation of jobs in Malaysia, estimating how many jobs could be automated given existing technologies. This is designed to provide a portrait of how many jobs could be affected by automation and which sectors are more and less vulnerable to the changes associated with digitization, automation, and Industry 4.0. Importantly, the report does not estimate the number of jobs that will actually be lost because of automation.

[1] This report was prepared by a team comprising Harry Moroz (Economist and Task Team Leader), Renjie Ge (Economist), and Martin Schmidt (Economist), in close collaboration with the Critical Skills Monitoring Committee (CSC) composed of Talent Corporation Malaysia Berhad (TalentCorp) and the Institute of Labour Market Information and Analysis (ILMIA).

The report then focuses on the automatability of occupations included in the 2017/2018 Critical Occupations List (COL). Occupations on the 2017/2018 COL have been identified by the Critical Skills Monitoring Committee (CSC) to be sought-after such that demand for and supply of workers in the COL occupations are mismatched (CSC 2018b). These occupations have also been identified as skilled and as strategic to Malaysia's economic growth and to the development of a knowledge-based economy. Identifying the automatability of these occupations is particularly important because, if feasible, automation may be a potential mechanism to fill the shortages identified.

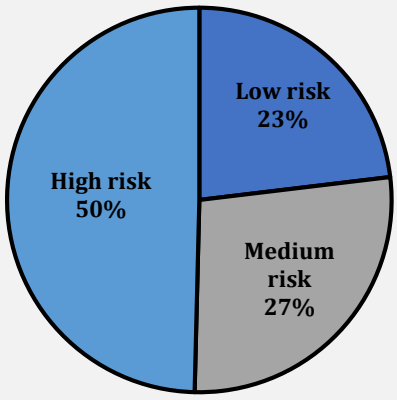
Profiles of the COL occupations are provided that address not only the technological feasibility of automation but also factors that make automation more and less likely in practice. For the COL occupations, the report also considers constraints to automation that go beyond the technical potential to automate the occupation. To do so, the report includes detailed profiles of the 58 COL occupations. In addition to presenting the probability of automating each occupation, these profiles include a discussion of how each occupation is likely to be transformed by automation. The profiles also include a discussion of three constraints to automation: 1) whether firms beyond globally connected top-tier firms adopt automation technologies; 2) whether cost is a constraint to adoption of automation technologies; and 3) whether there are legal, regulatory, or normative constraints to automation. The detailed profiles are designed to provide a portrait of the technical potential to automate each occupation, of how each occupation may evolve with automation, and of potential constraints to automation beyond technological ones.

II. THE AUTOMATABILITY OF OCCUPATIONS IN MALAYSIA

This section presents estimates of the probability of automation for all occupations in the Malaysian workforce. The probability of automation is adapted from Frey and Osborne (2017), an influential and frequently cited paper, to occupations in Malaysia. The authors estimate the probability of automation based on expert assessments and occupational skills profiles. This probability considers the potential for automating occupations based on whether "engineering bottlenecks" make automation technologically difficult. Adapting the probabilities to Malaysian occupations allows for an estimate of the share of jobs in Malaysia that are at low (probability of 30 percent or less), medium (probability greater than 30 percent but less than 70 percent), and high (probability greater than 70 percent) risk of automation. **Appendix 1** provides a detailed description of how the probabilities are calculated.

Half of employment in Malaysia is at high risk of automation (Figure 1). In Malaysia, 50 percent of jobs are at high risk of automation. About a quarter of employment is at low risk and another quarter is at medium risk. This means that half of Malaysia's workforce has jobs with a high probability of being affected by automation, a quarter have jobs with a medium probability of being affected by automation, and another quarter have jobs with a low probability of being affected by automation.

Figure 1: The percentage of the workforce at low, medium, and high risk of automation in 2016



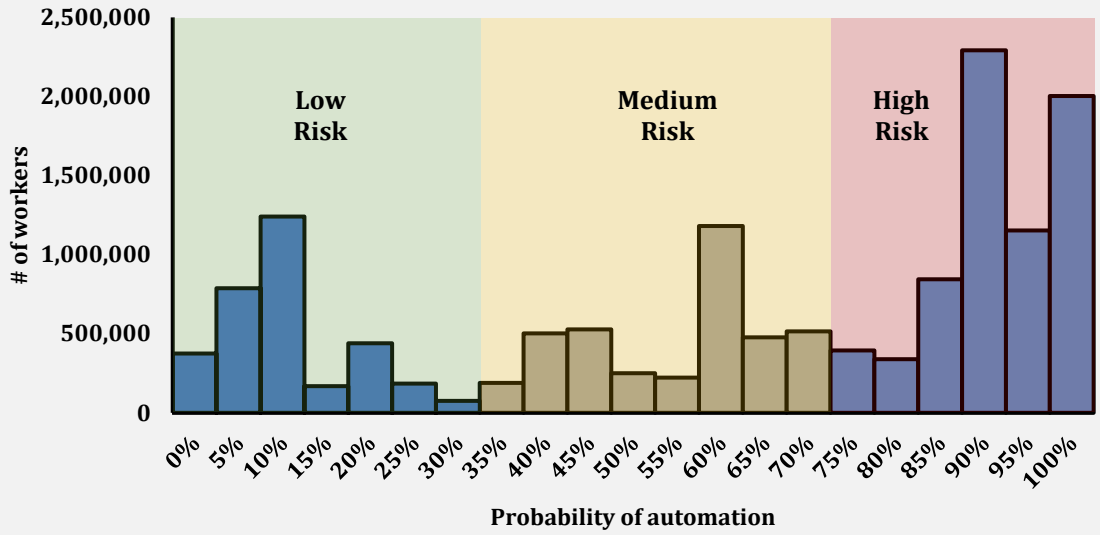
Source: World Bank based on Frey and Osborne (2017) and LFS (2016).

Around 7 million workers are at high risk of automation. Figure 2 shows the distribution of employment by the probability of automation. Each bar in the figure represents the number of people with a given probability of automation. For example, around 2 million workers in Malaysia have a probability of automation that is between 95 percent and 100 percent. Overall, around 7 million workers are at high risk of automation, nearly 4 million are at medium risk, and more than 3 million are at low risk.

Jobs with a high probability of automation are likely to be automated more quickly than those with a low probability. Figure 2 can be used as an approximate timeline for automatability, with low risk occupations facing the longest time horizons for automation and the high risk occupations

facing the shortest.[2] There is a cluster of jobs that have very high probabilities of automation (90 percent or more). These are jobs that involve routine tasks and jobs that are likely to be undertaken by computers relatively soon as the cost of robots and sensors declines. There is also a cluster of jobs that have very low probabilities of automation (10 percent or less). These jobs involve creativity, social perceptiveness, persuasion, and social intelligence, tasks that are likely to remain difficult to automate into the future. The distribution of employment in the middle range of automation probabilities is much flatter. In this range, jobs are not at immediate risk but may be automated as improvements are made that enhance the perception and manipulation capabilities of computers (Frey and Osborne 2017).

Figure 2: Employment at low, medium, and high risk of automation in Malaysia in 2016

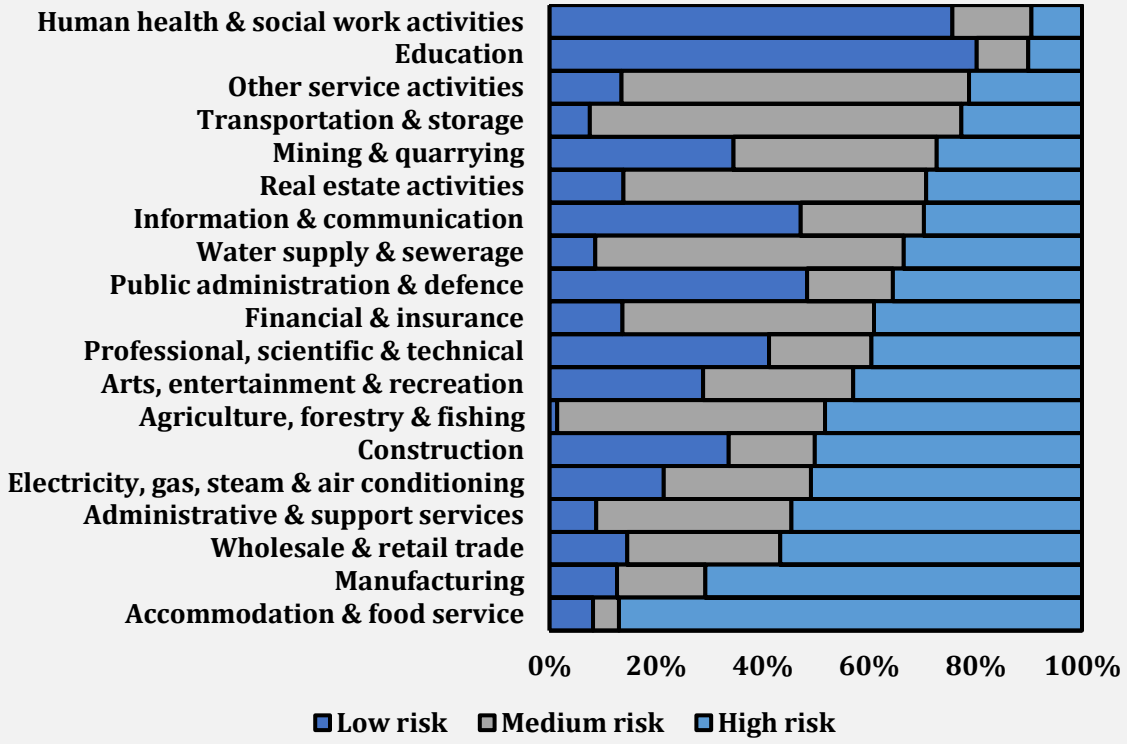


Source: World Bank based on Frey and Osborne (2017) and LFS (2016).

The risk of automation varies across sectors of the Malaysian economy (Figure 3). Nearly 90 percent of employment in the accommodations and food service sector is at high risk of automation. This reflects the advance of technologies in the services sector, such as automated checkout counters and chatbots that replace customer service agents. Indeed, more than 50 percent of employment in the services-dominated wholesale and retail trade and administrative and support service sectors is at high risk. Just over 70 percent of employment is at high risk of automation in the manufacturing sector, reflecting the continued potential to automate the routine tasks that characterize many manufacturing jobs. In contrast, only 9 percent of employment in human health and social work and 10 percent in education are at high risk of automation. This reflects the continued importance of creativity, social perceptiveness, persuasion, and social intelligence in these sectors. Descriptions of automatability by gender, citizenship, education, and wages are available in **Appendix 2**.

[2] See Frey and Osborne (2017) for more on this interpretation.

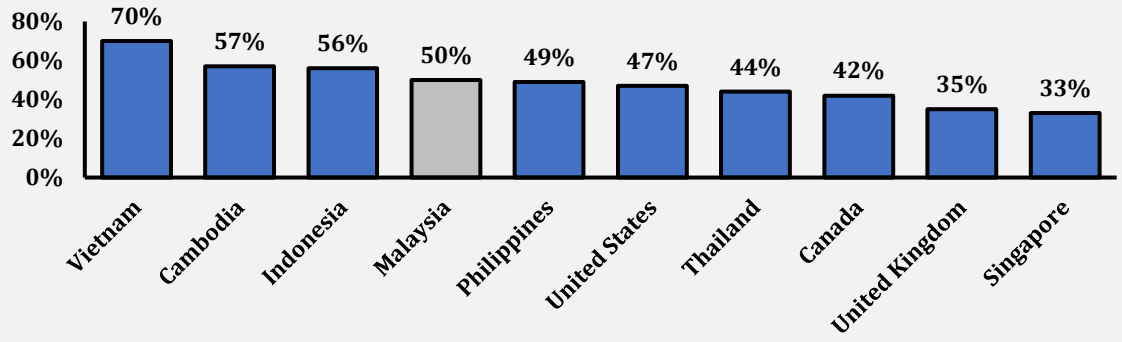
Figure 3: Employment at low, medium, and high risk of automation in Malaysia in 2016, by sector



Source: World Bank based on Frey and Osborne (2017) and LFS (2016).

The share of jobs at high risk of automation in Malaysia is similar to that in the United States. The percentage of employment at high risk of automation in Malaysia is similar to that of the United States (**Figure 4**). Vietnam and Cambodia, where large shares of employment remain in low-skilled employment, are highly exposed to automation. Singapore, where high-skilled work predominates, is much less exposed than even high-income countries like the United States and Canada.

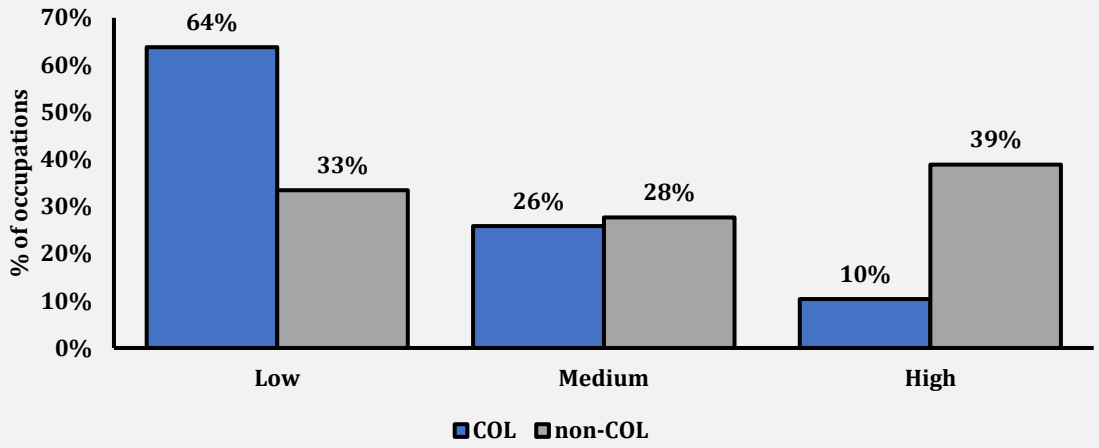
Figure 4: Percentage of employment at high risk of automation across countries



Source: Chang and Huynh (2016) for Cambodia, Indonesia, the Philippines, Thailand, and Vietnam; Lamb (2015) for Canada; World Bank based on Frey and Osborne (2017) and LFS (2016) for Malaysia; Centre for Strategic Futures (2015) for Singapore; Deloitte (2014) for the United Kingdom; and Frey and Osborne (2017) for the United States.

Occupations included in the 2017/2018 Critical Occupations List (COL) tend to be at low risk of automation. Occupations included in the 2017/2018 COL are skilled, sought-after, and strategic. This means that these occupations are mid- or high-skilled occupations; that demand for workers in these occupations is mismatched with supply; and that the occupations are strategic for Malaysia's economic growth and the development of a knowledge-based economy. Because COL occupations are skilled, they tend to involve fewer routine tasks and more oversight and managerial ones. This is reflected in the distribution of COL and non-COL occupations by risk of automation (**Figure 5**). About two-thirds of COL occupations are at low risk of automation, compared to just one-third of non-COL occupations. Conversely, only 10 percent of COL occupations are at high risk of automation compared to nearly 40 percent of non-COL occupations.

Figure 5: Percentage of COL and non-COL occupations by risk of automation in 2016



Source: World Bank based on Frey and Osborne (2017), LFS (2016), and CSC (2018).

III. AUTOMATABILITY PROFILES

This section presents detailed profiles of the automatability of each occupation on the 2017/2018 Critical Occupations List. The profiles are divided into two sections. The occupation overview section provides a description of the occupation, a description of the occupation's main tasks, and a description of the typical attributes of individuals working in that occupation.

- **Description**. The description defines the main activities undertaken by people working in the occupation. These descriptions are drawn from the Malaysian Standard Classification of Occupations (MASCO) 2013, which is used to classify the jobs done by Malaysians into a standardized system of occupations.
- **Tasks**. The task description reports how important five types of tasks are for each occupation. These tasks are selected because research has shown them to be related to how susceptible an occupation is to automation. The tasks are: 1) *non-routine analytical* tasks that involve creativity and problem-solving (e.g. forming a medical diagnosis); 2) *non-routine interpersonal* tasks that involve interacting with other people (e.g. managing others); and 3) *non-routine manual physical* tasks that are physical activities that involve adapting to different situations and recognizing language and visual cues (e.g. janitorial services). These three types of non-routine tasks are more challenging to automate because they cannot be described in simple rules that can be followed by a computer. Though still more challenging to automate, advances in machine learning, artificial intelligence, and robotics mean that automation of these tasks is now a possibility. The other two types of tasks are: 4) *routine manual* tasks that involve repeating the same physical procedure (e.g. car assembly); and 5) *routine cognitive* tasks that involve repeating the same analytical procedure (e.g. record keeping). These two types of routine tasks are less challenging to automate since they can generally be described in simple rules a computer can follow. Each task is assigned a score on a scale from 1 indicating that the task is not important in the occupation to 5 indicating that the task is extremely important. The score is taken from O*NET, a detailed database of occupational information collected from workers and experts in the United States.[3]
- **Attributes**. The attribute description presents the typical attributes of individuals working in the occupation. The information is taken from the 2016 Labour Force Survey (LFS) and the 2015 Salary and Wages Survey. Information is unavailable for some occupations, which have too few observations in the LFS or SWS. These cases are indicated by N/A.

The automatability section describes the probability that the occupation will be automated, how the occupation will be affected by automation, and the potential constraints to automation.

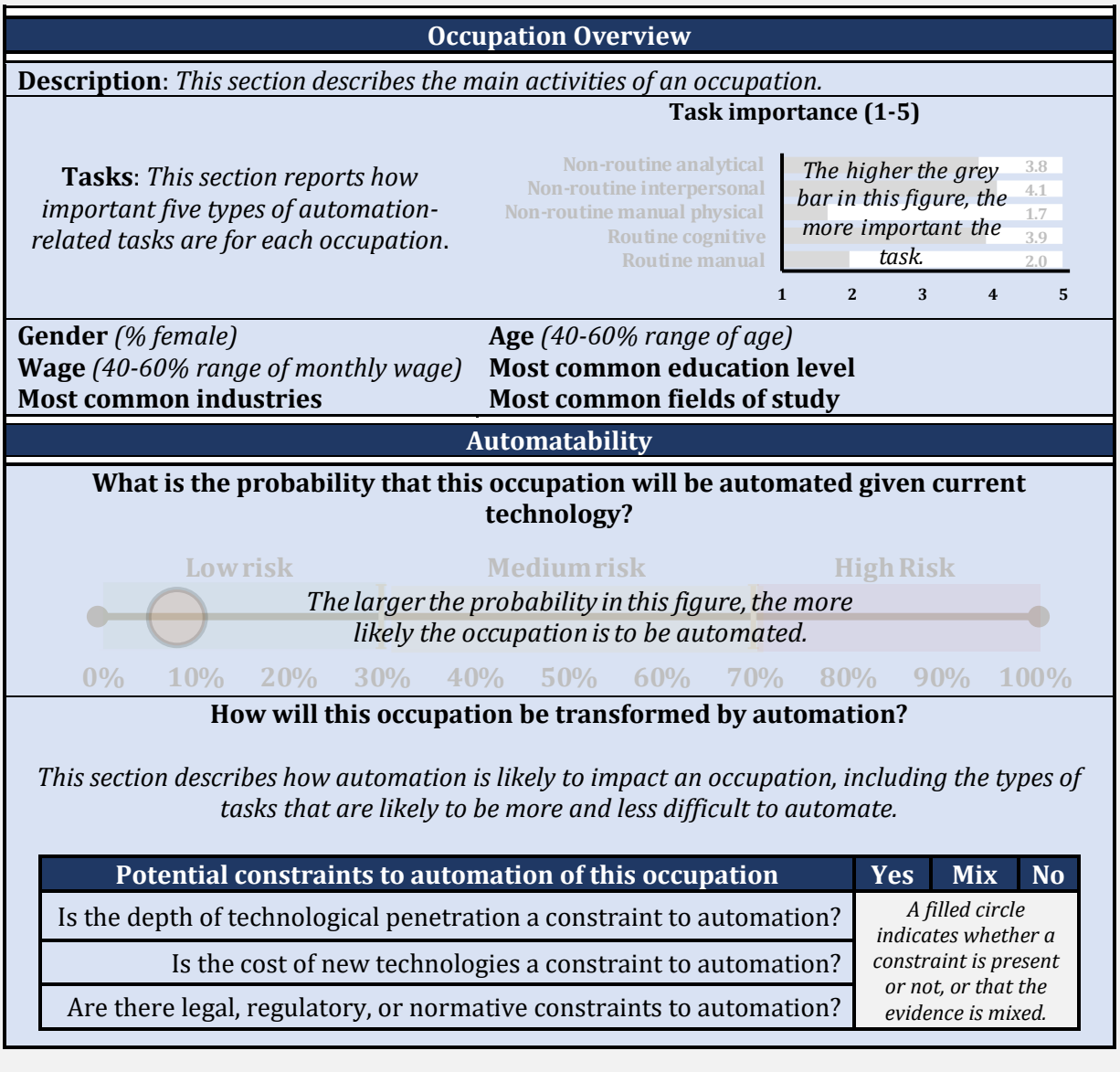
- **Probability of automation**. The profile reports the probability that the entire occupation will be automated given existing technologies. The higher the probability, the more likely the occupation is to be automated. The probability is based on expert assessments and the skills profiles of the occupations as described in Frey and Osborne (2017).
- **Transformation by automation.** The impact of automation on occupations may be to transform them, rather than to eliminate them entirely. That is, automation may affect one or a group of the tasks that compose an occupation, eliminating some tasks and making others more important. To take this possibility into account, the profile describes how the occupation is likely to be transformed by automation based on the importance of routine and non-routine tasks in the occupation and based on assessments by experts in data science, human resources, and industry in Malaysia.

