

2020

SINGAPORE BLOCKCHAIN ECOSYSTEM REPORT

Supported by:



Monetary Authority
of Singapore

A collaboration by:



Disclaimer

The information in this report is provided on an “as is” basis. With the support of the Infocomm Media Development Authority (IMDA) and the Monetary Authority of Singapore (MAS), this document was produced in collaboration by OpenNodes, Temasek, IBM, PwC Singapore, EY and SGTech as of the date of writing and may be subject to changes without prior notice. The findings, interpretations, and conclusions expressed in this publication do not necessarily reflect the views of the entities involved or any of their affiliates.

This report is intended for general guidance and information purposes only. This report is under no circumstances intended to be used or considered as financial or investment advice, a recommendation or an offer to sell, or a solicitation of any offer to buy any securities or other form of financial assets.

OpenNodes, Temasek, IBM, PwC Singapore, EY, SGTech, IMDA, MAS and their respective affiliates make no representation or warranty, either expressed or implied, as to the accuracy or completeness of the information in the report and shall not be liable for any loss (direct or indirect) arising from or otherwise in connection with the use of this report or its contents.

The contents of this report are not to be construed as legal, business, investment or tax advice. Each recipient should consult with its legal, business, investment and tax advisers as to legal, business, investment and tax advice.

Rights & Permissions

This report is subject to the copyright of OpenNodes, Temasek, IBM, PwC Singapore, EY, SGTech, IMDA and MAS. Content from this report may be reproduced, in whole or in part, solely for non-commercial purposes only provided full attribution to this work is given to the aforementioned entities.

Credits

Design & Compilation (OpenNodes):

Ivan Hong Dian Jie, Alicia Chong Li-Yan, Jolene Goh Wan Teng

Images:

Images throughout the report were sourced from Unsplash

Foreword	5
Executive Summary	6
Introduction	8
Singapore Blockchain Ecosystem Survey	9
About the survey	10
Survey respondents	11
Key findings	12
Blockchain Ecosystem Development	17
The Value of Ecosystems	18
Accelerating Startups	19
Industry Roundtables	20
Ecosystem Map 2020	21
Connecting to Global Ecosystems	22
Deepening Technical Capabilities	23
Governance & Regulatory Frameworks	23
Growing The Next Generation of Tech Talent	25
Engaging Students	26
Training Developers	27
Upskilling Business Professionals	29
Industry-Led Blockchain Projects	30
Financial Services	31
Food Industry	37
Consumer Retail	39
Trade	41
Digital Identities & Credentials	42
Blockchain Scientific Activity in Singapore	43
Main Focus Areas	44
Research Productivity & Quality	45
In Summary	48



FOREWORD

The first blockchains were published nearly 12 years ago now. Fast forward to today, distributed ledger technologies are providing new ways in which we can cooperate to create value. From enabling the authentication of documents, or tracking the movement of goods and people, to new open-source business models - these early experiments with blockchain are laying the foundations of a new digital economy. One in which competitiveness is increasingly defined by collaboration, one in which transparency is the norm, not the exception.

More than a decade on, blockchain technology has found fertile ground in Singapore in a range of applications. A variety of blockchain projects have emerged across 26 different categories and 8 different industries: from financial services, to supply chain management, and consumer retail. More companies are discovering how blockchain-based technologies can create common platforms for stakeholders along the value chain to improve workflow processes, reduce fraud, and create new sources of value for end consumers. While the global pandemic has impacted the progress of blockchain projects in some sectors, others are using blockchain technology to address the challenges which COVID-19 has created. As the technology continues to grow in security, scalability, and adoption, we can expect to see its diffusion throughout the broader economy in Singapore.

Much in the same way that we have seen blockchain bring firms together to address common issues, this report has brought together various stakeholders in government and industry with the common aim of growing Singapore's blockchain ecosystem. This report was made possible by the combined efforts of a year-long collaboration between OpenNodes, Temasek, IBM, PwC Singapore, EY and SGTech with the support of government agencies such as the Infocomm Media Development Authority (IMDA) and Monetary Authority of Singapore (MAS). The contributions of various business leaders' insights from the field were also invaluable. These collaborative efforts to grow the ecosystem will continue throughout the next year, as it has in the last.





EXECUTIVE SUMMARY

Singapore is fast becoming a leader in blockchain technology, both in the region as well as globally. A PwC survey conducted in Singapore found that businesses reported optimism over the growth of blockchain adoption in Southeast Asia, with many ranking Singapore as a global leader in the field ahead of countries such as the United Kingdom, Hong Kong and Japan. Numerous business leaders interviewed for this report identified regulatory clarity as a key factor in influencing their decision to house their blockchain activities in Singapore.

More blockchain-related projects are setting up in Singapore, while existing ones are gaining ground in both technical progress and funding. The Singapore blockchain ecosystem has seen substantial growth since 2019, according to the 2020 edition of the Singapore Blockchain Landscape Map jointly published by the IMDA and OpenNodes. Additionally, the PwC survey indicated that more in-house blockchain projects here are progressing towards full-scale deployment, while blockchain startups are moving towards more mature funding stages.

Finance and tech companies are spearheading the growth of blockchain use in Singapore. Much of this growth is traceable to industry consortiums established to address common pain points, as well as the use of blockchain for cross-border payments and asset securitisation. A new category, decentralised finance (DeFi) was also added to this year's edition of the Singapore Blockchain Landscape Map. The addition reflects the numerous developments in blockchain projects announced by the financial services sector in 2020. Trade and supply chain management follows closely behind. Much of the growth has been driven by consortia and other collaborations between firms along the value chain to enhance process efficiencies and tackle fraud. Blockchain projects in some consumer-facing sectors have had their progress hampered by the impact of the COVID-19 global pandemic as internal resources were diverted to address near-term priorities. However, blockchain projects in core sectors like food and energy have continued largely unaffected. Additionally, some companies have pivoted towards using blockchain to address the challenges of contact-tracing and health certification as countries work towards resuming international travel safely.

Research relating to blockchain in Singapore also appears to be thriving in both quantity and quality, with contributions from both academic institutions and the private sector. Bibliometric analysis of blockchain-related research publications from the Web of Science



database reveals that Singapore ranks 15th globally in terms of its share of publications, placing Singapore 5th in the Asia-Pacific region (behind China, Australia, South Korea and Japan) and the 1st in the ASEAN region. For its size, Singapore has produced nearly 28 blockchain-related publications per million resident population, one of the highest in the world. The high quality of blockchain research in Singapore is also notable. Singapore ranks 6th place globally among all blockchain-related publications identified as highly-cited in their field by the Web of Science. Surprisingly, the average number of citations for blockchain publications from Singapore (12.23) is one of the highest in the world, significantly ahead of countries like the US (9.7).

Key academic institutions involved in blockchain research are the major autonomous universities such as the National University of Singapore (NUS), Nanyang Technological University (NTU), Singapore Management University (SMU) and the Singapore University of Technology and Design (SUTD). About 80% of blockchain-related publications from Singapore have co-authors from one of these institutions. From the private sector, large multinational corporations such as IBM, Ant Financial, and Visa Inc. and also smaller home-grown startups such as Zilliqa and Kyber Networks publish research on blockchain technologies.

Three core research themes can be identified: technological developments, achieving scalability, and building ecosystems. Research into technological developments covered areas such as digital currencies, privacy and cybersecurity, and smart contract security. Achieving scalability, as well as building ecosystems were also key research areas with topics covered like interoperability, incentives, governance, and legal issues.

Finally, this report also highlights the various initiatives in Singapore aimed at growing the blockchain ecosystem. These different initiatives seek to grow the tech talent pool, support collaborations between academia and industry, and promote consortia to address common pain points. As successful deployments of blockchain technology become more prevalent with finance and logistics firms leading the way, growing awareness of blockchain's use cases may well spur the diffusion of blockchain technology more widely throughout the rest of the economy.

Certain data included herein are derived from Clarivate Web of Science. © Copyright Clarivate 2020. All rights reserved.



INTRODUCTION

The 2019 Singapore Blockchain Ecosystem report, jointly published by ConsenSys, the Infocomm Media Development Agency (IMDA), the Monetary Authority of Singapore (MAS) and Temasek, gave an overview of Singapore's vibrant and diverse blockchain landscape.

This year, the 2020 Singapore Blockchain Ecosystem report gives a qualitative overview of the key developments and trends in Singapore's blockchain ecosystem.

SECTION ONE

SINGAPORE BLOCKCHAIN ECOSYSTEM SURVEY



SINGAPORE BLOCKCHAIN ECOSYSTEM SURVEY

Presented by PwC Singapore

About the survey

In July 2020, PwC Singapore surveyed companies from across several industries and sectors to assess the developments of blockchain-related activities in Singapore. The survey provides insights into the current state of industry, and identifies emerging trends that may help in developing new initiatives to advance Singapore's blockchain ecosystem.

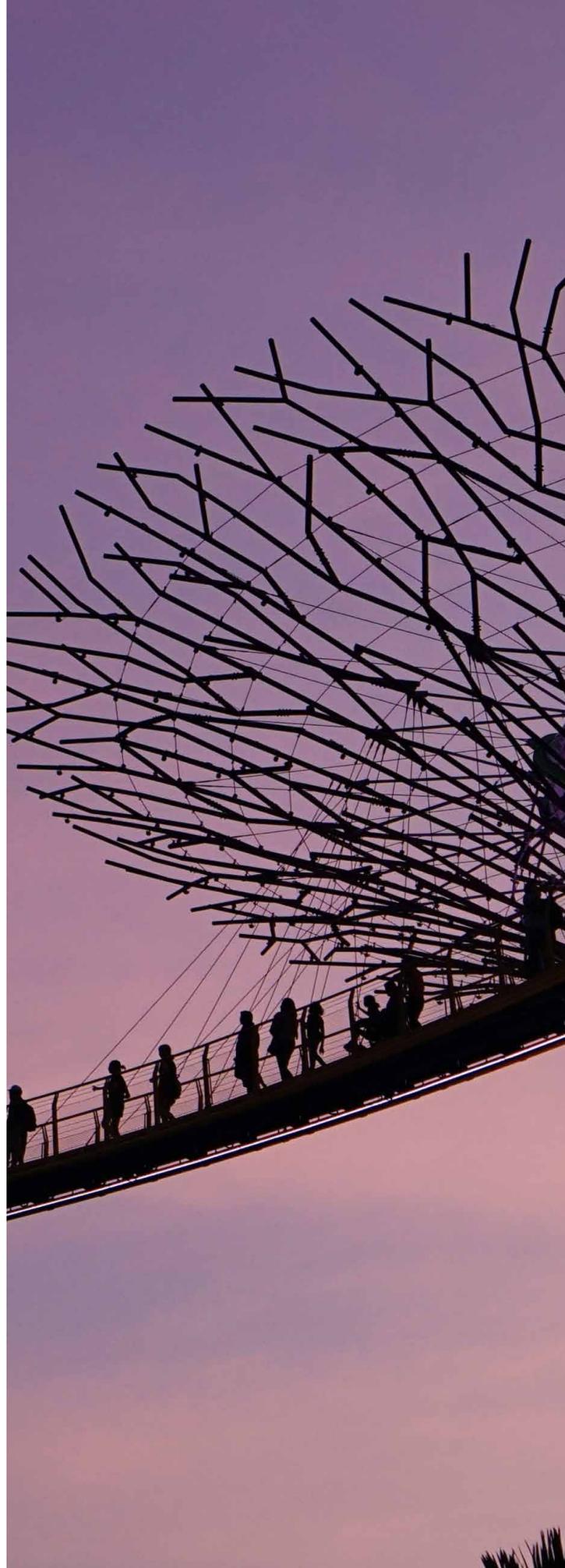


Exhibit 1:

Which of the following best describes your company?

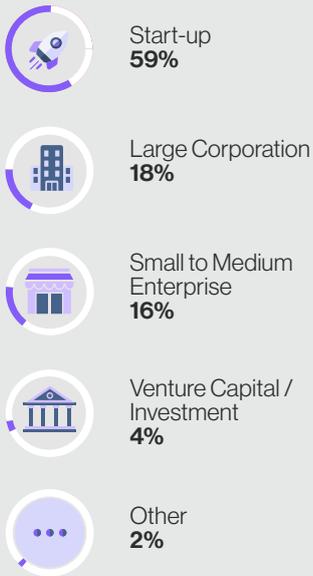


Exhibit 3:

What is your company's annual turnover?

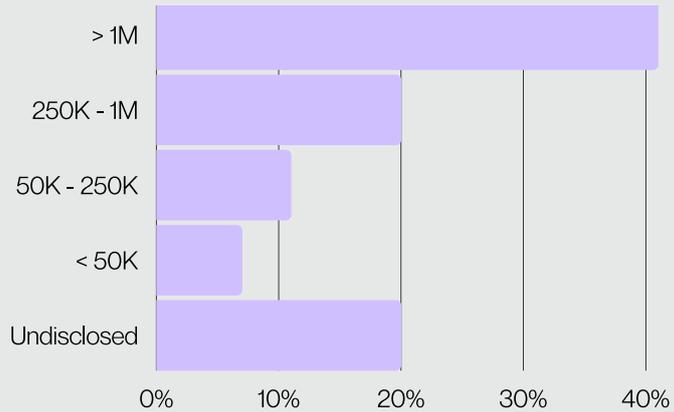


Exhibit 2:

How long has your company been established?

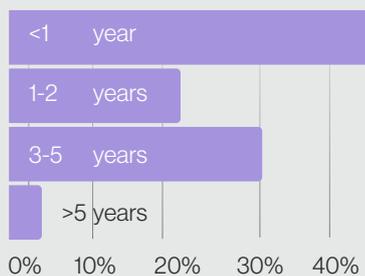


Exhibit 4:

How do you describe your organisation's current involvement with blockchain?

43%

Say that blockchain is their primary solution

40%

Consider blockchain their secondary solution

11%

Are researching into or considering blockchain solutions

6%

Are not involved with blockchain yet

Note: The numbers in the tables and charts may not add up to stated total or 100% due to rounding.

Survey respondents

Out of the companies surveyed, 70% are headquartered in Singapore. Companies that define blockchain as their primary product or service in the region appear to have been established for a relatively shorter period compared to the wider [FinTech scene](#) in general, with 44% of them starting operations over the past year (Exhibit 2). Mature blockchain-related companies operating for over five years account for just 4%, with 41% of the survey respondents having revenue over S\$1 million (Exhibit 3). 43% described blockchain as their primary solution, while 40% noted that blockchain complements their primary products and services portfolio (Exhibit 4).



