Startup Wharf

ENABLING STARTUP-DRIVEN
MARITIME INNOVATION
AND TRANSFORMATION

TRADE 2.0
– SINGAPORE –

Maritime
Startup and Innovation
Ecosystem Report

THE STARTUP MAGNET

Nick Chubb
Leonardo Zangrando

inmarsat
Research
Programme

STARTUP-DRIVEN INNOVATION IS THE NEW DRIVER OF MARITIME TRANSFORMATION FOR AN ETHICAL, SUSTAINABLE AND PROFITABLE MARITIME BUSINESS

Startup Wharf

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Foreword

We are delighted to be the key sponsor of this report, which is the second of a series of in-depth profiles into maritime technology and start-ups in a specific country and builds on the global Trade 2.0 report that we jointly launched with the authors in 2019.

Singapore is one of the leading maritime hubs in the world and so it's no surprise that Inmarsat has very strong foundations in the country with a deep relationship with the national telecommunications operator, Singtel as well as counting many of the shipowners and shipmanagers based there as longstanding and highly value clients.

Our office and warehouse located in Central Region is a vital maritime communications supply chain hub for the Asian region and is also the location of many of our Account teams, who provide support and assistance to our large customer base in not only Singapore, but the wider south-east Asia region.

As the authors so succinctly put it in the subsequent pages, Singapore is a modern-day 'David' when it comes to maritime technology with a unique and rapidly expanding innovation ecosystem that helps startups not only grow but absolutely thrive.

With this as a backdrop, it has been no surprise that our Certified Application Provider (CAP) programme has grown dramatically in the country over the last couple of years. We now have five Singapore companies already part of the programme with four of those in startup/scaleup mode and in talks with a number of other companies.

These CAPs cover a multitude of different maritime applications including vessel performance software, onboard video monitoring, fuel optimisation and crew wellbeing and are at the forefront of enabling digitalisation in the maritime industry.

We are also very actively involved with both the Singaporean Government including the Maritime Port Authority and a number of the maritime associations that are driving innovation including the Singapore Shipowners' Association and its influential Digital Technology Committee.

From an Inmarsat perspective, we now have five Global Xpress satellites operational and a further seven satellites planned by the end of 2023, so we will continue to add additional capacity to the network, but we have also developed a suite of specific value-added services including our Fleet Data IoT platform that means we will continue to build strong and solid partnerships with the startup community.

This kind of augmentation will be a consistent feature in the years to come, as we maintain the Fleet Xpress platform at the cutting edge of innovation in collaboration with our partners both in Singapore and across the globe in order to continue to drive digital transformation in the shipping industry.

Ronald Spithout

President, Inmarsat Maritime

inmarsat

Executive Summary

Singapore is a modern day David in a world of Goliaths and innovation driven by startups has been key to its recent success as a global capital for emerging maritime technology. Historically, the city has been a bridge between East and West, with its strategic geographical position making it an important port of call for many centuries. As news, ideas and technology spread around the world, they often travelled via Singapore, making the city an economic, cultural and technological hub.

Since the modern city was founded, its growth has been fuelled at least in part by immigration. This is hugely beneficial for innovation as it makes it easier to pull together teams with diverse experience to work on new ideas.

Further, with migrants more than twice as likely to start a company than non migrants, Singapore's high immigrant population also lends itself naturally to entrepreneurship. These demographic factors, combined with the city state's small geographic size, make it a startup cluster like no other. Singapore uses size to its advantage, leveraging the power of proximity alongside business friendly tax laws and its reputation as a centre of finance to become a startup magnet, attracting entrepreneurs and early stage businesses from around the world.

The maritime industry is no exception to this, the sector employs 170,000 people and contributes 7% of the country's GDP. The combination of Singapore's maritime industry and strong startup culture makes it a natural home for startups wanting to build solutions for the industry.

The local maritime technology ecosystem is heavily driven by government funding and institutions. In collaboration with NUS Enterprise, the Maritime and Port Authority of Singapore runs Pier71, a startup innovation programme that helps startups to establish partnerships with local corporates who have specific challenges that need solving. In addition, in recent years the Singapore government has made it much easier to form venture capital funds, and even co-invests heavily in early stage deep tech startups.

The Singapore startup ecosystem has become so rich that a number of major corporate interests in maritime, such as Eastern Pacific Shipping have started their own startup accelerator programmes or become active investors in the space.

Singapore's maritime information technology market is forecast to turn over $2.4billion USD in 2021 and achieve a 7.9% annual growth rate to 2030, making the sector worth $4.8billion USD by the end of the decade. Today, the technology sector makes up around a tenth of the overall maritime industry, but its relative contribution is set to almost double to become one fifth of Singapore's maritime economy by 2030.

The ecosystem is not perfect however, access to talent and the ability to fully commercialise emerging technology are barriers to industry growth. But Singapore has some unique opportunities ahead of it, including becoming a centre for R&D into zero emission bunkers, and a global hub for technology companies that has full access to Asian, European, and American markets.

Introduction

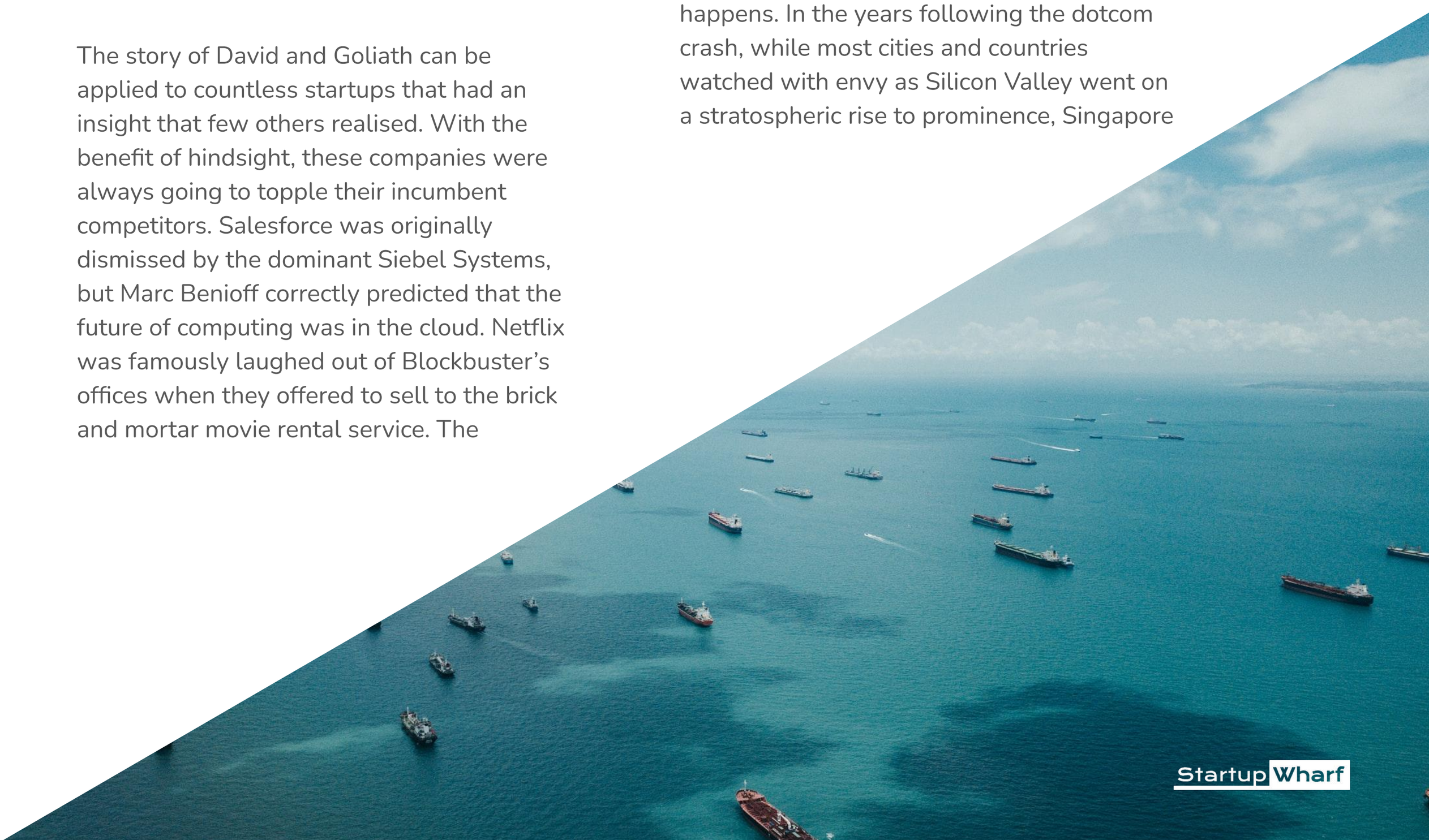
David and Goliath, the biblical story of the shepherd boy who killed a giant warrior with a single shot from his sling, is often cited as the original underdog story. But in reality, David was not an underdog at all. When the fight started, Goliath, the giant warrior, was expecting David to fight him in hand to hand combat. Goliath had best in class modern weaponry, and was equipped with thick armour to protect himself from the blows of hand to hand combat. There was never any doubt in Goliath's or anyone else's mind that David would lose in a hand to hand fight.

But David knew that Goliath would never get close enough to strike him. David had a distance weapon that made his victory over Goliath a near certainty. As a shepherd who had spent his short life using his slingshot to protect his flock from wolves, he was an expert shot and there was never any realistic chance that the lumbering Goliath, weighed down by armour, would get anywhere near him. David's real secret weapon was the fact that he knew he would win and neither Goliath, nor anyone present that day had come to the same realisation as him.

The story of David and Goliath can be applied to countless startups that had an insight that few others realised. With the benefit of hindsight, these companies were always going to topple their incumbent competitors. Salesforce was originally dismissed by the dominant Siebel Systems, but Marc Benioff correctly predicted that the future of computing was in the cloud. Netflix was famously laughed out of Blockbuster's offices when they offered to sell to the brick and mortar movie rental service. The founders of Slack correctly realised that the future of workplace communications was chat and not email, but the insight that their incumbent competitors did not realise is that when enterprise software is beautifully designed and fun to use, people are much more likely to buy it.

Though it is often applied to competition between startups and incumbent corporates, the David and Goliath story is less often applied to entire countries. But Singapore is a modern day David in a world of ancient Goliaths. Singapore is a small, fast moving, country that realised that technological innovation would be key to growth and prosperity in the 21st century.

Singapore was not alone in this realisation, but the key insight that most countries missed is that startup driven innovation is a tool to be deliberately fostered, developed and leveraged and not something that just happens. In the years following the dotcom crash, while most cities and countries watched with envy as Silicon Valley went on a stratospheric rise to prominence, Singapore



immediately set about replicating the success. By the early 2010s the country saw its first significant startup exits and the beginning of a flywheel effect that has continued at pace to this day. Significant exits attract capital, capital attracts entrepreneurs, entrepreneurs generate significant exits.

But Singapore's story is different from Silicon Valley's. Where Silicon Valley evolved organically out of military R&D in an area that was otherwise driven by agriculture, Singapore's technology ecosystem was built on top of one of the world's most strategically important centres for global trade. Ships have passed through Singapore for as long as history has been recorded. Since independence in the 1960s, the city has leveraged its geography to become the world's busiest port and one of Asia's key hubs for value-added manufacturing and technology exports.

This report attempts to tell the story of a modern day David, whose success as a maritime technology centre was inevitable, but still surprising to the industry's traditional centres of innovation. We will explore Singapore's unique advantage as an innovator and how those advantages are applied to the maritime sector. We will examine the island's innovation ecosystem, including the active role government bodies play in enabling new ideas and how the local maritime industry has leveraged the country's entrepreneurial nature. Finally, we will examine Singapore's future risks and opportunities as a centre for maritime innovation, including a forecast of the growth of the shipping technology sector, the risks of over funding startups, and the opportunity to become a global centre for zero emission marine fuels.

Singapore is unique for many reasons; size, geography, culture, and history to name a few. But Singapore's defining characteristic is agility. If it takes a long time to turn a ship, then Singapore is a tug. Small, powerful, nimble, and able to safely guide the world's shipping industry through the complexities of the 21st century.

Singapore's Innovation Advantage

In 2005, Darius Cheung was an engineering student at the National University of Singapore. While studying, he realised that the emerging smartphone market had serious security flaws. If a phone was lost or stolen, there was no way to find it, lock it, or secure the data on it. As more businesses were giving their employees phones, this problem would only grow over time. Along with two friends, Rishi Kumar and Varun Chatterji, Darius set about building a solution to the problem.

