



**Asia-Pacific
Economic Cooperation**

**Data Science and Analytics
Skills Shortage:
Equipping the APEC Workforce with
the Competencies Demanded
by Employers**

APEC Human Resource Development Working Group

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Table of Contents

Introduction	3
Study approach.....	3
Study limitations.....	4
DSA competencies	4
Our Findings:.....	5
1. Data Science and Analytics (DSA) sits at the top of the skills shortage.....	5
2. The skills shortage is impacting economies negatively	7
3. DSA skills shortages constrain growth across a range of sectors	8
The way forward: addressing the skills shortage through the DSA competencies framework.....	11
DSA-related jobs that align with the recommended APEC DSA competencies.....	14
Why are these competencies necessary?	14

Acronyms

APEC	Asia-Pacific Economic Cooperation
BHEF	Business Higher Education Forum
CFO	Chief Financial Officer
CIO	Chief Information Officer
DARE	Data Analytics Raising Employment
DSA	Data science and analytics
IDC	International Data Corporation
IT	Information technology

Introduction

Seventy-five million young people are out of work worldwide.¹ The number triples when accounting for underemployment, according to data from the International Labor Organization. The lack of employment is a problem across regions: In Asia-Pacific, the youth unemployment rate will likely increase from 12.4% in 2015 to 13.6% in 2017; and in Latin America, from 15.7% to 17.1%.² At the same time, McKinsey estimates that by 2020 the world will face a shortage of 38-40 million highly skilled workers.³

Across APEC, talent shortages—caused by gaps and mismatches between labor market needs and the available supply of educated and trained professionals—constrain economic growth.⁴ These shortages prevent firms from scaling up operations, meeting demand in new locations, and launching new products and services.⁵ Asia-Pacific employers state that the talent shortage will have a direct impact on their competitiveness and productivity.⁶ Governments, too, are realizing that in a more automated, data-driven future, workers need to upgrade their skills to avoid becoming obsolete and to fully unlock the potential of new technologies.

This report explores the scope of the skills shortage across the APEC region for data science and analytics (DSA) workers amid urgent employer demand for an upgraded workforce critical to sustaining competitiveness, productivity, and sustainable economic growth and prosperity. For this study, DSA is defined as the ability to gather, analyze, and draw practical conclusions from data, as well as communicate data findings to others.⁷

Study approach

APEC commissioned a research study on the skills shortage in DSA within the region under Project DARE (Data Analytics Raising Employment), which is co-led by the United States Department of Labor, Wiley, and the Business Higher Education Forum (BHEF).⁸

Long-term, this project seeks to inform young people in APEC of needed data-analytics competencies, enabling this generation's ability to find work in a data-driven landscape and move fluidly into labor markets across the region. Project DARE's 2017 research study was commissioned to quantify the shortage of data-analytics-enabled workers in the APEC region and, if possible, estimate the economic impact and job losses at stake. The research study findings will focus on the shortage of a data-analytics-enabled workforce in the APEC region, flagging the need to address this issue across stakeholders, sectors, and economies.

A broad-based search covering relevant content in academic literature, research and technical papers, government reports, working papers, and industry publications and surveys drove the consulting team's research to answer key questions. Any text reviewing, analyzing, evaluating, or describing DSA skills shortages in member economies—or the economic impact of these shortages—were considered to be within the broader selection criteria.

This initial content was complemented and built upon by further inputs gathered by the

1 International Labor Organization (2012), The Youth Employment Crisis. Highlights of the 2012 ILC Report

2 International Labour Organization (2016), World Employment and Social Outlook 2016: Trends for Youth

3 McKinsey (2012), The world at work: Jobs, pay, and skills for 3.5 billion people.

4 Stahl and Zheng (2002), Skill Shortages, Training Needs & HRD Strategies of MNCs in APEC Member Economies; Skinner, Saunders and Beresford (2004), Towards a shared understanding of skill shortages: differing perceptions of training and development needs.

5 Wintrop et al. (2013), Investment in Global Education. A Strategic Imperative for Business.

6 Manpower (2015), 2015 Talent Shortage Survey.

7 Society for Human Resource Management and American Statistical Association (2016), Jobs of the Future: Data Analysis Skills.

8 APEC Project number HRD 04 2016A.

project team through interviews with key stakeholders at the APEC Project Dare Advisory Group meeting held in Singapore on May 4-5, 2017.

Study limitations

While evidence continues to mount regarding DSA skills shortages in the APEC region, robust and comprehensive studies are rare. Of the studies that do exist, information is typically provided at the level of outputs (number of people trained) and outcomes (improvement of skills) but lacking details on the impact on jobs and incomes, including evidence on the quality, sustainability, and pay of the jobs gained after training. Therefore, this study is necessarily limited within the findings presented. Limitations include:

Relevance and scope of information gathered through interviews: Stakeholders' sector experience and willingness to share influences information collected, and may not be fully representative of an entire sector or economy. Furthermore, opinion, concerns, and current information are highly variable and dependent on changing business priorities and trends. Industry representatives raised numerous talent issues and supporting requirements during interviews and discussions, yet only those issues identified as common across economies were considered relevant to the research.

