

# SKILLS DEMAND FOR THE FUTURE ECONOMY

2022



SKILLS *future* SG

## FOREWORD

**Mr Chan Chun Sing  
Minister of Education  
Singapore**

The SkillsFuture Movement was launched in 2015, and has been gaining momentum since then. Workers and companies have heeded the call to continually upskill themselves, to seize opportunities in a rapidly changing business environment. The Institutes of Higher Learning, private training providers, SkillsFuture Queen Bee companies, and the Labour Movement have all contributed to a dynamic lifelong learning ecosystem that caters to different needs across our population and economy.

Against this backdrop, the inaugural Skills Demand for the Future Economy report was first published in 2021 to achieve three goals. First, it encourages citizens to be aware of global trends that can impact their own career growth, and that the best way they can prepare and adapt is to acquire the right set of knowledge and skills. Second, it articulates the specific skills that employers are asking for, and ranks these skills based on how transferable they are across job roles, so that citizens can prioritise and take specific action to upskill themselves. Third, the report also serves to guide SSG, as well as providers of continuing education and training, to respond and adjust the courses and training to meet the needs of the economy, in a timely fashion.

This 2022 edition is a significant enhancement from the inaugural report, as SSG continually improves its methods, and strengthens the network of experts and collaborators that contribute to the report. Using big data, quantitative analysis, and

research methodologies, the report provides readers with more detailed information on the skills that matter, and on what employers seek. The report also provides links to the relevant courses that can help citizens gain these needed skills.

It is of course not possible for such a report to have the full breadth and depth to describe the skills needs of all sectors in the economy. Nor can it be fully up-to-date with the myriad innovations in technology and business models. Therefore, to complement SSG's skills analysis work, the Government is also piloting a model where industry sector intermediaries are formally appointed to go deep into each sector, aggregate sectoral skills needs, and provide training that closely match the career needs of individuals and enterprises, big and small.

The ultimate objective is for lifelong learning to enable Singapore and Singaporeans to thrive in a world that is becoming ever more dynamic and unpredictable. This will require companies, unions, trade associations, adult educators, and of course Singaporeans themselves to work together, pool our knowledge and industry understanding, and support one another's upskilling journeys. This report is an example of how we can do so, and for that I am thankful to all who contributed.

### About SkillsFuture Singapore

SkillsFuture Singapore (SSG) drives and coordinates the implementation of the national SkillsFuture movement, promotes a culture of lifelong learning and strengthens the ecosystem of training and adult education in Singapore. Through a holistic suite of national SkillsFuture initiatives, SSG enables Singaporeans to take charge of their learning journey in their pursuit of skills mastery. SSG also works with key stakeholders to ensure that students and adults have access to high quality and industry-relevant training that meet the demands of different sectors of the economy for an innovative and productive workforce. For more information, visit <https://www.ssg-wsg.gov.sg>.

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# WHAT IS IN STORE FOR YOU?

**Dr Gog Soon Joo**  
**Chief Skills Officer**  
**SkillsFuture Singapore**

In the 2022 edition of the Skills Demand for the Future Economy Report, we continue to focus on the three high growth economies in Singapore – the Green Economy, the Digital Economy, and the Care Economy (Chapters II - IV). In each of these chapters, we update readers with the recent developments and trends in Singapore, and highlight key changes in skills demand, by analysing and presenting the demand growth and transferability of priority skills.

In addition, we decided to feature the application of priority skills in two ways. Firstly, we provide a sectoral perspective of how these skills are demanded in the advanced manufacturing sectors in Singapore (Chapter V). Readers will be able to appreciate the demand of Industry 4.0 skills, digital skills, and green skills across various job roles in the advanced manufacturing sectors. Secondly, we provide a population-specific perspective of skills demand; specifically, we examine upskilling options for the mid-career workforce (Chapter VI), in support of our efforts to support this group in their career planning. An important objective of this chapter is to show how they can take advantage of priority skills to access growth roles in the three economies, and the resources available to them.

Critical Core Skills (CCS) continue to be important, more so for enterprises embarking on transformation which require communication,

coordination and management. In the report, we share a recently completed study on the use and development of CCS in Singapore workplaces (Chapter VII). I encourage readers to try out the [online CCS profiling survey](#), so that we can continue to enhance the tool and deepen our understanding of CCS usage in various job roles.

Readers can learn about the analytical methodologies deployed for the report in the Methodology chapter (Chapter IX). Supplementing this report, we also provide the full list of [priority skills](#) for interested readers.

I encourage readers to follow SSG on our LinkedIn, Facebook and Instagram pages for announcements on upcoming workshops and webinars. More importantly, I hope the report will catalyse further thinking by readers on their own career and learning goals, encouraging them to partake in upskilling and reskilling opportunities.

This report is the culmination of efforts from multiple stakeholders in Singapore. SkillsFuture Singapore is deeply grateful to the many colleagues from government, industry partners, Institutes of Higher Learning, and fellow Singaporeans who have contributed to this report. I invite more professionals and experts to join us in the co-creation of jobs-skills insights. I look forward to hearing from you.

# CONTENTS

I. Executive Summary	5
II. Green Economy	8
III. Digital Economy	24
IV. Care Economy	40
V. Jobs and Skills in Industry 4.0 Implementation	56
VI. Growth Opportunities and Skills-based Pathways for Mid-career Workers	78
VII. The Use and Development of Critical Core Skills in Singapore	96
VIII. Charting Your Skills Development Journey	108
IX. Methodology	114
X. Glossary	119
XI. Acknowledgements	121

# EXECUTIVE SUMMARY

In 2021, the inaugural Skills Demand for the Future Economy Report identified the **Green, Digital** and **Care Economies** as growth engines that will create new job roles, change existing job content and bring about new skills requirements across a large swathe of the economy. It also introduced the idea of '**priority skills**', which are skills that are highly transferable across job roles within each of the three economies. In other words, these skills are applicable in many job roles and will contribute significantly to the individual's long term career versatility.

Since then, there have been redoubled efforts to green Singapore's economy; post-COVID tailwinds have quickened the pace of digitalisation and automation; on the care economy front, there has been increased focus on preventive healthcare, lifelong learning and mental well-being. SkillsFuture Singapore has, therefore, decided to maintain the spotlight on these three economies in the 2022 report. Building upon the inaugural report, this year's analysis of skills demand has been enriched in three ways.

First, a new dimension on skills demand growth has been added and analysed alongside skills transferability. **Demand growth** captures the relative scale of the increase in demand for that skill, while **transferability** captures the scope of the skill's applicability across different job roles. The two-dimensional analysis seeks to provide deeper insights to the reader on the nature of the priority skills identified.

Second, a chapter is included to illustrate how these economy-wide skills apply to a particular segment of the economy, with its distinct requirements. This chapter examines the effect of adopting **Industry 4.0 (I4.0)** technologies and processes in the manufacturing sector on job roles and skills. The chapter shows how changes to jobs and skills due to I4.0 are closely intertwined with the larger digitalisation and sustainability movements.

Third, this report includes content to look at skills acquisition from the worker's perspective, specifically focusing on a particular segment of the workforce, namely, the mid-career workers. As job roles undergo transformation and redesign, these workers can upskill to stay relevant, or reskill to take on opportunities in adjacent growth roles. Some of these transitions require more upskilling, but can lead to greater, longer-term returns. The report provides a guide to how mid-career workers can assess the different options available and select those that best support their career aspirations for career growth.

Similar to the inaugural report, a chapter on **Critical Core Skills**, or soft skills is included. In this instalment, some work-role archetypes were developed to shed light on which of such skills individuals might want to invest in, depending on their work-role archetypes.

## KEY HIGHLIGHTS

### GREEN ECONOMY

- Emerging domains<sup>1</sup>:
- Environmental and Sustainability Management
  - Green Infrastructure and Mobility
  - Energy, Resource Circularity and Decarbonisation
  - Sustainable Finance

### DIGITAL ECONOMY

- Emerging domains:
- AI, Data and Analytics
  - E-commerce and Digital Marketing
  - Cyber Security and Risk
  - Cloud, Systems and Infrastructure
  - Software Development
  - Technology Application and Management

### CARE ECONOMY

- Emerging domains:
- Person-centred Care
  - Collaboration with Stakeholders
  - Teaching and Learning
  - Health and Wellness

#### A. The Green Economy

Many existing jobs will require green skills, as companies across sectors adopt more environmentally sustainable practices and develop sustainability targets for compliance and reporting. While Green Infrastructure and Mobility, and Energy, Resource Circularity and Decarbonisation are key skills areas that see very high demand growth, they are dwarfed by skills demand growth in the domain of Sustainable Finance. On the other hand, skills in the Environmental and Sustainability Management domain enjoy high transferability.

#### B. The Digital Economy

Riding on the post-COVID-19 wave, Digital Economy jobs and skills continue to see high demand. In particular, Software Development skills see the highest demand growth, and also very high transferability. Cloud, Systems and Infrastructure is close behind in terms of demand growth. On the other hand, E-commerce and Digital Marketing, and Artificial Intelligence (AI), Data and Analytics register high transferability in the skills they cover.

#### C. The Care Economy

Preventive care, workplace learning, transformative human resource, learning and development practices, as well as the importance placed on mental well-being are driving changes to jobs and skills in the Care Economy. Collaboration with Stakeholders is a key skills area that sees very high demand growth, while Person-centred Care, and Teaching and Learning have the highest transferability in skills. Demand for Health and Wellness has accelerated since the COVID-19 pandemic and are needed by job roles beyond care provision to preventive personal care.

<sup>1</sup> Emerging domains cluster the jobs and skills trends and changes within the respective economies by growth areas.

#### **D. I4.0 in manufacturing sectors**

I4.0 technologies and processes enable manufacturing sectors to increase productivity and reduce environmental footprints. Engineers and other technical workers in the manufacturing sectors are increasingly required to possess digital and green skills. Non-tech job roles such as HR business partners, sales executives and order fulfilment coordinators will also need to have digital and green skills to stay relevant.

#### **E. Mid-career workers**

Mid-career workers, aged 40 to 59, form half of Singapore's resident workforce and are well-represented in five job families: (i) Operations and Administration; (ii) Sales, Marketing and Customer Service; (iii) Human Resource; (iv) Finance and Accounting; and (v) Engineering and Technology. As these job families evolve, mid-career workers will need to upskill to stay relevant within the same job family or to reskill to move to another. There are pathways that require greater effort in skilling, but may also yield greater longer-term returns. Mid-career workers will need to assess their career interests and goals, the skilling intensity that they are comfortable with, and evaluate the affordability of skilling options and the attractiveness of new job roles.

#### **F. Critical Core Skills (CCS)**

CCS are seeing increasing demand from employers as businesses transform. The top three most important CCS used at work are *Self Management*, *Influence* and *Creative Thinking*. Seven work-role archetypes are identified, each with its distinctive CCS requirements. In general, workplace learning is an effective mode for developing CCS.

#### **G. Resources for action**

Curated courses are available at the end of each chapter as quick references for the reader. Citizens can access the MySkillsFuture portal for a longer list of courses and speak with Skills Ambassadors to gain clarity on their career and skilling interests and options. Industry voices and individuals' stories provide insights into what employers are looking for and skilling pathways walked by fellow citizens. A list of resources can be found in the Charting Your Skills Development Journey chapter. It is hoped that the insights and resources in this report will empower citizens to respond to change, stay relevant and seize growth opportunities.



- Many existing jobs will require green skills as companies across sectors adopt more environmentally sustainable practices and develop sustainability targets for compliance and reporting
- Environmental, sustainability, and compliance-related green skills are the most transferable across sectors and job roles, and are 'no regrets' moves for citizens and workforce to start upskilling in

Since the launch of the Singapore Green Plan 2030 in March 2021, efforts have been accelerating to green our shared environment and economy. For example, there are ambitious new green targets under the Singapore Green Building Masterplan to green 80% of buildings by 2030, have 80% of new buildings to be super low energy, and achieve 80% improvement in energy efficiency for best-in-class green buildings<sup>1</sup>.

Efforts to decarbonise our energy sector, scale up investments in water technologies, and generate new energy from waste using innovative waste-to-energy technologies are just some of the **Green Economy** initiatives to better manage our limited resources sustainably. Regional collaborations are also crucial in the journey towards sustainability. For example, Singapore has started importing renewable energy from the region as part of plans to reduce the carbon footprint of the power sector. This is not only one

step towards our net-zero goals, but also strengthens energy security and supply diversification, contributing towards economic development for the region as a whole.

Other initiatives in sustainable finance, electrification of vehicles, agriculture technology (agri-tech), and sustainable tourism will require concerted efforts across public, private and non-governmental organisations to scale up the supporting investment and infrastructure. As Asia makes its transition to net zero, Singapore aims to be its centre for sustainability solutions. Towards this end, the Climate Impact X (CIX) – a global carbon exchange and marketplace – has been established in Singapore. A regional sustainable aviation fuel (SAF) production hub, capable of refining up to one million cubic metric tonnes of SAF, is slated for completion in 2023<sup>2</sup>.

As efforts accelerate to green the economy and grow the Green Economy, relevant jobs, skills and talent needs can be expected to also grow in tandem<sup>3</sup>. This requires employers, Institutes of Higher Learning and training providers to work very closely together, so that skills demand can be translated quickly into curriculum design and skills trained. One such initiative is the National Electric Vehicle (EV) Specialist Safety<sup>4</sup> certification programme, under the national EV Roadmap, which was launched this year to upskill automotive technicians in the maintenance and servicing of EVs. This supports EV adoption and greens Singapore's transport system<sup>5</sup>.

## Emerging domains in the Green Economy

Skills of increasing importance to the Green Economy can be defined in four emerging domains as follows:

- Environmental and Sustainability Management
- Energy, Resource Circularity and Decarbonisation
- Green Infrastructure and Mobility
- Sustainable Finance

The Environmental and Sustainability Management domain establishes the baseline knowledge and skills in different aspects of environment and sustainability management that are applicable across all industry sectors and workforce. It relates to the establishment of governance and adherence to environmental and sustainability compliance requirements, sustainability policies, and systems and processes to measure, report, verify and manage environment and sustainability initiatives, programmes and climate mitigation efforts.

Another key focus of the Green Economy is on the sustainable use of resources. The Energy, Resource Circularity and Decarbonisation domain relates to

skills associated with the management and maximising of resources through measures to close the resource loop, the sustainable use of energy, and the mitigation of global warming impact through the reduction or elimination of greenhouse gas<sup>6</sup> emissions.

As a city state, our urban infrastructure such as our built environment and transportation systems contribute to a sizeable portion of Singapore's domestic carbon emissions. The Green Infrastructure and Mobility domain includes skills that support the transition towards a sustainable and eco-friendly built environment, as well as the greening of air, land and sea transport systems.

Underpinning the Green Economy is a need for strong financial infrastructure to channel public and private sector investments into various green or greening initiatives. The Sustainable Finance domain focuses on skills that are important in strengthening the financial ecosystem and the provision of sustainable finance, especially in relation to regulations, standards setting (including taxonomy of sustainable activities), financial instruments for green investments (including green bonds and loans), and the operationalisation of carbon markets.

<sup>1</sup> Channel News Asia, 2022

<sup>2</sup> Singapore Economic Development Board, 2022

<sup>3</sup> While the focus in this chapter is on green skills, there are other supporting skills such as digital and engineering skills that may be required to green the whole economy and grow the Green Economy.

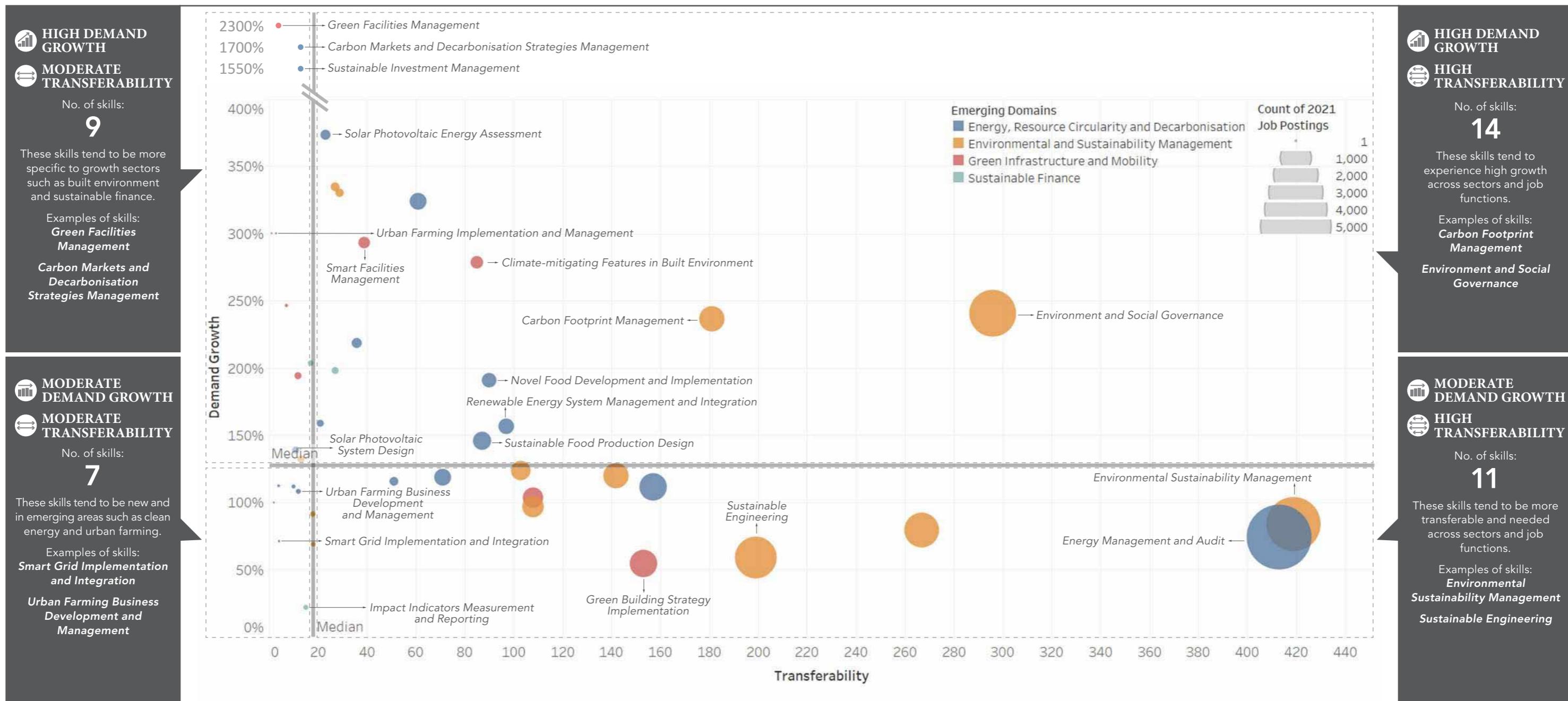
<sup>4</sup> Government of Singapore, 2022

<sup>5</sup> Channel News Asia, 2022

<sup>6</sup> "Greenhouse gases (GHGs)" refers to the atmospheric gases responsible for causing global warming and climate change. United Nations, retrieved 2022

Figure G1: Priority skills in the Green Economy

**Priority skills** refer to skills that citizens can prioritise to gain access and thrive in the emerging domains. These skills were derived from SSG's National Jobs-Skills Intelligence engine and validated via expert input from industry, academia and sector agencies. **Demand growth** (y-axis) refers to the **compound annual growth rate** of job postings (2018 to 2021) that mentioned a given priority skill. **Transferability** (x-axis) refers to the total number of unique job roles from job postings (2018 to 2021) that require a given priority skill<sup>7</sup>. Refer to the Methodology chapter for further details.



Skill Title	Green Facilities Management	Carbon Markets and Decarbonisation Strategies Management	Environment and Social Governance	Carbon Footprint Management	Smart Grid Implementation and Integration	Urban Farming Business Development and Management	Environmental Sustainability Management	Sustainable Engineering
Description	Manage facility operations and maintenance to minimise environmental impact and operational costs efficiently	Lead organisation's strategy and policies in response to current and projected carbon policy, market developments and decarbonisation strategies, and provide support for the organisation and clients in their efforts to decarbonise and become net-zero	Understand the latest industry and/or client standards regarding Environment and Social Governance (ESG) and undertake ESG research activities	Quantify and reduce the organisational carbon footprint	Develop and implement an integrated smart grid system using various distributed energy sources and energy management systems	Apply knowledge of urban farming techniques to formulate competitive agribusiness strategies, incorporating agri-technology innovations and sustainable farm-to-market business practices and value-chain	Integrate environmental sustainability through the development, implementation and review of sustainability strategies and programmes against industry best practices	Design, construct and operate engineering systems and assets to optimise energy management and enhance environmental performance

<sup>7</sup> Only data points with positive demand growth are shown. Outlier data points not discussed in this chapter are excluded.



## INDUSTRY VOICE

**National University of Singapore (NUS) Centre for Nature-based Climate Solutions**

### PROF. KOH LIAN PIN

**Director, NUS Centre for Nature-based Climate Solutions**

In the same way Singapore has had to transform itself when faced with an existential crisis half a century ago, we have to pivot ourselves again today as we face the existential crisis of climate change.

With the bold and decisive announcement of our intention to reach net zero ambition by 2050, and our revised carbon tax and carbon credit policies, we are signalling to the world that Singapore is serious about tackling climate change. Workers will need to keep abreast of changes in order to take appropriate steps to equip themselves with the relevant skills as Singapore gears itself towards a green economy.

This green transition will involve challenges as the government, private sector and citizens adapt to this push to reach net-zero emissions, but such challenges can be reduced through training and education.

Training and education will need to focus on developing fundamental knowledge in three key areas. First, developing foundational knowledge on climate change and sustainability. Second, developing function-specific skill sets to help corporate departments develop and deploy sustainability initiatives. Third, developing sector-specific competencies to enable the successful transition of key industries towards more sustainable business models. Skills in emerging domains such as Sustainable Finance

and Environment and Sustainability Management would further enable workers to determine the costs of business-as-usual, such as how environmental policies like a carbon tax would impact the bottom line. At the same time, the right training would also equip them with the ability to anticipate opportunities in the Green Economy, such as through the development of new products that are aligned with a more eco-conscious clientele.

Singapore aspires to be a 'bright green spark' in the world, but this requires the public, private and people sectors to have the right skills. This is especially since sustainability is a nascent but rapidly growing area in every economic space, with great demand for workforce upskilling. Universities and research institutes must work collaboratively with all sectors to identify skills in the Green Economy and accelerate skills training and adoption if we are to collectively transform Singapore into a Global City for Sustainability.

**“ Singapore aspires to be a ‘bright green spark’ in the world, but this requires the public, private and people sectors to have the right skills. ”**

### Key jobs and skills trends in the Green Economy

#### A. Green Infrastructure and Mobility, and Energy, Resource Circularity and Decarbonisation domains have the highest skills demand growth

Table G1: Emerging domains with highest skills demand growth

EMERGING DOMAIN	DEMAND GROWTH	EXAMPLE OF SKILL	EXAMPLE OF JOB ROLE
Green Infrastructure and Mobility	194%	<ul style="list-style-type: none"> <li>• Climate-mitigating Features in Built Environment</li> <li>• Green Facilities Management</li> <li>• Electric Vehicle and Hybrid Electric Vehicle Maintenance Management</li> </ul>	<ul style="list-style-type: none"> <li>• Architect/Architectural associate</li> <li>• Building supervisor</li> <li>• Technician (automotive)</li> </ul>
Energy, Resource Circularity and Decarbonisation	129%	<ul style="list-style-type: none"> <li>• Renewable Energy System Management and Integration</li> <li>• Solar Photovoltaic Energy Assessment</li> <li>• Urban Farming Implementation and Management</li> </ul>	<ul style="list-style-type: none"> <li>• Solar photovoltaic project development engineer</li> <li>• Energy systems engineer</li> <li>• Automation engineer</li> </ul>

Demand for skills in the Green Infrastructure and Mobility domain has grown by almost 200% from 2018 to 2021. This results from the growing need to imbue green building strategies into every aspect of the built environment, and the transition to cleaner energy transportation in our highly mobile and connected society. With more and more buildings and transport systems being required to meet mandatory emissions goals, more jobs will require skills to develop, implement and maintain the urban infrastructure while meeting low-to-zero emissions targets.

Specifically, demand for skills required throughout the entire built environment value chain are observed to be growing, such as those in the design and implementation of *Climate-mitigating Features in Built Environment* (+279%) and *Green Facilities Management* (+2300%). These skills are needed by job roles such as architect/architectural associate, engineering design engineer, and facilities manager. Existing workforce in automotive workshops will also need to acquire skills such as *Electric Vehicle and Hybrid Electric*

*Vehicle Maintenance Management* to keep in tandem with more EV adoption, as Singapore powers ahead with the electrification of our land transport systems, as we start to see more public and private transport operators transiting to EVs or hybrid electric vehicles, and with the deployment of more EV charging infrastructure nationwide.

As part of Singapore's energy transition strategies, skills under the Energy, Resource Circularity and Decarbonisation domain have also exhibited high demand growth, especially in the areas of design, deployment and management of solar photovoltaic (PV) systems. These skills include *Solar Photovoltaic Energy Assessment* (+373%), *Renewable Energy System Management and Integration* (+156%) and *Solar Photovoltaic Systems Designs* (+139%). It is also observed that skills in *Energy Management and Audit* have high transferability across job roles such as energy systems engineer, solar photovoltaic project development engineer and facilities engineer/technician dealing with power systems.

# PROFILE STORY:

## AZMAN BIN ABAS, senior executive for electric vehicle warranty and quality assurance at a local company

With a background in servicing Internal Combustion Engine (ICE) vehicles, Azman recently topped-up his skills to manage EVs.

### You took a course recently to expand your portfolio to include EVs. How did this come about?

In the course of my work, there were times when I was asked to stand in for my EV colleagues. However, I couldn't completely do so because I didn't have the know-how, and clients had to wait for my EV colleagues to return. So, with my company's support, I took a course to equip myself with the necessary skills. This was worthwhile because EVs are low in emissions and are part of the greener world we are moving towards.

### What was your learning journey like?

The course was a blend of e-learning and practical sessions. We learnt the theory online and went to the workshop for hands-on training. It was difficult at first, because my background was in mechanical engineering, and this course is more on electrical engineering. For example, we had to learn the names of different components, how to connect them and how they work. We also had to learn how to perform testing on them. It was challenging to learn the theory online because I've never done e-learning before. No physical textbook, everything online. But thankfully, the

hands-on sessions allowed us to see, smell, touch and hear how everything is. I have also dealt with some electrical stuff over the years, like fixing car dashboards, so I was able to tap on my existing skills to quickly adapt to the course material.

Even though it took time, I was determined to pick up new skills like *Electric Vehicle Battery Management*, *Electric Vehicle Charging Management*, and *Electric Vehicle Maintenance Management*. Now I know what goes on behind the wheel of an EV. My scope of work also expanded to include more and newer models of vehicles. It's very fascinating because the circuitry, high-voltage safety handling and the equipment used for diagnosis and maintenance are all different and require different ways of handling.

As I am more experienced now, I also have to advise clients on warranty matters. Even though I'm well-versed in skills like *Quality Control and Assurance*, increasingly, I need to pick up new skills specific to EV. Otherwise, I will not be able to perform that task anymore.

### How important is the ability to learn and adapt?

Very important. I can work on more than just ICE vehicles because I continue to learn and adapt. Learning and adapting has also helped me to remain relevant to my company.

## B. Skills in the Environmental and Sustainability Management domain have high transferability and are applicable across many job roles

Table G2: Skills with highest transferability under Environmental and Sustainability Management domain

SKILL	TRANSFERABILITY	EXAMPLE OF JOB ROLE
<i>Environmental Sustainability Management</i>	419	<ul style="list-style-type: none"><li>• Health, safety and environmental officer/manager</li><li>• Facilities manager</li><li>• Solar photovoltaic project development engineer</li></ul>
<i>Environment and Social Governance</i>	296	<ul style="list-style-type: none"><li>• Enterprise risk management executive</li><li>• Portfolio management analyst</li><li>• Sourcing coordinator</li></ul>
<i>Sustainable Engineering</i>	199	<ul style="list-style-type: none"><li>• Engineering manager</li><li>• Health, safety and environmental manager</li><li>• Process engineer</li></ul>

Skills in the Environmental and Sustainability Management domain are observed to be highly transferable as these skills are required across a wide range of industry sectors, from accountancy to hotel and accommodation services, infocomm technology, engineering, and transport-related sectors. Specifically, *Environmental Sustainability Management*-related skills are required by more than 400 job roles across business development, engineering project development, facilities management, and Environmental, Health and Safety (EHS).

Another highly transferable skill is *Environment and Social Governance*, which is required by close to 300 job roles, from C-suite positions to enterprise risk management executive, EHS manager and portfolio management analyst. Due to heightened awareness for organisations to

incorporate ESG practices into policies, services and implementation frameworks, organisations are increasingly hiring or transitioning existing employees into job functions related to ESG.

*Sustainable Engineering* involves the design, construction and operation of engineering systems, assets and processes to optimise energy efficiency and resource usage. This skill is highly transferable across close to 200 job roles, including engineering manager, EHS manager and process engineer. This skill is required by these job roles to implement sustainable engineering practices, monitor and analyse energy usage and performance data to improve environmental performance, as well as implement life cycle assessment and engineering solutions to meet long-term sustainability and environmental outcomes.



## INDUSTRY VOICE

PricewaterhouseCoopers (PwC)  
Singapore

### FANG EU-LIN

Partner, Sustainability and  
Climate Change Practice Leader,  
PwC Singapore

Singapore has pledged to be net zero by around mid-century and more recently is aiming to have emissions reach net zero by 2050. This commitment has translated to targets and ambitions that extend across areas in Sustainable Finance, towards becoming a carbon services hub and a carbon trading hub to facilitate appropriate conditions for transition towards a low-carbon economy.

Whether it is driven by regulations, investor expectations or other factors, more companies are transitioning towards a low-carbon business model. They are starting to measure their energy consumption and emissions, and finding pathways and solutions to decarbonise. Decarbonisation requires all hands on deck, involving carbon measurement specialists and decarbonisation strategists, and it also requires target setting, sustainable finance, verification, leveraging carbon offsets and renewable energy certificates.

I am a firm believer that as we leverage on our domain skills, and continue with targeted upskilling and reskilling, we will be able to explore more job role adjacencies in the transition towards a greener economy. A concrete example is how accountants' skills in numeracy, measurement and accounting complement skills such as *Sustainability Reporting*. These involve understanding carbon measurement, decarbonisation pathways, climate risk scenario analysis, impact measurement, and the application of the Global Reporting Initiative (GRI) standards or the

upcoming International Sustainability Standards Board (ISSB) standards to name a few.

Auditors' knowledge and technical skills are also highly relevant and transferable when it comes to performing an Environment, Social and Governance audit, an area that is seeing increasing regulatory controls being introduced. Many of my colleagues have successfully transitioned to these adjacent roles, including myself, and we have found this journey immensely rewarding from a personal development perspective. You feel a sense of mission.