KEY FINDINGS:

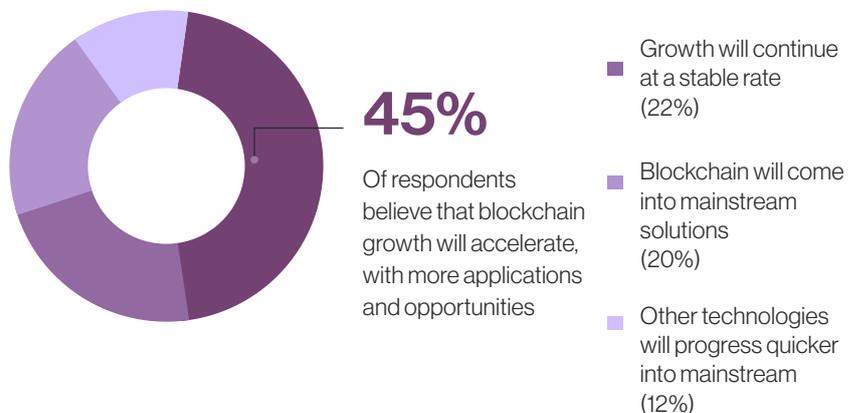
1 Businesses are optimistic about blockchain growth in Southeast Asia

70% of respondents are headquartered in Singapore, with a further 4% headquartered in another Southeast Asian country. Those outside the region included companies with headquarters in Europe (Switzerland, Netherlands, Luxembourg, Germany Geneva and the UK), USA, and India.

Nearly half the survey respondents believe blockchain technology growth will accelerate with more applications and opportunities, while 22% expect growth to be at a stable rate over the next 3-5 years (Exhibit 5).

Of the companies surveyed, most are optimistic about blockchain industry growth. Of those which expressed optimism about the industry's prospects, 80% are headquartered in Singapore. One in five survey respondents believe that blockchain will come into mainstream solutions.

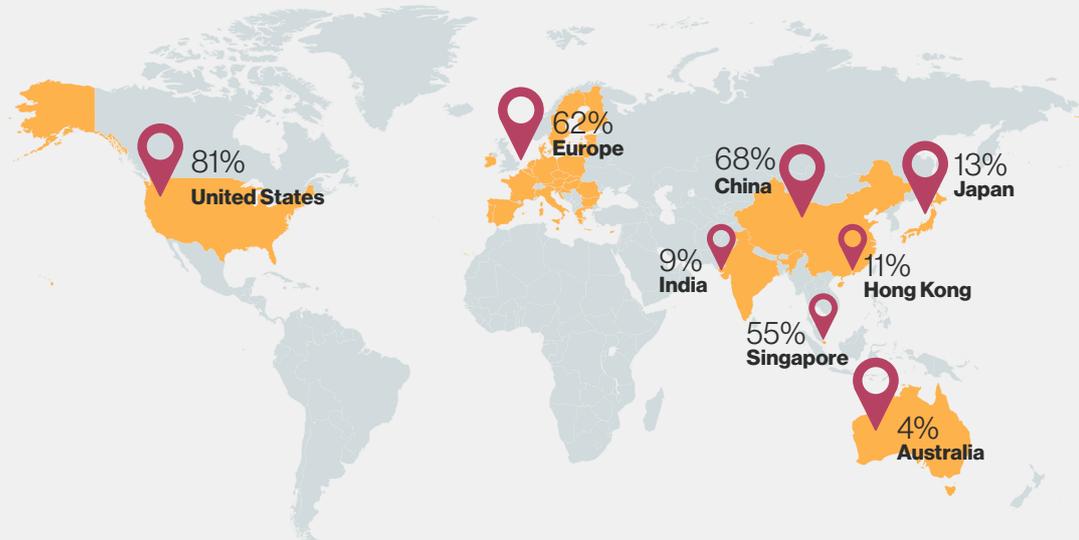
Exhibit 5:
What do you think the outlook for blockchain will be in Singapore in the next 3 to 5 years?



2

Singapore is among the territories considered as blockchain leaders

Exhibit 6:
In your opinion, what territories are blockchain leaders?



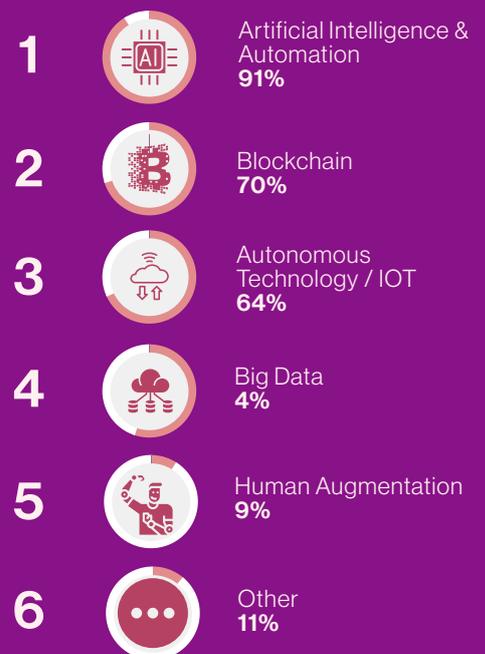
Unsurprisingly, the United States and China are considered the top 2 destinations for blockchain activities and thought leadership. Of the companies surveyed, 53% included Singapore in their list of blockchain leaders. Singapore remains a key hub and is ranked amongst the leading countries for blockchain in the Asia Pacific region.

3

Blockchain is among top three technology trends for Singapore in 2021

An overwhelming majority of surveyed respondents (91%) believe artificial intelligence & automation tops technology trends in Singapore for 2021. This is followed by blockchain (70%), and autonomous technology / IoT (64%) (Exhibit 7).

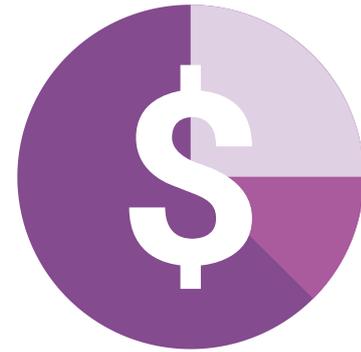
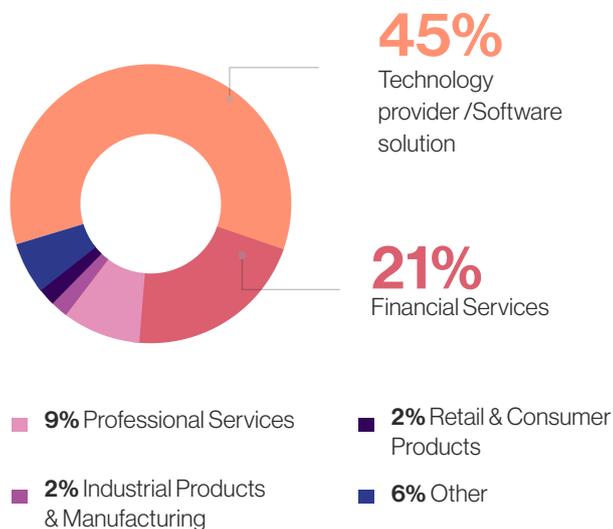
Exhibit 7:
What, in your opinion, are the top 3 Technology Trends in Singapore for 2021?



4 Technology and financial services are pioneers in adopting blockchain

Companies in traditional industries are under-represented in blockchain technology adoption, while financial services and software providers pioneer blockchain adoption in Singapore. Across the different types and sizes of the companies surveyed, the majority belong to the technology/software solutions sector (60%) (Exhibit 8). A fair number of them (21%) are associated with blockchain in the financial services sector, while the others cater to professional services (9%), industrial products & manufacturing (2%) and retail & consumer products (2%) and retail & consumer products (2%). The maturity and understanding of blockchain technology is still at a relatively nascent stage. Consequently, most companies in traditional industries have not taken significant steps in using blockchain for their business.

Exhibit 8: Which of the following best describes your company's primary industry?



5 Blockchain projects are progressing towards more mature funding stages

Of the blockchain companies headquartered in Singapore, 37% have seed funding and 27% have Series A funding. Two-thirds of those who are at the seed funding stage obtained their funding from Singapore, and more than three quarters of those who are at Series A funding stage derived their funding from Singapore. Others included crowdfunded and publicly listed companies.

Exhibit 9: What is the current fundraising status of your company?

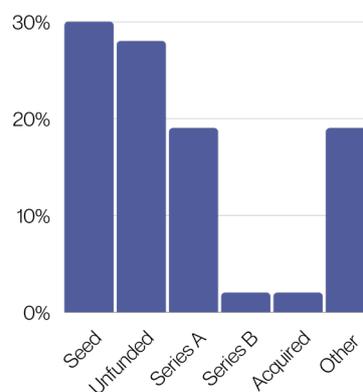


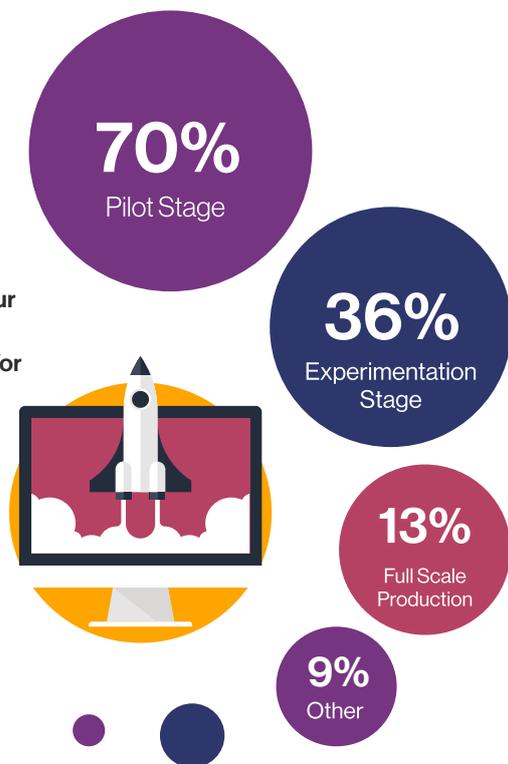
Exhibit 10: Where does most of your fundraising come from?



6 More projects progressing towards full scale production

The majority of blockchain initiatives in the region have moved into the pilot stage (70%), with only 36% in the experimentation phase, while 13% are already in full scale production or being deployed (Exhibit 11).

Exhibit 11:
What stage of the development lifecycle best describes your blockchain projects and/or solutions?



7 Blockchains thrive when being leveraged for multiple integrated applications

When asked about applications of blockchain, asset tracking and traceability were selected most by 52% of respondents, followed closely by digital tokens. This reflects the growing trend of companies using blockchain for supply chain improvements.

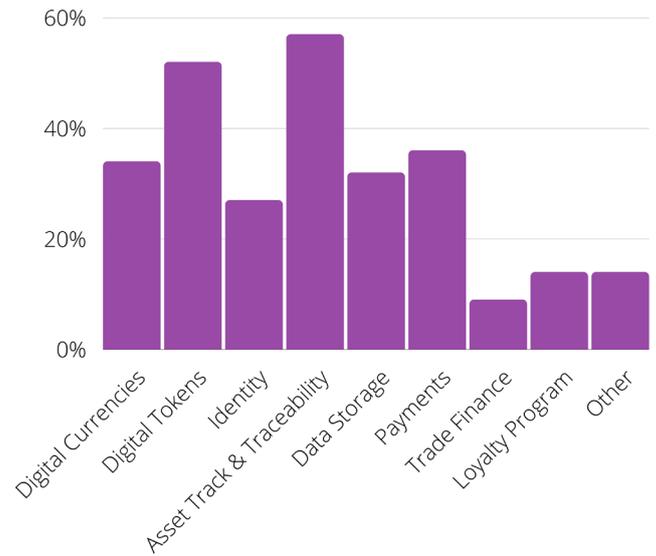


Exhibit 12:
Which of the following best describes your Blockchain applications/ use case(s)? (May select multiple)

Interestingly, 30% of respondents selected 4 or more applications, suggesting that many of the applications for blockchain are interrelated. We see this particularly with digital currency and digital tokens where 93% of respondents that chose digital currency also chose digital tokens. Similarly, 52% of those that selected asset track and traceability also selected trade finance. This indicates that blockchain's potential lies in how it can transform traditional workflows across different industries and organisational functions.

8 Collaborative environments encourage the adoption of blockchain

Blockchain activity appears to thrive in collaborative environments. This is reflected in the high rates of membership in industry consortiums and the prevalence of public-private partnerships in blockchain applications. In fact, involvement with industry consortiums is the norm for blockchain firms (55%), with only 17%

of firms not in a consortium but are actively looking to join one. Only a minority (4%) used to be members of a consortium and have since left. The most popular form of blockchain applications are a hybrid of public and private networks (Exhibit 13).

Exhibit 13:
For your organisation's blockchain applications / use case(s), how do you structure governance and network access?

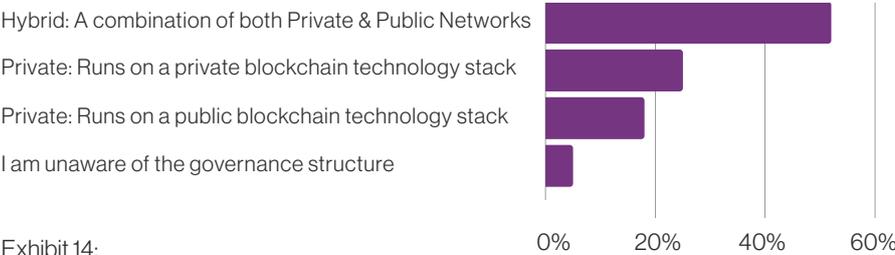
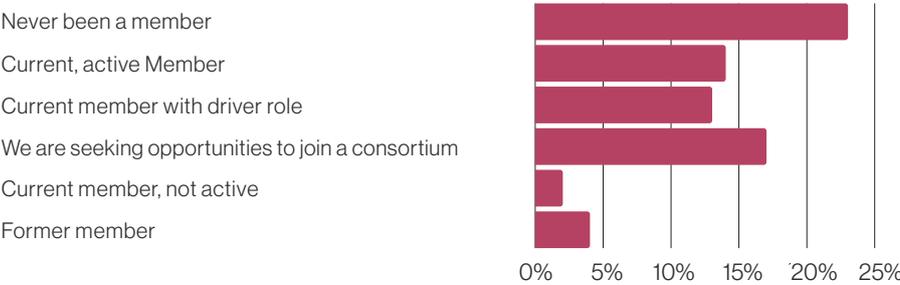


Exhibit 14:
Which of the following best describes your organisation's involvement with a blockchain industry consortium?



9 Lack of awareness is a top barrier to using blockchain

Of the respondents that are not currently engaged in blockchain initiatives, the majority (77%) believe that more awareness on its applications and use cases would encourage their organisation to consider using blockchain technology (Exhibit 15). For blockchain to gain traction among firms, the diverse applications and use cases of blockchain need to become more visible to the wider community. This can be done through management education and experimenting with blockchain solutions in daily operations, such as for customer loyalty programs, or digital identity.