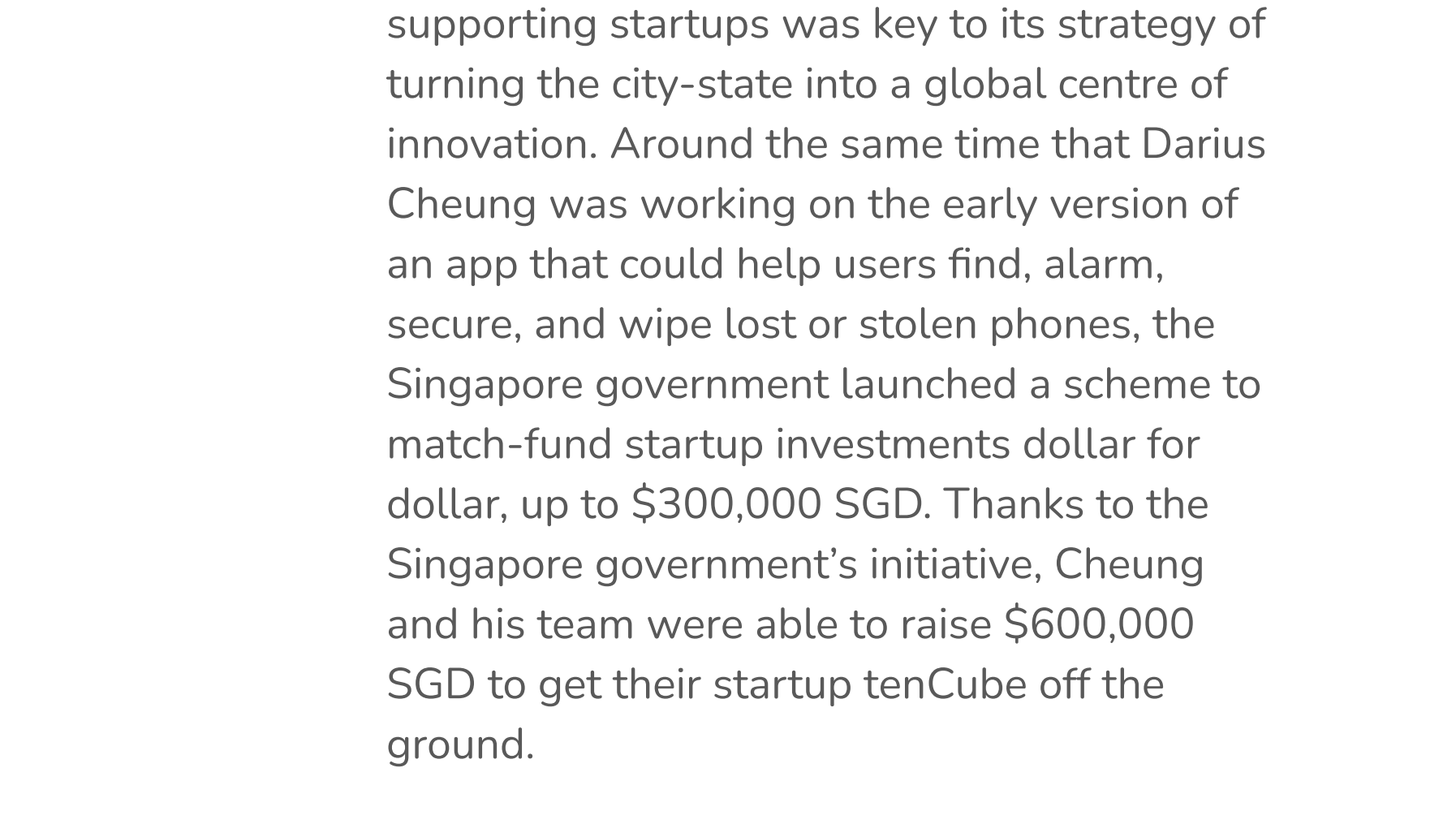
This was two years before the iPhone came out, and Singapore was not the startup hub that it is considered to be today. Luckily for Darius and his team, the Singapore government had already recognised that supporting startups was key to its strategy of turning the city-state into a global centre of innovation. Around the same time that Darius Cheung was working on the early version of an app that could help users find, alarm, secure, and wipe lost or stolen phones, the Singapore government launched a scheme to match-fund startup investments dollar for dollar, up to $300,000 SGD. Thanks to the Singapore government's initiative, Cheung and his team were able to raise $600,000 SGD to get their startup tenCube off the ground.

Five years later, just one month after the Find My iPhone app was launched by Apple, tenCube was acquired by cybersecurity giant McAfee for $25 million SGD.[1] tenCube was among Singapore's first significant startup exits. The deal helped to vindicate the government's strategy of financially supporting startup driven innovation. While tenCube was one of the first, it certainly wasn't the last. The government's strategy has played a part in creating one of the world's most vibrant startup communities outside of the USA.

In 2019 there were 151 startup acquisitions and seven IPOs across the ASEAN region, with that number expected to balloon to over 1,000 exits between 2020 and 2025.[2] Though Singapore cannot claim credit for all of this activity, it has become a powerhouse in the region and is able to attract both entrepreneurs and large technology businesses alike.

Singapore's startups have even led the charge to find solutions to the COVID-19 crisis. There are no less than 29 deep tech startups that have launched solutions to help contain the spread of coronavirus.[3] The startups have developed solutions covering everything from developing drugs to support the immune response, to developing rapid 10 minute COVID tests, and even a remotely accessible lab that enables pathologists studying the disease to work from home.

The entire land area of Singapore is smaller than New York City and the country has very little in the way of natural resources, yet it is able to consistently punch above its weight on the world stage. Singapore ranks first in the world for economic freedom,[4] third in the world for GDP per capita,[5] second in the world for maths and science education,[6] and first in the world for global competitiveness.[7] How does Singapore perform so highly on so many metrics, and, beyond government support, what is the secret behind its success as a startup nation?



A Bridge Between East and West

During its history, the island of Singapore has been an independent kingdom, part of the Sultanate of Malacca, a Portugese trading post, part of the British Straits Settlement, occupied by Japan, a British crown colony, and a state of the Federation of Malaysia. In 1965, Singapore became an independent sovereign state in its own right. Throughout the last thousand years of recorded history, Singapore has consistently held strategic geographic importance. The island was an important military garrison during the British colonial era and its position at the gates of the Malacca Strait made it an important hub for world trade, a fact that remains true today.

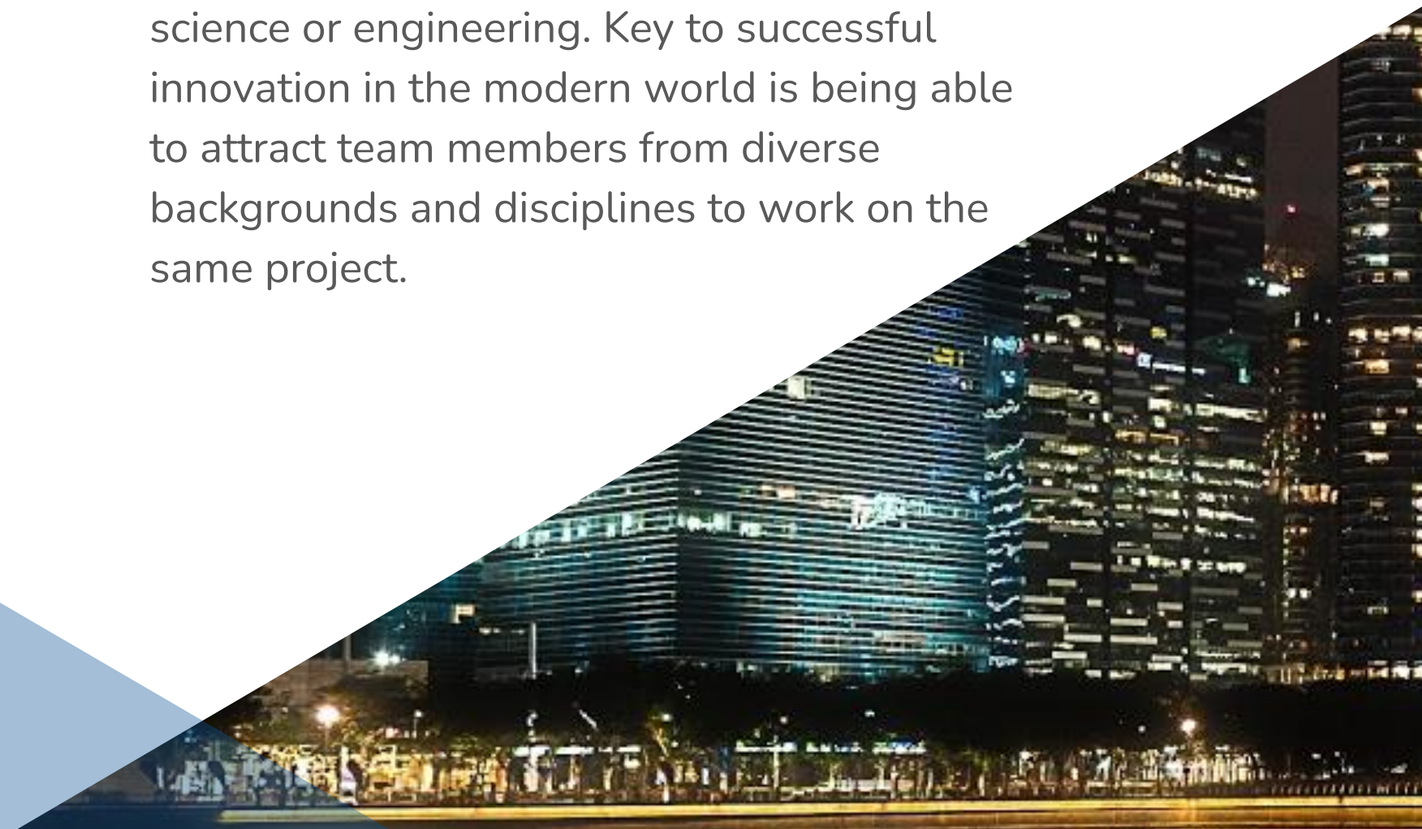
When Sir Stamford Raffles, a British Colonial Official, was looking for a strategically placed trading post to expand British influence in the region, he settled on Singapore, believing its large natural harbour would be perfect for passing ships. In 1819, Raffles negotiated an agreement with the Malay people that allowed him to set up a British trading post in exchange for an annual fee. The founding of what became modern Singapore was an attempt by the British to curtail the influence of The Netherlands in the region, as they imposed high tariffs and fees on British trade in the area. To undercut the Dutch trading posts, Raffles made Singapore a free port, charging no fees to ships who wanted to use the harbour to anchor, moor, or trade. The plan worked, and the port of Singapore quickly became a hub for trade passing through the area.

Singapore was often the first port of call in Asia for ships heading East, and the last port of call for ships heading West. Consequently, in the days before radio telegraphy, as news and ideas made their way around the world, they travelled via Singapore. The city grew to become an important bridge between Asia and Europe, sharing language, culture, and technology between two worlds that seldom met. Today, modern day Singapore is still a crucial calling point for ships passing between East and West and its position as an economic, cultural, and technological bridging point is stronger than ever before. Singapore's geographic, economic, and cultural position are key to its current status as a startup innovation hub.

The Outsider's Advantage

In the two centuries since modern day Singapore was founded, its growth has been fuelled, at least in part, by immigration. Workers from around the world flocked to the new trading hub after it was established and the flow of immigrants has not slowed since. Between 1990 and 2010, the population of Singapore grew by 2 million people. Of the growth in population, natural births accounted for just 700,000 people, and net migration accounted for 1.3 million.[8] This near-continuous influx of people has created a highly diverse society, where new ideas and experiences are continuously being integrated into the fabric of the country.

This is hugely beneficial for innovation. As technology has become more advanced, individuals have had to specialise. There is so much information in the world that it is simply impossible for one individual, no matter how intelligent or well-educated they are, to be able to absorb enough useful knowledge to work at the cutting edge of multiple fields of science or engineering. Key to successful innovation in the modern world is being able to attract team members from diverse backgrounds and disciplines to work on the same project.



Brian Uzzi, a professor at the Kellogg School of Management, studied 17.9 million publications across 8,700 journals in the Web of Science to understand what makes great innovation happen.[9] That is nearly every scientific paper written in the last 70 years. What he found was that the research papers that had the most impact and were cited most frequently were authored by teams from diverse backgrounds that were combining well-established, but seemingly unrelated ideas.[10] Diverse teams allow for depth of knowledge without sacrificing the ability to combine ideas from other disciplines. The diversity of Singapore and the historic free movement of people across its borders has helped to ensure that a steady flow of diverse ideas, disciplines, and expertise have continuously come together to solve problems in new ways.

Rosaline Chow Koo was born to immigrant parents in a poor neighbourhood of Los Angeles in 1962. Against the odds, she got into UCLA, studied engineering, and landed a job as a production line manager in Iowa after graduating. She went on to forge a successful banking career in New York City, before emigrating to Singapore with her husband, who had been offered a job on the island. In 2013, a few years after arriving in Singapore and helping her young family settle into the new country, she founded CXA Group.

After a 30-year career in management and HR, she spotted an opportunity to solve the problem of rising employee healthcare costs by personalising care and insurance.[11] CXA is an insurtech platform that uses artificial intelligence to improve employee wellbeing and lower health insurance costs. CXA now provides insurance services to 400,000 employees across 600 clients.[12] In total CXA has raised £58 million in venture funding and is well on the way to joining Singapore's growing ranks of unicorns, startups worth over $1 billion.[13]

Rosaline's story is not unique. Various academic studies have shown that immigrants are twice as likely to become entrepreneurs. In the USA, immigrants account for 13% of the population but 27.5% of those who start their own businesses.[14]

DIVERSE TEAMS ALLOW FOR DEPTH OF KNOWLEDGE WITHOUT SACRIFICING THE ABILITY TO COMBINE IDEAS FROM OTHER DISCIPLINES

It is not just starting businesses where immigrants beat native populations, it is scaling them too. 43% of companies in the Fortune 500, were founded or co-founded by immigrants or the children of immigrants. Between them, these companies employ nearly 13 million people. Immigrant and first generation founded companies account for 57% of the top 35 companies operating in the USA today.[15] Companies founded by immigrants are more likely to grow faster, employ more people, and survive longer.[16] As well as being more likely to start high-growth companies, immigrants are more likely to contribute to innovation. U.S based researchers were awarded 65% of Nobel Prizes over the last two decades, but more than half of the recipients were born abroad.[17] A quarter of all technology and engineering startups in the USA have at least one immigrant co-founder.[18] This is not just an American phenomenon, but a pattern that is replicated by studies around the world,[19] and Singapore is no exception.

