

Powering clients to a future shaped by growth



A Frost & Sullivan White Paper

Enabling a sustainable future through digitalisation

Trends driving the design & manufacturing and architecture, engineering & construction industries in APAC

By Rudranil Roysharma, Director - Energy & Environment (MEASA), Frost & Sullivan

In partnership with



F R O S T  S U L L I V A N

frost.com

Table of contents

3	<u>List of abbreviations</u>
4	<u>Foreward</u>
5	<u>Executive summary and key takeaways</u>
9	<u>The state of design & manufacturing and AEC industries in the APAC region</u>
26	<u>Digitalisation and its role in driving sustainability</u>
33	<u>Insights: end-user speak</u>
47	<u>Role and essence of technology in supporting sustainability and a circular economy</u>
51	<u>Conclusion</u>
53	<u>Appendix: key government initiatives</u>

List of abbreviations

3D	- Three dimensional	HVAC	- Heating, ventilation, and air-conditioning
5G	- Fifth generation wireless	IIoT	- Industrial internet of things
A&E	- Architecture and engineering	IoT	- Internet of things
AEC	- Architecture, engineering & construction	IMF	- International Monetary Fund
AI	- Artificial intelligence	KPI	- Key performance indicator
ANZ	- Australia and New Zealand	LNG	- Liquefied natural gas
APAC	- Asia Pacific	MD	- Managing director
APCC	- Australian Procurement and Construction Council	MJ	- Megajoules
AR	- Augmented reality	MOLIT	- Ministry of Land, Infrastructure and Transport
ASEAN	- Association of Southeast Asian Nations	MRT	- Metro rail transit
ATSE	- Advanced Technology Service Enterprise	NCC	- National Construction Code
BCA	- Building and Construction Authority	NDC	- Nationally Determined Contributions
BECC	- Building Energy Conservation Code	NIP	- National Infrastructure Pipeline
BIM	- Building Information Modelling	NMEEE	- National Mission on Enhanced Energy Efficiency
CAGR	- Compound annual growth rate	NTIS	- National Technology and Innovation Sandbox
CEO	- Chief executive officer	PET	- Polyethylene terephthalate
CEZ	- Coastal economic zones	PPA	- Power purchase agreement
CII	- Confederation of Indian Industries	R&D	- Research & development
CO ₂	- Carbon dioxide	RE	- Renewable energy
CSADI	- Central South Architectural Design Institute	REG[E]	- Resource Efficiency Grant for Energy
CSR	- Corporate social responsibility	RFID	- Radio frequency identification
D&M	- Design & manufacturing	ROI	- Return on investment
DISF	- Domestic Investment Strategic Fund	SDG	- Sustainable development goals
EHS	- Environmental, health and safety	SEC	- Specific energy consumption
ESG	- Environmental, social and governance	SFDR	- Sustainable Finance Disclosure Regulation
EU	- European Union	SLE	- Super low energy
GDP	- Gross domestic product	SUP	- Single-use plastics
GHG	- Greenhouse gas	SVP	- Senior vice president
GPS	- Global positioning system	USD	- United States dollar
GVA	- Gross value added	VP	- Vice president
GW	- Giga watts	VR	- Virtual reality
GVP	- Group vice president	ZEB	- Net-zero energy buildings

Foreward

Climate change has been one of the most talked-about issues during our time. Collective actions today will have a monumental impact on the lives of the next generation. The impact of climate change is global in scope and unprecedented in scale, compelling global economies to join hands to tackle this burgeoning threat to humanity. The Asia Pacific (APAC) region, which is home to the world's four largest economies and two most populous countries, emits more greenhouse gases (GHG) than all the other regions put together. The region has already invested more than \$250 billion USD investments in sustainability, but only two countries feature in the top 25 countries in the Global Sustainability Index. APAC needs to show increased commitment in the form of immediate and deliberate action, strategised and effected through all means necessary.

Autodesk and Frost & Sullivan have conducted a piece of research with more than 600 organisations from the two industries of design & manufacturing (D&M) and architecture, engineering, & construction (AEC) across nine countries in APAC. This research analyses the extent to which sustainability is at the core of an organisation's growth strategy, the key drivers and influencers of sustainability initiatives and investment areas. The report also highlights the role of digitalisation on this journey and the technological support required by the companies for compliance-related measurement, reporting, and verification.

This report also highlights contributions from select respondents in regard to their organisations' contributions towards sustainability. The learnings and initiatives of these organisations are truly encouraging and motivational and we are humbled by their consent to share them with others. We believe, sharing such success stories will contribute to the growing awareness for sustainability in the APAC region, and even in facilitating increased adoption. We urge the readers of this report to embrace digitalisation as an enabling pillar, increase the commitment towards sustainability, and contribute to the global cause while upholding often divergent stakeholder interests.