[3] For additional information on O*NET, see https://www.onetonline.org/ (last accessed June 28, 2018).

- **Constraints to automation.** While automation may be technologically possible, there are other potential barriers to automating occupations and tasks. There are three important barriers: 1) only top-tier firms may be able to access new technologies; 2) the cost of these technologies may be prohibitively expensive; and 3) there may be legal, regulatory, or normative factors that impede the adoption of the technologies. To take this possibility into account, the profile describes the presence of each of these three constraints based on assessments by experts in data science, human resources, and industry in Malaysia. The profile indicates where constraints are present and not present, and where evidence is mixed.

Figure 6 is a sample profile describing each of the sections. A detailed description of the methodology used to compile the automatability profiles is provided in **Appendix 1**.

Figure 6: Sample automatability profile

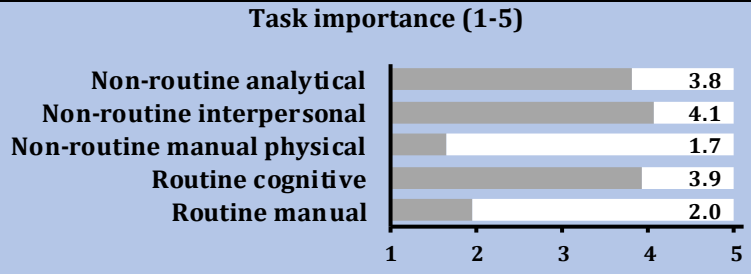


1. Managing Directors and Chief Executives (1121)

Occupation Overview

Description: Managing Directors and Chief Executives formulate and review policies and plan, direct, coordinate, and evaluate overall activities of organisations (except special interest ones and government departments) with support of other managers, usually within guidelines set by a board of directors or governing body to whom they answer for operations undertaken and results.

Tasks: Managing Directors and Chief Executives undertake non-routine interpersonal and analytical tasks, and routine cognitive tasks.



Gender: 18% female
Wage: 6,200-8,100 RM/month
Most common industries:

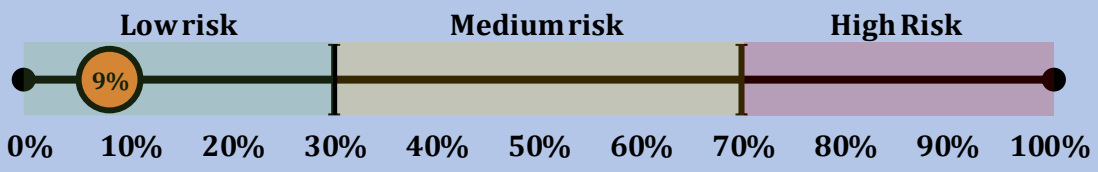
- Wholesale and retail trade; repair of motor vehicles and motorcycles
- Manufacturing

Age: 40-46 years old
Most common education level: Degree
Most common fields of study:

- Social sciences, business, and law
- Engineering, manufacturing, and construction

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Managing Directors and Chief Executives have a low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- Tasks undertaken by Managing Directors and Chief Executives that require reporting, such as board and regulatory reporting and payment approvals, are easier to automate, along with some decision making components, such as when analytics warn of potential governance breaches, though such decisions are variable and so will remain difficult to automate.
- Tasks like setting strategic direction, making decisions related to company values, negotiating, managing people, and dealing with crises are more difficult to automate.
- Additionally, corporate governance practices may require the tasks of Managing Directors and Chief Executives to be undertaken by humans, even if some could be automated.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	●	○

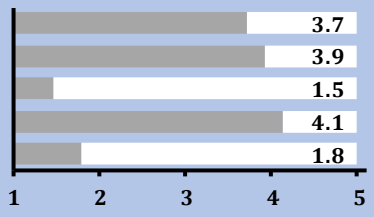
2. Finance Managers (1211)

Occupation Overview

Description: Finance Managers plan, organise, direct, control, and coordinate activities concerning financial operations, and participate in formulating financial policy in consultation with senior managers and other managers in the department and with other divisions.

Tasks: Finance Managers undertake routine cognitive tasks, and non-routine interpersonal and analytical tasks.

Task importance (1-5)



Gender: 63% female
Wage: 4,000-8,000 RM/month
Most common industries:

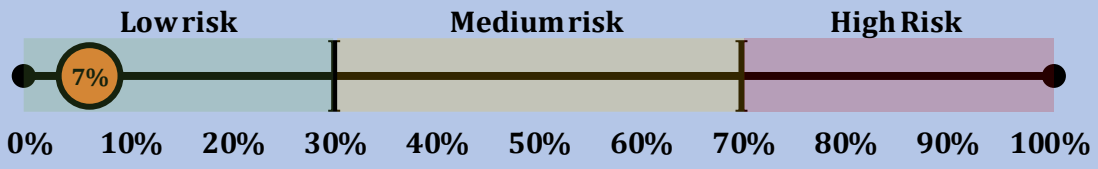
- Financial and insurance
- Professional, scientific, and technical activities

Age: 38-47 years old
Most common education level: Degree
Most common fields of study:

- Social sciences, business, and law
- Science, mathematics, and computing

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Finance Managers have a low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- Some of the inputs used by Finance Managers are standardized (e.g. spreadsheets and databases), which means that tasks related to analysis of these inputs could be automated.
- At the same time, Finance Managers interact with the chief executive and other senior managers, an activity which is less susceptible to automation.
- Laws and regulations related to the submission of financial regulatory documents may be a barrier to automation.

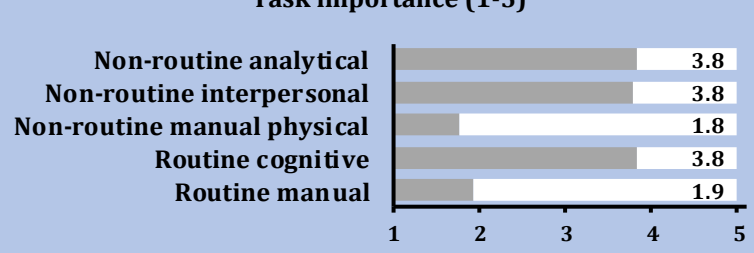
Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	●	○

3. Policy and Planning Managers (1213)

Occupation Overview

Description: Policy and Planning Managers plan, organise, coordinate, and advise on policy and strategic planning activities within the government or for non-government organisations and private sector agencies, or manage the activities of enterprises that provide policy and strategic planning services.

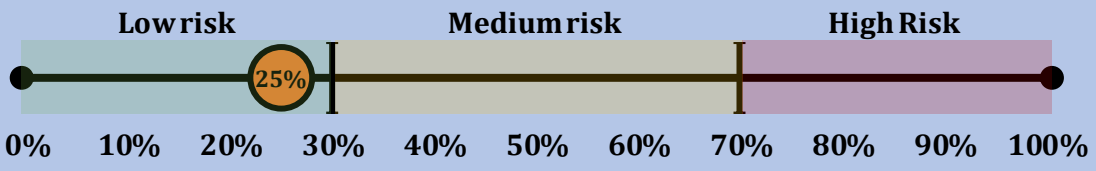
Tasks: Policy and Planning Managers undertake non-routine analytical and interpersonal tasks, and routine cognitive tasks.



Gender: N/A
Age: N/A
Wage: N/A
Most common education level: N/A
Most common industries: N/A
Most common fields of study: N/A

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Policy and Planning Managers have a low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- The common conception of the role of Policy and Planning Managers is one that requires creative thinking, which is less susceptible to automation. However, in Malaysia many "strategic planning" roles are of a more rote nature that involves obtaining and summarizing inputs such as surveys, rather than strategic thinking. These rote tasks are more susceptible to automation.
- The oversight by regulatory bodies of policies made by Policy and Planning Managers could be a barrier to automation.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	●	○

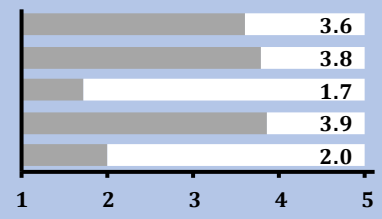
4. Business Services Managers (1214)

Occupation Overview

Description: Business Services Managers plan, organise, direct, control, and coordinate the sales and marketing activities of an enterprise or organisation.

Tasks: Business Services Managers undertake routine cognitive tasks, and non-routine interpersonal and analytical tasks.

Task importance (1-5)



Gender: 20% female
Wage: 4,950-5,250 RM/month
Most common industries:

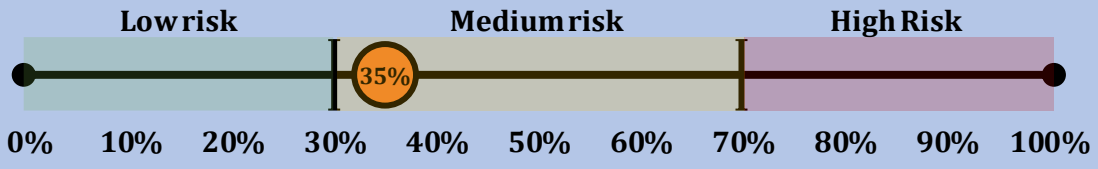
- Wholesale and retail trade; repair of motor vehicles and motorcycles
- Manufacturing

Age: 41-47 years old
Most common education level: Upper secondary
Most common fields of study:

- Social sciences, business, and law
- Engineering, manufacturing, and construction

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Business Services Managers have a low-medium risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- The growth of online platforms for sales and marketing means that data will increasingly drive buying and selling strategies, replacing to some degree the tasks undertaken by Business Services Managers.
- However, human interaction is still an important part of the sales and marketing process. Indeed, the low usage of e-commerce in Malaysia may inhibit automation of these positions in the near term.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	●	○	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

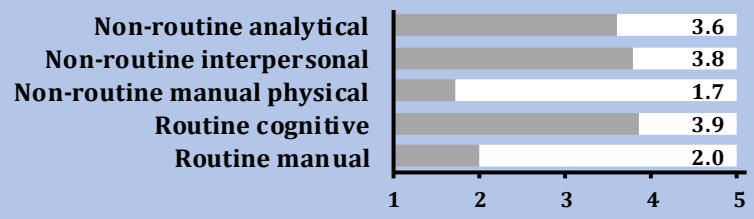
5. Business Services and Administration Managers Not Elsewhere Classified (1219)

Occupation Overview

Description: Business Services and Administration Managers Not Elsewhere Classified include job titles such as Purchasing Manager, Quality Control Manager, Quality Assurance Manager, Facilities Manager, and Corporate Services Manager that are not classified in other occupations.

Tasks: Business Services and Administration Managers Not Elsewhere Classified undertake routine cognitive tasks, and non-routine interpersonal and analytical tasks.

Task importance (1-5)



Gender: 27% female
Wage: N/A
Most common industries:

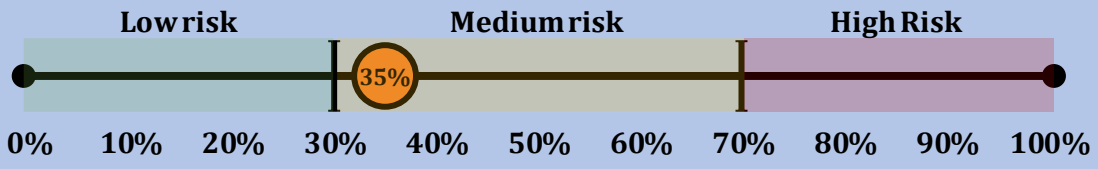
- Manufacturing
- Wholesale and retail trade; repair of motor vehicles and motorcycles

Age: 37-46 years old
Most common education level: Degree
Most common fields of study:

- Social sciences, business, and law
- Engineering, manufacturing, and construction

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Business Services and Administration Managers Not Elsewhere Classified have a low-medium risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- The growth of online platforms for sales and marketing means that data will increasingly drive buying and selling strategies, replacing to some degree the tasks undertaken by Business Services and Administration Managers Not Elsewhere Classified. Additionally, tasks, such as managing purchases and quality control, involve following rules and procedures and so can likely be automated.
- However, human interaction is still a key part of sales and marketing. Indeed, the low usage of e-commerce in Malaysia may inhibit automation of these positions in the near term.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	●	○	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

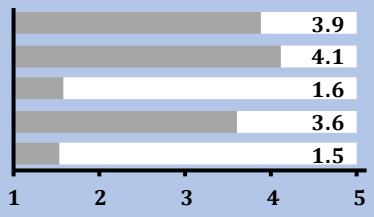
6. Sales and Marketing Managers (1221)

Occupation Overview

Description: Sales and Marketing Managers plan, organise, direct, control, and coordinate activities concerning the sales and marketing of an enterprise or organisation or of enterprises that provide sales and marketing services to other enterprises and organisations.

Tasks: Sales and Marketing Managers undertake non-routine interpersonal and analytical tasks, and routine cognitive tasks.

Task importance (1-5)



Gender: 26% female
Wage: 4,500-6,250 RM/month
Most common industries:

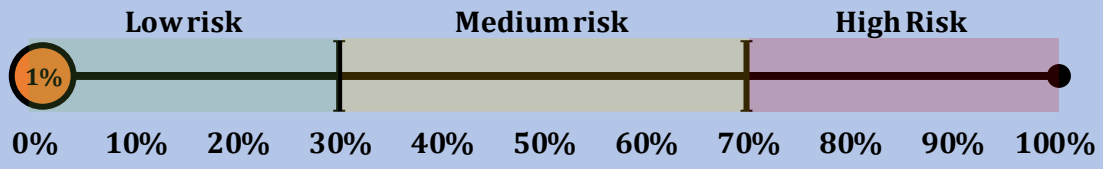
- Wholesale and retail trade; repair of motor vehicles and motorcycles
- Manufacturing

Age: 37-41 years old
Most common education level: Degree
Most common fields of study:

- Social sciences, business, and law
- Engineering, manufacturing, and construction

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Sales and Marketing Managers have a very low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- As selling and distribution move online, some of the tasks of Sales and Marketing Managers can likely be automated, particularly at less experienced levels.
- However, human interaction is still a key part of the sales and marketing process. Indeed, the low usage of e-commerce in Malaysia may inhibit automation of these positions in the near term.
- Additionally, automation is less likely for certain tasks, such as for large industrial sales where margins are higher, negotiation is important, and goods sold are variable.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	○	●	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

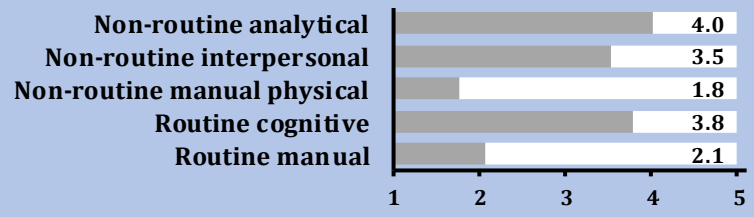
7. Research and Development Managers (1223)

Occupation Overview

Description: Research and Development Managers plan, organise, direct, control, and coordinate the research and development activities of organisations or of enterprises that provide development services to other enterprises and organisations.

Tasks: Research and Development Managers undertake non-routine analytical and interpersonal tasks, and routine cognitive tasks.

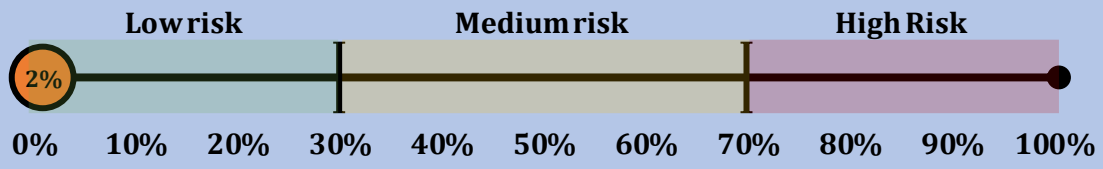
Task importance (1-5)



Gender: N/A
Age: N/A
Wage: N/A
Most common education level: N/A
Most common industries: N/A
Most common fields of study: N/A

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Research and Development Managers have a very low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- In Malaysia, Research and Development Managers tend to focus more on business development than on research. The business development function could in some cases be replaced by collaborative software linking teams of researchers.
- However, to the extent that Research and Development Managers undertake complex and ambiguous problem solving, automation will be more difficult.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	○	●	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

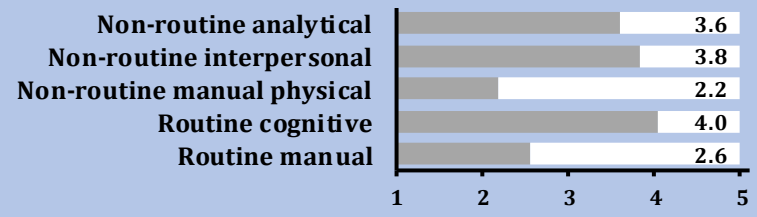
8. Manufacturing Managers (1321)

Occupation Overview

Description: Manufacturing Managers plan, organise, direct, control, and coordinate the manufacturing production activities of large enterprises or manage a small manufacturing company.

Tasks: Manufacturing Managers undertake routine cognitive tasks, and non-routine interpersonal and analytical tasks.

Task importance (1-5)

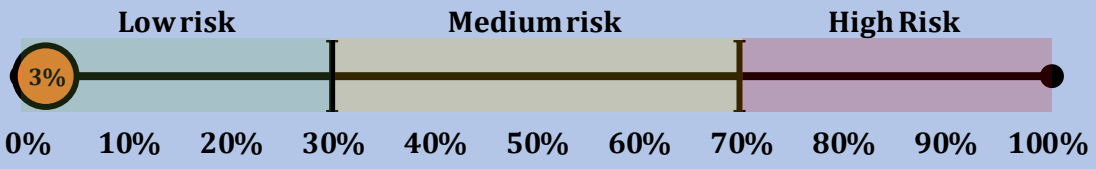


Gender: 11% female
Wage: 5,000-6,250 RM/month
Most common industries:
- Manufacturing

Age: 43-48 years old
Most common education level: Degree
Most common fields of study:
- Social sciences, business, and law
- Engineering, manufacturing, and construction

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Manufacturing Managers have a very low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- The combination of robotics in the manufacturing process and e-commerce in supply chain management makes Manufacturing Managers vulnerable to automation, particularly when production runs are long and products are relatively simple.
- However, such managers will likely remain necessary when production runs change and for manufacturing that involves one-off, custom, or specialized production runs.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

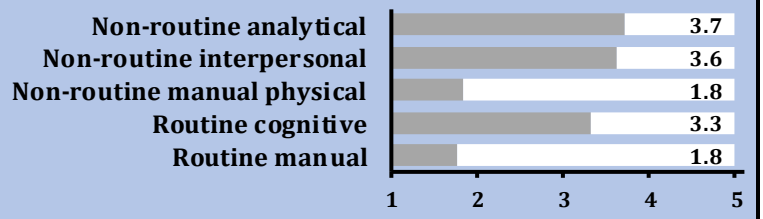
9. Construction Managers (1323)

Occupation Overview

Description: Construction Managers plan, organise, direct, control, and coordinate activities concerning the construction of civil engineering projects, buildings and dwellings.

Tasks: Construction Managers undertake non-routine analytical and interpersonal tasks, and routine cognitive tasks.

Task importance (1-5)



Gender: 4% female
Wage: 5,000-6,250 RM/month
Most common industries:

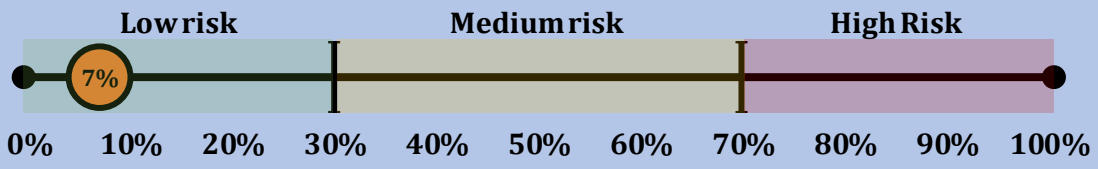
- Construction

Age: 41-47 years old
Most common education level: Upper secondary
Most common fields of study:

- Engineering, manufacturing, and construction
- Social sciences, business, and law

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Construction Managers have a low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- The labour intensiveness of the construction sector will likely make automation of the supervision tasks of Construction Managers difficult. That is, there will likely continue to be lower-skilled workers in the construction sector who require supervision and management.
- The variety of structures to be built also makes automation of tasks undertaken by Construction Managers difficult, though homogenous building units such as row houses and new construction processes such as industrialised building systems (IBS) could make automation easier.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	●	○	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

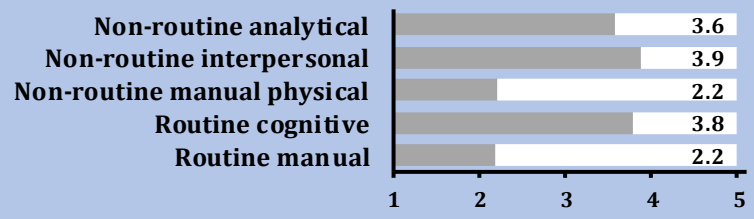
10. Supply, Distribution, and Related Managers (1324)

Occupation Overview

Description: Supply, Distribution, and Related Managers plan, organise, direct, control, and coordinate the supply, transport, storage, and distribution of goods.