In addition, 48% cited the need for increased regulations and guidance as a barrier to adoption. Despite Singapore's supportive regulatory environment for blockchain innovations, perhaps greater engagement is required with firms' on the regulatory frameworks and boundaries that govern various blockchain use cases. 35% also cited greater access to the required talent as also imperative to boosting the adoption of blockchain technology.

Exhibit 15:
Are there any external factors that you believe would encourage your organisation to consider using blockchain technology?

77%

believe that **more awareness on its applications and use cases** would encourage their organisation to consider using blockchain technology

48%

believe that **increased regulation and guidance** would encourage their organisation to consider using blockchain technology

35%

believe that **greater access to talent** would encourage their organisation to consider using blockchain technology

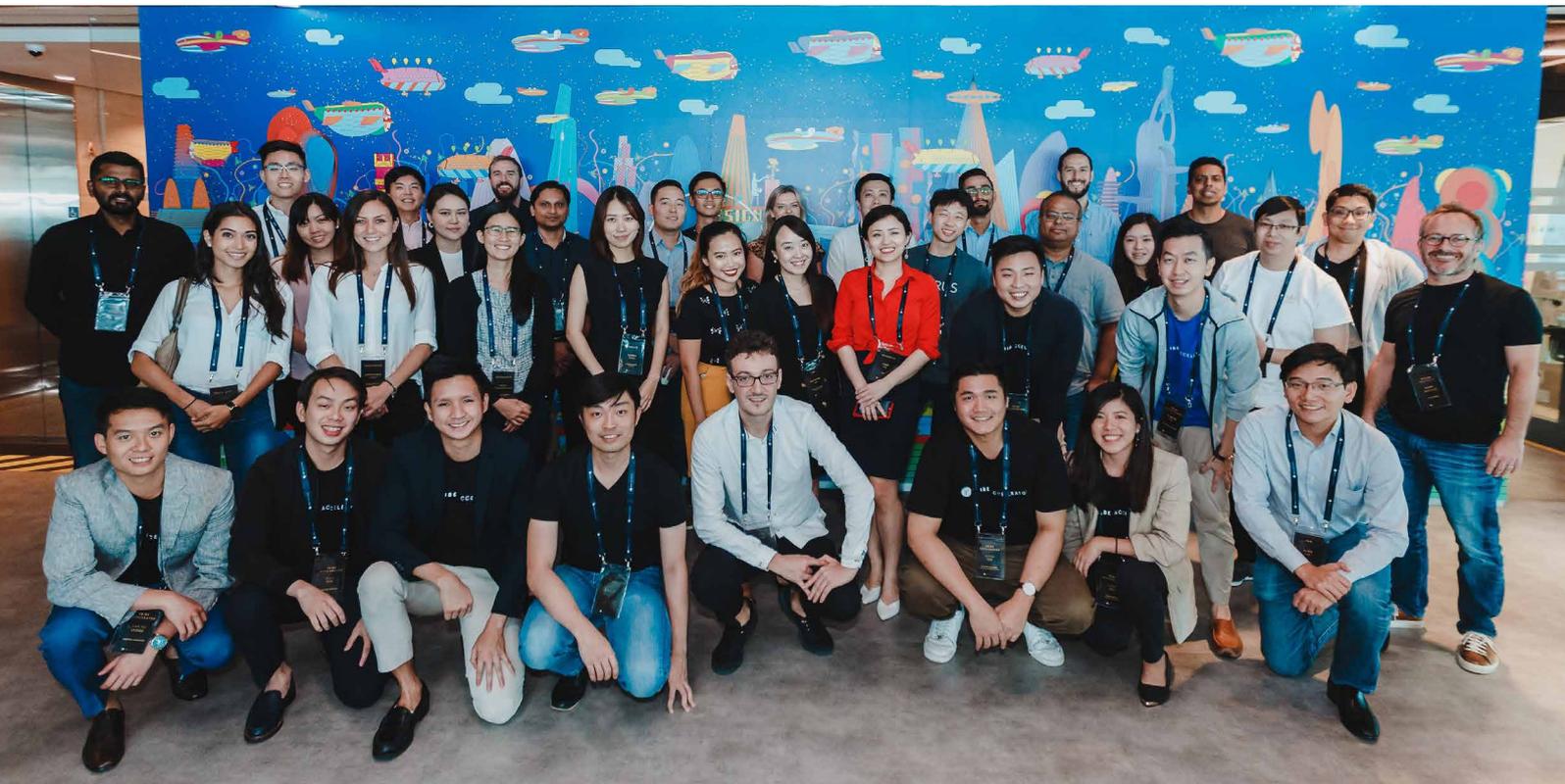
11%

believe in other means



SECTION TWO

BLOCKCHAIN ECOSYSTEM DEVELOPMENT



The Value of Ecosystems

A Vibrant Innovation Network.

Innovation tends to thrive in clusters. From Silicon Valley in San Francisco to Singapore's Block 71, networks of incubators, accelerators, and firms help germinating ideas grow into reality. Much of innovation really [depends on the quality of the ecosystem](#) needed to nurture it. Famed for its “[garden city](#)” philosophy, the Singapore government pays considerable attention towards shaping the city-state to becoming a hub for technological innovation in the Southeast Asian region.

Singapore has been ranked as Asia-Pacific's most innovative nation for the seventh year running. The annual [Global Innovation Index](#) co-authored by the World Intellectual Property

Organisation (WIPO), Cornell University and INSEAD, ranks 131 economies according to their capacity for, and success in innovation.

Singapore's political stability, ease of doing business, policy-making effectiveness, and highly-educated labour pool have traditionally kept it high on the Index's rankings.

Together with the government's [push to develop Singapore into a “Smart Nation”](#) since 2014, the innovation ecosystem supporting the deployment of frontier technologies like blockchain has allowed new ideas to thrive.

Accelerating Startups

Supporting new venture creation.

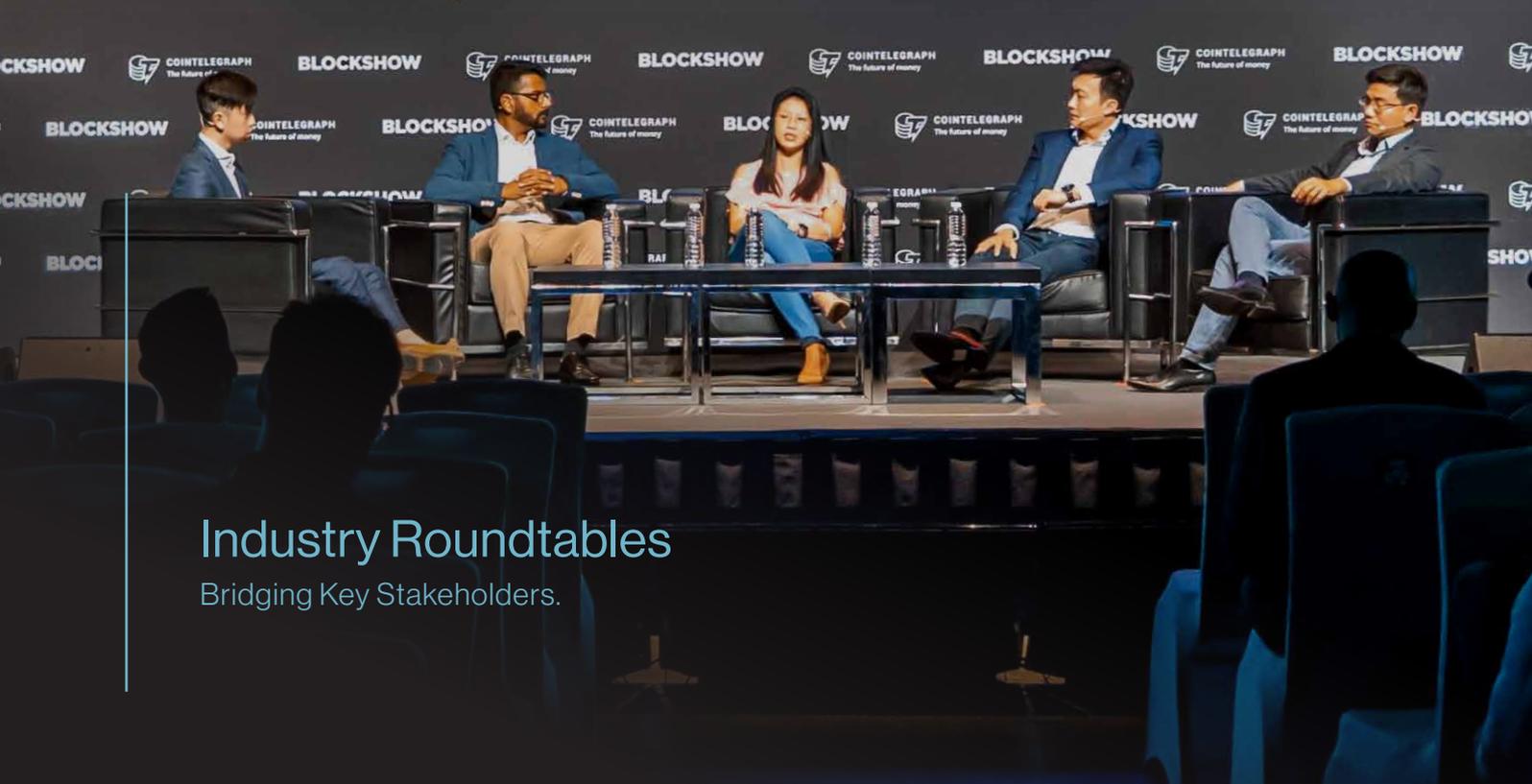
Accelerators play an important role in innovation clusters around the world. They spur the adoption of new ideas by putting entrepreneurs through intensive periods of learning and iteration. This produces higher quality products and services that are [more likely to find traction, receive funding, or get acquired](#). Good accelerators are also [magnets for attracting venture capital](#) and entrepreneurial financing to an ecosystem as fund managers seek higher quality dealflow.

Several blockchain accelerator programs here have since seen several batches of startups come through their doors. Over the course of four batches, Tribe Accelerator has helped local startups across diverse industries to grow their innovative blockchain use-cases in collaboration with various government entities and corporates. In late 2020, blockchain accelerator LongHash Ventures announced a new partnership with Filecoin for an accelerator program .



Other accelerators are built around specific protocols or industry-specific use cases. Zilliqa, a Singapore-grown, high-performance and high-security blockchain platform announced the second cohort for its ZILHive Accelerator programme. The accelerator is aimed at supporting early and late-stage startups in using the Zilliqa protocol to build blockchain solutions for Open Finance (OpFi) - from digital asset exchanges to stablecoins.

Although young, these blockchain accelerators have made notable strides in nurturing blockchain startups in Singapore. In 2019, Crunchbase [listed](#) Tribe as one of the leading accelerators in Asia. Its portfolio startup has successfully raised more than S\$50 million in follow on funding in just under 2 years, while LongHash Ventures startups has raised over S\$20 million till date.



Industry Roundtables

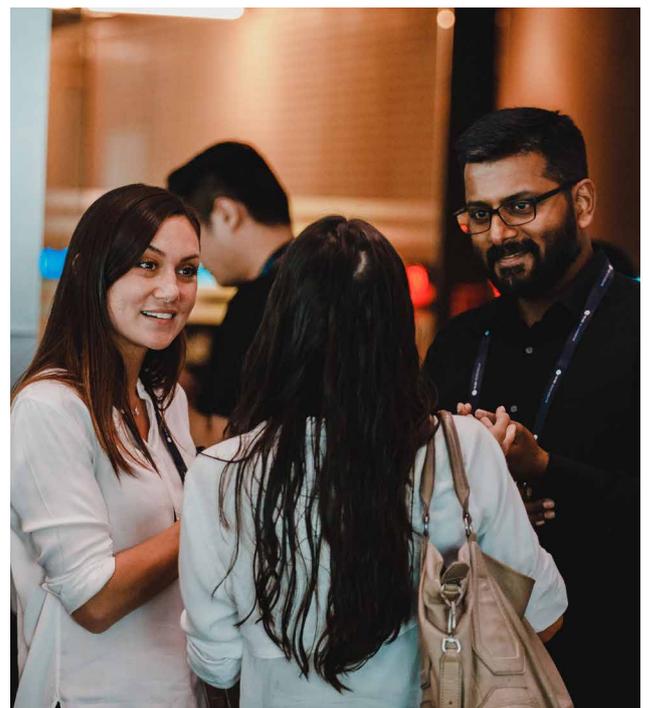
Bridging Key Stakeholders.

Blockchain technologies like distributed ledgers and smart contracts are ideal for fostering collaboration between organizations. **Platforms to encourage dialogue and collaboration between key stakeholders are needed to nurture blockchain projects across various sectors.**

To foster industry networking and idea sharing, OpenNodes and Temasek co-hosted multiple industry roundtable sessions in 2020. These roundtables enabled field experts from various global organisations to discuss their use of blockchain in areas such as agrifood, data, supply chains, digital currency, digital identity, and others. Participating companies included: Bank of Singapore, Ferrero, foodpanda, IBM, IMDA, Munich Re, Nestle, SGX, Shopee, Temasek, Ubisoft, and Unilever.

To promote the adoption of blockchain within FinTech stakeholders across ASEAN, Zilliqa

has launched the ZILHive Open Finance (OpFi) consortium. The consortium will consist of Zilliqa Research, Xfers, Elliptic, Switchero Network, XanPool, and Magic, together with the eight startups participating in the ZILHive Accelerator. The firms in the consortium hope to work together on blockchain projects within the OpFi space.



Ecosystem Map 2020

Visualising Blockchain Developments in Singapore.

SINGAPORE BLOCKCHAIN LANDSCAPE 2020



In Support of: **SG:D** Co-Developed by: **TRIBE** **OpenNodes** DISCLAIMER: This is not meant to be an exhaustive list of the companies in Singapore's blockchain ecosystem. The appearance of a company does not reflect an endorsement by IMDA and/or the Singapore Government of the said company. (Last updated: Q2 2020)

As with natural ecosystems, the complex networks supporting innovation clusters aren't always as visible to the passing observer. In a world increasingly defined by data, visualization is an important part of giving form to intangible ideas and concepts - like the ecosystem of technological innovation.

The Singapore blockchain landscape map is part of IMDA's efforts to promote awareness of the different areas of blockchain technology adoption in Singapore. It is co-developed by IMDA and OpenNodes, and was first published in October 2019. This landscape map is categorised into major sectors and provides a visualisation of blockchain usage in various industries.

In 2020, Singapore's blockchain ecosystem has made progress, and the refreshed landscape map features new players and initiatives. A new category, decentralised finance (DeFi) was added this year to reflect the numerous developments in blockchain projects announced by the financial services sector this year.