Executive summary and key takeaways

The APAC¹ region is a key economic bloc globally, contributing to 37% of the world's gross domestic product (GDP) (source: IMF). Economic growth in the region over the last decade has been characterised by investments in manufacturing, infrastructure, energy, and real estate, with a majority of countries in the region focusing on in-country economic value add, and/or improvement in quality of life and standard of living.

37%
APAC's contribution to
the global economy

However, the growth has come at a price. The pace of urbanisation, manufacturing activity, and improvements in standard of living, are exerting pressure on land and natural resources in the region, posing a significant challenge to sustainability. The result can be seen in the fact that APAC now contributes to 53% of global GHG emissions (2018)², producing 18.3 billion metric tons of carbon dioxide (CO₂) in 2020³, which is more than the cumulative emissions from the rest of the world. Manufacturing / construction and building sectors account for 17% and 4% of GHG emissions in the region respectively.

53%
APAC's contribution
to global emissions

As the region strives to maintain its economic significance, Mainland China, Taiwan, Vietnam, and India are becoming attractive manufacturing

destinations for many global corporations. The infrastructure sector in APAC is estimated to grow at a compound annual growth rate (CAGR) of approximately 6% until 2026 as Southeast Asian countries are experiencing a boom in infrastructure development.

However, this growth trajectory presents a unique challenge to the countries in the region—of balancing economic growth with sustainability and improving the impact of actions on the environment and resources. Large economies in the region have already committed more than \$250 billion USD in investment towards sustainability and indicated timelines to become carbon-neutral. Yet only two countries from the region appear in the top 25 in the Global Sustainability Index 2021. For the world to achieve net-zero aspirations, APAC needs to show increased commitment in the form of immediate and deliberate action, strategised and effected through all means necessary.

\$250 billion USD+
Investment commitment
of the region
towards sustainability

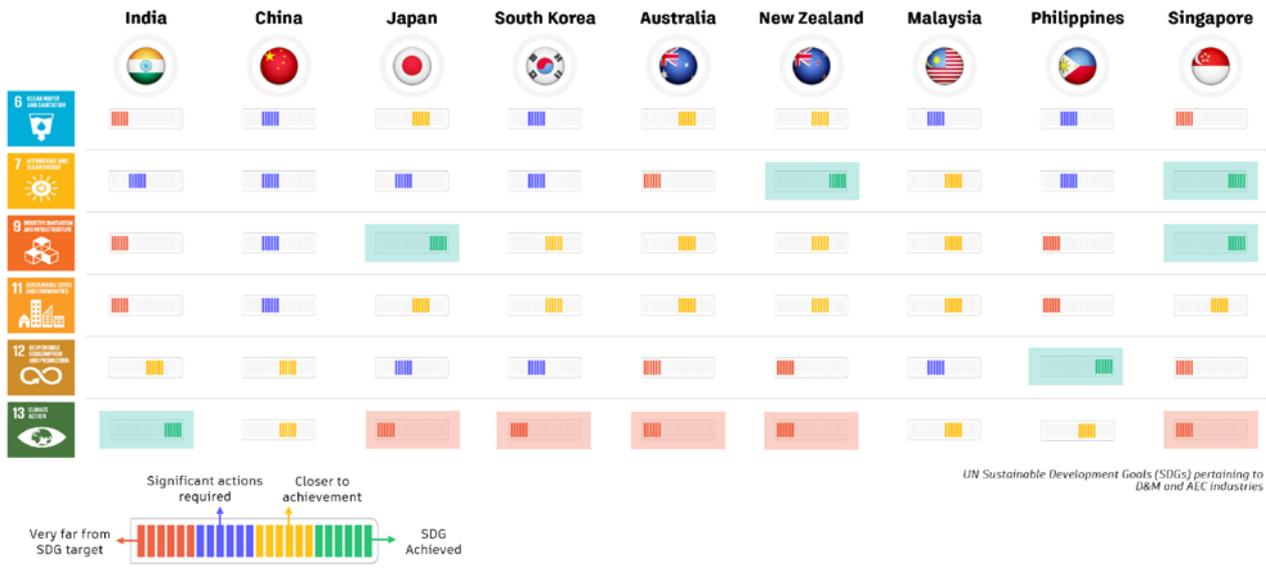
Nationally Determined Contributions (NDC) have been at the fore, with Japan and South Korea committed to carbon-neutrality by 2050, China by 2060, and India by 2070. This is a great start, but it also reflects the need to do more. At present, countries are taking actions largely driven by government mandates and regulations, increasing corporate responsibility, and on a larger scale, through social awareness and adoption.