The cost of employee health insurance and care in Singapore has been spiralling upwards for years,[20] yet incumbent insurance providers have not been able to see the benefits of digitally enabled personalised health plans. Rosaline Chow Koo not only saw the benefits, but risked everything to pursue them, investing her life savings and borrowing $5 million to start her company. No one knows exactly why people from immigrant families make better technology entrepreneurs, but it takes an outsider's mindset to question the assumptions and conventions that exist in incumbent industries. Further, having already experienced what it is like to risk everything, leave home behind, and start from scratch, it is believed that immigrants are more likely to be able to tolerate the risks and uncertainty that come from starting a new business.

In Singapore, of a population of 5.6 million people, only 3.5 million are citizens of the country. The other 2 million are either non-resident or have chosen to become permanent residents.[21] Of those Singaporeans who are citizens, many study abroad during higher education, and 85% said in a 2018 poll that they would like to live and work abroad at some point in their lives.[22] The high mobility and diversity of Singapore's native and immigrant populations makes the city-state a perfect breeding ground for new ideas and ventures that can disrupt the status quo.

The Power of Proximity

Diverse ideas and risk-taking entrepreneurs on their own are not enough to build a startup-driven ecosystem, however. There are other factors that need to be taken into account including access to capital, talent, and support from the wider business community. In recent years, the Singapore government has embarked on a deliberate strategy to foster innovation across the country and move the economy to become powered by value creation and innovation.

To enable this, as well as pursuing a liberal immigration policy, the government has introduced a range of measures to improve capital flow, strengthen ties between academia and industry, and convince big technology corporations to make the city their home.

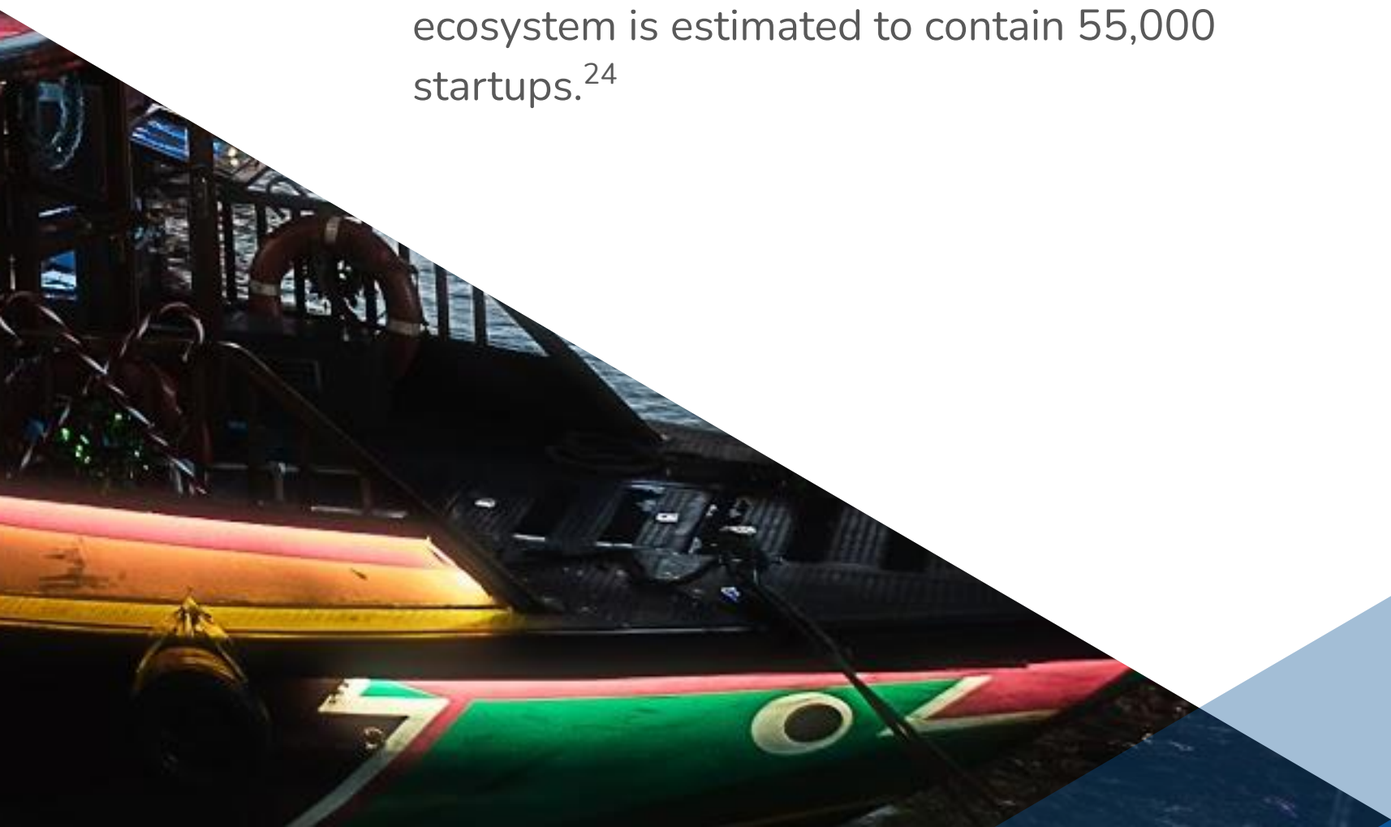
There is now a dizzying array of innovation and investment schemes that are backed, if not owned, by the government. These innovation bodies provide patent expertise, mentoring, access to investors, and access to talent. Usually all of this is provided in one place, even in the same building, capitalising on the idea that proximity breeds new ideas and innovation.

Proximity is an incredibly powerful force when it comes to generating value from a startup ecosystem. For example, an ecosystem with 1,000 startups generates $5.1 million per startup in economic value. For 2,000 startups, the average value generated is $6.9 million per startup, for 3,000 the figure becomes $8.7 million, and for 4,000 startups the value jumps to $10.6 million.[23] An ecosystem that is three times larger will generate five times more in economic value. For reference, Singapore's ecosystem is estimated to contain 55,000 startups.[24]

On top of this, business friendly regulation and tax laws, and the country's reputation as a centre of finance, mean Singapore has attracted some of the biggest technology firms including Facebook, Google, Netflix, Apple, and Microsoft to set up their Asian headquarters in the city.

On a larger scale, when all of the government schemes, big tech businesses, academic institutions, and startup accelerators are looked at holistically, Singapore capitalises on the power of proximity at scale. When more than 5 million people call an island that is just 31 miles wide home, and that same island is home to some of the world's best technical universities, business-friendly laws, a diverse and mobile workforce, and technology giants, innovation becomes an inevitable and unstoppable byproduct.

PROXIMITY IS AN INCREDIBLY POWERFUL FORCE WHEN IT COMES TO GENERATING VALUE FROM A STARTUP ECOSYSTEM



Applying Singapore Innovation to Maritime

As well as being a centre for innovation, finance, and technology, Singapore's geographical position makes it a crucial global centre for the maritime industry. The history of Singapore is so closely entwined with the maritime industry that it is almost impossible to separate the two, and its position as a centre for world trade goes back much further than the arrival of Stamford Raffles. Portugese maps of Singapore from the 1500s name the island as Barxingapara, which can be roughly translated as the "gateway to China" and Ming Dynasty pots have been found at archeological sites that indicate the existence of a thriving port during the 16th and 17th centuries.[25] Singapore's position as a transition point between two maritime zones makes it a crucial hub in the world's maritime economy that has only grown in importance in the last five centuries.

One-quarter of the world's traded goods pass through the Singapore Strait each year.[26]A great many of the ships that pass through the Strait stop to make use of the vast range of maritime services available on the island. A passing ship can refuel, change crew members, restock on supplies, get hold of spare parts, and even pick up cash without having to tie up alongside the quay.

Singapore's vast anchorage areas cover the entire south coast of the island, giving the 130,000 ships that call at the port each year somewhere to safely stop and take on supplies before continuing their individual voyages around the world.[27]

Every 2-3 minutes a ship calls at the port of Singapore, and this passing trade makes maritime a key industry for the island. Singapore's 5,000 maritime related businesses and institutions employ 170,000 people and contribute 7% of the country's GDP.[28] Singapore's maritime economy is principally made up of services including ship management, flag registration, ship financing, legal services, and broking. Additionally, despite having no oil reserves, Singapore is the world's largest bunkering port for ships needing fuel,[29] and operates the world's busiest container transhipment hub alongside a small but thriving ship building, repair, and offshore engineering industry. Such is the importance of Singapore's shipping industry that frontline maritime workers were prioritised in the queue to receive a COVID-19 vaccination. More than 10,000 workers including port workers, harbour pilots and marine surveyors were vaccinated by the end of January 2021.[30]

The combination of Singapore's vibrant maritime community, and the wider support for innovation and entrepreneurship, gives Singapore a natural advantage when it comes to developing and growing maritime startups. Such is the strength of Singapore's startup ecosystem that it is fast becoming a maritime startup magnet, drawing founders from around the world to set up their Asian offices, or completely relocate their businesses to the city. By the end of 2019, the founders of Danish digital documentation startup C-Log, now operating as Riverr, had spent so much time in the city-state that they decided to move their global headquarters 10,000km from Copenhagen to Singapore.[31] This was after the company achieved success in two of Singapore's dedicated maritime accelerators: the Maritime and Port Authority's Pier71 Accelerator, and the Techstars and Eastern Pacific Shipping Global MaritimeTech Accelerator.[32] Though not moving their headquarters, NYC based Nautilus Labs, who build vessel performance optimisation and collaborative management software, have been similarly attracted by acceptance into the Techstars Eastern Pacific accelerator. In 2019, Nautilus Labs set up an office and are building a team in Singapore to support their Asia Pacific clients.[33] The same is true for Norwegian vessel IoT startup ScanReach, who began their expansion into Asia by setting up a Singapore office early in 2021.

While SGInnovate is aimed at building deep tech across a number of industry verticals, there is now a growing community of incubators, accelerators, and venture builders across Singapore. Alongside the dedicated venture vehicles, established corporate and government entities across the industry are beginning to engage seriously with startup-driven innovation too. From the Maritime and Port Authority through to major corporate entities like Wilhelmsen Ship Services. As a country, Singapore is still in the early stages of its transition to an innovation economy, but unlike in other cities and countries around the world, the maritime industry is front and centre in the transformation.

Singapore Maritime Innovation Ecosystem

Buildings such as Marina Bay Sands and attractions such as the Singapore Flyer make the city's iconic skyline instantly recognisable to people around the world. But if you take a walk through the Ayer Rajah Industrial Estate in the South Western Singapore suburb of Queenstown you would be forgiven for not spotting anything of note.

The tree-lined street is flanked by offices and light industrial buildings that are occupied by multinational corporates such as ABB and Thales. But housed in a 1970s building that could easily be mistaken for a multi-story car park is one of the secrets to Singapore's success as a global leader in startup-driven innovation.

The blue stripes of Singapore's Block71 are a global beacon for entrepreneurship. Block71 and its ecosystem has attracted entrepreneurs from around the world to build future technologies in a building that, just ten years ago, had been written off and earmarked for demolition.

For thirty years at the end of the 20th century, Block71 served as a light manufacturing building, supporting small businesses during the city state's electronics manufacturing boom. But as Singapore's industrial strategy moved away from manufacturing and towards advanced technology and digital services, the building gradually declined and fell out of use.

In 2010, alongside a number of others in the estate, the building was scheduled for demolition.

At the time, Singapore's startup community was dispersed across the city and there was no geographic focus for technology entrepreneurship anywhere in the country. But recognising the power of proximity that had fuelled much of Singapore's innovation and growth in the preceding century, a plan was hatched by NUS Enterprise, the government's Media Development Authority, and Singtel Group's corporate venture arm to create an experimental startup village in the otherwise redundant space.

Founded in 2011, Block71 acts as a technology-focused ecosystem builder which catalyses and aggregates the start-up community. The generally accepted infrastructure required to fully enable technology startups and entrepreneurs to flourish needs to bring together industry, academia, and government. The Block71 collaboration was a perfect combination of academic, government, and industry support. Within the first three years of operation, Block71 had actively incubated 350 startups and had become home to more than 30 investors who had collectively poured S$120 million into startups in the community.[34]

In July 2013, Block71's first major success came to fruition when HomeAway acquired TravelMob for an undisclosed cash sum. HomeAway went on to be acquired by Expedia two years later for $3.9 billion.[35] Today, Block71 has expanded to two more buildings on the same estate and the local neighbourhood has become home to more than 1,000 technology startups, investors and enablers.[36] There is no doubt that Block71 has become a successful driver of innovation in its own right, but the real power of the ecosystem is how it has leveraged vertical integration.

From Vertical Villages to Global Communities

Though Block71 is a powerhouse for innovation, it does not have the specialist knowledge or ties to corporates to deeply impact some of Singapore's largest and complex industries. Overcoming this limitation has required the development of specialist innovation communities, clustered around strategically important verticals.

One of those verticals is of course the maritime industry. Less than 2,000 metres from the Block71 building is the boundary of the Pasir Panjang container terminal. This enormous port terminal has berth space for 35 container vessels along its 13.5km of quay space[37] and is a constant reminder to entrepreneurs resident in Block71 of the importance of Singapore's maritime economy.

portcast.io

EF portfolio company Portcast launched in 2018 with the mission of making the shipping industry profitable through AI-driven demand forecasting. Traditional demand forecasting techniques rely on historical data, market averages and intuition, but unexpected events can cause those models to become wildly inaccurate. Portcast's solution creates data-driven predictions that turn market volatility into a competitive advantage. By capturing over 12,000 real-time market signals, searching those signals for patterns that could predict disruption, and quantifying the impact using proprietary machine learning algorithms, Portcast enables their clients to dynamically shift their assets' spot pricing to match demand.