The landscape has also expanded considerably in size. There are 234 entities represented across 26 categories on the 2020 landscape map. **Singapore's blockchain landscape map has grown more than 50% from 2019, with 91 more companies represented now versus last year.**

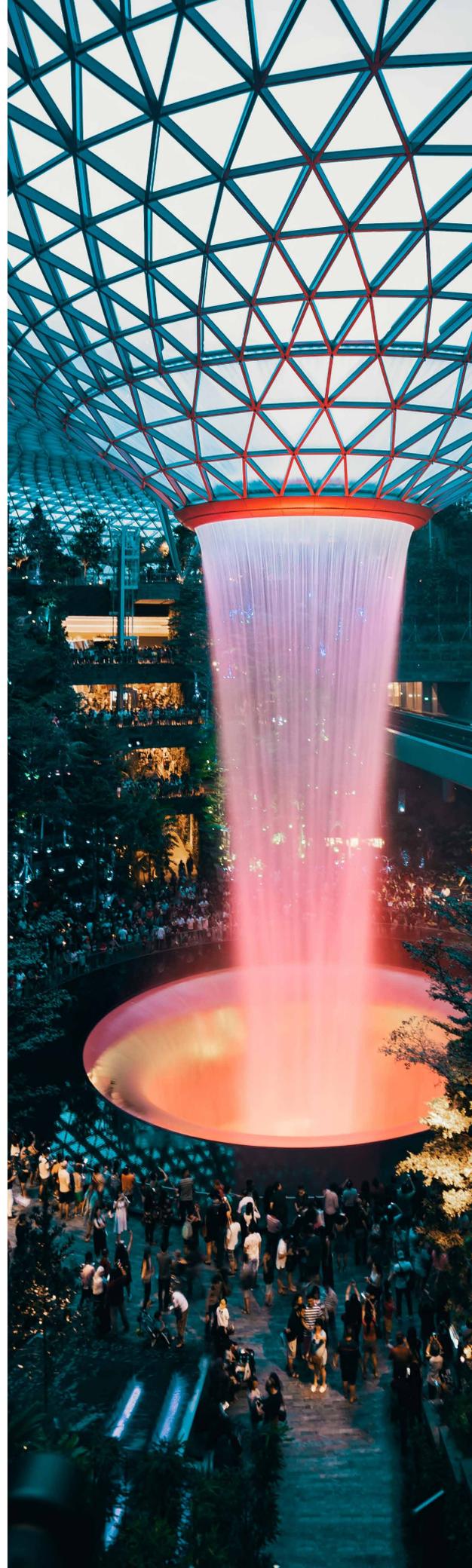
Connecting to Global Ecosystems Linking Innovation Clusters.

As a small but strategically-located trading hub, Singapore's economic growth story has historically been tied to broader global macroeconomic trends. Booming European demand for spices from the East drove a frenzy of [colonial development in 19th century Singapore](#). During the 1920s, surging global demand for tin and rubber during the Industrial Revolution [fueled another wave of growth for Singapore](#). Supporting services in banking, shipping and law developed to eventually define Singapore's significance as an international financial services centre in Asia. As the world enters the fourth industrial revolution, Singapore's continued prosperity similarly depends on its linkages to other global innovation clusters elsewhere.

Government-to-government (G2G) cooperations between analogous public service bodies have been instrumental in connecting blockchain ecosystems between Singapore and other major economic hubs.

As early as 2017, the central banks of Hong Kong and Singapore agreed to cooperate on a cross-border trade project based on blockchain technology as part of a broader joint strategy on financial technology.

Private initiatives also link blockchain innovation clusters here with their overseas counterparts. For instance, OpenNodes has struck several cross-border partnerships to share knowledge about blockchain use-cases and learnings. Some of these global engagements include the Dutch Blockchain Coalition Partnership, collaborating with Dubai International Financial Centre (DIFC) and engaging in the Chong Qing Blockchain Alliance.



Deepening Technical Capabilities

Translating Blockchain Research to Industry.

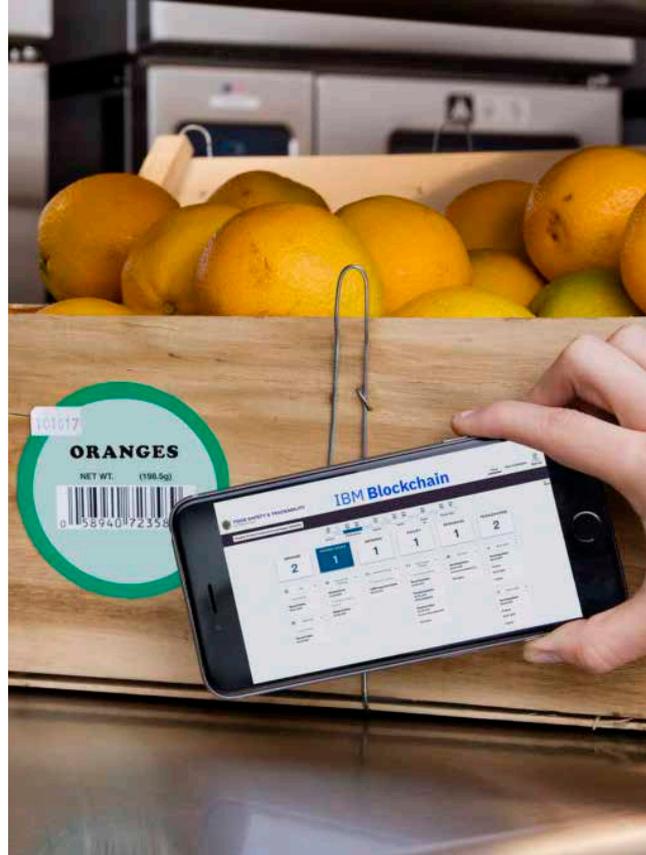
As Singapore continues to thrive in the digital economy, the reliance on sharing of knowledge, technologies and the need to innovate and build new capabilities will inevitably increase. Since 2019, there has been substantial growth in the Singapore blockchain ecosystem, with more industry players leading blockchain developments in different sectors. To further deepen technical capabilities within the ecosystem, IMDA, Enterprise Singapore (ESG), and the Monetary Authority of Singapore (MAS), hosted by the National University of Singapore (NUS) and funded by the National Research Foundation (NRF), launched the [Singapore Blockchain Innovation Programme \(SBIP\)](#). It aims to develop blockchain technology research capabilities and to translate these into applications through collaboration with industry.

Through SBIP, academia and research institutes can collaborate with industry players to develop new commercial value propositions of blockchain technology. This programme seeks to bridge the gap between basic research often conducted in universities, and commercially-driven research which private firms may lack the in-house capacity to carry out.

Governance & Regulatory Frameworks

Regulatory Clarity in an Emerging Space

Innovation often moves faster than regulation can keep up. However, that has not stopped



Singapore's regulators from trying to remain nimble. As early as 2016, Ravi Menon, Managing Director of the MAS explained the three principles underlying Singapore's regulatory approach to innovation: regulators must not stifle innovation prematurely but instead "run alongside" new developments. This has proven to be instrumental in how companies decide where to house their blockchain operations. For instance, Ripple Labs' CEO Brad Garlinghouse [announced](#) that it had shortlisted several countries to move to should the blockchain payment services company decide to leave the US amid a lack of regulatory clarity there. The list included Singapore, Japan, Switzerland, the UK and the United Arab Emirates as potential destinations.

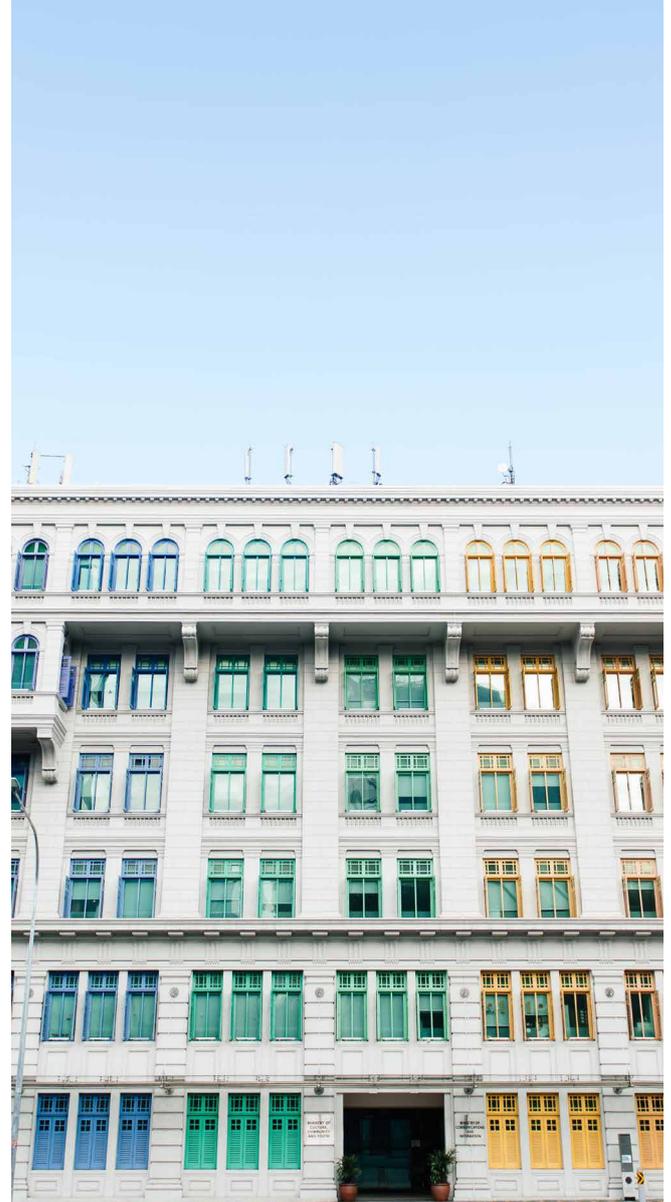
"The common denominator between all of them is that their governments have created a clarity about how they would regulate different digital assets, different cryptocurrencies," he explained. In an interview with Bloomberg Television, Ripple's CEO explained the importance of regulatory certainty

to innovators. “...we also need regulatory clarity in order for us to invest and grow the business”, he said. In Singapore, existing laws and regulations have been continually updated or clarified to provide clarity and enable compliance for blockchain industry participants.

This has cultivated an innovation-friendly legal regime in Singapore that provides institutional support for investors, enterprises and consumers by introducing clear rules and compliance obligations.

The [Financial Advisers Act](#) (FAA) and the [Securities and Futures Act](#) (SFA) are the main pieces of legislation governing financial advisers, activities and institutions in the securities and derivatives industry. They have expanded the scope of capital market products to include digital tokens, subjecting crypto-related businesses to the same regulatory and licensing terms as traditional capital markets products. As blockchain protocols and applications increasingly involve the use of digital tokens carrying contractual and financial rights, enhanced consumer protection must be balanced with fostering innovation. These measures protect consumers from fraudulent practices and maintain trust in Singapore’s financial markets, while enabling compliance for new financial actors who use emerging technologies like digital currencies.

The introduction of the [Payment Services Act](#) (PS Act) this year further established a flexible



framework for the regulation of payment systems and payments service providers in Singapore. Under this Act, companies must obtain a license for providing payment services, which includes digital payment token (including digital currency) services.

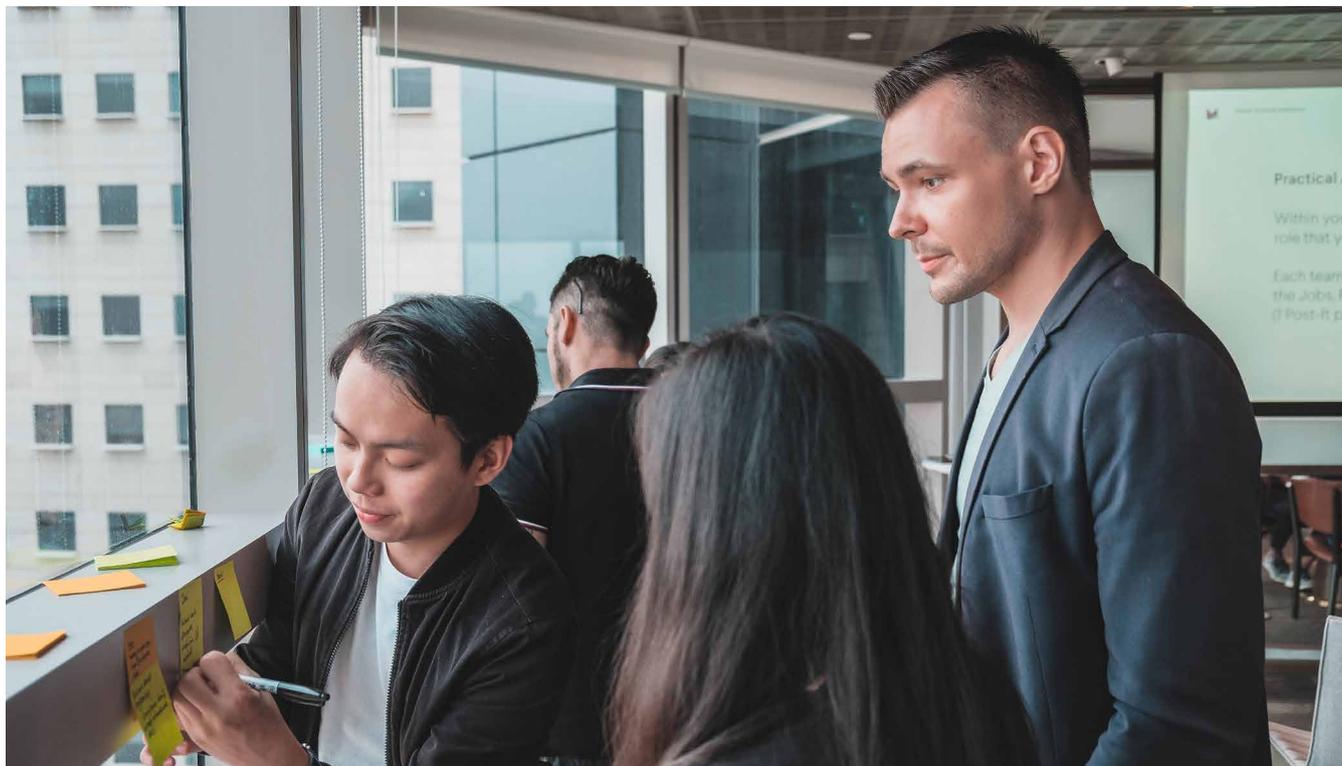
Both the SFA and PS Act contain various anti-money laundering and counter-financing of terrorism (AML/CFT) regulations, which effectively address risks arising from virtual assets, due to the anonymity, speed and cross-border nature of digital transactions. Taken together, these regulations help to protect investors and consumers, creating confidence and bolstering trust in a business-friendly financial hub.

