SINGAPORE DIGITAL ECONOMY REPORT

INFOCOMM MEDIA DEVELOPMENT AUTHORITY

CONTENTS

EXECUTIVE SUMMARY

This is the second edition of the Singapore Digital Economy Report (SGDE 2024), which aims to provide a holistic analysis of the state of Singapore's Digital Economy (DE) in 2023[1]. Similar to the inaugural Singapore Digital Economy Report published in Oct 2023 (SGDE 2023), this year's report covers key aspects of Singapore's DE, namely:

01 size of DE

02 state of enterprise digitalisation

03 state of tech manpower

It will delve deeper into SMEs' digitalisation, as well as the adoption of Artificial Intelligence (AI) by enterprises. Additionally, SGDE 2024 will cover a new module on digital innovation in Singapore[2].

Singapore's Digital Economy Maintains Momentum

As in SGDE 2023, we have defined DE size in this current report as comprising both the value-added (VA) of the Information & Communications (I&C) sector and the VA arising from digitalisation in the rest of the economy.

There remains a lack of consensus internationally on how to define and measure the digital economy. Various countries, organisations and academics have used different definitions of digital economy, with different assumptions and methodologies. Therefore, estimates on the size of digital economy are not easily comparable across jurisdictions. Caution needs to be exercised with international comparison of estimates of the digital economy. Instead, our main purpose in estimating the size of the digital economy in Singapore is to get a sense of its economic contribution and its change over time.

Singapore's Digital Economy (DE) continues to be significant. In 2023, the VA of Singapore's DE came in at S$113.2 billion in nominal terms. It accounted for **17.7% of Singapore's GDP** (or approx. S$1 out of every S$6 of our economy), sustaining the 2022 level[3]. Similar to 2022, the I&C sector accounted for around one third of Singapore's DE, with the remaining two thirds attributed to the VA arising from digitalisation in the rest of the economy.

Our DE in nominal terms grew at a compound annual growth rate **(CAGR) of 11.2% from 2018 to 2023**, almost double the nominal GDP growth rate (CAGR of 5.8%) over the same period.

[1] *This report is published by Infocomm Media Development Authority (IMDA), with inputs and data support from Ministry of Digital Development and Information of Singapore (MDDI), Ministry of Trade and Industry (MTI), Ministry of Manpower (MOM), Singapore Department of Statistics (DOS), Economic Development Board (EDB), Building and Construction Authority (BCA), Monetary Authority of Singapore (MAS), Government Technology Agency (GovTech), Agency for Science Technology and Research (A*STAR), Enterprise Singapore (Enterprise SG), etc.*

[2] *The new module will vary for subsequent years' SGDE reports.*

[3] *Singapore's digital economy size in 2022 was 17.3% of GDP as published in the Singapore Digital Economy Report 2023. It was re-estimated and revised upwards to 17.7% of GDP, due to the annual revision to National Accounts statistics by Singapore Department of Statistics (DOS) in 2024.*

Enterprise Digitalisation is Deepening Among SMEs

Digitalisation is becoming more pervasive among enterprises in Singapore, based on improved adoption of:

Digital areas[4]

94.6% of Singapore firms already implemented at least one digital area, an increase of 0.5 percentage point (pp) from 2022.

Digital solutions that support general business functions[5]

The share of SMEs that adopted at least one such solution has risen from 69% in 2021 to 82% in 2023. The general business functions that are most commonly digitised include Accounting, Document Management and Digital Marketing.

Digital solutions that support sector specific needs[6]

85% of SMEs adopted at least one sector-specific digital solution in 2023, up from 61% in 2021.

Importantly, digitalisation has brought positive impact to the enterprises. SMEs that adopted digital solutions under the Productivity Solutions Grant (PSG) have reported cost savings of around 50% on average during the period of 2018 to 2023.

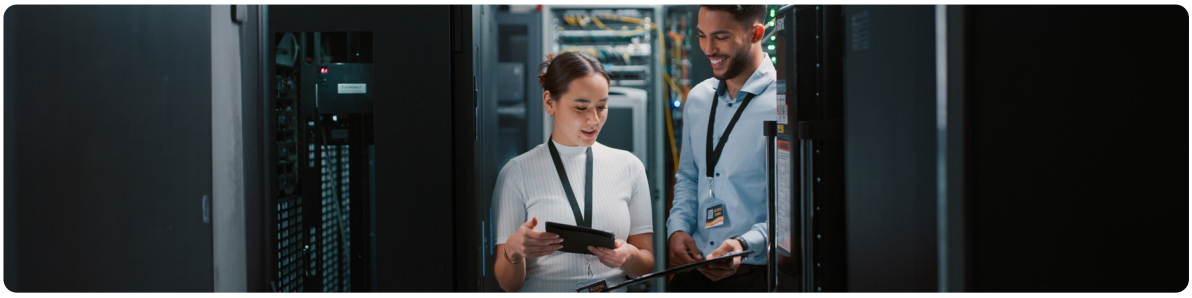
Adoption of AI on the Rise, Especially Among Larger Enterprises

The adoption rate of AI continues to rise. Among larger enterprises, 44% adopted AI in 2023, more than doubling the 16.7% in 2018. This is encouraging. SMEs also saw modest improvements in AI adoption rate, from 3.5% in 2018 to 4.2% in 2023.

Almost all SMEs and larger enterprises that adopted AI indicated that AI usage contributed to improvements in productivity and processes.

[4] *We examined six digital areas, namely Cybersecurity, Cloud, E-payment, E-commerce, Data Analytics and AI.*
[5] *General business functions refer to core activities that most businesses across all sectors perform to operate effectively, such as resource management and revenue generation functions. Digital solutions for such functions include Accounting Management, Human Resources Management, Customer Relationship Management, Collaboration Tools, etc.*
[6] *Examples of sector-specific digital solutions include Integrated POS (with mobile features) in the Retail sector, and Digital Ordering systems in the Food Services sector.*

Tech Jobs Continue To Grow and Pay Well



Demand for tech professionals[7] continued to rise in 2023. Despite the more cautious tech hiring taking place globally as well as in Singapore, tech jobs increased by 3.4% year-on-year to reach 208,300, from 201,400 in 2022. Tech professionals continued to account for 5.2% of total employment, similar to that in 2022.

The growth in tech jobs was largely driven by the non-I&C sector (i.e. the horizontal pillar of Singapore's DE) which grew by 5.0% in 2023, faster than the 1.4% increase in the I&C sector (i.e. the vertical pillar of Singapore's DE). This strong demand for tech professionals continues to benefit locals, with more than 70% of tech jobs held by Singaporeans and Permanent Residents.

Tech jobs continued to offer good and competitive wages in 2023. The median monthly wage (S$7,000) for resident[8] tech workers was much higher than the overall residents' median monthly wages (S$4,550) in 2023.

Digital Innovation Grows Steadily

Innovation is key to the long-term competitiveness of the digital economy. There is no internationally agreed standard to define and measure Digital Innovation, and a lack of international studies on Digital Innovation. Innovation activities are complex and can encompass many processes and outcomes, which make it difficult to define and measure. In this report, we focus on some of the activities related to Digital Innovation.

Digital Innovation in Singapore continued to grow over the years. Business Expenditure in R&D (BERD) in Digital Innovation[9] has grown from S$535 million in 2018 to S$1,058 million in 2021 (CAGR of 25.5% p.a.), faster than the growth of BERD in the overall economy (CAGR of 8.9% p.a.).

Product/service innovation in I&C sector has remained high compared to other major sectors, with close to half of I&C firms introducing digital products or services that are either new to enterprise or to market in 2023.

The number of digital tech startups (defined as tech startups in the I&C sector) has grown from 1,920 in 2018 to 2,580 in 2022[10] (CAGR of 7.7% p.a.), accounting for 53% of the total number of tech startups in Singapore.

Conclusion

Overall, Singapore's Digital Economy remained resilient in 2023 and its longer-term outlook remains positive.

[7] Tech professionals refer to those engaged primarily in infocomm and digital technology-related work either in an IT, online, software or telecommunication equipment and/or services provider, or user organisation (such as in a bank). The scope of work may include the development, distribution, implementation, support, operation, sales or marketing of telecommunication, computer hardware/software, IT services or multimedia contents.
[8] Residents refer to Singapore Citizens and Permanent Residents.
[9] BERD in Digital Innovation is defined as the sum of two components: 1) BERD in I&C sector and 2) BERD in Info-communication & Media (ICM) technology in the rest of the economy (i.e. BERD in ICM technology by non-I&C sectors).
[10] Based on latest available data on tech startups in the I&C sector (i.e. digital tech startups) (2022).

This annual report of Singapore Digital Economy seeks to provide a holistic analysis of the state of Singapore's Digital Economy (DE).

OVERVIEW OF SINGAPORE'S DIGITAL ECONOMY

There is a lack of consensus internationally on how to define and measure the digital economy. Various countries, organisations and academics have used different definitions of digital economy, with different assumptions and methodologies. Therefore, estimates on the size of digital economy are not easily comparable across jurisdictions. Caution needs to be exercised with international comparison of estimates of the digital economy. Instead, our main purpose in estimating the size of the digital economy in Singapore is to get a sense of its economic contribution and pace of change.

Using the same approach as outlined in the Singapore Digital Economy Report 2023[11], we define the Singapore's DE as comprising two components:

Value-added (VA) of the Information & Communications (I&C) sector

VA arising from digitalisation in the rest of the economy (i.e. excluding I&C sector)

The I&C sector[12] is a key driver of digitalisation, supplying digital services such as telecommunication, computer programming & IT consultancy, cloud computing, software development, as well as production and distribution of content and media. The I&C sector is commonly used by national statistical offices (NSOs) for GDP sectoral classification purposes, including in Singapore.