¹ Asia Pacific includes East Asia, Southeast Asia, South Asia, Australia and Oceania.

² World Resource Institute

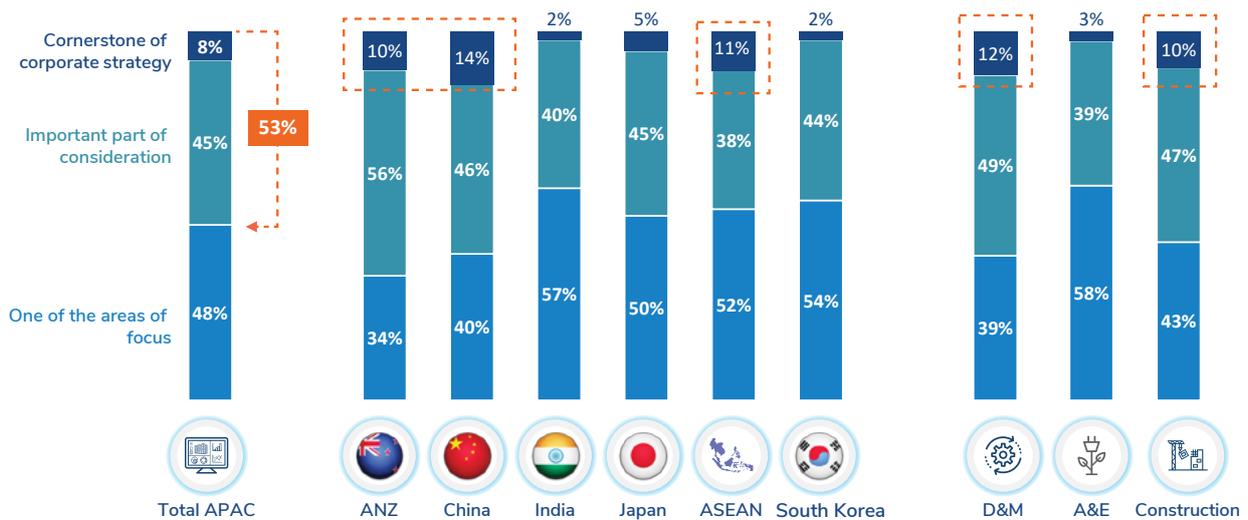
³ Statista

Exhibit 1: Status of SDGs related to design & manufacturing and AEC segments, APAC, 2021



source: UN SDG Progress; Frost & Sullivan Analysis

Exhibit 2: Disparity across industries with respect to sustainability maturity



source: Frost & Sullivan

53% of private sector enterprises are going the environmental, social, and governance (ESG) way with investor relations and competitive advantage among the top three key drivers for improved sustainability adoption in the private sector. Low carbon innovation and developing climate resilient communities feature among the most prominent sustainability initiatives in the region. However, adoption varies significantly across industries and underscores the need for sectors to ramp up efforts. Companies across the region have

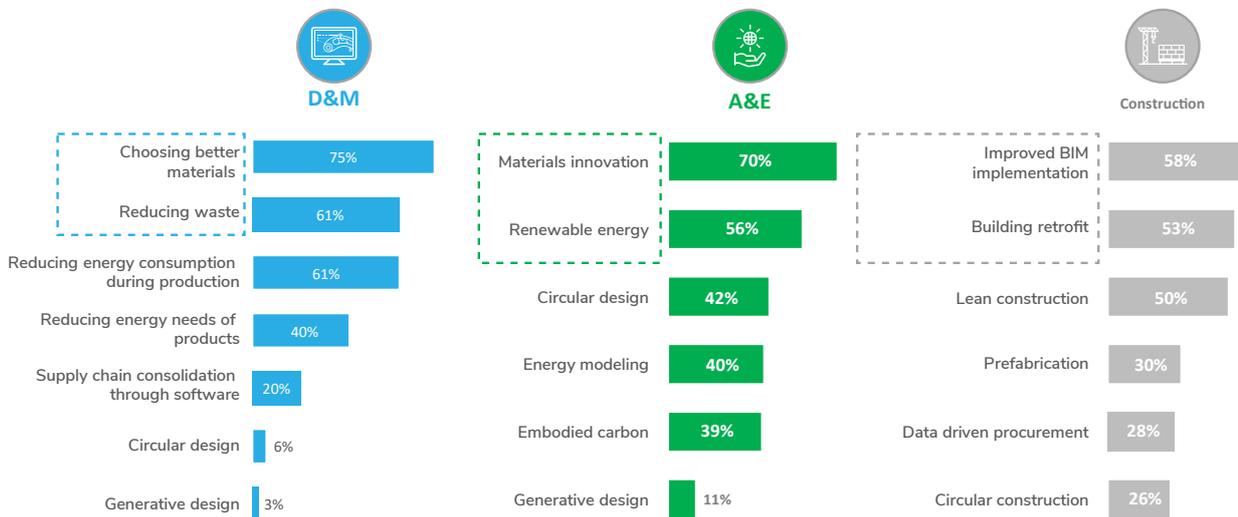
indicated that sustainability is still a cost driver for most of them as their customers are not willing to pay for it. With several APAC countries committing for carbon-neutrality policy, strategy reforms can be expected in the region which would bring in behavioural changes among customers and they will soon start finding value in sustainable products.