Portcast was founded by Nidhi Gupta and Lingxiao Xia. Nidhi studied engineering and business management in India before moving to Singapore where she worked her way up to become a Director at DHL. Lingxiao studied and worked as a software engineer in Hong Kong and moved to Singapore to join the EF programme. The startup is a perfect example of the power of diversity of ideas, skills, and experiences. In the two years since they graduated from Entrepreneur First, they have won the Hong Kong startup competition Captain's Table, placed second in the Ocean of Opportunities startup challenge in Singapore, and run successful proofs of concept with the Singapore headquartered Japanese carrier Ocean Network Express.

aéras medical

In 2010 Ping Heng Tong set up a company to improve diabetic people's access to blood glucose monitoring solutions. Over the last decade he and his team built the company up to become a leading distributor of innovative medical devices that helps people take better control of their health.

During that time, the company developed a proprietary remote vital signs monitoring solution and a platform to collect data from different devices and applications and allow users to securely share it with medical professionals. This enabled Aeras Medical to pivot away from device distribution and towards becoming an integrated medical IoT platform provider. The system was initially designed to help diabetic people to better monitor their glucose levels, but when Pier71 announced a challenge to enable remote crew health monitoring, the technology was a natural fit.

The challenge, put forward by OMC shipping in 2018, was designed to help solve the problem of poor healthcare infrastructure on ships by connecting seafarers to doctors remotely. This drastically reduces the cost of care for crew, making it more accessible for the industry.

The pilot with OMC Shipping was a success, but the Aeras Medical platform came into its own during the 2020 pandemic. By adapting the platform to include a video consult module, the Aeras Medical team was able to launch a Fit-to-Travel service that enabled doctors to remotely assess crews and facilitate crew changes. Between July and September 2020, the Fit-to-Travel service enabled 200 crew changes to take place in Singapore by giving doctors the ability to assess health on board and certify that the crew are safe to travel without physically boarding the vessel.

In 2018, NUS Enterprise and the Maritime and Port Authority (MPA) Singapore came together to form Pier71, a maritime and ports focused innovation community built on top of the Block71 ecosystem. Since its founding in 2018, Pier71 has orchestrated more than 80 innovation opportunities to foster collaboration between local maritime corporations and technology startups from Singapore and around the world through their Smart Port Challenge programme.

Smart Port Challenge is an annual competition that partners with local maritime corporations to identify challenges the industry faces and invites startups to pose solutions. Previous winners have included USA based Ocean Freight Exchange's bunker tanker scheduling tool, Dravam PTE Ltd's fuel quality monitoring system, and BeeX's unmanned underwater inspection system.[38]

Pier71 has developed a wide range of corporate partnerships from across industry including local and international stakeholders such as Wilhelmsen, Pacific International Lines, Ocean Network Express, BP, Cargotec, Wärtsilä, Vopak, and Bernhard Schulte Shipmanagement to name a few. Promising entrants to the Smart Port Challenge each year are shortlisted and invited to join Pier71 Accelerate, a programme of mentoring and support that gives startups access to this

ecosystem of corporate partners and helps them to create and validate their business model. The eventual winners and runners up of the Smart Port Challenge receive a small cash prize, but all of the finalists in the programme become eligible to access a S$50,000 grant provided by MPA Singapore. The grant is specifically focused on funding proof of concept pilots of their technology with local corporate members of the ecosystem. This helps to remove one of the key barriers that come with trialling new technology in the industry, cost.

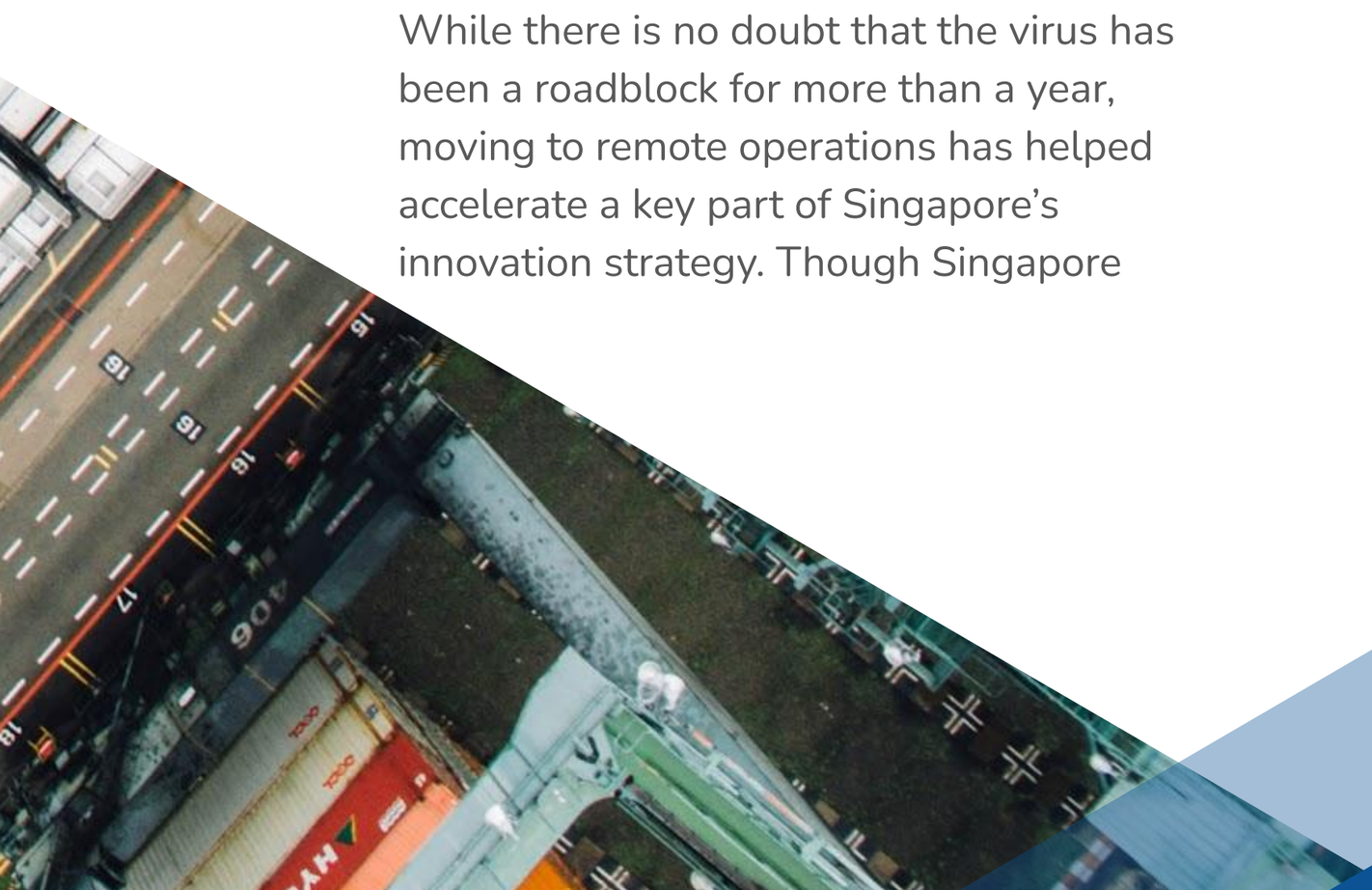
This approach of clustering a village of startups together that are focused on a single vertical market and integrating them into the corporate environment has been highly successful in Singapore and maritime is not the only industry where this approach has been deployed. In 2015 the National Additive Manufacturing Centre was launched to enable startups in the 3D printing sector. In 2017 Launchpad@JIC was founded as a space for cleantech and climate startups and in 2018 ICE71 was founded as a space for innovation in the cybersecurity ecosystem. There are 220 accelerators and incubators in Singapore and 25% of them are linked to major corporates in the city state, 13% of them are linked to government agencies, and 11% are linked to academic institutions.[39]

Though the vertical village model has proved to be incredibly successful in normal times, COVID-19 has made it nearly impossible to run physical innovation spaces. 2020 forced Pier71 and the rest of Singapore's innovation incubators to work remotely, with only very occasional physical meetings when restrictions allowed.

While there is no doubt that the virus has been a roadblock for more than a year, moving to remote operations has helped accelerate a key part of Singapore's innovation strategy. Though Singapore punches above its weight in many categories, there is no escaping the fact that it is a physically small island with a relatively small population. There is a strong local economy in Singapore, but it is not large enough in its own right to attract the biggest and the best technology companies from around the world. Instead, the island has been attempting to position itself as Asia's local technology hub for much of the last decade. Singapore's unique infrastructure means that an Asian startup that moves to the city will get access to American and European markets, and an American or European startup that does the same will get access to Asian markets. This makes Singapore a natural home for global communities and gives these highly specialised vertical villages global reach, even in times when the world can't travel.

Though the journey began long before COVID-19 took hold, Block71 is now a global community, with physical hubs in the USA, China, Indonesia, Japan and Vietnam. Through the COVID-19 crisis, Block71 has remotely supported startups within their respective ecosystems. Similarly, Pier71's Smart Port Challenge, which was conducted entirely online in 2020, attracted strong interest from international startups. 38% of the finalists in the 2020 Smart Port Challenge were international startups from North America, Europe, Asia, and Oceania.

Despite the travel restrictions caused, 2020 proved to be an accelerant to a deliberate move by local ecosystem managers across Singapore to become globally focused community managers. The rapid move to online and remote collaboration and acceleration has begun an expansion of Singapore's highly successful vertical innovation villages to become powerful global communities that put Singapore at the centre of transformation in maritime and beyond.



One of the recipients of MPA's grant funding is virtual and augmented reality digital development studio Kanda. In 2020 they received a S$50,000 grant to work with Teekay to develop a virtual reality digital twin that will enable vessel crews to run realistic training simulations in an immersive but safe environment.

Most seafarers have to travel to dedicated training centres around the world to learn or update skills such as fire fighting, operating survival craft and rescue boats, and other emergency procedures. Most training relies on using physical simulators made of real equipment such as a lifeboat and davits to train people in safe procedures. But often the equipment used in real life will be slightly different from the training equipment, and the expense of sending people to centres around the world to train makes it difficult to do regularly. High quality training in the maritime industry is expensive and difficult to achieve.

Kanda is building a digital twin of one of Teekay's vessels to allow the ship's crew to conduct training on a procedure known as Lock Out Tag Out, where equipment must be correctly shut off when its use might be dangerous, for example when it has been opened for maintenance. By creating a realistic simulation of the vessel and its equipment, crew members can repeatedly practice the procedure in a completely safe environment. The simulation can be updated any time equipment on board changes to keep it realistic. Most importantly however, unlike a physical simulation, a digital simulation of this nature can be made available any time, anywhere in the world, on relatively low cost VR equipment. This drastically reduces the cost of delivering the training on an ongoing basis to crew members and has the potential to make regular high quality training available to everyone.

Financing Innovation

Beyond technology and shipping, one thing Singapore is known for is the country's love of food. Hainanese chicken rice is widely considered to be the island's national dish, but in the last few months, a select few restaurants have been serving chicken rice that has no chickens in it. TiNDLE is a new plant based chicken made of a combination of soy and wheat starch proteins, and coconut and sunflower oils. It apparently perfectly replicates the taste and texture of chicken but uses 74% less land, consumes 82% less water, and produces 88% less GHG emissions.[40]

But the remarkable thing about TiNDLE is not the food, but the funding. Next Gen Foods, the Singapore food tech startup behind the meatless chicken launched in October 2020, with the founder putting $2.2million of his own money into the company. The initial funding was used to establish a Singapore R&D centre, with the ambitious aim of launching a plant based chicken by March 2021 and having the capacity to serve 9,000 restaurants through a European production partnership. In February 2021, four months after launch, the company raised a $10million seed round, in what is claimed to be the world's largest food technology seed round.[41] The seed round is being used to fund expansion plans throughout the world, with Next Gen planning to use Singapore as a springboard to enter to Asian, European, and American markets.

Next Gen Foods is a remarkable story, but it is also indicative of a funding and investment environment that is unrivalled in Asia. Singapore is Asia's leading city for attracting venture capital led foreign direct investment and it is third in the world behind London and New York.[42] Similar to most of the country's innovation ecosystem, the success

of Singapore as a startup hub is at least in part led by the government's proactive stance on enabling investments in the country.

In 2017, the country's financial regulator, the Monetary Authority of Singapore (MAS), announced sweeping changes to regulations that affect the formation and management of venture capital funds under a simplified regulatory scheme. The new rules relaxed a requirement for managers of venture capital funds to meet certain capital and experience criteria.[43] This has made it easier for investors to set up funds specifically targeted at early stage ventures.

On top of this, Singapore operates a Startup Tax Exemption Scheme which exempts 75% of the first SGD$100,000 of a company's taxable income and 50% of the next SGD$100,000 during the first three years of incorporation.[44] Further, the Singapore government offers a productivity and innovation tax deduction scheme where companies can claim back up to 400% of the cost of purchasing IT and automation equipment, staff training, registering IP and trademarks, research and development, and investments in design products. The scheme is capped at SGD$400,000 but is designed to help startups and small businesses make significant investments in R&D that would otherwise be impossible.[45]

As well as making it easier for others to invest in Singapore, the government is also an active investor themselves. Enterprise Singapore's investment arm SEEDS Capital is set up as a co-investment vehicle that will match funding being put into startups by private investors. The startup must be based in Singapore but can be in any market sector. For general technology startups, SEEDS Capital will put 70% of the funding into the first $250,000 the company has raised and 50% of the funding up to $2million.[46] Though it is government money, these investments are made just like any other venture capital fund, with SEEDS Capital taking an equity stake in the startup alongside the other investors.

