



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 initiative¹, 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 crime². With initiatives such as digital trust R&D centres, sandboxes, cybersecurity training, and data governance frameworks³, 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 2025⁴. 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 2027⁵, 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.

¹ [Smart Nation Singapore, 2022](#)

² [Statista, 2022](#)

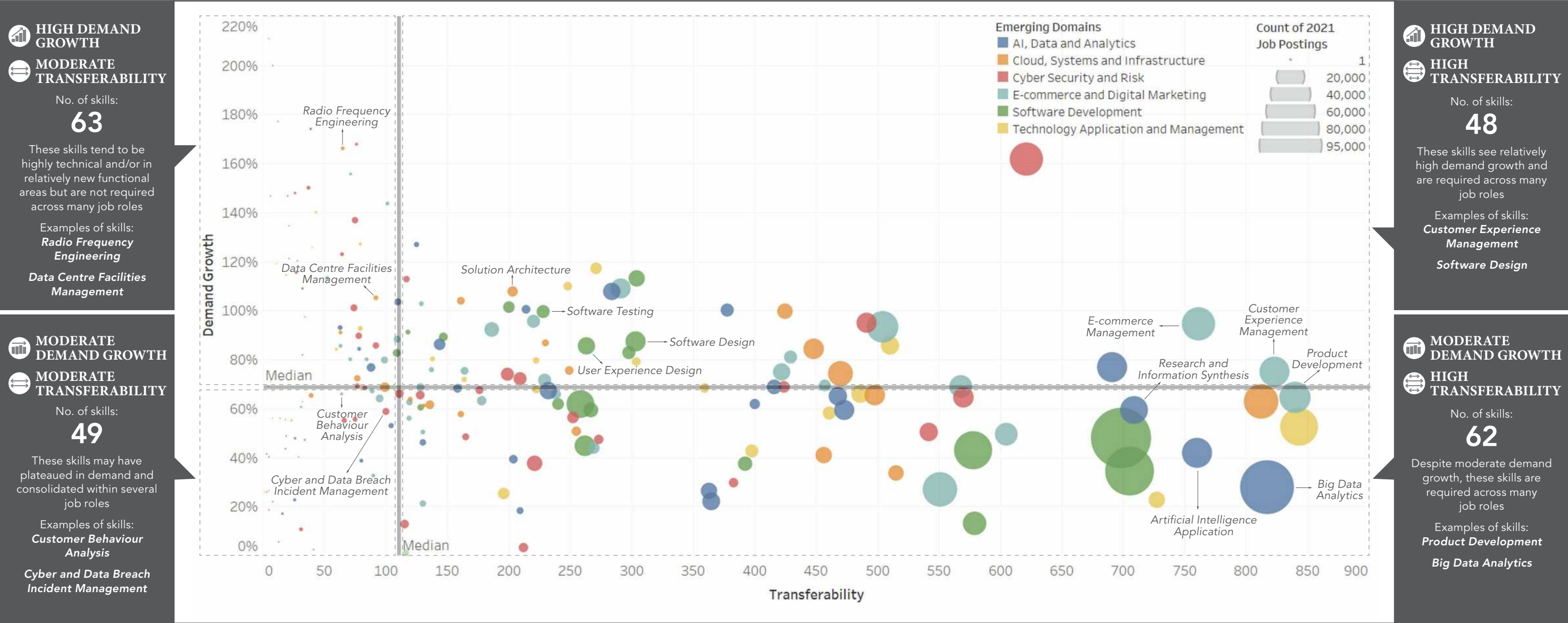
³ For instance, SGTech, the trade association for Singapore's tech industry, undertook a global landscape study and identified technology, governance, and people enablers to boost digital trust. [SGTech, 2022](#)

⁴ [Microsoft, 2020](#)

⁵ [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 skill⁶. 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

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



INDUSTRY VOICE

IBM Consulting, Singapore

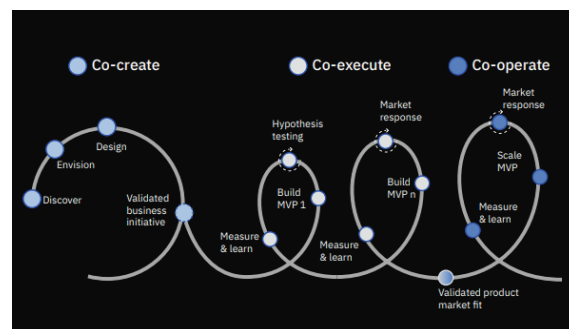
NG LAI YEE

Managing Partner and
Country Leader,
IBM Consulting, Singapore

Today, the world is at an inflexion 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

experience with technical skills. For example, front-end developers and back-end developers used to be specialised, but full-stack developers are in demand today. Similarly, user experience designers bring more value when equipped with business needs and process analysis and/or technical skills. 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. The willingness to understand disciplines outside your core expertise will help you accelerate your career.