I am also seeing companies, including PwC, committing to and bringing to life tailored ESG upskilling programmes for the whole firm to accelerate the embedding of ESG in its DNA. For example, it is mandatory for all 3,500 of our staff to complete our foundational ESG upskilling modules.

By taking deliberate steps to develop skills in ESG and *Sustainability Management* now, we can better compete in a global economy and make this an opportunity of a lifetime for companies and the workforce in Singapore.

**“ We leverage on our domain skills to explore more job role adjacencies in the transition towards a greener economy. ”**



## INDUSTRY VOICE

Johnson Controls, Singapore

### CHARLES LIM

Director,  
Johnson Controls, Singapore



### ALVIN NG

Former Vice President,  
Digital Solutions, Asia Pacific  
Johnson Controls, Singapore

According to a recent survey commissioned by Johnson Controls<sup>8</sup>, 70% of business leaders from Southeast Asia have identified sustainability as an increasing priority but many face hurdles around coordination across multiple teams, partners and sites.

Digitalisation plays a critical role in the Green Economy and supports companies in their sustainability agenda. Companies need to integrate their sustainability and digitalisation efforts via software platforms – allowing them to measure, control and optimise every aspect of their building operations from a single dashboard. This also helps them better monitor and coordinate across multiple teams, partners and sites.

While having the right technology is important, we also need the right capabilities to make full use of it. Combining our domain expertise in the built environment with digital capabilities, Johnson Controls has designed a SGUnited 'Mid-Career Pathways Programme — Company Training (SGUP-CT)' course to equip mid-career

learners with fundamental digital knowledge and sustainability-related skills, enabling them to pivot into the built environment. This can help them capture opportunities in the sector, with the increasing demand for skills such as *Smart Facilities Management* and *Green Building Strategy Implementation*.

In Johnson Controls, we have also transformed the way we service chillers through training and guidance. Now, our service technicians can monitor chiller performance remotely and predict faults, thus reducing the need for regular onsite inspection while improving our energy efficiency and work productivity. We are committed to share our experience to help the industry.

**“ Digitalisation plays a critical role in the Green Economy and supports companies in their sustainability agenda. ”**

## C. Growing skills demand in emerging areas relating to sustainable finance, urban farming, food technologies, and novel food development

Table G3: Skills in emerging areas under Sustainable Finance and Energy, Resource Circularity and Decarbonisation domains

EMERGING DOMAIN	DEMAND GROWTH	EXAMPLE OF SKILL	EXAMPLE OF JOB ROLE
Sustainable Finance	1550% <sup>9</sup>	<ul style="list-style-type: none"> <li>• Carbon Markets and Decarbonisation Strategies Management</li> <li>• Sustainable Investment Management</li> <li>• Impact Indicators, Measurement and Reporting</li> </ul>	<ul style="list-style-type: none"> <li>• Underwriting manager</li> <li>• Investment analyst</li> <li>• Sales and distribution specialist</li> </ul>
Energy, Resource Circularity and Decarbonisation	168%	<ul style="list-style-type: none"> <li>• Urban Farming Implementation and Management</li> <li>• Urban Farming Business Development and Management</li> <li>• Novel Food Development and Implementation</li> </ul>	<ul style="list-style-type: none"> <li>• Food safety specialist</li> <li>• Food technologist</li> <li>• Quality assurance and quality control specialist</li> </ul>

The Sustainable Finance domain is an emerging area where the financial services sector is beginning to introduce green investments, loans and financial instruments to support companies tapping Green Economy opportunities. In particular, skills in Carbon Markets and Decarbonisation Strategies Management and Sustainable Investment Management saw the highest demand growths of 1700% and 1550% respectively, albeit starting at relatively low bases. It is anticipated that more financial and corporate professionals will require these skills to lead organisation strategy and policy changes in response to carbon policy, market development, and investment and decarbonisation strategies, in their business processes and operations, as well as managing their service offerings and portfolio. Examples of job roles requiring these skills include investment analyst, underwriting manager, and sales and distribution specialist/coverage officer.

Skills in urban farming, food technologies, and novel food development under the Energy, Resource Circularity and Decarbonisation domain are also a nascent trend. This is in tandem with Singapore's aim to safeguard food security by

producing 30% of our nutritional needs by 2030<sup>10</sup>. The global supply chain disruption during the COVID-19 pandemic further compound the need to grow the food industry locally. Skills required by companies include *Urban Farming Implementation and Management*, and *Urban Farming Business Development and Management*. These support the growth of vertical farms within buildings' premises and rooftops. Companies utilise agri-tech such as hydroponics and/or aquacultural technology, and incorporate automation in growing, harvesting and packaging before goods are distributed. Job roles requiring these skills include business development manager, research and development engineer/executive, and automation engineer. At the same time, the development of food technologies and novel food concepts, such as plant-based proteins and lab-grown proteins, are also gaining traction locally. Skills in *Novel Food Development and Implementation* and *Sustainable Food Production Design* are required by job roles ranging from food technologist to chef, to quality assurance and quality control specialist.

## PROFILE STORY:

### ONG SHU YI, environmental, social and governance analyst at a local bank

Shu Yi started her career in sustainability policy in the public service, before transiting to her current role that focuses on ESG research.

#### Your career transition was rather recent. Why and how did you manage to do it?

From my previous role, I learnt that financial institutions play a pivotal role in financing the green transition as well as the adaptation of green strategies in developing countries. I became interested in this space and decided to make the switch. While this is a new field, I'm thankful for my company's support in sponsoring me for courses. One of which was the Certified ESG Analyst Programme, called CESGA, which enabled me to incorporate sustainability-focused aspects into my work.

#### What was your learning journey like?

I took up the CESGA programme, together with seven other colleagues, that enabled us to better apply Environment and Social Governance and Sustainability Risk Management skills in our workflow, such as (i) understanding the regulatory environment in the EU who are leaders in the space and apply

the learnings to Asian markets, as well as (ii) understanding how clients may be affected by upcoming regulatory changes and ESG risks to better support them on their risk assessments.

I also signed up for various sustainability workshops and learning series provided by the company to employees to better understand the role of financial institutions in driving sustainable change. This learning helped in my analysis and can better inform my organisation and our clients in their ESG decisions.

#### How important is the ability to learn and adapt?

It is very important to learn new skills to evolve professionally, that can lead to further personal and career growth. The sustainability space is a good example of a trend that has rapidly picked up pace, and both businesses and individuals are learning new skills to adapt to an environment that prioritises sustainability. It is expected that there will be a lot more interest and influence in this space moving forward, so it is important to stay abreast with developments and trends.

<sup>9</sup> There is a limited number of skills in the Sustainable Finance domain derived from job posting data. The very high skills demand growth seen by the domain is due to correspondingly high demand growth of these skills.

<sup>10</sup> Singapore Food Agency, 2020

## Skills featured in this chapter

SKILL TITLE	SKILL DESCRIPTION	Quality Control and Assurance	Implement checks and testing processes for the measurement and assurance of product quality and services to meet consumer expectations
<i>Carbon Footprint Management</i>	Quantify and reduce the organisational carbon footprint	<i>Renewable Energy System Management and Integration</i>	Analyse impact of renewable energy system integration on energy grid in steady state and during dynamic operation.
<i>Carbon Markets and Decarbonisation Strategies Management</i>	Lead organisation's strategy and policies in response to current and projected carbon policy, market developments and decarbonisation strategies, and provide support for the organisation and clients in their efforts to decarbonise and become net zero	<i>Smart Facilities Management</i>	Integrate digital technologies and smart automation into facility operations and maintenance to optimise efficiency and performance
<i>Climate-Mitigating Features in Built Environment</i>	Research, develop and implement climate-mitigating features in built environment	<i>Smart Grid Implementation and Integration</i>	Develop and implement an integrated smart grid system using various distributed energy sources and energy management systems.
<i>Electric Vehicle and Hybrid Electric Vehicle Battery Management</i>	Apply knowledge in electric vehicle and/or hybrid electric vehicle battery management and implement maintenance activities in a safe work environment	<i>Solar Photovoltaic Energy Assessment</i>	Assess feasibility of solar photovoltaic (PV) installations for buildings based on location and energy assessments
<i>Electric Vehicle and Hybrid Electric Vehicle Charging Management</i>	Apply knowledge of electric vehicle and/or hybrid vehicle charging and implement charging and maintenance activities in a safe work environment	<i>Solar Photovoltaic Systems Designs</i>	Oversee design of solar photovoltaic (PV) systems according to project requirements and site constraints
<i>Electric Vehicle and Hybrid Electric Vehicle Maintenance Management</i>	Apply knowledge of electric vehicle and hybrid electric vehicle to implement maintenance activities in a safe work environment	<i>Sustainable Engineering</i>	Design, construct and operate engineering systems and assets to optimise energy management and enhance environmental performance
<i>Energy Management and Audit</i>	Perform energy audits to optimise the energy performance of energy consuming systems and manage energy consumption	<i>Sustainable Food Production Design</i>	Design and implement sustainable food production policies, processes and initiatives within the organisation
<i>Environment and Social Governance</i>	Understand the latest industry and/or client standards regarding Environment and Social Governance (ESG) and undertake ESG research activities	<i>Sustainable Investment Management</i>	Lead organisation's strategies on sustainable investment and implement sustainable investment concepts and approaches on portfolio management
<i>Environmental Sustainability Management</i>	Integrate environmental sustainability through the development, implementation and review of sustainability strategies and programmes against industry best practices	<i>Sustainability Management</i>	Plan, develop and roll out of an organisation-wide sustainability strategy. This includes the assessment of the organisation's utilisation and/or consumption of energy and other resources, vis-a-vis the availability and stability of supply sources and external best practices and standards
<i>Green Building Strategy Implementation</i>	Develop environmental sustainability plans throughout the building lifecycle through the development, implementation and review of sustainability strategies to enhance environmental performance	<i>Sustainability Reporting</i>	Lead development of organisation's sustainability reporting and accounting policies and processes in line with regulatory requirements and international best practices
<i>Green Facilities Management</i>	Manage facility operations and maintenance to minimise environmental impact and operational costs efficiently	<i>Sustainability Risk Management</i>	Develop frameworks, strategies and policies for managing sustainability risks for the organisation to minimise and mitigate risks and impact to the organisation
<i>Impact Indicators Measurement and Reporting</i>	Analyse, monitor and report impact of sustainability actions and lead the organisation in setting impact mission and targets for the organisation or customers	<i>Urban Farming Business Development and Management</i>	Apply knowledge of urban farming techniques to formulate competitive agribusiness strategies, incorporating agri-technology innovations and sustainable farm-to-market business practices and value-chain
<i>Novel Food Development and Implementation</i>	Research and develop novel food and ingredients based on food bio-science concepts, incorporating knowledge in agri-technology and innovative food processing technology that yield nutritious value with viable mass market potential	<i>Urban Farming Implementation and Management</i>	Manage the day-to-day urban farming operations which include, supply-chain management, maintenance management and incorporating sustainable and good urban farming practices

The skills featured in this chapter are non-exhaustive.  
To see the full list of priority skills, please visit this link:



<https://go.gov.sg/2022skills-ge>

Please visit this link for information on suggested courses for the  
Green Economy:



<https://linktr.ee/GreenEconomy>



DIGITAL ECONOMY

- Skills in Software Development and Cloud, Systems and Infrastructure are growing in demand as businesses develop more digital products and build up their IT networks and infrastructure
- E-commerce and Digital Marketing, and AI, Data and Analytics-related skills are the most transferable across sectors and job roles

The COVID-19 pandemic has accelerated the rate of digital transformation. Today, there is an increasing adoption of technologies across multiple sectors. Examples of technologies include AI and data, Internet-of-Things (IoT), cybersecurity, and 5G applications. These technologies are now vital for many processes such as hybrid work, e-commerce and digital payments. These technologies are also used to develop applications that enable businesses to connect with more consumers and provide better services.

Today, Singapore's economy is undergoing intensive digitalisation. Examples of digitalisation include the launch of new fully digital banks, continued growth of e-retail, and the enhancement of Singapore's digital connectivity through 5G networks. This macro trend will likely continue as Singapore emerges from the pandemic.

The government continues to play a significant role in driving whole-of-nation digitalisation. Under the

national Smart Nation initiative<sup>1</sup>, the three key pillars are **Digital Economy**, Digital Government and Digital Society. Widespread adoption of national digital infrastructure, especially digital identity system and PayNow, will continue to spur digital innovations across the board. The government continues to lead by example in digital adoption to better serve the citizenry. For example, the government created the GoWhere app to help eligible citizens find the locations to collect ART kits. Another example is GovWallet which helps government agencies disburse monies and credits in a secure and convenient way.

As more talents are equipped with digital skills to exploit the e-opportunities such as e-finance, e-retail and e-government, there is also an increasing need to provide individuals with the skills to secure their digital space. As we strive to preserve the internet as a safe space for commerce, data security and digital trust becomes critical. Unfortunately, there have been more reported cases of online scams and compromised data. In 2021, Singapore recorded close to 3,700 computer misuse cases, while cybercrime made up 48% of all crime<sup>2</sup>. With initiatives such as digital trust R&D centres, sandboxes, cybersecurity training, and data governance frameworks<sup>3</sup>, both the public and private sectors are investing more in this space.

## Emerging domains in the Digital Economy

With rapid developments in the **Digital Economy**, there are many opportunities to uplift jobs and skills. Emerging business operating models challenge conventional notions on how businesses are structured, how firms and citizens interact, and how consumers obtain goods, services, and information. In Microsoft's estimate about the growth in demand for digital skills, the global number of technology-oriented jobs will increase to 190 million in 2025<sup>4</sup>. The skills that are of increasing importance to the Digital Economy can be defined in six emerging domains:

- AI, Data and Analytics
- Cloud, Systems and Infrastructure
- Cyber Security and Risk
- Software Development
- E-commerce and Digital Marketing
- Technology Application and Management

The AI, Data and Analytics domain supports how data-related skills are being used in **tech-lite** areas, such as business data analysis and data visualisation, and **tech-heavy** areas, such as AI application and data engineering. As businesses deal with more data and use them more intensively, technical expertise needs to grow to effectively manage data as a resource.

The Cloud, Systems and Infrastructure domain is related to the deployment and administration of cloud infrastructure, database and 5G networks. These skills drive the maintenance, implementation and continuous improvement of the underlying systems and infrastructure that

businesses rely on to enhance their digital functions and services.

The Cyber Security and Risk domain relates to data and IT management and protection, security and threat management, and incident and recovery management. With more people connected online, digital assets must be protected. These skills enable the protection and governance of customers' data and ensure that the integrity of systems is not compromised. They also support organisations with the ability to set up robust incident and recovery management measures to prevent breaches in databases and systems.

The Software Development domain focuses on technical skills such as software application interface development and customer experience. They support the development of digital products and applications for organisations to interface with both consumers and internal staff.

The E-commerce and Digital Marketing domain includes skills related to market research, consumer behaviour insights, product sales and market management, and digital marketing communications. As Singapore's growth in e-commerce sales is expected to reach \$19.6 billion by 2027<sup>5</sup>, these skills will continue to play a significant role in the economy.

The Technology Application and Management domain focuses on skills that support the adoption and deployment of technology. These skills help to bridge the 'technical push' with the 'operational pull', so that businesses can maximally harness emerging digital technologies to innovate processes and create new revenue channels.

<sup>1</sup> Smart Nation Singapore, 2022

<sup>2</sup> Statista, 2022

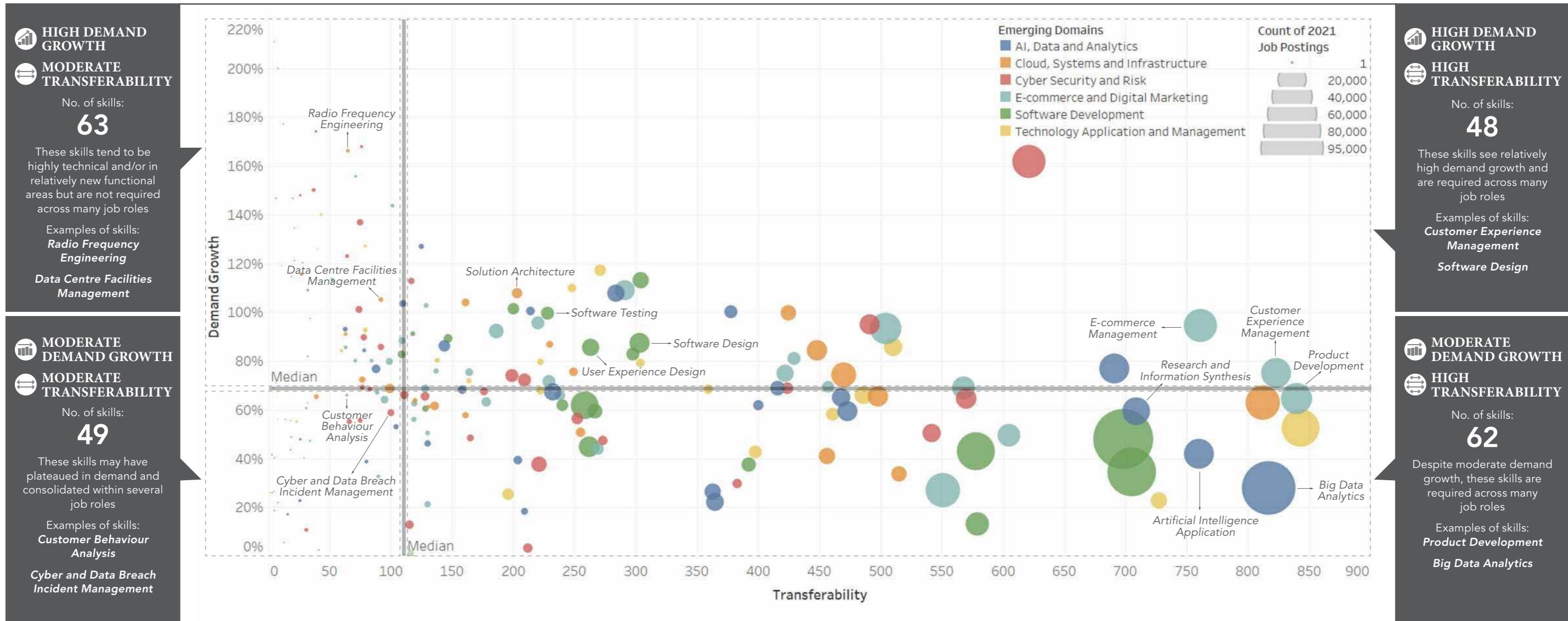
<sup>3</sup> For instance, SGTech, the trade association for Singapore's tech industry, undertook a global landscape study and identified technology, governance, and people enablers to boost digital trust. SGTech, 2022

<sup>4</sup> Microsoft, 2020

<sup>5</sup> The Straits Times, 2022

Figure D1: Priority skills in the Digital Economy

**Priority skills** refer to skills that citizens can prioritise to gain access and thrive in the emerging domains. These skills were derived from SSG's National Jobs-Skills Intelligence engine and validated via expert input from industry, academia, and sector agencies. **Demand growth** (y-axis) refers to the **compound annual growth rate** of job postings (2018 to 2021) that mentioned a given priority skill. **Transferability** (x-axis) refers to the total number of unique job roles from job postings (2018 to 2021) that requires a given priority skill<sup>6</sup>. Refer to the Methodology chapter for further details.



Skill Title	Radio Frequency Engineering	Data Centre Facilities Management	Customer Experience Management	Software Design	Customer Behaviour Analysis	Cyber and Data Breach Incident Management	Product Development	Big Data Analytics
Description	Design, deploy and maintain radio frequency infrastructure for IT systems and wireless communication networks	Manage and maintain data centre resources, facilities and/or physical infrastructure to ensure smooth, stable and sustainable operations within data centres	Compile and analyse information gathered through various channels and manage communication across customer touch points to ensure a consistent and pleasant customer experience	Create and refine the overall plan for the design of software, including the design of functional specifications	Devise customer behaviour analysis tools and approaches, to perform analysis on information pertaining to customer behaviours, leading to improved customer recommendations	Detect and report cyber and data-related incidents, identify affected systems and user groups, trigger alerts and announcements to relevant stakeholders and efficient resolution of the situation	Evaluate consumer and market trends to determine value proposition, cost-effectiveness and profitability of proposed products in different markets	Analyse and validate significant volumes of data to discover and quantify patterns and trends to improve business operations

<sup>6</sup> Only data points with positive demand growth are shown. Outlier data points not discussed in this chapter are excluded.



## INDUSTRY VOICE

IBM Consulting, Singapore

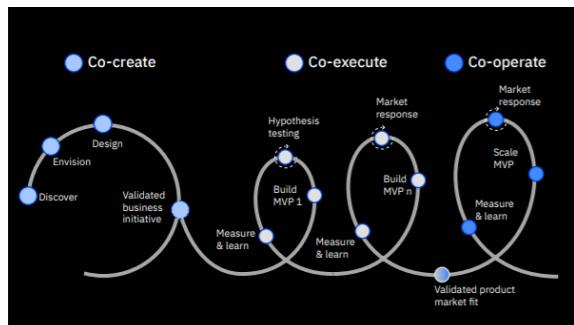
NG LAI YEE

Managing Partner and  
Country Leader,  
IBM Consulting, Singapore

Today, the world is at an inflection point where technology has radically transformed how businesses work. The convergence of new exponential technologies like AI, automation, IoT, blockchain, and 5G has changed the playing field. Organisations need to reimagine how they work, reinvent their business models, and reskill their workforce to remain relevant.

A paradigm-shift in the ways of working and thinking is key for digital success. This means roles and responsibilities within the organisation need to change. An open mindset to accept new skilling, upskilling and cross-skilling, helps organisations to brace for their digital transformation endeavours.

Figure D2: The IBM Garage Journey



For example, IBM Garage is an end-to-end model created to help clients accelerate their digital transformation journey. To implement the model, Garage teams with deep domain skills and the ability to work effectively in an agile manner are set up. A typical Garage team would comprise business analysts, experience designers and technical developers. We see a need to merge business domain knowledge, human machine interaction design, and

In an era where the relevancy and lifecycle of skills diminish unceasingly, we need a culture of continuous learning to survive and the desire to learn and cross-learn. This is a unique characteristic of the Digital Economy.

**“ When deep skills are siloed from other disciplines, whether in technical or business domain knowledge, they are not as valuable as hybrid cross-functional skills. ”**

## Key jobs and skills trends in the Digital Economy

### A. Skills in the Software Development domain have the highest demand growth and transferability

Amongst the six emerging domains, Software Development surpasses other domains in terms of skills demand growth and transferability, growing by 83% between 2018 to 2021. The growing demand for software and applications on devices, coupled with exponential growth in digitalisation spurred by the COVID-19 pandemic, has led to an increasing need for related skills in software development.

There are three skills in the Software Development domain that have high growth and high transferability (see Table D1). Specifically, *Software Testing* skill is required by job roles such as quality assurance tester and vulnerability assessment and penetration testing analyst. They need to conduct software testing more frequently to check on the effectiveness and performance, identify issues and defects, and ensure product quality.

The other two skills are related to design. Job roles such as product designer and customer experience manager use *User Experience Design* skill to enhance user interactions and engagement with products and services. Software architects and embedded systems engineers use *Software Design* skill to translate complex software ideas and concepts into design blueprints, including the design of functional specifications. The growth and transferability of these design-related skills emphasise the importance of a user-centric approach in the software development and product design process. While the functionality of a digital product is crucial, the user experience and alignment with current and future needs are also critical.

Table D1: High growth and high transferability skills under Software Development domain

SKILL	DEMAND GROWTH	TRANSFERABILITY	EXAMPLE OF JOB ROLE
Software Testing	100%	228	<ul style="list-style-type: none"><li>• Quality assurance tester</li><li>• Vulnerability assessment and penetration testing analyst</li><li>• Applications support engineer</li></ul>
User Experience Design	86%	263	<ul style="list-style-type: none"><li>• Product designer</li><li>• Customer experience manager</li><li>• Associate software engineer</li></ul>
Software Design	87%	303	<ul style="list-style-type: none"><li>• Software architect</li><li>• Embedded systems engineer</li><li>• Software engineer</li></ul>

# PROFILE STORY:

## JEREMY HUGON KOSMAN, user experience (UX) designer at a multinational technology corporation

An electrical engineer by training, Jeremy successfully made the leap to his current role, where he creates mobile, web and enterprise applications. He is motivated to serve users better by designing how an app behaves and functions.

### You made a career switch from electrical engineering to UX design. Why?

Designing offers more room for improvisation and trial and error, than the definite ones-and-zeroes in engineering or programming work. Alongside simplifying complex information and processes for greater accessibility, UX covers psychology, visual design and the aesthetics of a product. All these fit with my personal interests.

### What was your learning journey like?

Besides a Specialist Diploma in Mobile Applications, I actively sought out UX design certification courses online, and undertook a short course at the National University of Singapore on user experience. These courses led me to pick up skills such as *Interaction Design Practice*. From the moment a user enters a store, there are various touchpoints that could be designed to provide more positive interaction with customers. Importantly, service design is not limited to a physical product, but involves its accompanying experiences as well.

My current work also involves gathering and analysing information on target users for insights. *Customer Behaviour Analysis* skills allow me to use these insights to develop prototypes of mobile applications and websites. Adobe XD and Figma are useful tools to learn and use at this stage. Through this process, I address user pain points and enhance user experiences, leading to improved customer recommendations.

I have a quote at my desk. It says: "Design is a social function. Its true purpose is to improve people's lives." Ultimately, design serves humans. Honing this ability to use design as a social good, drives me in my work.

### How important is the ability to learn and adapt?

It's beneficial to learn outside your field. In keeping up to date on business and IT, I find myself working better with teammates while expanding my knowledge. Motivation for me comes from striving for excellence at my job. While extrinsic motivation can be provided by employers when they send their staff for courses, I believe intrinsic motivation is equally, if not more, important.

## B. Skills in Cloud, Systems and Infrastructure domain have relatively higher demand growth

As businesses scale up digitalisation efforts, systems such as cloud, system administration, database, and network infrastructure form the foundation of the Digital Economy. Networks, IT and data systems that are secure and robust ensure minimal disruption to productivity and enable businesses to meet increasing demand for their services.

Skills such as *Radio Frequency Engineering*, *Solution Architecture* and *Data Centre Facilities Management* (see Table D2) are some of the skills with the highest demand growth in the Cloud, Systems and Infrastructure domain. Specifically, *Radio Frequency Engineering* skill is used by radio

frequency engineers for the development of 5G networks, which is a relatively new area. In addition, properly implemented and integrated IT systems and infrastructure are important to any organisation. Therefore, *Solution Architecture* skill used by infrastructure architects and data architects is integral to develop structured and integrated systems and infrastructure. *Data Centre Facilities Management* is an important skill used by data centre operations engineers and facilities managers to manage the increasing demand on data centres from network and IT services and the growth of hyperscalers.

Table D2: High growth skills under Cloud, Systems and Infrastructure domain

SKILL	DEMAND GROWTH	EXAMPLE OF JOB ROLE
<i>Radio Frequency Engineering</i>	166%	<ul style="list-style-type: none"><li>• Senior assistant engineer</li><li>• Radio frequency engineer</li><li>• Artificial intelligence applied researcher</li></ul>
<i>Solution Architecture</i>	108%	<ul style="list-style-type: none"><li>• Infrastructure architect</li><li>• Data architect</li><li>• Software architect</li></ul>
<i>Data Centre Facilities Management</i>	105%	<ul style="list-style-type: none"><li>• Data centre operations engineer</li><li>• Senior technician</li><li>• Facilities manager</li></ul>

# PROFILE STORY:

## TERENCE TAN, digital solutions director at a facilities management firm

A building facilities domain expert for more than 20 years, Terence embraced digitalisation into his area of expertise five years ago to enhance facilities management and operations for his clients.

### What motivated you to embrace digitalisation?

Facilities management is not new. However, in the past decade, competition has increased as more companies, including those from regional countries, entered this line of business with low-cost business models. There was a need to differentiate ourselves by moving up the value chain. At the same time, building owners were also becoming more aware of using data to improve energy efficiency and, in more recent years, enhanced sustainability compliance. When my company adopted digitalisation into its solutions five years ago, I felt it was timely and joined the pioneer digital solutions team without hesitation.

### What was your learning journey like?

The learning was challenging at first, as I needed to change my mindset. Digitalisation means I need not be on premise to check on buildings and could rely on sensors installed to do that job more effectively and efficiently. However, it required me to understand what data to capture, how to integrate all the data,

and make sense of the data to derive actionable insights. Next, I had to pick up *Data Visualisation* skills to present the analysis and insights to building owners so that they can see the benefits of having such information at their fingertips to better conduct preventive maintenance and enhance the experience of their tenants. *Solutioning* skills also enabled me to promptly diagnose potential problems with the building, propose corrective measures, evaluate each measure on its effectiveness, before taking early actions to resolve issues.

As technology is never on a standstill, the learning never stops. I am always on a lookout for emerging technologies that can further enhance my company's value proposition. Specifically, I will gather information on these technologies and then perform a cost-benefit analysis to determine if it makes sense to integrate them. Applying these *Emerging Technology Scanning* skills helps me to ensure that the latest technology ultimately brings more value to my clients.

### How important is the ability to learn and adapt?

In my line of work, it is absolutely critical to learn and adapt continuously. This opens up new possibilities to do things smarter and more flexibly. I believe this applies to anybody and the job that he/she is passionate about.



# INDUSTRY VOICE

SGTech

## YEAN CHEONG

Executive Director,  
SGTech

At SGTech, informed by more than 1,000 member companies, we keenly recognise the pressing need to grow and nurture relevant tech talent to support the broader digitalisation efforts across all sectors.

The array of tech skills that are in demand in the market is manifold, so I will focus on one emerging area of the Digital Economy that promises much opportunity – Digital Trust.

There is a significant opportunity for Singapore to bring its reputation as a trusted hub for business, finance and aviation into the digital space. An ambitious global landscape study that SGTech released in October 2022<sup>7</sup> identified Digital Trust enablers in the areas of technology, governance and people, underpinned by key digital skills to make Digital Trust a success in Singapore.

*Data Engineering* skills will be needed to realise the immense potential of emerging 'trust tech' like privacy enhancing technologies, cybersecurity innovations, and digital identity solutions. Data scientists will be at the heart of these technologies, while development approaches such as 'data protection by design' and 'security by design' will ensure that developers incorporate these functionalities into everyday workflows to enhance trust in technology.

More balanced and effective legislation, interoperable regulatory frameworks, and formulation of international governance tools,

such as trustmarks and certifications, will be needed. This will require skilled legal and consulting practitioners specialising in international data laws and digital regulation. Cyber insurance services will also be a growing need as more organisations seek protection against rising fraud threats.

Digital Trust professionals will quickly move from being niche appointments to becoming common features of corporate offices around the world. One can look out for job descriptions like 'digital trust manager' on LinkedIn feeds soon. With skills like *Data Protection Management*, *Cyber Risk Management*, and *Security Governance*, these new roles will integrate existing job functions across data to risk, legal and compliance, and require specialist curricula developers, trainers, assessors, certifiers, and recruiters.

Digital Trust will be a game-changer for Singapore to secure its place as a global digital and data node. SGTech looks forward to being a mobilising force in this ecosystem to catalyse capability building and skills development.