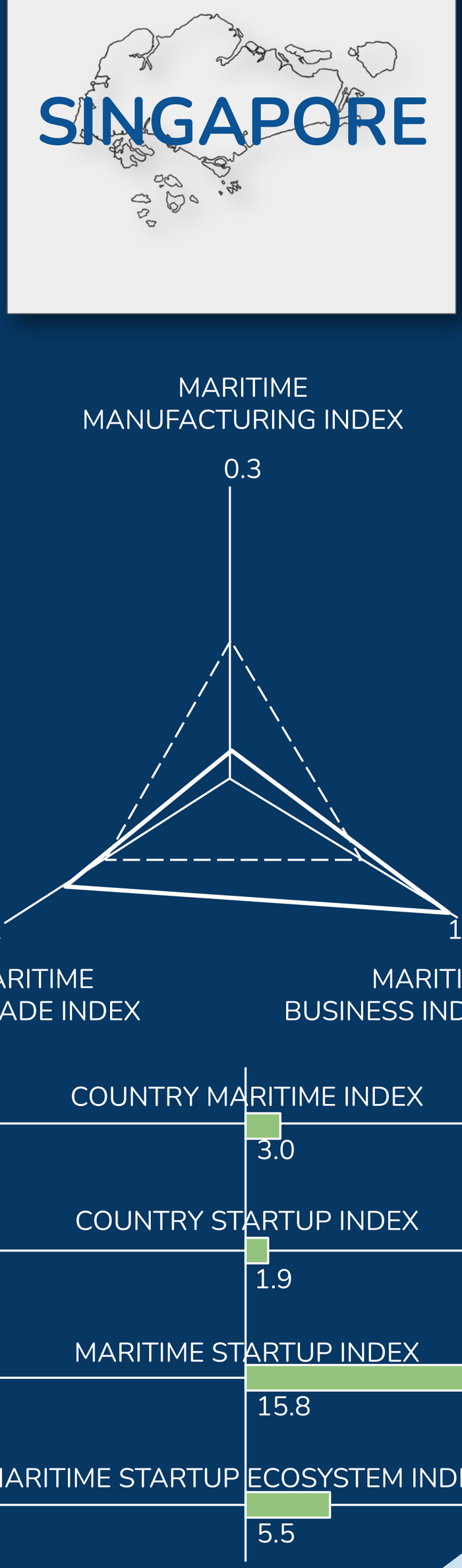
SOL-X

Enclosed space entry is just one of a number of high risk activities that crew members have to complete to maintain and operate their ships. Managing and mitigating risks is one of the most challenging aspects of running a safe ship. Risk controls have to be simple enough to not be overbearing and therefore bypassed, and comprehensive enough to actually keep crew members from harm.

Sol-X, a Singapore startup is working to solve the problem of risk management onboard with a holistic platform to manage both the control of work and also crew wellbeing to improve safety outcomes. Their product, Safevue.ai uses a combination of IoT and artificial intelligence technologies to enable a behaviour based safety system that combines permits to work and risk management, real time operations management, situational awareness and crew wellness.

Sol-X was founded in California and incubated by Boston Consulting Group, but the team located their HQ in Singapore to benefit from the City's position as a global hub for fleet management companies. The company claims to have saved more than 4,600 man hours for customers through their Safevue.ai product, and helped customers to avoid average costs of $25,000 in non-compliance or safety incident costs according to P&I Club estimates.[59]

Maritime Startup & Innovation



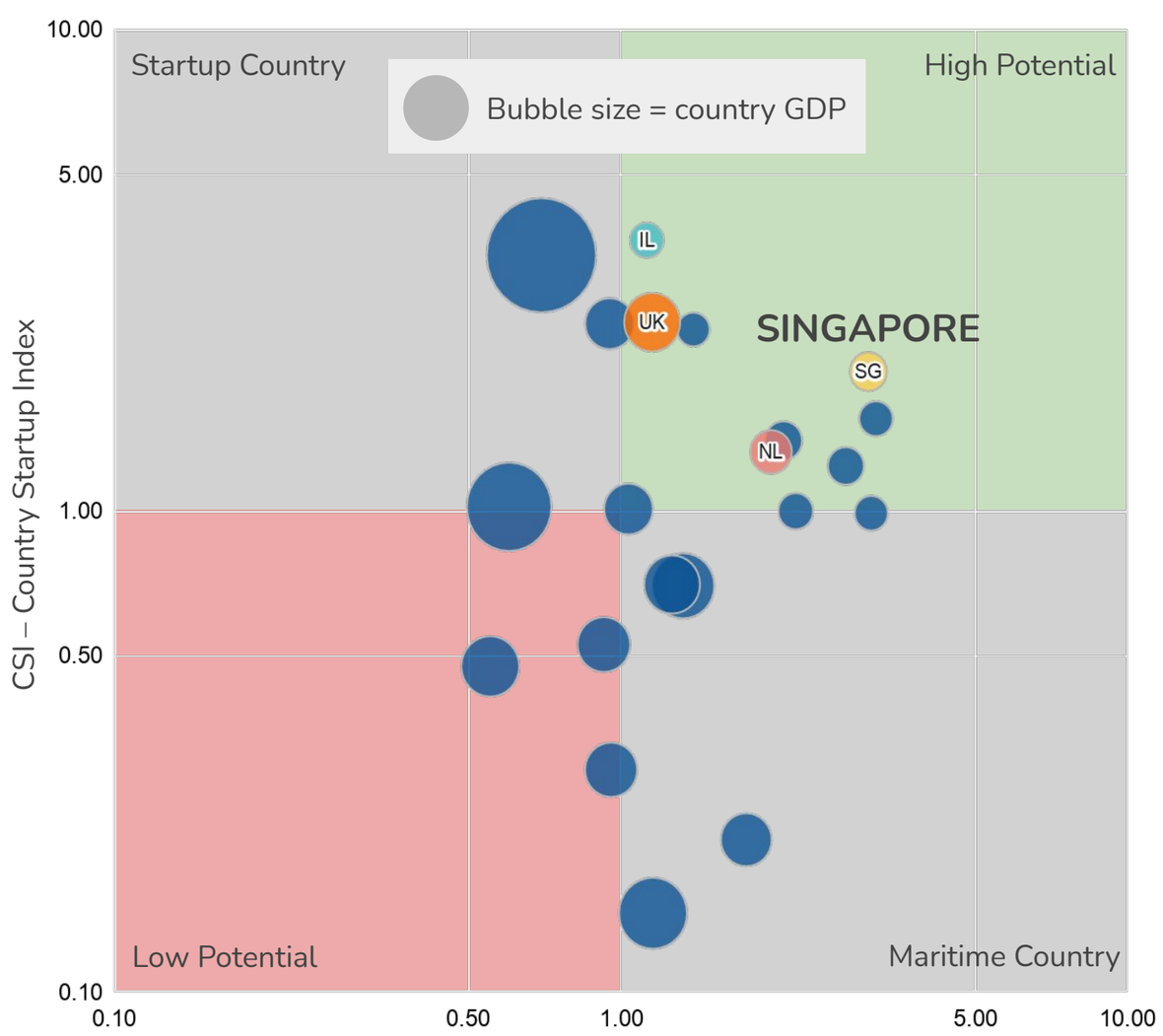
Growth forecast analysis

Singapore's maritime information technology market is forecast to turn over $2.4billion USD in 2021 and achieve a compound annual growth rate of 7.9% to 2030, making the sector worth $4.8billion by the end of the decade.

Today, information technology spending makes up nearly 11% of the overall maritime industry in Singapore. By 2030, information technology is expected to make up one fifth of the maritime industry, with the sector's contribution forecast to grow to be 20.4%.

Singapore's maritime industry is forecast to grow 1.39% per year from 2021 to 2030. Without the contribution from the rapidly growing technology sector, that figure would be just 0.22%.

Maritime Startup Ecosystem Development Potential



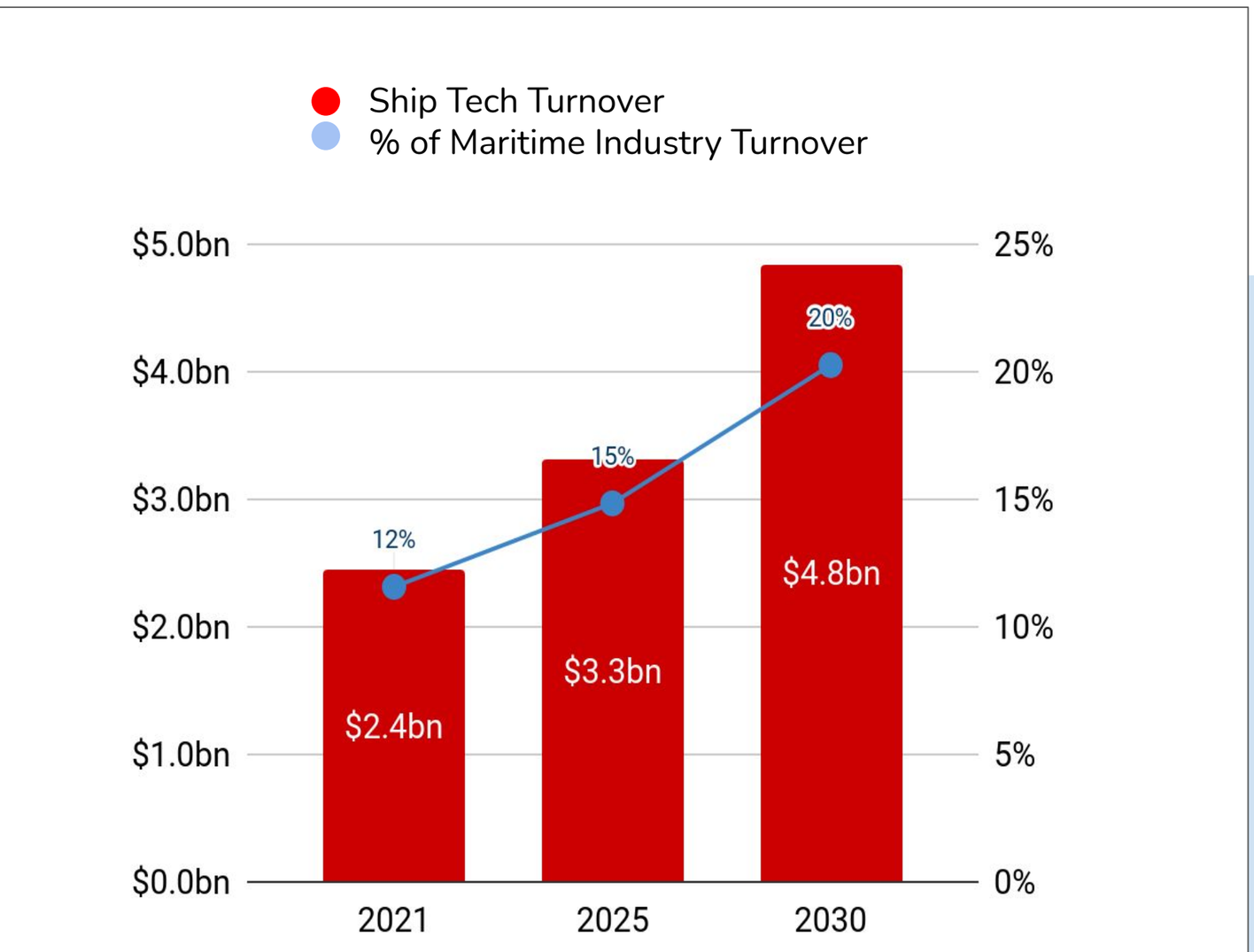
The graph above displays a country's potential to develop a maritime startup ecosystem in relation to their entrepreneurial attitude (CSI) and importance of the local maritime industry (CMI).