Tasks: Supply, Distribution, and Related Managers undertake non-routine interpersonal and analytical tasks, and routine cognitive tasks.

Task importance (1-5)



Gender: 8% female

Age: 43-48 years old

Wage: N/A

Most common education level: Upper secondary

Most common industries:

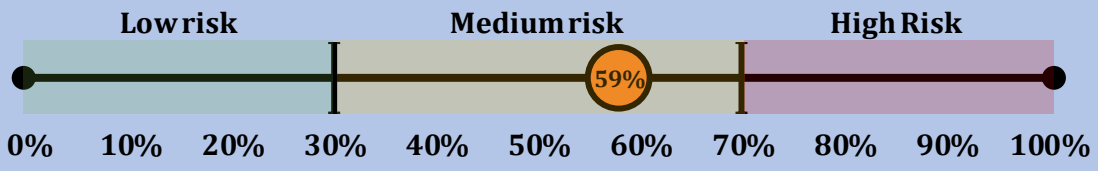
- Transportation and storage
- Wholesale and retail trade; repair of motor vehicles and motorcycles

Most common fields of study:

- Social sciences, business, and law
- Engineering, manufacturing, and construction

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Supply, Distribution, and Related Managers have a medium risk of automation overall, the non-routine interpersonal and analytical tasks that they undertake may be more difficult to automate.

- This role is already being automated, as transportation and logistics systems themselves are automated (e.g. driverless trains eliminate the role of station masters and warehouses employ robots rather than workers). The movement of commerce online will also facilitate automation of the tasks of Supply, Distribution, and Related Managers.
- Still, the economies of scale required for automation to be economical mean that only top-tier firms are currently able to adopt automation technologies for the tasks of Supply, Distribution, and Related Managers.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

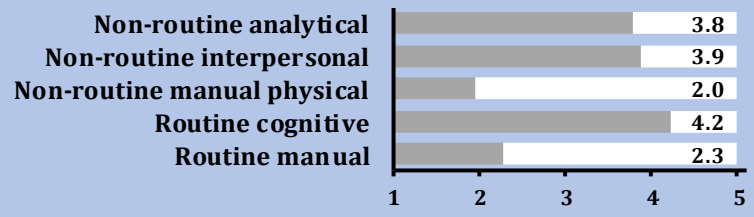
11. Information and Communications Technology Managers (1511)

Occupation Overview

Description: Information and Communications Technology Managers organise, plan, direct, control, and coordinate the acquisition, development, maintenance, and use of computers and telecommunications systems.

Tasks: Information and Communications Technology Managers undertake routine cognitive tasks, and non-routine interpersonal and analytical tasks.

Task importance (1-5)

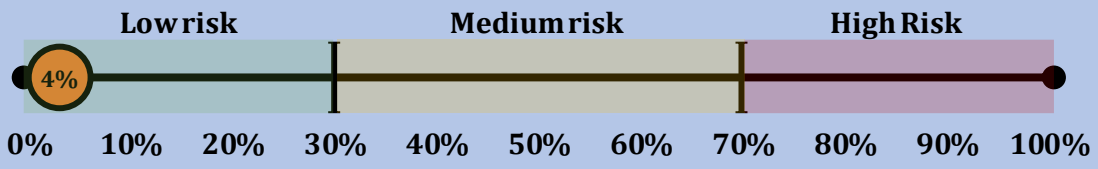


Gender: 22% female
Wage: 5,085-6,200 RM/month
Most common industries:
- Information and communication

Age: 40-44 years old
Most common education level: Degree
Most common fields of study:
- Science, mathematics, and computing
- Social sciences, business, and law

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Information and Communications Technology Managers have a very low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- Tasks of Information and Communications Technology Managers that are unlikely to be automated include interacting with other senior managers, developing IT strategies and roadmaps, gathering IT system requirements and then planning and scoping according to these requirements, and project management.
- More routine tasks are more likely to be automated. These include monitoring data loads, systems performance checks, increasing data storage capacity, business reporting, asset management, and data governance.

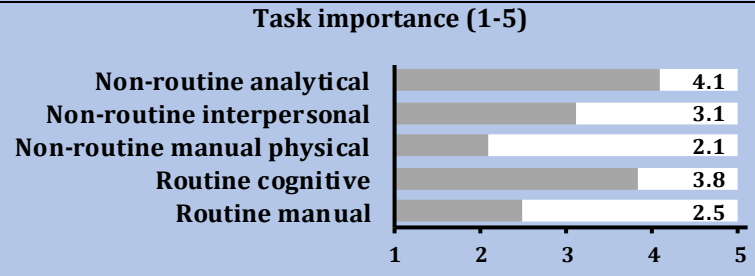
Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	○	●	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

12. Chemists (2113)

Occupation Overview

Description: Chemists conduct research, improve or develop concepts, theories, and operational methods, or apply scientific knowledge relating to chemistry, mainly to test, develop, and improve materials and industrial products and processes.

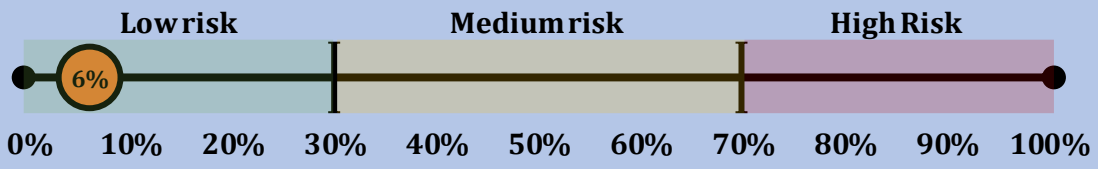
Tasks: Chemists undertake non-routine analytical tasks and routine cognitive tasks.



Gender: N/A
Age: N/A
Wage: N/A
Most common education level: N/A
Most common industries: N/A
Most common fields of study: N/A

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Chemists have a low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- Advances in computer modelling allow for simulations of many chemical interactions, which may reduce the number of chemists needed and free others to focus on higher-level tasks.
- The tasks of industrial chemists are likely to be more susceptible to automation than those of research chemists because the work of industrial chemists involves less originality.

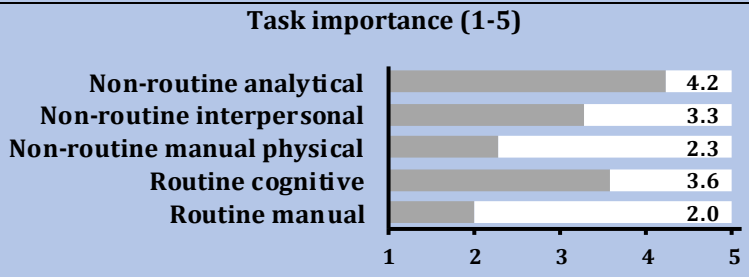
Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

13. Geologists and Geophysicists (2114)

Occupation Overview

Description: Geologists and Geophysicists conduct research, improve or develop concepts, theories, and operational methods, or apply scientific knowledge relating to geology and geophysics in fields such as oil, gas, and mineral exploitation, water conservation, civil engineering, and telecommunications and navigation, and assess development projects and the effects of waste disposal on the environment.

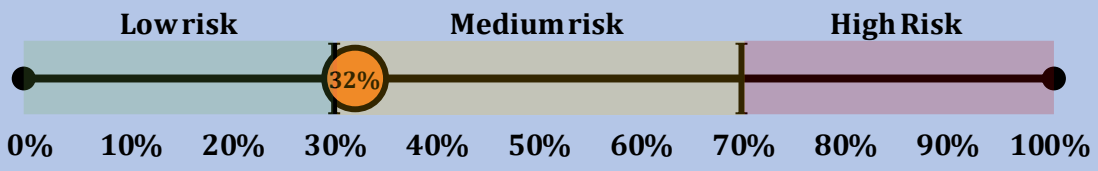
Tasks: Geologists and Geophysicists undertake non-routine analytical tasks and routine cognitive tasks.



Gender: N/A
Wage: N/A
Most common industries: N/A
Age: N/A
Most common education level: N/A
Most common fields of study: N/A

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Geologists and Geophysicists have a low-medium risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- The testing and analysis tasks undertaken by Geologists and Geophysicists can likely be automated, though variations in geology pose a potential constraint.

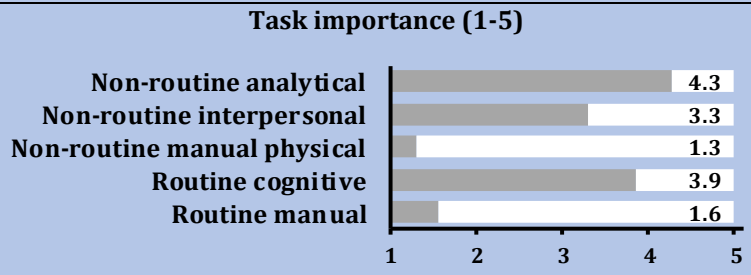
Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	●	○	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

14. Mathematicians, Actuaries, and Statisticians (2121)

Occupation Overview

Description: Mathematicians, Actuaries, and Statisticians conduct research and improve or develop mathematical, actuarial, and statistical concepts, theories, operational methods, and techniques, and advise on or engage in their practical application in such fields as engineering, business, social, and other sciences.

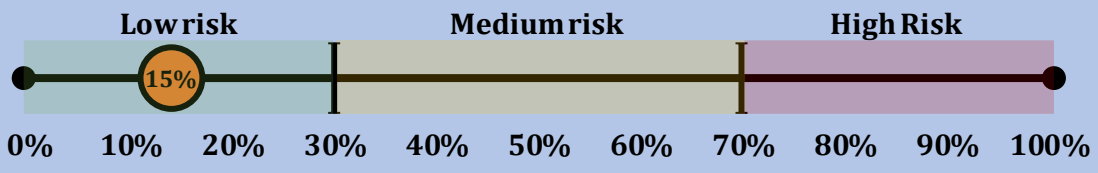
Tasks: Mathematicians, Actuaries, and Statisticians undertake non-routine analytical tasks and routine cognitive tasks.



Gender: N/A
Age: N/A
Wage: N/A
Most common education level: N/A
Most common industries: N/A
Most common fields of study: N/A

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Mathematicians, Actuaries, and Statisticians have a low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- Some of the tasks formerly undertaken by Mathematicians, Actuaries, and Statisticians such as computations are already embedded in advanced software. As this software continues to be adopted, the remaining human mathematicians, actuaries, and statisticians will likely be leveraged across much larger databases than in the past and have increasingly complex tasks.
- Tasks that involve abstract thinking such as theoretical mathematics or statistics will be more challenging to automate.

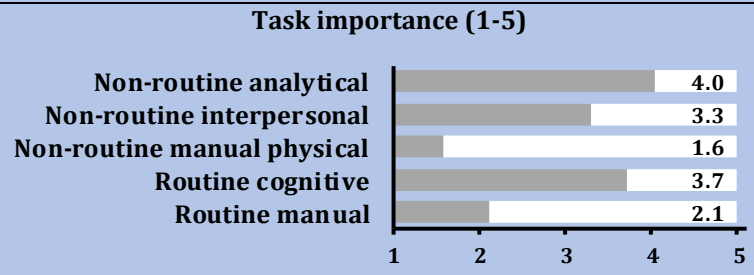
Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	○	●	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

15. Industrial and Production Engineers (2141)

Occupation Overview

Description: Industrial and Production Engineers plan, conduct research, design, and oversee the construction, operation, and maintenance process and installation of plants. They establish programmes for the coordination of manufacturing activities and assess cost effectiveness and safety.

Tasks: Industrial and Production Engineers undertake non-routine analytical tasks and routine cognitive tasks.



Gender: 14% female
Wage: 3,800-4,200 RM/month
Most common industries:

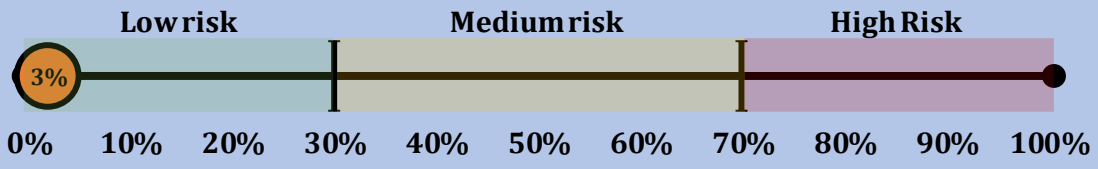
- Manufacturing

Age: 30-34 years old
Most common education level: Degree
Most common fields of study:

- Engineering, manufacturing, and construction

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Industrial and Production Engineers have a very low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- Variations in project and plant sites and sizes make automation of the tasks of Industrial and Production Engineers challenging. Additionally, these engineers tend to be responsible for developing automation strategies and processes.
- However, the job relies heavily on data for decision making. Some of these aspects of the job could be susceptible to automation.

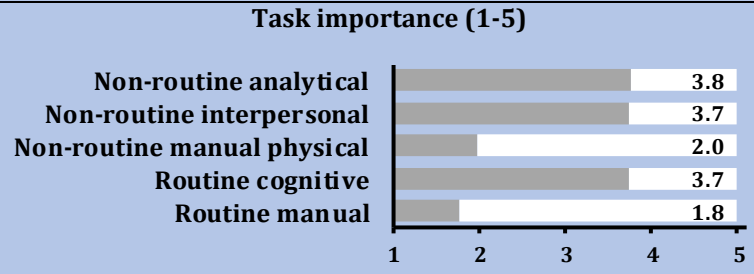
Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	●	○	○
Are there legal, regulatory, or normative constraints to automation?	○	●	○

16. Civil Engineers (2142)

Occupation Overview

Description: Civil Engineers plan, conduct research, advise on, design, and direct construction activity; manage the operation and maintenance of civil engineering structures; or study and advise on technological aspects of particular materials.

Tasks: Civil Engineers undertake non-routine analytical and interpersonal tasks, and routine cognitive tasks.

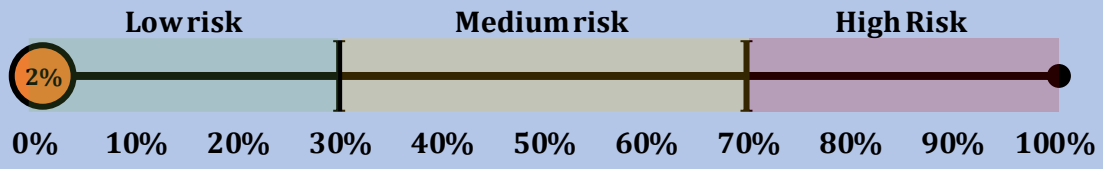


Gender: 20% female
Wage: 4,000-5,000 RM/month
Most common industries:
- Construction
- Public administration and defence; compulsory social security

Age: 33-38 years old
Most common education level: Degree
Most common fields of study:
- Engineering, manufacturing, and construction

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Civil Engineers have a very low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- The variety of infrastructure and facilities to be developed and maintained make automation of the tasks of Civil Engineers difficult.
- Regulatory requirements are important to consider. For higher level Civil Engineers, regulatory requirements are in place that involve sign off. For lower level Civil Engineers, regulatory requirements could be superseded by process standards, facilitating automation.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	●	○	○
Are there legal, regulatory, or normative constraints to automation?	○	●	○

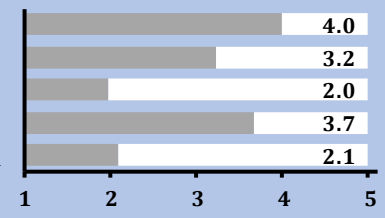
17. Mechanical Engineers (2144)

Occupation Overview

Description: Mechanical Engineers conduct research and advise on, design, and direct the production of machinery and equipment and industrial plant systems, and advise on and direct their functioning, maintenance, and repairs, or study and advise on technological aspects of particular materials, products, or processes.

Tasks: Mechanical Engineers undertake non-routine analytical tasks and routine cognitive tasks.

Task importance (1-5)

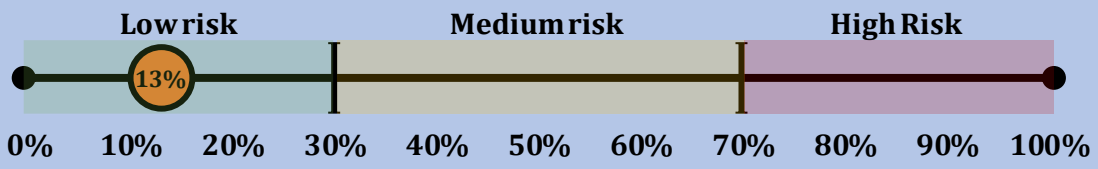


Gender: 14% female
Wage: 4,400-5,910 RM/month
Most common industries:
- Manufacturing
- Mining and quarrying

Age: 29-33 years old
Most common education level: Degree
Most common fields of study:
- Engineering, manufacturing, and construction

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Mechanical Engineers have a low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- The design-related tasks undertaken by Mechanical Engineers are likely to be more difficult to automate, though tasks that are more closely related to manufacturing and procedural responsibilities can likely be automated.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	●	○	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

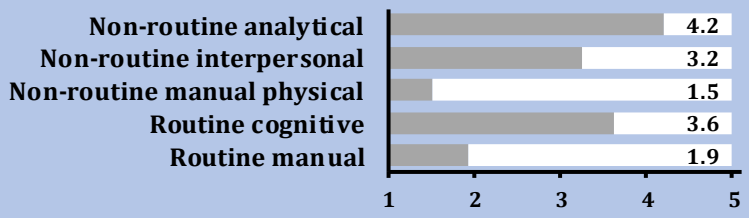
18. Chemical Engineers (2145)

Occupation Overview

Description: Chemical Engineers conduct research and develop, design, and advise on and direct commercial-scale chemical processes and production of various substances and items such as crude oil, petroleum derivatives, food and drink products, medicaments, or synthetic materials, and direct maintenance and repair of industrial plants, or study and advise on technological aspects of particular materials, products, or processes.

Tasks: Chemical Engineers undertake non-routine analytical tasks and routine cognitive tasks.

Task importance (1-5)



Gender: 38% female
Wage: N/A
Most common industries:

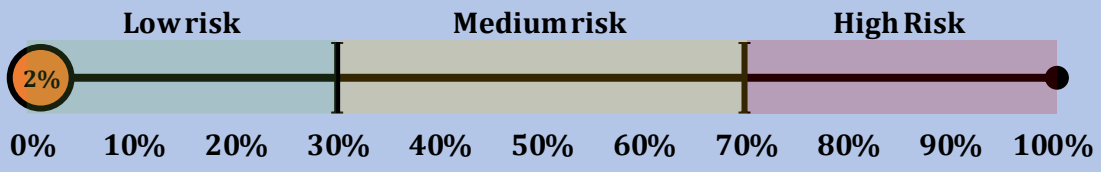
- Manufacturing
- Professional, scientific, and technical activities

Age: 27-29 years old
Most common education level: Degree
Most common fields of study:

- Engineering, manufacturing, and construction
- Science, mathematics, and computing

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Chemical Engineers have a very low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- Systems and technologies currently exist to automate some of the tasks of Chemical Engineers. The tasks of those performing process monitoring are likely to be easier to automate, while the tasks of those doing design are likely to be more difficult to automate.

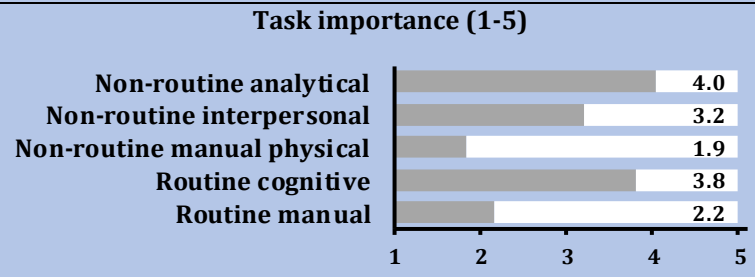
Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	○	●	○
Is the cost of new technologies a constraint to automation?	●	○	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

19. Mining Engineers, Metallurgists, and Related Professionals (2146)

Occupation Overview

Description: Mining Engineers, Metallurgists, and Related Professionals conduct research, design, and develop and maintain commercial-scale methods of extracting metals from their ores or minerals, water, and oil or gas from the earth and of developing new alloys, ceramic, and other materials, or study and advise on technological aspects of particular materials, products, or processes.

Tasks: Mining Engineers, Metallurgists, and Related Professionals undertake non-routine analytical tasks and routine cognitive tasks.

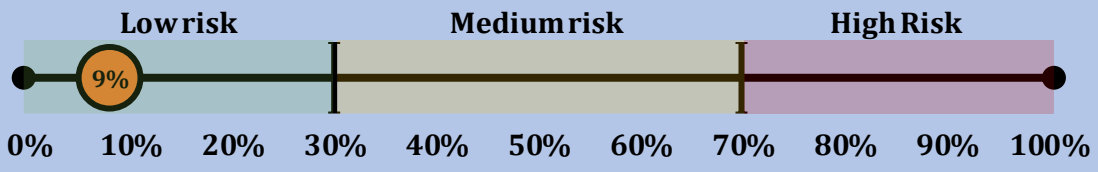


Gender: 18% female
Wage: N/A
Most common industries:
- Mining and quarrying
- Professional, scientific, and technical activities

Age: 31-35 years old
Most common education level: Degree
Most common fields of study:
- Engineering, manufacturing, and construction

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Mining Engineers, Metallurgists, and Related Professionals have a low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- The knowledge production function of Mining Engineers, Metallurgists, and Related Professionals, and variations in geology, which is the basis for much of their work, are challenges to automating this occupation.