**“Digital Trust professionals will quickly move from being niche appointments to becoming common features of corporate offices around the world.”**

### C. More job roles will require skills in E-commerce and Digital Marketing, and AI, Data and Analytics domains

A study by Forbes<sup>8</sup> highlighted changing business models and customer behaviour as top digital trends. With more businesses opting for omnichannel customer support, businesses must provide more outreach options to enhance customer experience. In addition, with the growth of e-commerce business models, skills such as *Product Development*, *Customer Experience Management* and *E-commerce Management* in the E-commerce and Digital Marketing domain are needed to enhance outreach strategies and customer experience. These skills have a high transferability of about 800 job roles requiring these skills. Many businesses need to develop products to bring sustainable growth and value to the organisations, making the *Product Development* skills highly transferable. The other two skills, *Customer Experience Management* and *E-commerce Management*, are related to customer engagement which is key to increase

customer loyalty and trust especially in today's volatile business environment.

Skills such as *Big Data Analytics*, *Artificial Intelligence Application* and *Research and Information Synthesis* in the AI, Data and Analytics domain are required by about 700 job roles (see Table D3). A tremendous amount of data is collected every day and can be an asset if businesses know how to tap on it. *Big Data Analytics* is a skill often used by job roles such as data scientists, data engineers and data architects. However, this skill is also demanded by other tech-lite roles, such as business intelligence manager and risk analytics manager. The difference lies in the application of the skill. Analytics and customer insight managers may use advanced analytical techniques to interpret large quantities of data, but data scientists may have to develop new data models to transform how data is used.

**Table D3:** Skills with high transferability

SKILL	DOMAIN	TRANSFERABILITY	EXAMPLE OF JOB ROLE
<i>Product Development</i>	E-commerce and Digital Marketing	840	<ul style="list-style-type: none"> <li>• Product development manager           <ul style="list-style-type: none"> <li>• Product manager</li> <li>• Merchandising manager</li> </ul> </li> </ul>
<i>Customer Experience Management</i>	E-commerce and Digital Marketing	823	<ul style="list-style-type: none"> <li>• Customer experience manager           <ul style="list-style-type: none"> <li>• Principal service designer</li> <li>• Sales executive</li> </ul> </li> </ul>
<i>Big Data Analytics</i>	AI, Data and Analytics	817	<ul style="list-style-type: none"> <li>• Data analyst</li> <li>• Data engineer</li> <li>• Data scientist</li> </ul>
<i>E-commerce Management</i>	E-commerce and Digital Marketing	761	<ul style="list-style-type: none"> <li>• E-commerce manager</li> <li>• Marketing assistant</li> <li>• Merchandising associate</li> </ul>
<i>Artificial Intelligence Application</i>	AI, Data and Analytics	760	<ul style="list-style-type: none"> <li>• Senior machine learning engineer           <ul style="list-style-type: none"> <li>• Data scientist</li> <li>• Data architect</li> </ul> </li> </ul>
<i>Research and Information Synthesis</i>	AI, Data and Analytics	709	<ul style="list-style-type: none"> <li>• Analytics and customer insights manager</li> <li>• Data scientist</li> <li>• Threat analysis manager</li> </ul>



## INDUSTRY VOICE

**Singapore Computer Society (SCS)**

**SAM LIEW**

**President,  
SCS**

The proliferation of AI has created opportunities for both start-ups and established businesses to achieve more than we could ever imagine. According to Gartner's forecast of 2022, the worldwide AI software market will reach \$62 billion<sup>9</sup>, and the value of AI-derived businesses will reach \$3.9 trillion<sup>10</sup>. Yet, the power of AI has also sparked concerns about its biases and potential exploitation by unethical individuals and businesses.

*AI Ethics and Governance* is a valuable skill that helps increase the levels of trust and confidence in various AI platforms and ecosystems. It helps eliminate risks of unintended discrimination that will potentially lead to unfair outcomes. Examples of how *AI Ethics and Governance* can be applied includes performing updates to internal governance structures to ensure robust oversight of AI, disclosing parameters used in developing AI model to users, and ensuring proper documentation throughout the developmental process for stakeholder accountability.

Being the largest infocomm and digital media society in Singapore, SCS stepped up and took the lead to drive the *AI Ethics and Governance* movement. In October 2019, partnering with Infocomm Media Development Authority (IMDA), SCS developed and launched the *AI Ethics and Governance Body of Knowledge* based on IMDA's AI governance framework.

Subsequently, the Certificate in *AI Ethics and Governance*, the first certification programme jointly created by SCS and Nanyang Technological University (NTU), was launched in October 2021. The SCS-NTU joint certification on *AI Ethics and Governance* for Professional Level ensures that we continuously build a pipeline of adequately trained and certified professionals in this emerging area of *AI Ethics and Governance*.

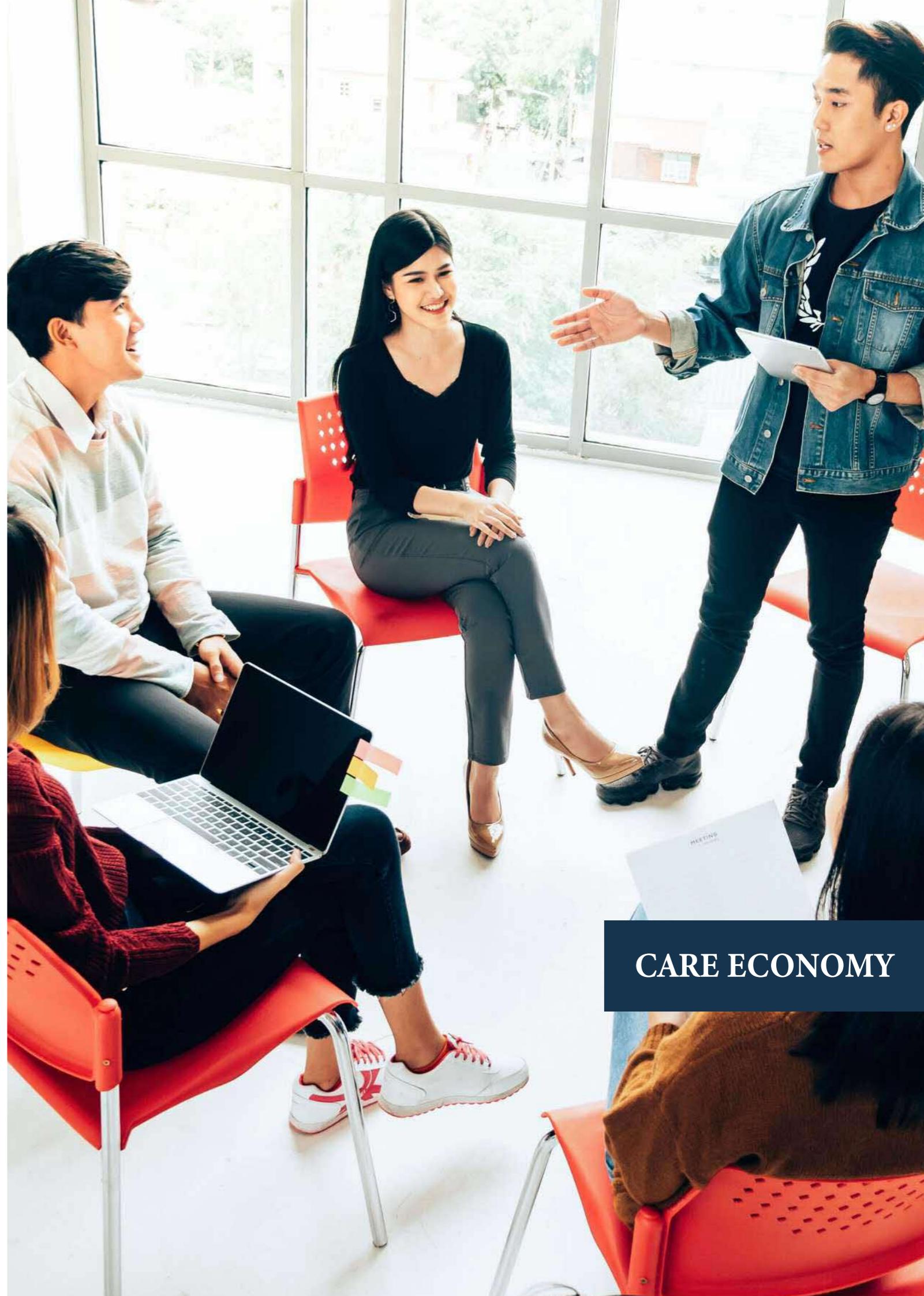
SCS has also partnered with Polytechnics and the Institute of Technical Education (ITE) to roll out the *AI Ethics and Governance (Associate)* Certification and *AI Literacy* programmes infused with *AI ethics* on human centricity for students.

To date, we have trained 208 trainees and certified 184 professionals in *AI Ethics and Governance*. *AI* will continue to expand in every aspect of our lives and become more pervasive in the Digital Economy. Hence, we need to be prepared and equip ourselves with skills in *AI Ethics and Governance*.

**“ *AI Ethics and Governance* is a valuable skill that helps increase the levels of trust and confidence in various AI platforms and ecosystems. ”**

## Skills featured in this chapter

SKILL TITLE	SKILL DESCRIPTION	SKILL TITLE	SKILL DESCRIPTION
<i>Artificial Intelligence Application</i>	Apply algorithmic, statistical and engineering knowledge to integrate artificial intelligence into engineering processes	<i>Security Governance</i>	Develop and disseminate corporate security policies, frameworks and guidelines to ensure that day-to-day business operations guard or are well protected against risks, threats and vulnerabilities
<i>Big Data Analytics</i>	Analyse and validate significant volumes of data to discover and quantify patterns and trends to improve business operations	<i>Software Design</i>	Create and refine the overall plan for the design of software, including the design of functional specifications
<i>Customer Behaviour Analysis</i>	Devise customer behaviour analysis tools and approaches, to perform analysis on information pertaining to customer behaviours, leading to improved customer recommendations	<i>Software Testing</i>	Assess and test the overall effectiveness and performance of an application, involving the setting up of suitable testing conditions, definition of test cases and/or technical criteria
<i>Customer Experience Management</i>	Compile and analyse information gathered through various channels and manage communication across customer touch points to ensure a consistent and pleasant customer experience	<i>Solution Architecture</i>	Design or refine a solution blueprint or structure to guide the development of IT solutions in hardware, software, processes, or related components
<i>Cyber and Data Breach Incident Management</i>	Detect and report cyber and data-related incidents, identify affected systems and user groups, trigger alerts and announcements to relevant stakeholders and efficient resolution of the situation	<i>Solutioning</i>	Generate solutions by systematic analysis of the problem, proposing preventive and/or corrective measures and evaluating the effectiveness of the measures from different perspectives
<i>Cyber Risk Management</i>	Develop cyber risk assessment and treatment techniques that can effectively pre-empt and identify significant security loopholes and weaknesses and provide risk treatment and prioritisation strategies	<i>User Experience Design</i>	Conceptualise and enhance users' interactions and engagement with products and services by integrating elements of interaction design, information architecture, information design, visual interface design, user assistance design and user-centred design
<i>Data Centre Facilities Management</i>	Manage and maintain data centre resources, facilities and/or physical infrastructure to ensure smooth, stable and sustainable operations within data centres	<p>The skills featured in this chapter are non-exhaustive. To see the full list of priority skills, please visit this link:</p>  <p><a href="https://go.gov.sg/2022skills-de">https://go.gov.sg/2022skills-de</a></p>	
<i>Data Protection Management</i>	Develop and implement a Data Protection Management Programme to comply with the Personal Data Protection Act 2012	<p>Please visit this link for information on suggested courses for the Digital Economy:</p>  <p><a href="https://go.gov.sg/digital-econ-courses">https://go.gov.sg/digital-econ-courses</a></p>	
<i>Data Visualisation</i>	Implement contemporary techniques, dynamic visual displays with illustrative and interactive graphics to present patterns, trends, analytical insights from data or new concepts in a strategic manner for the intended audience		
<i>E-commerce Management</i>	Develop, manage and execute e-commerce strategies and activities according to organisational objectives		
<i>Emerging Technology Scanning</i>	Review new developments in emerging technology to determine their relevance to the organisation		
<i>Interaction Design Practice</i>	Develop digital and/or physical interactions across technology, products, space and services media to enhance relationships and engagement with users		
<i>Product Development</i>	Evaluate consumer and market trends to determine value proposition, cost-effectiveness and profitability of proposed products in different markets		
<i>Radio Frequency Engineering</i>	Design, deploy and maintain radio frequency infrastructure for IT systems and wireless communication networks		
<i>Research and Information Synthesis</i>	Identify, source and interpret information from various sources to obtain deep understanding of specific area to identify patterns, uncover insights, integrate findings into recommendations and/or guide decision-making		



CARE ECONOMY

- With the demographic shift, there is an increasing need for preventive and community care, adult education, and workplace learning and development, to cater to the needs of an ageing population and workforce. HR practices will also need to transform to cater to hybrid working arrangements, look after workforce mental well-being, and facilitate skills acquisition amid rapid technology and business model changes
- Skills in the Collaboration with Stakeholders domain are among the fastest-growing, while those in Person-centred Care and Teaching and Learning domains have the highest transferability across job roles. Demand for Health and Wellness-related skills has grown since the pandemic and are needed from care provision to preventive personal care roles

The **Care Economy** continues to grow in importance in 2022. As Singapore moves into the endemic phase of COVID-19, organisations are dealing with new challenges, such as the Great Resignation, talent shortages and the greater spotlight on mental well-being. At the national level, Healthier SG<sup>1</sup> is an ambitious plan focusing on preventive care to help all Singaporeans achieve better quality of life by promoting health, wellness and fitness. The plan will require the support of technology, data and more care personnel in roles relating to wellness and fitness promotion to complement traditional healthcare roles.

In community care, innovation and job redesign efforts are ongoing to improve the quality of community care, amid manpower shortages. Under the Job Redesign trial by the Agency for Integrated Care (AIC), new community care roles have been piloted with four community care organisations, by blending various support care functions to uplift the value and attractiveness of the new roles<sup>2</sup>. The Community Care Digital Transformation Plan, announced recently by the

Ministry of Health, seeks to drive digitalisation, enhance productivity, and job satisfaction in community care organisations<sup>3</sup>. In response, care providers have been incorporating technology into their business models, operations, and service offerings. This includes testing and integrating new models of care between hospital and home. The skills of community care personnel will need to keep pace with these changes.

In education sectors, the Early Childhood Development Agency (ECDA) is creating an inclusive preschool education<sup>4</sup>, informed by multi-disciplinary experts from education, health and social sectors. On the lifelong learning front, SkillsFuture Singapore (SSG) anticipates a greater uptake of reskilling and upskilling efforts among the workforce over the next five years. To cope with the increasing demand, continuing education and training partners are taking advantage of education-learning technologies to provide skills-based learning, that are bite-sized, personalised, and application-led. Other emerging trends include the increased emphasis on workplace learning, which necessitate capabilities to organise workplaces for learning, to supplement institution-based learning. Demand for career/learning counselling and coaching will also rise in a more dynamic labour market, to help workers translate industry trends and business transformations into tangible actions, enhancing worker performance or preparing them for career transition.

Finally, the COVID-19 pandemic has accelerated change to the nature of work. With the emergence of remote or hybrid working arrangements, companies need to review their employee engagement approaches, and deal with recruitment and retention challenges (a.k.a. the "Great Resignation"). In this new construct of the workplace, Human Resource (HR) professionals need to dig into available data, listen to workers, and understand their priorities, so that trust and cooperation within the company are not eroded. Organisations also need to respond effectively to the greater emphasis on employee well-being, work-life balance, and inclusivity.

## Emerging domains in the Care Economy

Skills of increasing importance in the Care Economy are classified into four emerging domains as follows:

- Person-centred Care
- Collaboration with Stakeholders
- Teaching and Learning
- Health and Wellness

Skills in the Person-centred Care domain support effective delivery of personalised care to an individual. These skills support tasks in operational management, client data management, and service excellence in interaction.

Skills in the Collaboration with Stakeholders domain strengthen care professionals' partnership abilities to deliver care services that benefit clients, as well as their families and caregivers. Strong collaboration across stakeholder groups remains a key enabler in delivering quality care. These

stakeholder groups include professionals across multiple disciplines, community partners, and social service agencies.

Skills in the Teaching and Learning domain seek to maximise individuals' performance and realise their potential. More organisations are now treating employee learning as a strategic priority, to prepare their employees for changing business needs and to promote their career growth. Learning specialists and business unit managers need skills to design and implement workplace learning modes and to effectively engage employees through career conversations.

Skills in the Health and Wellness domain promote and develop the individual's overall health and well-being. Along with more healthcare, there will also be a greater societal need in skills related to preventive care, wellness and fitness promotion, mental resilience and self-care. These are needed both within companies and in the larger community.

<sup>1</sup> HealthierSG, 2022

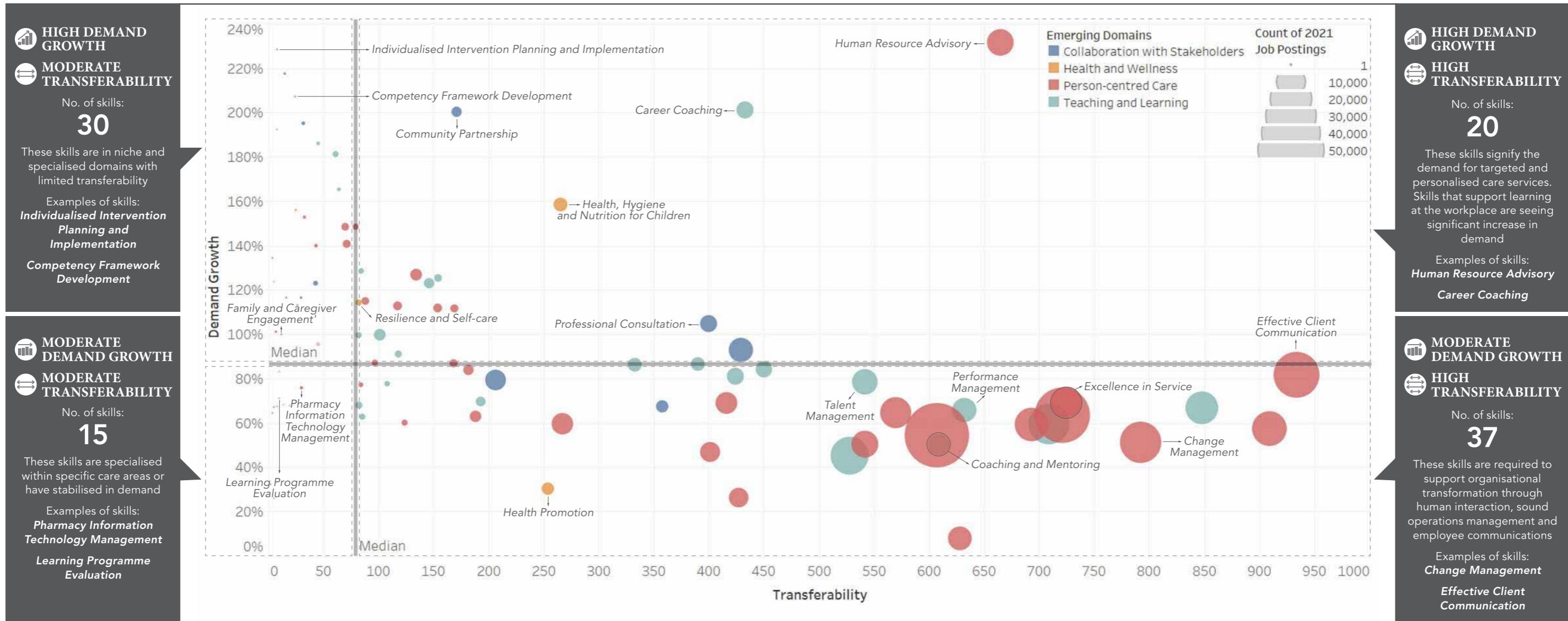
<sup>2</sup> AIC Yearbook, FY2021

<sup>3</sup> Straits Times, 2022

<sup>4</sup> One such initiative is the Inclusive Support Programme, to support children with developmental needs in preschools, ECDA, 2022

Figure C1: Priority skills in the Care Economy

**Priority skills** refer to skills that citizens can prioritise to gain access and thrive in the emerging domains. These skills were derived from SSG's National Jobs-Skills Intelligence engine and validated via expert input from industry, academia, and sector agencies. **Demand growth** (y-axis) refers to the **compound annual growth rate** of job postings (2018 to 2021) that mentioned a given priority skill. **Transferability** (x-axis) refers to the total number of unique job roles from job postings (2018 to 2021) that requires a given priority skill<sup>5</sup>. Refer to the Methodology chapter for further details.



Skill Title	Competency Framework Development	Individualised Intervention Planning and Implementation	Human Resource Advisory	Career Coaching	Pharmacy Information Tech. Management	Learning Programme Evaluation	Change Management	Effective Client Communication
Description	Design and develop competency frameworks within organisation, ensuring that human resource (HR) programmes are aligned to support their application across organisation levels and functions	Develop and implement intervention plans that integrate the goals, needs, interests and capabilities of children with the desired functional outcomes	Deliver human resource (HR) advisory and consultancy services to internal and external clients to meet their requirements	Provide career coaching programmes to develop talent	Maintain and enhance pharmacy information technology systems and workflows to ensure optimum performance	Evaluate the effectiveness of learning experiences and modify the teaching approaches and materials accordingly	Initiate and facilitate organisational changes and business transformation initiatives	Demonstrate effective communicative skills when communicating with clients and caregivers

<sup>5</sup> Only data points with positive demand growth are shown. Outlier data points not discussed in this chapter are excluded.



## INDUSTRY VOICE

Institute for Human Resource Professionals (IHRP)

MAYANK PAREKH

Former Chief Executive Officer,  
IHRP

To a large extent the pandemic has profoundly changed the workplace and what employees expect of their employers. Flexible work arrangements are fast becoming a key value proposition for talent attraction and retention.

But should we just stop at workplace flexibility? Or are today's workers expecting much more from employers that go well beyond just workplace flexibility? There is evidence that employees are now prioritising their self-care needs ahead of professional and financial, and if these are not met, they are more than likely to seek employment elsewhere.

Here, I emphasised three areas of leadership skills that can lead to a more unified company culture and stronger results as you continue to grow your business:

### Organisational Relationship Building

As more companies adopt hybrid work schedules, companies should expect employees to feel increased levels of stress. Recognising this will go long way towards reassuring employees that they are seen and supported. Organisational relationship building skills are essential for the workplace: Companies gain from increase in productivity and enhance employee engagement. Engaged employees are more creative. In return, companies would experience higher employee retention.

“  
**There is a solid case for all of us to embrace skills in care, wellness, learning, and lead changes to create a more open, inclusive and fair workplace culture.**  
”

### Organisational Culture Development

Leaders must continually reiterate organisation values and connect employee contribution to an organisation's overall purpose. Companies that place emphasis on long-term values and core purpose will thrive.

### Coaching and Mentoring

We have been caught in a cycle of uncertainty and upheaval for over two years now (although some of these issues have been around much longer). When the news is filled with uncertainty and stress-inducing headlines, trusted leadership is absolutely essential. Sustained coaching and mentoring practices within an organisation will build a high trust environment where holistic people development and wellness care are the foundation.

These leadership skills are also highly transferable across industries and job roles. There is a solid case for all of us to embrace skills in care, wellness, learning, and lead changes to create a more open, inclusive and fair workplace culture.



## INDUSTRY VOICE

St. Luke's ElderCare Ltd

ASSOCIATE  
PROFESSOR (DR)  
KENNY TAN

Chief Executive Officer,  
St.Luke's ElderCare Ltd

Every day, over 5,000 families and caregivers entrust the care of their elders to St Luke's ElderCare's (SLEC) 24 senior care centres, active ageing hubs, and residential homes spread across the island. We are privileged to have a dedicated team comprised of 700+ teammates, 37% of whom are above the age of 55.

The urgency of providing competent workers for the eldercare sector is pressing. By 2035, it is estimated that our nation will face a super-ageing phase, with a third of the population over the age of 65. As an AIC-appointed learning institute for the community care workforce, how should we envision delivering care to elders, with a workforce that is ageing as well?

In response to operating in a VUCA (volatile, uncertain, complex, and ambiguous) world, it is necessary for community care organisations to place emphasis on managing staff development. We want to nurture staff with the attitude and aptitude to be enthusiastic, unfazed, committed, and agile. We aim to develop staff with *Learning Agility* skills to continuously co-learn with others and equip staff with *Coaching and Mentoring* skills to transfer knowledge and experience to junior members and career-switchers joining the care economy.

SLEC has embarked on a Job Redesign (JR) Project, led by former centre managers, who

transitioned into in-house trainers. To train care-related technical and soft skills which are application-based in nature, these in-house trainers developed *Workplace Learning Delivery* skills to deliver learning that encompass cognitive, emotional, and technical areas through experiential learning. For staff participating in the JR Project, they also underwent extensive training and picked up new skills such as *Intervention Implementation in Therapy Support* and *Nursing Productivity and Innovation* as they adopt equipment and technology solutions to support their newly redesigned roles.

To co-create meaningful work that continues to appeal to staff that do caregiving work, organisations and employees need to be jointly committed to co-create relevant and meaningful work that appeals to workers in different life stages and with varying life experiences.

“  
**We want to nurture staff with the attitude and aptitude to be enthusiastic, unfazed, committed, and agile. We aim to develop staff with *Learning Agility* skills to continuously co-learn with others.**  
”

## Key jobs and skills trends in the Care Economy

### A. Skills in the Collaboration with Stakeholders domain are amongst the fastest-growing

Increased emphasis for the provision of holistic care services has resulted in the Collaboration with Stakeholders domain skills demonstrating some of the highest growths. Among the fastest-growing skills in this domain are *Professional Consultation*, *Family and Caregiver Engagement*, and *Community Partnership*, reflecting the collective efforts needed for a holistic care plan (see Table C1).

Skills such as *Community Partnership* and *Family and Caregiver Engagement* are required as these partnerships are critical in creating the supportive

environment for the client and their families. These two skills are required by job roles across various care sectors such as early childhood, social services, and healthcare. *Professional Consultation* is a core skill in the Care Economy. It establishes a trusted relationship with clients and peers and provides professional knowledge and skills in engagements to co-create solutions. It has the strongest demand in healthcare job roles, such as nurse clinician and allied health professional, as well as social service job roles in social work and youth work.

Table C1: High growth skills under the Collaboration with Stakeholders domain

SKILL	DEMAND GROWTH	EXAMPLE OF JOB ROLE
<i>Community Partnership</i>	200%	<ul style="list-style-type: none"> <li>• Programme executive</li> <li>• Senior care staff</li> <li>• Volunteer manager</li> </ul>
<i>Professional Consultation</i>	105%	<ul style="list-style-type: none"> <li>• Nurse clinician</li> <li>• Social worker</li> <li>• Manager, employee experience and relations</li> </ul>
<i>Family and Caregiver Engagement</i>	100%	<ul style="list-style-type: none"> <li>• Childcare centre manager</li> <li>• Patient service assistant supervisor</li> <li>• Senior nurse educator</li> </ul>

### B. Skills in Person-centred Care and Teaching and Learning domains have the highest transferability

Across all the four emerging domains, skills in Person-centred Care and Teaching and Learning have the highest transferability across job roles. Specifically, *Change Management*, *Excellence in Service*, and *Human Resource Advisory* are required by more than 600 job roles across HR,

healthcare, social services, and training and adult education sectors. An example is the learning and organisation development manager who engages employees to develop workable change interventions, addressing business needs and employees' concerns.

This signals the enduring needs of managing change and delivering excellent service to clients, as the COVID-19 pandemic resulted in a tight labour market and high staff burn-out. There is an

urgent need for more progressive human resource practices, such as innovative ways to access and retain talent, and manage skills needs of the organisation (see Table C2).

Table C2: Highly transferable skills under the Person-centred Care domain

SKILL	TRANSFERABILITY	EXAMPLE OF JOB ROLE
<i>Change Management</i>	792	<ul style="list-style-type: none"> <li>• Learning and organisation development manager</li> <li>• Learning solutionist</li> <li>• Manager in social work</li> </ul>
<i>Excellence in Service</i>	725	<ul style="list-style-type: none"> <li>• Learning quality manager</li> <li>• Patient service executive</li> <li>• Youth worker</li> </ul>
<i>Human Resource Advisory</i>	665	<ul style="list-style-type: none"> <li>• Head of HR business partner</li> <li>• Social worker</li> <li>• Director of nursing (clinical)</li> </ul>

In the Teaching and Learning domain, skills such as *Performance Management*, *Talent Management* and *Coaching and Mentoring* have surfaced as highly transferable skills. Job roles that require these skills range from HR roles managing talent performance and rewards to supervisory/managerial roles at business units such as senior social worker, as well as learning and development (L&D) related roles such as nurse educator. Specifically, HR teams apply their skills in workforce planning and strategy formulation to

optimise talent capabilities and organisational workforce needs, by ensuring skills and talent priorities are aligned with business needs. L&D teams also work closely with business units to rethink what work means and develop talent management as a growth strategy that caters to a multi-generational workforce. Line managers deepen their skills in *Coaching and Mentoring* and regularly help their teams align business needs with individual career aspirations (see Table C3).

Table C3: Highly transferable skills under the Teaching and Learning domain

SKILL	TRANSFERABILITY	EXAMPLE OF JOB ROLE
<i>Performance Management</i>	632	<ul style="list-style-type: none"> <li>• Manager, performance and rewards</li> <li>• Nurse manager</li> <li>• Physiotherapist</li> </ul>
<i>Coaching and Mentoring</i>	609	<ul style="list-style-type: none"> <li>• Learning and development specialist</li> <li>• Nurse educator</li> <li>• Youth worker</li> </ul>
<i>Talent Management</i>	542	<ul style="list-style-type: none"> <li>• Manager, talent management</li> <li>• Psychologist</li> <li>• Senior social worker</li> </ul>



## INDUSTRY VOICE

**Singapore Institute of Management (SIM)**

**SEAH CHIN SIONG**

**President and Chief Executive Officer,  
SIM**

The global economy is increasingly more complex. Organisations must have the capabilities for understanding and leading in constant change in order to thrive. At the same time, they are also facing challenges in finding enough talent to meet this new reality.

Upskilling and cross-skilling their workforce to meet the demands of their business is now a constant imperative. Therefore, lifelong learning is fast becoming critical in the future economy. At the same time, organisations must continuously seek to develop new skills and capabilities for meeting the new demands in this exciting new era.

To build this capability for complexity, I believe that organisations should focus their skills development efforts on achieving impact on their organisation's business outcomes. For instance, consider the Care Economy skills of *Learning Needs Analysis* and *Learning Solutions Design*. Organisations should build deep expertise in these key areas to provide their people learning solutions that are highly contextualised and bespoke to the unique needs of their business.