SECTION THREE

GROWING THE NEXT GENERATION OF TECH TALENT



GROWING THE NEXT GENERATION OF TECH TALENT



Engaging Students

Blockchain has attracted significant interest amongst younger Singaporeans owing to rapidly growing adoption among firms and the popularity of digital currencies to a new generation of digital natives. University blockchain clubs have been formed in the country's major universities—including the [NUS FinTech Society](#), [Blockchain@NTU](#), [SMU Blockchain Club](#) and [3DC](#) at the Singapore University of Technology and Design (SUTD). These student clubs hope to create communities where like-minded students can gather to learn more about the technology, and tap on opportunities to enhance their skills to kickstart their career in this field.

Leaders of these student clubs have organised various events such as blockchain hackathons, workshops and events featuring tech leaders in the field to provide their members with greater exposure to blockchain projects and industry insights. For instance, the SMU Blockchain Club holds an annual Blocknight that brings together experts from the blockchain landscape such as R3, Tribe, EY, GovTech, and Zilliqa amongst others, to share their experiences with this frontier technology.

However, according to a survey conducted with club leaders, these local university clubs operate in silos and often have difficulty engaging in more

industry-related activities and projects with companies.

To encourage greater collaboration among students from different tertiary institutes and nurture the next generation of tech talent, the [OpenNodes Campus Collective](#) was developed. It aims to build a community of students in tech and provide them with practical opportunities to engage in innovation. This initiative will also help bridge the tech talent gap by providing industry immersion opportunities, like the IBM Technology Practicum and the Cargill Blockchain Practicum. These practicums select top talents from academic institutes to form student consulting groups to work on industry projects alongside experts from leading global organisations.

This year, the Campus Collective has started to bridge connections between WeBank and local tertiary institutions. [WeBank](#) and [Forms Syntron](#) explored a solution to hasten post COVID-19 reopening by mentoring a cross-university team to develop a decentralised, private contact

tracing solution. Through the mentorship and guidance from these experts, the cross-university team built a functioning prototype that was also submitted and shortlisted for the GovTech Singapore's COVID-19 idea sprint.

Training Developers

One strategy to ensure the longer-term flow of tech talent is to engage the student community. But it is also critical to build up a larger tech talent pool of developers qualified to build blockchain applications today. This is critical to blockchain adoption in industries. Singapore suffers from a [tech talent shortage](#). While the high salaries software developers command is a boon to tech workers, it directly translates to a high cost of building and deploying new technologies. That can severely limit the rate at which innovative applications are built and deployed in private industry. According to Deloitte's 2019 Global Blockchain Survey of 1386 global companies, 51% [cited](#) cost savings as a key metric in measuring blockchain business case results. Increasing the





supply of blockchain-capable developers can lower the cost barrier to adopting blockchain-based technologies.

To meet this need, numerous coding schools and academies have emerged in recent years. They offer short, intensive courses aimed at equipping developers and professionals with the technical knowledge and skills to hit the road running.

For instance, global blockchain protocol companies such as R3 and ConsenSys have engaged in efforts to develop a pipeline of talent who will be proficient in working with their blockchain protocols. R3 offers programming courses and bootcamps for blockchain beginners and more experienced developers to learn app development on both Corda and Corda Enterprise. ConsenSys [launched](#) the first cohort of its ConsenSys Academy Developer Program in 2017 which received over 1,300 applicants from a global pool of 95 countries worldwide during its two-month application window – attesting to the interest in, and demand for Ethereum education. Following their success,

they will be launching several blockchain training courses in Singapore, [available](#) with financial support through IMDA and CITREP+ for qualified applicants.

While these blockchain courses that train developers in technical skills exist in the market, there remains a prevalent talent gap in the deep tech industry. Graduates and young developers still have difficulty landing technical jobs due to their lack of industry experience, and the different technical skills each company may require.

To bridge this gap, a new educational institute, [Tribe Academy](#), works with aspiring developers looking to propel their career in deep tech areas like blockchain and machine learning. Tribe Academy hosts programmes that provide graduates with industry-ready capabilities to meet the hiring requirements of employers. These programmes offer students the opportunity to work on real industry projects, mentorship from technical experts from top-tier tech companies and short apprenticeships with their network of hiring partners.

Other coding schools are centered around specific programming languages. Ngee Ann Polytechnic, Indorse, and OpenNodes established [GoSchool](#), the first Go Programming Language Academy in Singapore, supported by Skillsfuture Singapore. As Golang is a common language used by numerous blockchain companies across the region, the academy aims to equip Go developers with industry-ready skills to meet the demand for tech talent at companies like Shopee, foodpanda and Zalora.

Upskilling Business Professionals

Professionals, managers, executives, and technicians (PMETs) are an important, but sometimes neglected segment of tech talent. Although armed with knowledge and experience in their specific industries, PMETs lack a background in technology, which can help them build their career in tech.

In Singapore, tailored courses also exist to help these business professionals better understand the technical aspects of blockchain. [ZILHive Education](#), Zilliqa's developer training school, is an example. Participants learn about blockchain fundamentals through a business-centric programme designed for PMETs in the fintech industry, and dive into real-world business use-cases, with a focus on Zilliqa's smart contracting language, Scilla. Global technology companies such as IBM also offer blockchain courses suited



for business professionals, providing them with knowledge on how to apply the technology to transform their businesses.

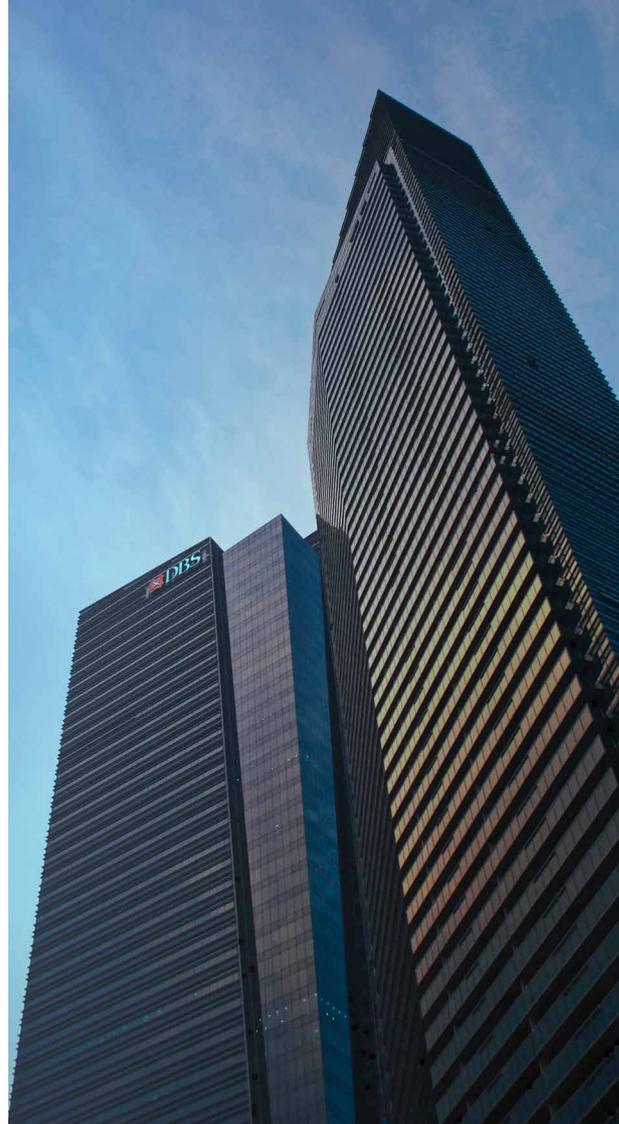
It is crucial to upskill this particular group of individuals and provide them with the knowledge to use blockchain technology appropriately, especially since they often have influence over the decision-making and direction of their companies.

SECTION FOUR

INDUSTRY-LED BLOCKCHAIN PROJECTS



INDUSTRY-LED BLOCKCHAIN PROJECTS



Financial Services

The finance sector is perhaps the leading adopter of blockchain technologies in Singapore. This is perhaps unsurprising considering that the earliest documented uses of ledgers have [historically emerged](#) from commerce. Similarly, blockchain use cases in Singapore's financial services industry appear to be closely tied to its status as a trading hub.

Trade Finance

Financing trade has traditionally been heavily reliant on paper documents and manual processes. This has made trade finance not only beset by long processing times for letters of credit, but also fraud. These challenges map neatly to the core features that blockchain

technology is well-suited to address. Banks are forming consortia among themselves to create blockchain-based platforms where they can collaborate to make processing credit applications faster, and detecting fraud easier. Blockchain-driven trade finance network Contour is led by R3 and comprises eight global banks – Bangkok Bank, BNP Paribas, CTBC, HSBC, ING, Standard Chartered and SEB. It works with financial institutions to put letters of credit (LCs) on a distributed ledger. With their recent tie-up with local bank DBS, Contour has also pushed [the network's first fully digital end-to-end secured LC](#) between several organisations in the mining value chain – Nanjing Iron & Steel, Singapore Jinteng International

and Hope Downs Marketing Company. The solution enables greater collaboration between parties by providing access to real-time status updates at each step of the transaction, and also reduces trade document processing times for LCs by over 90%. What used to take from 5 to 10 days can now be done [under 24 hours](#).

Fraud is another key challenge in trade finance which banks are hoping blockchain can address. Within the year, three large commodities traders in Singapore collapsed: Hin Leong, Agritrade and ZenRock. In all three cases, banks have alleged fraud in connection with trade finance where forged or duplicated trade documents were used to secure financing with different banks.

To tackle such attempts at duplicate financing, banks are hoping that blockchain can serve as a harmonised global record for the industry. In early October, DBS Bank and Standard Chartered [announced](#) that they would be leading a group of 12 other banks here to create a harmonised record of trade transactions financed across lenders in Singapore. The new Trade Finance Registry (TFR), taps on blockchain technology to provide an opportunity for multiple lenders to work together to overcome the industry issue of fraud and duplicate financing more effectively.

Built on a platform developed by Singapore-based technology firm dltledgers using Hyperledger Fabric, it is now at proof-of-concept stage following pilot testing that started in June. Details associated with trade documents are submitted to the platform, which can then determine whether financing is being sought multiple times using the same cargo. Such documents could include bills of lading, charter party bills of lading or letters of indemnity.

But rather than submit those documents in full, banks upload pre-agreed sets of information from those documents onto



the platform. Data submitted includes the type of financing being sought, loading and vessel information and the identity of the exporter and importer. That information is encrypted and not visible to other participants, but rather sits within each bank's own node in the network. The registry can then compare data uploaded by different banks, flagging up any indications that double financing is being sought on a single transaction but without sharing potentially sensitive data.

The proof-of-concept is supported by government innovation agency Enterprise Singapore, and endorsed by The Association of Banks in Singapore (ABS) which includes 12 other banks such as ABN Amro, ANZ, CIMB, Deutsche Bank, ICICI, Lloyds, Maybank, Natixis, OCBC, Rabobank, SMBC and UOB.

In August, Global eTrade Services (GeTS) [announced](#) a partnership with Singapore-based TranSwap, a cross border-payments platform, to launch the CALISTA TranSwap Pay. Targeted at SMEs in ASEAN, CALISTA TranSwap Pay has a suite of financial automation solutions to make cross-border payments easy and seamless. Features include automated credit assessment, dedicated customer service, fees transparency for easy reconciliation, and enabling businesses to manage and track their funds end-to-end in real time.

Just a month later, Singapore-based Finaxar, [announced](#) a partnership with GeTS. Finaxar provides lending services to financial institutions, trade and e-commerce platforms

using data-driven methods to provide tailored financing solutions for small businesses. The partnership will enable Finaxar's users to access GeTS' CALISTA™, a supply chain platform that enables the coordination of logistics, compliance and finance activities across the ecosystem.

Digital Currencies & Digital Assets

These are other key areas in which blockchain technology is gaining traction. In July 2020, Project Ubin successfully concluded its fifth and final phase. Created by MAS in collaboration with J.P. Morgan and Temasek, it saw the development of a prototype blockchain-based multi-currency payments network. The project

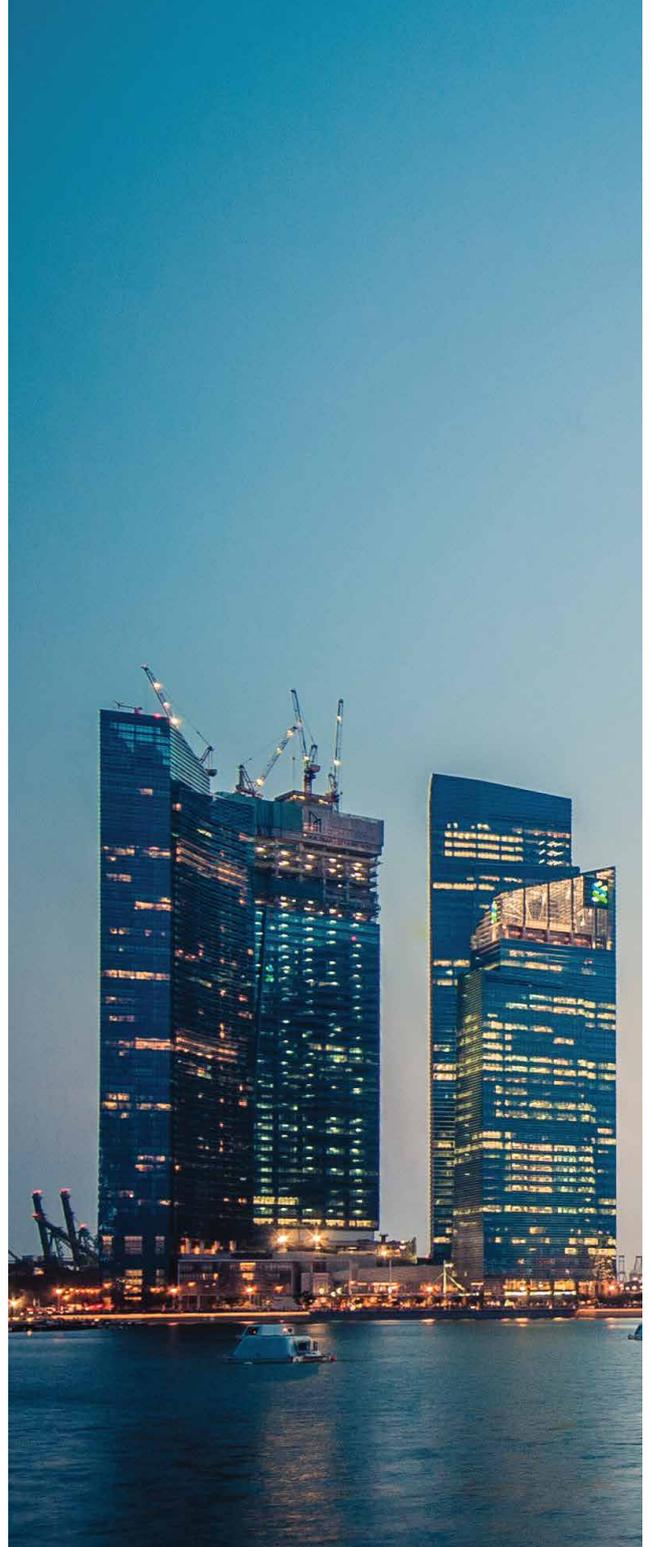


was launched in 2016 by MAS with the support of the financial industry, and in its final phase MAS and partners engaged more than 40 financial and non-financial firms to explore the potential benefits of the network.