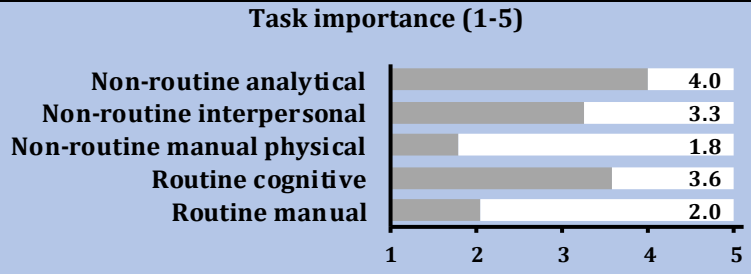
Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	●	○	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

20. Engineering Professionals (Excluding Electrotechnology) Not Elsewhere Classified (2149)

Occupation Overview

Description: Engineering Professionals (Excluding Electrotechnology) Not Elsewhere Classified include job titles such as Building Surveyor Grade J41, Factories and Machinery Inspector Grade J41, Process Engineer, and Quality Control Engineer that are not classified in other occupations.

Tasks: Engineering Professionals (Excluding Electrotechnology) Not Elsewhere Classified undertake non-routine analytical tasks and routine cognitive tasks.

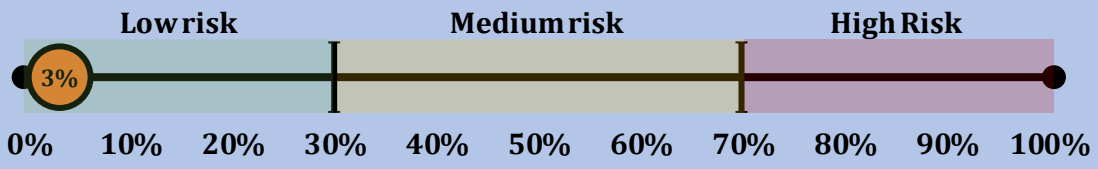


Gender: 40% female
Wage: 3,900-5,000 RM/month
Most common industries:
- Manufacturing
- Construction

Age: 30-35 years old
Most common education level: Degree
Most common fields of study:
- Engineering, manufacturing, and construction

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Engineering Professionals (Excl. Electrotechnology) Not Elsewhere Classified have a very low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- Tasks of engineers that involve planning and scoping work and gathering technical and user requirements are unlikely to be automated.
- Tasks that involve occupational safety and health may also face barriers to automation from requirements imposed by laws and regulations.
- Other tasks are more likely to be automated, such as when technological improvements reduce the need for maintenance (e.g. an air conditioning chiller plant is automated to optimise performance, which reduces the need for maintenance).

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	●	○	○
Are there legal, regulatory, or normative constraints to automation?	○	●	○

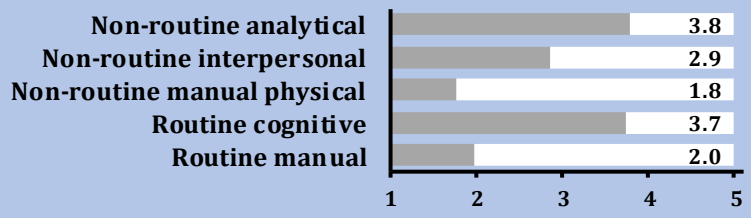
21. Electrical Engineers (2151)

Occupation Overview

Description: Electrical Engineers conduct research and advise on, design, and direct the construction and operation of electrical systems, components, motors, and equipment, and advise on and direct their maintenance and repair, or study and advise on technological aspects of electrical engineering materials, products, and processes.

Tasks: Electrical Engineers undertake non-routine analytical tasks and routine cognitive tasks.

Task importance (1-5)



Gender: 14% female
Wage: 4,000-5,000 RM/month
Most common industries:

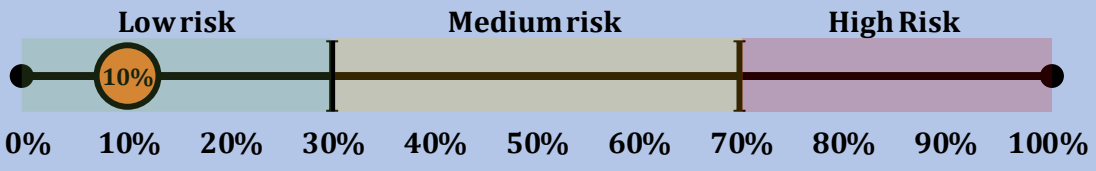
- Electricity, gas, steam, and air conditioning supply
- Manufacturing

Age: 31-35 years old
Most common education level: Degree
Most common fields of study:

- Engineering, manufacturing, and construction

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Electrical Engineers have a low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- Electrical Engineers have a role in designing and commissioning capital projects, which would be difficult to automate.
- However, tasks related to repetitive and routine inspection and testing are more likely to be automated.

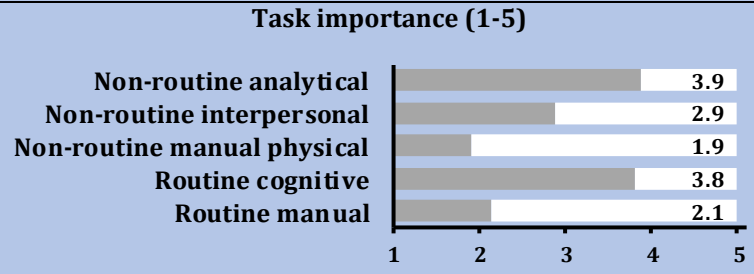
Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

22. Electronic Engineers (2152)

Occupation Overview

Description: Electronic Engineers conduct research on, design, and direct the maintenance and repair of electronic systems. They study and advise on technological aspects of electronic engineering materials, products, and processes.

Tasks: Electronic Engineers undertake non-routine analytical tasks and routine cognitive tasks.

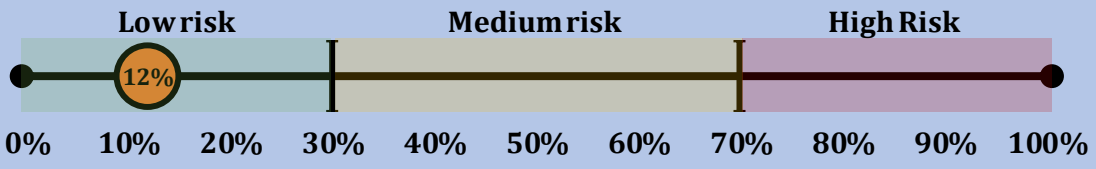


Gender: 15% female
Wage: 4,810-5,000 RM/month
Most common industries:
- Manufacturing
- Information and communication

Age: 30-34 years old
Most common education level: Degree
Most common fields of study:
- Science, mathematics, and computing
- Engineering, manufacturing, and construction

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Electronic Engineers have a low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- The research aspects of this occupation will be more difficult to automate.
- Regulations requiring the approval of Electronic Engineers for certain projects may be a constraint to automation, though these can generally be circumvented through process standards and by elevating approval to a higher-level position.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	●	○	○
Are there legal, regulatory, or normative constraints to automation?	○	●	○

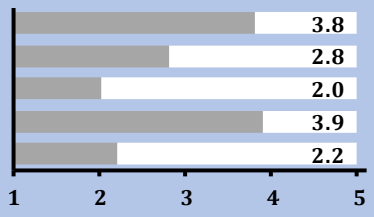
23. Telecommunications Engineers (2153)

Occupation Overview

Description: Telecommunications Engineers conduct research, design, and direct the maintenance and repair of systems and telecommunications equipment. They study and advise on technological aspects of materials, products, and processes in telecommunications engineering.

Tasks: Telecommunications Engineers undertake non-routine analytical tasks and routine cognitive tasks.

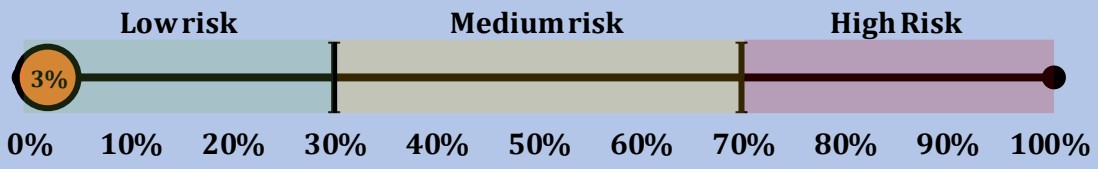
Task importance (1-5)



Gender: N/A
Age: N/A
Wage: N/A
Most common education level: N/A
Most common industries: N/A
Most common fields of study: N/A

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Telecommunications Engineers have a very low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- The research aspects of this occupation will be more difficult to automate.
- Regulations requiring the approval of Telecommunications Engineers for certain projects may be a constraint to automation, though these can generally be circumvented through process standards and by elevating the approval to a higher-level position.

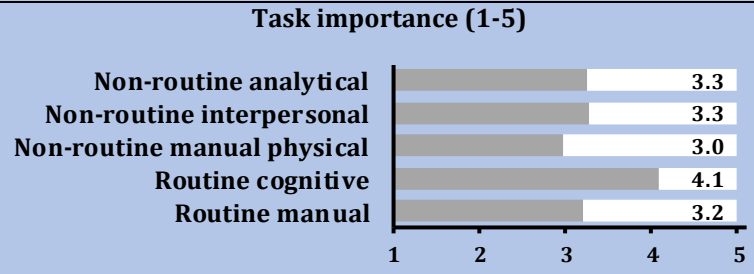
Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	●	○	○
Are there legal, regulatory, or normative constraints to automation?	○	●	○

24. Ships Engineers (2171)

Occupation Overview

Description: Ships Engineers control and participate in the operation, maintenance, and repair of electrical and electronic equipment and machinery on board, or perform related supporting functions.

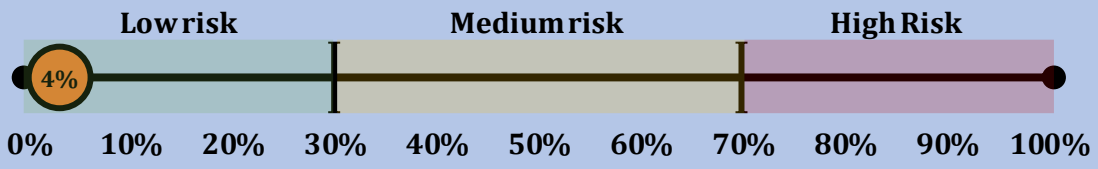
Tasks: Ships Engineers undertake routine cognitive tasks, and non-routine analytical and interpersonal tasks.



Gender: N/A
Age: N/A
Wage: N/A
Most common education level: N/A
Most common industries: N/A
Most common fields of study: N/A

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Ships Engineers have a very low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- Fully automated vessels would make Ships Engineers unnecessary. However, in terms of actual adoption of automation technologies the maritime industry worldwide is lagging.
- Diverse ships and demand for custom tasks in shipyards are also constraints to automation.

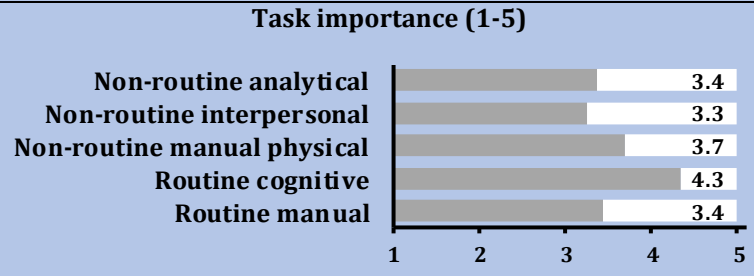
Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

25. Aircraft Pilots and Related Professionals (2173)

Occupation Overview

Description: Aircraft Pilots and Related Professionals control the operation of mechanical, electrical, and electronic equipment in order to navigate aircraft and perform pre-flight and in-flight tasks.

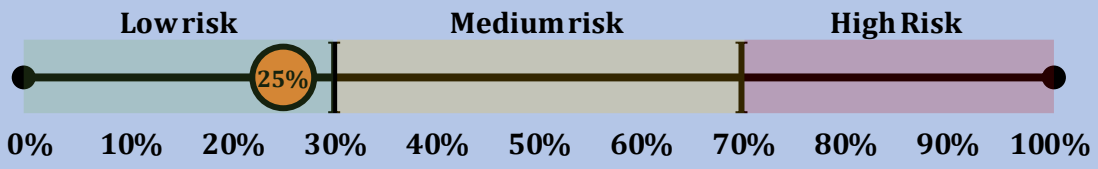
Tasks: Aircraft Pilots and Related Professionals undertake routine cognitive tasks and non-routine manual physical tasks.



Gender: N/A
Age: N/A
Wage: N/A
Most common education level: N/A
Most common industries: N/A
Most common fields of study: N/A

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Aircraft Pilots and Related Professionals have a low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- Drones and remote controlled aircraft already exist. Over time, these and related automated flight craft will likely become more prominent.
- Automation of commercial flight may be slower, however, due to perceived safety issues.
- Human pilots may also be seen as a last line of defence in the case of a technical malfunction.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	○	●	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	●	○	○

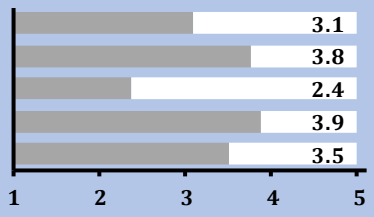
26. Manufacturing Professionals (2182)

Occupation Overview

Description: Manufacturing Professionals conduct research and improve or develop concepts, theories, and operational methods, or apply existing knowledge concerning quality assurance and the production of food, paper, and other materials.

Tasks: Manufacturing Professionals undertake routine cognitive and manual tasks, and non-routine interpersonal tasks.

Task importance (1-5)



Gender: 31% female
Wage: 3,145-4,100 RM/month
Most common industries:

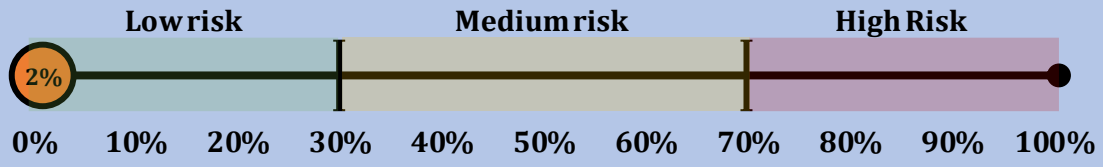
- Manufacturing

Age: 33-39 years old
Most common education level: Degree
Most common fields of study:

- Engineering, manufacturing, and construction
- Social sciences, business, and law

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Manufacturing Professionals have a very low risk of automation overall, the routine cognitive and routine manual tasks that they undertake may be automated.

- The tasks of Manufacturing Professionals are likely to be automatable for large operations with large production runs (e.g. manufacturing of mass market soft drinks). The tasks of Manufacturing Professionals in the electronics sector – such as inspection, testing, and equipment design – are already automated to a significant degree.
- However, process design tasks are more difficult to automate.

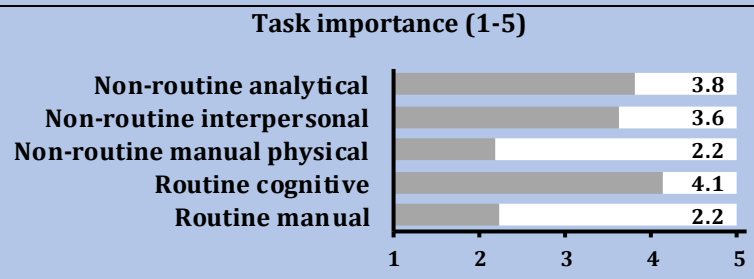
Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

27. Specialist Medical Practitioners (2212)

Occupation Overview

Description: Specialist Medical Practitioners diagnose, treat, and prevent illnesses, infections, injuries, and other physical and mental impairments in humans using specialised testing, diagnostic, medical, surgical, physical, and psychiatric techniques through application of the principles and procedures of modern medicine. They specialise in certain disease categories or methods of treatment, and may conduct medical education and research in their chosen areas of specialisation.

Tasks: Specialist Medical Practitioners undertake routine cognitive tasks, and non-routine analytical and interpersonal tasks.

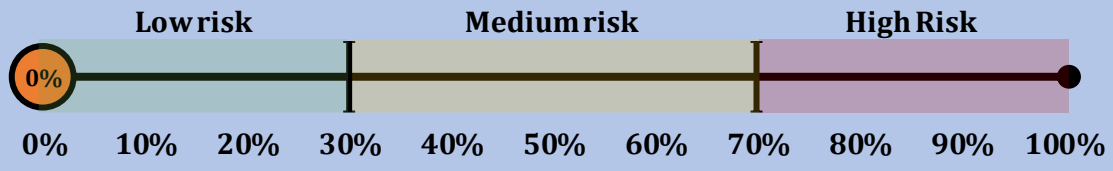


Gender: N/A
Wage: N/A
Most common industries: N/A

Age: N/A
Most common education level: N/A
Most common fields of study: N/A

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Specialist Medical Practitioners have a very low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- As technology improves, the data acquisition, analysis, and diagnostic functions of Specialist Medical Practitioners are likely to be progressively automated.
- Telemedicine may reduce the number of specialist practitioners needed, such as if a specialist cardiac surgeon worked in partnership with several different general practitioners to perform heart surgeries.
- However, the medical field is heavily regulated, which may hinder the introduction of automation technologies.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	●	○

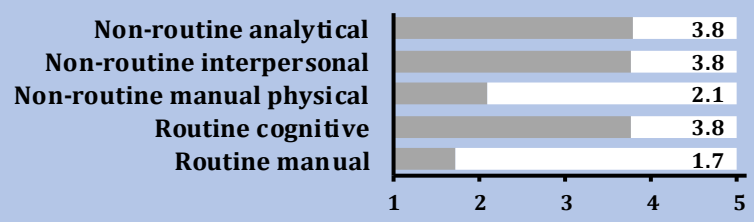
28. Environmental and Occupational Health and Hygiene Professionals (2263)

Occupation Overview

Description: Environmental and Occupational Health and Hygiene Professionals assess, plan, and conduct programmes to identify, monitor, and control environmental factors that can potentially affect human health to ensure safe and healthy workplaces, and to prevent disease or injury caused by chemical, physical, radiological, and biological agents or ergonomic factors.

Tasks: Environmental and Occupational Health and Hygiene Professionals undertake non-routine analytical and interpersonal tasks, and routine cognitive tasks.

Task importance (1-5)



Gender: 18% female
Wage: 3,145-4,144 RM/month
Most common industries:

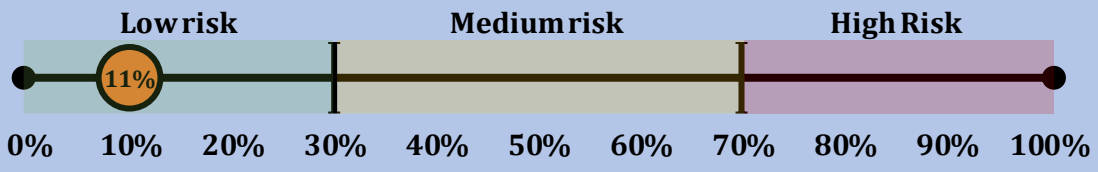
- Public administration and defence; compulsory social security
- Human health and social work activities

Age: 29-34 years old
Most common education level: Diploma/Certificate
Most common fields of study:

- Health and welfare

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Environmental and Occupational Health and Hygiene Professionals have a low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- Supervisory control and data acquisition (SCADA) systems may facilitate automation of the tasks performed by Environmental and Occupational Health and Hygiene Professionals. However, cost-effectiveness is a significant barrier, as such systems require facility redesign.
- Health, safety, and environmental regulations may be a constraint to automation.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	○	●	○
Is the cost of new technologies a constraint to automation?	●	○	○
Are there legal, regulatory, or normative constraints to automation?	○	●	○

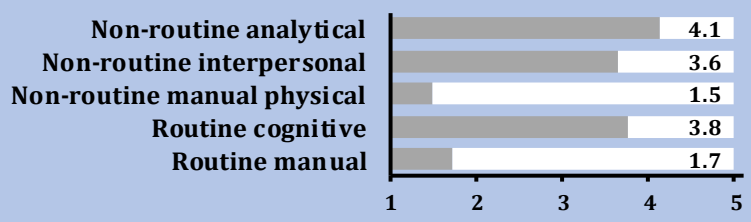
29. University and Higher Education Professional Teachers (2311)

Occupation Overview

Description: University and Higher Education Professional Teachers prepare and deliver lectures and conduct tutorials in one or more subjects within a prescribed course of study at a university or other higher educational institution. They conduct research and prepare academic papers and books.

Tasks: University and Higher Education Professional Teachers undertake non-routine analytical and interpersonal tasks, and routine cognitive tasks.