Availability of information/data for analysis: Data and research on data-analytics-enabled workforce from different economies is limited or simply unavailable. To support the study, the project team relied on available information, supplemented by findings obtained from stakeholder interviews and conference discussion.

The study covered a broad range of interviews to capture of insights from both industry and educational institutions. Overall, all outcomes and findings come from a best-effort analysis of the information provided, and therefore may not be fully representative of any one economy or industry.

DSA competencies

DSA is defined as the ability to gather, analyze, and draw practical conclusions from data, as well as communicate data findings to others.⁹ The potential of data analytics to gain new insights and create value that may transform both organizations and society itself has been widely recognized by experts across multiple sectors. Data scientists have been described as “the sexiest job of the 21st century”,¹⁰ but there is still a lack of clarity and consensus about what exactly a data scientist is, what skills they need, and how entry to the sector is gained in the first place.¹¹

Despite this uncertainty, demand for data analysis, big data, and data science skills across sectors has continued to grow rapidly throughout the last five years, and the increasing need for a DSA-skilled workforce will influence the future. As DSA-specific and DSA-enabled jobs become more prevalent across a range of economies, competencies will need to be developed for these positions. While not all jobs will require highly advanced doctoral degrees, they will necessitate varying levels of appropriate skills. These skills are likely to become prerequisites for a number of workers, from chief executive officers to entry-level positions.¹² A 2017 PwC survey highlighted this trend, as cross-sectoral business leaders responded that by 2020, DSA skills would be “required of all managers” in their respective companies.¹³ Economies seeking to educate their workforce in a data-driven world must

9 Society for Human Resource Management and American Statistical Association (2016), Jobs of the Future: Data Analysis Skills.

10 Harvard Business Review (2012), Data Scientist: The Sexiest Job of the 21st Century

11 Chatfield et al. (2014), Data scientists as game changers in big data environments

12 APEC (2017), Recommended APEC Data Science & Analytics (DSA) Competencies

13 PwC and BHEF (2017), Investing in America's data science and analytics talent. The case for action

understand and incorporate DSA skills in order to prepare their citizens for tomorrow's jobs. A DSA-enabled workforce is not immune to automation but uses skills that augment and support technological development, capitalizing on the potential change brought about by data availability and innovation. Therefore, a basic understanding of DSA definitions and competencies is necessary.¹⁴ Even the terms “data science”, “big data”, and “data analytics” require clarification and definition, alongside examples of the varied skills and jobs found within the sector.

Data Science: The data science field addresses both structured and unstructured data in terms of data cleansing, preparation, and analysis. Overall, data science is a grouping of techniques that enable insight and information extraction from data.¹⁵ Internet searches, search recommenders, and digital advertisements and profiles all fall under the application of data science.

Big Data: The big data field addresses the massive volumes of data that are generated across industries; the majority of this data is simply too large to be processed or interpreted effectively with traditional approaches. The analysis of big data can deliver insights to support better decision-making and business strategies.¹⁶ Financial services, retail, and communication all generate big data and thus require skilled techniques.

Data Analytics: The data analytics field examines raw data to draw conclusions out from the information. Inference skills are necessary within data analytics, as the researcher must derive conclusions from what he or she already knows.¹⁷ Healthcare, travel, gaming, and energy management are key applications of the data analytics profile.

Our Findings:

1. Data Science and Analytics (DSA) sits at the top of the skills shortage

Leaders in both the private sector and public sector agree that DSA will change the face of business and government, but skills shortages continue to delay its adoption and utilization.¹⁸ Educational and training institutions are often unable to meet the needs of a changing labor market, resulting in gaps that constrain growth.¹⁹ This future talent shortage leaves demand unmet from both consumers and employers, as the workforce struggles to match skills to need and firms find themselves unable to scale operations to launch new products and services.²⁰

DSA skills are in high demand, but supply is critically low with employers facing severe shortages. Given the recent emergence of the field of DSA, not all economies have information detailing the demand for a DSA workforce, but the shortage in the Asia-Pacific region has been identified by several reports. In 2012, Gartner forecast the creation of 960,000 new DSA jobs in Asia-Pacific by 2015 due to increased investment in DSA, but warned that only one-third of these positions would be staffed as a result of skills shortages.²¹ Teradata estimates the shortage of data scientists to number around one million in Asia-Pacific, seriously constraining growth.²² These numbers are likely to persist and extend to all

14 PwC and BHEF (2017), Investing in America's data science and analytics talent. The case for action

15 NYU (2013), What is data science?

16 OECD (2015), Data-Driven Innovation: Big Data for Growth and Well-Being

17 OECD (2015), Data-Driven Innovation: Big Data for Growth and Well-Being

18 Gamage, P. (2016) Big Data: are accounting educators ready?

19 Stahl and Zheng (2002), Skill Shortages, Training Needs & HRD Strategies of MNCs in APEC Member Economies; Skinner, Saunders and Beresford (2004), Towards a shared understanding of skill shortages: differing perceptions of training and development needs.