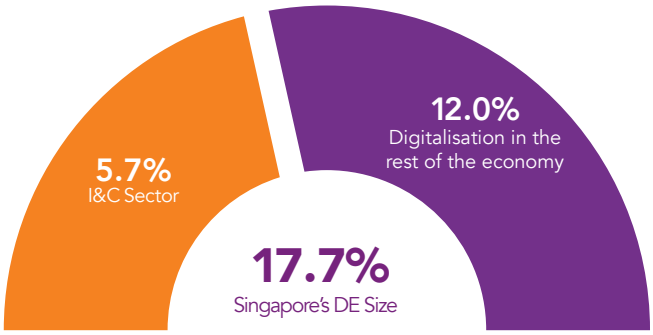
For the component of digitalisation in the rest of the economy, we define it as the VA generated from investment in digital capital across all other sectors (i.e. excluding the I&C sector). Firms invest in digital technologies to better reach customers, optimize business processes as well as for product and service innovation, which may in turn lead to better economic outcomes. Hence, part of their VA can be attributed to such digital investment. We estimate such VA based on the returns from digital capital investment and spending by different sectors using growth accounting technique[13].

In 2023, the SGDE accounted for 17.7% of Singapore's overall economy, sustaining the 2022 level. Singapore's overall nominal GDP declined by 2.0% in 2023. Correspondingly, our DE VA in nominal terms decreased slightly from S$115.9 billion in 2022 to S$113.2 billion in 2023. Nevertheless, the nominal overall DE VA has expanded at a CAGR of 11.2% p.a. over the period of 2018 to 2023, almost double the nominal GDP growth rate (CAGR of 5.8%) over the same period. As for the growth rate of SGDE in real terms, although there are no statistics to directly deflate the nominal DE VA, our estimates suggest that the year-on-year (yoy) change of SGDE in real terms was likely within 4% and 5%[14], as compared to the real GDP growth rate of the entire economy of 1.1% in 2023.

[11] *The Singapore Digital Economy Report 2023 can be found on IMDA's website: https://www.imda.gov.sg/-/media/imda/files/infocomm-media-landscape/research-and-statistics/sgde-report/singapore-digital-economy-report-2023.pdf.*
[12] *In the Singapore Standard Industrial Classification (SSIC) system, the I&C sector corresponds to SSIC 58-63.*
[13] *The growth accounting technique is used to estimate the portion of the VA in other sectors (finance & insurance, wholesale trade, manufacturing, etc.) of the economy that is contributed by digital capital. In particular, it decomposes the total returns to capital owners, i.e. gross operating surplus (GOS) which is a major component of GDP accounting from income approach, into returns to digital capital and returns to non-digital capita. Details of the methodology is discussed in the Singapore Digital Economy Report 2023.*
[14] *Based on IMDA's calculation using publicly available real VA for I&C sector, and a derived real VA from digitalisation using our own estimated deflator for GOS. See footnote 20 for more details.*

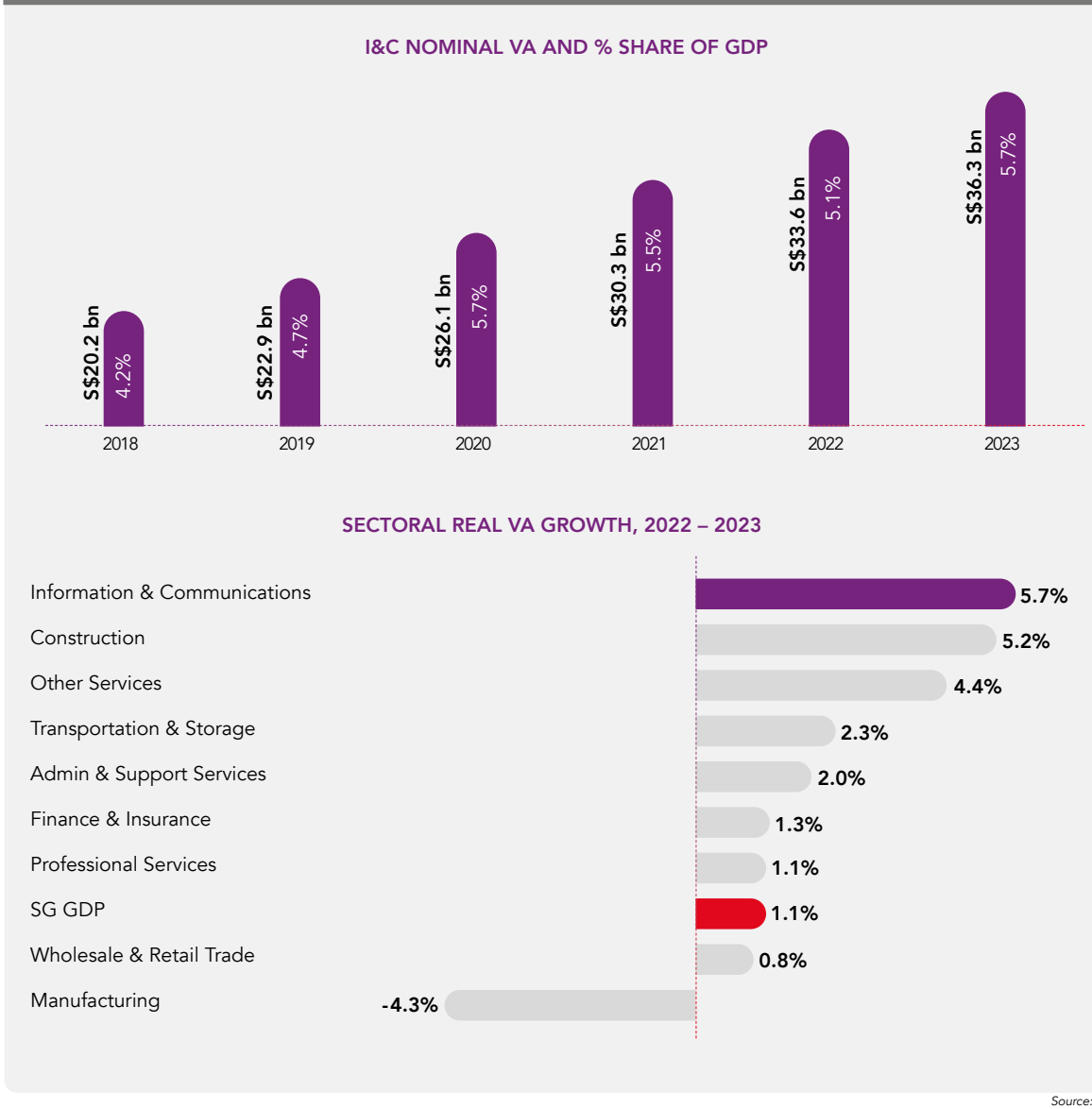
Similar to 2022, the I&C sector accounted for around one third of Singapore's DE, with the remaining two thirds attributed to the VA arising from digitalisation in the rest of the economy[15].

COMPOSITION OF SINGAPORE'S DIGITAL ECONOMY SIZE
(% OF GDP), 2023



The I&C sector is one of the key growth engines of the Singapore economy [Fig 1]. The sector's nominal VA amounted to S$36.3 billion in 2023, and its share of the economy rose to 5.7% of GDP, up from 5.1% in 2022[16]. Driven by sustained demand for digitalisation by enterprises, the I&C sector grew by 5.7% in real VA in 2023, and was one of the faster growing sectors of the economy.

FIGURE 1: **I&C SECTOR'S NOMINAL VA AND ANNUAL SECTORAL REAL VA GROWTH[17]**

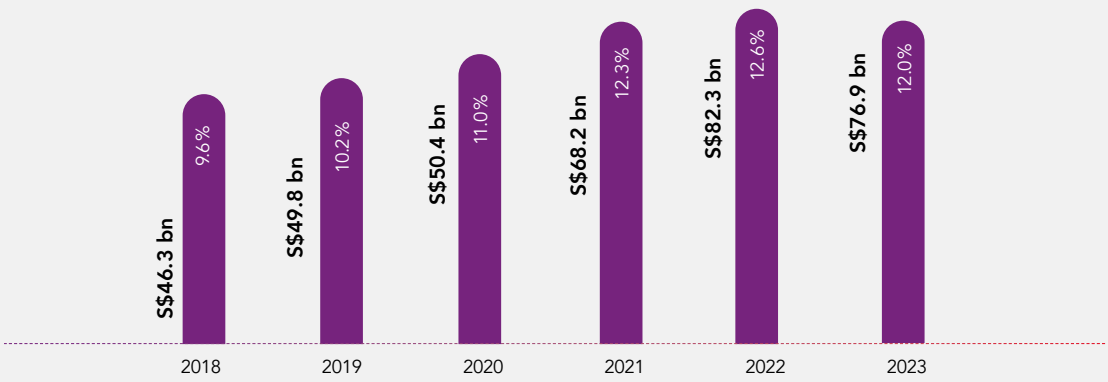


Source: DOS

[15] *In SGDE 2023 report, we have estimated the DE sizes of selected countries using our definition and method using data from external sources such as EU KLEMS. However, these data sources have not been updated since last publication, hence we are not able to provide updated estimates for other countries' DE sizes in this report.*
[16] *In this report, the latest available statistics for I&C sector as published by DOS were used.*
[17] *For the chart of sectoral real VA growth for selected sectors, Accommodation & Food Services is not included due to its relatively small size. In 2023, the sector grew by 7.4%.*

The nominal VA from digitalisation in the rest of the economy came in at S$76.9 billion in 2023, accounting for 12.0% of GDP. This was lower than the S$82.3 billion and 12.6% of GDP registered in 2022[18] [Fig 2]. The decline in nominal VA from digitalisation (i.e. returns to digital capital) came on the back of the drop in nominal GDP in the overall economy and especially the Gross Operating Surplus component of GDP in 2023[19]. If taken in real terms, while there is no fixed approach to deflating the *nominal* DE, the annual *real growth rate* was estimated to be between 3% and 4%[20], as compared to real GDP growth of 1.1% in 2023.