Task importance (1-5)



Gender: 54% female
Wage: 5,000-6,236 RM/month
Most common industries:

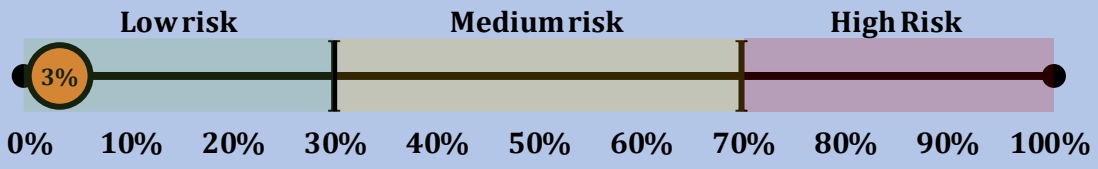
- Education

Age: 36-40 years old
Most common education level: Degree
Most common fields of study:

- Social sciences, business, and law
- Science, mathematics, and computing

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although University and Higher Education Professional Teachers have a very low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- Automation of teaching tasks performed by University and Higher Education Professional Teachers is already occurring via online courses. Online platforms can allow professors from around the world to teach large populations of students. Malaysian universities may lack the international recognition necessary to supply the professors for these online courses.
- Research tasks undertaken by University and Higher Education Professional Teachers may be less easily automated.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	○	●	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

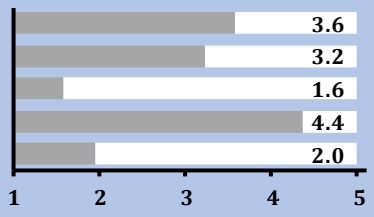
30. Accountants (2411)

Occupation Overview

Description: Accountants plan, organise, and administer accounting systems, and examine and analyse the accounting and financial records of individuals and establishments to ensure accuracy and compliance with established accounting standards and procedures.

Tasks: Accountants undertake routine cognitive tasks and non-routine analytical tasks.

Task importance (1-5)



Gender: 70% female
Wage: 3,200-4,500 RM/month
Most common industries:

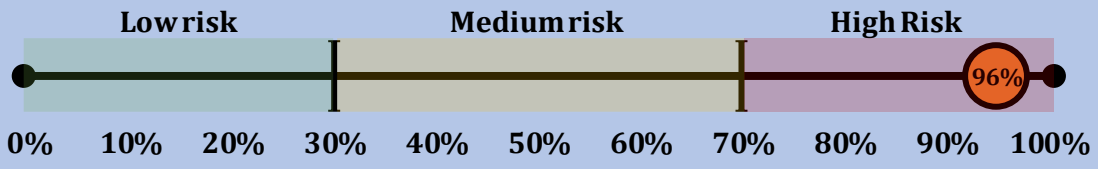
- Professional, scientific, and technical activities
- Manufacturing

Age: 30-35 years old
Most common education level: Degree
Most common fields of study:

- Social sciences, business, and law

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Accountants have a very high risk of automation overall, the non-routine analytical tasks that they undertake may be more difficult to automate.

- The tasks of Accountants typically require analysing structured data based on established principles, making the occupation a good candidate for automation. Tax software and blockchain are examples of technologies that will facilitate automation.
- There are some regulatory restrictions, such as requirements for auditors to sign off on accounts, that may be constraints to automation at higher levels of the occupation.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	○	●	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	●	○

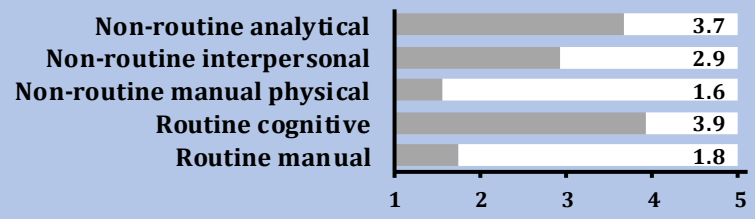
31. Financial Analysts (2413)

Occupation Overview

Description: Financial Analysts conduct quantitative analyses of information affecting investments in public and private institutions.

Tasks: Financial Analysts undertake routine cognitive tasks and non-routine analytical tasks.

Task importance (1-5)

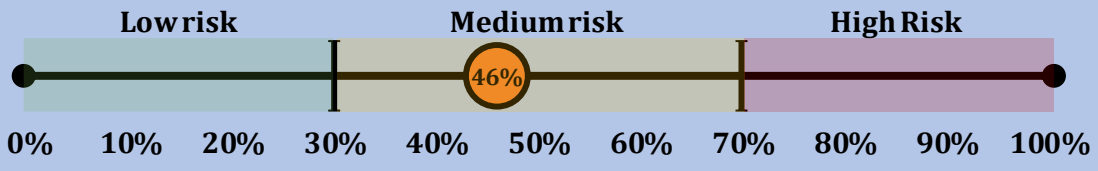


Gender: 40% female
Wage: N/A
Most common industries:
- Financial and insurance
- Mining and quarrying

Age: 30-37 years old
Most common education level: Degree
Most common fields of study:
- Social sciences, business, and law

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Financial Analysts have a medium risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- The tasks of Financial Analysts are being heavily automated by technology (e.g. online financial portals) and by new financial instruments (e.g. target date funds and index funds).
- Analysis by Financial Analysts is frequently done on structured datasets, which makes automation possible. In some cases, a team of Financial Analysts and computers working together may dominate other options.
- For some Financial Analysts, such as those who develop financial products, originality is needed. These tasks are likely to be more difficult to automate.
- Laws and regulations requiring an accredited analyst to submit regulatory financial filings could be a barrier to automation.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	○	●	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	●	○

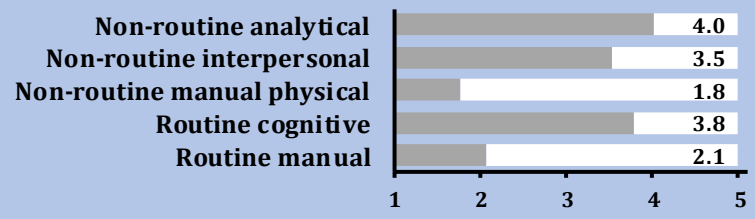
32. Research and Development Professionals (2426)

Occupation Overview

Description: Research and Development Professionals plan and execute policies, and are responsible for basic research and science for the development of technology and new inventions.

Tasks: Research and Development Professionals undertake non-routine analytical and interpersonal tasks, and routine cognitive tasks.

Task importance (1-5)



Gender: 61% female
Wage: 3,760-4,200 RM/month
Most common industries:

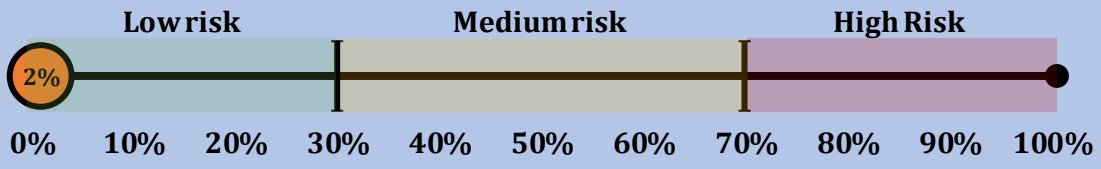
- Public administration and defence; compulsory social security
- Professional, scientific, and technical activities

Age: 33-34 years old
Most common education level: Degree
Most common fields of study:

- Science, mathematics, and computing
- Agriculture and veterinary

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Research and Development Professionals have a very low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- Research generally requires tacit knowledge, such as understanding whether a research outcome is workable or ethical when applied in the real world, which may hinder automation.
- However, some research tasks are repetitive and rules-driven, which would allow for automation. Additionally, advances in artificial intelligence mean that computers are able to automate research in some cases. Examples include research into human cognitive behaviour, the human genome, and human speech.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	●	○	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

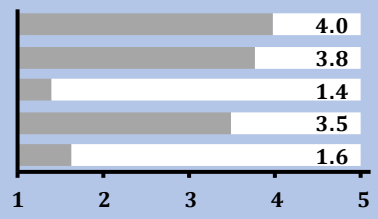
33. Public Relations Professionals (2432)

Occupation Overview

Description: Public Relations Professionals improve, advise or apply operational methods to build, maintain, and manage communications between an organisation and the public.

Tasks: Public Relations Professionals undertake non-routine analytical and interpersonal tasks, and routine cognitive tasks.

Task importance (1-5)



Gender: 67% female
Wage: 2,600-3,450 RM/month
Most common industries:

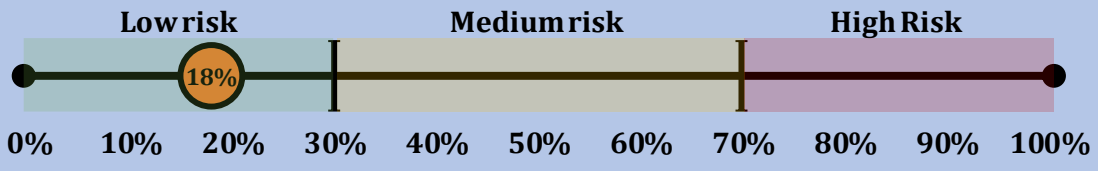
- Financial and insurance
- Information and communication

Age: 29-33 years old
Most common education level: Degree
Most common fields of study:

- Social sciences, business, and law
- Science, mathematics, and computing

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Public Relations Professionals have a low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- Tasks of Public Relations Professionals that are related to common, repeated questions or to questions or interactions that can be shaped via decision or choice architecture are more likely be automated (e.g. through online FAQs or chatbots).
- However, tasks such as managing responses to crises and developing communications strategies that require understanding the changing psychology of the target audience will be more difficult to automate. Still, big data can inform such responses.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	●	○	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

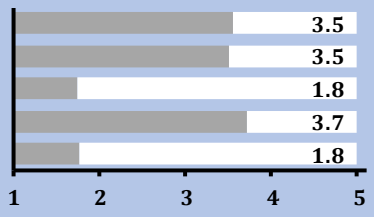
34. Information and Communications Technology (ICT) Sales Professionals (2434)

Occupation Overview

Description: Information and Communications Technology (ICT) Sales Professionals sell a range of computer hardware, software, and other information and communications technology goods and services including installation, and provide specialised information as required.

Tasks: ICT Sales Professionals undertake routine cognitive tasks, and non-routine analytical and interpersonal tasks.

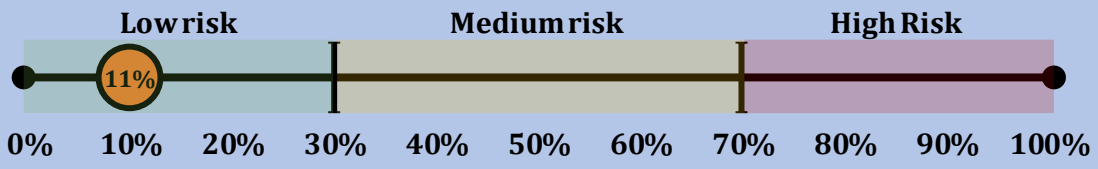
Task importance (1-5)



Gender: N/A
Age: N/A
Wage: N/A
Most common education level: N/A
Most common industries: N/A
Most common fields of study: N/A

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although ICT Sales Professionals have a low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- The sales tasks performed by ICT Sales Professionals may be automated and migrated online.
- In contrast, advisory tasks undertaken by ICT Sales Professionals are likely to be more difficult to automate.

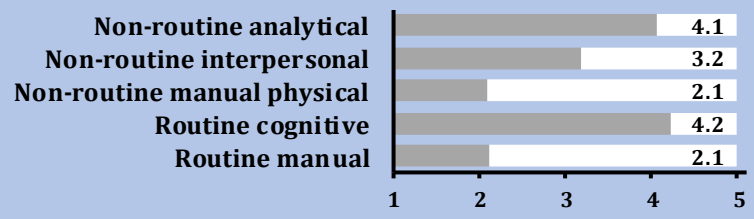
Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	○	●	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

35. Systems Analysts (2511)

Occupation Overview

Description: Systems Analysts gather and analyse facts on operations, procedures, and systems for transfer into a program appropriate for data processing equipment, and recommend computer use to increase productivity, efficiency, and organisational profit.

Tasks: Systems Analysts undertake routine cognitive tasks, and non-routine analytical tasks.

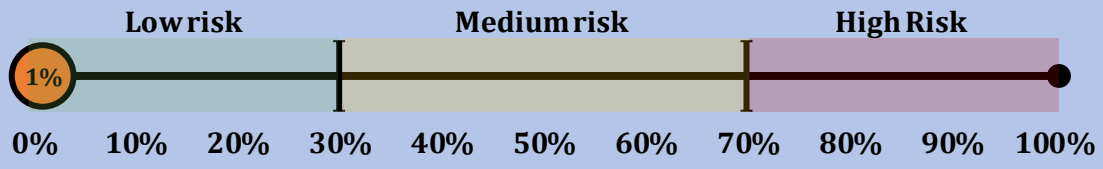


Gender: 30% female
Wage: 4,810-5,000 RM/month
Most common industries:
- Information and communication
- Professional, scientific, and technical activities

Age: 33-38 years old
Most common education level: Degree
Most common fields of study:
- Science, mathematics, and computing

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Systems Analysts have a very low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- Tasks undertaken by Systems Analysts that are more likely to be automated include coding, selection of tools, and rules-based system architecture development.
- Tasks undertaken by Systems Analysts that are less likely to be automated include gathering system and user requirements, work scoping and project management, team and project management, client and user management, non-routine troubleshooting, and crisis response.
- New developments in IT systems are likely to continue to require System Analysts with higher order skills.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	○	●	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

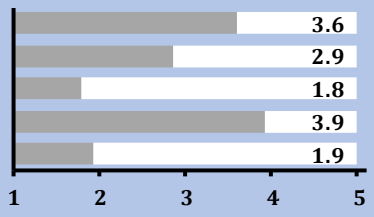
36. Software Developers (2512)

Occupation Overview

Description: Software Developers study, analyse, and evaluate requirements for existing or new software applications and operating systems, and design, develop, test, and maintain software solutions to meet requirements.

Tasks: Software Developers undertake routine cognitive tasks and non-routine analytical tasks.

Task importance (1-5)

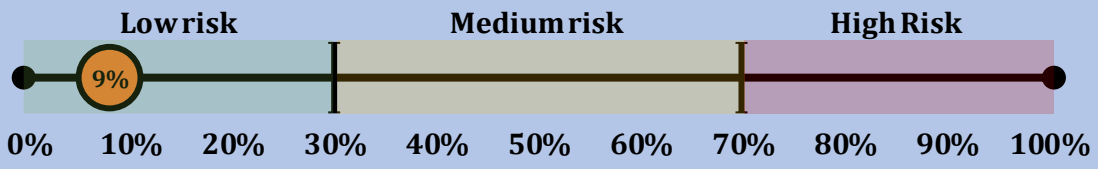


Gender: 9% female
Wage: N/A
Most common industries:
- Information and communication
- Manufacturing

Age: 31-33 years old
Most common education level: Degree
Most common fields of study:
- Science, mathematics, and computing
- Engineering, manufacturing, and construction

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Software Developers have a low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- Tasks undertaken by Software Developers that are more likely to be automated include coding and design selection, such as selection of colours, shapes, and other design aspects that meet customer requirements.
- Tasks undertaken by Software Developers that are less likely to be automated include gathering system and user requirements, work scoping and project management, team and project management, client and user management, non-routine trouble shooting, and crisis response. Human Software Developers will likely remain necessary to ensure that software meets market demand.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	●	○	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

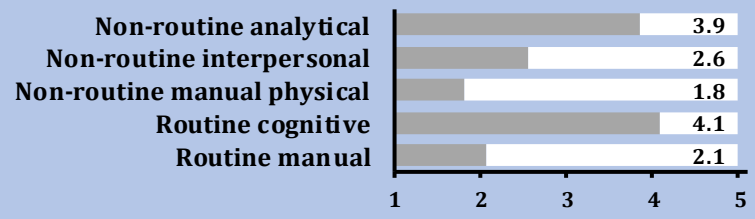
37. Applications Programmers (2514)

Occupation Overview

Description: Applications Programmers write and maintain programmable code outlined in technical instructions and specifications for software applications and operating systems.

Tasks: Applications Programmers undertake routine cognitive tasks and non-routine analytical tasks.

Task importance (1-5)



Gender: 31% female
Wage: 3,500-4,000 RM/month
Most common industries:

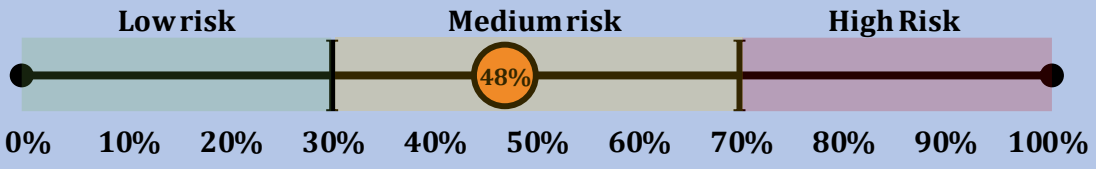
- Information and communication
- Wholesale and retail trade; repair of motor vehicles and motorcycles

Age: 29-32 years old
Most common education level: Degree
Most common fields of study:

- Science, mathematics, and computing

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Applications Programmers have a medium risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- The tasks of Applications Programmers are increasingly being automated, though there is likely to be a continued need for human programmers in dynamic and/or one-off projects.
- Tasks undertaken by Applications Programmers that are more likely to be automated include basic coding, design selection, and deployment of applications.
- Tasks undertaken by Applications Programmers that are less likely to be automated include gathering system and user requirements, work scoping and project management, team and project management, client and user management, non-routine troubleshooting, and crisis response.

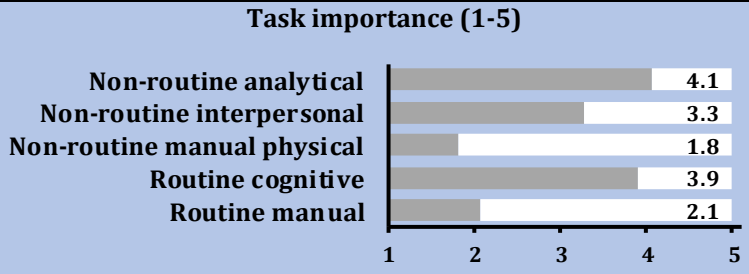
Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	○	●	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

38. Software and Applications Developers and Analysts Not Elsewhere Classified (2519)

Occupation Overview

Description: Software and Applications Developers and Analysts Not Elsewhere Classified include job titles such as Software Tester, Systems Tester, Product Quality Assurance Engineer, Solution Architect, and Application Consultant that are not classified in other occupations.

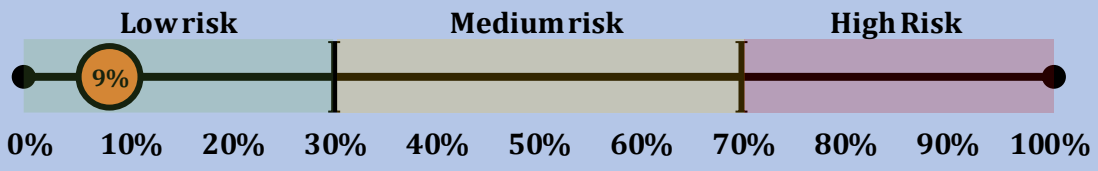
Tasks: Software and Applications Developers and Analysts Not Elsewhere Classified undertake non-routine analytical tasks and routine cognitive tasks.



Gender: N/A
Age: N/A
Wage: N/A
Most common education level: N/A
Most common industries: N/A
Most common fields of study: N/A

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Software and Applications Developers and Analysts Not Elsewhere Classified have a low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- Inputs and outputs of the tasks undertaken by Software and Applications Developers and Analysts Not Elsewhere Classified are largely logic-based, and so appropriate for automation.
- However, automation may not be appropriate for tasks that involve testing how human users interact with software.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

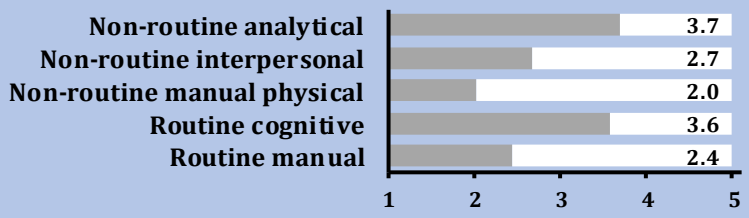
39. Database Designers and Administrators (2521)

Occupation Overview

Description: Database Designers and Administrators design, develop, control, maintain, and support the optimal performance and security of databases.

Tasks: Database Designers and Administrators undertake non-routine analytical tasks and routine cognitive tasks.

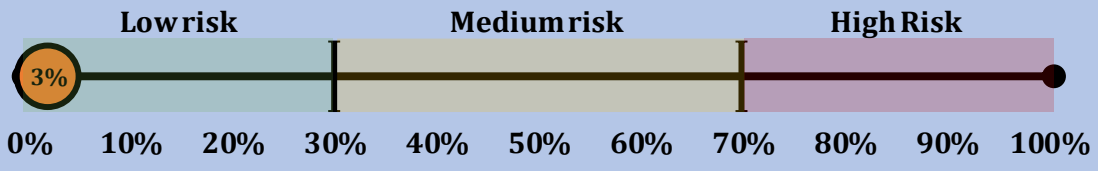
Task importance (1-5)



Gender: N/A
Age: N/A
Wage: N/A
Most common education level: N/A
Most common industries: N/A
Most common fields of study: N/A

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Database Designers and Administrators have a very low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- The decision making involved in the tasks of Database Designers and Administrators tends to be capturable by algorithms. However, top-tier firms are likely to invest continuously in updating databases, and so may require humans to oversee this process.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	○	●	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

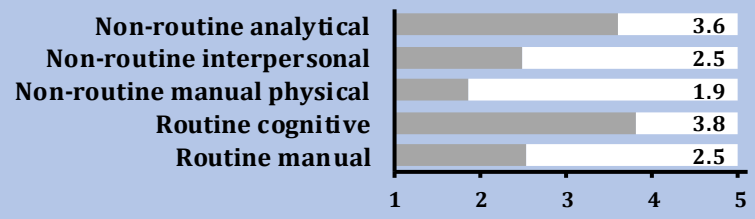
40. Systems Administrators (2522)

Occupation Overview

Description: Systems Administrators develop, maintain, and support optimal performance and control security of information technology systems.