20 Wintrop et al. (2013), Investment in Global Education. A Strategic Imperative for Business

21 Gartner (2012), Gartner forecast the creation of 960,000 new DSA jobs by 2015

22 Bangkok Post (2017), Data science poised to boom

types of DSA-empowered positions as IDC predicts a 29% compound annual growth rate of DSA-professional services in Asia-Pacific by 2020.²³

The following are projections for DSA workforce demand from select APEC economies, which illustrate its rapid increase.

Projected DSA Workforce Demand in Select Economies

Economy	Current DSA Workers	Projected DSA Workers Needed	Percent Change
Malaysia²⁴	4,000 (2016)	20,000 (2020)	400%
The Philippines²⁵	147,420 (2016)	340,880 (2022)	131%
Singapore²⁶	9,300 (2015)	15,000 (2018)	61%
Canada²⁷	33,600 (2016)	43,300 (2020)	33%
United States²⁸	2,350,000 (2015)	2,720,000 (2020)	16%

In the face of this growing demand, the supply of DSA workers is not keeping up. A 2015 survey of more than 400 companies in ten economies revealed that approximately 43% of DSA vacancies remain unfilled.²⁹ For example, **Viet Nam** by 2020 is expected to face a shortage of over 500,000 employees with DSA skills, which could severely undermine its IT sector growth. Cisco estimates that 80% of the 54 million workers in Viet Nam do not have the necessary skill sets to participate in the digital economy.³⁰ This compromises Viet Nam’s goal of becoming a strategic business hub for IT, while the economy’s growing demand for specialists—especially in cloud computing, big data, business intelligence, and information security—serves to widen the gap.³¹

Viet Nam is not alone in the Asia-Pacific region in suffering from DSA skills shortages. The IDC reports 62% of **Indonesian** firms identify these shortages as challenging their ability to deliver the full value of big data analytics to customers.³² Similarly, Teradata estimates **Thailand** is home to only 300-400 data scientists, imposing limits on potential growth in a number of sectors.³³ The shortage of big-data talent in **China** by 2015 numbered over 1.5 million workers.³⁴ **Japan’s** current DSA shortage of skilled workers is estimated by the Ministry of Economy, Trade and Industry to grow from 15,000 currently to 50,000 missing workers by 2020.³⁵ Gartner claims the data scientist gap may reach 250,000 in the future.³⁶

Singapore, despite ranking as the best-prepared economy in the world for the new digital economy by the 2016 World Economic Forum,³⁷ lacks the 15,000 workers needed by 2018 to

23 IDC (2015), IDC FutureScape: Worldwide Big Data and Analytics 2016 Predictions – APEJ Implications

24 Projections cover the period between 2016 and 2020. Based on information from MCDE (2016), Big Data Week 2016

25 Projections cover the period between 2016 and 2020. Based on information from IBPAP (2016), Roadmap 2022

26 Projections cover the period between 2015 and 2018. Based on information from iDA Singapore (2016), Annual Survey of Infocomm Manpower 2015

27 Projections cover the period between 2016 and 2020. Based on information from ICTC (2015), Big Data and the Intelligence Economy

28 Projections cover the period between 2015 and 2020. Based on information from Burning Glass Technologies (2017), The Quant Crunch.

29 A.T. Kearney (2015), The 2015 Leadership in Analytic Practices (LEAP) Study: Answering the Digital and Analytics Talent Gap: The New ‘Trilinguals’

30 Cubird (2017), Cisco’s initiatives prepare Vietnam’s workforce for the digital future.

31 Robert Walters (2017), Salary Survey 2017

32 IDC (2016), Leveraging Big Data for Enhanced Data-Driven Insights

33 Bangkok Post (2017), Data science poised to boom

34 APEC Concept Note (n.d.), Training on Health and Medical Big Data Innovation

35 Nikkei Asian Review (2017), Japanese startup, Indian students team to develop AI

36 Maruyama (n.d.), Developing Data Analytics Skills in Japan: Status and Challenge

37 World Economic Forum (2016), The Global Information Technology Report 2016

meet base demand.³⁸ Highlighting this issue, 64% of firms name DSA skills shortages as the main challenge for Singaporean businesses seeking to deliver value to clients.³⁹ Concurrently, Singapore’s data science recruitment firm Big Cloud found pay for junior data scientists with up to two years of experience outstripping mean salaries of university graduates by US\$59,480 to US\$30,000, demonstrating businesses’ willingness to pay for scarce talent.