More importantly, *Learning Needs Analysis* and *Learning Solutions Design* skills should be developed in tandem with capability building efforts in organisation impact analysis, ideally with an emphasis on data-driven decision-making frameworks and methodology. This is crucial as each organisation will have their

own strategic objectives and therefore may face unique challenges requiring different learning interventions. For instance, one of the things we have learnt is that data analytics provided us the insight that learning solutions design should be focused on grouping learners with similar learning gaps, rather than grouping learners with similar role and responsibilities.

Finally, organisations should build the capability for skilled workplace learning to better translate learning into business outcomes. These skills and capabilities ultimately translate into new and higher value-added job roles within the organisation, and ultimately better professional and career development for their people. For example, our experiences and collaborations provided us insights into how career transitions are best navigated as a combination of re-defining one's mindset for purpose, developing new habits, and designing one's own learning ecosystem. In so doing, the organisation can deliver on its purpose through a highly skilled and capable workforce.

**“ Upskilling and cross-skilling their workforce to meet the demands of their business is now a constant imperative. Therefore, lifelong learning is fast becoming critical in the future economy. ”**

## PROFILE STORY:

**NIKKO AW, solutions consultant in educational technology services**

Nikko is a solutions consultant who analyses learner data, researches global and industry trends, and packages the insights into learning strategies for school, businesses, and governments.

**Your first degree is in tourism. Why did you make a switch to become a consultant?**

Back then, I took a degree in tourism to have the most relevant education for my family's business, which is within the tourism industry. In the end, I did not join my family business but started work in a government agency managing the workforce development needs of the tourism and F&B sectors. As I dived deeper into L&D, I pursued a Masters in this field. I continued to pursue my passion in L&D across different industries and eventually landed myself as a solutions consultant in an EdTech company.

**You have been in L&D for more than 10 years. How was your learning journey like?**

The learning journey is exciting as this field is always growing and evolving. For example, the COVID-19 pandemic forced everyone to change their way of work and life. My adaptability skills were put to the test as I had to research on the impact of the pandemic on learning and how learning approaches must

adapt. Subsequently, I packaged all these research insights into actionable learning strategies for my clients, in turn building healthy customer relationships and generating business opportunities.

As a solutions consultant, I get to apply my *Professional Consultation* skills daily when I provide my clients and peers with professional knowledge and skills. This helped me to learn on-the-job, especially in balancing the time needed for research with time needed for stakeholder management. To help my clients translate these research insights and drive implementation of learning solutions and interventions, I take additional steps to ensure a smooth handover to my colleagues to identify and implement the business tasks. These include drafting responses together with my colleagues and providing further background support as a team.

**How important is the ability to learn and adapt?**

We need to adopt a growth mindset. We also need to be curious, adopt *Critical Thinking* skills when devising solutions to solve complex learning needs, and be willing to rethink our conclusions from other points of view. When presented with new and pivotal information, we should be courageous in pivoting to new solutions.

**C. Demand for skills in the Health and Wellness domain have increased significantly since 2019. Today, these skills are needed by job roles beyond care provision to preventive personal care**

With the increasing awareness and focus on health management and mental well-being of our citizens and workforce, especially during the COVID-19 pandemic, demand for skills in the Health and Wellness domain have seen significant growth since 2019 (see Table C4). Organisations had to quickly re-examine work practices and put in place hybrid work arrangements and wellness initiatives to combat burn-out and provide workplace flexibility. Frontline care professionals, such as nurses and social workers, play their part to recalibrate their mental well-being and eliminate emotional fatigue experienced at work by engaging in self-care activities, driving the growth in *Resilience and Self-care* skill.

Child-related health skills such as *Health, Hygiene and Nutrition for Children* also experienced high growth, as care professionals see to the nurturing and cultivation of good health routines and habits at an early stage. Job roles that entail interacting

with children, and require these skills, include care professionals at preschools, healthcare workers who provide treatment to children in various health-related areas, as well as those in other sectors such as voluntary managers who organise activities involving families and children and air crew who are involved in meal preparations.

*Health Promotion* is a highly transferable skill that is required by 254 job roles, as health education is a shared responsibility and require collective contribution from care professionals at various touchpoints. These job roles include healthcare professionals, who share knowledge on health maintenance and prevention with patients and their caregivers. Other examples of such job roles include nurse, patient service associate, allied health professional and healthcare assistant. Beyond the Care Economy, job roles in HR and food and services also require this skill to encourage healthy living and eating.

Table C4: High growth and/or high transferability skills under the Health and Wellness domain

SKILL	DEMAND GROWTH	TRANSFERABILITY	EXAMPLE OF JOB ROLE
<i>Resilience and Self-Care</i>	156%	82	<ul style="list-style-type: none"> <li>• Occupational therapist</li> <li>• Senior staff nurse</li> <li>• Social worker</li> </ul>
<i>Health, Hygiene and Nutrition for Children</i>	159%	265	<ul style="list-style-type: none"> <li>• Early intervention educator</li> <li>• Enrolled nurse</li> <li>• Volunteer manager</li> </ul>
<i>Health Promotion</i>	30%	254	<ul style="list-style-type: none"> <li>• Senior care staff</li> <li>• Speech therapist</li> <li>• HR business partner</li> </ul>

## PROFILE STORY:

### RAHMAT BIN HAMID, community care associate in senior care services

Rahmat is a community care associate who supervises the welfare of clients from his community care organisation.

#### How did you get into your current job?

I worked in a hotel for 20 years, then as a F&B coordinator in a restructured hospital for another 18 years before deciding to take a break from work. After the break, I took up a job as a security officer for only two years as I was already 60 years old and the long working hours were difficult for me. However, I wanted to continue working and eventually applied for a job opening as a cleaner in a care facility. Due to the people management skills I picked up from my previous work at the hotel and hospital, I was offered a community care associate role instead.

#### How was your learning journey like?

Over the years, the most important skill I picked up is *Effective Client Communication*. From working in the hotel and hospital to my current role as a care coordinator associate, I need to interact with many colleagues and clients. In my current role, I learn to understand the needs of clients and adapt my communication style with them through on-the-job training. For example,

there is a difference how I should communicate with clients with dementia and those who had a stroke. I learnt to use touch, like holding patients' hands, to calm down patients who are frustrated. Also, I continuously learn how to maintain ethical conduct and professional work practices so that I can be regarded by clients and their loved ones as a trustworthy caretaker that will respect my patients' personal space.

Sometimes, I encounter difficult and unpleasant situations with my patients. I am learning how to manage my emotions and I also share my experiences with my colleagues so that we can learn from each other. As I age, I must also consider my physical constraints and learn to manage my stress and emotions. I agreed to take on this job as my workplace is near my house and the 5-day work week allows me to rest sufficiently.

#### How important is the ability to learn and adapt?

Other people always say, "Aiyah, I cannot manage more new things...". I believe I can always improve myself. For me, the world is changing so I need to learn to change and pick up new skills or I will not be able to do my job effectively.

## Skills featured in this chapter

SKILL TITLE	SKILL DESCRIPTION	Learning Programme Evaluation	Evaluate the effectiveness of learning experiences and modify the teaching approaches and materials accordingly
<i>Career Coaching</i>	Provide career coaching programmes to develop talent	<i>Learning Solution Design</i>	Design and evaluate learning solutions which drive performance enhancement
<i>Change Management</i>	Initiate and facilitate organisational changes and business transformation initiatives	<i>Nursing Productivity and Innovation</i>	Adopt technology and innovative practices to drive quality and productivity
<i>Coaching and Mentoring</i>	Develop and implement coaching and mentoring approaches to address learner developmental needs	<i>Performance Management</i>	Establish organisation-wide performance management strategies to facilitate performance management, including identification of key performance indicators and employee performance assessment
<i>Community Partnership</i>	Establish and foster partnerships with community stakeholders through a culture of collaboration to develop mutually beneficial programmes for children and families	<i>Pharmacy Information Technology Management</i>	Maintain and enhance pharmacy information technology systems and workflows to ensure optimum performance
<i>Competency Framework Development</i>	Design and develop competency frameworks within organisation, ensuring that human resource (HR) programmes are aligned to support their application across organisation levels and functions	<i>Professional Consultation</i>	Provide guidance or professional assistance in response to requests from the clients, other professionals, external organisations and the general public
<i>Critical Thinking</i>	Adopt diverse perspectives in combining ideas or information and making connections between different fields to create different ideas, improvements and solutions	<i>Resilience and Self-care</i>	Understand the actions and the activities that will enhance overall health and well-being to enable continued practice as a professional in the sector
<i>Effective Client Communication</i>	Demonstrate effective communicative skills when communicating with clients and caregivers	<i>Talent Management</i>	Drive talent management strategies and programmes to identify, develop, review and retain talent to meet the current and future organisational needs
<i>Excellence in Service</i>	Create strategies to foster positive customer and/or patient experiences and deliver service excellence throughout the engagement lifecycle	The skills featured in this chapter are non-exhaustive. To see the full list of priority skills, please visit this link:	
<i>Family and Caregiver Engagement</i>	Recognise the central role of the family in every child's life and develop strategies for family engagement, nurturing trust and rapport building capabilities in a family to enhance child's developmental outcome	 <a href="https://go.gov.sg/2022skills-ce">https://go.gov.sg/2022skills-ce</a>	
<i>Health Promotion</i>	Raise awareness to maintain and optimise health and well-being of clients	Please visit this link for information on suggested courses for the Care Economy:	
<i>Health, Hygiene and Nutrition for Children</i>	Establish health, hygiene and nutrition standards and procedures that support children's development	 <a href="https://go.gov.sg/care-econ-courses">https://go.gov.sg/care-econ-courses</a>	
<i>Human Resource Advisory</i>	Deliver human resource (HR) advisory and consultancy services to internal and external clients to meet their requirements		
<i>Individualised Intervention Planning and Implementation</i>	Develop and implement intervention plans that integrate the goals, needs, interests and capabilities of children with the desired functional outcomes		
<i>Intervention Implementation in Therapy Support</i>	Provide support to therapists in performing interventions		
<i>Learning Needs Analysis</i>	Assess capability and performance within an organisation to identify learning needs		



## JOBS AND SKILLS IN INDUSTRY 4.0 IMPLEMENTATION

- Singapore is ranked second globally in terms of robot density in manufacturing, with 605 robots per 10,000 workers. This number is expected to increase as more sectors adopt Industry 4.0 (I4.0), as a response to Singapore's ageing workforce demographics and manpower shortages
- Under I4.0, companies across a wide range of sectors exploit technological advancements, particularly in the digital space, to make transformational improvements in process efficiency, sustainability, and product or service quality
- I4.0 will require work processes and functions to change. Job tasks will in turn be impacted. Companies need to upskill the workforce in a bundle of I4.0, digital and green skills to support job roles that are emerging and in demand

Businesses are increasingly turning to I4.0, such as using robots and automation to plug workforce gaps. This move accelerated during the COVID-19 pandemic, where many industries faced workforce shortages. A 2021 report by the International Federation of Robotics showed that Singapore has 605 robots installed per 10,000 employees in the manufacturing industry<sup>1</sup>.

This is the second-highest globally, after South Korea's 932. The use of robotics and automation will continue rising as I4.0 adoption is part of the solution to Singapore's ageing workforce demographic and manpower shortages. A Lightcast report shows that by 2040, growth in the working population will slow down for nine in ten countries around the world, and those populations will decline for three in ten countries.<sup>2</sup> This demographic drought is a global phenomenon. To reduce the impact of manpower shortages, many employers are turning to I4.0 as a solution.

For instance, in Singapore, I4.0 adoption can be seen in the newly launched fully automated Tuas Port. Besides using unmanned vehicles to transport containers around the facility, it has also incorporated the use of artificial intelligence (AI) and machine learning to handle more complex operations<sup>3</sup>. In the area of food production, SATS, which is Asia's largest food solutions and gateway service, is also establishing a network of Internet-of-Things (IoT) technology at its new food hub that will aid in planning, raise asset utilisation, and cut food waste. It is also automating the production of meals, while manual processes such as meal assembly will be carried out by robotic finger grippers and auto dispensing units for efficiency<sup>4</sup>.

In manufacturing, many leading companies have chosen Singapore as their strategic manufacturing and trade hub. To support these companies in implementing I4.0, the Economic Development Board, together with a network of technology and industry experts, developed the Smart Industry Readiness Index (SIRI)<sup>5</sup>, the world's first independent digital maturity assessment for manufacturers. It comprises a suite of frameworks and tools to help companies start, scale, and sustain their manufacturing transformation journeys. Insights from the SIRI initiative showed that companies across 14 industry groups are

adopting I4.0 at different rates, with semiconductors, pharmaceuticals and electronics companies being the most mature (see Figure i1). I4.0 is also a critical enabler to Singapore's Manufacturing 2030<sup>6</sup> plan, where its target is to grow the manufacturing sector by 50% before 2030. I4.0 implementation can help manufacturing companies increase productivity by reducing downtime and maintenance costs, increase energy and resource efficiency, and drive innovation. To do so, the workforce will need to be equipped with skills to implement I4.0.

**Figure i1:** Insights from SIRI initiative showing the industries adopting I4.0 and transforming at different rates and the top 3 most mature industries<sup>7</sup>

The archetypes of transformation map featuring the 14 industry groups



A higher ranking in SIRI maturity indicates that the industry is likely to be further ahead and more mature in its industrial transformation journey.

The lower the SIRI variance, the more uniform the pace of industrial transformation in the sector.

<sup>1</sup> International Federation of Robotics, 2022

<sup>2</sup> Lightcast, 2022

<sup>3</sup> The Straits Times, 2022

<sup>4</sup> Asian Aviation, 2022

<sup>5</sup> SIRI, retrieved 2022

<sup>6</sup> Singapore Economic Development Board, 2021

<sup>7</sup> World Economic Forum, 2022

## Key jobs and skills trends in I4.0 implementation

Along with I4.0 implementation, sustainable manufacturing and circular economy skills are also prioritised as consumers gravitate towards more sustainable products and manufacturers respond by finding ways to bring resources back into the

economy to be used more efficiently and sustainably (see Figure i2). The end-to-end manufacturing process, enabled by I4.0, is increasingly digitalised, connected and sustainable.

Figure i2: Key trends affecting manufacturers implementing I4.0<sup>8</sup>

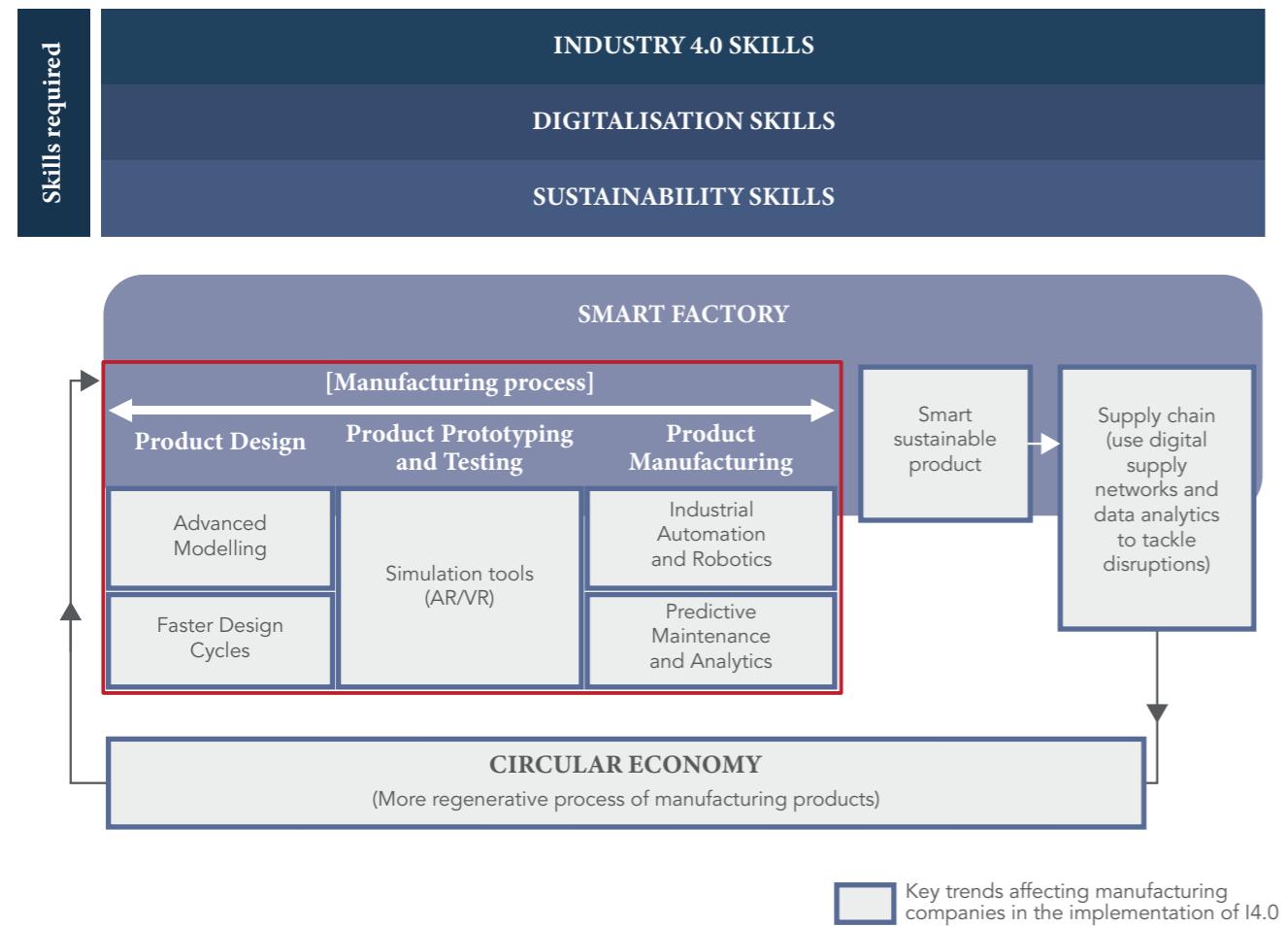


Figure i3 shows a snapshot of the different I4.0, digital and green skills demanded by companies embarking on the industrial transformation journey. The subsequent three key findings are

based on the trends and data-driven analysis of some of these skills and jobs in demand that require them.

## INDUSTRY VOICE

The Institution of Engineers,  
Singapore (IES)



**DALSON CHUNG**  
President, IES



**CHANG SAU SHEONG**  
Chairman, Infocomm Technology  
Technical Committee, IES



**PROFESSOR SEERAM  
RAMAKRISHNA**  
Chairman, Climate Change  
Technical Committee, IES

Singapore is leveraging major global trends to emerge stronger from the COVID-19 pandemic and Ukraine war. Besides notching up our climate ambitions to achieve net-zero emissions by mid-century, a progressive carbon tax is also used to encourage decarbonisation and accelerate our transition to a low-carbon economy. The Resource Sustainability Act, aimed at building a resource-efficient circular economy in Singapore, requires quality and reliable information transfer among diverse stakeholders across value chains.

IES is drawing up an IES Green Plan 2030 to support Singapore's sustainability agenda. IES identifies, develops and conducts skills development courses for practicing engineers.

As I4.0 transforms the way companies manufacture and supply their products and services, it requires the workforce to possess skills in managing technologies such as, *Big Data Analytics*, *Cloud Computing Application*, *Machine Learning*, *Artificial Intelligence Application*, *Additive Manufacturing*, *Cyber Security*, and *Robotic and Automation Technology Application*. Related technologies include, Industrial Internet-of-Things (IIoT), smart sensors and embedded software, materials informatics, digital twinning, and modelling and simulation. Such digital technologies and their relevant skills enable preventive maintenance, optimise process improvements, and facilitate

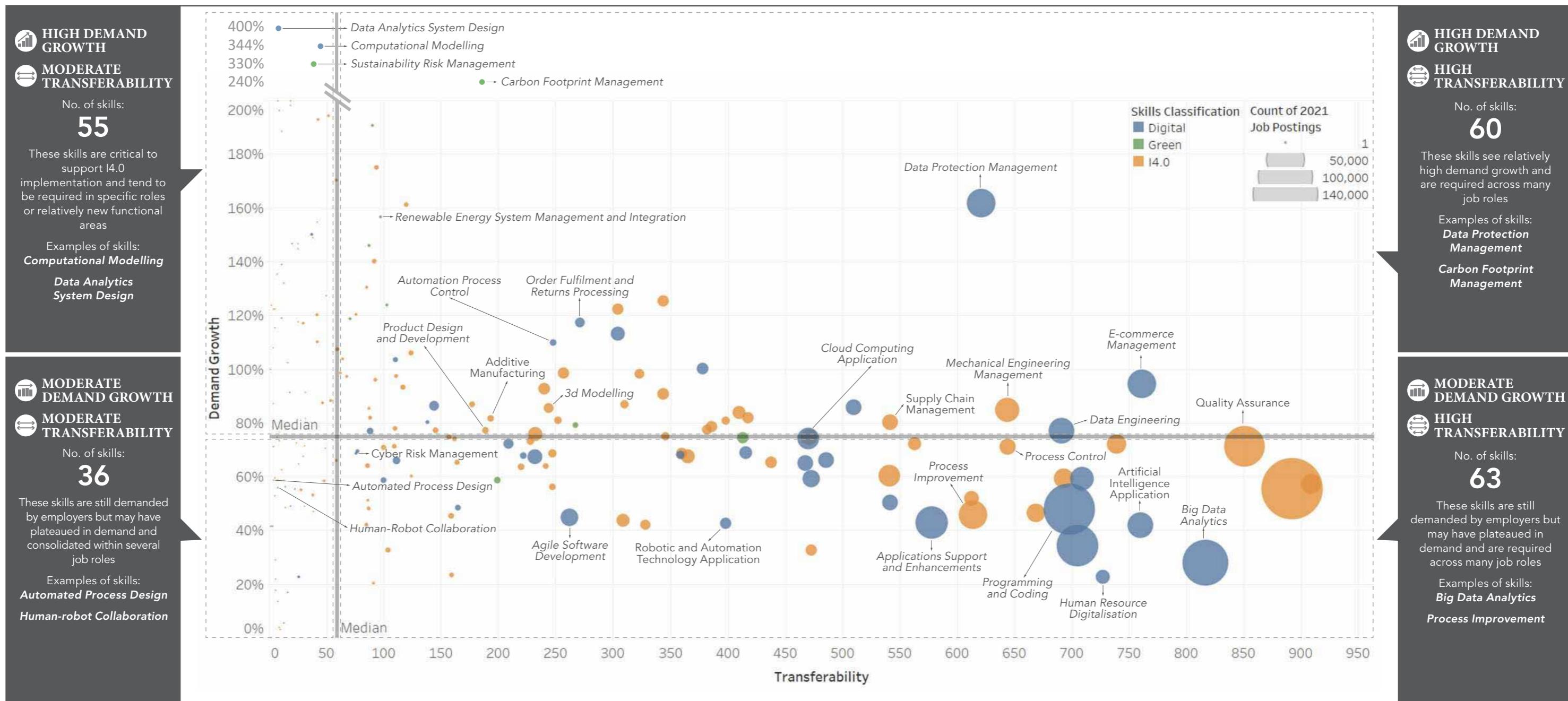
tagging and labelling to segregate waste for resource recovery, remanufacturing and upcycling. I4.0 technologies can also enhance green solutions by improving the nutrients and water delivery in urban farming to enhance yield, monitor carbon offsets, and improve efficiency of energy systems. These require digital, green and I4.0-related skills such as *Data Collection and Analysis*, *Automation Design*, and *Sustainability Reporting*.

There is a wide spectrum of digitalisation opportunities across our industries. For example, in renewables and reducing carbon emissions, or energy efficiency in the energy industry. In other industries, it could be about sustainable use of building materials or reducing food waste or recycling. Just as our engineers and technicians have innovated and facilitated our nation to realise water circularity and water security over the past five decades, Singapore's net zero and circular economy commitments now provide impetus for our engineers and technicians to strive and innovate in the coming years and decades.

**“ As I4.0 transforms the way companies manufacture and supply their products and services, it requires the workforce to possess skills in managing technologies. ”**

Figure i3: Priority skills required for I4.0 implementation

**Priority skills** refer to skills that citizens can prioritise to gain access and thrive in Advanced Manufacturing (AM)-related sectors. These skills were derived from SSG's National Jobs-Skills Intelligence engine and validated via expert input from industry, academia, and sector agencies. **Demand growth** (y-axis) refers to the **compound annual growth rate** of job postings (2018 to 2021) that mentioned a given priority skill. **Transferability** (x-axis) refers to the total number of unique job roles from job postings (2018 to 2021) that requires a given priority skill<sup>9</sup>. Refer to the Methodology chapter for further details.



Skill Title	Automated Process Design	Big Data Analytics	Carbon Footprint Management	Computational Modelling	Data Analytics System Design	Data Protection Management	Human-Robot Collaboration	Process Improvement
Description	Design processes that utilise automated manufacturing equipment and control systems	Analyse and validate significant volumes of data to discover and quantify patterns and trends to improve business operations	Quantify and reduce the organisational carbon footprint	Develop, select and apply algorithms and advanced computational methods to enable systems or software agents to learn, improve, adapt and produce desired outcomes or tasks	Integrate the use of data analytics in the production environment for the identification of bottlenecks and system improvements	Formulate the organisation's data protection strategy and ensure effectiveness of Data Protection Management Programme (DPMP)	Implement Human-Robot Collaboration (HRC) applications to enhance the efficiency and effectiveness of work processes	Evaluate strategic and longer-term impacts of change and improvement processes, as well as communicate to employees improvement plans, goals and changes to operational procedures

<sup>9</sup> Only data points with positive demand growth are shown. Outlier data points not discussed in this chapter are excluded.

## A. To implement I4.0, companies need to invest in a bundle of I4.0, digital and green skills to support in-demand roles across the manufacturing value chain

As the end-to-end manufacturing process becomes more digitalised, connected, efficient, and sustainable, there is a mix of I4.0, digital, and green skills that are fast-growing and highly transferable across job roles. For instance, besides I4.0 skills like *Quality Assurance*, *Mechanical Engineering Management*, and *3D Modelling*, digital skills such as *Big Data Analytics*, *Data Engineering*, and *Data Protection Management* are highly transferable and required by more than 600 job roles. Green skills are amongst the fastest-growing skills, especially skills such as *Sustainability Risk Management*, *Carbon Footprint Management*, and *Renewable Energy System Management and Integration* (see Figure i4).

These skills are also increasingly needed to support job roles in demand across the

manufacturing value chain. For instance, besides *Big Data Analytics*, a logistics solutions manager also requires green skills such as *Carbon Footprint Management* and I4.0 skills such as *Process Improvement* when performing work tasks to enhance supply chain processes and end-to-end logistics solutions to meet customers' needs, while ensuring cost, efficiency, and carbon footprint reduction priorities are met (see Figure i4).

Similarly, a product designer requires fast-growing digital skills such as *Programming and Coding*, *Big Data Analytics* and *Applications Support and Enhancement*, as well as transferable I4.0 skills such as *Additive Manufacturing* and *3D Modelling* to support the strong growth in electronics, pharmaceuticals and semiconductor sectors.

Figure i4: Examples of skills in demand for a logistics solutions manager

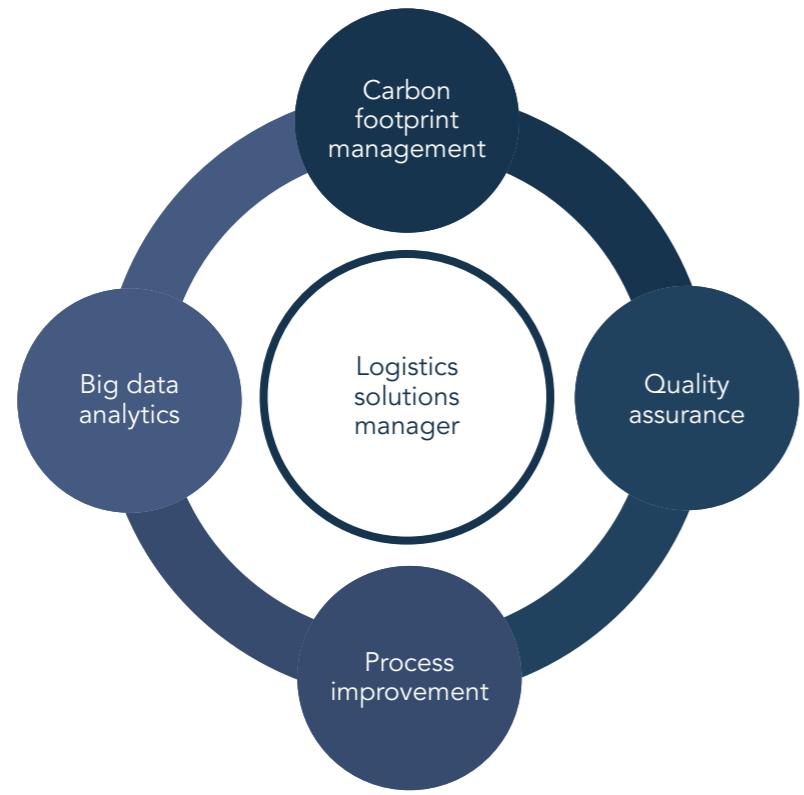


Table i1: List of skills with their associated statistics on demand growth and transferability categorised by the type of skill

TYPE OF SKILL	SKILL	DEMAND GROWTH	TRANSFERABILITY	EXAMPLE OF JOB ROLE
Digital	<i>Big Data Analytics</i>	28%	817	<ul style="list-style-type: none"> <li>• Data engineer</li> <li>• Data scientist</li> <li>• Machine learning engineer</li> </ul>
	<i>Data Engineering</i>	77%	691	<ul style="list-style-type: none"> <li>• Data engineer</li> <li>• Data analyst</li> <li>• QA and QC manager</li> </ul>
	<i>Data Protection Management</i>	162%	621	<ul style="list-style-type: none"> <li>• Data protection executive</li> <li>• Senior technician (manufacturing)</li> <li>• Production engineer</li> </ul>
	<i>Programming and Coding</i>	48%	698	<ul style="list-style-type: none"> <li>• Software engineer</li> <li>• Machine learning engineer</li> <li>• Embedded systems engineer</li> </ul>
I4.0	<i>3D Modelling</i>	86%	244	<ul style="list-style-type: none"> <li>• Senior 3D artist</li> <li>• Product engineer</li> <li>• Design engineer</li> </ul>
	<i>Additive Manufacturing</i>	82%	193	<ul style="list-style-type: none"> <li>• Product engineer</li> <li>• Designer (engineering design)</li> <li>• Research technologist</li> </ul>
	<i>Mechanical Engineering Management</i>	85%	644	<ul style="list-style-type: none"> <li>• Senior technician (mechanical)</li> <li>• Senior electrical engineer</li> <li>• Design engineer</li> </ul>
	<i>Quality Assurance</i>	71%	851	<ul style="list-style-type: none"> <li>• Quality control engineer</li> <li>• Quality assurance manager</li> <li>• Quality control assistant</li> </ul>
Green	<i>Carbon Footprint Management</i>	236%	181	<ul style="list-style-type: none"> <li>• Logistics solutions manager</li> <li>• Health, safety and environmental officer</li> <li>• Energy trading manager</li> </ul>
	<i>Sustainability Risk Management</i>	330%	29	<ul style="list-style-type: none"> <li>• Health, safety and environmental officer</li> <li>• Health, safety and environmental manager</li> </ul>
	<i>Renewable Energy System Management and Integration</i>	157%	97	<ul style="list-style-type: none"> <li>• Solar photovoltaic project development engineer</li> <li>• Engineer (power)</li> <li>• Health, safety and environmental manager</li> </ul>



## INDUSTRY VOICE

### National Additive Manufacturing Innovation Cluster (NAMIC)

**HO CHAW SING**

Chief Executive Officer,  
NAMIC Singapore

Singapore's strong foundation in manufacturing began over 50 years ago. Today, Singapore is one of the largest global exporters of high-tech goods and ranks highly in the Global Talent Competitiveness Index. With manufacturing contributing 21% of Singapore's gross domestic product, it is imperative that Singapore continues to invest and develop our workforce to keep up with our industry needs.