Tasks: Systems Administrators undertake routine cognitive tasks and non-routine analytical tasks.

Task importance (1-5)

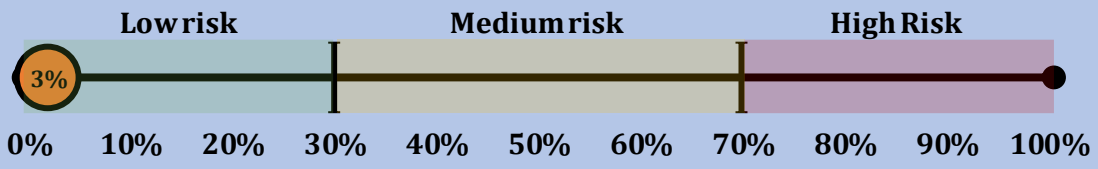


Gender: 37% female
Wage: 3,748-4,810 RM/month
Most common industries:
- Information and communication
- Public administration and defence; compulsory social security

Age: 31-34 years old
Most common education level: Degree
Most common fields of study:
- Science, mathematics, and computing

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Systems Administrators have a very low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- Systems Administrators rely on data to track system performance and faults, which can now be done by intelligent IT systems in many cases. This is the case in IT security, for example, where both threats and protections from those threats are provided in many cases by automated bots.
- However, there is likely an equilibrium between humans and machines that is necessary for optimal results, though this equilibrium will shift towards machines over time.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	○	●	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

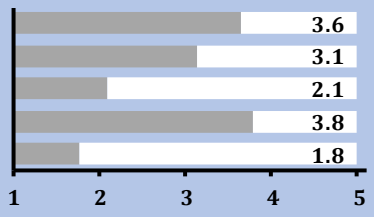
41. Computer Network Professionals (2523)

Occupation Overview

Description: Computer Network Professionals research, analyse, and recommend strategies for network architecture and development. They implement, manage, maintain, and configure network hardware and software, and monitor, troubleshoot, and optimise performance.

Tasks: Computer Network Professionals undertake routine cognitive tasks and non-routine analytical tasks.

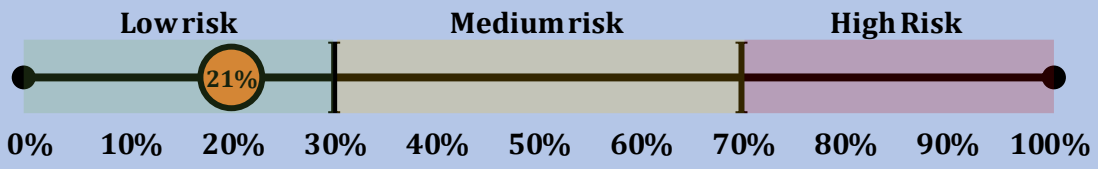
Task importance (1-5)



Gender: N/A
Age: N/A
Wage: N/A
Most common education level: N/A
Most common industries: N/A
Most common fields of study: N/A

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Computer Network Professionals have a low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- Some highly variable manual tasks performed by Computer Network Professionals such as changing mother boards will likely be more difficult to automate.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

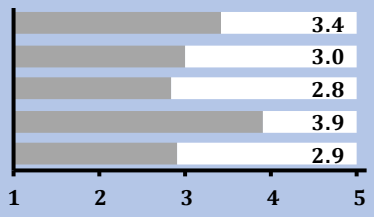
42. Electrical Engineering Technicians (3113)

Occupation Overview

Description: Electrical Engineering Technicians perform technical tasks to aid in electrical engineering research, and in the design, manufacture, assembly, construction, operation, maintenance, and repair of electrical equipment, facilities, and distribution systems.

Tasks: Electrical Engineering Technicians undertake routine cognitive tasks and non-routine analytical tasks.

Task importance (1-5)



Gender: 4% female
Wage: 2,500-3,192 RM/month
Most common industries:

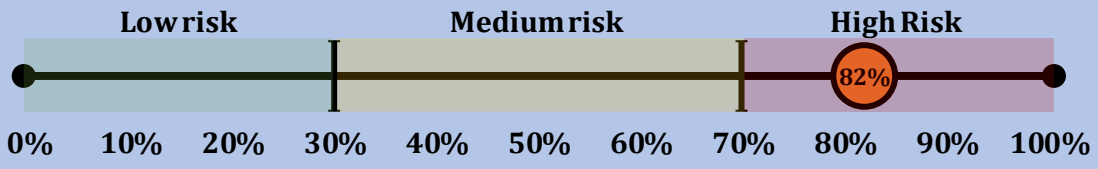
- Electricity, gas, steam, and air conditioning supply
- Construction

Age: 31-37 years old
Most common education level: Diploma/Certificate
Most common fields of study:

- Engineering, manufacturing, and construction

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Electrical Engineering Technicians have a high risk of automation overall, the non-routine analytical tasks that they undertake may be more difficult to automate.

- Some tasks undertaken by Electrical Engineering Technicians require creativity and flexibility based on customer requirements and problems to troubleshoot. Some tasks require working in variable environments, which could make automation difficult. For example, to wire a home an Electrical Engineering Technician must know where the electrical fixtures and fittings are and advise on the best location for electrical appliances based on factors like electrical load requirements. Additionally, interactions with the customer are difficult to automate.
- Occupational health and safety rules regulating electrical work may impede automation.

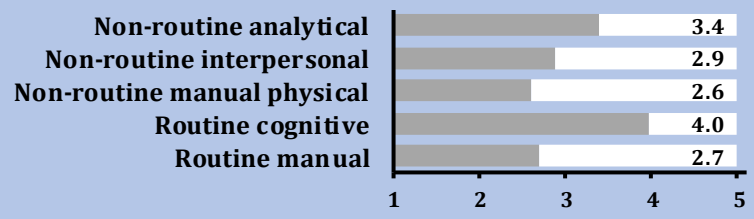
Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	●	○	○
Are there legal, regulatory, or normative constraints to automation?	○	●	○

43. Electronics Engineering Technicians (3114)

Occupation Overview

Description: Electronics Engineering Technicians perform technical tasks to aid in electronic research, and in the design, manufacture, assembly, construction, operation, maintenance, and repair of electronic equipment.

Tasks: Electronics Engineering Technicians undertake routine cognitive tasks and non-routine analytical tasks.

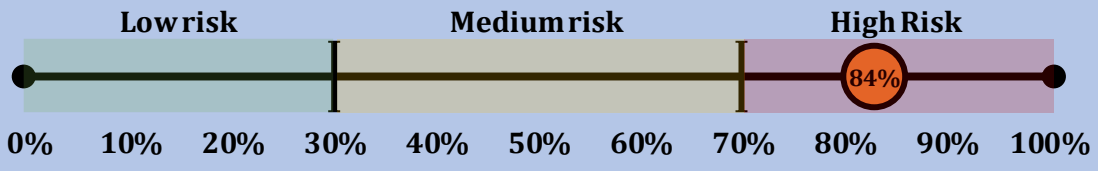


Gender: 14% female
Wage: 2,300-2,600 RM/month
Most common industries:
- Manufacturing

Age: 29-33 years old
Most common education level: Diploma/Certificate
Most common fields of study:
- Engineering, manufacturing, and construction

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Electronics Engineering Technicians have a high risk of automation overall, the non-routine analytical tasks that they undertake may be more difficult to automate.

- The research tasks undertaken by Electronics Engineering Technicians may be difficult to automate, as well as the manual aspects of the occupation that can be involved in activities like troubleshooting and handling certain types of equipment.
- However, the tasks of Electronics Engineering Technicians tend to be undertaken in controlled environments, such as workshops, which increases the likelihood of automation.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	○	●	○
Is the cost of new technologies a constraint to automation?	●	○	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

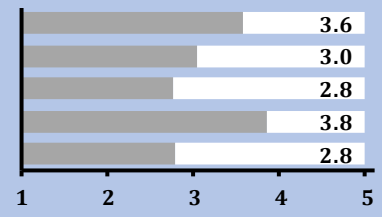
44. Mechanical Engineering Technicians (3115)

Occupation Overview

Description: Mechanical Engineering Technicians perform technical tasks to aid in mechanical engineering research, and in the design, manufacture, assembly, construction, operation, maintenance, and repair of machines, components, and mechanical equipment.

Tasks: Mechanical Engineering Technicians undertake routine cognitive tasks and non-routine analytical tasks.

Task importance (1-5)

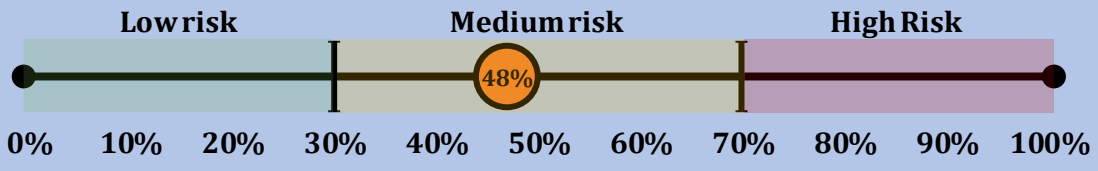


Gender: 5% female
Wage: 2,300-3,000 RM/month
Most common industries:
- Manufacturing

Age: 31-36 years old
Most common education level: Diploma/Certificate
Most common fields of study:
- Engineering, manufacturing, and construction

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Mechanical Engineering Technicians have a medium risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- Tasks of Mechanical Engineering Technicians are already being automated, particularly for simpler work (e.g. in automobile factories).
- However, automation is more expensive for certain kinds of engineering such as for rotating equipment and turbofans.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	●	○	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

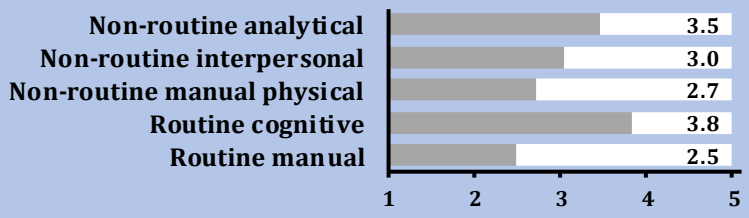
45. Physical and Engineering Science Technicians Not Elsewhere Classified (3119)

Occupation Overview

Description: Physical and Engineering Science Technicians Not Elsewhere Classified include job titles such as Surveying Technician Grade J17, Irrigation Inspector Grade J17, Motor Vehicles Examiner Grade A17, Factory and Machinery Inspector Assistant Grade J17, and Process Technician that are not classified in other occupations.

Tasks: Physical and Engineering Science Technicians Not Elsewhere Classified undertake routine cognitive and non-routine analytical tasks.

Task importance (1-5)



Gender: 10% female
Wage: 2,300-3,000 RM/month
Most common industries:

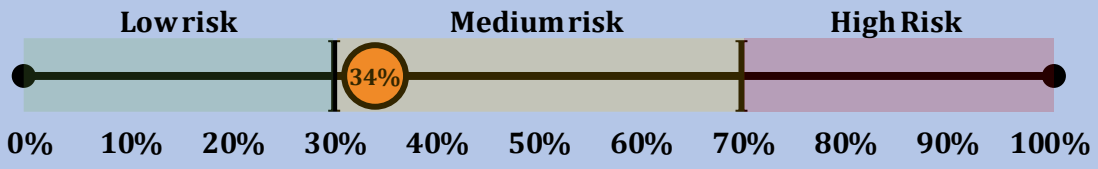
- Manufacturing
- Construction

Age: 30-35 years old
Most common education level: Diploma/Certificate
Most common fields of study:

- Engineering, manufacturing, and construction

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Physical and Engineering Science Technicians Not Elsewhere Classified have a low-medium risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- The data acquisition functions of Physical and Engineering Science Technicians Not Elsewhere Classified are likely to be easier to automate.
- Additionally, roles that occur in a controlled space, such as a warehouse, are likely to be easier to automate while those that occur in a more open domain, such as when surveying roads, are less susceptible to automation.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	●	○	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

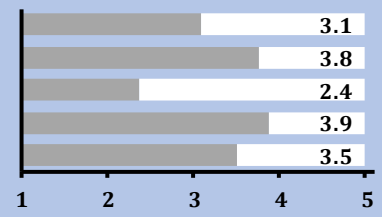
46. Manufacturing Supervisors (3122)

Occupation Overview

Description: Manufacturing Supervisors coordinate and supervise the activities of process control technicians, machine operators, assemblers, and other manufacturing labourers.

Tasks: Manufacturing Supervisors undertake routine cognitive and manual tasks, and non-routine interpersonal tasks.

Task importance (1-5)

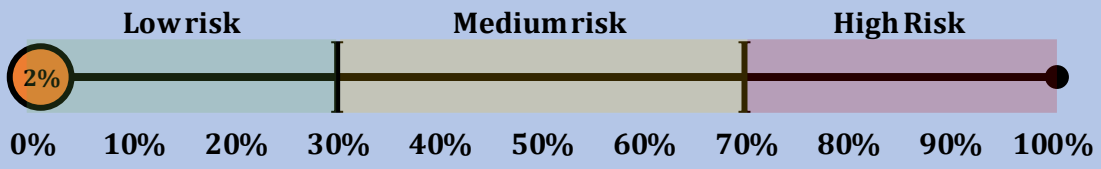


Gender: 26% female
Wage: 2,000-2,500 RM/month
Most common industries:
- Manufacturing

Age: 35-42 years old
Most common education level: Upper secondary
Most common fields of study:
- Engineering, manufacturing, and construction

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Manufacturing Supervisors have a very low risk of automation overall, the routine cognitive and manual tasks that they undertake may be automated.

- Though tasks involving social interaction and persuasion, which are more difficult to automate, are typically associated with supervisory roles, in reality these tasks are infrequently exercised by Manufacturing Supervisors in Malaysia.
- Additionally, as the jobs supervised by Manufacturing Supervisors are increasingly replaced by robots it will be easier to automate supervision. The extent to which this is possible depends in part on the environment in which Manufacturing Supervisors work, with closed factory environments more amenable to automation.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	○	●	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

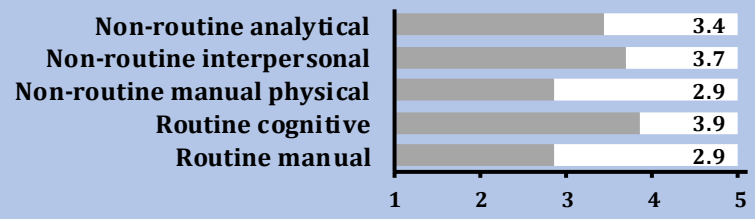
47. Construction Supervisors (3123)

Occupation Overview

Description: Construction Supervisors coordinate, supervise, and schedule the duties of workers engaged in the construction and repair of buildings and structures.

Tasks: Construction Supervisors undertake routine cognitive tasks, and non-routine interpersonal and analytical tasks.

Task importance (1-5)



Gender: 9% female
Wage: 2,200-3,000 RM/month
Most common industries:

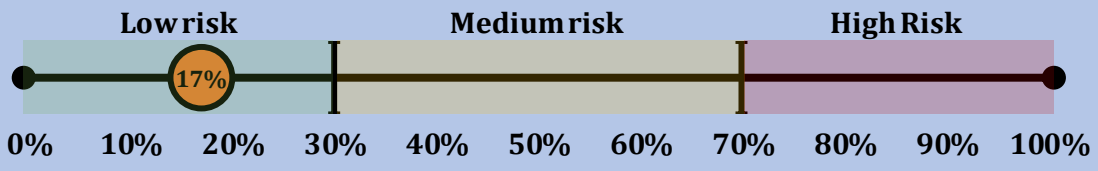
- Construction

Age: 34-40 years old
Most common education level: Upper secondary
Most common fields of study:

- Engineering, manufacturing, and construction

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Construction Supervisors have a low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- The labour-intensiveness of the construction sector and the heterogeneity of construction project sites are likely to make automation of the tasks of Construction Supervisors more difficult.
- Regulatory sign-off and occupational health and safety requirements may be a constraint to automation.

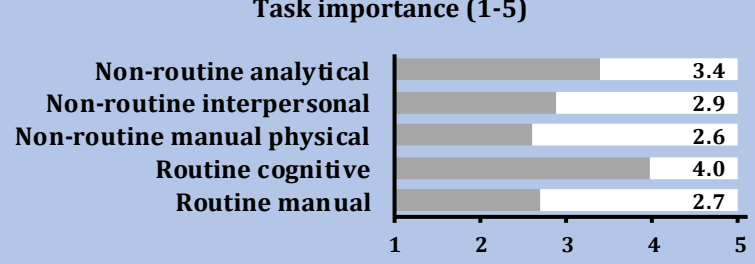
Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	●	○	○
Are there legal, regulatory, or normative constraints to automation?	○	●	○

48. Aircraft Technicians (3151)

Occupation Overview

Description: Aircraft Technicians repair, overhaul, examine, test, and service aircraft engines and other aircraft mechanical equipment.

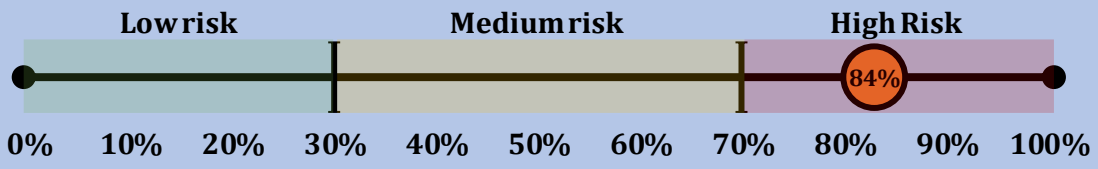
Tasks: Aircraft Technicians undertake routine cognitive tasks and non-routine analytical tasks.



Gender: N/A
Age: N/A
Wage: N/A
Most common education level: N/A
Most common industries: N/A
Most common fields of study: N/A

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Aircraft Technicians have a high risk of automation overall, the non-routine analytical tasks that they undertake may be more difficult to automate.

- The tools used by Aircraft Technicians, such those currently used for performing visual inspections, will likely be increasingly automated.
- However, the dexterity and the variability in work environments (apron, hangar, etc.), aircraft types, and types of problems to troubleshoot are likely to make automation more challenging.
- Regulatory conservatism in public safety could be a constraint to automation.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	●	○	○
Are there legal, regulatory, or normative constraints to automation?	○	●	○

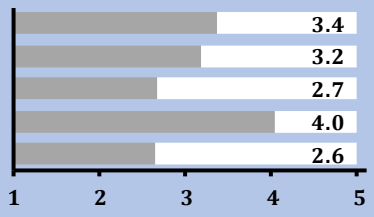
49. Environmental and Occupational Health Inspectors and Associates (3257)

Occupation Overview

Description: Environmental and Occupational Health Inspectors and Associates inspect environmental factors that can affect human health, occupational safety, and the goods production or service process in accordance with related laws and regulations.

Tasks: Environmental and Occupational Health Inspectors and Associates undertake routine cognitive tasks and non-routine analytical tasks.

Task importance (1-5)

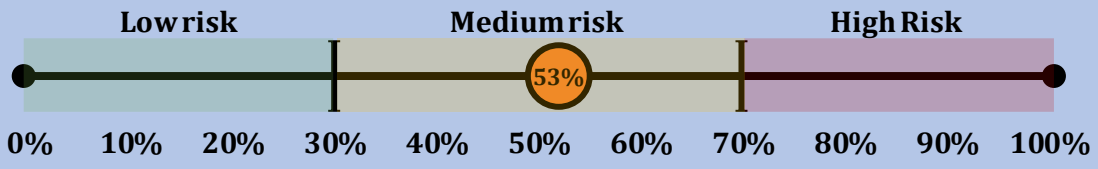


Gender: 45% female
Wage: 1,850-2,500 RM/month
Most common industries:
- Manufacturing

Age: 29-32 years old
Most common education level: Upper secondary
Most common fields of study:
- Engineering, manufacturing, and construction

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Environmental and Occupational Health Inspectors and Associates have a medium risk of automation overall, the non-routine analytical tasks that they undertake may be more difficult to automate.

- Supervisory control and data acquisition (SCADA) systems are likely to automate the data acquisition and analysis tasks of Environmental and Occupational Health Inspectors and Associates.
- However, cost-effectiveness is a significant barrier, as such systems require redesign of facilities. Additionally, the variety of facilities to be inspected is likely to make automation challenging.
- Legal and regulatory requirements related to the environment and to occupational safety and health are likely to be constraints to automation.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	●	○

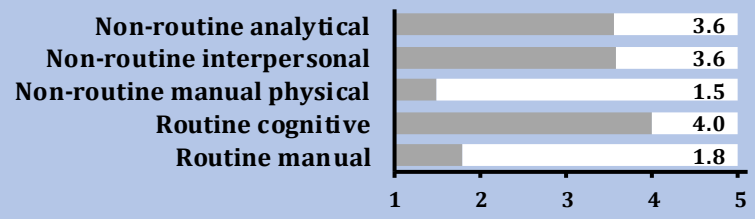
50. Insurance Agents (3321)

Occupation Overview

Description: Insurance Agents advise on and sell life, accident, automobile, liability, endowment, fire, marine, and other types of insurance to new and existing clients.