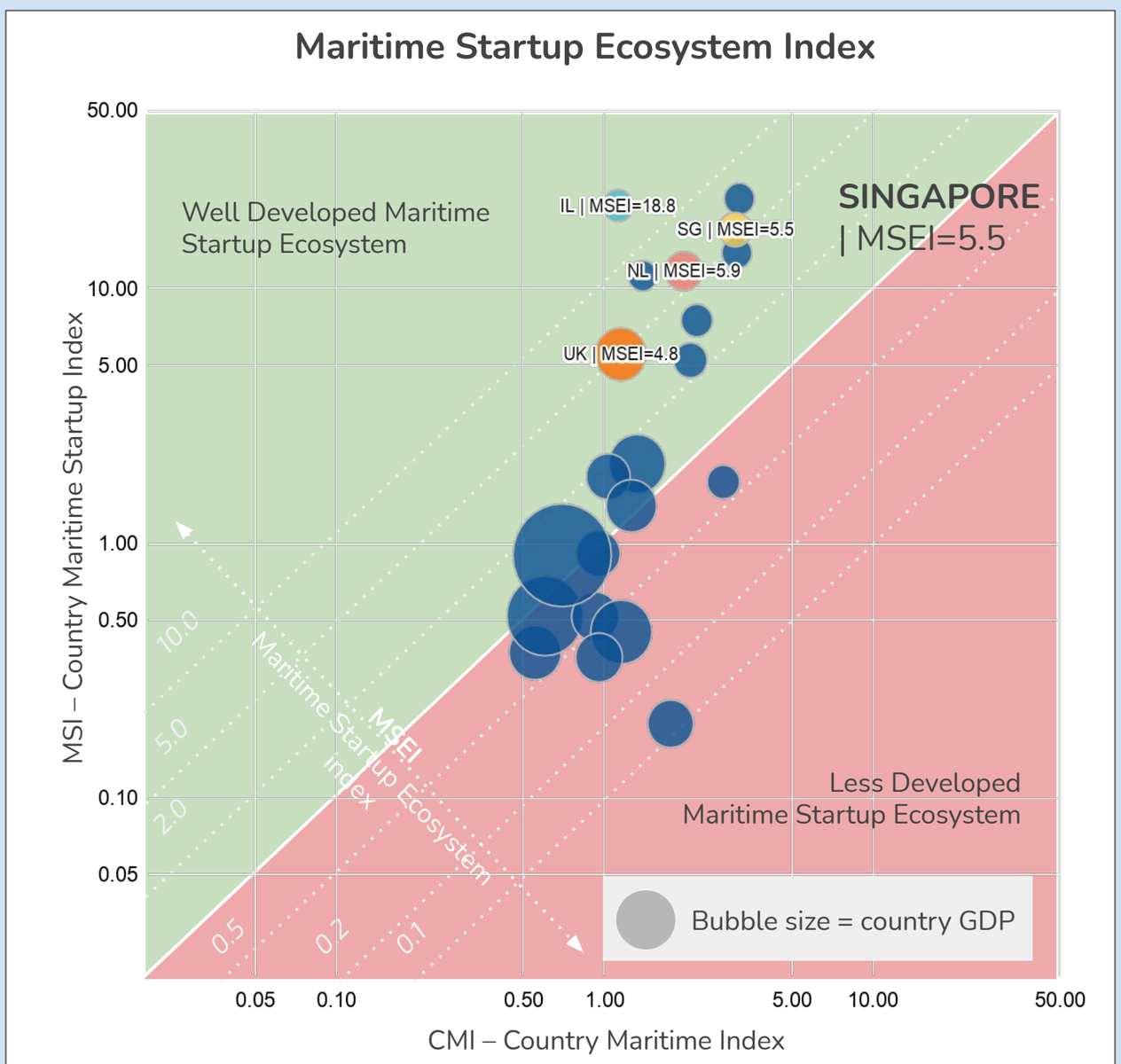
Singapore is clearly very well positioned as a Maritime Country, as well as a Startup Country, with clear potential to develop a healthy Maritime Startup Ecosystem, as it is in fact happening.

Startup Wharf

Ecosystem Overview

inmarsat Research Programme





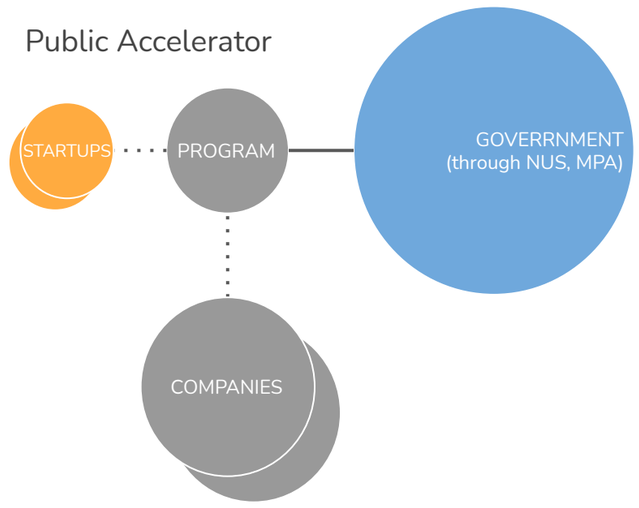
The graph above displays the importance of the Maritime sector to an economy (CMI) against the development of its Maritime Startups (MSI). Closer to the centre are larger countries with diversified industrial interests.

To the top right of the graph are relatively small, entrepreneurial maritime nations with a comparatively highly developed Maritime Startup Ecosystem (MSEI = MSI / CMI). Here belongs Singapore, with a MSEI of 5.5.

Relative Stakeholders Importance in the Local Maritime Startup and Innovation Ecosystem

Above is a purely qualitative analysis of the drivers of the local maritime innovation ecosystem, comparing Singapore to Israel and the Netherlands. Singapore's ecosystem is predominantly driven by the government who supports a strategy for startups development.

Prevailing Engagement Models in the Local Maritime Startup and Innovation Ecosystem



Above is a schematic diagram of the main engagement model in Singapore's startup and innovation ecosystem. Thick lines mean ownership, dotted lines mean relationship.

The Hunt for Deep Tech

In 2019, two PHD students from National University of Singapore were working on an academic project to understand if there is a way to detect diseases by measuring volatile organic compounds in a person's breath. If viable, the method would allow hospitals to test for diseases such as lung cancer and tuberculosis using a cheap and simple breathalyzer test, in the same way a police officer might check for alcohol. The early results were promising and the pair decided to spin out their project and form a company.

As COVID rolled around in 2020, the technology from the newly formed Breathonix took on an entirely new purpose, quickly and cheaply screening for coronavirus. Just nine months after COVID-19 landed in Singapore, the startup team had used their breakthrough technology to develop a breath test for the disease that produces results that are 90% accurate in less than 60 seconds.

The vast majority of startups around the world are created using commonly available technologies to develop a new product or service. But a small slice of the world's startups, like Breathonix, are attempting to make fundamental leaps in science, technology or engineering before commercialising their technology.

A particular focus for the Singapore government in recent years has been the pursuit of enabling this type of innovation, known as deep tech. Deep tech startups build a business based on substantive scientific research, often resulting in technology that is patented and hard to reproduce. These startups usually need a long time for research and development, and may be in existence for years before they have a commercial product. Today, deep tech startups are taking on building technologies like personalised medicine, carbon capture, and autonomous vehicles that, if successful, will have a transformative effect on society.

Deep tech startups usually require much more funding than their traditional competitors, and work on a timeline of years and decades instead of weeks and months. They are often highly risky too. It is possible for most startups to know within a few months of launch if they are getting traction in the market, but deep tech companies can spend years working on a transformative technology with no way of knowing if the innovation is viable. This can make it harder for those companies to attract investment from traditional investors.

The combination of a strong academic sector and a willingness to fund moonshot ideas makes Singapore's innovation ecosystem naturally geared up for deep tech startups.

TAGVANCE

Pinpointing the position of a person or asset in an open space is incredibly easy thanks to GPS and other global navigation satellite systems. But as soon as you move indoors, or into a steel environment like a ship, satellite signals lose their reliability. Satellite positioning signals are low power and cannot penetrate through concrete or steel. Even when they do reach a receiver, in a built up area such as a port the signals bounce off structures such as cranes and buildings causing multipath errors that make the position reading unreliable. But being able to track people and assets in industrial environments has huge implications for safety and productivity.

Tagvance is a Singapore startup working on the use of Bluetooth Low Energy and LoRa radio frequencies to enable high resolution real time tracking in environments where other technologies don't work. The system uses cheap low energy tags that can be used to track people or assets, a mesh of LoRa nodes that pick up signals from the trackers, and a data platform that provides real time tracking information, dashboards, and data integrations via an API.

Founded in 2017, the startup successfully deployed and tested installations in 17 underground mines across four countries, before exploring whether they have a product market fit in the maritime industry through Pier71's 2018 Smart Port Challenge. Tagvance were finalists in the 2018 competition, having successfully kicked off proof of concepts with Jurong Port, Sembcorp Marine, Keppel, and Vopak during the course of the accelerator.[60]

GREYWING

Founded in 2019 by the former Managing Director of a maritime security company who joined startup accelerator Entrepreneur First, Greywing was originally intended as a security platform for the maritime industry. The digital platform made it easier for ship operators to get access to security resources anywhere in the world by matching high quality suppliers with clients and providing project management and due diligence as part of the process.

But as the crewing crisis erupted in early 2020, Greywing pivoted to focus on making it easier for seafarers to safely get to and from their ships. As crew change rules kept throughout the year, Greywing's platform was adapted to analyse data from 100,000 ports, immigration restrictions, visas, port controls, and flight availability to show crewing managers how they could get their crews safely home.

Greywing's platform has since been adapted to provide a full pandemic risk assessment tool using current and historical COVID data to help crewing managers understand the risk of calling at, embarking and disembarking crew members in a particular port. These reports are available for individual vessels based on their schedule and can be customised with data from additional sources to give fleet managers the best possible chance of safely managing the COVID risk for the ship.

SEEDS Capital, the Singapore government's venture investment arm will co-invest at much higher levels for deep tech startups than for traditional startups. The cap is four times higher for deep tech at $8 million, with SEEDS Capital putting in 70% of the first $500,000, 50% up to $4million, and then 70% up to $8 million.[47] Further, in 2016 the government launched a wholly owned private organisation, SGInnovate, that is solely focused on helping scientists in the country to launch deep tech companies.

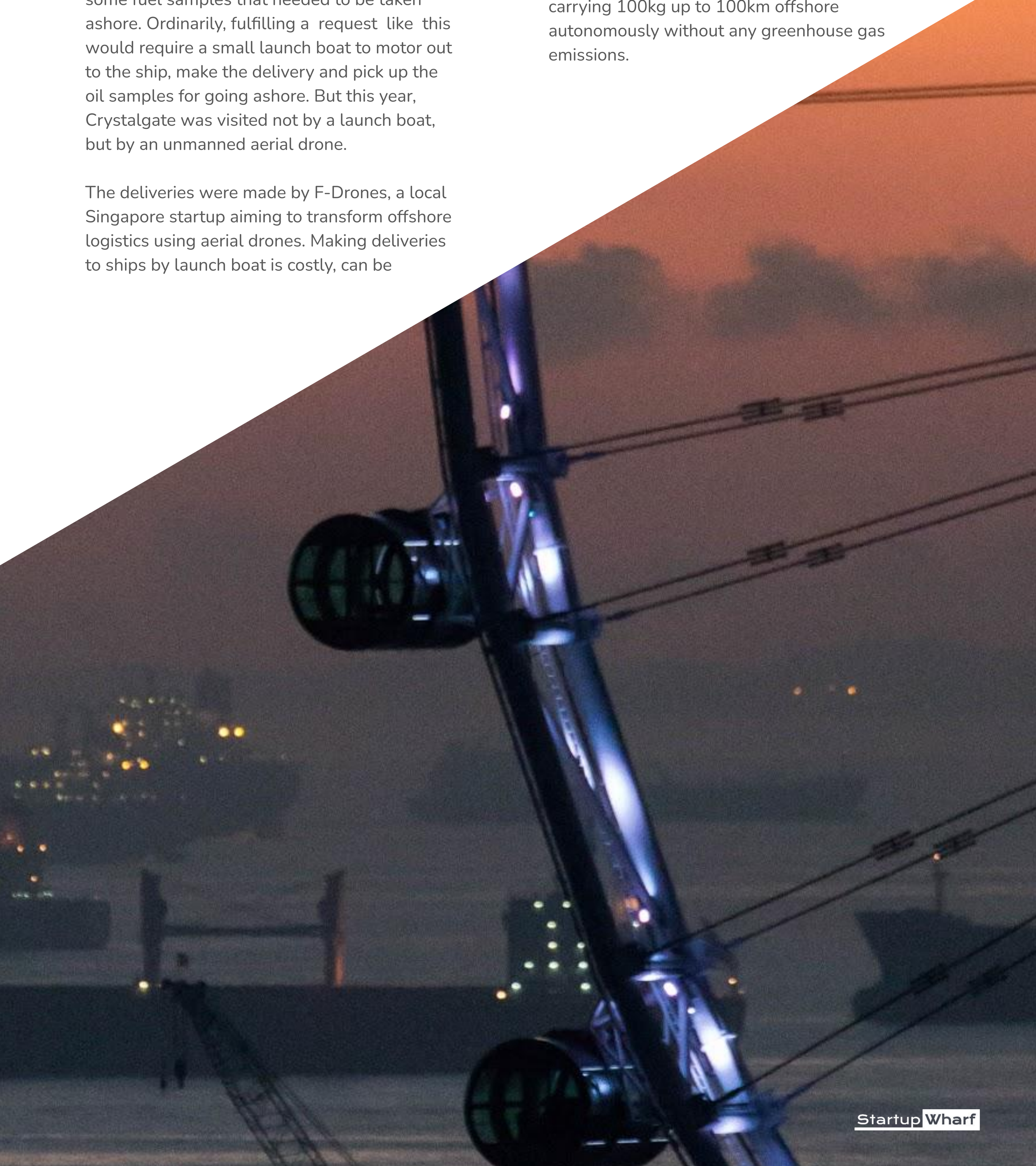
SGInnovate's launch partners included four universities, the national patent office, and world renowned startup accelerator, Entrepreneur First.[48] SGInnovate exists to give the founding teams of startups easy access to the support they need to turn what is often scientific and academic research into a commercial venture.

The maritime industry has not been immune from the focus on deep tech. In June 2020, the Maritime Port Authority of Singapore and Enterprise Singapore announced that S$50million of SEEDS Capital funding would be ring fenced for the maritime industry with a special focus on deep tech. Six key private sector industry investors were identified as partners to help distribute the funds, with SEEDS Capital co investing alongside them. The private sector co-investors include Schulte Group's venture capital arm Innoport, Zeaborn's seed fund TecPier and corporate venture partner Rainmaking's new fund Motion Ventures.