The Digital Economy will also demand a new kind of leadership to make substantive progress in new digital areas. Therefore, it is important to build a new coalition of leaders across different executive teams. Business leaders, technology or digital partners, and transformation or innovation officers need to start working closely together to synchronise lines of control overseeing their transformation, including shared metrics and incentives.

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
<i>Software Testing</i>	100%	228	- Quality assurance tester - Vulnerability assessment and penetration testing analyst - Applications support engineer
<i>User Experience Design</i>	86%	263	- Product designer - Customer experience manager - Associate software engineer
<i>Software Design</i>	87%	303	- Software architect - Embedded systems engineer - Software engineer

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. It’s 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%	• Senior assistant engineer • Radio frequency engineer • Artificial intelligence applied researcher
<i>Solution Architecture</i>	108%	• Infrastructure architect • Data architect • Software architect
<i>Data Centre Facilities Management</i>	105%	• Data centre operations engineer • Senior technician • Facilities manager

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

YEAP 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 2022⁷ 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.”

⁷ SGTech, 2022

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

A study by Forbes⁸ 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	• Product development manager • Product manager • Merchandising manager
<i>Customer Experience Management</i>	E-commerce and Digital Marketing	823	• Customer experience manager • Principal service designer • Sales executive
<i>Big Data Analytics</i>	AI, Data and Analytics	817	• Data analyst • Data engineer • Data scientist
<i>E-commerce Management</i>	E-commerce and Digital Marketing	761	• E-commerce manager • Marketing assistant • Merchandising associate
<i>Artificial Intelligence Application</i>	AI, Data and Analytics	760	• Senior machine learning engineer • Data scientist • Data architect
<i>Research and Information Synthesis</i>	AI, Data and Analytics	709	• Analytics and customer insights manager • Data scientist • Threat analysis manager



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 billion⁹, and the value of AI-derived businesses will reach \$3.9 trillion¹⁰. 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.
”

⁸ Forbes, 2021

⁹ Gartner, 2021

¹⁰ Gartner, 2018

Skills featured in this chapter

SKILL TITLE	SKILL DESCRIPTION
Artificial Intelligence Application	Apply algorithmic, statistical and engineering knowledge to integrate artificial intelligence into engineering processes
Big Data Analytics	Analyse and validate significant volumes of data to discover and quantify patterns and trends to improve business operations
Customer Behaviour Analysis	Devise customer behaviour analysis tools and approaches, to perform analysis on information pertaining to customer behaviours, leading to improved customer recommendations
Customer Experience Management	Compile and analyse information gathered through various channels and manage communication across customer touch points to ensure a consistent and pleasant customer experience
Cyber and Data Breach Incident Management	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
Cyber Risk Management	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
Data Centre Facilities Management	Manage and maintain data centre resources, facilities and/or physical infrastructure to ensure smooth, stable and sustainable operations within data centres
Data Protection Management	Develop and implement a Data Protection Management Programme to comply with the Personal Data Protection Act 2012
Data Visualisation	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
E-commerce Management	Develop, manage and execute e-commerce strategies and activities according to organisational objectives
Emerging Technology Scanning	Review new developments in emerging technology to determine their relevance to the organisation
Interaction Design Practice	Develop digital and/or physical interactions across technology, products, space and services media to enhance relationships and engagement with users
Product Development	Evaluate consumer and market trends to determine value proposition, cost-effectiveness and profitability of proposed products in different markets
Radio Frequency Engineering	Design, deploy and maintain radio frequency infrastructure for IT systems and wireless communication networks
Research and Information Synthesis	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

Security Governance	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
Software Design	Create and refine the overall plan for the design of software, including the design of functional specifications
Software Testing	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
Solution Architecture	Design or refine a solution blueprint or structure to guide the development of IT solutions in hardware, software, processes, or related components
Solutioning	Generate solutions by systematic analysis of the problem, proposing preventive and/or corrective measures and evaluating the effectiveness of the measures from different perspectives
User Experience Design	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

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-de>

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



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