Under Singapore's Manufacturing 2030 plan, Singapore aims to grow the manufacturing sector by 50%, by helping our enterprises transform towards innovation and high value-added manufacturing. NAMIC was founded in late 2015, and is tasked to accelerate the adoption of hybrid and digital additive manufacturing technologies to support the plan, while standardising additive manufacturing training and certification for industry professionals.

As a digital technology, additive manufacturing allows parts to be produced from digital design without going through intermediary steps such as injection moulding and tooling, resulting in faster design iterations and more efficient production workflows. With increased precision and customisation over traditional manufacturing, additive manufacturing can achieve enhanced performance in wide-ranging products, from personalised implants with tissue regenerative properties to more reliable and efficient rocket engines.

Enterprises without the resources to invest in such technologies and human capital can tap on

**“**  
**The diverse verticals that additive manufacturing serves also underscore the need to integrate expertise from other domains such as biomedicine, material science, and even design thinking.**  
**”**

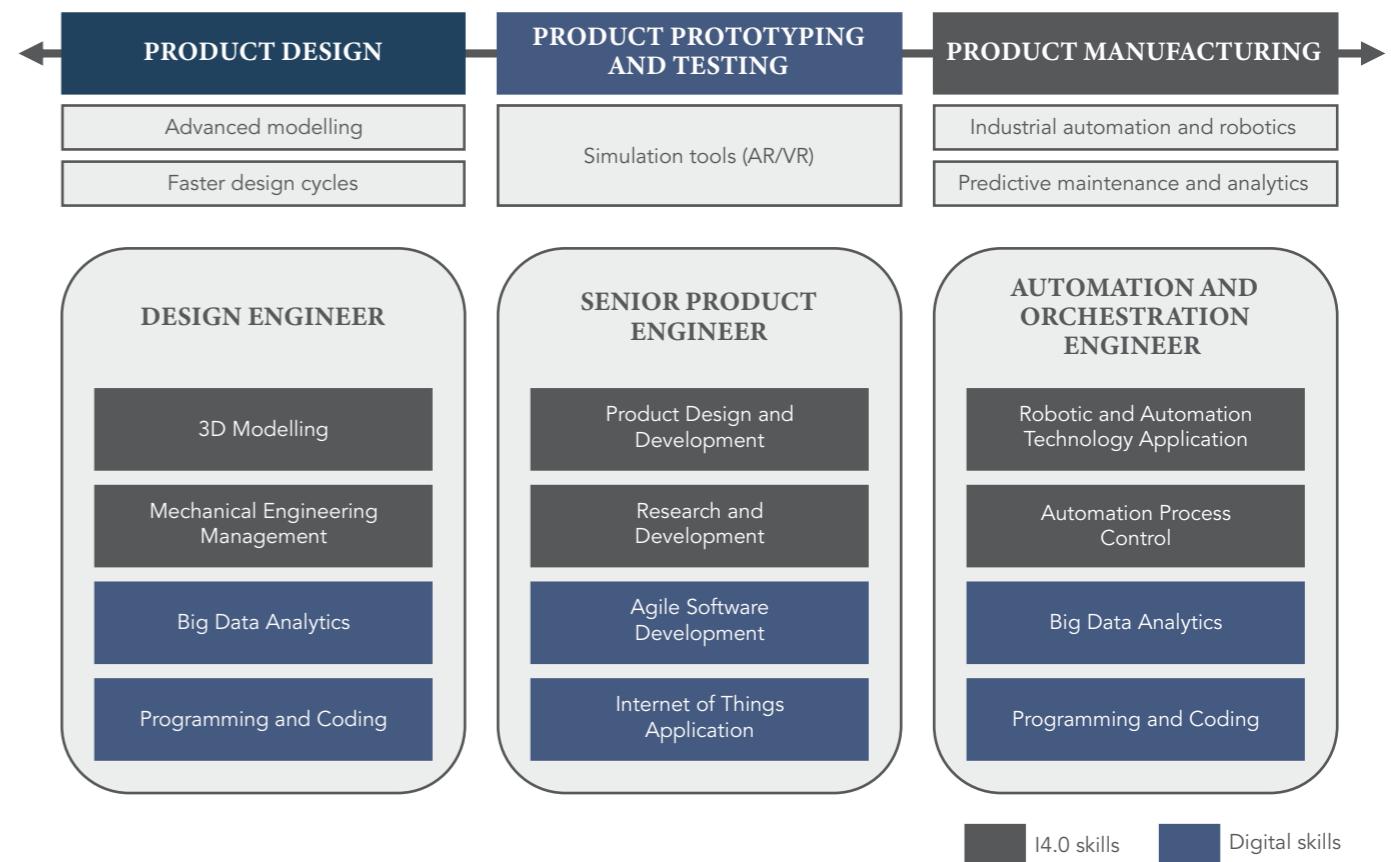
### B. As companies transform through I4.0, the work functions and skills demands of engineers are also changing to incorporate fast-growing digital, I4.0 and green skills

Today, some of the common engineer job roles involved in I4.0 implementation are design engineer, product engineer, and automation and orchestration engineer. Based on hiring demand data, the fastest-growing skills in demand are a mix of digital and I4.0 skills. This includes skills such as *3D Modelling, Additive Manufacturing, Mechanical Engineering Management, Big Data Analytics, Data Protection Management, and Programming and Coding* (see Table i1).

Specifically, these three engineer job roles are also amongst the fastest-growing job roles in

the top three manufacturing sectors, including semiconductors, electronics and pharmaceuticals<sup>10</sup>, which are the most mature in their I4.0 transformation. Job content of these roles have changed as companies redesign the work processes because of I4.0 implementation, making the end-to-end process from product design to prototyping and manufacturing more connected, automated and accurate. Figure i5 shows the set of fastest-growing skills demanded by these job roles at different stages of the manufacturing process.

Figure i5: Fastest-growing digital and I4.0 skills demanded by engineer job roles<sup>11</sup>



<sup>10</sup> World Economic Forum, 2022

<sup>11</sup> Figure i5 is based on information from CB Insights, retrieved 2022 and SkillsFuture Singapore

## FEATURED COMPANY CASE STUDY:

### United Test and Assembly Center (UTAC)

UTAC, headquartered in Singapore, is a leading independent provider of assembly, test and bumping services for diverse semiconductor devices. Due to the highly competitive nature of the outsourced assembly and test business, UTAC operates with a highly cost-sensitive business model, especially in Singapore where labour cost is on the rise. Hence, UTAC embarked on an I4.0 transformation to shift from a labour-intensive model to a highly productive and sustainable smart manufacturing plant to maintain its competitiveness.

UTAC focused its I4.0 transformation on process and system automation and has built up world-class overall equipment effectiveness and process control systems to simplify processes, reduce error and mistakes, and improve productivity and product quality. In November 2020, UTAC participated in the Industry 4.0 Human Capital Initiative programme and completed its first SIRI assessment. With the insights gained, UTAC Singapore formulated a new five-year I4.0 Transformation Roadmap focusing on five key pillars – Hands-Free, Remote Control, Data Mining, Artificial Intelligence, and Process/Factory Automation.

UTAC also recognises human capital development as an equally important pillar to I4.0 implementation. With I4.0 transformation, repetitive and manual work will gradually be

replaced by automation. Operators and technicians in UTAC will see their job scope redesigned to focus on automation monitoring and maintenance, while engineers and supervisors will take up new functions in robotics programming, data analytics and visualisation, and sustainable operations management.

To enable its employees to take up higher-value tasks, UTAC worked with the Advanced Manufacturing Training Academy to reskill its workforce by performing a skills and training needs analysis, to identify the priority skills required for its workforce and develop holistic training programmes to reskill and upskill them. For example, one of UTAC's project teams is taking up training on autonomous mobile robots to automate manual processes in the cleanroom.

UTAC will also progressively equip its workforce with I4.0 skills in digitisation, data science, artificial intelligence, robotics, and robotic process automation in the near future to operate, maintain, enhance and manage its transformed smart manufacturing plants. Skills such as *Learning Agility* and *Change Management* are also on UTAC's radar to upgrade their workforce to the next level. With I4.0 implementation, UTAC can remain competitive through transforming its manufacturing plant into a smart and sustainable one.



## INDUSTRY VOICE

### Advanced Manufacturing Training Academy (AMTA)

#### DR ZENG XIAN TING

Programme Director,  
AMTA

The manufacturing industry is transforming rapidly with the adoption of I4.0 through convergence of advanced technologies. With an increasingly tightening labour market for the manufacturing industry, the adoption of IoT and industrial automation is no longer an option but a necessity for Singapore's manufacturing companies to survive and progress into the next decade.

Industrial automation technologies will liberate the human from time-consuming, repetitive operations to focus on higher value-added activities, such as product innovation, process improvement and problem solving. Industrial IoT, on the other hand, enables real-time visibility, predictive production planning, and AI-powered resource optimisation for the connected enterprise. The implementation of I4.0 will not only enhance the productivity, capability, and competitiveness of companies, but also transform the image of manufacturing and make it more attractive for young talents to join.

We are delighted to see that many local companies have taken the leap of faith in piloting smart factories with the implementation of IoT and industrial automation technologies. They have robotics lines, Automated Guided Vehicles and Autonomous Mobile Robots implemented to carry out almost all the functions of operators, and an entire shopfloor with equipment of different origins and generations connected into one unified manufacturing execution system. Productivity gains, as much as 80%, have been

reported from the pilot smart factories, and the companies are eager to further expand their roll-out of I4.0 technologies.

As a result, we have seen an increasing demand for skills in *Internet of Things Application*, *Robotic and Automation Technology Application*, *Automated Process and System Design*, *Automation System Maintenance*, and *Cyber Risk Management* to facilitate the adoption of I4.0 by companies. With limited supply of such skills and talent in the ecosystem, companies are starting to develop talent in-house and upskill their current workforce with such skills to optimise smart factory operation and reduce reliance on external system integrators.

Looking five years and beyond down the road, the talent in the manufacturing industry will need to be multi-skilled in both AM processes and I4.0 technologies to perform their job functions. We have a narrowing window to close the skills gaps in IoT, robotics and automation for the manufacturing workforce of future.

**“ Looking five years and beyond down the road, the talent in the manufacturing industry will need to be multi-skilled in both AM processes and I4.0 technologies to perform their job functions. ”**

# PROFILE STORY:

## SIMON WONG, trainer and welding engineer at a manufacturing company

A former construction project manager, Simon now conducts training for a manufacturing company while pursuing certification as a lead instructor in fields related to manufacturing.

### What motivated you to advance your skills?

I have been working in the construction sector for 15 years, specialising in structural steel work. That was also when I first learnt about welding and protective coating. When the COVID-19 pandemic came, I felt the impact on the construction sector. However, that also gave me time to acquire new skills and knowledge to further develop as a trainer, which I have also been doing for over 10 years.

### What was your learning journey like?

I enrolled in SIMTech's Graduate Diploma in Precision Engineering Advanced Welding Technologies, where I was exposed to various I4.0 advancements, like using digital tools, robotic welding, additive manufacturing, and other uses of automation. Although many of these technologies are not immediately applicable to the construction sector today, I believe we need to stay updated on the

emerging technologies and continuously evaluate how we can improve our productivity. For instance, while *Non-Destructive Testing* skills are already very established in manufacturing, we are also seeing more advanced equipment today that incorporate data collection and analysis to make the testing process more effective. Other skills such as *Equipment and Systems Testing* and *Inspection Engineering Management* are also becoming relevant and applicable across different manufacturing sectors.

Today, I am working towards earning a leading instructor position by pursuing course certifications. I am thankful that my company provides me with the flexibility I need for this.

### How important is the ability to learn and adapt?

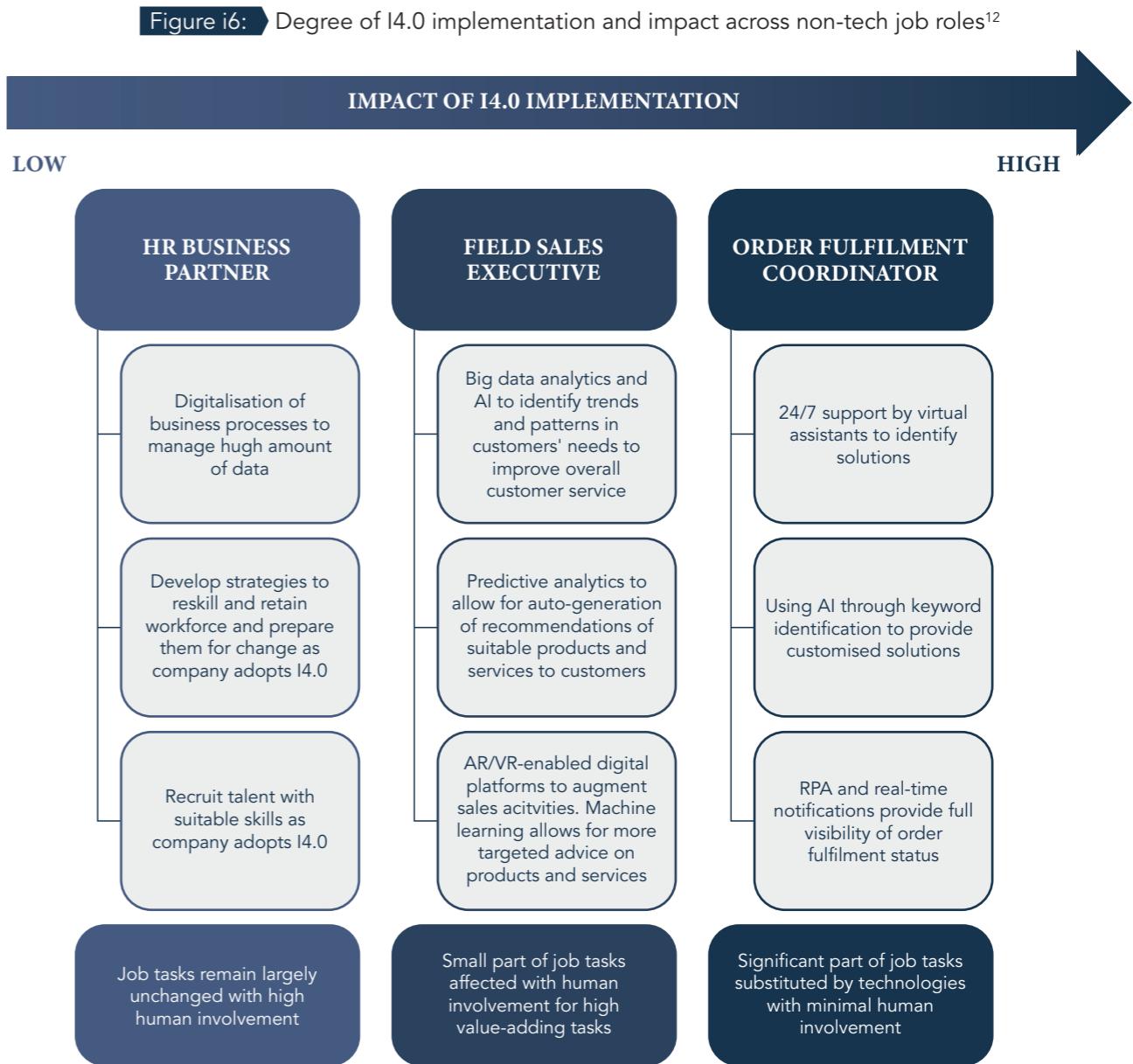
I believe technology can help us do our work more effectively, but it cannot replace humans. For example, as the use of data becomes more prevalent, qualified inspectors need to learn what data is valuable and how to collect it with their equipment. Otherwise, they will just generate 'rubbish' data that is not useful for further analysis.

### C. I4.0 implementation has caused non-tech job roles such as those in customer service, sales, and HR to evolve, as processes are affected across the value chain. The degree of change in job scope and skills varies across work functions and job roles

As I4.0 implementation affects business processes across the manufacturing value chain, the work functions and skills required of non-tech roles are also changing, such as those in customer service, sales, and HR. Examples of these roles include field sales executive, order fulfilment coordinator, business development manager, and HR business partner. As more of the manual and repetitive tasks are substituted by I4.0 technologies, such as Robotic Process Automation (RPA), to provide full visibility and real-time notifications of order fulfilment status, I4.0 implementation has enabled workforce in

these job roles to focus on more high value-added areas. For instance, they can use behavioural and data analytics to categorise customers, develop data-driven leads generation and customer retention strategies, and use AI and simulation modelling to identify and test different prototypes to customise solutions for customers' needs.

To meet these changes in work functions, new I4.0 and digital skills are required. Figure i6 shows the varying impact of I4.0 implementation across these non-tech roles.



<sup>12</sup> Figure draws I4.0 implementation information from *Workforce Singapore, 2020*, and job role information from *SHS Web of Conferences, 2020*

Figure i7 summarises some of the priority I4.0 and digital skills that non-tech job roles will require as part of I4.0 implementation, while Table i2 provides more detail on the growth and the transferability of these skills.

Figure i7: Important skills that non-tech job roles will require with I4.0 implementation

HR BUSINESS PARTNER	FIELD SALES EXECUTIVE	ORDER FULFILMENT COORDINATOR
<ul style="list-style-type: none"> <li>• Human Resource Digitalisation</li> <li>• Big Data Analytics</li> <li>• Process Control</li> <li>• Data Protection Management</li> </ul>	<ul style="list-style-type: none"> <li>• E-commerce Management</li> <li>• Artificial Intelligence Application</li> <li>• Cloud Computing Application</li> <li>• Supply Chain Management</li> </ul>	<ul style="list-style-type: none"> <li>• Order Fulfilment and Returns Processing</li> <li>• E-commerce Management</li> <li>• Applications Support and Enhancement</li> <li>• Mechanical Engineering Management</li> </ul>

Table i2: List of skills with their associated statistics on demand growth and transferability categorised by job role

NON-TECH JOB ROLE	SKILL	TYPE OF SKILL	DEMAND GROWTH	TRANSFERABILITY	EXAMPLE OF JOB ROLE THAT ALSO REQUIRES THIS SKILL
HR business partner	Big Data Analytics	Digital	28%	817	<ul style="list-style-type: none"> <li>• Manager - analytics and customer insights           <ul style="list-style-type: none"> <li>• Internal auditor</li> <li>• Business analyst</li> </ul> </li> </ul>
	Data Protection Management	Digital	162%	621	<ul style="list-style-type: none"> <li>• Business-to-customer sales manager</li> <li>• Head of compliance</li> <li>• Manager, talent management</li> </ul>
	Human Resource Digitalisation	Digital	23%	727	<ul style="list-style-type: none"> <li>• Manager, talent management</li> <li>• Business-to-customer sales manager</li> <li>• Manager, employee experience and relations</li> </ul>
	Process Control	I4.0	71%	644	<ul style="list-style-type: none"> <li>• Quality assurance senior specialist</li> <li>• Business process improvement executive</li> <li>• HR manager</li> </ul>
Field sales executive	Artificial Intelligence Application	Digital	42%	760	<ul style="list-style-type: none"> <li>• Head of quality</li> <li>• Customer success manager</li> <li>• Analyst - analytics and customer insights</li> </ul>
	Cloud Computing Application	Digital	74%	470	<ul style="list-style-type: none"> <li>• Customer success manager</li> <li>• Sales account manager</li> <li>• Business development manager</li> </ul>
	E-commerce Management	Digital	95%	761	<ul style="list-style-type: none"> <li>• E-commerce manager</li> <li>• Marketing assistant</li> <li>• Customer experience manager</li> </ul>
	Supply Chain Management	I4.0	80%	542	<ul style="list-style-type: none"> <li>• Logistics contracts manager</li> <li>• Procurement manager</li> <li>• Logistics solutions manager</li> </ul>

Order fulfilment coordinator	Applications Support and Enhancement	Digital	43%	578	<ul style="list-style-type: none"> <li>• Client support service manager           <ul style="list-style-type: none"> <li>• Customer success manager</li> <li>• Assistant customer support executive</li> </ul> </li> </ul>
	E-commerce Management	Digital	95%	761	<ul style="list-style-type: none"> <li>• E-commerce manager</li> <li>• Marketing assistant</li> <li>• Customer experience manager</li> </ul>
	Mechanical Engineering Management	I4.0	85%	644	<ul style="list-style-type: none"> <li>• Senior procurement executive</li> <li>• Claims manager</li> <li>• Quality manager (manufacturing)</li> </ul>
	Order Fulfilment and Returns Processing	Digital	117%	271	<ul style="list-style-type: none"> <li>• Order management executive</li> <li>• E-commerce manager</li> <li>• Supply chain manager</li> </ul>

## FEATURED COMPANY CASE STUDY:

### Universal Aquaculture

A Singapore start-up founded in 2020 by a team of aquaculture enthusiasts whose aim is to produce seafood using sustainable methods, coupled with cutting-edge technology. The company wanted to develop high-tech zero-disruption seafood farming systems that are highly exportable and places Singapore on the map of sustainable seafood production.

To achieve its aim, it implemented I4.0 in its production end-to-end. Together with R&D and collaboration with partners, Universal Aquaculture developed a multi-phased automation roadmap comprising a few phases – (i) installation of sensors and data acquisition equipment to monitor vital water parameters 24/7 and collect real-time data on key behaviour such as feeding habits, growth and mortality; (ii) implementation of AI-assisted auto feeder to enable auto dosing of minerals and supplements based on real-time water conditions monitoring, which in turn minimises feed wastages and improves water quality; and (iii) incorporation of automated harvesting and shrimp transfer technologies such as computer vision AI for auto sorting of shrimp sizes to reduce stress on shrimps during the transfer, and cut harvesting manpower and time by 30%.

Its team of aquaculture specialists and engineers also designed and built their

proprietary hybrid biological recirculation system, which is a next-generation water treatment system that saves up to 80%-90% of water and energy, and sustains pH and bacteria levels to ensure optimal water quality.

To manage these technologies, its team must be equipped with skills in digital, I4.0 and sustainability. To build some of this critical expertise, especially in domain aquaculture management skills, it recruited and trained mid-career workers from [Workforce Singapore's Career Conversion Programme for Professional Executives](#).

It also had to collaborate with other partners for complementary skills and capabilities to achieve automated and sustainable food production. These partners complemented its team with skills such as *Sustainable Food Production Design*, especially in the area of feed production (joint research with Grobest), *R&D* skills which is integral to the innovation-led start-up, digital skills such as *Artificial Intelligence Application*, and *Data Collection and Analysis*, and I4.0 skills such as *Robotic and Automation Technology Application* (with partners like SESTO). As a result, the company can produce quality seafood that are healthy and free of chemicals and pesticides, at competitive prices.

## PROFILE STORY:

### CHRISTIAN NUGRAHA, senior full-stack developer in I4.0 technology

Having started his career as a manufacturing test engineer, Christian transited into a new role as a full-stack developer for his company.

#### What motivated you to make this career transition?

Back in 2017, I was fortunate to be able to participate in a company-sponsored '[Career Conversion Programme \(CCP\) for Tech Professionals - Full Stack Web Developer](#)', offered by National University of Singapore's Institute of Systems Science. This course focused mainly on software development, which was something I found missing in my role before.

At that time, we saw our industry shifting towards AI and IoT, and the company that I was placed with saw the need to have these skills.

#### What was your learning journey like?

The programme comprised full-time training that lasts two months. After that, I had four months of project work, which I did as part of on-the-job training. Beyond basic programming, I learnt how the whole software development process works, and how to use codes to interact with hardware. This is a concept that I find very helpful to understanding the communication between software and hardware.

After completing the course, I continued to learn a lot of new technologies along the way.

Most of this came from client engagement, through their use cases and pain points. I applied many skills in serving both internal and external clients. For instance, *Data Engineering* skills helped me better capture and analyse user behaviour information, while *Supply Chain Solutioning* skills enabled me to develop models to optimise supply chain operating models based on data, leading to improved inventory levels, delivery times, and cost savings.

With external clients, I also had to help them integrate the hardware with software. Skills such as *Internet of Things Application*, *Robotic and Automation Technology Application*, and *Automated System Design* helped me understand and work with different hardware, such as robots, Automated Guided Vehicles and IoT sensors.

#### How important is the ability to learn and adapt?

I think it is very important to have an open mind and understand that our jobs are never static. Technology is changing and so is our society at large. At some point, the skills that we have might become obsolete. Hence, it is important to look at the industries and see what skills are in demand and be open to pick up these skills. In addition, the past learning that we gained from previous jobs are often not wasted and can be applied in new settings.

## Skills featured in this chapter

SKILL TITLE	SKILL DESCRIPTION		
<b>3D Modelling</b>	Generate 3D models using a variety of modelling software to represent characteristics of a real-world system	<b>Cyber Security</b>	Develop awareness of cyber security threats
<b>Additive Manufacturing</b>	Design and apply additive manufacturing workflows to create three-dimensional objects	<b>Data Analytics System Design</b>	Integrate the use of data analytics in the production environment for the identification of bottlenecks and system improvements
<b>Agile Software Development</b>	Plan and implement Agile methodology and the use of adaptive and iterative methods and techniques in the software development lifecycle	<b>Data Collection and Analysis</b>	Collect, extract and interpret data according to defined requirements to obtain project insights
<b>Applications Support and Enhancement</b>	Provide ongoing technical support and improvements to users of applications	<b>Data Engineering</b>	Develop and implement efficient and stable processes to collect, store, extract, transform, load and integrate data at various stages in the data pipeline.
<b>Artificial Intelligence Application</b>	Apply algorithmic, statistical and engineering knowledge to integrate artificial intelligence into engineering processes	<b>Data Protection Management</b>	Formulate the organisation's data protection strategy and ensure effectiveness of Data Protection Management Programme (DPMP)
<b>Automated Process Design</b>	Design processes that utilise automated manufacturing equipment and control systems	<b>E-commerce Management</b>	Develop, manage and execute e-commerce strategies and activities according to organisational objectives
<b>Automated System Design</b>	Design and commission automated systems as well as evaluate the system design specification against functional requirements	<b>Equipment and Systems Testing</b>	Execute equipment and systems testing procedures to ensure continuity of operations and meet standards of performance
<b>Automation Process Control</b>	Apply automation process control to monitor performance metrics and quality of manufacturing outputs to determine the optimal settings as well as productivity improvement strategies	<b>Human Resource Digitalisation</b>	Innovate human resource (HR) processes and practices through digitalisation
<b>Automation Design</b>	Manage control systems and information technology to reduce the need for human work in the production of goods and services in order to streamline operations	<b>Human-Robot Collaboration</b>	Implement Human-Robot Collaboration (HRC) applications to enhance the efficiency and effectiveness of work processes
<b>Automation System Maintenance</b>	Maintain automation systems to meet operation requirements as well as propose strategies for improvement of automation systems' performance	<b>Inspection Engineering Management</b>	Manage fixed equipment and piping inspection schemes, materials selection, construction, corrosion control, condition and fitness-for-service through on-stream, risk-based monitoring programmes and downtime inspections
<b>Big Data Analytics</b>	Analyse and validate significant volumes of data to discover and quantify patterns and trends to improve business operations	<b>Internet of Things Application</b>	Implement Internet of Things (IoT) technologies to drive efficiency and effectiveness of operations
<b>Carbon Footprint Management</b>	Quantify and reduce the organisational carbon footprint	<b>Machine Learning</b>	Apply machine learning knowledge and algorithms, optimise the models learnt into project execution and maintenance processes
<b>Change Management</b>	Manage organisational change management systems to drive organisational success and outcomes by preparing, equipping and supporting adoption of change	<b>Mechanical Engineering Management</b>	Manage the design, technical specification, selection, modification and troubleshooting of mechanical equipment, structures and systems
<b>Cloud Computing Application</b>	Manage cloud computing technologies in order to offer a collaborative framework with centralised storage and contact points, fewer visibility barriers, and opportunities to enact simplified, standardised processes	<b>Non-Destructive Testing</b>	Execute non-destructive tests to ensure structural integrity, insulation resistance, continuity and satisfactory performance of electrical equipment and installations
<b>Computational Modelling</b>	Develop, select and apply algorithms and advanced computational methods to enable systems or software agents to learn, improve, adapt and produce desired outcomes or tasks	<b>Order Fulfilment and Returns Processing</b>	Develop order fulfilment guidelines and execute order fulfilment activities
<b>Cyber Risk Management</b>	Develop cyber risk assessment and treatment techniques that can effectively pre-empt and identify significant security loopholes and weaknesses and provide risk treatment and prioritisation strategies	<b>Process Control</b>	Apply process control to monitor and optimise process plant performance and quality of production output
		<b>Process Improvement</b>	Evaluate strategic and longer-term impacts of change and improvement processes, as well as communicate to employees improvement plans, goals and changes to operational procedures

<b>Product Design and Development</b>	Manage new product design and development from Research and Development (R&D), including initial product design concepts, small batch piloting, market testing and evaluation
<b>Programming and Coding</b>	Develop technical capabilities to understand, design and write instructions to be processed by computers as software programmes to achieve desired outcomes
<b>Quality Assurance</b>	Develop, implement and monitor practice of clear quality expectations and standards aligned to the organisation's values and business objectives
<b>Research and Development</b>	Optimising manufacturing processes, material developments and development of new product lines
<b>Renewable Energy System Management and Integration</b>	Analyse impact of renewable energy system integration on energy grid in steady state and during dynamic operation.
<b>Robotic and Automation Technology Application</b>	Integrate robotic and automation technologies in manufacturing workflows, to enhance productivity, precision and reduce reliance on manual tasks
<b>Supply Chain Management</b>	Develop and maintain supply chain processes, comprising feedstock, production, storage, and export, to ensure supply and demand are managed in an integrated manner
<b>Supply Chain Solutioning</b>	Develop new operating models and solutions for customers to manage their supply chain needs as well as improve inventory levels, delivery time and cost saving
<b>Sustainable Food Production Design</b>	Design and implement sustainable food production policies, processes and initiatives within the organisation
<b>Sustainability Reporting</b>	Lead development of organisation's sustainability reporting and accounting policies and processes in line with regulatory requirements and international best practices
<b>Sustainability Risk Management</b>	Develop frameworks, strategies and policies for managing sustainability risks for the organisation to minimise and mitigate risks and impact to the organisation

The skills featured in this chapter are non-exhaustive.  
To see the full list of priority skills, please visit this link:

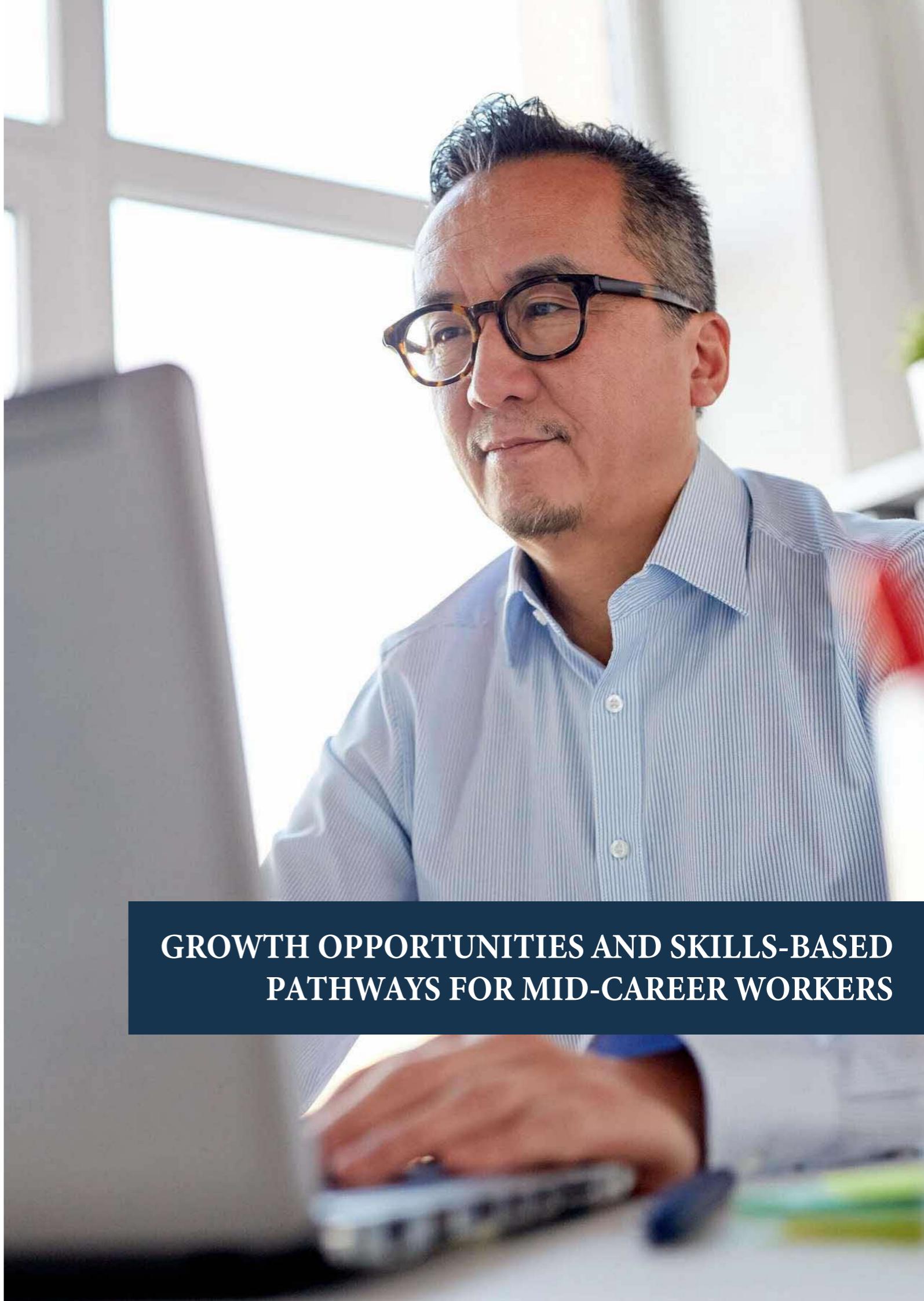


<https://go.gov.sg/2022skills-i40>

Please visit this link for information on suggested courses for I4.0:



<https://go.gov.sg/i40-econ-courses>



## GROWTH OPPORTUNITIES AND SKILLS-BASED PATHWAYS FOR MID-CAREER WORKERS

- Mid-career workers, aged 40 to 59, form half of Singapore's resident workforce
- They are well represented in five job families: (i) Operations and Administration; (ii) Sales, Marketing and Customer Service; (iii) Human Resource; (iv) Finance and Accounting; and (v) Engineering and Technology
- As these job families undergo transformation, it is important for mid-career workers to consider upskilling or reskilling to stay versatile within their job families, or to take on opportunities to move into growth roles
- Some transition options require a greater skills top-up than others, but they may lead to potentially greater longer-term returns
- Mid-career workers should assess the different options available and select those that best support their own aspirations for career growth

In the last four chapters, we highlighted the range of **priority skills** and how these skills can enable our workforce to tap growth opportunities in the **Digital, Green, and Care Economies**.

Many mid-career workers are in these five **job families**<sup>1</sup>: (i) Operations and Administration; (ii) Sales, Marketing and Customer Service; (iii) Human Resource; (iv) Finance and Accounting; And (v) Engineering and Technology.

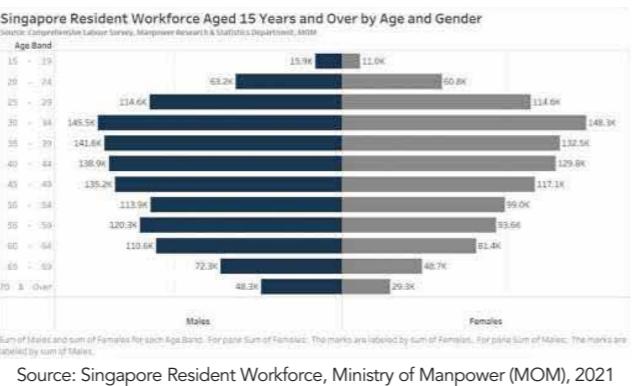


This chapter takes the lens of **mid-career workers** to review the career options available if they want to tap on these growth opportunities. This chapter also suggests a simple framework to evaluate different skills-based training pathways to enable them to move into **growth roles** more confidently.

### Majority of mid-career workers have 15-25 years of experience and are mainly in five job families

Today, based on official statistics from the Singapore Ministry of Manpower, mid-career workers, those aged between 40 and 59, form half of Singapore's working adult resident population (see Figure M1).

Figure M1: Singapore Resident Workforce



As these job families undergo transformation and job redesign, it is important for mid-career workers to consider **upskilling** or **reskilling**, to stay versatile within their job families, or to take on opportunities to move into **growth roles**.

With increasing technology adoption, changing business and operating models and rising focus on sustainable practices, the work content and skills needed by these roles are increasingly changing.

Figure M2: Trends affecting changes in jobs and skills



#### TREND 1

Evolving operating models to meet new business needs and changing customer expectations



#### TREND 2

Accelerating adoption of digital and automation tools



#### TREND 3

Rising focus on sustainable practices

Source: Jobs Transformation Maps, [Workforce Singapore, 2021](#)

**HR managerial** roles increasingly require skills in applying tech-enabled service delivery solutions and data analytics to support more strategic functions and to anticipate workforce needs and the changing profiles of the talent pool.

**Operations and Administration** job roles require an understanding of the workflows augmented by Industry 4.0. Employees can expect that there will be a demand for them to take on more data-driven tasks, such as planning and forecasting. They might also expect to drive process improvements and optimisation activities using digital tools and automation technologies.

**Finance** job roles are increasingly about embedding sustainable practices. There is a strong and growing demand for sustainable finance talent as Singapore plays a larger role as a sustainable finance hub for the region.

As the job content changes and demand for new skills increases, there is a need to help mid-career workers in these roles raise their career versatility, either to take on new tasks within the job family or to consider options to move out of the job family. It is also important that employers and training providers recognise the accumulated skills and experiences of these workers, when providing workplace and learning opportunities. In other words, it is best to 'stack' on the skills that mid-career workers already have, when considering their learning and professional growth (see Feature Story on the next page).

**Upskilling** is the process of learning additional skills to move to other roles within the same job family. For example, a customer service officer upskills in *Digital Marketing* to move into a marketing executive job role within the same job family.

**Reskilling** is the process of learning new skills to move into a different job role in another job family. For example, a customer service officer from the Sales, Marketing and Customer Service job family reskills into a compliance analyst in the Finance and Accounting job family.

<sup>1</sup> Job families are groupings of jobs related by common job roles. Job roles in a job family require similar knowledge, skills and abilities; have a continuum of knowledge, skills and abilities that represent a career path from the lowest to the highest level job

## FEATURE STORY:

**MR CLEMENT YEN, Customer Service Officer to Junior Technician at Wah Son Engineering**

and

**MS LIM HEE JOO, Executive Director, Wah Son Engineering**

Mr Clement Yen has more than 15 years of experience as a customer service officer at a call centre. After being in the service line, Clement decided to take a leap of faith to make a career switch into a more hands-on technical role to challenge himself. When he saw Wah Son Engineering's job posting for a Junior Technician position that required no prior experience, Clement was determined to take on the challenge.

Despite having no technical background, he had the following determining factors: his willingness to learn and relearn, very positive learning attitude, and good engagement and communication skills.

According to Ms Lim Hee Joo, Executive Director of local precision engineering firm Wah Son Engineering, mid-careerists bring with them an ocean of experience and cross-industry perspectives. These attributes allow them to offer fresh insights to current processes and be more innovative when executing tasks. In Clement's case, he was able to complement the skill sets of his colleagues with his strong customer orientation and stakeholder management skills that he has honed in his previous service role.

As part of the transition, the apprenticeship programme that Wah Son Engineering had put in place also enabled Clement to learn technical skills on the job. The coaching and buddy culture eased Clement's transition into the new role as support from his supervisors and peers addressed his many questions and hands-on guidance allowed him to acquire new skills while strengthening existing ones.

A piece of advice that Clement would like to give other fellow mid-careerist switchers, is that there is no age limit to learning! Anyone is capable of going beyond their psychological boundaries and work towards their goals. However, no achievement is possible without hard work. From the employer perspective, Hee Joo also encouraged other employers to be realistic when hiring mid-careerists and allow them time to navigate their way into the new job role. This will allow mid-careerists to appreciate the new role, work culture, and environment that they are in. From learning agility to resilience, mid-careerists have more to offer to any industry. To reap the benefits as an employer, having an open heart and mind is critical.



## INDUSTRY VOICE

**HRnetGroup Limited**

**ADELINE SIM**

**Co-owner/Executive Director and Chief Corporate Officer, HRnetGroup**

In Singapore today, it is imperative that anyone interested in having a career is constantly growing, evolving, and undergoing training. It is much too late to wait till you are out of a job to work on the 'top-ups' you need in hard and soft skills to land another job. You have to move in tandem with the macro environment whilst you are still employed, and this applies across all levels of seniority.

Job titles may not have innovated much, but there has been a distinct change in job content over a very short span of time. Not so long ago, someone in talent acquisition might dismiss InstaLive and Telegram channels as being platforms 'for kids', but today, they are very effective tools of the trade. The same goes for job seekers in marketing who have not assiduously kept up with search engine optimisation and the platforms and media on which their desired demographics can be found. They may previously have held the title of 'marketing executive', but upon leaving employment, they struggle to find a job as they no longer have the skills for the role.

Employers have a critical role to play to ensure their employees do not 'work themselves out' of the workforce. If lifelong training is hard

coded into KPIs, we reduce the likelihood of having managers who are ill-equipped to manage hybrid teams or have no knowledge of available tools and who, as a result, have become less employable.

In a very open economy like Singapore's, change increasingly comes in gusts and it is now rather uncommon to stay in one job for decades till retirement. So, the question is how to ensure that there are options available when the time comes to seek a new role. Moving into a completely new area is one possibility, but less dramatic options include continuing to play a similar role but for an adjacent industry. The critical thing to remember is that you must be able to value-add no matter where you go, so do make it a point to gain new skills as a way of life!

**In Singapore today, it is imperative that anyone interested in having a career is constantly growing, evolving, and undergoing training.**

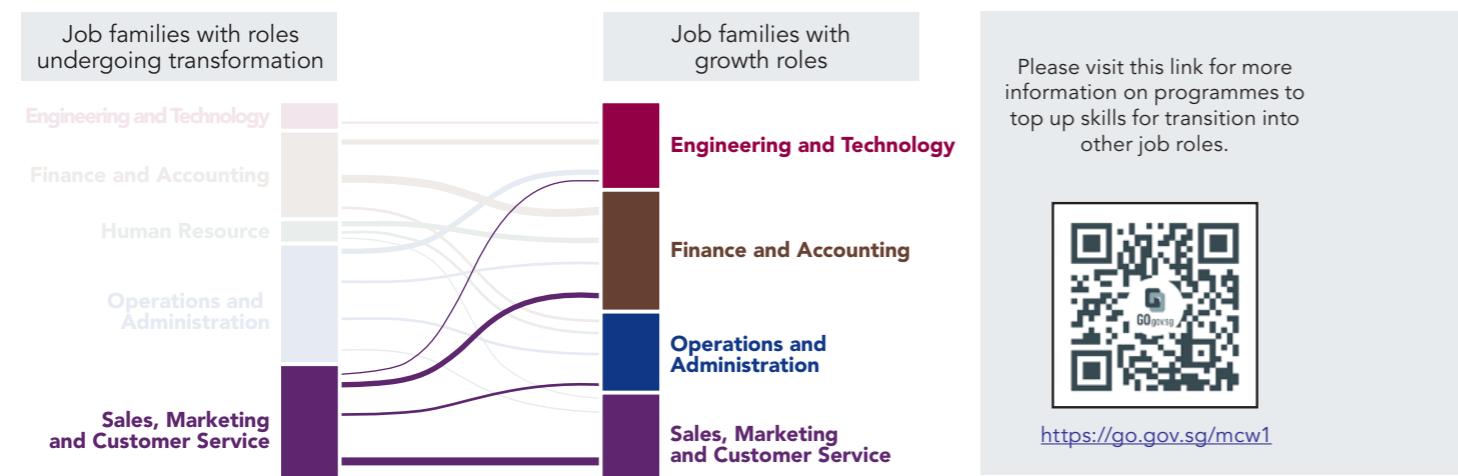
## Opportunities for mid-career workers in Sales, Marketing and Customer Service job roles

There are various transition options for mid-career workers to either upskill and move to adjacent roles within the same job family or reskill to move into growth roles in other job families. Some options require a greater skills top-up than others, but they may lead to potentially greater longer-term returns.

For example, mid-career workers in Sales, Marketing and Customer Service job roles typically have *Customer Management*, *Service Excellence*, *Business Negotiation*, *Business Development*, and *Adaptability* skills that are required by other different job roles within the same job family or across job families.

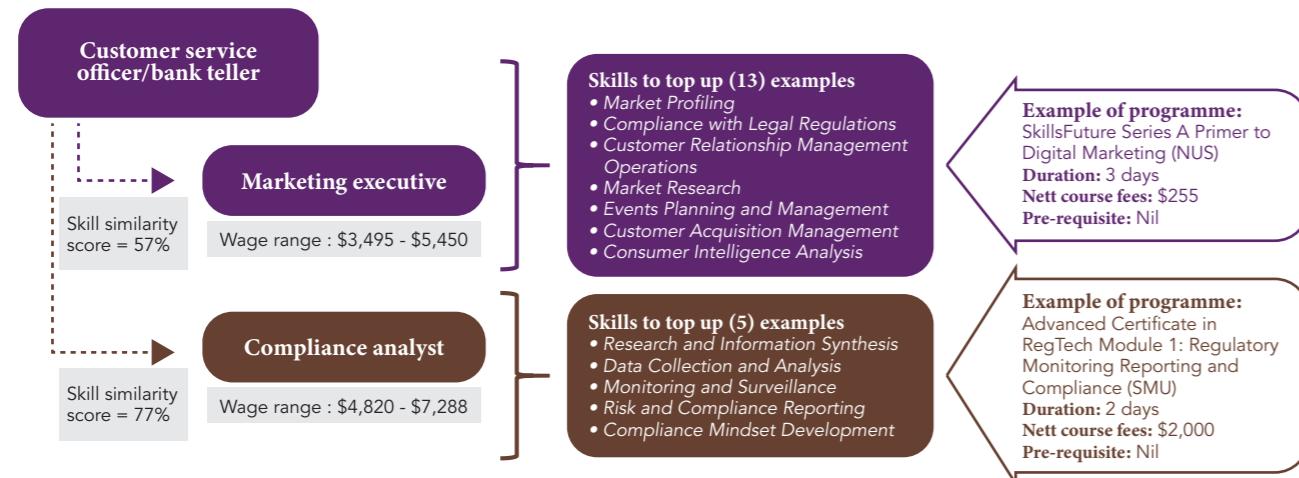
Because of this, they can potentially leverage these skills to move to adjacent roles within the same job family, or to growth roles in other job families. In this analysis, growth roles refer to job roles that exhibit sustained moderate-to-strong hiring demand over a period of one year.

**Figure M3:** Potential pathways for mid-career workers in Sales, Marketing and Customer Service job roles



\* For more information on how to read this figure, please refer to page 117 of the Methodology chapter

**Figure M4:** Potential transition pathways of a customer service officer/bank teller moving into similar seniority roles within/across job families



## FEATURE STORY:

### MS NELLY LEE, travel product planner to DevOps engineer

Ms Nelly Lee has 20 years of experience in the tourism industry as a travel product planner. Living through the global COVID-19 pandemic resulted in dramatic changes in her life and this was when she decided to make a career switch.

Based on her experience in using numerous travel technologies, such as virtual reality tours, robot technology in hotels, facial recognition check-in facilities and the Internet-of-Things (IoT), Nelly was determined to acquire new skills

and qualifications to launch a new career in technology. Hence, she enrolled in the SGUnited 'Mid-Careers Pathways Programme (Company Training) in Cloud Support and DevOps' under Microsoft and Generation Singapore's #GetReadySG initiative. During her apprenticeship, she got to apply her skills in cloud and automation and was able to get a job offer as a DevOps engineer with a tech company within three months.

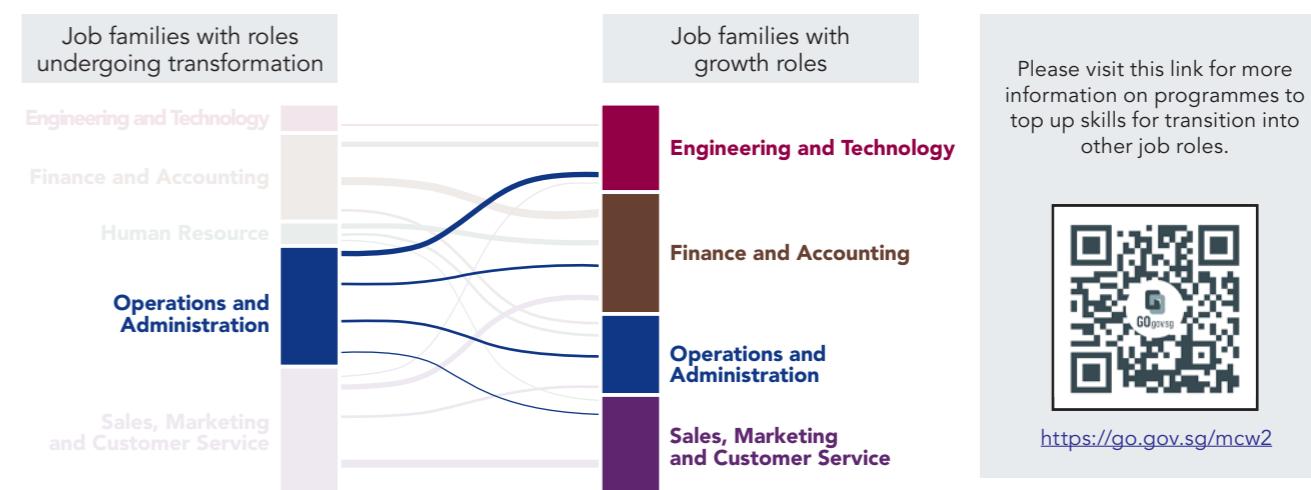
## Opportunities for mid-career workers in Operations and Administration job roles

Similarly, mid-career workers in Operations and Administration job roles typically have *Business Continuity Management*, *Project Management*, *Operations Risk Management*, *Innovation Management*, and *Human-Robot Collaboration* skills that are required by other different job roles within the same job family or across job families

into Engineering and Technology, Finance and Sales.

Because of this, they can potentially leverage these skills to move to adjacent roles within the same job family or move to growth roles in other job families.

**Figure M5:** Potential pathways for mid-career workers in Operations and Administration job roles



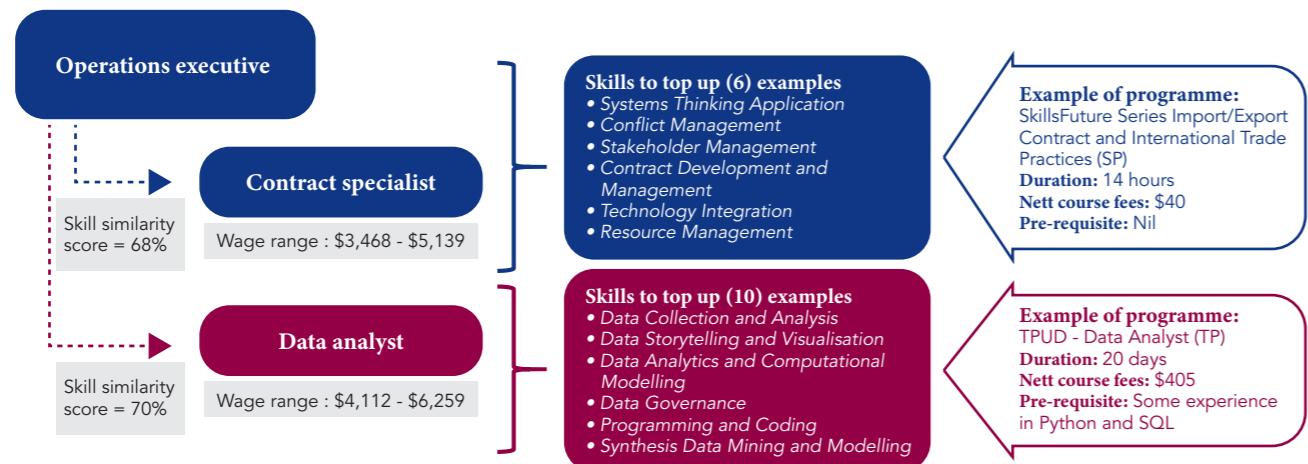
\* For more information on how to read this figure, please refer to page 117 of the Methodology chapter

Figure M5 shows the different job families where mid-career workers in Operations and Administration job roles can move into. Again, the thickness of the lines denotes the number of potential job role transitions; the thicker the line, the higher the number of job role transitions

between the two job families based on the similarities between the work content and skills required. Due to the high level of similarity, there are many possible transitions to Finance and Accounting and/or Engineering and Technology job families.

Figure M6 shows examples of pathways to upskill an operations executive into a contract specialist role within the same job family, or take on a bolder career move to pivot into other growth roles like a

**Figure M6:** Potential transition pathways of an operations executive moving into similar seniority roles within/across job families



data analyst within the Engineering and Technology job family. The diagram includes programmes that can help them glide into these new roles by targeting the skills top-ups required.

## Opportunities for mid-career workers in Human Resource job roles

Likewise, mid-career workers in Human Resource job roles typically have *Employee Communication Management*, *Human Resource Analytics and Insights*, *Learning Needs Analysis*, *Talent Capability Assessment* and *Human Resource Practices Implementation* skills that are required by other different job roles within the same job family or across job families into Finance, Operations and Administration, and Sales.

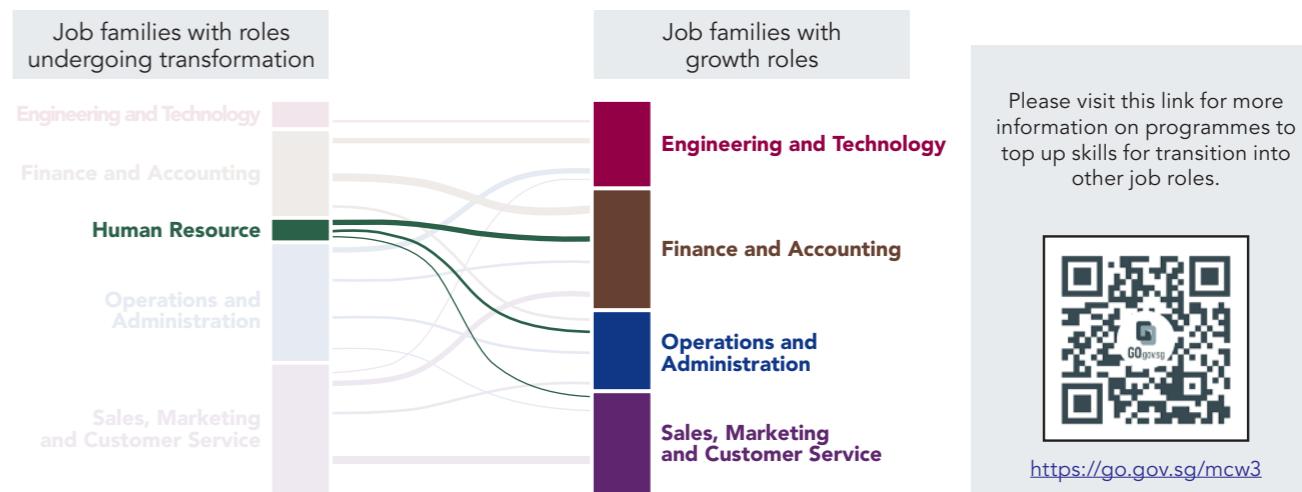
Because of this, they can potentially leverage these skills to move to adjacent roles within the same Human Resource job family or move to growth roles in other job families.

Figure M7 shows the different job families where mid-career workers in Human Resource job roles

can move into. Due to the adjacencies of the work content and skills similarities of the impacted Human Resource roles, there are more job role transitions to adjacent growth roles in the Finance and Accounting job family compared to other job families. Hence, the line linking the Human Resource and Finance and Accounting job families is relatively thicker than the rest.

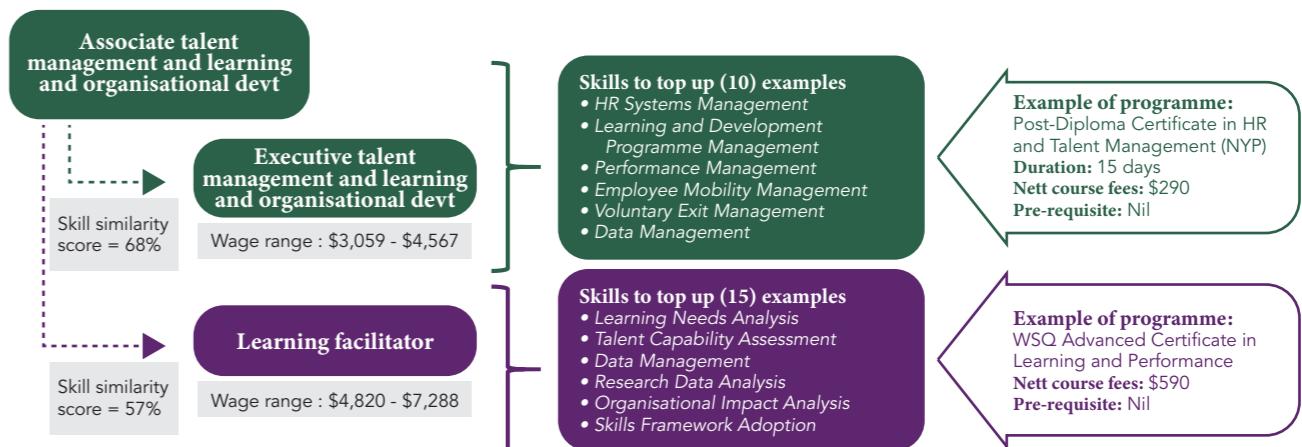
Figure M8 shows examples of pathways to upskill a talent management associate into a talent management executive role within the same job family or reskill into a learning facilitator role within the Sales, Marketing and Customer Service job family. The diagram includes programmes that can help them glide into these new roles by targeting the skills top-ups required.

**Figure M7:** Potential pathways for mid-career workers in Human Resource job roles



\* For more information on how to read this figure, please refer to page 117 of the Methodology chapter

**Figure M8:** Potential transition pathways of a talent management associate/executive moving into similar seniority roles within/across job family



## FEATURE STORY:

### MR GAZALI AHMAD, taxi driver to junior full stack developer

Mr Gazali Ahmad, 53, has taken up several jobs, such as civil engineer, insurance agent, trainer, and taxi driver. Even though he had been driving for seven years, he was hungry for growth and wanted a career change.

Although he was initially worried about his age, he made a bold move to enrol in the SGUnited 'Mid-Careers Pathways Programme (Company Training) in Junior Full Stack Developer' under Microsoft and Generation Singapore's #GetReadySG initiative. Five months into his

apprenticeship, he got a job as a junior MuleSoft developer.

Gazali was able to transfer the skills he had gained over his years of experience to his new work environment, such as time management skills, data analytics skills, and communication and interpersonal skills. The project ended after seven months, and he was able to secure a new role as Java developer in another technology company within three weeks.

# FEATURE STORY:

## MS FARIDAH BEGUM, corporate support officer to enrolled nurse, obstetrics and gynaecology (O&G)

Being a corporate support officer (HR administration) for more than 10 years, Ms Faridah Begum was providing support for human resource functions, including leave matters, medical records, performance management and training and development. This required her to possess project and time management skills, good communication and interpersonal skills, meticulous attention to details, and the ability to form working relationships with people at all levels.

With limited opportunities for career advancement, Faridah wanted to make a transition to a skilled career with good learning and progression opportunities. With encouragement from her family and friends,

she enrolled in the Nitec in Nursing, 18-month programme, at ITE. The classroom training was coupled with attachments to hospitals for on-the-job-training.

Having met turbulent waters in the beginning, it was not an easy feat for her to switch to a new industry. Often, she questioned her decision to switch careers. Nonetheless, thanks to her experience in paying meticulous attention to detail and good interpersonal skills, Faridah learned on the job fast and was determined to excel in her new role as an enrolled nurse at an O&G specialist clinic. Her advice to other mid-careerists is, "Perseverance, hard work and determination will help you to cross all hurdles and help you reach your pinnacle."