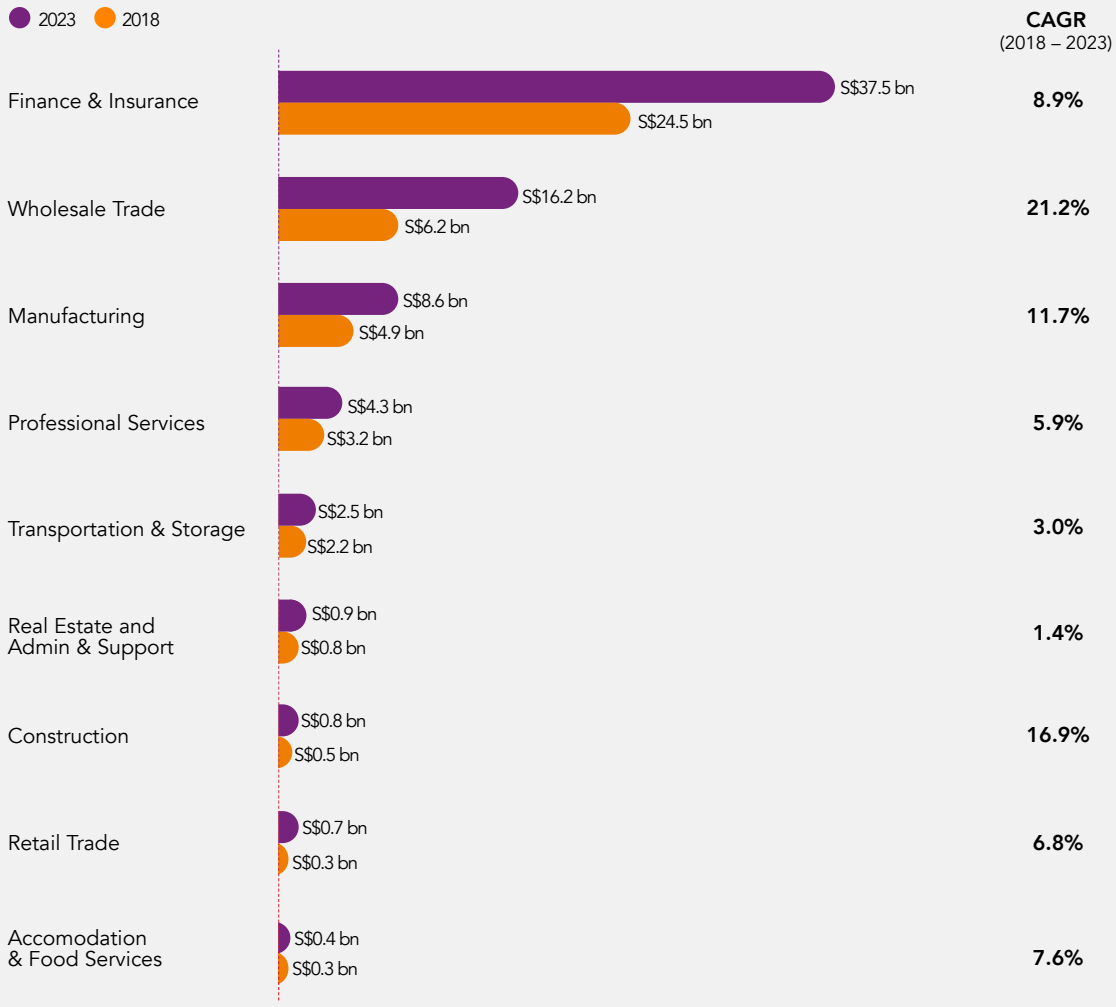
FIGURE 2: **NOMINAL VA FROM DIGITALISATION IN THE REST OF ECONOMY AND % SHARE OF GDP**



Source: IMDA

We further analysed the breakdown of the VA from digitalisation for key sectors of the economy [Fig 3]. The bulk of this VA was contributed by the Finance & Insurance, Wholesale Trade and Manufacturing sectors.

FIGURE 3: **VA FROM DIGITALISATION FOR SELECTED SECTORS, 2018 AND 2023**



Source: IMDA

[18] *VA from digitalisation for 2022 was revised upwards from the publication in Singapore Digital Economy Report 2023 due to annual update and revision to National Accounts statistics by DOS.*
[19] *In 2023, Singapore's nominal GDP fell by 2.0%, dragged down by the Gross Operating Surplus (GOS, i.e. total return to capital) component which decreased by 9.3% yoy. Hence, the estimated VA from digitalisation (i.e. return to digital capital) for 2023 has decreased yoy due to the fall in GOS. Nonetheless, the share of return to digital capital out of total return to capital continued to increase as digitalisation deepens.*
[20] *The VA from digitalisation is estimated from GOS, which is only available in nominal terms. To obtain real GOS, we derived an approximation of a GOS deflator using real GDP, nominal GDP and its compensation of employees (COE) component. Broadly, our approach first estimates a real COE using an implicit deflator derived from nominal and real wages. The GDP net of COE in both real and nominal terms are then used to arrive at a close proxy for the GOS deflator. This deflator is used to get a sensing of the real growth in VA from digitalisation.*

ENTERPRISE DIGITALISATION

Enterprises in Singapore continued to make progress in their digitalisation efforts. The digital adoption rate among all enterprises (percentage of firms adopting at least one out of the six digital areas examined[21]) rose by 0.5 percentage point (pp) to reach 94.6% in 2023. The digital adoption intensity (average number of digital areas adopted per firm, out of the six areas examined) also registered sustained improvement, reaching 2.0 last year, up from 1.9 in 2022.

The larger firms (non-SMEs) are already on a higher and relatively stable level of digital adoption [Fig 4]. On average, they adopted about 4.7 of the 6 digital areas examined, with e-payment and cybersecurity being adopted by almost all non-SMEs.

SMEs continued to make progress in digitalisation, with its adoption intensity improving from 1.9 in 2022 to 2.0 in 2023. There is still room for SMEs to improve, as the pace of digital adoption remains modest.

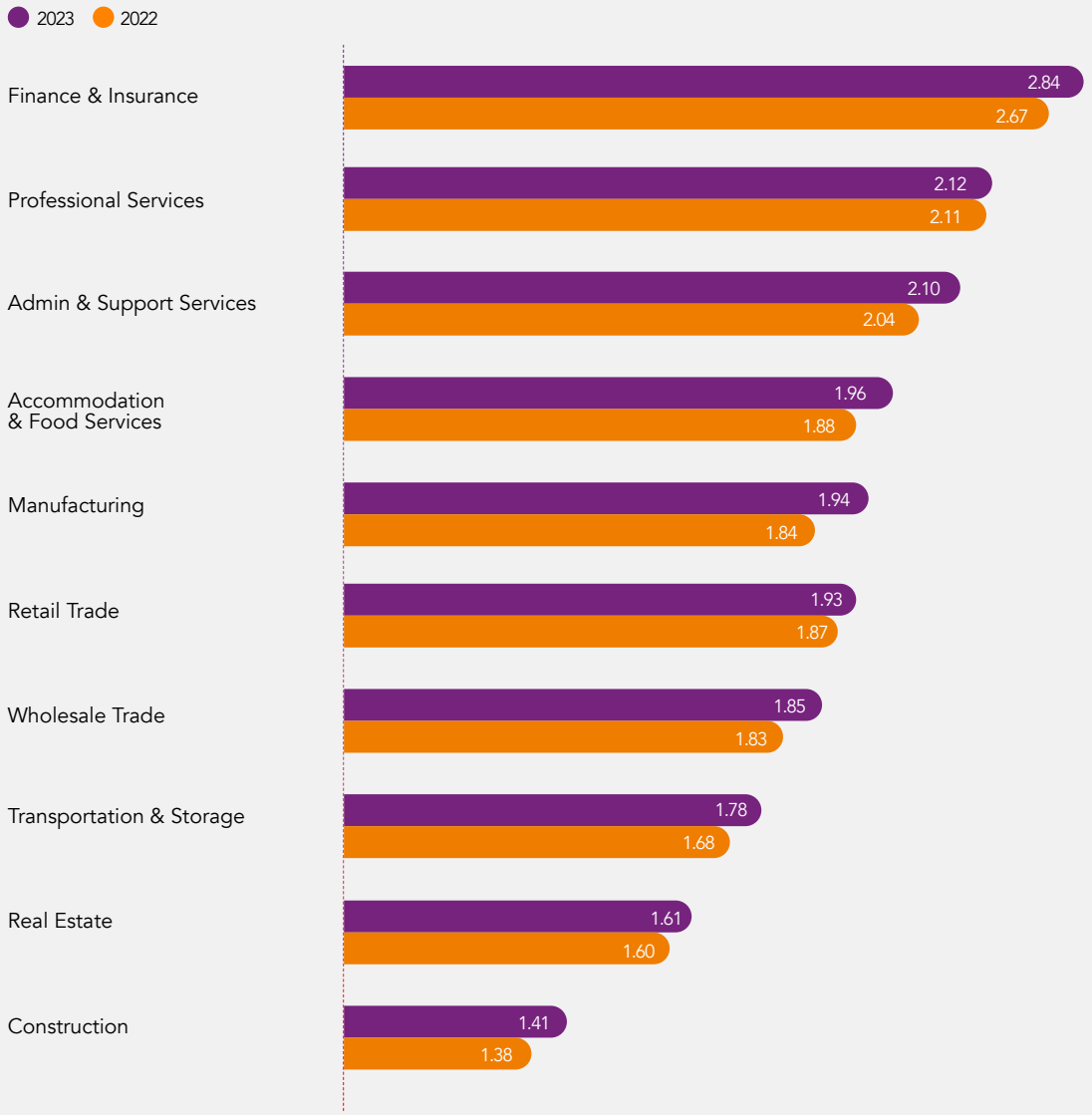
FIGURE 4: **DIGITAL ADOPTION RATE AND INTENSITY BY SMEs AND NON-SMEs, 2018 – 2023**

Source: IMDA

[21] *Percentage of firms that adopted at least one out of the six digital areas, namely Cybersecurity, Cloud, E-payment, E-commerce, Data Analytics and AI. Compared to SGDE2023 report, we have removed three digital areas namely IoT, Blockchain and Immersive Media from our basket, as these technologies may not have widespread applications across all sectors. This adjustment will better reflect the extent of technology diffusion across the whole economy.*

The digital adoption intensity improved across all sectors in 2023 compared to 2022 [Fig 5]. Sectors like Finance & Insurance and Professional Services adopted relatively more digital areas on average, as compared to sectors like Construction, Real Estate and Transportation & Storage.