Early Adopters

In December 2019, the Liberian flagged bulk carrier Crystalgate, which is managed by Singapore-based Eastern Pacific Shipping, was at anchor off the coast of Singapore to take on bunkers and supplies. The ship needed a small number of engine spares delivered along with some Christmas goodies for the crew, and had some fuel samples that needed to be taken ashore. Ordinarily, fulfilling a request like this would require a small launch boat to motor out to the ship, make the delivery and pick up the oil samples for going ashore. But this year, Crystalgate was visited not by a launch boat, but by an unmanned aerial drone.

The deliveries were made by F-Drones, a local Singapore startup aiming to transform offshore logistics using aerial drones. Making deliveries to ships by launch boat is costly, can be dangerous, and contributes to local emissions. Though the emissions for a single delivery to a vessel by boat is negligible, when you consider that at any one time there are around 1,000 ships in Singapore's anchorages and 130,000 ships visit the port each year, the net effect is significant.[49] F-Drones plan is to change how offshore deliveries are carried out. Their ultimate goal is to build a drone capable of carrying 100kg up to 100km offshore autonomously without any greenhouse gas emissions.



OceanFreightExchange

For a bulk cargo vessel like an oil tanker or iron ore carrier to carry a cargo it must first be fixed in a charter. This is the process where the owner of the vessel and the owner of the cargo agree a fee for carrying the shipment from point A to point B. There is usually a shipbroker in the middle, helping to facilitate the transaction. But monitoring the positions of vessels in a fleet, predicting their future movements, and fully understanding costs of a voyage can be difficult for all of the parties.

Ocean Freight Exchange exists to act as a marketplace to help ship owners, charterers and brokers to access the information they need to make the most out of their fleet. Founded in Singapore in 2016, the company has built a platform driven by artificial intelligence that allows users to create and update vessel position lists instantly, calculate voyage costs, track cargo trade flows, and optimise bunkering operations.

The platform parses data from a user's emails and other messaging platforms eliminating the need to manually input data. Most importantly however, the AI-driven engine makes it easier for maritime stakeholders to predict future supply and demand for both vessels and cargoes, making it easier to optimise the location of a fleet to ensure they are fully utilised.

Enabling a startup to deliver goods by drone to ships is the sort of initiative that would only be possible in Singapore. Six months prior to F-Drones' first commercial deliveries, the Maritime and Port Authority and the Civil Aviation Authority of Singapore jointly established the Maritime Drone Estate as a test bed to allow operators to legally and safely conduct test and commercial flights.

The delivery to Crystalgate was the first of a commercial deal signed between the startup and corporate to conduct 200 deliveries to Eastern Pacific ships throughout 2020. But to F-Drones, the Eastern Pacific Shipping team are not just customers, they are also investors and mentors to the fledgling business. Eastern Pacific Shipping is pioneering a new way for corporates in the maritime industry to successfully partner with transformative technology startups.

In 2019, Eastern Pacific Shipping announced a partnership with Techstars, a global technology and innovation ecosystem builder to establish a dedicated MaritimeTech Accelerator, with the stated mission of cultivating and mentoring the next generation of maritime technology entrepreneurs.[50] The accelerator has provided a home to nine emerging technology companies each year for the past two years, offering funding, office space, and access to expertise to startups working in everything from blockchain to 3D printing.

For a startup, one of the most important things an industry accelerator such as the EPS Techstars one can provide is access to a large anchor customer. Eastern Pacific Shipping operates a fleet of more than 200 vessels of various types, providing the perfect test bed for new technological solutions. This reduces risk for both the startup, the corporate, and any investors and helps to shorten the feedback loop between innovators and the industry's problems to be solved. In March this year, F-Drones closed a seed round that was led by Eastern Pacific Shipping, but also attracted the Schulte Group's investment arm Innoport and had co-investment funding from SEEDS Capital.

Access to early customers is critical to a startup's ability to test and validate their idea and Eastern Pacific is just one of a number of maritime corporations that have begun working with startups in this way. PSA, Singapore's port and terminal operator and one of the largest terminal operators in the world runs PSA unboXed, an accelerator and investor in startups targeted at the container logistics sector. KSL Maritime Ventures is a corporate venture capital fund owned by Kuok Singapore Limited, a group with diverse interests across ship owning, ship building, ship management, real estate and agriculture.

But it is not just the early adopters that call Singapore home. The streets that surround Singapore's Marina Bay are littered with shipping related businesses, most of the world's major fleet operators have offices within a 30 minutes walk of each other.[51] Beyond ship management, there are thousands of maritime related businesses on the island including cargo interests, ship's agents, charterers, ship owners, brokers, and logistics providers. It only takes a small cluster of shipping businesses across the city to take the lead by conducting venture and acceleration activity to open up the entire maritime ecosystem to Singapore's emerging startups. This creates a flywheel effect, where more adoption leads to more startups which leads to more adoption. This allows technology adoption to spread across the industry much more quickly than in more dispersed maritime economies.

Singapore Innovation Outlook

Singapore's story is a remarkable one. When the city became an independent state, unemployment was high, literacy rates were low, and the new country faced an uncertain future. In less than 60 years, the island's economy has been radically transformed from one of low value manufacturing to one of high value technology and services. In the last ten years, the commitment of both government bodies and industry has made the city a world leader in startup driven innovation in the maritime sector. But its future position as a leader is not guaranteed and the next decade will offer both strategic opportunities and risks for the country's maritime technology sector.

Singapore's Maritime Technology Market

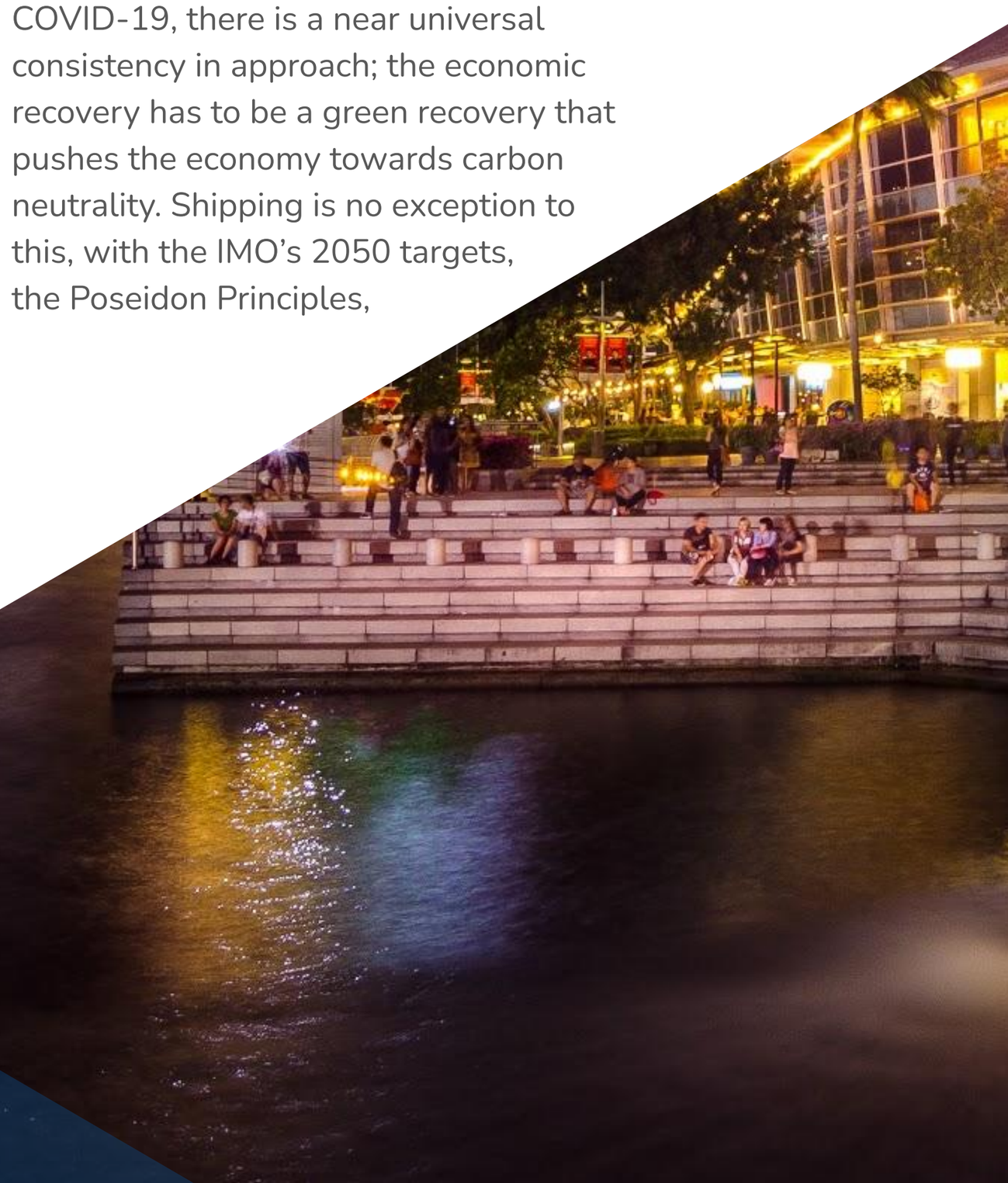
Singapore's maritime information technology market is forecast to turn over $2.4billion USD in 2021 and achieve a compound annual growth rate of 7.9% to 2030, making the sector worth $4.8billion by the end of the decade. Information technology spend includes software, hardware, communication equipment, and related services across ship ownership and management, shipbuilding, and ship machinery manufacture.

The remarkable thing about Singapore's technology sector however, is the fact that it is becoming an engine for growth in a sector that has otherwise limited potential. Today, information technology spending makes up nearly 11% of the overall maritime industry in Singapore. By 2030, information technology is expected to make up one fifth of the maritime industry, with the sector's contribution forecast to grow to be 20.4%. Singapore's maritime industry is forecast to grow 1.39% per year from 2021 to 2030. Without the contribution from the rapidly growing technology sector, that figure would be just 0.22%.

Strategic Opportunities and Risks for the Industry

Before the COVID crisis, Singapore's economy was showing signs of slowing. 2019 GDP growth was at its lowest level since the aftermath of the global financial crash.[52] The country's strong response to the coronavirus crisis meant that the economy contracted by 5.4% in 2020, which is a marginally better outcome than most developed countries. The finance, technology, and advanced manufacturing sectors actually grew through 2020.[53]

As the world looks to rebuild after COVID-19, there is a near universal consistency in approach; the economic recovery has to be a green recovery that pushes the economy towards carbon neutrality. Shipping is no exception to this, with the IMO's 2050 targets, the Poseidon Principles,



and the Sea Cargo Charter all early attempts at pushing the industry towards less a carbon intense operating model. As the world's largest bunker port and as a world leading centre for research and development, Singapore is incredibly well placed to lead the charge on developing and eventually distributing low and zero carbon fuels.

South of Singapore's main land mass lies Jurong Island, a small island devoted entirely to refining petroleum products. The island's refineries have the capacity to process 1.3million barrels of oil per day, a significant proportion of which ends up fuelling the world's maritime industry.[54] We don't yet know what the industry's zero emission fuels will look like, but the depth of expertise and infrastructure, combined with the country's willingness to back deep tech startups that may take years to develop technology gives Singapore a clear natural advantage in a sector that will one day be at least as big as the current global bunkers market.

SINGAPORE IS INCREDIBLY WELL PLACED TO LEAD THE CHARGE ON DEVELOPING AND EVENTUALLY DISTRIBUTING LOW AND ZERO CARBON FUELS

GAZELLES ARE A MAJOR ENGINE OF ECONOMIC GROWTH AND HELP TO CREATE LARGE NUMBERS OF SUSTAINABLE JOBS

But the Singapore government's willingness and ability to fund startups does also come with some drawbacks. By now, we all understand the term unicorn, meaning high growth startups that are worth more than $1bn. Singapore has become a hub in Asia for unicorns. But some less known terms are gazelle, a profitably growing company; zombie, a loss making company that is not growing, and tortoise, a profitable company that is not growing. Unicorns make headlines and provide big exits for their founders, but gazelles are a major engine of economic growth and help to create large numbers of sustainable jobs. Both unicorns and gazelles are important to a startup ecosystem, but Singapore lacks the latter.

Just 8% of Singapore's startups are said to be gazelles. More concerning however, is that according to research by the NUS Entrepreneurship Centre, 57% of Singapore's startups are zombies.[55]

Because of the widespread availability of grant and equity funding and the high number of government support schemes, startups are more likely to survive for five years in Singapore than the USA or UK, but much less likely to grow beyond the R&D phase and create jobs. Between 2010 and 2016, the rate of startups accessing government support schemes rose from 19% to 69%. But in the same year, nearly a quarter of Singapore's startups (24%) recorded no sales revenue.[56] While Singapore's strategy of supporting deep tech startups has enabled an increase in startup driven R&D, there is a clear gap between research and its commercialisation. This is normal for any developing startup ecosystem, but it is a challenge that needs to be addressed if the city is to maximise the potential of the R&D dollars that are currently spent in the city.

Another issue facing Singapore's ability to maintain its leading position as a global maritime technology centre is access to talent. In part due to COVID-19 related border closures, but also a wider shift in immigration policy, it is getting harder for startups to attract talent from overseas.

Whenever a ship enters port, there is a huge amount of information that needs to be exchanged between various parties including the ship, port, agent, and local authorities such as customs, immigration and port state control officers. This information is transmitted and exchanged by email, radio, and physical documents.