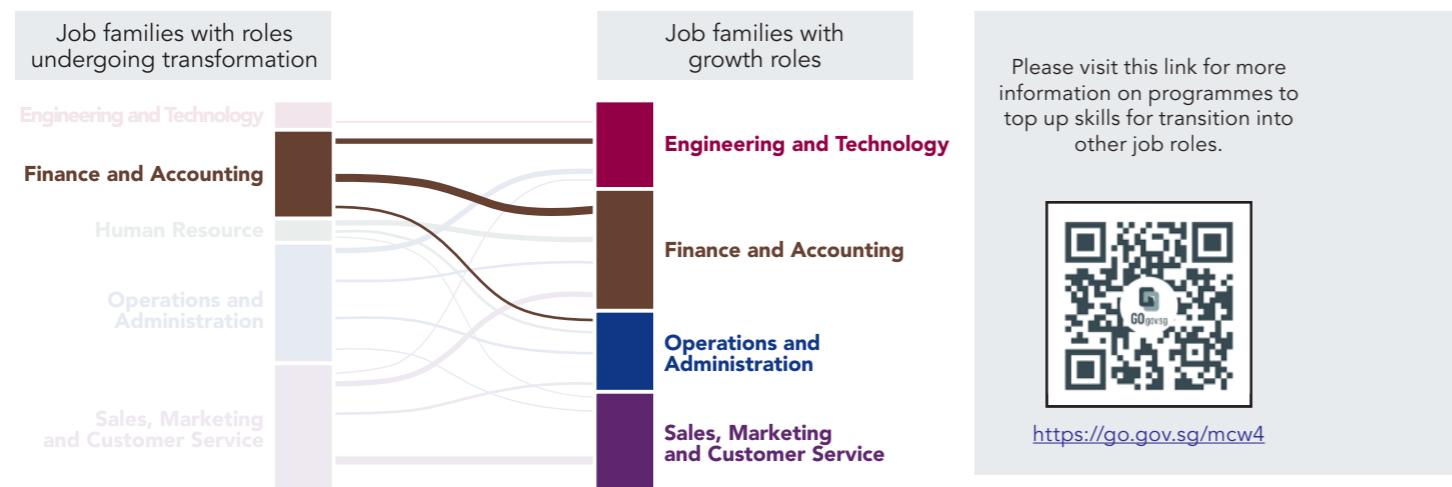
## Opportunities for mid-career workers in Finance and Accounting job roles

Mid-career workers in Finance and Accounting job roles typically have Accounting Standards, Financial Statements Analysis, Stakeholder Management, Project Execution and Control, and Risk Assessment skills that are required by other different job roles within the same job family, or

across job families into Engineering and Technology, and Operations and Administration.

Because of this, they can potentially leverage these skills to move to adjacent roles within the same Finance and Accounting job family or move to adjacent growth roles in other job families.

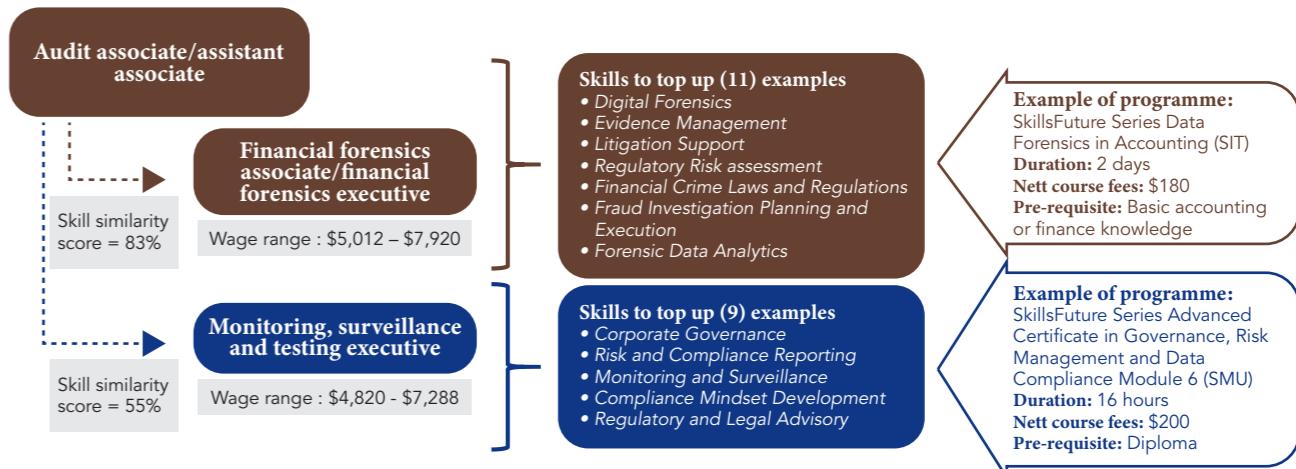
Figure M9: Potential pathways for mid-career workers in Finance and Accounting job roles



\* For more information on how to read this figure, please refer to page 117 of the Methodology chapter

Figure M9 shows the different job families where mid-career workers in Finance and Accounting job roles can move into. Due to the specialised nature of the work tasks in this area, the greatest growth opportunities lie within the same family. Bolder moves entail transiting to the Engineering and Technology job family.

Figure M10: Potential transition pathways of an audit associate/assistant associate moving into similar seniority roles within/across job families



# FEATURE STORY:

## MS INDRIE TJAHJADI, auditor (finance and accounting) to consultant, sustainability and climate change, PricewaterhouseCoopers (PwC)

Ms Indrie Tjahjadi has more than 20 years of experience in the finance and accounting sector as an auditor. During these years, Indrie has been primarily involved in financial statements auditing and capital market transactions for corporate clients.

However, four years ago, she wanted to do something different while keeping her passion alive for auditing, and she moved to the sustainability and climate change team within PwC. Her role involves sustainability assurance practice, managing green loans and green bond assurance and helping companies set up sustainability postures, strategies and policies.

Based on her experience in dealing with financial numbers, managing corporate clients, and compliance reporting, Indrie was determined to acquire new skills and make her career move into sustainability.

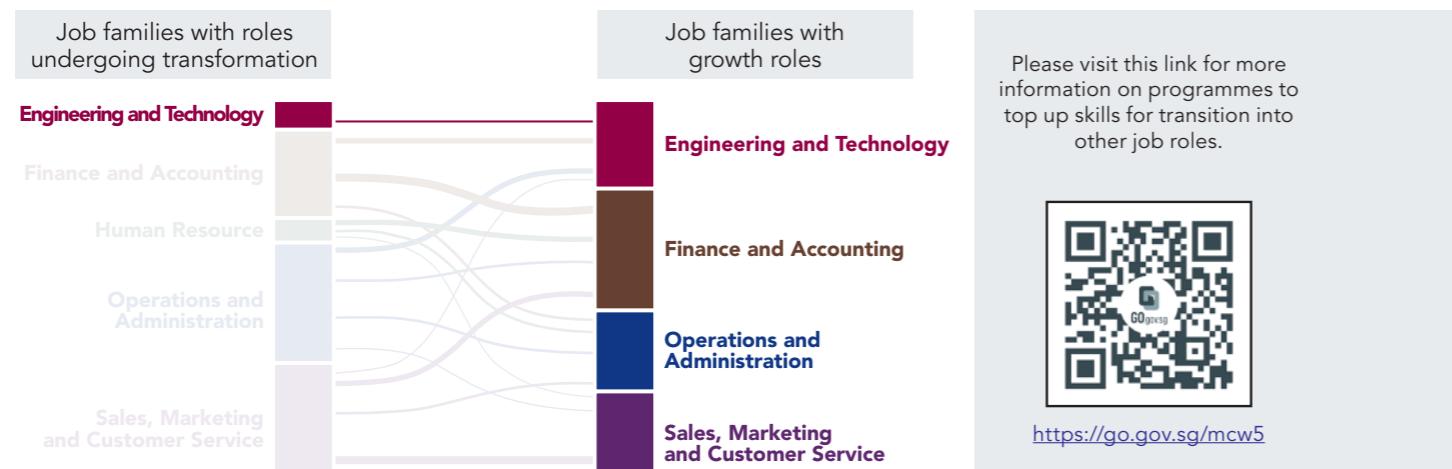
As this area is relatively new, she has been doing a lot of research on sustainability best practices overseas, which she can adapt and adopt locally. Her passion to learn and explore new things was one of the key drivers for her to make the switch. Although progression in this new role was slower than expected as she started from scratch, she is looking to learn vastly in this nascent, growing area.

## Opportunities for mid-career workers in Engineering and Technology job roles

Mid-career workers in Engineering and Technology job roles typically include *Quality System Management*, *Continuous Improvement Management*, *Data and Statistical Analytics*, *Business Needs Analysis*, *Stakeholder Management* and *Project Management* skills, which are required by other different job roles within the same job family.

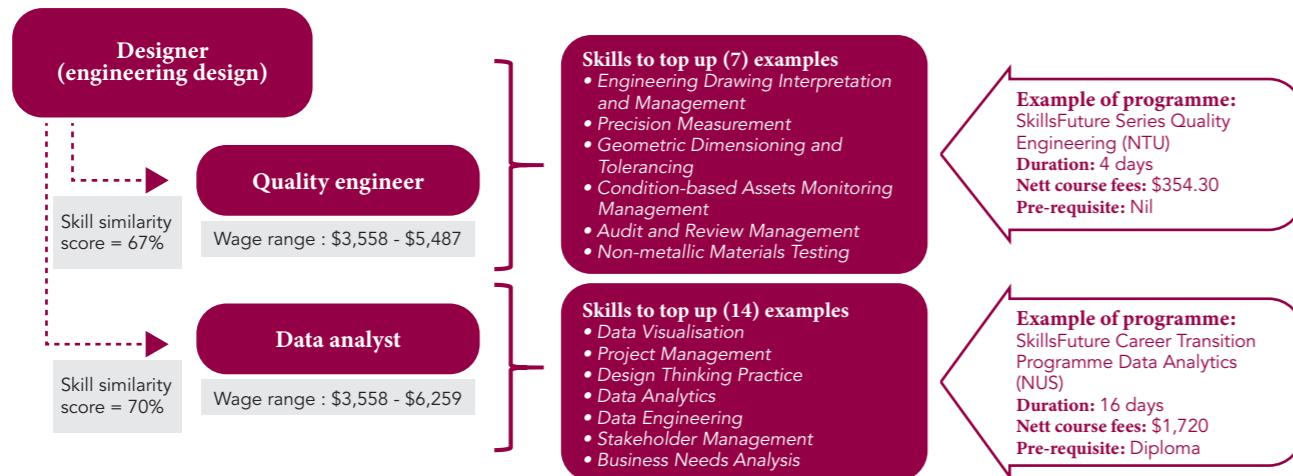
They can potentially leverage these skills to move to other adjacent roles within engineering or technology related roles.

**Figure M11:** Potential pathways for mid-career workers in Engineering and Technology job roles



\* For more information on how to read this figure, please refer to page 117 of the Methodology chapter

**Figure M12:** Potential transition pathways of a designer (engineering services) moving into similar seniority roles within job family



## FEATURE STORY:

### MDM AMINAH MOHAMED LAH, administrative manager to business analyst

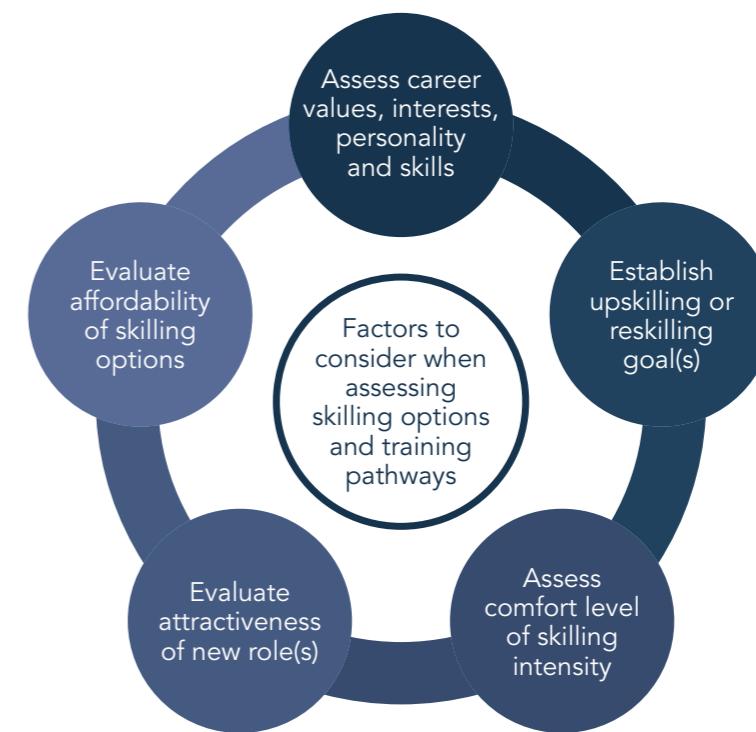
Mdm Aminah is a mechanical engineer by training. She has been in finance, procurement, and general administration roles for the past 20 years. During the pandemic, the many SGUnited programmes in technology made her consider a career switch, as she is equipped with skills in *Data and Statistical Analytics*, *Business Needs Analysis*, *Stakeholder Management* and *Project Management*, due to her engineering background.

She enrolled in the SGUnited 'Mid-Career Pathways Programme (Company Training) in Business Intelligence and Data Analyst'. This training, together with the project-based internship at a bank, successfully landed her into a full-time business analyst role with that same bank. Mdm Aminah notes that "at this age, the experience of learning new knowledge and skills is amazing! I enjoy the breadth of learning and get a great sense of satisfaction upon the completion of every engagement".

**Mid-career workers can use a simple five-step approach to assess the different options available based on the intensity, attractiveness, and affordability, and select those that best support their own aspirations for career growth**

This section shows a simple five-step approach on what factors mid-career workers can consider when evaluating the different skills-based pathways available to find the ones better suited for them.

**Figure M13:** Recommended considerations when assessing skills-based pathways



## A. Assess career values, interests, personality and skills

Making a mid-career switch requires a holistic consideration of the individual's interests, strengths, skills, and career values. Here are some questions to guide mid-career workers:

**What are my career values?**  
In other words, what represents the beliefs that I have about what is important in my work and what makes it meaningful for me?

**How aligned are my career values to my skills?**

**How willing am I to take up a skilling programme and learn new skills?**

## B. Establish upskilling or reskilling goals

To assess which skilling options or pathways best meet their needs, mid-career workers need to be clear what their end goals are. This can vary, whether they are moving into adjacent industries or reskilling into completely new areas. Career coaches from Workforce Singapore (WSG) recommend that the best way is to split into long- and short-term goals<sup>2</sup>. Long-term goals provide mid-career workers with the big picture about where they eventually want to reach, while short-term ones chart the different steps to take to achieve a long-term goal.

With clarity on upskilling or reskilling goals, mid-career workers can be more focused in finding relevant courses to address their skills gaps, assessing the different modalities to balance work and training (if employed), researching available job openings for new job roles and talking to friends, family or mentors on the career transition process. SkillsFuture Singapore (SSG) and WSG has a wide network of Skills Ambassadors and Career Coaches across the island who can help advise on any of these questions.

Short-term goals are goals that you want to achieve soon, usually within a year. Long-term goals are goals that you want to achieve further in the future, usually takes a year or more.

Goals should be:

- (a) Specific – Are there specific roles/sectors to move into?
- (b) Measurable - What are the tangible and trackable aspects?
- (c) Achievable - What can you do to achieve them?
- (d) Relevant - To your long-term career goals; and
- (e) Time-based – What is the ideal timeline to achieve this goal?

## C. Assess comfort level of skilling intensity

Skilling intensity can be determined by three key factors:

**ARE THERE DIFFERENT MODALITIES TO SUIT MY NEEDS, E.G.: PART-TIME?**

Typically, full-time programmes tend to be more intensive than part-time ones

**WHAT SKILLS DO I NEED TO TOP-UP?**

Typically, the higher the skills jump, the greater the skilling intensity

## HOW BIG IS THE “JUMP”?

Some specialised technical skills may require more intensive reskilling due to the skills' nature

## FEATURE STORY:

### MR GABRIEL LAM, Chief Operating Officer, Shalom Movers Pte. Ltd.

Mr Gabriel Lam, chief operations officer at Shalom Movers shared that, at Shalom, several mid-career workers from non-logistics sectors like finance, banking and real estate are hired. "Qualifications are not all that matter. These mid-career workers bring with them an ocean of experience and cross-industry perspectives. These attributes allow them to offer fresh perspectives to current processes and be more innovative when executing tasks," he reiterated, when asked about what are some factors that Shalom considers when hiring mid-career workers.

Shalom has been recruiting mid-career workers from the job market as well as through [Workforce Singapore's Career Conversion Programmes for Supply Chain Professionals](#). It places particular emphasis on the goals of these mid-career workers joining them. Prior to hiring, the organisation conducts a learning needs analysis and offer a structured career pathway for the mid-career workers after considering whether there is a good fit for both parties. With this system in place, Shalom can elevate the existing capabilities of mid-career workers and provide them better growth opportunities within the organisation.

Individual capabilities are also matched with a conducive workplace environment at Shalom. As an important first step to build the confidence of newly hired mid-career workers, Shalom adopts a buddy system to ease them into the organisation. Though these mid-career workers come with plenty of work experience, they are still new to the culture and operating systems at their new workplace. On-the-job training is followed by a career transition programme to ease newly hired mid-career workers into their new roles. This allows the workers ample time to orientate into their new roles and gives assurance that Shalom provides the necessary resources to support their learning in the organisation.

Gabriel's advice to other employers is to be realistic when hiring mid-career workers and allow them time to navigate their way in the new job roles. This will allow them to appreciate the new roles, work culture and environment. With their learning agility and resilience, mid-career workers have more to offer to any industry. To embrace the benefits as an employer, having an open mind is critical.

<sup>2</sup> Source: Goal-Setting Tips You Need for a Successful Mid-Career Switch, [Workforce Singapore](#), retrieved 2022

## D. Evaluate attractiveness of new roles

There are three factors mid-career workers can consider when evaluating the attractiveness of new job roles before deciding to make a switch:



## E. Evaluate affordability of skilling options

Apart from the above factors, another consideration is the affordability of reskilling programmes. Today, there are many courses that enjoy SkillsFuture funding, especially under the SkillsFuture Mid-Career Support Package<sup>3</sup>. These

training programmes provided under the support package also include skills and training advisory to help trainees select suitable courses, with employment facilitation and career coaching activities integrated into the programme design.

### SkillsFuture Career Transition Programme (SCTP)

A train-and-place programme that supports mid-career individuals to acquire industry-relevant skills to improve their employability and pivot to new sectors or job roles. Available in a part-time or full-time format and ranging from three to 12 months, SCTP courses are funded by SSG at up to 95% of course fees, covering emerging skills in Digital, Green, and Care Economies.



SCTP page:  
<https://go.gov.sg/sctp-home>



SCTP course listings:  
<https://go.gov.sg/sctp-courses>

### SGUnited Mid-career Pathways Programme for Mid-career Individuals and Career Conversion Programmes

WSG also has a series of programmes that match jobseekers to growth roles and supports company-sponsored training to reskill mid-career workers with new capabilities for the new/redesigned jobs.



SGUnited Mid-career Pathways Programme for Mid-career Individuals:  
<https://go.gov.sg/sgu-mid>



Career Conversion Programmes:  
<https://go.gov.sg/ccp-mid>

### Additional SkillsFuture Credit (Mid-Career Support)

To help mid-career workers manage remaining out-of-pocket costs, they can also pay using the additional SkillsFuture Credit (Mid-Career Support) given to individuals aged 40 to 60, under the SkillsFuture Mid-Career Support Package.



<https://go.gov.sg/add-sfc>

### SkillsFuture Series

In addition, mid-career workers can also look to modular SkillsFuture Series courses to pick up emerging skills in the Digital, Green, and Care Economies as part of pre-emptive upskilling.



<https://go.gov.sg/sf-series>

## Conclusion

This chapter highlights actual examples of skills-based pathways, as well as individuals who have embarked on these pathways, to demonstrate how both 'bite sized' upskilling and bolder moves might be realistically pursued. SSG is working with MOM and partners to make this information more accessible and available on a self-help basis to the public. In the meantime, we encourage mid-career workers to approach any of SSG's and WSG's networks of Skills Ambassadors or Career Coaches.

Employers also play a key role in recognising the skills that mid-career workers bring to their organisations and providing them with the right workplace environment to facilitate career growth and transition. In doing so, employers will be able to better tap the full potential of this important part of our workforce.

<sup>3</sup> See <https://www.skillsfuture.gov.sg/midcareersupportpackage> for more details.



**THE USE AND DEVELOPMENT OF  
CRITICAL CORE SKILLS IN SINGAPORE**



- There is increasing employer demand for Critical Core Skills (CCS) as these skills are essential for supporting business transformation
- The top three most important CCS used at work are *Self Management*, *Influence* and *Creative Thinking*
- Seven work-role archetypes were identified with unique CCS use and CCS development needs
- Workplace learning is an effective mode for developing CCS

## Increasing demand for soft skills amid enterprise transformation

There is an increasing demand for soft skills to support enterprise transformation. Singapore employers identified 16 **Critical Core Skills (CCS)** most critical to their business (see Diagram 1). This set of CCS is a combination of digital, cognitive and socio-emotional skills presented in three bundles – Staying Relevant, Interacting with Others and Thinking Critically.

Figure CS1: CCS for the future economy



With the increasing demand for CCS, SkillsFuture Singapore (SSG) sees the need to understand how CCS are used at work and how to develop CCS effectively. In 2021, SSG partnered the Institute for Adult Learning (IAL) to conduct a mixed-method study<sup>1</sup>. The study surveyed a nationally representative sample of 2,000 members of the local workforce on the importance of CCS at work.

Among them, 40 participated in an additional semi-structured interview on their experiences in CCS development modes. As part of the study, IAL developed a CCS profiling tool<sup>2</sup> to support decision-making in skills utilisation and development. Based on this survey, the top three most important CCS used at work are *Self Management*, *Influence* and *Creative Thinking*.

## Usage of CCS and development needs by work-role archetype

The study derived seven unique work-role archetypes by clustering the most important CCS across different occupations<sup>3</sup>. A description of each archetype, the most important CCS<sup>4</sup> to that archetype, and the CCS to develop<sup>5</sup> for that

archetype are presented below. The seven archetypes are: Front-liners, Nurturers, Deal-makers, Wayfinders, Managers, Administrators, and Analysers.

Most important CCS:
<i>Self Management</i> <b>3.89 / 5</b>
<i>Customer Orientation</i> <b>3.64 / 5</b>
<i>Influence</i> <b>3.46 / 5</b>

### Front-liners

Front-liners jobs have a high level of customer engagement in daily work, managing varied requests from customers where communication is critical. Work demands constant negotiation within tight business processes and regulations. Examples of Front-liners include taxi drivers, shop and store salespersons.

### Usage of CCS by Front-liners



**CCS to develop:**  
This group did not identify any CCS for development.

# SKILLS TO BUILD SKILLS

<sup>1</sup> The details of this research report are available at [IAL's webpage](#).

<sup>2</sup> CCS Profiling Survey is accessible [here](#).

<sup>3</sup> The details of the skills clustering method and the derivation of the seven unique working contexts are in the Methodology chapter of the report.

<sup>4</sup> The most important CCS are reported by respondents as CCS that support work activities deemed most important to their work context.

<sup>5</sup> CCS for development are identified where an archetype's average confidence level for a given CCS is significantly lower than the rest of the sampled population, after adjusting for CCS importance and other demographics.

# PROFILE STORY:

## NURA SHEREEN BINTE NORDIN, social media service manager in the financial services sector

Shereen is a social media service manager at a bank with eight years of experience in her role. She is currently leading a team of service executives who perform community management on the bank's social media platforms.

### Which are the top CCS most applicable to your work, and why?

If I had to pick, *Communication* skills would naturally come up on top. In particular, writing skills are important – not so much learning to write more efficiently but learning to write in a non-hostile manner. In favour of efficiency in the corporate world, people can often appear curt in writing. I believe good *Communication* through writing can go a long way, especially when it comes to managing external partners and expressing ourselves.

*Digital Fluency* skills are highly relevant as well. Social media may be associated with the younger generation, but that is not a reason for those who are older to stop learning about it. It is all about being interested in the work you do. My organisation offers training courses to facilitate our learning – most recently, I attended a course on digital technology specific to the banking industry.

*Problem Solving* skills are important to help me manage my team. When you manage people, you also deal with their personal issues. Some

of the team members prioritises family concerns. I would then seek to work out an arrangement with them empathetically. After all, it is not just about the figures and numbers one produces at work.

### Did you attend any training courses to develop your CCS?

I took a course on emotional intelligence a few years ago within the organisation. After the course, I took what I learnt, applied it, and immediately saw shifts in my connection with others. In particular, the course covered *Communication* through body language. Deploying the techniques I learnt from the trainer actually helped me connect better with someone who was more resistant to opening up. Going through that course with a certified professional helped me a lot.

### What advice do you have for others who are looking to develop their CCS further?

The CCS involved in social media management can be quite innate to some. For those without these natural born inclinations but are keen on the role, I would encourage them to register for courses by SSG, or complimentary training by their organisations. Take it as a chance to get to know others better, and to get out of your comfort zone!

### Nurturers

Nurturers perform various carer roles with high level of interpersonal engagement. Examples of Nurturers include educators, human resource practitioners and nurses. They require strong interpersonal skills and emotional management.

### Usage of CCS by Nurturers



### Most important CCS:

*Self Management*

**3.91 / 5**

*Creative Thinking*

**3.73 / 5**

*Communication*

**3.52 / 5**

### CCS to develop:

- Adaptability
- Problem Solving
- Building Inclusivity
- Sense Making
- Communication
- Creative Thinking
- Develop People
- Influence

### Most important CCS:

*Problem Solving*

**3.73 / 5**

*Creative Thinking*

**3.69 / 5**

*Decision Making*

**3.68 / 5**

### Deal-makers

Deal-makers grow the company via activities in sales and business development. Such tasks require high level CCS to synthesise information and insights across a variety of sources and contexts, and to manage demands from employers and customers. Examples of Deal-makers include sales and business development managers.

### Usage of CCS by Deal-makers



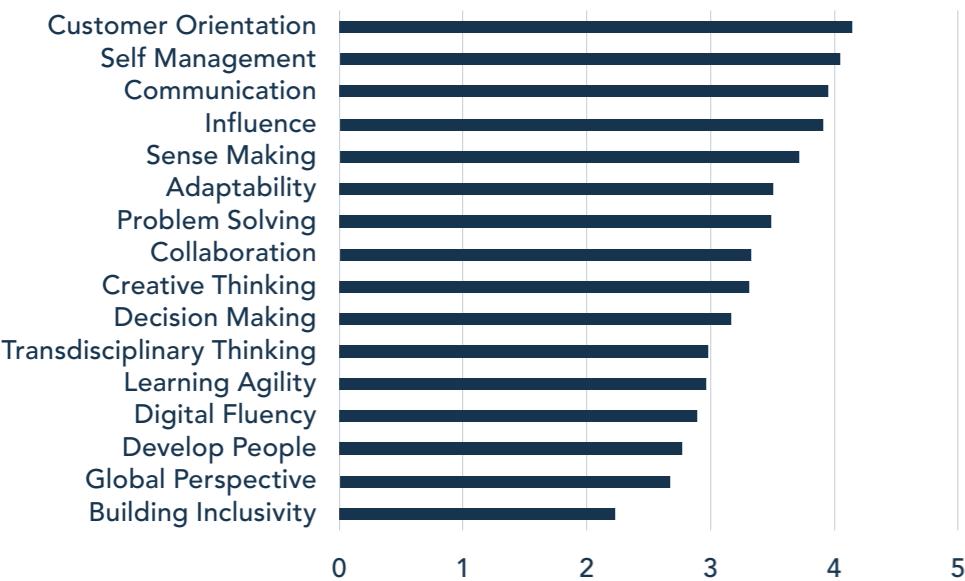
### CCS to develop:

- Building Inclusivity
- Digital Fluency
- Influence
- Problem Solving

## Wayfinders

Wayfinders ensure smooth operation of businesses and organisations. Managing customers' and stakeholders' needs is the core. Examples of Wayfinders include management and business consultants, managing directors, chief executives and general managers.

Usage of CCS by Wayfinders



## Most important CCS:

Customer Orientation

**4.13 / 5**

Self Management

**4.04 / 5**

Communication

**3.96 / 5**

## Administrators

The work of Administrators revolves around creating better solutions and enhancing work processes and productivity, ensuring orderliness, system discipline, and resources management. Examples of Administrators include accountants and system analysts.

Usage of CCS by Administrators



## Most important CCS:

Self Management

**4.25 / 5**

Creative Thinking

**3.68 / 5**

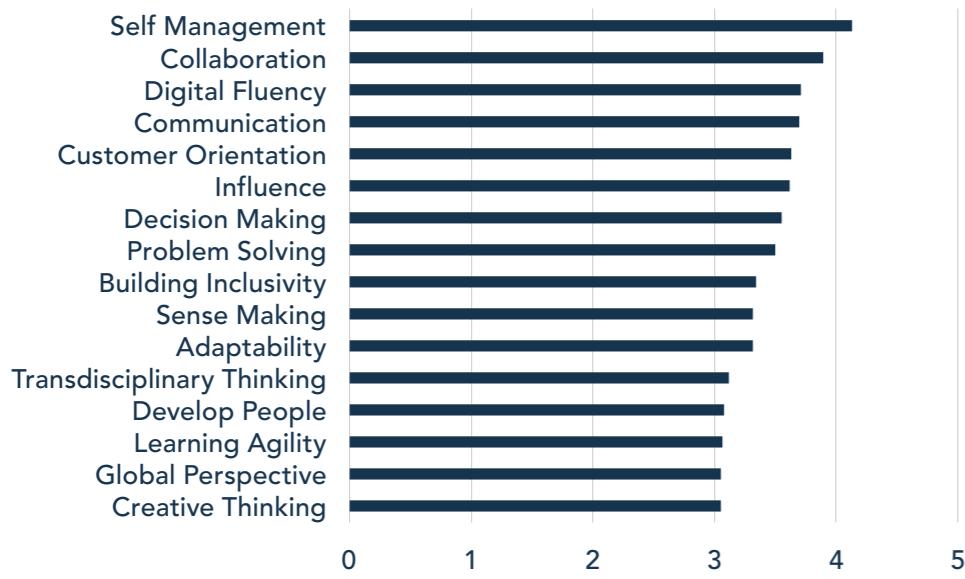
Problem Solving

**3.57 / 5**

## Managers

Managers work across multiple stakeholders to coordinate delivery of services and solutions. Information processing and collaboration across stakeholders, and use of digital tools are critical. Examples of Managers include supervisors and general foremen for building and related trades, business services, and administration managers.