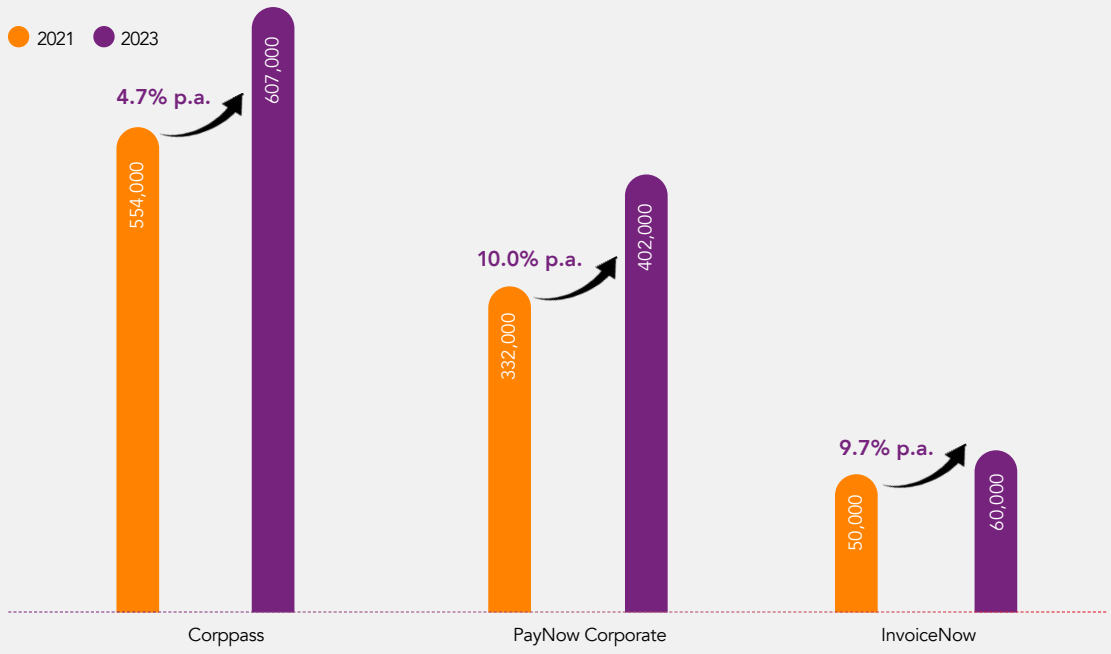
FIGURE 5: **DIGITAL ADOPTION INTENSITY FOR ALL ENTERPRISES BY SECTORS, 2022 AND 2023**



Source: IMDA

Digital Utilities (DUs), which refer to certain foundational functionalities brought by digital technologies, are essential to broad-based digitalisation. DUs, such as digital identity, e-payment and e-invoicing, serve as the soft digital infrastructure to enable interoperable digital transactions as well as trust and security. Today, the adoption of DUs has been encouraging. For instance, by 2023, Corppass and PayNow Corporate, Singapore's major digital identity and e-payment system, already achieved more than 90% adoption rate. Likewise, InvoiceNow, a national e-invoicing initiative, also made inroads among entities since its launch in 2019. Specifically, over 60,000 entities have been onboarded onto InvoiceNow by 2023, marking a 9.7% growth p.a. from 50,000 in 2021 [Fig 6].

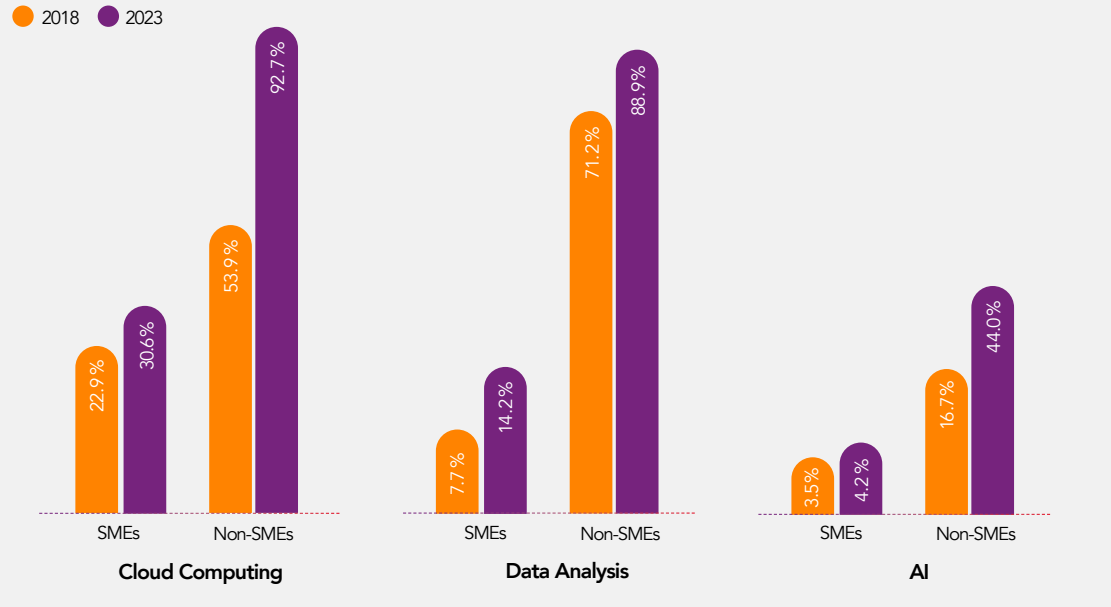
FIGURE 6: **NUMBER OF ENTITIES[22] THAT ADOPTED DIGITAL UTILITIES, 2021 AND 2023**



Source: GovTech, MAS, IMDA

As for more advanced digital areas such as Cloud Computing, Data Analytics and Artificial Intelligence[23] (AI), larger firms have seen significant increase in adoption over time, with the gap remaining between SMEs and non-SMEs [Fig 7]. A vast majority of non-SMEs have adopted cloud computing and data analytics in 2023, while about 2 in 5 non-SMEs have adopted AI in 2023.

FIGURE 7: **ADOPTION RATES OF SELECTED DIGITAL AREAS BY SMEs AND NON-SMEs, 2018 AND 2023**



Source: IMDA

[22] *Corppass and InvoiceNow adoption numbers cover a broader base to include not only business firms, but also entities such as charities, societies, government agencies, schools; while PayNow Corporate adoption number only includes entities registered with Accounting and Corporate Regulatory Authority of Singapore (ACRA).*

[23] *In IMDA's Annual Survey of Infocomm Usage by Enterprises, Artificial Intelligence (AI) is defined as a set of tools that enable computers or machines to perform tasks which typically require human intelligence. Some applications of AI include content generation, customer engagement, analytics and process automation. It also covers AI enabled digital solutions where AI is integrated with other software or platforms.*

DIGITAL ADOPTION BY SMEs

SMEs face various challenges and require more support in their digital transformation efforts. In this section, we will delve into the digital adoption of SMEs, to gain a deeper understanding of their digitalisation progress.

Digital solutions refer to applications that leverage various digital technologies to meet operational needs and support business functions. In this section, we aim to provide insights on SMEs' adoption levels of digital solutions, be it to address general business functions, or sector specific needs.

The share of SMEs that adopted at least one digital solution for general business functions[24] rose steadily from 69% in 2021 to 82% in 2023 [Fig 8].

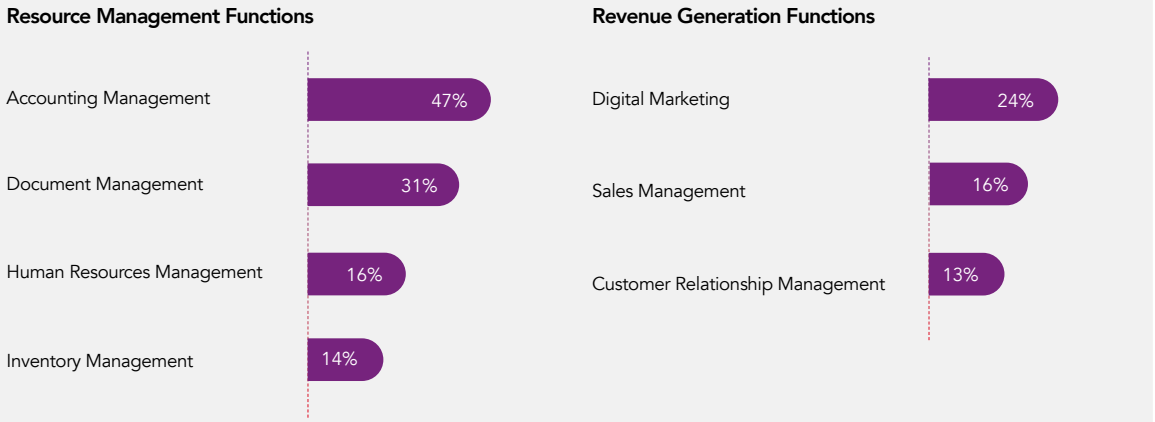
FIGURE 8: **SMEs' ADOPTION OF AT LEAST ONE DIGITAL SOLUTION FOR GENERAL BUSINESS FUNCTIONS, 2021 AND 2023**

Source: IMDA

[24] *These digital solutions address general business functions and could be applied across sectors, such as resource management and revenue generation functions. Such digital solutions include Accounting Management, Human Resources Management Customer Relationship Management, Collaboration Tools, etc..*

Among the digital solutions for general business functions, resource management functions such as Accounting Management and Document Management were more commonly adopted. In contrast, SMEs' adoption of digital solutions for revenue generation functions remained modest, except for Digital Marketing [Fig 9].