In **Australia**, 90% of respondents to an Institute of Analytics Professionals of Australia poll found recruiting for DSA more difficult than prior years, despite organizations paying nearly twice the median Australian salary for DSA professionals. These DSA professionals saw salaries rise 14%, from AU\$110,000 to AU\$125,000, in 2014; those with social data skills received salaries three times the national average at AU\$200,000.⁴⁰

IDC predicts shortages in the **United States** as data-reliant roles increase. By 2018, the United States will need nearly 900,000 workers skilled in data management and interpretation as well as 181,000 highly trained data analysts.⁴¹ In 2011, McKinsey estimated the current gap of 140,000 data scientists would grow to 190,000 by 2017.⁴² A research study conducted by Accenture found that more than 90% of clients planned to hire workers with DSA expertise, but 40% were confronted by a lack of available talent.⁴³ The shortage led to the 2016 ranking of data scientist as “the best job in America” due to high earnings, career opportunities, and number of job openings. Challenges to acquiring talent saw the number of data scientist job postings grow 57% year-over-year by 2015 as searches for data scientists grew 73.5% during the same period.⁴⁴ Those hired receive median salaries of US\$104,000 to US\$113,000—double that of a regular programmer—and in major metropolitan areas, starting salaries can exceed US\$200,000.⁴⁵

Canada’s data analytics market is expected to grow from US\$1.1 billion in annual revenue to US\$1.8 billion by 2020. Similarly, direct employment in the DSA market is predicted to rise from 33,600 jobs in 2016 to over 43,000 by 2020.⁴⁶

The salaries mentioned above reflect scarcity, and may be unlikely to decrease as long as demand remains high: a 2016 CrowdFlower Data Science Report noted 83% of respondents globally reported a lack of available data scientists, up from 79% only a year earlier.⁴⁷ While these salaries are individually beneficial to DSA professionals, rising costs for firms have slowed the uptake of data-driven decision-making, and may decrease spending on innovation and research.⁴⁸

2. The skills shortage is impacting economies negatively

While the reasons for a shortage of DSA-skilled employees are varied, the negative effects are apparent across APEC economies. Asia-Pacific economies are seeking to capitalize on DSA, but are held back by a lack of skills and talent. In a global survey of Chief Information Officers (CIOs), 71% of APEC CIOs stated skills shortages hindered their organization’s ability to keep pace with change—12% higher than the global average. Forty-one percent predicted reduced competitiveness and productivity as a result of lack of talent, followed by

38 The Guardian (2017), ‘It’s important no one gets left behind’: Singapore’s government data strategy

39 IDC (2016), Leveraging Big Data for Enhanced Data-Driven Insights

40 IAPA (2014), IAPA Skills and Salary Survey 2014: Insights into business analytics in Australia

41 IDC (2014), IDC FutureScape: Worldwide Big Data & Analytics 2015 Predictions

42 McKinsey (2011), Big data: The next frontier for innovation, competition, and productivity

43 Accenture (2014), Big Success With Big Data

44 Forbes (2016), How To Become A Data Scientist In 2017

45 O’Reilly (2015), 2015 Data Science Salary Survey; Datanami (2016), Tracking the Data Science Talent Gap

46 ICTC (2016), Digital Talent: Road to 2020 and Beyond

47 CrowdFlower (2016), Data Science Report

48 IAPA (2014), IAPA Skills and Salary Survey 2014: Insights into business analytics in Australia

reduced ability to serve clients and decreased innovation and creativity. This trend is growing quickly, evidenced by the 65% of IT leaders worried about their firm's adaptability, a rise of 10% in just one year. Exacerbating this is steadily increasing demand for DSA-skilled talent like big data analytics, with demand being nearly six times higher than the next scarcest skill—change management.⁴⁹ Further supporting this trend, the International Data Corporation (IDC) surveyed 636 IT decision-makers and influencers from organizations with over 500 employees in seven Asian economies and found the lack of business and analytic skills as the main barrier to growth and value-delivery.⁵⁰

The Microsoft Asia Data Culture Survey of 940 business leaders from 13 Asian nations found a number of barriers to firms' ability to capitalize on data-driven transformation. Eighty-eight percent of respondents noted the importance of data-driven agility to improve efficiency, decision-making, continuity, and customer satisfaction within their firms. However, only 42% felt their employees possessed the relevant skills to use data effectively to produce better business outcomes.⁵¹ The survey revealed the difficulty in developing talent and building a data-driven culture in Asia-Pacific firms. Forty-nine percent of business leaders felt high costs prohibited adoption and 43% were concerned with data security, whereas 36% noted the lack of digital skills in the workforce. Further barriers included the fear of change and securing funding.⁵² Overall, despite wide recognition of the importance of integrating DSA into organizations, technical and cultural constraints combine to stymie these efforts.