Usage of CCS by Managers



## Most important CCS:

Self Management

**4.13 / 5**

Collaboration

**3.90 / 5**

Digital Fluency

**3.68 / 5**

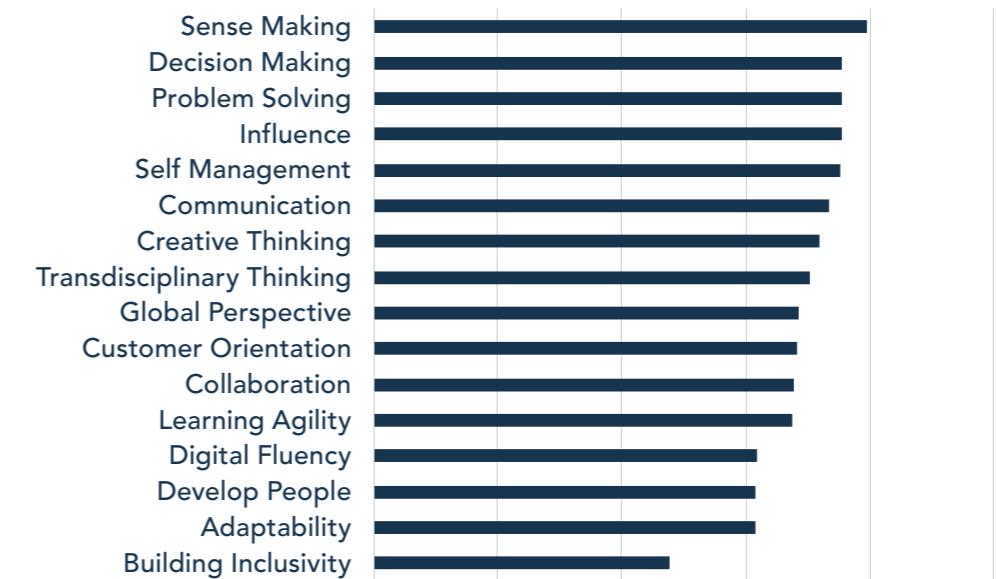
## CCS to develop:

- Adaptability
- Customer Orientation
- Self Management

## Analysers

Analysers are the typical knowledge workers in the **Digital Economy**, requiring strong cognitive skills to create value. Their decisions have major impacts on the organisations. Examples of Analysers include financial analysts, data scientists, investment managers, and purchasing agents.

Usage of CCS by Analysers



## Most important CCS:

Sense Making

**3.93 / 5**

Decision Making

**3.92 / 5**

Problem Solving

**3.86 / 5**

## CCS to develop:

This group did not identify any CCS for development.

# PROFILE STORY:

## SARINA BINTE MOHD YASAR, finance executive cum administrator in the healthcare sector

Sarina is a finance executive cum administrator in the healthcare sector supporting polyclinics and hospitals. Her job scope had only recently expanded from administration to include providing financial services.

### Your job scope recently expanded from administrative work to include finance. How did this change occur?

Having been in the organisation for around four years, I was offered the opportunity to take up a basic accounting course. The course helped me understand fundamental finance terminologies, and helped me put a name to the processes I was involved in. Following this, I took up more finance-related work as part of my official job scope. Taking on these additional responsibilities has been a learning journey!

### Which are the top CCS most applicable to your work, and why?

I liaise closely with hospital staff on their claims submission process. There are instances where there are hospital staff who are working on the ground and managing claims at the same time. They may not be trained in finance, leading to errors in their submissions at times. Part of my work involves identifying issues pertaining to such financial processes, suggesting changes,

and using my Communication skills to close the loop successfully with the staff. For instance, when an item has been coded incorrectly, I reach out to the staff to seek clarity, and keep in mind to translate any complex terminologies into simpler language for their understanding. *Problem Solving* at this scale is important, as small errors made in the claims process can affect a healthcare organisation's financial system.

It helps that I am someone who truly enjoys talking to people as well! With this, I began practicing *Collaboration* as an administrator with the organisation. Having nurtured healthy working relationships with my colleagues, this became a good foundation for my work processes today. My role also involves working with large agencies via email and phone call, so having the ability to build good rapport is very helpful.

### What advice do you have for others who are looking to develop their CCS further?

Love learning new things! Taking on a new course was daunting at first, but I enjoyed it in the end. Though you may have a hard time when starting out in any transitions, things eventually get better with time and practice. It is all about time-management, self-management and good communication with others.

The seven work-role archetypes provide an insightful overview of the use of CCS in the various working contexts in Singapore. As enterprises embark on business transformation, it is worthwhile paying attention to the design of job roles and task activities to better leverage CCS to achieve transformation.

### The CCS development of the seven work-role archetypes

The summary in Figure CS2 implies the importance of job design and the need to make full use of workplace learning to support the

Figure CS2: The development modes<sup>6</sup> of the most important CCS in various working contexts

SEVEN GROUPS OF WORKING CONTEXTS	CONTEXTUAL PRACTICES AT WORKPLACES			CLASSROOM TRAINING
	TRIAL AND ERROR	ON-THE-JOB TRAINING	PEER SUPPORT	
1. Front-liners	✓	✓	✓	
2. Nurturers	✓	✓	✓	✓
3. Deal-makers		✓	✓	✓
4. Wayfinders		✓	✓	
5. Managers	✓	✓	✓	✓
6. Administrators		✓		✓
7. Analysers		✓	✓	

development of CCS. Designing skills-related tasks in daily jobs would provide more opportunities for individuals to develop CCS.

With the typical development modes, such as contextual practices in work contexts via on-the-job training, peer support, and trial and error, learning designers and facilitators are strongly encouraged to incorporate workplace learning into learning interventions. Institution-based learning should collaborate with workplaces to allow for workplace contexts to be part of the skills-based learning design.

<sup>6</sup> Modes of CCS development: the ways which could facilitate the development of CCS.

## Tips to enhance the use and development of CCS

- Develop CCS awareness among employees and supervisors, including the use of the CCS Profiling survey developed by IAL
- Unpack CCS into work activities that help to establish shared understanding between work performance expectations and developmental design
- Embed CCS into job role-related technical skills training to enhance the effectiveness of CCS application, including leveraging the National Centre of Excellence for Workplace Learning's (NACE)<sup>7</sup> networks to support CCS development
- Consider using a variety of CCS development modes in workplace learning, including reflective practice, peer support, and embedding CCS development as part of skills training

### Help us improve our analysis

Our study is only as good as the data we get. We seek your help to contribute to our study and enhancing our understanding of CCS. If you have 20 minutes, please go to [this link](#) to identify the important CCS and the CCS to develop for your particular work-role archetype.



Please visit this link for information on suggested courses for CCS:



<https://go.gov.sg/ccs-courses>



## INDUSTRY VOICE

Resorts World Sentosa

LEE SHI RUH

Chief People Officer and Accounting,  
Resorts World Sentosa

At Resorts World Sentosa (RWS), where we offer a wide and diverse range of experiences to millions of guests, Critical Core Skills (CCS) are important for our team members to be future ready and adaptive, especially as we embark on our growth and expansion plans for 'RWS 2.0'.

Our centre of excellence for capability development, RWS Academy, uses the CCS as the foundation of a structured framework to curate training curricula and programmes for the reskilling and upskilling of our team members. We also offer an online learning platform with more than 75,000 courses to our team members where they can e-learn courses aligned to CCS.

Besides the opportunity to learn new skills such as data analytics and robotic process automation, our team members also get the opportunity to deepen their CCS in Customer Orientation. These diverse learning opportunities empower and equip our team members to better navigate the new business environment especially in this growing digital economy, where there is prevalent adoption of the latest technologies.

CCS are also incorporated to complement functional training for our team members. For example, our attractions park ambassadors are

trained in relevant CCS, such as *Self Management*, as part of their cross-training for different attractions, so that they can supervise teams to create memorable experiences for our guests.

We recently piloted a game-play behavioural assessment tool. This is a fun and unique way to help our team members be more self-aware of their behavioural attributes and allows them to identify potential gaps for further development. We plan to extend this assessment tool to more team members so that everyone can identify and chart their development pathway forward.

RWS is moving towards self-directed learning and allowing our team members to take ownership of their skills development. We recognise that they are our most valuable assets, and by helping them see the importance of CCS, we want our team members to always want to improve themselves and thus cultivate a lifelong learning culture in RWS.

**Critical Core Skills are important for our team members to be future ready and adaptive.**

<sup>7</sup> NACE helps business leaders use workplace learning in developing and encapsulating best practices to retain and build competencies to support business sustainability, growth and strategies.



## INDUSTRY VOICE

**National Centre of Excellence for Workplace Learning at Singapore Institute of Technology (NACE@SIT)**

**ARTHUR POH**

**Director,  
NACE@SIT**

With the support of SkillsFuture Singapore, the National Centre of Excellence for Workplace Learning (NACE) was established with the aim of helping companies build and develop their workplace learning capacities, solutions and systems through training and consultancy projects. Over the past two years, one key observation from our workplace learning journeys is that we often undervalue the importance of soft skills.

In fact, 'soft' skills may be a little under-represented in its role in a VUCA (volatile, uncertain, complex, and ambiguous) environment like today. With technology growing at an unprecedented pace, jobs that require standard work with little need for human interventions may become obsolete as they are easily replaced by automation and digitalisation. While technical skills are still essential, CCS are key, as they cannot be replaced by technology.

A report by Deloitte<sup>8</sup> stated that soft skills will account for almost two thirds of the jobs by 2030 and hiring employees with soft skills will yield greater profits. CCS, as I would refer to, are the new skills currency. Though current jobs might become obsolete in the future, skills and competencies are not easily replaceable and would have their fair share in the future.

**“ Human resource professionals may wish to infuse CCS in their training, such that skills are caught and practised at work, and not just taught. ”**

Given its increase in importance, NACE@SIT has taken an active role in embedding the CCS in the trainings we offer. When the CCS complement technical skills, it equips the employee to be future ready. In our recent study, our participants shared that CCS, like abilities to adapt, communicate and influence, are important future skills to hone and practice!

We strongly believe embracing CCS would be the way forward to better combat the uncertainty the future holds. On the part of companies, human resource professionals may wish to infuse CCS in their training, such that skills are caught and practised at work, and not just taught. Companies seeking to equip themselves with skills like technology sensing and job redesign could approach any of the eight NACE centres to support their workforce transformation plans.



**CHARTING YOUR SKILLS DEVELOPMENT JOURNEY**

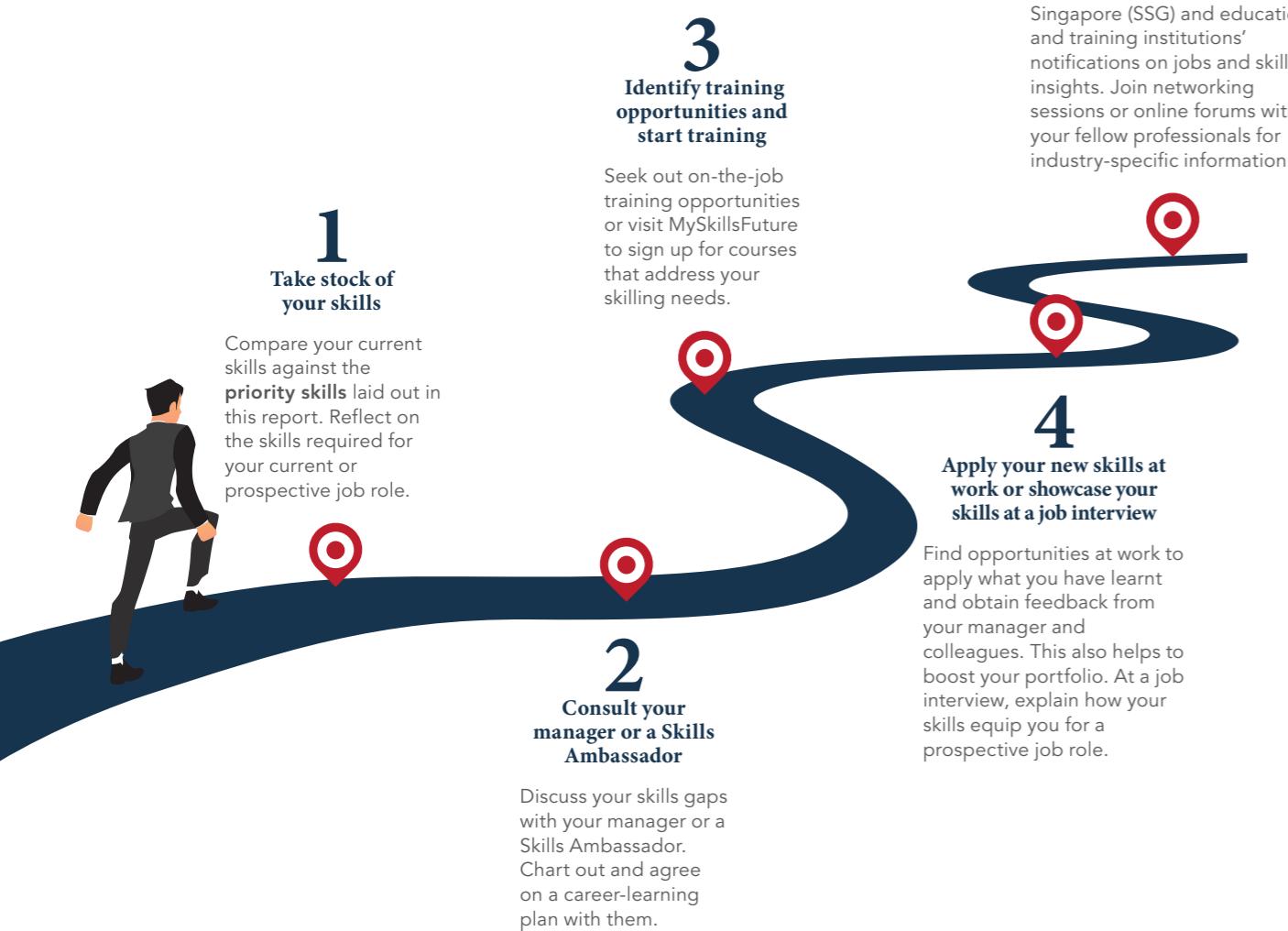
## The future economies offer exciting opportunities

The preceding chapters of this report shed light on jobs in demand and the priority skills for you to thrive in the **Green, Digital and Care Economies**.

Courses are available and subsidised to support your skilling needs. SkillsFuture Credit can be used to further offset out-of-pocket costs. You will

therefore find it within your means to access these courses, acquire useful skills, and leverage your skills credentials to stay relevant and secure good jobs.

Here are some useful tips to help you embark on your skills development journey:



## TIPS FROM A SKILLS AMBASSADOR

KENDRAY LAU

Skills Ambassador,  
Senior Manager,  
Lifelong Learning Institute

the next level or to an adjacent role, and chart out a learning plan for your progression.

You can also approach Skills Ambassadors for one-to-one personalised consultations to gain clarity on your career goals and options. One client shared that he was interested in switching to the early childhood sector. Through RIASEC and after speaking with the Skills Ambassador, he realised that his personality suited jobs in this industry and he recognised the skills required for these jobs. Meanwhile, another client who wanted to grow in her career as an administrative executive discovered that HR and business analyst were also possibilities for her after consulting the Skills Ambassador.

Once you are clearer on your goals and the skills needed, the next step is to look up courses that correspond with your career interests. Apart from that, you can also seek course recommendations from our Skills Ambassadors.

To progress towards your goals, it is critical to take the first step forward! When it comes to learning, always be open to seeing things from a different perspective.

**“ One of the greatest misconceptions is believing that the skills gained years ago can see us through our entire career. ”**

# UNLOCKING OPPORTUNITIES THROUGH SKILLS APPLICATION



**GERALD TAN**

Projects Director,  
Lead Career Developer,  
Avodah People Solutions



**JEREMIAH WONG**

Clinical Practice Supervisor,  
Lead Career Developer,  
Avodah People Solutions

When it comes to learning new skills, we usually ask: "What courses should I take?".

Beyond acquiring new skills, we should also think about 'how can I apply what I learned', since the skills we learn stay merely as knowledge if they are not applied in a productive way. Without application, skills mastery is impossible as well.

Here are three real stories from our clients who had proactively applied what they learnt.

## Start with problems and challenges

Ben observed how ineffective air conditioning services were and how the cleaning tools were not the best for cleaning at heights. Motivated by this issue, Ben learnt more about air conditioners and about the different types of allergens and mould that breed in air conditioners. He used his engineering skills and creativity to build his own cleaning machine, and registered the design as his intellectual property. Today, Ben uses his machine to maintain air conditioners and educates homeowners about proper maintenance.

## Be with like-minded people

Joyce was assigned to manage the web analytics of her organisation's portal, though she only had a basic understanding of data analytics. Besides relying on online self-help forums, Joyce sought support from her peers. They attended data analytics-related training together, discussed

how to solve related challenges and reminded each other of what they had learnt. Joyce also joined an external community of data enthusiasts and experts so that she can seek help and learn from them.

## Find time to practise

Mary worked in the media industry, but always had a desire to counsel people. She developed her interest through a part-time, year-long counselling course. It was hard work as she had to balance between work, studies and personal life. After completing her course, Mary devoted her personal time to volunteering with a social agency, offering pro bono counselling. This helped Mary practise what she had learnt and build up her experiences, as she hopes to make a switch to the social service sector one day.

The inspiring upskilling stories of Ben, Joyce and Mary have shown that new opportunities can be created when we invest determination, creativity and time to utilise and practise our newly-acquired skills.

**“ Beyond acquiring new skills, we should also think about “How can I apply what I learned”, since the skills we learnt stays merely as knowledge if they are not applied in a productive way. ”**

## Resources to support your skills development

SSG offers a range of resources, tools, programmes and initiatives to help you identify and acquire the necessary skills to increase employability, improve job performance and adapt to job content changes.

Here are some specially curated resources to build a viable, long-term professional development skills strategy.

### Jobs-and-Skills Insights Resources

Make use of our resources to keep abreast of trends impacting jobs and skills in Singapore.

#### Jobs-Skills Insights Webinars

- for Individuals
- for Enterprises



<https://go.gov.sg/jsi-webinar>

Contact us at [JSInsights@ssg.gov.sg](mailto:JSInsights@ssg.gov.sg) to be added to our eDM contact list for webinars.

#### Jobs-Skills Insights Commentaries

- for Individuals

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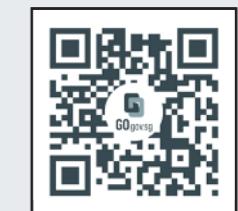
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## Skills Information Resources

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for Individuals

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for Individuals



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## Programmes and Initiatives

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for Individuals



[www.skillsfuture.gov.sg/series](http://www.skillsfuture.gov.sg/series)

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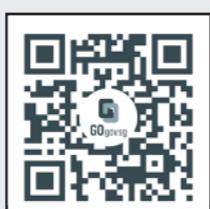
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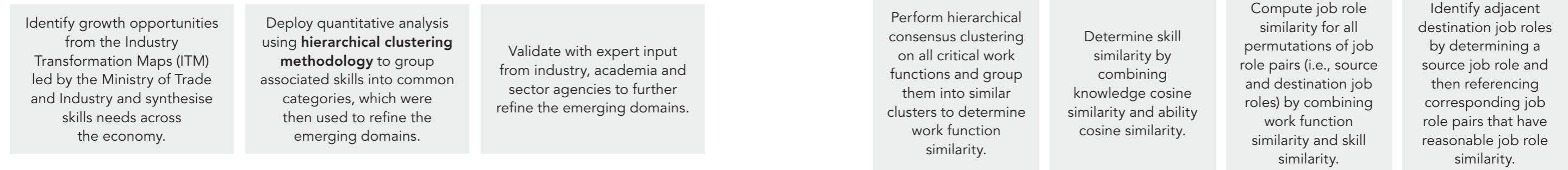
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## Analysis methodologies applied in the Digital, Green and Care Economies, and ‘Jobs and Skills in Industry 4.0 Implementation’

### A. Identification of emerging domains

Emerging domains cluster the jobs and skills trends and changes within the respective economies by growth areas. The emerging domains are identified using a 3-step approach:



### B. Measurement of demand growth and transferability for priority skills

**Priority skills** refer to skills that citizens can prioritise to gain access and thrive in the emerging domains or specific sectors. These skills were derived from SSG’s National Jobs-Skills Intelligence engine and validated with expert input from industry, academia and sector agencies.

In the various charts within this report, SSG chose to spotlight skills whose demand rose significantly in recent years, rather than skills with a large, existing demand. These skills would be more likely to see shortages now and in the near future. **Demand growth** for a given priority skill refers to the growth in employers’ demand for the skill as reflected in job postings over four calendar years.

$$\text{Demand Growth}_{\text{CAGR}} = \left( \frac{\text{Number of job postings in 2021}}{\text{Number of job postings in 2018}} \right)^{(1/3)} - 1$$

**Transferability** for a given priority skill refers to the number of unique job roles that require the skill. SSG spotlighted highly transferable skills as, all things being equal, these skills would contribute the most to an individual’s career versatility. A job role is deemed to require a skill when job postings

Growth in employers’ demand for a given priority skill is then computed as the **compound annual growth rate (CAGR)** of job postings that mentioned the skill. If two priority skills, ‘S1’ and ‘S2’, are mentioned in a single job posting, the job posting will be counted twice, once under ‘S1’ and once under ‘S2’ to compute the respective CAGR. If a priority skill is mentioned more than once in a single job posting, the job posting will only be counted once under that priority skill to compute the CAGR. In this report, demand growth is calculated using CAGR based on job postings from 2018 to 2021.

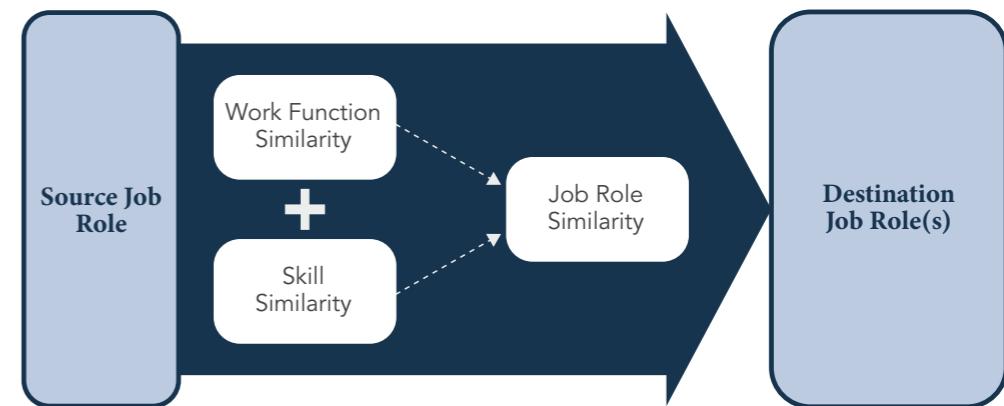
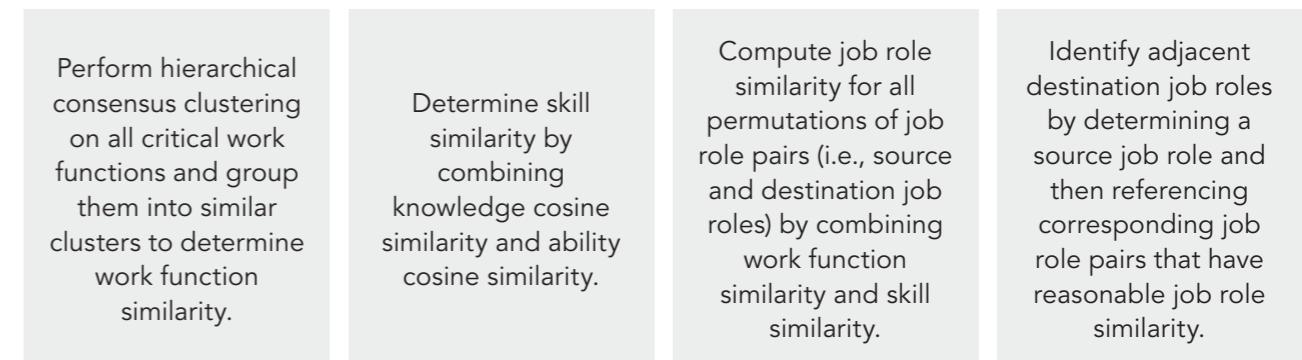
for that job role mention the skill. In computing the number of unique job roles, a job role is counted only once even when there are multiple job postings for the job role. In this report, transferability is aggregated based on job postings from 2018 to 2021.

$$\text{Transferability} = \sum_{i=1}^n \text{Unique job role}_{(2018-2021)}$$

## Analysis methodologies applied in ‘Growth Opportunities and Skills-based Pathways for Mid-career Workers’

### A. Identification of adjacent job roles and skills top-up

**Adjacent job roles** are identified using a 4-step approach:

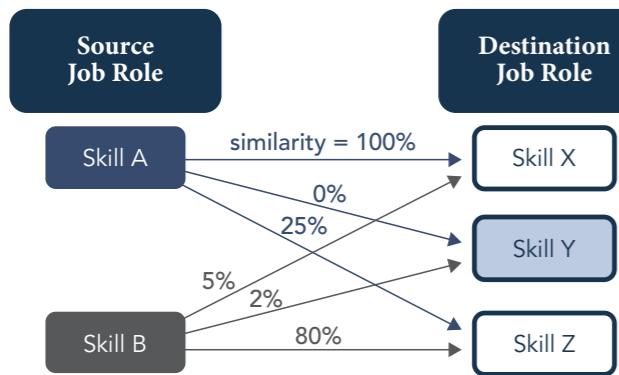


A job role similarity of 50% and above is deemed to reflect reasonable similarity between two job roles (i.e.: destination job role is adjacent). A job role similarity of less than 50% reflects bold moves that may require more effort to move into the destination job role. Work function similarity is assigned a weight of 0.7 while skill similarity a weight of 0.3 (total=1) in computing the job role similarity.

Beyond job role similarity, other factors such as, (i) maintained and increased wages for the

destination job role; and (ii) high employer demand for the destination job role are considered when recommending adjacent destination job roles.

Once a destination job role is identified, the skills top-up required to transit from the source job role to destination job role is then determined. Skills top-up refers to skills in the destination job role that have poor similarity with skills in the source job role. Poor skill similarity suggests that those skills in the destination job role will need to be picked up as new skills, hence the need for a skills top-up.

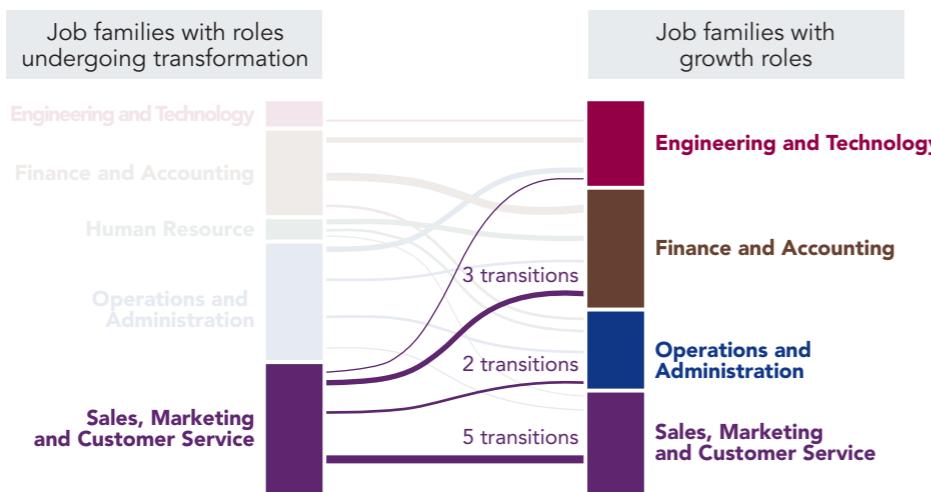


When transiting from source to destination job role, Skill Y should be prioritised for skills top-up because the source job role does not contain a skill with high similarity to it.

## B. How to interpret the Sankey chart

- This chart maps the options where the identified job role transitions can flow to
- The left column represents job families with roles undergoing transformation, and the thickness of each block shows the number of such roles within each job family
- The right column represents job families with growth roles and the thickness of each block shows the number of growth roles within each job family
- The thickness of the lines measures the magnitude of the potential transition pathways.

For example, if a customer service officer role in the 'Sales, Marketing and Customer Service' job family has 10 job role transitions and five are going to other roles within the same job family while another three are going to 'Finance and Accounting' and two to 'Operations and Administration', the line connecting the job families will be the thickest for 'Sales, Marketing and Customer Service' to 'Sales, Marketing and Customer Service', followed by 'Sales, Marketing and Customer Service' to 'Finance and Accounting', and the thinnest for 'Sales, Marketing and Customer Service' to 'Operations and Administration'



## Research methodology applied in 'The Use and Development of Critical Core Skills in Singapore'

The **Critical Core Skills (CCS)** study was conducted through a survey from 2021 to 2022, covering employed Singapore citizens and permanent residents, aged 20 to 70. A stratified random sample of 5,000 households, based on dwelling type, was selected for the survey. Of which, a total of 2,000 participants from these 5,000 households responded to the survey.

A participant's score on the importance of any given CCS is calculated as the average of the participant's reported five task scores pertaining to that CCS. Using these CCS importance scores, a CCS profile is created for each of the 116, 4-digit

Singapore Standard Occupational Classification (SSOC) occupations that had sufficient data from the survey. Using these 116 CCS profiles, hierarchical cluster analysis is used to classify the 116 CCS profiles into seven work-role archetypes that are statistically distinct.

In analysing CCS development modes, 40 participants from the seven work-role archetypes took part in follow-up interviews, based on their skills profiles matching the findings of the cluster analysis. 26 participants were male while the remaining 14 participants were female.

## GLOSSARY OF TERMS

TERMINOLOGY	DEFINITION
Adjacent job role(s)	One or more job role(s) with high job role similarity as compared to the job role in question
Care Economy	An economy that is based on a professional cluster of jobs and skills that provides care and support services involved in the nurturing and teaching of current and future populations
Compound annual growth rate (CAGR)	The average annual growth rate over a specified period of time longer than one year. It represents one of the most accurate ways to calculate anything that can rise or fall in value over time.
Critical Core Skills	A unique set of 16 core skills identified by Singapore employers as the most critical to thrive in the future economy
Digital Economy	An economy that is based on digital computing technologies, based on interconnecting people, organisations and machines through the Internet, mobile technology and the Internet-of-Things (IoT)
Green Economy	An economy that strives to achieve environmental, economic and social outcomes to take care of the environment and use limited resources as efficiently and sustainably as possible
Growth job	A job that exhibits sustained moderate-to-strong hiring demand over a period of one year
Hierarchical clustering methodology	A data science method for clustering objects within groups, that are similar to each other and different from objects in other groups
Industry 4.0	The exploitation of technological advancements, particularly in the digital space, to make step improvements in process efficiency, sustainability, and product or service quality
Job family	Used in SSG's research on mid-career growth opportunities, a job family is a job grouping related by common job roles. Job roles in a job family require similar knowledge, skills and abilities; and have a continuum of knowledge, skills and abilities that represent a career path from the lowest to the highest level job.
Job role similarity	A measure of similarity between any two job roles by applying natural language processing techniques on job role data in the Skills Framework, which includes work function, tasks and skills
Mid-career worker	A worker aged between 40 and 59 years old

Priority skill	A skill that citizens can prioritise to gain access and thrive in emerging domains or specific sectors. These skills were derived from SSG's National Jobs-Skills Intelligence engine, and validated with expert input from industry, academia and sector agencies.
Skill similarity	A measure of similarity between any two skills by applying natural language processing techniques on skills data defined in the Skills Framework
Skill demand growth	Demand growth that captures the relative scale of the increase in demand for that skill
Skill transferability	Transferability for a given skill refers to the number of unique job roles that require the skill. Transferability captures the scope of the skill's applicability across different job roles.
Tech-heavy	Tech-heavy roles are specialised roles responsible for the development, implementation and maintenance of more complex technological solutions and applications
Tech-lite	Tech-lite roles are job roles that involve the use of foundational digital solutions at work

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