FIGURE 9: **SMEs' ADOPTION OF SELECTED DIGITAL SOLUTIONS FOR GENERAL BUSINESS FUNCTIONS BY SOLUTION TYPES, 2023**



Source: IMDA

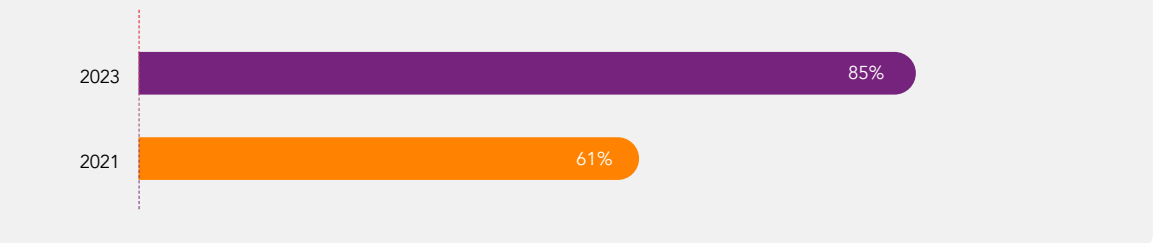
Diving deeper, the rate of adoption varied by firm age [Fig 10]. About nine in ten SMEs which are less than one year old adopted at least one digital solution for general business functions, which suggests that these younger firms are likely digital natives. About eight in ten SMEs that are older adopted at least one such digital solution, indicating an opportunity to improve the adoption among this segment.

FIGURE 10: **SMEs' ADOPTION OF DIGITAL SOLUTIONS FOR GENERAL BUSINESS FUNCTIONS BY FIRM AGE, 2023**

Source: IMDA

Beyond these solutions that address general business functions across all sectors, SMEs also made progress in adopting digital solutions that address sector-specific needs. In 2023, 85% of SMEs have adopted at least one sector-specific solution as recommended in IMDA's Industry Digital Plans (IDPs)[25], up from 61% in 2021 [Fig 11].

FIGURE 11: **SMEs' ADOPTION OF AT LEAST ONE SECTOR-SPECIFIC DIGITAL SOLUTION, 2021 AND 2023**

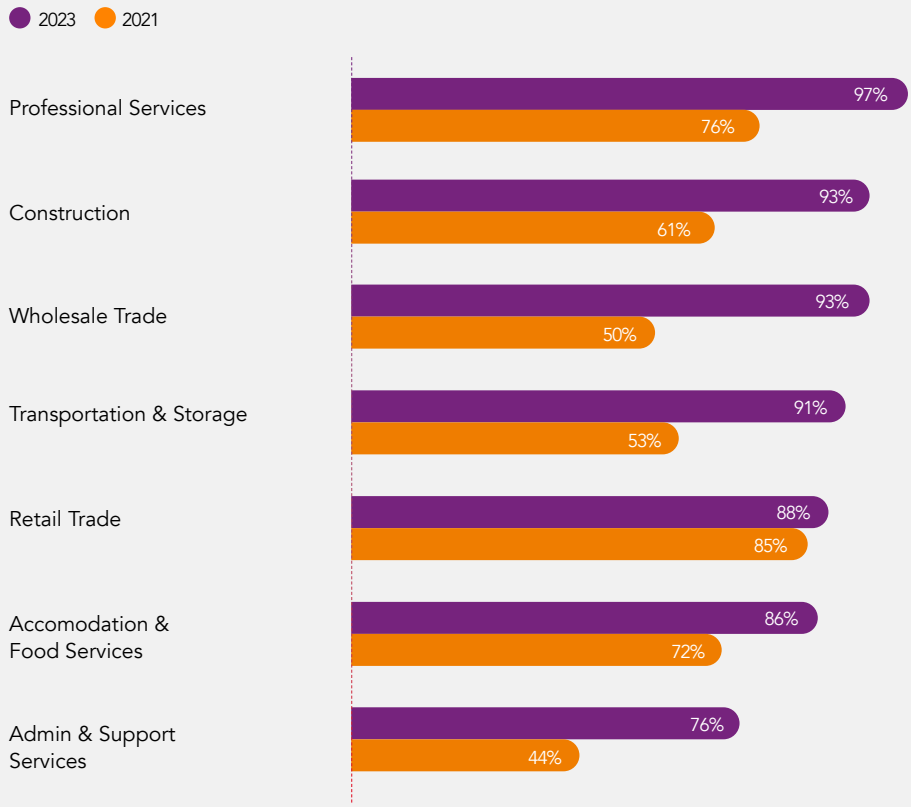


Source: IMDA

[25] *Industry Digital Plans (IDPs) provide SMEs with a step-by-step digitalisation guide, which includes a tailored set of sector-specific digital solution categories for adoption by SMEs at different stages of their growth. Examples of sector-specific solution categories include Integrated POS (with mobile features) in the Retail sector, and Digital Ordering systems in the Food Services sector.*

Across sectors, the adoption of sector-specific digital solutions by SMEs increased from 2021 to 2023, with Professional Services seeing the highest adoption and Wholesale Trade registering the largest increase [Fig 12]. The key factor driving the improvement for Professional Services was the adoption of solutions such as Document and Audit Management systems, while the improvement in the Wholesale Trade sector was due to the increased adoption of Workforce Management and Distribution Management systems.

FIGURE 12: **PERCENTAGE OF SMEs THAT ADOPTED AT LEAST ONE SECTOR-SPECIFIC SOLUTION FOR SELECTED SECTORS, 2021 AND 2023[26]**



Source: IMDA

The adoption of digital solutions has brought about noticeable impact among SMEs. For instance, SMEs which adopted digital solutions under the Productivity Solutions Grant (PSG) reported average cost savings of 48%[27], per solution adopted, during the 2018 to 2023 period, highlighting the benefits of digitalisation.

On the whole, the roll-out of IDPs and other digitalisation initiatives by the government have supported SMEs from different sectors in their digitalisation journey, which in turn brought about encouraging outcomes for firms. Looking ahead, IMDA together with other government agencies, will continue to drive SME digitalisation – from identifying problem statements to curating relevant digital solutions.

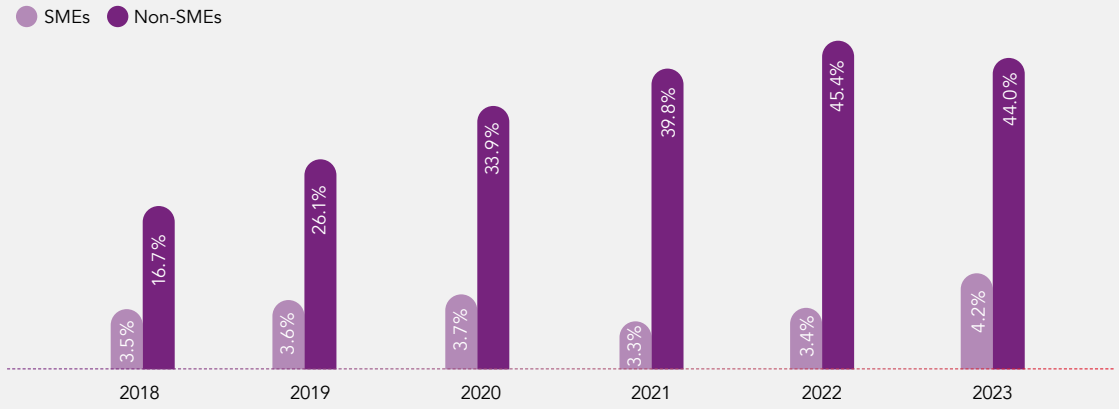
[26] IDPs are only available for selected industries, which constitute a subset of the broader economic sectors listed in Figure 12. For example, the Professional Services sector in this analysis only refers to the Accountancy industry which has an IDP. In addition, there is no IDP available for the Finance and Real Estate sectors. The Manufacturing sector is not included in the analysis as the relevant IDPs were launched after the 2021 survey.
[27] Based on PSG applicants' self-declared business outcomes after adopting the digital solutions. The statistic represents the average cost saving per firm per PSG application.

STATE OF ARTIFICIAL INTELLIGENCE (AI) ADOPTION AMONG ENTERPRISES

Singapore is committed to leverage AI in the next bound of our Smart Nation journey. This section seeks to shed light on the adoption of AI technology by enterprises in Singapore.

Generally, the overall adoption rate of AI has been rising over the 2018 - 2023 period, although there was significant variation in adoption levels across different firm types [Fig 13]. Specifically, 44.0% of non-SME firms adopted AI in 2023, more than doubling from 16.7% in 2018. AI uptake among SMEs stood modest at 4.2%, a slight improvement from the 3.5% in 2018.