The cohort of blockchain firms that participated in the final phase included Capbridge 1exchange, Hashstacs, Digital Ventures, and Digital Asset. The different blockchain-based applications were able to integrate with the Ubin prototype network for transaction processing. As part of these efforts, MAS collaborated with IMDA to launch a multi-thematic Blockchain Challenge – “Growing and Connecting Blockchain Business Networks”. One of the themes in the Blockchain Challenge invites industry partners with commercial use cases to submit proposals to test out and use Project Ubin’s blockchain-based prototype for multi-currency payments.

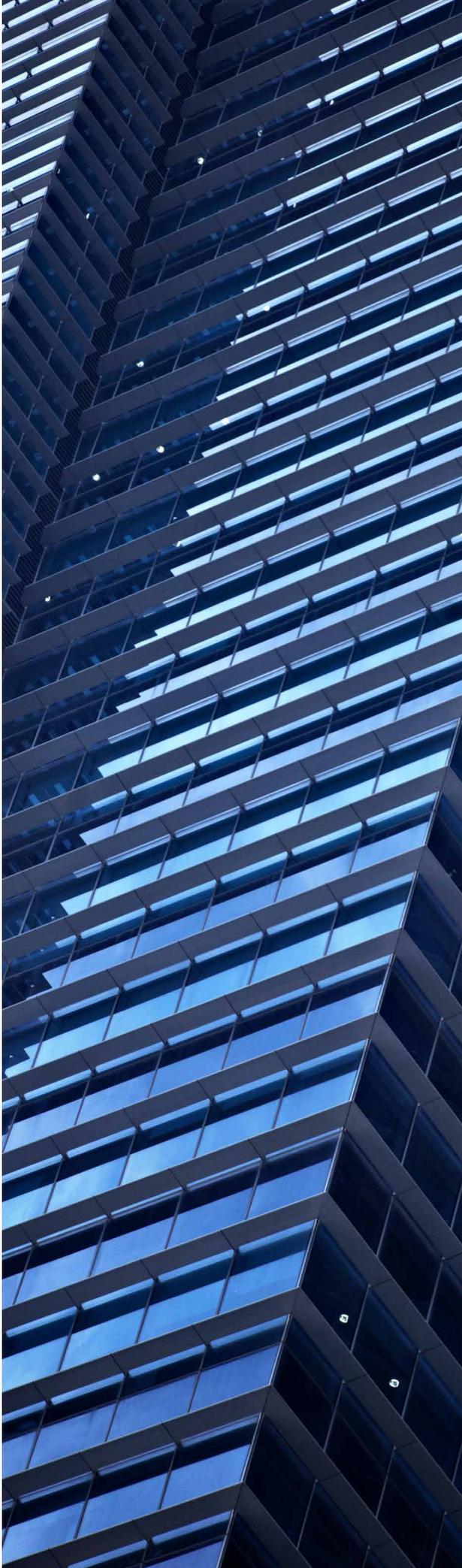
JP Morgan, which was part of MAS’ Project Ubin, announced in October that its digital currency, JPM Coin, had been adopted by a large technology company for cross border payments. The dollar-backed stablecoin was originally [announced](#) in February 2019. In addition, the company also announced the creation of a new subsidiary, Onyx. Takis Georgakopoulos, JP Morgan’s global head of wholesale payments, told CNBC that it set up Onyx because “we believe we are shifting to a period of commercialization of those technologies, moving from research and development to something that can become a real business.”

In 2020, JP Morgan launched Onyx as a new



business unit within its wholesale payments division. Coin Systems, one of the four divisions within Onyx, is based primarily in Singapore, and built by a team of 20 professionals that were also supporting Project Ubin. In November, the bank appears to be actively hiring both junior and senior positions to grow the team in Singapore.

Separately, Xfers, a Major Payment Institution



(“MPI”) licensed by the MAS for e-money issuance, recently [announced](#) the release of XSGD - a Singapore dollar stablecoin. Each XSGD token is fully backed one-for-one by SGD bank deposits and represents one SGD. Under its licence, Xfers can mint unlimited amounts of XSGD tokens as long as the corresponding money is safeguarded in segregated accounts with a fully regulated MAS-approved bank. XSGD tokens are available on both Ethereum’s protocol as an ERC-20 token and Zilliqa’s protocol as a ZRC-2 token.

Digital assets is another growth area where even traditional capital markets players are looking to leverage blockchain technology to tokenize securities such as bonds and private equities. In September, the Singapore Exchange (SGX) worked together with HSBC Singapore and Temasek to [complete its first digital bond issuance](#). The project successfully replicated a S\$400 million 5.5-year public bond issue and a follow-on S\$100 million tap of the same issue by Olam International. This was Asia’s first syndicated public corporate bond, and marks the first step towards wider use of smart contracts and DLT for the Asian bond market.

SGX used DAML, a smart contract language created by Digital Asset, to model the bond and its distributed workflows for issuance and asset servicing over the bond’s lifecycle. SGX’s solution uses smart contracts to capture the rights and obligations of parties involved in issuance and asset servicing, such as arrangers, depository agents, legal counsel and custodians. The digital bond used HSBC’s

on-chain payments solution which allows for seamless settlement in multiple currencies to facilitate transfer of proceeds between the issuer, arranger and investor custodian.

The pilot demonstrated how blockchain could streamline processes for issuers, underwriters, investors and ecosystem participants across primary issuance and asset servicing. Key efficiencies observed within the pilot include timely ISIN (identifier) generation, elimination of settlement risk (for issuer, arranger and investors), reduction in primary issuance settlement (from 5 to 2 days) as well as automation of coupon and redemption payments and registrar functionality.

Accompanying this growth in digital currencies and assets, other companies providing ancillary services have emerged. Headquartered in Singapore, [Merkle Science](#) provides blockchain transaction monitoring and intelligence solutions for digital-asset service providers, financial institutions and government agencies to detect, investigate and prevent money laundering, terrorist financing and other criminal activities. Propine, a digital asset custodian, [entered](#) into MAS's regulatory sandbox in 2019. Propine was granted the first Capital Market Services licence in Singapore to provide independent digital asset custody services.





Food Industry

Food is a major part of the Singapore landscape. Not only in terms of the dizzying array of cuisines and culinary innovations available throughout the island, but more importantly because of the strategic role it plays in Singapore's economy. Being a small yet largely urbanized island means that over 90% of the country's food is [imported](#) from around the world - from neighbouring Thailand and Indonesia, to as far away as Argentina and Uruguay. Against this

backdrop, innovation along the food supply chain has been a common theme among the emergent blockchain applications in Singapore's food and beverage landscape.

Revolutionising Food Safety with Blockchain Innovation

An emerging theme is innovation to improve food safety and tackle food fraud. With blockchain's ability to track and trace ownership records, and its tamper-resistance, this technology could play a significant role in addressing these issues that plague food systems globally. According to the World Health Organisation, an estimated 600 million — almost 1 in 10 people globally — fall ill after eating contaminated food and 420,000 die [every year](#). To tackle this problem, local blockchain companies such as DiMuto and veriTag have developed solutions to digitise the food supply chain and enable a more secure and efficient system for different stakeholders.

Agri-food trade platform DiMuto works with packing houses and producers from across 8 countries including the US, China, Australia, Thailand, and Colombia, to create digital twins for physical agrifood products at the supply chain's upstream through industry-standard [GS1 QR Codes](#). Their track and trace solutions allow for greater visibility across the supply chain from farm to table. The improved data integrity can enable swift food recalls, and ensure that the highest food safety standards and quality are maintained.

End consumers can also scan the QR codes on the product labels using their mobile phone

where they can access the product origin information retrieved from the blockchain. Educational information like recipes and videos, as well as promotions can also be found, allowing food producers to market directly to end consumers. Consumers can also leave feedback on their produce, allowing suppliers to glean important information about the product quality and consumer trends.



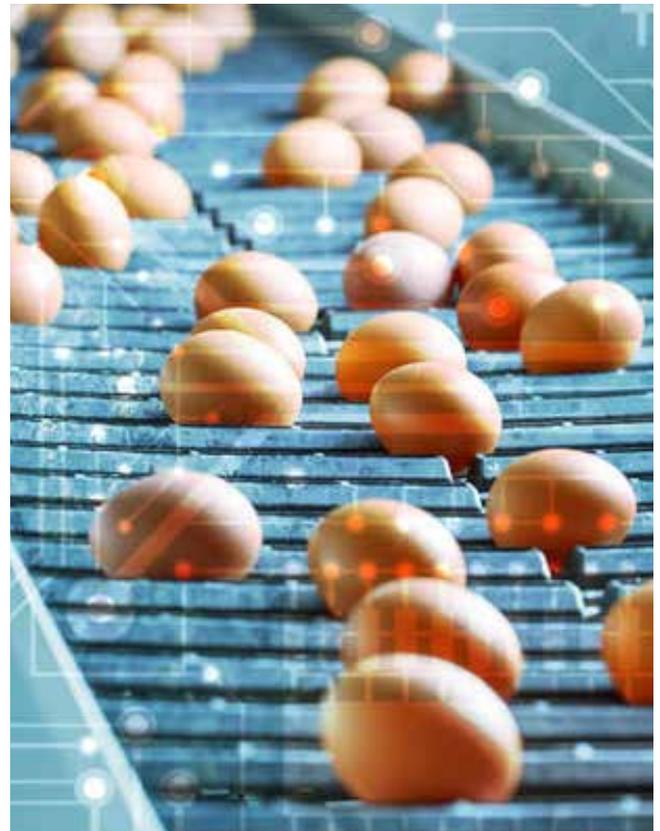
In August, the company [announced](#) a partnership with Jupiter Group, a global fruit grower and supplier, to deploy blockchain traceability for the group's core range of produce. Jupiter Group farms and supplies new and traditional varieties of grapes and citrus alongside melons, pineapples, limes, avocados and kiwi grown in countries around the globe including India, Greece, Colombia, Spain, South Africa, Morocco, Costa Rica and more. An estimated total of 10 million cartons or nearly 500 million individual pieces of fruit will be tracked and traced on the DiMuto blockchain platform.

Reducing Food Supply Chain Inefficiencies & Building Trust

Using blockchain to enhance the food value chain by reducing operational inefficiencies and establishing models of trust is another recurring

theme in the Singapore food space. The ability to share information among different stakeholders along the value chain makes it easier to identify lapses in real-time, rectify discrepancies between transactions quickly, and streamline operational processes. For instance, DiMuto's blockchain-powered trading platform provides greater visibility about where food shipments come from, and resolves trade disputes among different stakeholders in the food system. This can improve coordination and trust between partners, and allow more efficient product shipments.

Global food giant, Cargill, also recently launched [Splinter](#), their own open-source platform for secure and private distributed applications. In October, Cargill collaborated with the OpenNodes Campus Collective to host a [blockchain technology practicum in Singapore](#) where college students worked with



Cargill's experts to optimise port orchestration to improve arrival and departure accuracy for Cargill's shipping operations. Students were able to prototype a blockchain solution to mitigate shipping delays in a trustless manner using Splinter.

As with the interbank consortiums, the benefits of industry collaborations are evident in the food industry too. The Splinter platform was built on Hyperledger Grid, an ecosystem of reusable, open-source digital tools that developers can work with to build products, prototypes and applications that address food supply-chain use cases, including traceability, food safety, trade settlement and more. Hyperledger Grid builds upon the Hyperledger Sawtooth project, originally contributed to The Linux Foundation by Intel and

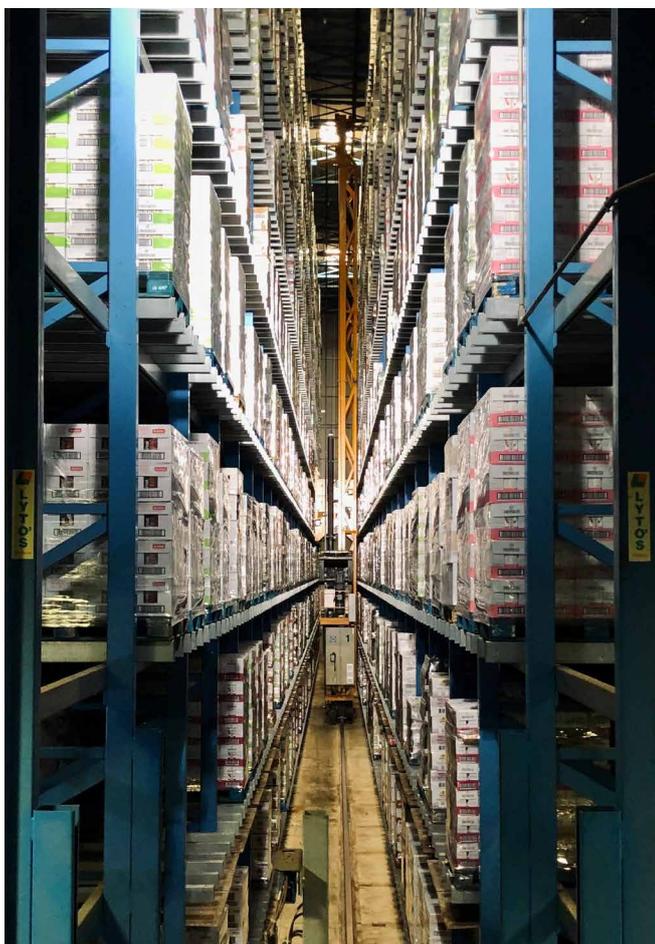
maintained by Cargill, Bitwise IO, Intel and others. The project is supported by other companies that, like Cargill, see its advantages for food and agricultural supply chains.

Consumer Retail

While blockchain technology has predominantly been used for enterprise-level applications in Singapore such as supply chains and financial services, consumer-facing applications have also emerged. Innovative Singapore companies are using blockchain to find new ways to create customer loyalty.

Bringing Value Back to Consumers & Elevating the Consumer Experience

Several companies in the retail sector have engaged in interesting blockchain innovations that are aimed at creating brand loyalty. Marketing tech startup Aqilliz aims to use blockchain to create greater value for consumers by implementing more useful loyalty programs. As part of IMDA's Blockchain Challenge, Aqilliz partnered with MyRepublic, a regional internet and telecommunications company, to launch MyRewards, a blockchain-based loyalty and rewards platform. Loyalty points that are earned by MyRepublic users can be redeemed at any of the company's retail outlets through an in-app QR code system. This enables consistent system integration and transparent reward reconciliation. The initiative also explored the possibility of a PointSwap across different loyalty programs, where loyalty points could be transferred to and redeem rewards from another program (eg. Loyalty points from Grab can be transferred to Zalora's loyalty program).