The increased demand of DSA competencies has led to delays in firms' ability to hire. In the United States, DSA jobs take nearly 45 days to fill, five days longer than market averages.⁵³ From 2006 to 2015, the percentage of APEC employers noting difficulties in filling vacancies climbed from 28% to 48%. While these delays stem from both contextual and structural factors within individual economies—the speed of technological innovation, lack of training and provision of initial skills, aging societies, and cultural and social barriers that limit the workforce—they negatively affect firms' competitiveness and leave key positions unmanned.

3. DSA skills shortages constrain growth across a range of sectors

Around the world, the data economy is transforming employer needs in every sector, with growing demands for not just DSA workers (i.e., data scientists, data analysts, etc.) but also DSA-enabled workers—workers who do not work solely with data but leverage data to make decisions to support their job functions. The growing demand for DSA workers is therefore only a subset of the demand for DSA-enabled workers. Indeed, United States data suggests that DSA-enabled workers represent one of the largest areas of employment and economic impact.⁵⁴

DSA usage can improve a number of sectors: manufacturing, health care, financial services, cybersecurity, government services, and retail, among others. By capitalizing on the use of DSA, companies see efficiency improvements, cost and waste reduction, better planning and risk analysis, targeted marketing, and customer retention.⁵⁵ Studies show 5-6% gains for firms across sectors when adopting DSA-powered decision making, outperforming their competitors.⁵⁶ Further evidence indicates that 77% of companies that use data effectively

49 Harvey Nash (2015) Harvey Nash CIO survey 2015 in association with KPMG: Into an age of disruption

50 IDC (2016), Leveraging Big Data for Enhanced Data-Driven Insights

51 Microsoft (2016), The Microsoft Asia Data Culture Study 2016

52 Idem

53 Burning Glass Technologies (2017), The Quant Crunch: How the Demand for Data Science Skills is Disrupting the Job Market

54 PwC (2017), Investing in America's data science and analytics talent.

55 Gillis, T.H. and Stephanny, P. (2014), Going beyond the data: tax data is Big Data

56 Harvard Business Review (2012), Making Advanced Analytics Work for You; Tene, O. and Polonetsky, J. (2013), Big Data for all: Privacy and user control in the age of analytics

achieve better financial performance; early adopters with advanced capacity gain initial leads and outpace competition by large margins.⁵⁷

The Asia-Pacific region will especially benefit from DSA adoption, as developing economies give rise to a prosperous middle class. New capabilities in the financial sector make banking more profitable and available to a wider range of consumers; better data analysis of patient data makes healthcare more efficient; and improved public sector functions make governments more responsive in a number of ways.⁵⁸

As the benefits of DSA-skills adoption emerge, so do the constraints caused by shortages across the following sectors:

Manufacturing leaves the largest gains on the table by not adapting quickly to big data and analytics innovations. Some estimates note that United States manufacturers could boost productivity by 30%, decrease product development and assembly costs by 50%, and save substantially on transportation, fill, and inventory costs through effective use of data analytics.⁵⁹ In South East Asian economies, using DSA technology is predicted to increase annual economic impact in manufacturing by as much as US\$25-45 billion by 2030. Improved demand forecasting and production planning also enhances customer service, while analyzing data from the supply chain and downstream delivery assists manufacturers to better manage inventory and maximize production capacity, leading to possible profit margin increases of 2-3%.⁶⁰ While big data adoption may also drive a 7% reduction in working capital for manufacturers, many companies have not updated IT systems or employed and empowered DSA-skilled employees.⁶¹

In response, spending on DSA throughout the Asia-Pacific region is expected to grow nearly 30% annually between 2013 and 2017. The IDC reports that 37% of Asian manufacturers already use DSA to improve quality management, and 29% utilize DSA for inventory management.⁶² A recent survey of 500 Asian-Pacific executives noted that 15% of respondents were optimistic regarding DSA's capacity to increase revenue and efficiency by more than 50% through improved accuracy in forecasting.⁶³

Healthcare is another vital sector with increasing demand for DSA-enabled workers. By 2022, the global eHealth market, powered by DSA, is expected to exceed US\$300 billion.⁶⁴ In Singapore, the Ministry of Health has named healthcare IT and data analytics as a key pillar of training; the Ministry is seeking further integration of geospatial, lifestyle, behavioral, and genotype data into the healthcare sector to improve health outcomes.⁶⁵ Furthermore, the "H-Cloud," a central, private cloud hosting mission-critical systems for the public hospitals, specialty centers, and polyclinics that make up Singapore's Integrated Health Information Systems, cuts costs and pools information for more effective, efficient patient care.⁶⁶

Canada and the United States are seeking improvements in healthcare through DSA as well. eHealth in Canada generates an annual revenue of US\$3.4 billion, directly and

57 Pearson, T. and Wegener, R. (2013), Big Data: The organizational challenge; EY (2014), Order from chaos Where big data and analytics are heading, and how life sciences can prepare for the transformational tidal wave