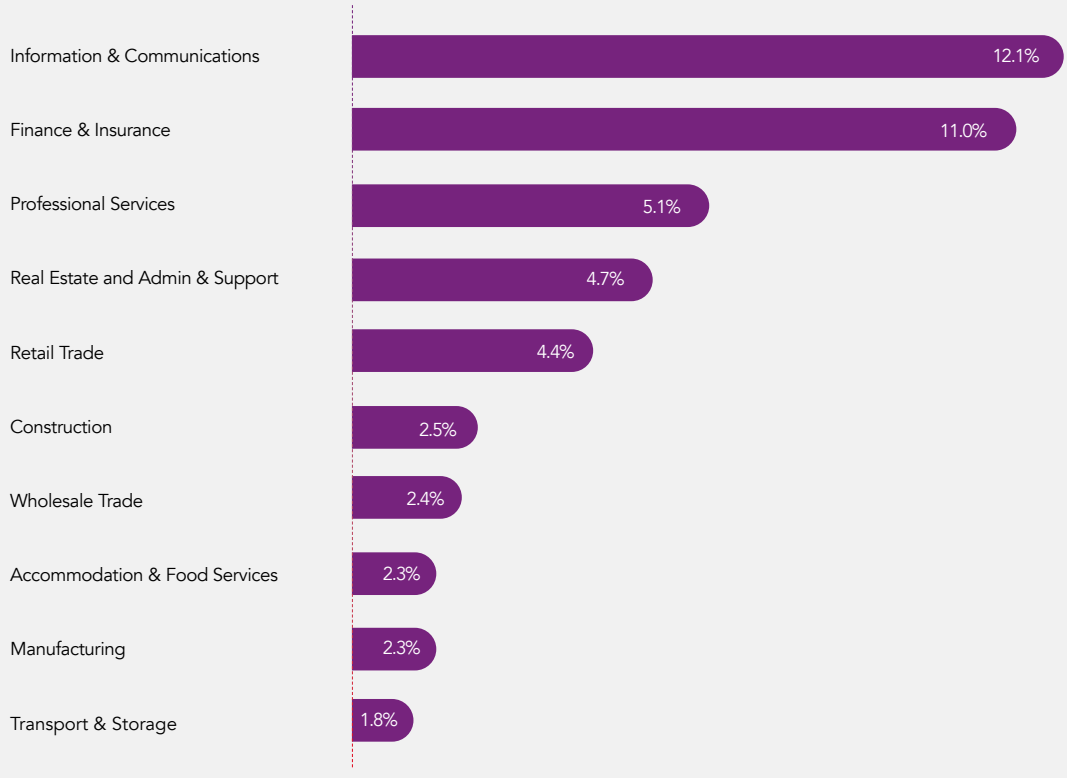
FIGURE 13: **PERCENTAGES OF SMEs AND NON-SMEs THAT ADOPTED AI, 2018 – 2023**



Source: IMDA

AI adoption differed significantly across sectors [Fig 14]. Notably, the I&C and Finance & Insurance sectors were leading the way, while AI adoption remained relatively low in sectors such as Transport & Storage, Manufacturing and Accommodation & Food Services.

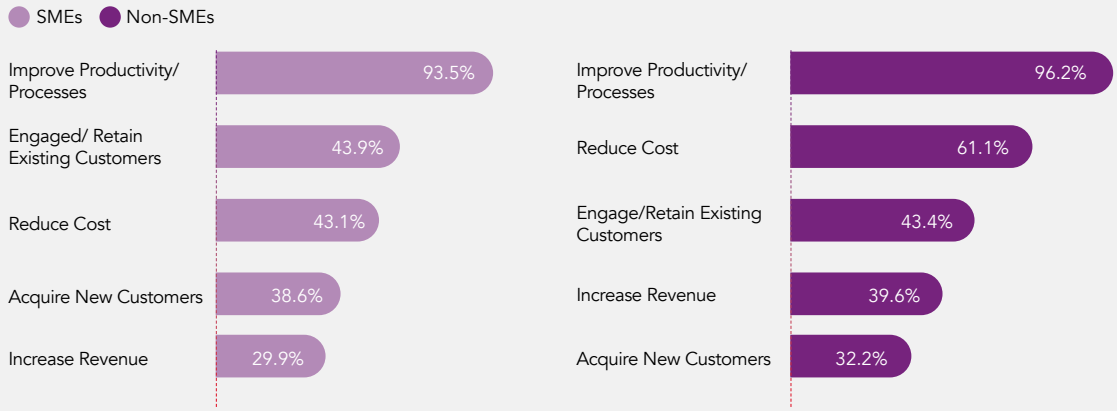
FIGURE 14: **PERCENTAGE OF ALL ENTERPRISES THAT ADOPTED AI BY SECTORS, 2023**



Source: IMDA

Firms that took up AI reported various benefits from using the technology [Fig 15]. In particular, 96.2% of non-SMEs and 93.5% of SMEs indicated that AI usage contributed to improvements in productivity and processes. Almost two thirds of non-SMEs also reported cost reduction from using AI.

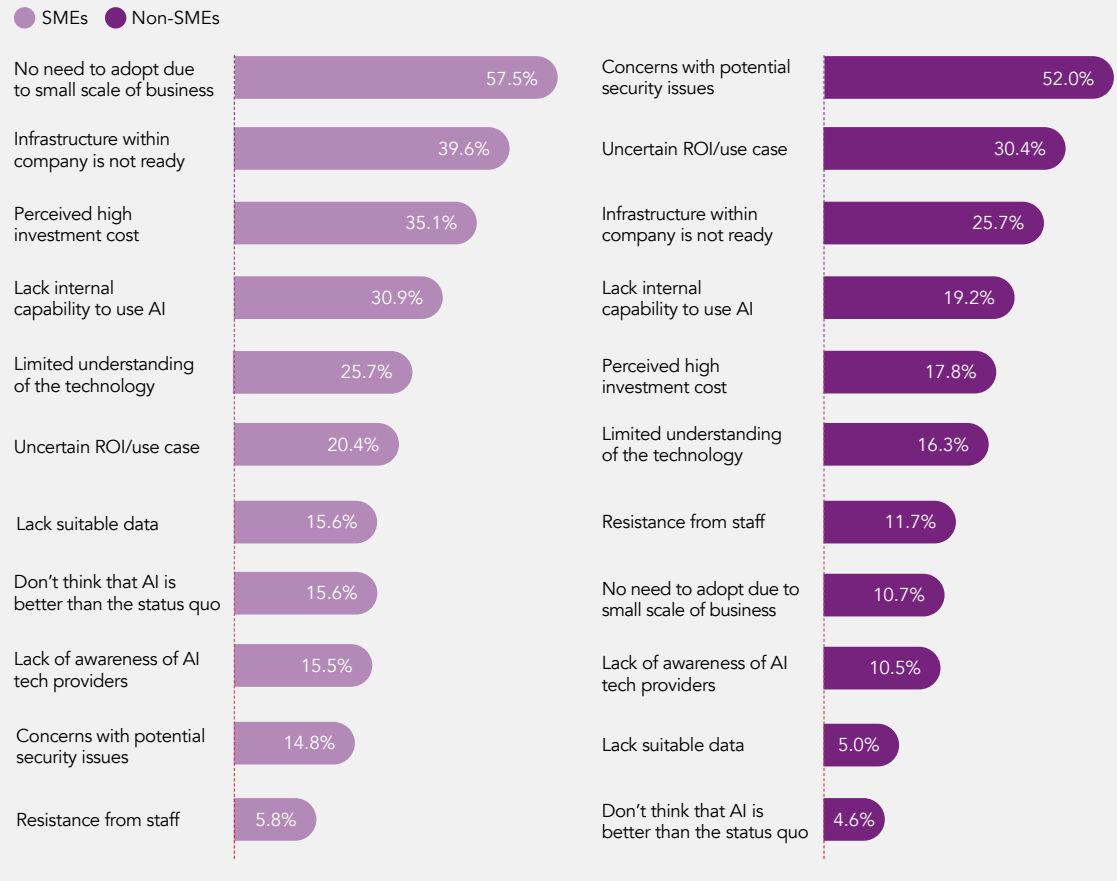
FIGURE 15: **BENEFITS OF USING AI BY FIRM TYPES, 2023**



Source: IMDA

There remains a sizable portion of enterprises that have yet to use AI and their reasons for not doing so differed for SMEs and non-SMEs [Fig 16]. For instance, "concerns with potential security issues" was the top reason mentioned by more than half of non-SMEs, followed by "uncertain ROI or use case". By comparison, for SMEs, 57.5% indicated "no need to adopt AI due to the small scale of their businesses". This was followed by reasons such as insufficient infrastructure and high investment costs. These findings suggested the need for different measures targeted at different types of firms.

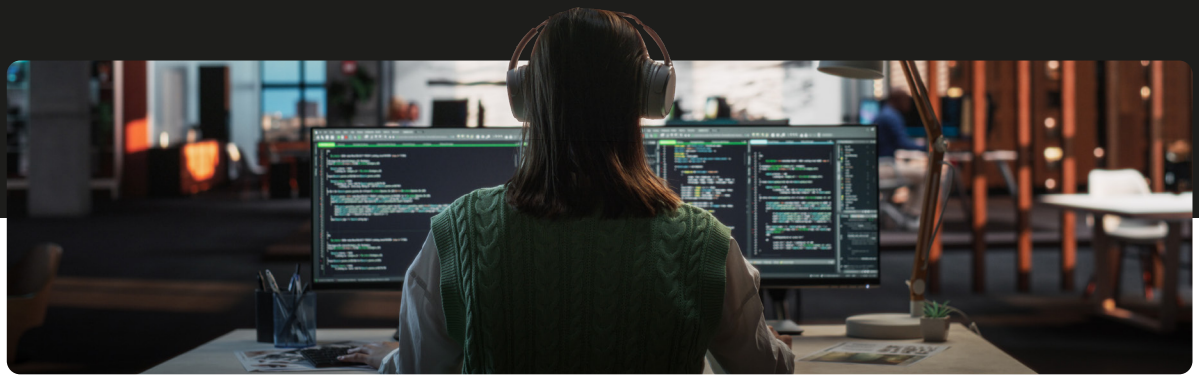
FIGURE 16: **REASONS FOR NOT USING AI FOR SMEs AND NON-SMEs, 2023**



Source: IMDA

IMDA supports AI adoption for both the broad base of SMEs and the digitally mature companies. For SMEs, approximately 20% of all pre-approved solutions on the Chief Technology Officer as-a-Service (CTOaaS) Platform are AI-enabled. Digitally mature companies can leverage the Gen AI x Digital Leaders programme to develop bespoke AI solutions to address their business needs.