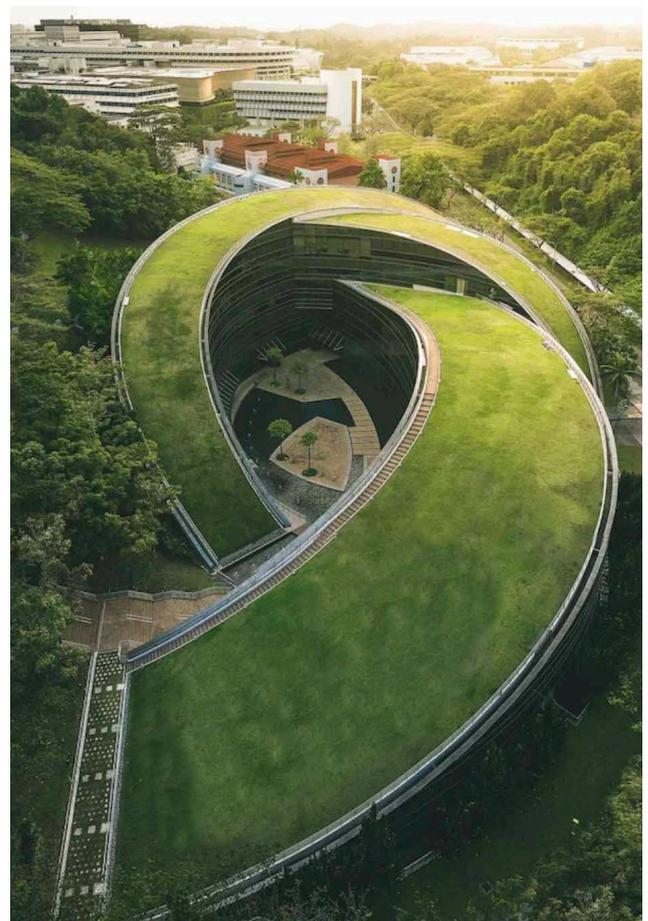
Sustainability is also an area in which blockchain innovations can be found, as greater attention is being cast on environment-related risks. Companies have started to explore how blockchain can be used to tackle sustainability challenges as Singapore remains committed to meeting the [UN Sustainable Development Goals by 2030](#), with efforts like the launch of the [Zero Waste Masterplan 2019](#).

A winning project for IMDA's 2020 Blockchain Challenge hopes to connect off-take recovery manufacturing to enable a zero-waste economy. Orobo is a [partnership](#) between Chemistry, So Now, and Kryha to develop a public blockchain platform that tracks the provenance and quality of production inputs along the value chain. The platform is a joint effort to achieve 'circularity' via digital badges that indicate compliance of materials or products to specific trade standards. Orbo also aims to create digital representations of physical goods to track the state of every unit of material or product throughout its life cycle. These are captured on a distributed ledger that logs all activities with a signature and timestamp, providing traceability and transparency along the value chain. This enables brands and consumers to participate in conscious consumption efforts like fair trade or recycled products.

Apart from using the blockchain for traceability, other companies are using it to tokenise energy resources. Electrify, a Singaporean retail electricity marketplace startup launched in 2017, recently launched its first [peer-to-peer \(P2P\) energy trading platform – SolarShare](#), in partnership with Senoko Energy, one of Singapore's largest and most established energy

companies. The platform will undergo a pilot test sponsored by the venture arm of French multinational electric utility company, ENGIE.

The project will allow consumers to purchase renewable electricity produced by private solar panel owners via an online marketplace from across the city. Private owners of solar panels list their energy offerings at their preferred rates on SolarShare, which automatically matches them to prospective customers. Running from July 2020 to June 2021, the year-long pilot aims to deploy P2P energy trading capabilities for residential and business clients of Senoko Energy. Electrify hopes the grid-wide P2P energy trading platform will create economic incentives to increase the proliferation of distributed urban solar systems.





Trade

Greater Collaboration Between Different Digital Ecosystems

In the trade and logistics sector, blockchain innovation is used to optimise document processing between fragmented digital ecosystems. The possibility of having a single source of truth and tamper-resistance has

fuelled greater collaboration among different stakeholders, enabling transactions that previously operated in silos to be integrated into a single trade ecosystem. Supply chain solutions company [Tramés](#) will be among the first few to be integrated with Trade Trust. Built with R3's Corda, the Tramés solution facilitates the interoperability of electronic trade documents exchanged between diverse parties in global trade. The company's product aims to reduce trade barriers and increase efficiency across international supply chains. Blockchain-based accreditation reduces processing times by removing the need for repetitive checks by the various trade ecosystem parties to ascertain whether the documents/information received are legitimate.

In May, Singapore-based [dltledgers](#), a blockchain company focused on cross-border trade digitisation, [announced](#) its integration with Singapore's Networked Trade Platform (NTP). Launched in 2018, the NTP was developed by Singapore Customs in collaboration with the Government Technology Agency of Singapore (GovTech) as a trade and logistics IT ecosystem connecting businesses, community systems and platforms, and government systems – in Singapore and abroad. The integration with NTP gives [dltledgers](#) access to the NTP's ecosystem of traders and service providers, enabling parties to exchange trade information digitally between themselves, as well as Singapore government agencies such as customs authorities. With the addition of [dltledgers](#) to its ecosystem, NTP can offer its users the ability to digitize their trade execution activities, end to end, on a blockchain.

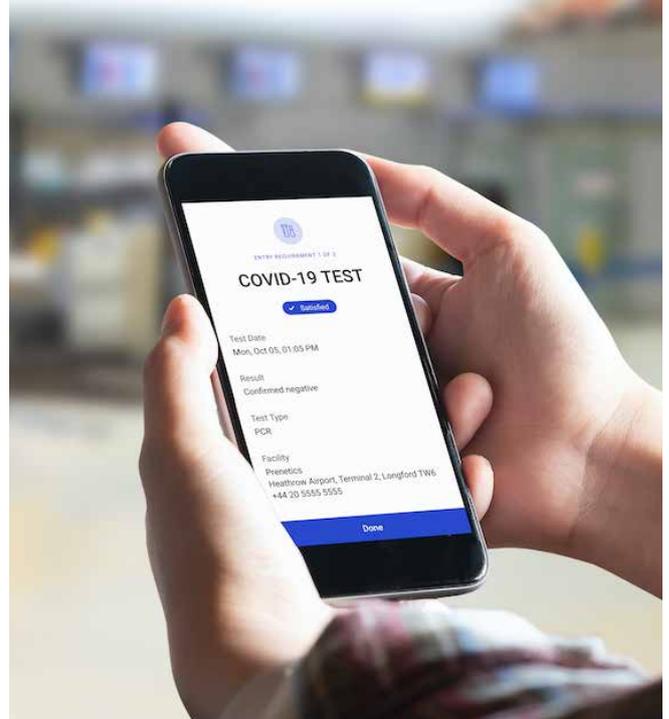
Digital Identities & Credentials

In the year since the Singapore Blockchain Ecosystem 2019 report was published, COVID-19 has upended the global economy.

Singapore, being a highly open economy, has made safe re-opening of its economy and borders a priority. To do this, it has turned to technology to ramp up contact tracing efforts and border control measures to ensure that future outbreaks can be prevented or contained. Various institutions in Singapore have been working with blockchain technology providers to integrate blockchain in a variety of processes in public health operations.

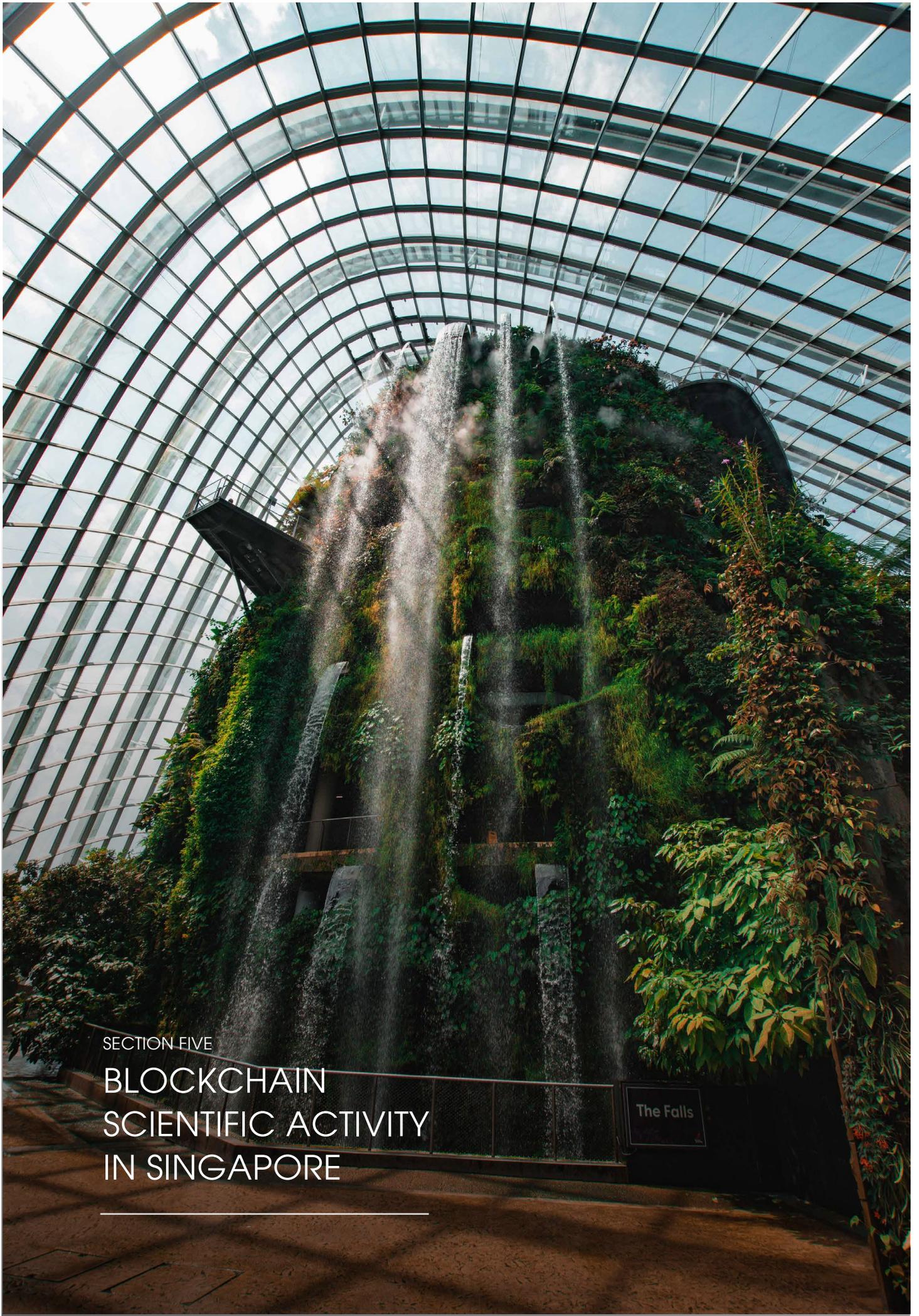
Countries are gradually lifting border restrictions and stepping up monitoring efforts as international travel resumes. Singapore-based startup Accredify has [partnered](#) with SGInnovate to launch a Digital Health Passport to accelerate these operations. The Digital Health Passport is built on GovTech's [OpenAttestation](#) framework and stores tamper-proof, verifiable medical records, including COVID-19 testing and vaccination reports digitally signed by accredited bodies, in a mobile application. Individuals will receive unique badges when they obtain the verified COVID-19 documents.

Authorities can scan the document's QR code in the app to verify its authenticity. In addition, Accredify plans to make the application use multiple standards, which will enable accredited labs around the region to come onboard too.



Travellers and authorities can benefit from streamlined safe travel operations by using blockchain to store health data and generate tamper-proof protections for each medical document.

Similarly, businesses are also keen on their employees re-entering the workforce safely, in compliance with the new safety requirements and precautions. To address this, the International Chamber of Commerce (ICC) has partnered with International SOS to launch the ICC AOKpass mobile application that provides trusted recognition of individuals' "COVID-19 compliance status". ICC AOKpass users can exert full control over their own medical information, which is stored securely and privately on their mobile device. International SOS has since [piloted](#) this with the Energy Drilling Management, a Singapore-based company, where their workers used ICC AOKpass to send their verified swab test results to a client in Thailand prior to their travel there. The trusted source of medical information gave assurance to the relevant authorities and allowed them to approve their entry with ease and with confidence.



SECTION FIVE

BLOCKCHAIN
SCIENTIFIC ACTIVITY
IN SINGAPORE

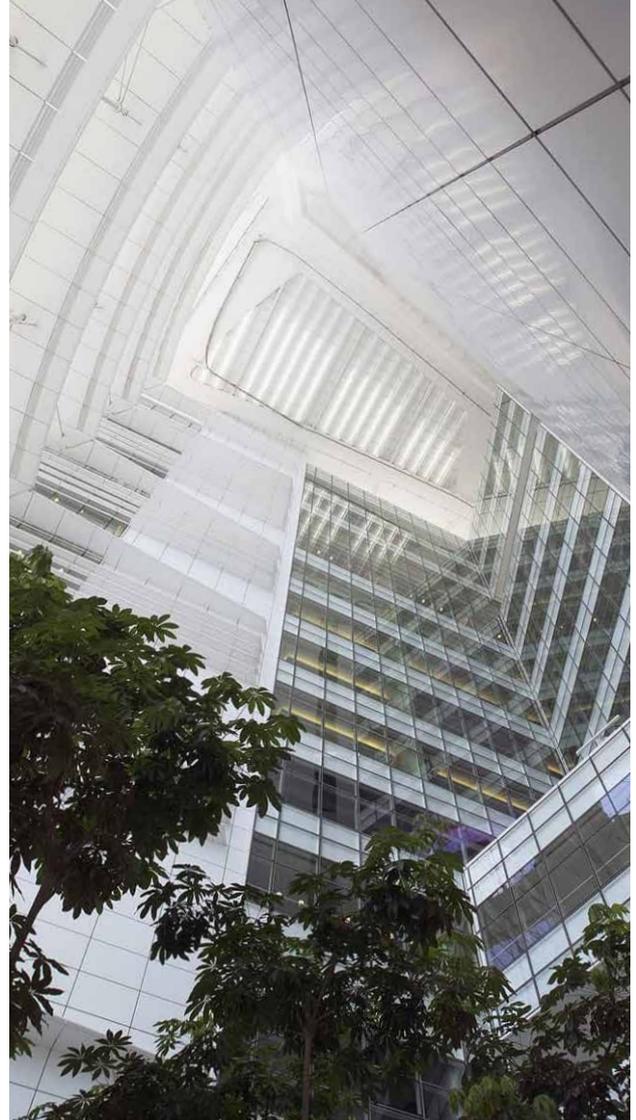
The Falls

BLOCKCHAIN SCIENTIFIC ACTIVITY IN SINGAPORE

Main Focus Areas

Singapore has a vibrant blockchain research landscape with contributions from both academic institutions and the private sector. Singapore has led the way in blockchain adoption in financial services (e.g. digital currencies, securitisation) and trade (e.g. logistics & supply chain). Singapore has also made its mark on the international blockchain research landscape, producing both a high quantity and quality of research.