58 McKinsey (2014), Southeast Asia at the crossroads: Three paths to prosperity

59 Ohio University (2016), How Software and Big Data are Changing Manufacturing in the United States.

60 McKinsey (2014), Southeast Asia at the crossroads: Three paths to prosperity

61 McKinsey Global Institute (2011), Big Data: The next frontier for innovation, competition and productivity

62 IDC (2013), Big Data and Analytics: Core to Next-Gen Manufacturing

63 Economist Intelligence Unit (2013), The hype and the hope: The road to big data adoption in Asia-Pacific

64 ICTC (2016), Digital Talent: Road to 2020 and Beyond

65 National Health Care Group (n.d.), Evolution of Singapore's Healthcare Landscape.

66 McKinsey (2014), Southeast Asia at the crossroads: Three paths to prosperity

indirectly employing nearly 50,000 workers with the potential to add another 32,000 by 2020.⁶⁷ The United States could see yields of US\$300 billion annually if DSA is adopted to improve quality and efficiency, paired with reductions in healthcare spending of nearly 8%.⁶⁸

Financial and insurance services are also confronting significant DSA skills shortages. In a global survey by Chartered Global Management Accountants, 87% of Chief Financial Officers (CFOs) and finance professionals stated that DSA will change the way business is done over the next decade.⁶⁹ Only 44% of respondents to a financial innovation survey conducted globally in 2015 believe their company's current finance functions can keep pace with the increasing complexity and volume of data.⁷⁰ Half of Asia-Pacific executives lack confidence in the ability of their finance functions to offer adequate analysis, demonstrating the need for greater DSA skills.⁷¹ And 34% of Singaporean CFOs point to big data analytics as having the greatest impact on the sector, while 40% are concerned with the talent shortage.⁷²

Despite this, the banking sector is poised to capitalize on DSA with the possibility of generating US\$11-22 billion in annual economic impact by 2030. New technology has lowered transaction costs, reduced non-performing loans, and increased lending, especially for underserved SMEs. Digitization has allowed banks to serve millions of “unbanked” customers, driving an economic gain of US\$52 billion as these individuals access financial tools and systems.⁷³

Cybersecurity is a rapidly-growing sector wherein data analytics plays a crucial role. According to research firm Gartner, cybersecurity analytics allow organisations to sift through massive amounts of security-related data — generated both inside and outside the organisation — to uncover hidden relationships, detect patterns and remove security threats, establishing a bigger and broader picture of the security landscape. Cybersecurity analytics are involved in a multitude of security and fraud cases through the detection of advanced threats, insider threats, and account takeovers.⁷⁴

As the cybersecurity industry evolves over the next decade, becoming more diverse and sophisticated, global spending is expected to almost double from current estimates of US\$126 billion.⁷⁵ For example, Japan's rapidly expanding cybersecurity sector is expected to grow 19% to reach US\$2.7 billion by 2016.⁷⁶ However, a Frost & Sullivan report found that by 2020, more than 1.5 million cybersecurity positions worldwide are expected to remain unfilled.⁷⁷

Customers increasingly demand refined and complex products to meet critical cyber security needs, especially within Asia-Pacific. Nearly 35% of CIOs report major IT security attacks in the last year, 10% higher than the global average, highlighting the need for increasing investment and skills.⁷⁸

67 ICTC (2016), Digital Talent: Road to 2020 and Beyond

68 McKinsey (2011), Big data: The next frontier for innovation, competition, and productivity

69 CGMA (2014), Big Data: Reading business for the big data revolution

70 CFO Research (2015), Thriving in the Digital Economy: The Innovative Finance Function.

71 Bruce (2015), For data analytics leaders in Asia Pacific, success comes from willingness to fail

72 SIA (2017), Skills shortages are key challenge for financial services sector.

73 McKinsey (2014), Southeast Asia at the crossroads: Three paths to prosperity

74 Gardner (2014), By 2016, 25 Percent of Large Global Companies Will Have Adopted Big Data Analytics For At Least One Security or Fraud Detection Use Case

75 Australian Cyber Security Growth Network (2017), Cyber Security Sector Competitiveness Plan

76 Center for Strategic and International Studies (2016), Hacking the Skills Shortage A study of the international shortage in cybersecurity skills

77 Harvard Business Review (2017), Cybersecurity Has a Serious Talent Shortage. Here's How to Fix It

78 Harvey Nash (2015) Harvey Nash CIO survey 2015 in association with KPMG: Into an age of disruption

According to Centre for Strategic International Studies and Intel research, 82% of companies surveyed in the United States suffer from a shortage of cybersecurity skills. Current estimates show up to 1 million cybersecurity job openings in the United States with demand expected to rise to 6 million globally by 2019⁷⁹ and at a faster rate than IT jobs.⁸⁰ Ninety-seven percent of United States employers said that candidates with needed cybersecurity skills were difficult to find and hire.⁸¹