MANPOWER ASSOCIATED WITH THE DIGITAL ECONOMY



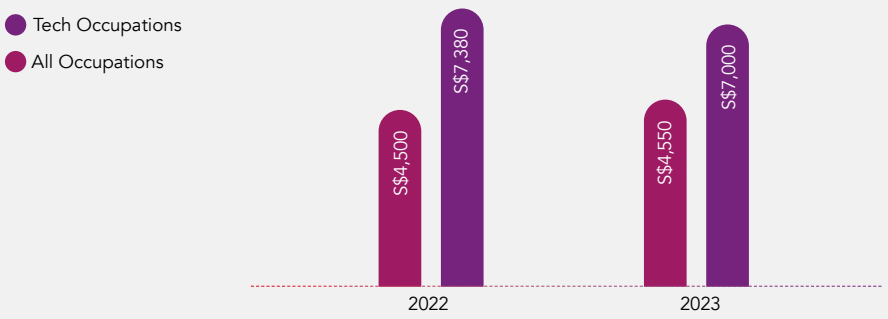
Despite the tech sector's cautious hiring outlook globally and domestically in 2023, the number of tech jobs in Singapore rose by 3.4% from 201,400 in 2022 to 208,300 in 2023 [Fig 17], moderating slightly from the 4.3% y-o-y growth in 2022. Job roles related to cybersecurity, AI & data and product development were among the faster growing tech jobs in 2023. The increase in number of tech jobs was largely driven by the non-I&C sectors which grew by 5.0% in 2023, faster than the 1.4% growth in the number of tech jobs for the I&C sector. Overall, tech jobs accounted for 5.2% of total employment in 2023, similar to that in 2022.

FIGURE 17: **NUMBER OF TECH PROFESSIONALS, 2022 AND 2023**

Source: IMDA, MOM

Tech jobs continued to offer good wages to workers. The median monthly wages for resident tech workers grew at a CAGR of 4.0%, higher than the CAGR of 3.7% for overall resident workers' median monthly wages[28], between 2018 and 2023. Although median monthly wages for resident tech workers eased slightly from 2022 to 2023, in line with the more cautious hiring outlook of the tech sector, it remained much higher at S$7,000 compared to the median monthly wages for overall resident workers of S$4,550 in 2023 [Fig 18].

FIGURE 18: **RESIDENT MEDIAN MONTHLY WAGE BY OCCUPATIONS (S$), 2022 AND 2023**



Source: MOM

[28] Data for "All Occupations" pertains to median gross monthly income from work (excluding employer's CPF contribution) of full-time employed residents from Comprehensive Labour Force Survey, Manpower Research & Statistics Department, MOM. Data for "Tech Occupations" pertains to median gross monthly wages (excluding employer's CPF contribution & bonuses) of full-time resident employees from Occupational Wage Survey, Manpower Research & Statistics Department, MOM. Data for 2022 and 2023 were coded based on Singapore Standard Occupational Classification (SSOC) 2020 and data for 2018 were coded based on SSOC 2015. The tech occupational grouping for 2022 and 2023 data had been updated to include Interaction designer (21664) and exclude Media and broadcasting engineer (21531) and Multimedia artist and animator (21663).

DIGITAL INNOVATION

Innovation in the digital economy (referred to as "Digital Innovation" in this report) is key to our competitiveness. Digital Innovation brings about development of new technologies and products as well as improvement in business processes, which in turn contribute to the growth of the digital economy.

There is no internationally agreed standard to define and measure Digital Innovation, and a lack of international studies on Digital Innovation. Innovation activities are complex and can encompass many processes and outcomes, which make it difficult to define and measure.

In this report, we focus on some of the key activities related to Digital Innovation to provide some insights on the state of Digital Innovation in Singapore. Specifically, we will examine activities such as:

- Research & Development (R&D)
- Firms with new digital products and services
- Tech Startups in Singapore

Research and Development (R&D)

R&D, as measured by Business Expenditure in R&D (BERD), is a key component of Digital Innovation. We define BERD in Digital Innovation as the sum of two components:

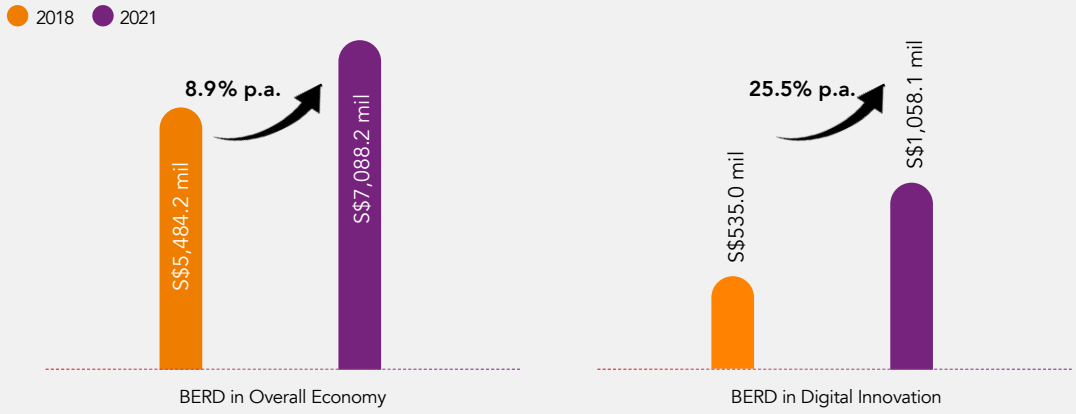
01 **BERD in I&C sector:**
This reflects the total spending on R&D by firms in the I&C sector.

02 **BERD in Info-communication & Media (ICM) technology[29] in the rest of the economy[30] *(i.e. BERD in ICM technology by non-I&C sectors)*:**
Firms in non-I&C sectors may also undertake R&D in digital-related technologies. Hence, this component captures R&D spending on ICM technology by firms in non-I&C sectors.

[29] *According to the National Research, Innovation and Enterprise (RIE) Survey (administered by A*STAR), the types of R&D conducted are classified by fields of Science and Technology. One field called "Info-communication & Media (ICM) technology" includes two broad areas, namely (i) Info-communication & Media Technology which covers information and communication technologies and digital media/communication; and (ii) Computer & Related Sciences which covers computer programming, computer studies, electronic data processing, information sciences, system analysis and areas related to software development.*
[30] *R&D in ICM technology for the I&C sector are included under the computation for BERD in I&C sector.*

Based on this definition, BERD in Digital Innovation almost doubled from S$535 million in 2018 to S$1,058 million in 2021[31], with a CAGR of 25.5% p.a.. This growth was faster than the growth of BERD in the overall economy (CAGR of 8.9% p.a.) [Fig 19]. The share of BERD in Digital Innovation out of BERD in overall economy rose from 9.8% in 2018 to 14.9% in 2021.

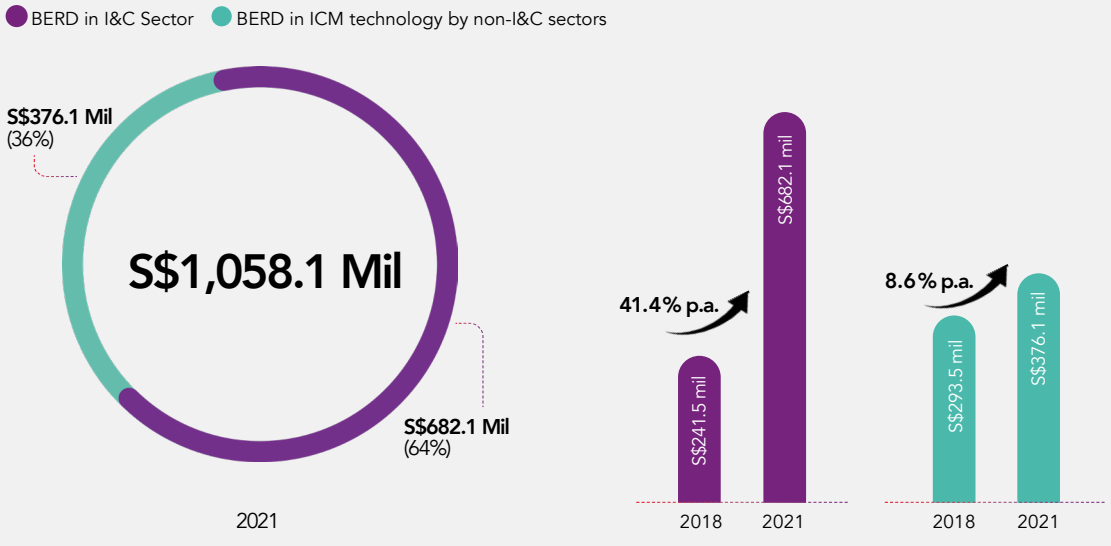
FIGURE 19: **BERD IN OVERALL ECONOMY AND IN DIGITAL INNOVATION, 2018 AND 2021**



*Source: IMDA and A*STAR*

The I&C sector plays an important role in driving BERD in Digital Innovation. BERD in I&C sector increased from S$241.5 million to S$682.1 million between 2018 and 2021, at a CAGR of 41.4% p.a. [Fig 20]. The I&C sector accounted for about two-thirds (64%) of BERD in Digital Innovation in 2021, an increase from 45% in 2018.