The key academic institutions involved in blockchain research include National University of Singapore (NUS), Nanyang Technological University (NTU), Singapore Management University (SMU) and Singapore University of Technology and Design (SUTD). From the private sector, both large multinational corporations such as IBM, Ant Financial, and Visa Inc. and smaller home-grown startups such as Zilliqa and Kyber Networks produce research on blockchain technologies.



While blockchain research in Singapore spans a wide variety of topics, the main thrust of scientific activity lies in the following three areas:

Technological developments: Key topics being studied include cryptographic fundamentals, cybersecurity, security & privacy of blockchain systems, and smart contract security.

Achieving scalability: Core research areas include data management, distributed architecture, and consensus protocols.

Building ecosystems: Key topics include interoperability, game theory (incentives), governance, legal, and ethical issues.

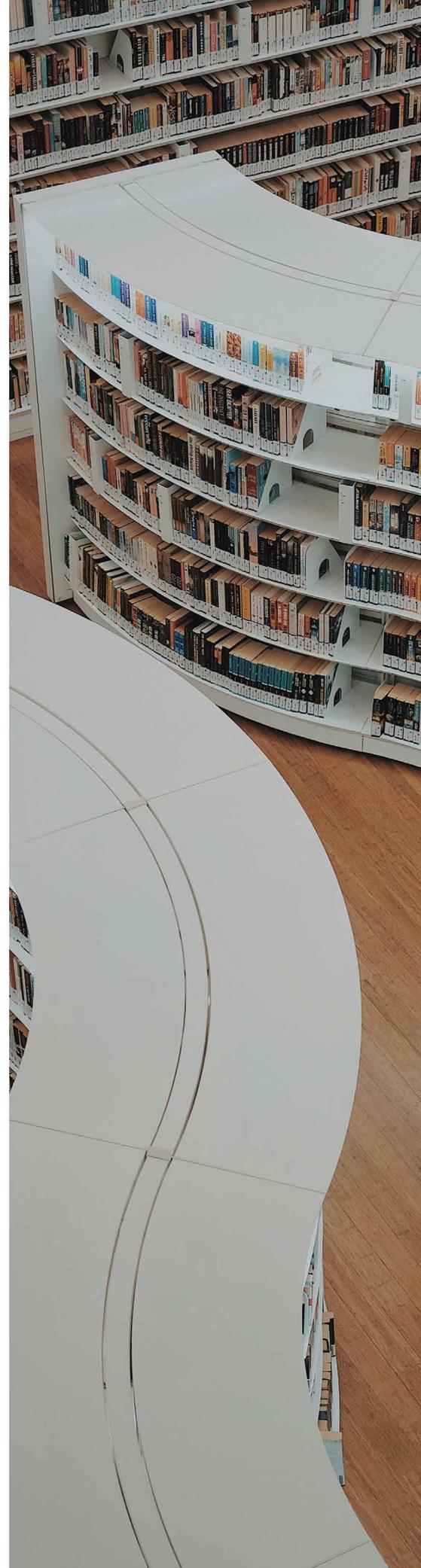
Research Productivity & Quality

Bibliometric analysis of blockchain-related scientific publications using the Web of Science database reveals that 162 articles have co-authors from institutions in Singapore. **Singapore ranks 15th in the world in terms of overall number of publications, accounting for 2.25% (162 out of 7,187) of all blockchain-related publications over the last 15 years, behind China (24%) and USA (20%).** Singapore ranks 5th in the Asia-Pacific region (behind China, Australia, South Korea and Japan) and the 1st in the ASEAN region.

Among all blockchain-related publications, 103 of them are identified as highly cited publications in the field by Web of Science. 8 out of these 103 highly cited publications on blockchain have co-authors based in Singapore. This ranks Singapore in 6th place globally in terms of number of highly-cited publications. As of November 2020, the [SciVal Field-Weighted Citation Index](#) placed Singapore 3rd in the world behind Macau and Israel who have a citation count over 1000. The h-index of blockchain publications from Singapore is also quite high (21), placing Singapore 9th in the world. Finally, the average number of citations for blockchain publications from Singapore is 12.23, which is one of the highest in the world, significantly ahead of the USA (9.27).

Within Singapore, the four main academic institutions listed earlier (NUS, NTU, SMU, and SUTD) contribute to the bulk of the published scientific literature on blockchain. In fact, about 80% of blockchain-related publications from Singapore have co-authors from one of these institutions. Outside the academia, A*STAR leads the way with 9 publications followed by IBM Singapore with 8 publications.

Certain data included herein are derived from Clarivate Web of Science. © Copyright Clarivate 2020. All rights reserved. Certain data included herein are derived from SciVal. © Copyright Elsevier 2020. All rights reserved.



Singapore has produced approximately 28 blockchain-related publications per million resident population. This is one of the highest in the world and is far ahead of Switzerland (~19) and Australia (~16).

To build upon the strong blockchain research foundation in Singapore, IMDA, Enterprise Singapore (ESG), and Monetary Authority of Singapore (MAS) hosted by NUS and funded by the National Research Foundation, jointly established the Singapore Blockchain Innovation Programme (SBIP). SBIP is a collaborative and nationwide technical community, which aims to equip the local blockchain ecosystem with the right knowledge and capabilities.

IMDA and ESG will facilitate engagements and collaborations among academia, research institutes, startups, corporates etc. to establish a conducive environment for blockchain innovation as part of blockchain ecosystem development efforts. In view of supporting blockchain research and innovation, SBIP's areas of research include:

Scalability – to incorporate enhancements to Hyperledger Fabric such as sharding, real-time provenance query, and concurrency control for smart contract parallelism etc.;

Interoperability – to create cross-chain interoperability mechanisms for any fungible assets such as fiat, distributed ledger (blockchain), in-game tokens, or any other type of assets tracked on a ledger; and

Trust and security – to develop a rigorous analysis tool to perform full verification for the safety and correctness of smart contracts.

Methodology:

The primary data source for this analysis is the [Web of Science Core Collection](#). Web of Science is a trusted publisher-independent global citation database. In the Web of Science database, the following search was conducted:



Topic: Blockchain



Timespan: 2005-2020



Indexes: SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI.

The above search query returns all the articles on the topic of blockchain published between 2005-2020 in the specified list of indexes.

These articles were then filtered based on Countries/Regions for the following analysis. After filtering the articles based on Countries/Regions, a citation report can be created to get the h-index of these publications and the average citations per item.

Certain data included herein are derived from Clarivate Web of Science. © Copyright Clarivate 2020. All rights reserved.

Key groups involved in Blockchain Research in Singapore

In the process of data collection and analysis, key groups involved in blockchain-related scientific activity in Singapore were identified. The following presents a non-exhaustive list of academic and industry research teams involved in blockchain-related scientific activity:

Academic groups:

- NUS – CRYSTAL Centre
- NUS – Database System Research Group
- NUS – Centre for Quantum Technologies
- NUS – Singapore Blockchain Innovation Programme (SBIP)
- NTU – Strategic Centre for Research in Privacy-Preserving Technologies & Systems (SCRIPTS)
- NTU – School of Computer Science and Engineering
- NTU – Business School
- SMU – School of Information Systems
- SMU – Computational Law
- SUTD – iTrust

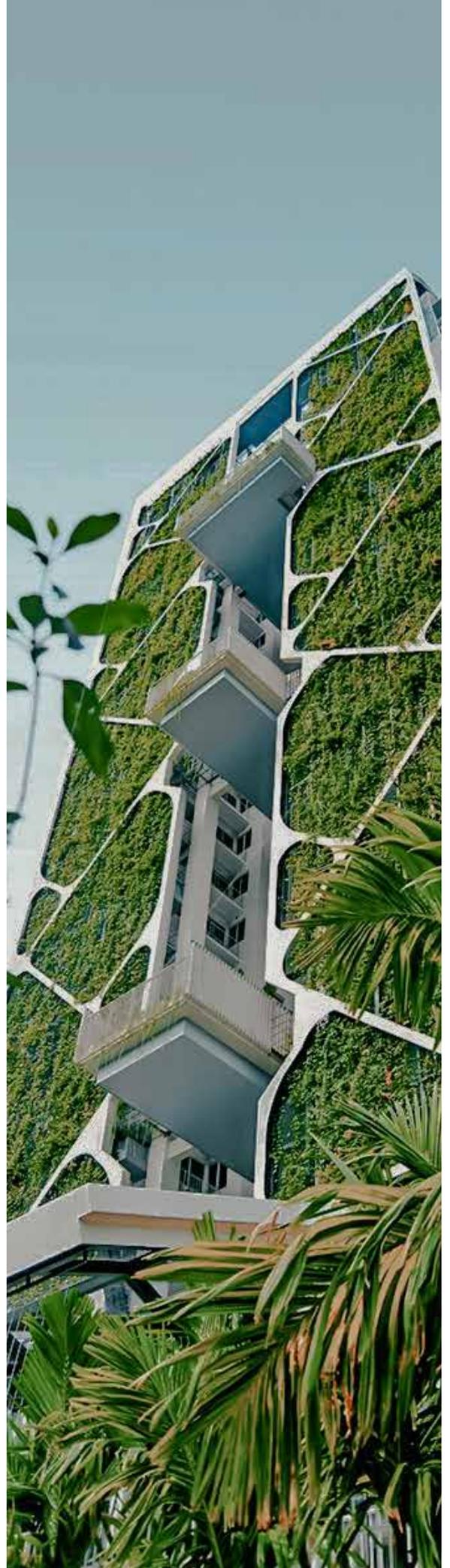
Industry research teams:

Multinational Corporations

- IBM – IBM Center for Blockchain Innovation/Blockchain Center of Competency (COC)
- Visa – Future of Payments
- Ant Financial
- A*STAR

Startups

- Zilliqa
- Kyber Network



IN SUMMARY

Blockchain is steadily transforming the way people work together in the global economy. The skepticism over its usefulness, and uncertainty of its legal status in previous years has given way to bold experiments. These experiments have achieved notable milestones - some of which are firsts in the region.

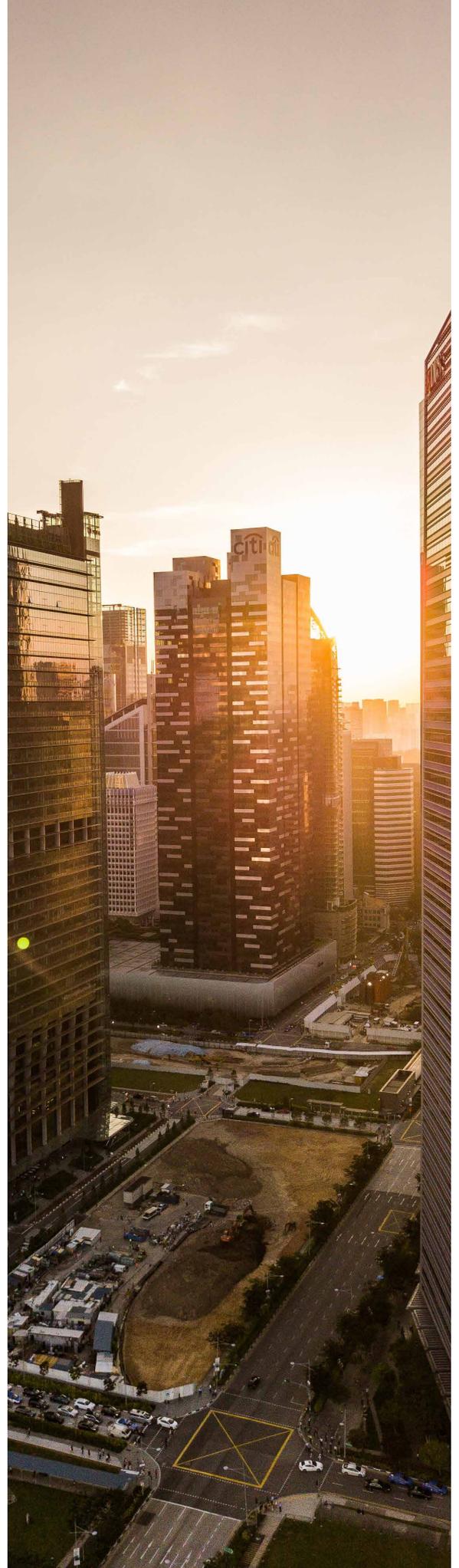
Despite the pandemic's significant impact on global travel, Singapore has shown that its ecosystem building efforts have continued to draw innovators and investment from those seeking to tap into Southeast Asia's rapid rise up the ranks of the global economy.

Over the past few years, the contributors to this report have been an active part of this growth story. As representatives of regulators and industry, we have both witnessed and helped to shape Singapore's growing prominence in the global blockchain arena.

We have found that the technological progress of a nation is not a product of lone geniuses, locked in a solitary race to build the better product.

The triumph of open-source engineering in the last decade has shown us that collaboration, not competition will be the business model of tomorrow.

If we are to build effective solutions to our increasingly complex problems, we must continue to kindle this spirit of collaboration - between firms, between industry and government, between our schools and our companies. The 2020 Singapore Blockchain Ecosystem report is an expression of that collaborative spirit.

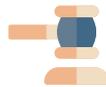




A strong collaborative ecosystem has, and will continue to define Singapore on the global blockchain stage. Singapore's rise in this space will continue to be measured by:



More successful blockchain applications, which will be examples for new business ideas and blockchain solutions to other sectors.



Innovation-friendly regulations, and government agencies playing an active role in both leading by example, and supporting new initiatives.



Support and funding for blockchain-related research in Singapore's universities and private industry.



Growing the tech talent pool of developers and innovators who can contribute to and effectively deploy open source solutions in the space.

The launch of this report at the 2020 Singapore Fintech Festival x Singapore Week of Innovation and TeCHnology (SFFxSWITCH) is but another milestone in our journey to transform Singapore into a truly Smart City. As we celebrate the progress made over the past year, it is perhaps fitting to end this report, with a quip from the legendary film director Jonathan Nolan:

"The goal from the beginning was to find the future. If you go out in the world the future is there, it's right there in places like Singapore"