Singapore's push to be a leader in cybersecurity is currently limited by a lack of professionals who are considered IT security specialists.⁸² Malaysia has only one cybersecurity professional for every 4,000 internet users, well below the number experts say are needed.⁸³

In Australia, senior IT security specialist jobs are considered one of the most difficult positions to fill.⁸⁴ This shortage is readily apparent to Australian cybersecurity professionals, of whom 88% report skills shortages and gaps in job readiness—one of the worst rates in the world. This endangers the potential growth of Australia's cybersecurity industry—which is forecasted to grow to AU\$6 billion by 2026 from the current AU\$2 billion. This growth will necessitate an increase from 19,000 cyber security professionals currently to more than 26,000 by 2026, a rate of at least 3.5% a year.⁸⁵

Government services can be improved by moving many citizen services online, increasing efficiency, transparency, and cost-effectiveness. Public-sector employees are expected to understand DSA, as evidenced by a newly released Singaporean government plan to train 10,000 public servants to better comprehend and address issues of data science and service delivery.⁸⁶ Singapore's Online Business Licensing System, a cross-agency, one-stop website for new businesses, saw average license processing times drop from 21 to 12.5 days.⁸⁷ Tax collection and transfer payments provide other opportunities for advanced algorithms and DSA to reduce fraud and error.⁸⁸

The **consumer and retail sector** are likely to see gains from DSA stemming from productivity improvements due to e-retail. While 2013 saw e-retail reaching valued at US\$3.3 billion and reaching only 0.7% of the total retail market, forecasts predict a growth rate of 18% annually to value US\$7.6 billion by 2018. Big data and the Internet of Things will improve retailer positions through better demand prediction and inventory management, and consumers will likely see lower prices and greater product selection.⁸⁹

The way forward: addressing the skills shortage through the DSA competencies framework

Project DARE's "Recommended APEC DSA Competencies" were developed to address both the need for greater understanding of the DSA skills shortage, and what is essential to growth in the field. They serve as a resource for policymakers, academia and the private sector to manage and support DSA skills development. To arrive at these competencies, a 50-person

79 Center for Strategic and International Studies (2016), Hacking the Skills Shortage A study of the international shortage in cybersecurity skills

80 Burning Glass Technologies (2015), Job Market Intelligence: Cybersecurity Jobs, 2015

81 PwC and BHEF (2017), Investing in America's data science and analytics talent. The case for action

82 Tan and Tang (2016), New skills at work: Managing skills challenges in ASEAN-5.

83 Wahab (2015), Nurturing Malaysia's next-gen cybersecurity professionals.

84 Australian Government (2015), Labour Market Research – Information Technology (IT) Professions

85 Australian Cyber Security Growth Network (2017), Cyber Security Sector Competitiveness Plan

86 The Guardian (2017), 'It's important no one gets left behind': Singapore's government data strategy

87 Chua, J (2012), The e-transformation journey of Singapore," in National Strategies to Harness Information Technology

88 McKinsey (2014), Southeast Asia at the crossroads: Three paths to prosperity

89 Idem

Advisory Group—assembled from the 14 APEC member economies and co-chaired by the Business Higher Education Forum (BHEF) and the global skills and knowledge company Wiley—drew insights from business leaders managing DSA needs for their firms, academic leaders overseeing DSA-focused inter-disciplinary initiatives and curricula, and government officials directing human resource development.⁹⁰

The Advisory Group recommended the following 10 competencies to measure and support both highly trained data scientists and the emerging cohort of DSA-enabled professionals. This competency framework acknowledges that data scientists and DSA-enabled professionals possess varied combinations of these 10 competencies, with differences in their levels of mastery of business and organizational skills, technical skills, and workplace skills.⁹¹ By utilizing a full range of competencies, an organization can build and enhance its analytics capability.

⁹⁰ APEC (2017), Recommended APEC Data Science & Analytics (DSA) Competencies

⁹¹ Idem

10 RECOMMENDED APEC DATA SCIENCE & ANALYTICS (DSA) COMPETENCIES

Jobs requiring a familiarity with DSA are rising dramatically, resulting in a shortage of qualified employees. DSA-related jobs were at the top of those that employers in the Asia Pacific region are having the most difficulty filling.

1 OPERATIONAL ANALYTICS

Use data analytics and specialized Business Analytics (Business Intelligence) techniques for the investigation of all relevant data to derive insight for decision making.



2 DATA VISUALIZATION & PRESENTATION

Create and communicate compelling and actionable insights from data using visualization and presentation tools and technologies.



3 DATA MANAGEMENT & GOVERNANCE

Develop and implement data management strategies and governance, incorporating privacy and data security, policies and regulations, and ethical considerations.



4 DOMAIN KNOWLEDGE & APPLICATION

Apply domain-related knowledge and insights to effectively contextualize data, achieved by practical experience and exposure to emerging innovations.



5 STATISTICAL TECHNIQUES

Apply statistical concepts and methodologies to data analysis.