Singapore blockchain startup Navozyme has developed a blockchain platform to enable secure and efficient data sharing between parties involved in the maritime supply chain. Their Port Clearance application makes it possible for authorised parties to exchange and access verified data about the vessel's port call in one place. In an impact trial at the ports of Barcelona and Tenerife in 2020, the Port Clearance application eliminated 359,537 physical signatures, saved 473,075 sheets of paper, and saved 66,198 admin hours.[61]

As well as port clearance, the Navozyme team has deployed their technology to three other use cases where data needs to be exchanged securely between multiple authenticated parties. Navozyme's other solutions include a pollution reporting platform, a ship registration platform for flag state authorities, and seafarer certificates. The system has even been repurposed during the COVID-19 crisis to enable medical centres to authenticate PCR test results for seafarers who are being repatriated.

During the height of the unemployment caused by the COVID crisis, in May 2020 the government introduced an expansion of rules requiring companies to advertise jobs to local people first and raising the minimum salary threshold for immigrants to receive an employment pass.[57] A lack of access to talent is one of the most severe limitations that can be placed on a fast growing company.

In the shipping industry particularly, the talent pool is a global one and a huge part of the country's maritime success story is its ability to attract international startups to set up Asian or global headquarters in the city. For Singapore to continue to grow its position as the maritime industry's global startup magnet, it needs to be able to attract not just entrepreneurs but also talented employees, technologists and shipping experts from around the world.

Perhaps the strongest opportunity for Singapore as a maritime technology hub lies in its geopolitical positioning. Due in no small part to the vast size of its domestic market, China is rapidly becoming one of the shipping industry's most important emerging technology centres. From a near standing start two decades ago, Shanghai has risen to become the tenth largest startup hub in the world as well as one of the global shipping industry's most important cities. But unleashing China's potential as a hub for innovation is more difficult than it may appear. China is the world's top destination for sourcing goods, but concerns about intellectual property, the legal system, and the complex nature of software sales make it difficult for innovative technology businesses to launch internationally.

Hong Kong is usually seen as China's bridging point with the rest of the world. Until very recently, the semi autonomous region has been viewed as a centre for financial and legal services in Asia. But the ongoing political unrest and the introduction of new security laws has led to a rapid demise. Having spent 25 years at the top of the Heritage Foundation's Economic Freedom Index, Hong Kong was overtaken by Singapore in 2020, and removed from the Index entirely in 2021 on the grounds that it is no longer independent enough from Beijing.[58]

Hong Kong's withdrawal from the international stage is a major opportunity for Singapore as a maritime technology centre. A fully independent state with strong trading ties to major European, American and Asian economies, Singapore has a well functioning judiciary, and a strength in technology discussed throughout this report. Combined, this gives the country the potential to become a truly global centre for technology and innovation that is open to both the cutting edge technologists of China and Western economies, not to mention the burgeoning ecosystem that exists across India and South East Asia.

Singapore only has a small domestic market, but its geographic and economic position make it perfectly suited to become Asia's capital for importing and exporting cutting edge maritime technology. This gives entrepreneurs that bet on Singapore access to a global ecosystem, connected by the long established position of the city in the world's maritime economy. As long as Singapore can support the proper commercialisation of technology and continue to make it easy for people to come and go, the city will become a stronger magnet, attracting best in class technologies from around the world and becoming a likely home to the maritime industry's push to decarbonisation.

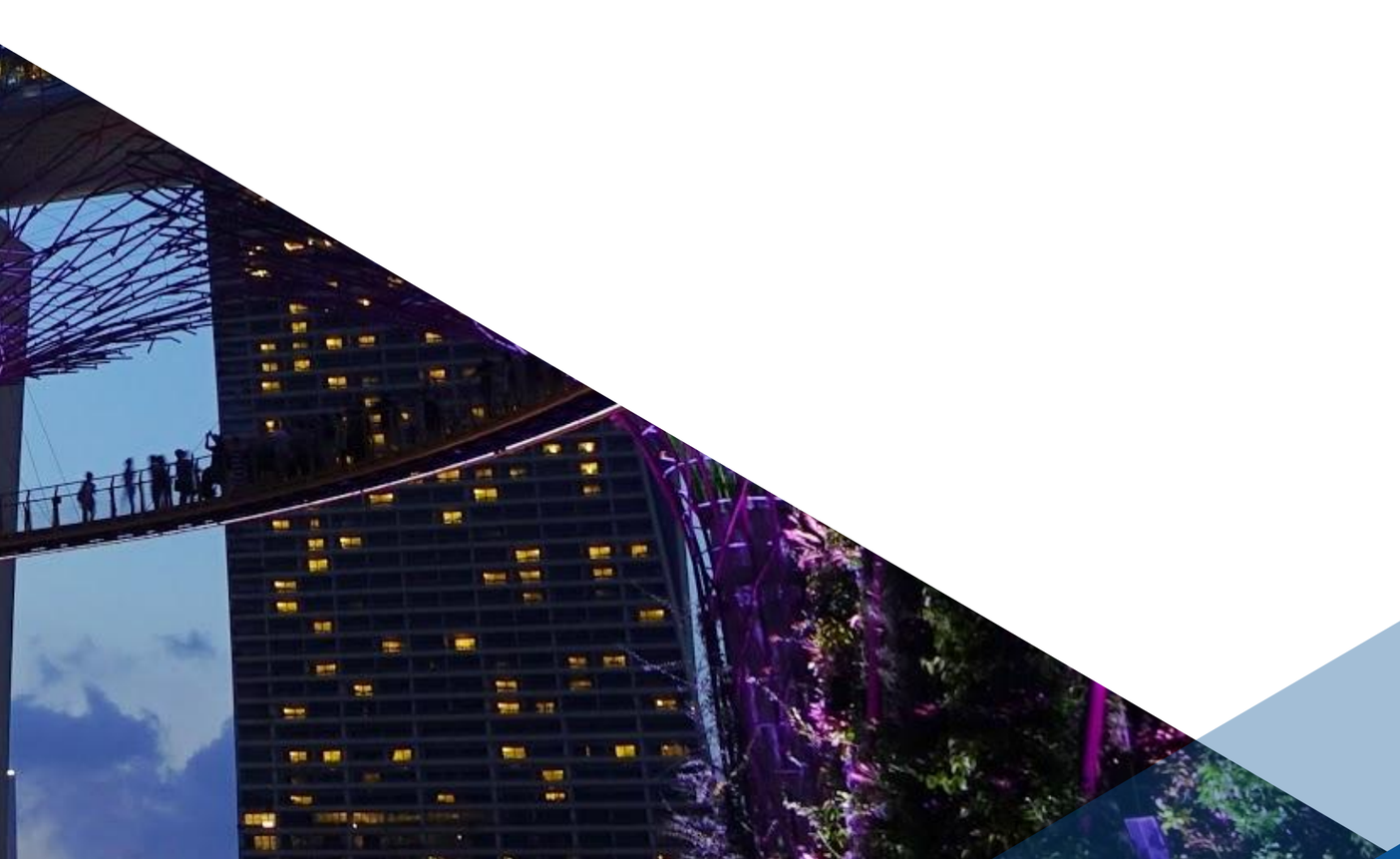
CLARITECS

DATA + TECHNOLOGY = CLARITY

In 2017, the Maritime and Port Authority of Singapore made it mandatory for all bunker tankers operating in the country to be fitted with Mass Flow Meters. These devices allow accurate measurements of bunker transfer data whenever ships refuel in the port and their use is intended to reduce the number of bunker quantity disputes that occur each year. But analysing that data that is generated by the flow meters can be a highly involved and manual task that means it can take as long as ten hours to create a report for a bunker delivery.

Founded in Singapore in 2017, Claritecs exists to use digital tools and a strong foundation of maritime expertise to develop applications for decision makers in shipping operations and commercial management.

The Claritecs Auto Profiling bunker analytics tool automatically detects different flow conditions during a bunker operation and generates an automated report in seconds. The tool can also flag up anomalies to users, reducing the chances of disputes later on and decreasing the manual work required for all parties. As well as their tool to profile bunker flows, the Claritecs team has created two other solutions including a bunker tanker fleet deployment and scheduling tool and a data-driven vessel market valuations tool.



Conclusion

Singapore's maritime innovation ecosystem is unique in the world. The combination of a high level of government intervention and support, a thriving startup and business environment, and the critical importance of the local maritime industry make the city state a force to be reckoned with when it comes to developing the technologies that will support the next generation of global trade at sea.

The country's position as a historical bridge between east and west has made the port city a crucial link in the world's supply chain today. Perhaps more importantly though, Singapore has become an economic, cultural and technological confluence point on the world stage.

In part, this is down to the country's ability to attract immigrants, not just from neighbouring countries but from around the world. Nearly 40% of Singapore's population were not born there, and this outsiders' advantage is crucial to technology entrepreneurship. Immigrants are more likely to start companies, scale those companies, and contribute to science and technology research than non immigrants.

Singapore's highly entrepreneurial and mobile population is driven further by the power of proximity. Singapore's small geographic footprint means that everything is close together. In clear traffic, it is possible to drive across the entire country in less than one hour. This means that for everyone in Singapore, some of Asia's best technology universities, biggest venture capital funds, and global technology giants are literally on the doorstep. Proximity is an incredibly powerful force when it comes to startup driven innovation. A startup ecosystem that is three times larger, will generate five times more in economic value.

Recognising this power, the Singapore government has pursued a highly interventionist strategy, with a multitude of innovation support services, funding sources, and startup programmes that are owned and run by government agencies. The maritime industry is no exception, with the Maritime and Port Authority partnering with the now world famous Block71 to create Pier71, a challenge driven innovation hub that connects Singapore's budding startups with one of the country's most important industries.

Driven by the combination of support, funding and access to industry, the Singapore maritime information technology market is forecast to become a net driver of growth for the entire maritime industry. The sector is forecast to turn over $2.4billion this year, and double in size by the end of the decade. As a proportion of the whole maritime industry, the technology sector is forecast to grow from making up 11% today to 20% of the industry by 2030.

As the maritime industry looks towards its recovery from the COVID-19 crisis, there is a growing realisation that decarbonisation will become the defining problem of the decade. Singapore is uniquely positioned to capitalise on this trend. As the world's largest bunker port, a major global hub for oil refining, and a significant research and development centre, decarbonisation represents a major opportunity for the country. But it can only fully capitalise on this shift if it continues to allow people and ideas to flow easily across its borders, and finds a way to turn promising deep tech startups into fast growth companies.

Singapore is less than 60 years old as an independent nation state. In a short space of time, the country has become a magnetic force for the world's maritime startups, pulling world class entrepreneurs and companies to its shores. But as the world looks to Asia as this century's source of growth, prosperity, and innovation and as Hong Kong recedes from the world stage, Singapore has a clear opportunity to continue its already impressive David and Goliath story of rapid ascension.

Methodology

This report is based on a combination of primary research, including telephone interviews, surveys, and financial modelling, and secondary research from various sources including Startup Wharf's database of startup driven innovation, the Thetius maritime innovation intelligence platform, and a wide range of books, publications, journals, and media outlets. The aim of this report was to create the most comprehensive and accurate overview of maritime innovation in Singapore to-date, but it is by no means complete. The maritime sector is fractured, it suffers from a lack of visibility at all levels and it is also fast moving and ever changing. Despite the work of a number of organisations to improve technology visibility across the industry and the resources put into this research project, the analysis cannot cover the full scope of innovation going on in Singapore's maritime industry. While it would be impossible to showcase every innovation across the country, the aim of the authors was to capture the key themes and trends that are impacting the industry in Singapore and around the world.

The market sizing and forecast was calculated using a proprietary financial modelling method that takes into account Singapore's current and historic GDP, forecasted GDP growth, economic output from shipbuilding, maritime manufacturing, ship owning, ship operating, trade in export services, and trade in goods. This is combined with the country's innovation efficiency index and startup ecosystem index.

The effect of Covid-19 on financial forecasts was considered negligible assuming a V-shaped recovery in 2021.

Data sources for the market sizing and forecast include the World Bank, United Nations Conference on Trade and Development, the Global Innovation Index, Startup Wharf, Thetius, Crunchbase, Startupblink, Startup Ranking. The market sizing and forecast was cross-checked against forecasts from other reputable sources including Cebr and MPA.

All financial figures are in United States dollars unless otherwise specified.

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Authors

Leonardo Zangrando

Leonardo is a MSc Naval Architect and MBA with 4 generations of seafaring tradition. He designed and built RoRo, LNG and other cargo ships, and participated in the design, acquisition, conversion of container terminals, ranging from small regional to multi million TEU greenfield projects like Hutchison Ports' BEST in Barcelona.

In 2010 he brought to Europe from Silicon Valley the Lean Startup techniques for entrepreneurship and has been working with startups ever since.

In 2017 Leonardo founded Startup Wharf by coupling his Maritime and Startup expertise.

Nick Chubb

Nick Chubb is the Managing Director of Thetius, an organisation dedicated to enabling innovation in the maritime industry through a combination of research, advisory, and talent services.

Nick started his career as a navigator on commercial ships before moving into maritime technology. Since moving ashore he has worked in technology in and out of the maritime industry and has held senior commercial positions overseeing the launch of digital products and services in a number of organisations including Marine Society and Intelligent Cargo Systems.

Startup Wharf

Startup Wharf is the independent, global network of maritime startups, with the mission to enable startup-driven maritime innovation and transformation.

Startup Wharf supports startups and entrepreneurs develop their business in maritime, while helping the industry and investors find and engage with maritime startups.

Startup Wharf publishes reference content for the maritime innovation ecosystem used by all the most important maritime companies to shape their own strategy of startup-driven innovation.

Thetius

Thetius exists to enable innovation across the maritime industry. Our research team provides the knowledge and information needed to make better technology decisions. Our advisory team helps organisations to prepare for the future and create tangible opportunities for growth. Our talent team closes critical technology skill gaps that exist across organisations and the wider industry.

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