Tasks: Insurance Agents undertake routine cognitive tasks, and non-routine analytical and interpersonal tasks.

Task importance (1-5)

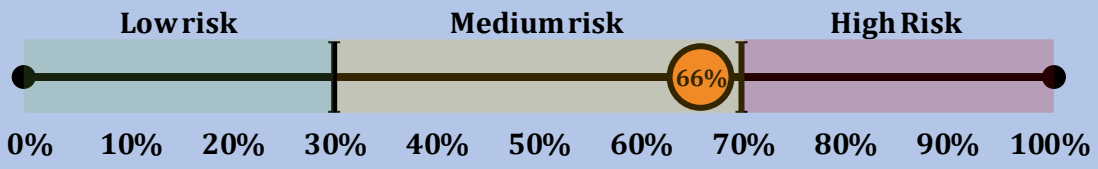


Gender: 43% female
Wage: 2,600-3,000 RM/month
Most common industries:
- Financial and insurance

Age: 33-40 years old
Most common education level: Upper secondary
Most common fields of study:
- Social sciences, business, and law

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Insurance Agents have a high-medium risk of automation overall, the non-routine analytical and interpersonal tasks that they undertake may be more difficult to automate.

- Tasks undertaken by Insurance Agents are already being automated through online sales and purchasing.
- As a group, Insurance Agents may exert pressure to impose legal or regulatory constraints that could hinder the automation of their roles.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	○	●	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	●	○

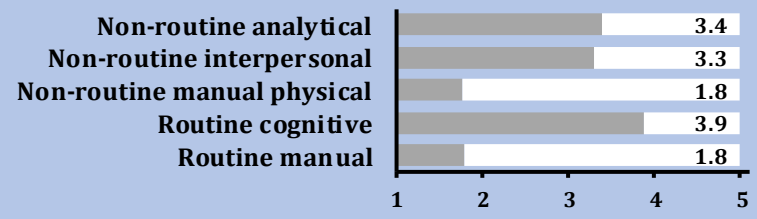
51. Commercial Sales Agents (3322)

Occupation Overview

Description: Commercial Sales Agents sell various goods and services to retail, industrial, wholesale, and other establishments, and provide specific information on products as required.

Tasks: Commercial Sales Agents undertake routine cognitive tasks, and non-routine analytical and interpersonal tasks.

Task importance (1-5)



Gender: 36% female
Wage: 2,500-3,000 RM/month
Most common industries:

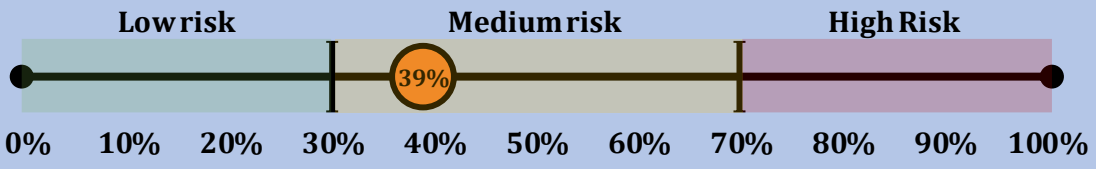
- Wholesale and retail trade; repair of motor vehicles and motorcycles
- Manufacturing

Age: 30-35 years old
Most common education level: Upper secondary
Most common fields of study:

- Social sciences, business, and law

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Commercial Sales Agents have a low-medium risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- E-commerce will likely displace many of the tasks of Commercial Sales Agents, as knowledge such as product information and RFPs that was formerly held by the agents is embedded in online sales platforms. The more definable a good or service is, the more easily the role of Commercial Sales Agents is likely to be automated.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	○	●	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

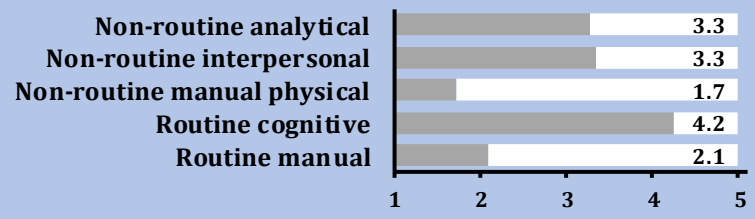
52. Buyers (3323)

Occupation Overview

Description: Buyers buy goods and services for use or resale on behalf of industrial, commercial, government, or other enterprises and organisations.

Tasks: Buyers undertake routine cognitive and non-routine analytical and interpersonal tasks.

Task importance (1-5)



Gender: 53% female
Wage: N/A
Most common industries:

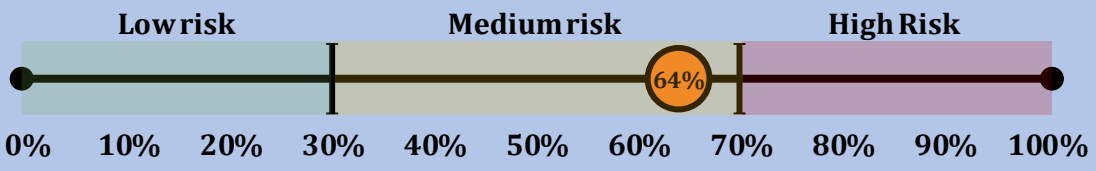
- Manufacturing
- Wholesale and retail trade; repair of motor vehicles and motorcycles

Age: 29-31 years old
Most common education level: Degree
Most common fields of study:

- Social sciences, business, and law

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Buyers have a high-medium risk of automation overall, the non-routine analytical and interpersonal tasks that they undertake may be more difficult to automate.

- The use of electronic RFPs and blockchain is likely to automate the tasks of Buyers. This is particularly the case for goods and services that are easily definable.
- However, the social interactions necessary for the negotiations conducted by Buyers may make automation of their role more difficult.
- Additionally, there may be normative constraints to automation, as there may be a preference for human engagement in interactions with Buyers, such as for purchases, selection of items, and selection of suppliers.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	●	○

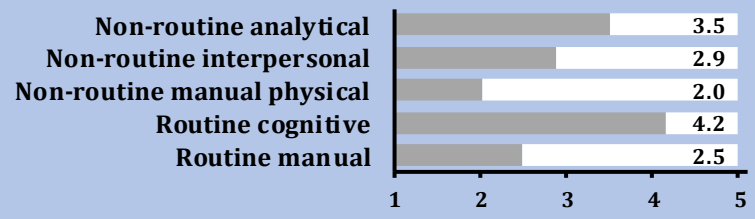
53. Computer Network and Systems Technicians (3513)

Occupation Overview

Description: Computer Network and Systems Technicians establish, operate, and maintain network and other data communications systems.

Tasks: Computer Network and Systems Technicians undertake routine cognitive and non-routine analytical tasks.

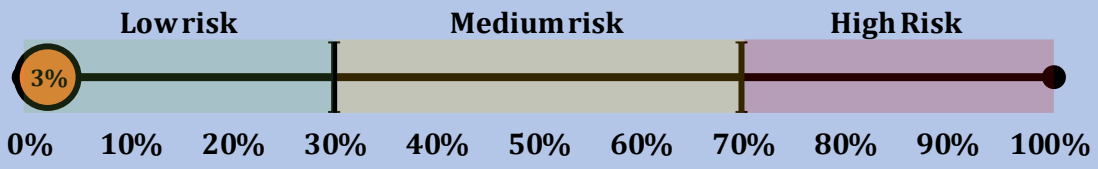
Task importance (1-5)



Gender: N/A
Wage: N/A
Most common industries: N/A
Age: N/A
Most common education level: N/A
Most common fields of study: N/A

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Computer Network and Systems Technicians have a very low risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- The operation, maintenance, and routine troubleshooting of network systems undertaken by Computer Network and Systems Technicians are susceptible to automation. These include tasks such as rules-based system network design and system tracking, monitoring, and alerts.
- Tasks that are less likely to be automated include gathering system and user requirements, work scoping and project management, team and project management, client and user management, non-routine troubleshooting, crisis response, and manual tasks such as hooking up servers.

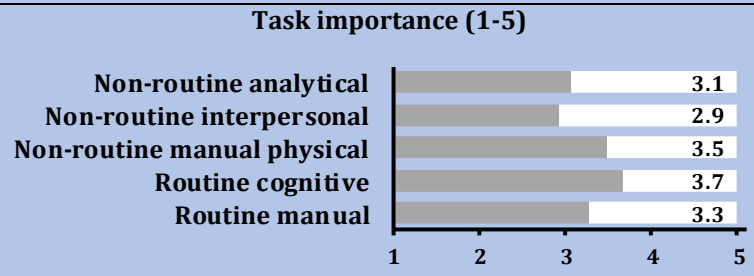
Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

54. Agricultural and Industrial Machinery Mechanics and Repairers (7233)

Occupation Overview

Description: Agricultural and Industrial Machinery Mechanics and Repairers repair, install, adjust, or maintain agricultural and industrial production and processing machinery or refinery and pipeline distribution systems.

Tasks: Agricultural and Industrial Machinery Mechanics and Repairers undertake routine cognitive and manual tasks, and non-routine manual physical tasks.



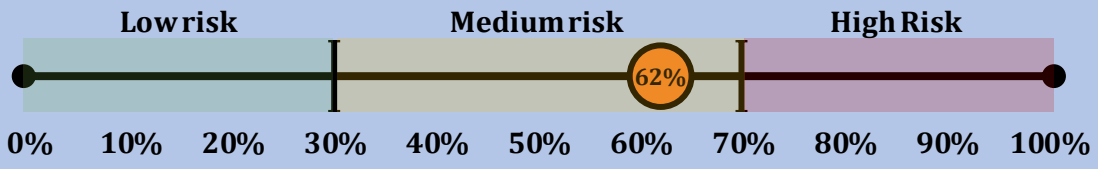
Gender: 1% female
Wage: 1,703-2,200 RM/month
Most common industries:

- Manufacturing
- Agriculture, forestry, and fishing

Age: 31-37 years old
Most common education level: Upper secondary
Most common fields of study: N/A

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Agricultural and Industrial Machinery Mechanics and Repairers have a high-medium risk of automation overall, the non-routine manual physical tasks that they undertake may be more difficult to automate.

- The repair and maintenance tasks undertaken by Agricultural and Industrial Machinery Mechanics and Repairers are likely to be easier to automate.
- Cost may make automation prohibitively high for onsite repair work, though this may be overcome in the case of intelligent machines connected to a central server that monitors equipment function.

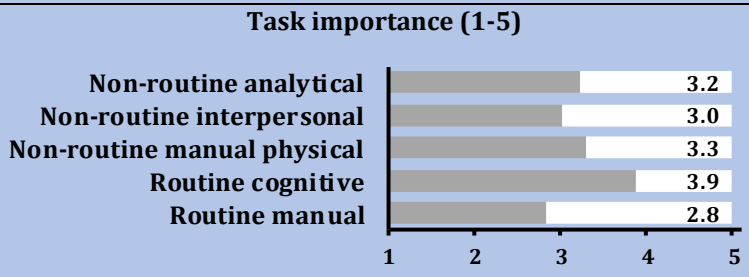
Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	●	○	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

55. Electrical Mechanics and Fitters (7412)

Occupation Overview

Description: Electrical Mechanics and Fitters fit, adjust, install, service, and repair electrical machinery and other electrical apparatus and equipment in buildings, factories, workshops, or other places.

Tasks: Electrical Mechanics and Fitters undertake routine cognitive tasks, and non-routine manual physical and analytical tasks.

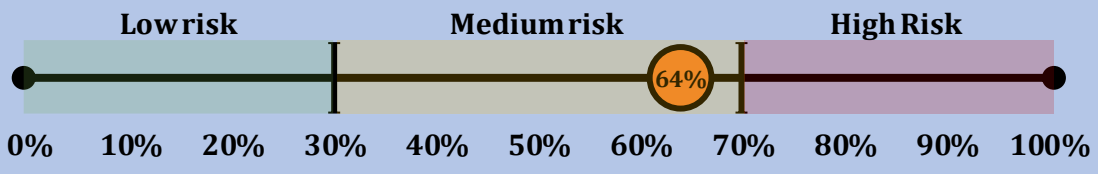


Gender: 2% female
Wage: 1,630-1,900 RM/month
Most common industries:
- Construction
- Manufacturing

Age: 30-36 years old
Most common education level: Upper secondary
Most common fields of study:
- Engineering, manufacturing, and construction

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Electrical Mechanics and Fitters have a high-medium risk of automation overall, the non-routine manual physical and analytical tasks that they undertake may be more difficult to automate.

- The tasks of Electrical Mechanics and Fitters that involve monitoring equipment for faults are more likely to be automated.
- However, the manual tasks involved in installing and repairing equipment are likely to be more difficult to automate. The large variety of facilities in which Electrical Mechanics and Fitters work may also make automation challenging.
- Approvals required for safety reasons may be a barrier to automation.

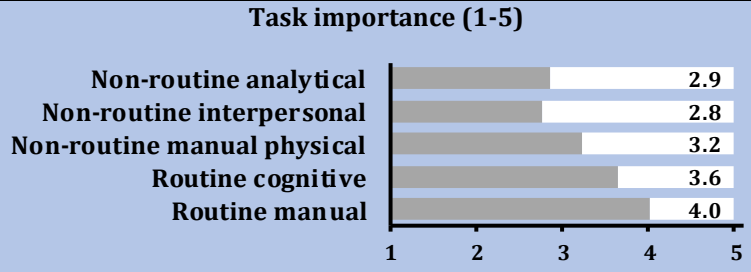
Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	●	○	○
Are there legal, regulatory, or normative constraints to automation?	○	●	○

56. Rubber Products Machine Operators (8141)

Occupation Overview

Description: Rubber Products Machine Operators operate and monitor machines that knead and blend rubber and rubber compounds, and produce various components and products from natural and synthetic rubber such as moulded footwear, domestic articles, insulating materials, industrial accessories, or tyres for bicycles, automobiles, tractors, aircraft, and other vehicles.

Tasks: Rubber Products Machine Operators undertake routine manual and cognitive tasks.



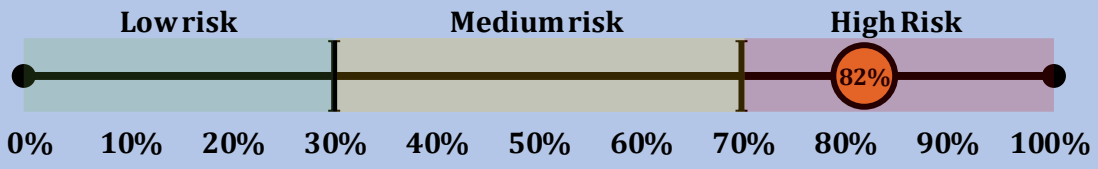
Gender: 39% female
Wage: 1,000-1,200 RM/month
Most common industries:

- Manufacturing

Age: 26-33 years old
Most common education level: Upper secondary
Most common fields of study: N/A

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

The routine manual and cognitive tasks undertaken by Rubber Products Machine Operators mean that this occupation is likely to be automated.

- Machine operator roles, which involve repetitive and programmable manual work, are generally vulnerable to automation such as with computer-controlled machine tools.

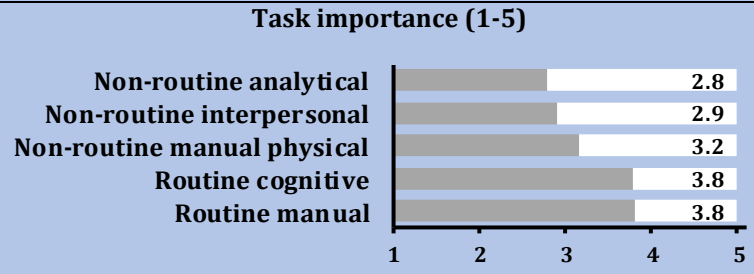
Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	○	●	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

57. Stationary Plant and Machine Operators Not Elsewhere Classified (8189)

Occupation Overview

Description: Stationary Plant and Machine Operators Not Elsewhere Classified include job titles such as Equipment and Machine Operator and Production Operator that are not classified in other occupations.

Tasks: Stationary Plant and Machine Operators Not Elsewhere Classified undertake routine manual and cognitive tasks.



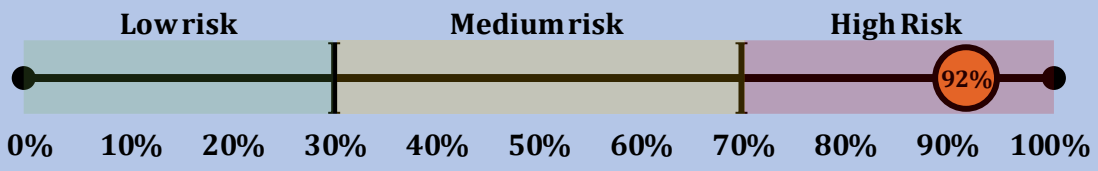
Gender: 45% female
Wage: 1,220-1,600 RM/month
Most common industries:

- Manufacturing

Age: 26-31 years old
Most common education level: Upper secondary
Most common fields of study: N/A

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

The routine tasks undertaken by Stationary Plant and Machine Operators Not Elsewhere Classified mean that this occupation is likely to be automated.

- Machine operator roles, which involve repetitive and programmable manual work, are generally vulnerable to automation such as with computer-controlled machine tools.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	○	●	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	○	○	●

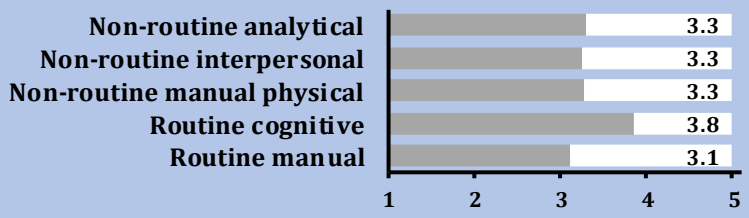
58. Heavy Truck and Lorry Drivers (8332)

Occupation Overview

Description: Heavy Truck and Lorry Drivers drive and tend heavy motor vehicles to transport goods, liquids, and heavy materials over short or long distances.

Tasks: Heavy Truck and Lorry Drivers undertake routine cognitive tasks, and other routine and non-routine tasks.

Task importance (1-5)



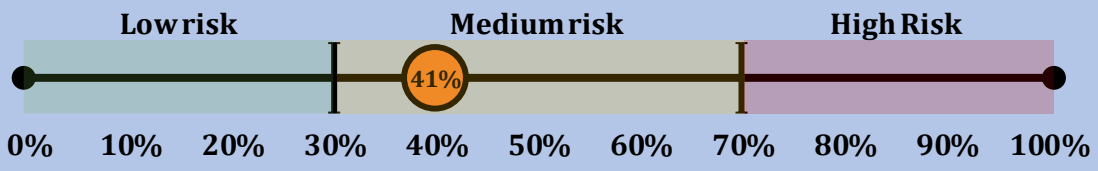
Gender: 0% female
Wage: 1,600-1,900 RM/month
Most common industries:

- Transportation and storage
- Wholesale and retail trade; repair of motor vehicles and motorcycles

Age: 34-40 years old
Most common education level: Upper secondary
Most common fields of study: N/A

Automatability

What is the probability that this occupation will be automated given current technology?



How will this occupation be transformed by automation?

Although Heavy Truck and Lorry Drivers have a medium risk of automation overall, the routine cognitive tasks that they undertake may be automated.

- Autonomous vehicles may automate the tasks of Heavy Truck and Lorry Drivers.
- However, this would require redesign of logistics infrastructure such as warehouses.
- Legislation regarding autonomous vehicles and lobbies emerging to protect jobs related to these tasks are potential constraints to automation.

Potential constraints to automation of this occupation	Yes	Mix	No
Is the depth of technological penetration a constraint to automation?	●	○	○
Is the cost of new technologies a constraint to automation?	○	●	○
Are there legal, regulatory, or normative constraints to automation?	●	○	○

APPENDIX 1: METHODOLOGY

A. Probability of automation

This report draws on the findings of Frey and Osborne (2017), an influential and heavily cited paper that estimates the automatability of occupations in the United States. The authors argue that automation is possible for most tasks, except where "engineering bottlenecks to computerisation" arise. They define three such bottlenecks – tasks involving perception and manipulation, tasks involving creative intelligence, and tasks involving social intelligence – and identify variables in O*NET, a large database of occupational information in the United States, that measure these bottlenecks. The authors then develop a model that relates the O*NET variables to occupations that have been labelled as automatable or not automatable by a group of machine learning researchers. This approach allows the authors to estimate the probability of automation for 702 occupations in the United States. The authors define thresholds for "low" risk of automation at 30 percent and below and for "high" risk of automation at 70 percent and above.

This report adapts the probability of automation estimated in Frey and Osborne (2017) to occupations in Malaysia. Frey and Osborne (2017) provide automation probabilities for occupations coded in SOC-2010 at the 6-digit level[4], the occupational classification scheme used by federal statistical agencies in the United States. These probabilities must be translated into MASCO-2013, the occupational classification scheme used by the Government of Malaysia. MASCO-2013 is created based on the international occupational classification scheme ISCO with revisions to meet the specific needs of the Malaysian labour market. This allows for a transitional mapping of SOC-2010 occupations into ISCO-2008 using an established crosswalk, before ISCO-2008 occupations are translated into MASCO-2013 using a crosswalk created for this report.