6 COMPUTING

Apply information technology, computational thinking, and utilize programming languages and software and hardware solutions for data analysis.



7 DATA ANALYTICS METHODS & ALGORITHMS

Capture, clean and inspect data. Implement and evaluate data analytics and machine learning methods and algorithms on the data to derive insights for decision making.



8 RESEARCH METHODS

Utilize the scientific and engineering methods to discover and create new knowledge and insights.

9 DATA SCIENCE ENGINEERING PRINCIPLES

Use software and system engineering principles & modern computer technologies, incorporating a data feedback loop, to research, design & prototype data analytics applications. Develop structures, instruments, machines, experiments, processes, systems to support the data lifecycle.



10 21ST CENTURY SKILLS

Exhibit crosscutting skills essential for DSA at all levels: collaboration, communication & storytelling, ethical mindset, organizational awareness, critical thinking, planning & organizing, problem solving, decision making, customer focus, flexibility, business fundamentals, cross cultural awareness, social & societal awareness, dynamic (self) re-skilling, professional networking & entrepreneurship.



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Human Resources Development
Working Group, June 2017

Source: Recommended APEC Data Science & Analytics (DSA) Competencies⁹²

92 APEC (2017), Recommended APEC Data Science & Analytics (DSA) Competencies

DSA-related jobs that align with the recommended APEC DSA competencies

The “Recommended APEC DSA Competencies” identify the skills needed to develop a competitive workforce, but employers and other users may want a further break down to better understand the roles and occupations requiring these skills. The Recommended Competencies allow organizations to group occupations within certain skill sets, gaining insight into just what a given role will do for a firm. While not exhaustive, the following table provides an example of DSA-related roles and occupations that align with the competencies proposed and which can serve as guidance for organizations interested in developing a DSA-enabled workforce.

DSA Framework category	Functional role	Sample occupation
Data Scientists and Advanced Analytics	Create sophisticated analytical models used to build new datasets and derive new insights from data	Data Scientist
Data Analysts	Leverage data analysis and modelling techniques to solve problems and glean insight across functional domains	Data Analysts Business Intelligence Analyst
Data Systems Developers	Design, build and maintain an organization’s data and analytical infrastructure	Systems Analyst Database Administrator
Analytics Managers	Oversee analytical operations and communicate insights to executives	Chief Analytics Officer Marketing Analytics Manager
Functional Analysts	Utilize data and analytical models to inform specific functions and business decisions	Business Analyst Financial Analyst
Data-Driven Decision-Makers	Leverage data to inform strategic and operational decisions	IT Project Manager Marketing Manager

Source: Adapted from PwC and BHEF (2017)⁹³

Why are these competencies necessary?

Alignment among employers, academia and government on a set of workplace-ready competencies for DSA-enabled workers will help to address the critical skills shortage. Defining competencies for a DSA-enabled worker enables educators to frame curricula that are practical and needed. A PwC survey found that 69% of United States employers expect candidates to demonstrate DSA skills, while only 23% of university leaders say their students will be equipped with those skills.⁹⁴ In addition, 83% of United States educators interviewed in a PwC survey stated that a common framework would help them prepare curricula devoted to DSA skills.⁹⁵ These competencies can then be expanded into multiple sectors or domains, informing not only the data scientist, but the healthcare professional, manufacturing engineer, or government employee. Creating this set of DSA competencies is therefore the first step to addressing the skills shortage threatening competitiveness and productivity.

DSA competencies can aid firms in understanding who they need to hire and for what positions. As the DSA field changes rapidly, firms are often left to play “catch up,” hiring workers who may not have the right skills or be in the right position. Firms reported that they had difficulty in filling positions because potential employees lacked appropriate skills.

⁹³ PwC and BHEF (2017), Investing in America’s data science and analytics talent. The case for action

⁹⁴ PwC and BHEF (2017), Investing in America’s data science and analytics talent. The case for action

⁹⁵ PwC and BHEF (2017), Investing in America’s data science and analytics talent. The case for action

Furthermore, businesses report that current employees often lack essential skills for the jobs they have. Competencies help employers identify the exact skills needed, and can inform in-job training to develop those skills.

Just as educational and training institutions adjust their curricula to match the need set out by employers, future employees can use competencies to train for the jobs they seek. Knowing what is expected of workers in various positions within the framework ensures that training and knowledge are aimed at on-the-job goals. This will also allow employees who already possess certain jobs to continue their training in specific fields, and avoid generalized training or training in skills they may not need.

Providing a set of DSA competencies ensures that money spent in education or training by universities, governments, and firms is aimed at bridging skill gaps. In seeking to improve their workforce and support better skills development, stakeholders and policymakers spend heavily on a variety of programs. By codifying and aligning the skills needed, this money will be spent more effectively on the jobs that employers need filled, ensuring students learn skills that are usable and effective for future employment.