FIGURE 20: **BERD IN DIGITAL INNOVATION, 2018 AND 2021**

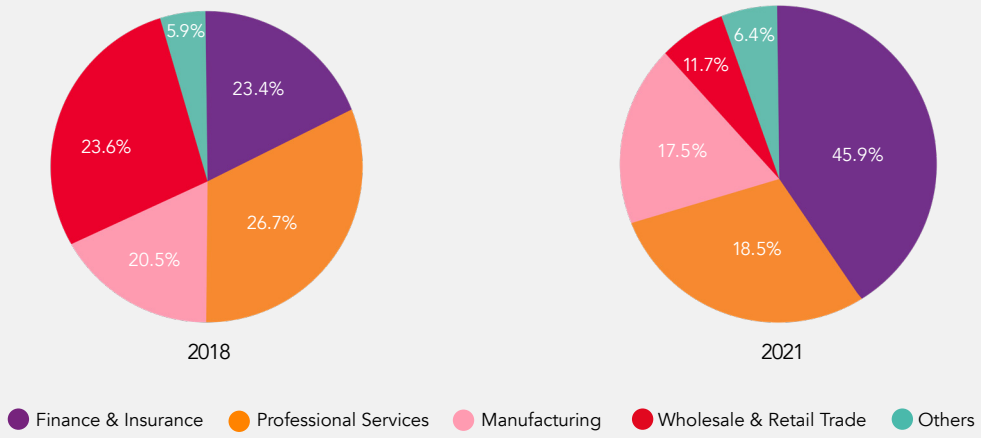


*Source: A*STAR*

[31] *Based on latest available data on BERD from A*STAR (i.e. 2021)*

The remaining one-third of BERD in Digital Innovation was driven by non-I&C firms investing in BERD in ICM technology[32]. Among the non-I&C sectors, the Finance & Insurance sector was the largest contributor. Its share of total BERD in ICM technology grew considerably from 23.4% in 2018 to 45.9% in 2021, reflecting an increasing focus on Digital Innovation within the sector. Other sectors such as Professional Services, Manufacturing, and Wholesale & Retail Trade also made substantial contributions, accounting for 18.5%, 17.5%, and 11.7% of the total BERD in ICM technology respectively in 2021 [Fig 21]. The diverse contributions highlight the role that the various sectors play in driving Digital Innovation in the economy.

FIGURE 21: **CONTRIBUTION OF BERD IN ICM TECHNOLOGY BY NON-I&C SECTORS, 2018 AND 2021**

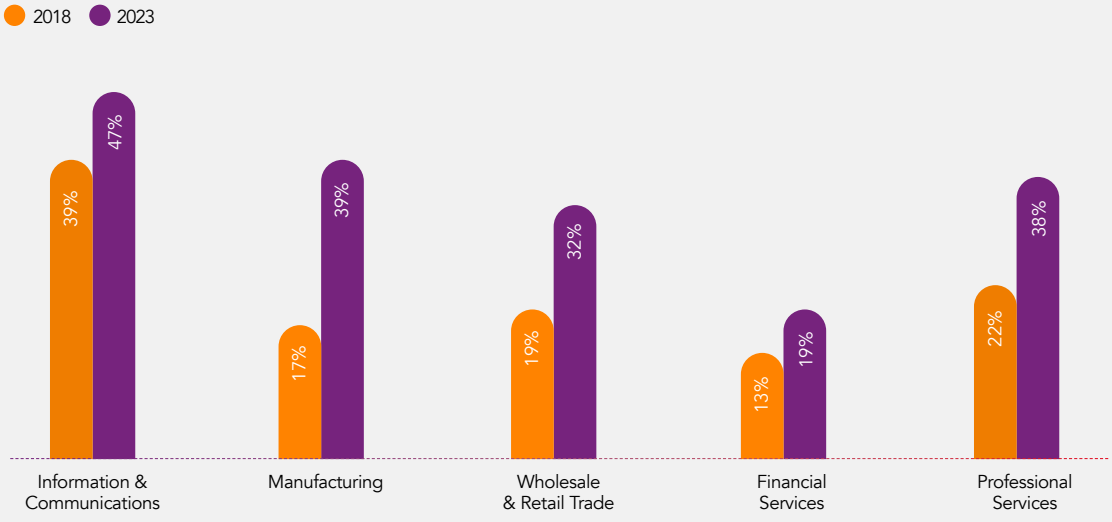


*Source: A*STAR*

Firms with New Digital Products and Services

The development of new digital products and services is another indicator of Digital Innovation. Product/service innovation for I&C sector firms has remained consistently high compared to the other major sectors. In 2023, close to half of the firms within the I&C sector introduced digital products/services that are either new to the enterprise or market [Fig 22], reflecting a healthy level of innovative activities by firms in the sector in developing new digital products/services.

FIGURE 22: **SHARE OF FIRMS INTRODUCING NEW DIGITAL PRODUCTS OR SERVICES BY KEY SECTORS, 2018 AND 2023**



Source: IMDA

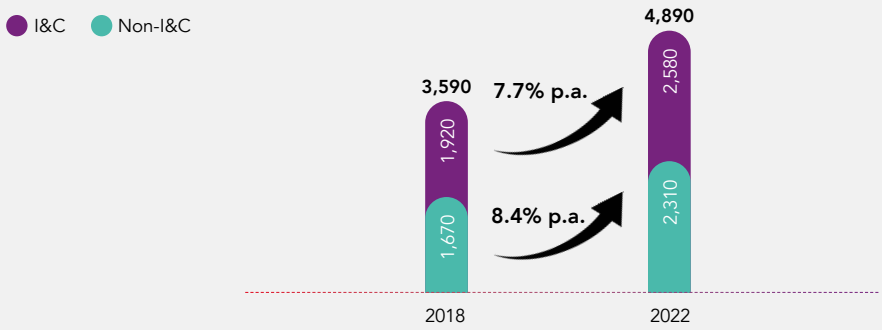
[32] *BERD in ICM technology accounted for 5.9% of the total BERD of non-I&C sectors in 2021, inching up slightly from that in 2018.*

Tech Startups

Startups are important catalysts of innovation in the economy as such firms may introduce new products/services or more efficient ways of production. To understand the startup landscape in the DE, we focus our analysis on tech startups[33] in the I&C sector, which will be referred to as digital tech startups for the purpose of this report[34].

The number of digital tech startups in Singapore has been rising over the years. Specifically, the number of digital tech startups in 2022 was around 2,600, representing 53% of the total number of tech startups in Singapore in 2022. The number of digital tech startups has increased at a CAGR of 7.7% p.a. between 2018 and 2022 [Fig 23].

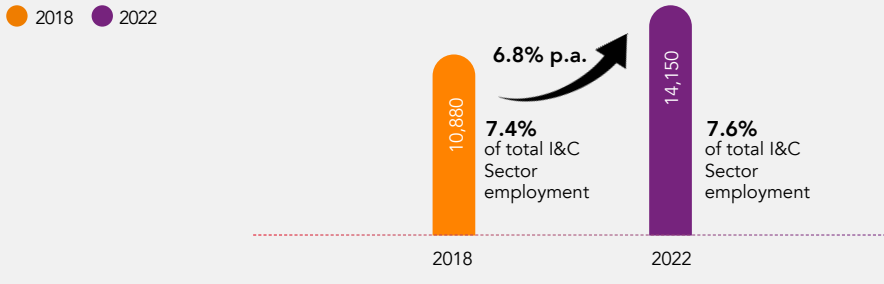
FIGURE 23: **NUMBER OF TECH STARTUPS, 2018 AND 2022**



Source: DOS

Digital tech startups contributed much to employment among the tech startups, accounting for an average of 46% of total employment in tech startups between 2018 and 2022. Employment in digital tech startups registered a CAGR of 6.8% p.a., growing from 10,880 employees in 2018 to 14,150 employees in 2022. Share of employment in digital tech startups out of total employment in I&C sector also saw a slight increase from 7.4% to 7.6% between 2018 and 2022 [Fig 24].

FIGURE 24: **NUMBER OF EMPLOYEES IN DIGITAL TECH STARTUPS, 2018 AND 2022**



Source: DOS, MOM

[33] According to Enterprise Singapore (EnterpriseSG), tech startup is defined as an enterprise that (i) has been registered in the past 10 years, (ii) not a subsidiary of a corporate entity at point of incorporation, and (iii) develops or possesses innovation. Innovation is defined as the development, production or commercialisation of tech products services or platform; or holding of a patent registered with an approved national IP institution; or having an ongoing research collaboration with a research institution (contract of services is not considered to be research collaboration).

[34] EnterpriseSG's definition of tech startups encompasses those operating in the digital and non-digital space. Hence, to proxy for tech startups that contribute to innovation in the digital economy, this report focuses on tech startups in the I&C sector. While tech startups from other sectors may also engage in innovation activities, the innovation activities undertaken by these tech startups may include innovation in areas that fall outside the scope of our analysis (e.g. agritech, biotech, medtech).

CONCLUSION

Our digital economy remains a key driver of the Singapore economy, sustaining its share of GDP at 17.7% in 2023. Digitalisation among SMEs is deepening, with a greater share of SMEs adopting more digital technology and solutions. In emerging tech areas such as AI, adoption is rising but there remains much room for further adoption. The number of tech professionals continued to rise in 2023, in spite of a more cautious hiring outlook worldwide. Innovation in the digital economy has been healthy, as evident from the growing investments in digital R&D as well as from the growing presence of digital tech startups.

As the rate of change in digital technology accelerates, the future is being re-imagined by tech. IMDA will continue to work with other government agencies to put Singapore businesses at the forefront, and to work with the industry, the labour movement and research institutions to architect Singapore's digital future.

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