To translate the automatability probabilities from SOC-2010 into MASCO-2013 at the 4-digit occupation level, the 702 SOC-2010 occupations in Frey and Osborne (2017) are mapped to ISCO-2008 using a crosswalk file provided by the United States Bureau of Labour Statistics.[5] Where multiple SOC-2010 occupations map to a single ISCO-2008 occupation, a simple average of the automatability probabilities is taken to obtain a single score. Where multiple ISCO-2008 occupations map to a single SOC-2010 occupation, the automatability score for the single SOC-2010 occupation is mapped to all corresponding ISCO-2008 occupations. 31 non-military ISCO-2008 occupations do not have automobility scores based on this mapping. 28 of these 31 ISCO-2008 occupations are manually mapped to SOC-2010 based on the SOC-2010 and ISCO-2008 occupation titles and descriptions.[6] Next, the scores are mapped from ISCO-2008 occupations to MASCO-2013's 480 non-military occupations using a crosswalk developed by the World Bank in partnership with TalentCorp based on MASCO-2013 and ISCO-2008 occupation titles and descriptions.[7] Where multiple ISCO-2008

[4] There are a total of 820 6-digit non-military occupations in SOC-2010.
[5] See https://www.bls.gov/soc/soccrosswalks.htm (last accessed June 18, 2018).
[6] The 3 for which good matches could not be identified are Legislators (1111); Astrologers, fortune-tellers and related workers (5161); and Fur and leather preparing machine operators (8155). These ISCO-2008 occupations are not assigned an automatability probability.
[7] Creating the crosswalk between MASCO-2013 and ISCO-2008 involved several steps. First, the seven military occupations in MASCO-2013 were dropped, resulting in 480 MASCO-2013 occupations. Second, since MASCO-2013 was developed based on ISCO and many occupations have identical titles and codes, MASCO-2013 was matched to ISCO-2008 using the occupation code. 344 of the 480 MASCO-2018 occupations were matched in this way. A validation exercise comparing the MASCO-2013 and ISCO-2008 occupation titles and job descriptions confirmed the matches. Third, a fuzzy matching technique based on the similarity of MASCO-2013 and ISCO-2008 occupation titles was used to match an additional 79 matches. A validation exercise

occupations map to a single MASCO-2013 occupation, the closest match from ISCO-2008 is selected based on the MASCO-2013 and ISCO-2008 occupation titles and descriptions.[8] Where multiple MASCO-2013 occupations map to a single ISCO-2008 occupation, the automatability score for the single ISCO-2008 occupation is mapped to all corresponding MASCO-2013 occupations. This results in automatability probabilities for 477 of the 480 MASCO-2013 occupations and for all of the occupations included on the 2017/2018 Critical Occupations List.[9] The automatability probabilities for each MASCO-2013 occupation are matched to the 2016 Malaysian Labour Force Survey (LFS) and the 2016 Salary and Wages Survey (SWS), which both include 4-digit MASCO-2013 occupation codes.[10]

This adaptation of the automatability probabilities estimated in Frey and Osborne (2017) has been undertaken in numerous reports and research papers. See, for example, Chang and Huyng (2016) for Cambodia, Indonesia, the Philippines, Thailand, and Vietnam; Lamb (2016) for Canada; and Deloitte (2014) for the United Kingdom and London. A partial adaptation of Frey and Osborne (2017) was undertaken for Malaysia in Ng (2017). However, the analysis in Ng (2017) is limited by the use of 30 MASCO-2013 occupational groupings, rather than the 480 detailed occupations used in this report. This means that the author must average many automation probabilities in Frey and Osborne (2017) in order to obtain a single score for each of the 30 groupings. Ng (2017) acknowledges that "the results should be interpreted as an approximation rather than a precise replication of the exact methods of Frey and Osborne (2017)…" (Ng 2017 at p.6)

The methodology employed in the report makes the assumption that occupations in Malaysia involve the same set of skills as corresponding occupations in the United States since automatability scores from the United States are applied to Malaysian occupations. While there is some evidence of

comparing the MASCO-2013 and ISCO-2008 occupation titles and job descriptions confirmed the matches. Finally, the remaining 57 occupations were matched manually. To do so, the MASCO-2013 and ISCO-2008 occupations were matched based on their descriptions and tasks. For example, "Ship/Marine technicians" in MASCO-2013 (occupation code 3152) was matched to "Ships' engineers" in ISCO-2008 (occupation code 3151), because of the similarity of the tasks involved. According to the task descriptions, the tasks of these occupation categories in both MASCO-2013 and ISCO-2008 include: examining engines to locate defects using various tools and instruments and performing technical supervision of the installation, maintenance and repair of ships' machinery and equipment. In cases in which a best fit was still unclear, the MASCO-2013 occupation was mapped to a corresponding ISCO-2008 category for "other" or "not elsewhere classified." An example of a case in which the MASCO-2013 occupation was mapped to an "other" or "not elsewhere classified" category is that of "Legal managers" in MASCO-2013, which was mapped to the ISCO-2008 occupation "Professional services managers not elsewhere classified." For a similar procedure, see Chang and Huyng (2016).

[8] This occurs in the case of three MASCO-2013 occupations: Transport Technicians Not Elsewhere Classified (3159); Receptionists (4224); and Tailors, Dressmakers, Furriers and Hatters (7621). These are matched to three ISCO-2008 occupations, respectively: Town and Traffic Planners (2164); Receptionists (General) (4226); and Tailors, Dressmakers, Furriers and Hatters (7531).

[9] The MASCO-2013 occupations without automatability probabilities are the same 3 occupations for which good matches could not be identified between ISCO-2008 and SOC-2010: Legislators (1111); Astrologers, fortune-tellers and related workers (5161); and Fur and leather preparing machine operators (8155).

[10] Eleven occupations matched to MASCO-2013 do not appear in either the 2016 LFS or the 2016 SWS data: Legal Managers (1617); Services Managers Not Elsewhere Classified (1629); Audiologists and Speech Therapists (2266); Occupational Therapists (2268); Database and Network Professionals Not Elsewhere Classified (2529); Clowns, Magicians, Acrobats and Related Professionals (2847); Nuclear Research and Development Associate Professionals (3161); Health Associate Professionals Not Elsewhere Classified (3259); Surface and Window Cleaners (9123); Agricultural, Forestry, Farming, and Fishery Labourers Not Elsewhere Classified (9219); and Water and Firewood Collectors (9624).

differences in the skills required in occupations between developing countries and the United States, this evidence is for countries at lower levels of development than Malaysia, and there is evidence that these differences moderate as countries develop (Dicarlo et al. 2016). To the extent that the results are biased by this assumption, it is likely that they show less automation than they would otherwise because the skills content of jobs in the United States is likely higher than that in Malaysia (Aedo, et al. 2013). That is, the automatability probabilities are likely lower-bound estimates.

B. Task scores

Frey and Osborne (2017)'s methodology analyses the probability of automation at the level of occupations. However, technologies may automate *tasks* rather than entire *occupations* (Arntz, Gregory, and Zierahn 2016; Autor 2015). This implies that occupations may evolve due to automation, rather than be automated out of existence.

In order to address this possibility, this report incorporates an additional indicator of automatability based on the task composition of occupations. In a seminal paper, Autor, Levy, and Murnane (2003) hypothesize that cognitive and manual tasks that are *routine* – tasks that "follow explicit programmed rules" and "can be exhaustively specified with programmed instructions and performed by machines" – are more susceptible to automation. In contrast, analytical and interpersonal cognitive tasks and manual physical tasks that are *non-routine* – tasks that "cannot at present be described in terms of a set of programmable rules" – are more susceptible to automation (Autor, Levy, and Murnane 2003 at p.1283). To measure the intensity of use of routine and non-routine tasks in different occupations, and thus to measure how susceptible different occupations are to automation, Acemoglu and Autor (2011) build on Autor, Levy, and Murnane (2003) and identify 16 measures of the importance of different tasks in different occupations that capture 5 categories of routine and non-routine tasks: non-routine cognitive analytical tasks, non-routine cognitive interpersonal tasks, and non-routine manual physical tasks, which are less susceptible to automation; and routine cognitive and routine manual tasks, which are more susceptible to automation.[11] This allows the authors to show how intensively each of these 5 categories of routine and nonroutine tasks is used in each occupation. This, in turn, shows how susceptible each occupation is to automation based on its task composition, rather than assuming an entire occupation is or is not automatable.

This report adapts the methodology of Acemoglu and Autor (2011). Scores for each of the 16 task measures for each of the 5 categories of routine and non-routine tasks are obtained from the O*NET database. **Table 1** shows these task measures and their corresponding skills categories. The scores are available from O*NET in the O*NET SOC-2010 occupational classification scheme, which is similar to but distinct from the SOC-2010 classification scheme. Out of the 1,110 O*NET SOC-2010 occupations, 966 have data on the task measures included in Acemoglu and Autor (2011). As with the automatability probabilities, these scores must be translated into MASCO-2013.

[11] See also Autor and Handel (2013). Frey and Osborne (2017) argue that developments in machine learning and robotics are making many non-routine tasks automatable.

Table 1: O*NET task measures used to construct skills categories

Skill category	O*NET task measure
Non-routine cognitive analytical	Analysing Data or Information
	Thinking Creatively
	Interpreting the Meaning of Information for Others
Non-routine cognitive interpersonal	Establishing and Maintaining Interpersonal Relationships
	Guiding, Directing, and Motivating Subordinates
	Coaching and Developing Others
Non-routine manual physical	Manual Dexterity
	Spatial Orientation
	Operating Vehicles, Mechanized Devices, or Equipment
	Spend Time Using Your Hands to Handle, Control, or Feel Objects, Tools, or Controls
Routine cognitive	Importance of Repeating Same Tasks
	Importance of Being Exact or Accurate
	Structured versus Unstructured Work
Routine manual	Controlling Machines and Processes
	Pace Determined by Speed of Equipment
	Spend Time Making Repetitive Motions

Source: O*NET based on Acemoglu and Autor (2011).

The scores are first mapped from the O*NET SOC-2010 classification scheme to the 840 SOC-2010 occupations using a crosswalk provided by O*NET.[12] Where multiple O*NET SOC-2010 occupations map to a single SOC-2010 occupation, a simple average of the task measures is taken to obtain a single score for each SOC-2010 occupation. The scores are then mapped from SOC-2010 occupations to ISCO-2008 using a crosswalk file provided by the United States Bureau of Labour Statistics.[13] Where multiple SOC-2010 occupations map to a single ISCO-2008 occupation, a simple average is taken to obtain a single score. Where multiple ISCO-2008 occupations map to a single SOC-2010 occupation, the task score for the single SOC-2010 occupation is mapped to all corresponding ISCO-2008 occupations. The scores are then mapped from ISCO-2008 occupations to MASCO-2013's 480 occupations using a crosswalk developed by the World Bank in partnership with TalentCorp based on MASCO-2013 and ISCO-2008 occupation titles and descriptions.[14] Where multiple ISCO-2008 occupations map to a single MASCO-2013 occupation, the closest match is selected based on the MASCO-2013 and ISCO-2008 occupation titles and descriptions.[15] Where multiple MASCO-2013 occupations map to a single ISCO-2008 occupation, the automatability score for the single ISCO-2008 occupation is mapped to all corresponding MASCO-2013 occupations. This results in task scores for 468 MASCO-2013 4-digit occupations and for all of the occupations included on the 2017/2018

[12] See https://www.onetcenter.org/crosswalks.html (last accessed June 18, 2018).
[13] See https://www.bls.gov/soc/soccrosswalks.htm (last accessed June 18, 2018).
[14] See Footnote 7.
[15] See Footnote 8.

Critical Occupations List.[16] Finally, the scores on each of the 16 measures are averaged within the 5 categories of routine and nonroutine tasks to derive a composite score for each category. While Acemoglu and Autor (2011) provide a normalized score expressed with mean zero and standard deviation one, the report provides raw scores weighted by employment for ease of interpretation. The O*NET scores for each MASCO-2013 occupation are also matched to the 2016 Malaysian Labour Force Survey (LFS) and the 2016 Salary and Wages Survey (SWS), which both include 4-digit MASCO-2013 occupation codes.[17]

As in the estimation of automation probabilities, the methodology employed in the report makes the assumption that occupations in Malaysia have the same skill intensities as those in the United States since the task measures from the United States are applied to Malaysian occupations. As noted above, to the extent that the results are biased by this assumption, it is likely that occupations in Malaysia that involve more non-routine tasks (that is, are less susceptible to automation) are less intensive in these non-routine tasks than similar occupations in the United States (Aedo, et al. 2013). Overall, then, this would mean these occupations would be more susceptible to automation than in the United States.

A similar approach to replicating Acemoglu and Autor (2011) has been undertaken and extended in Aedo et al. (2013), Arias et al. (2014), and Dicarlo et al. (2016).

C. Qualitative assessment of automatability

Frey and Osborne (2017)'s methodology does not take into account several factors that may influence the pace and breadth of adoption of technologies that permit automation. These factors relate to the depth of technological adoption in an economy (e.g., top tier firms may adopt the most advanced technologies but smaller firms may face barriers to doing so); the relative prices of capital and labour (e.g., the abundance of labour may mean that investments in labour-saving technology are not cost-effective); and legal, ethical, and normative obstacles to technology adoption (e.g. human preferences to interact with humans may slow replacement of human labour, even where technologies exist to do so) (Arntz, Gregory, and Zierahn 2016).

In order to take these additional factors into account, experts in data science, human resources, and Malaysian industry were asked to provide guidance on the role of these barriers in Malaysia. For each COL occupation, the experts were asked the following three Yes/No questions:

- Have firms beyond the top tier adopted technologies that can be used to automate this occupation?
- Do the current average labour costs favour the adoption of labour-reducing technologies that can be used to automate this occupation?
- Are there existing laws, regulations, or normative constraints that would oppose the automation of this occupation?

[16] The 12 occupations that do not have O*NET scores are Legislators (1111); Clowns, Magicians, Acrobats and Related Professionals (2847); Creative and Performing Artists Not Elsewhere Classified (2849); Religious Associate Professionals (3612); Pawnbrokers and Money-Lenders (4213); Astrologers, Fortune-Tellers and Related Workers (5161); Building Structure Cleaners (7133); Fur and Leather Preparing Machine Operators (8155); Textile, Fur and Leather Products Machine Operators Not Elsewhere Classified (8159); Animal-Drawn Vehicles Drivers (9332); Street and Related Service Workers (9511); and Sweepers and Related Labourers (9613).

[17] See Footnote 10.

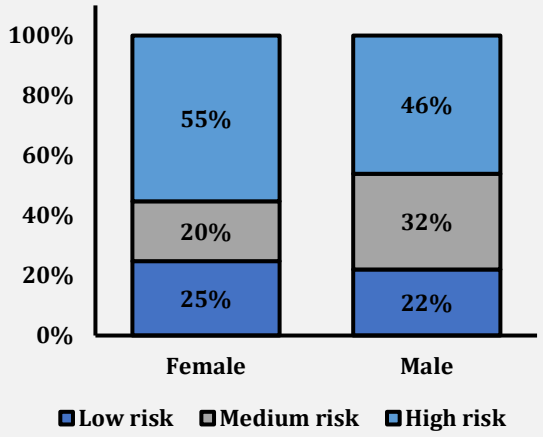
Answers to these questions are compiled using a "stoplight" approach: when a factor is unanimously cited as a constraint to automation, the constraint is considered to be binding; when a factor is unanimously cited not to be a constraint to automation, the constraint is considered not to be binding; when there is no consensus, evidence is considered to be mixed. This approach is designed to provide qualitative information about potential barriers to automation that are difficult to describe in systematic measures of the automatability of occupations.

As noted above in the description of the task scores methodology, automation may affect individual tasks within an occupation without eliminating the entire occupation. In order to address this possibility, the same experts were also surveyed about important characteristics to consider when evaluating the automatability of each COL occupation, particularly the kinds of tasks in each occupation that are more susceptible to automation and the kinds of tasks that are less susceptible to automation. Responses were elicited in the form of an open-ended question, and have been edited for inclusion in the profiles.

APPENDIX 2: ADDITIONAL RESULTS

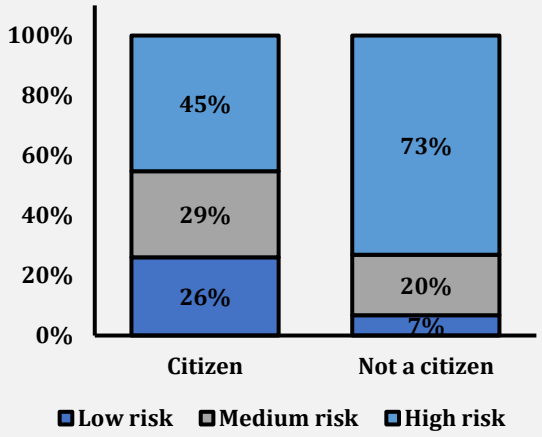
The probability of automation varies with gender, citizenship, education, and wage. A higher percentage of women work in occupations that are at high risk of automation than men (**Figure 7**). A much larger share of non-citizens work in occupations that are at high risk of automation than Malaysian citizens (**Figure 8**). The share of workforce that is at low risk of automation generally increases with education (**Figure 9**). Finally, wages generally decline with the probability of automation, suggesting that the occupations that are at most risk of automation are the lowest-paying, lowest-skilled jobs (**Figure 10**)

Figure 7: Employment at low, medium, and high risk of automation in Malaysia in 2016, by gender



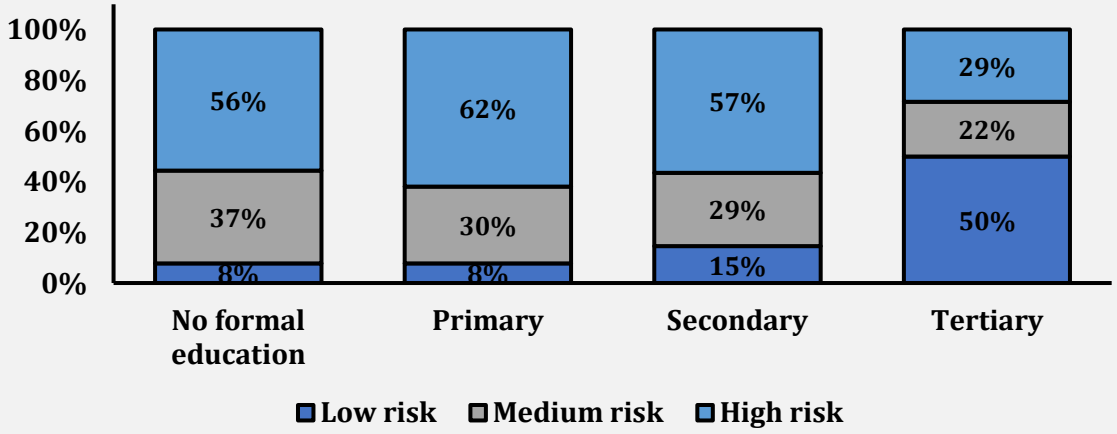
Source: World Bank based on Frey and Osborne (2017) and LFS (2016).

Figure 8: Employment at low, medium, and high risk of automation in Malaysia in 2016, by citizenship



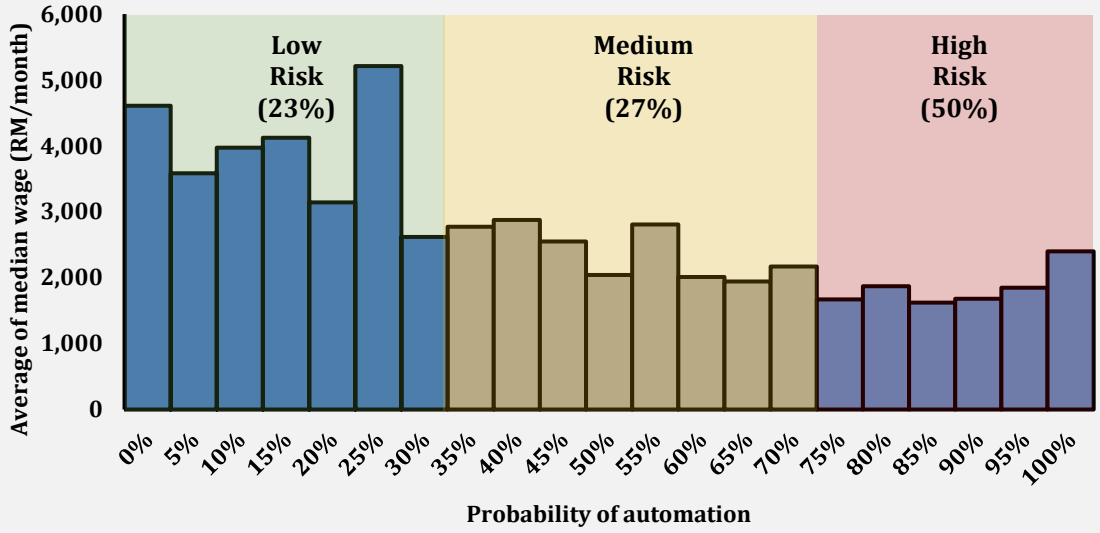
Source: World Bank based on Frey and Osborne (2017) and LFS (2016).

Figure 9: Employment at low, medium, and high risk of automation in Malaysia in 2016, by education



Source: World Bank based on Frey and Osborne (2017) and LFS (2016).

Figure 10: Average median monthly wage in Malaysia in 2016 by probability of automation



Source: World Bank based on Frey and Osborne (2017) and SWS (2016).

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