Solution providers have made significant progress from a technology standpoint - a range of solutions

are available that can meet the most discerning and challenging of demands and assuring they are fit for purpose. A range of existing digital solutions, such as software for energy management, waste minimisation, supply chain sustainability, and measurement and reporting of sustainability initiatives can assist in the sustainability journey - from design to decommissioning. The benefits of investing in these solutions include achieving compliance, reducing cost, and improving efficiency, presenting a clear return on investment (ROI)-based business case for adoption.

As countries and industry invest efforts to support aspirations and strategies, some clear trends are emerging, reflecting action on addressing embedded carbon in the value chain. Companies are deliberate on their approach in choosing the right materials and efficient processes to minimise the material wastage and energy consumption. Following these trends are also the strategies to include life cycle assessment and circularity, opening up the doors for technology to play a wider role in driving the sustainable outcomes.

Exhibit 3: Trending action points to reduce emissions



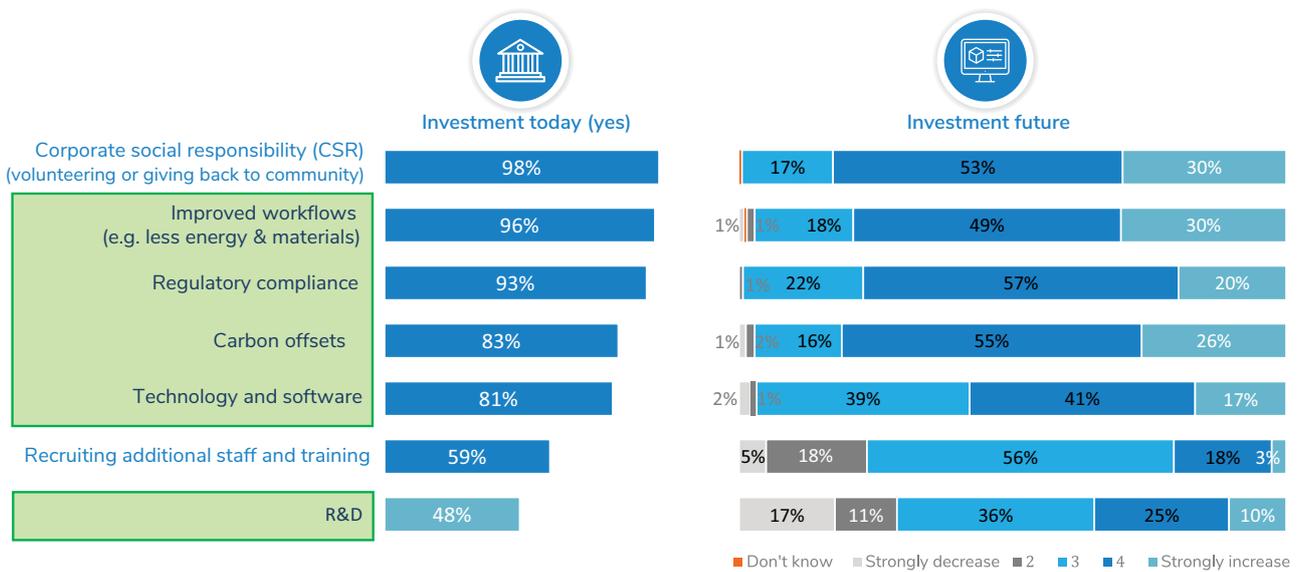
source: Frost & Sullivan

A transition is underway. Future investments need to be directed to support aspirations and strategies, with more focus required on research & development (R&D) to achieve long-term sustainability goals. To ensure successful ROI, technology adoption is essential as digital tools

can track, monitor, and measure initiatives aiming at improving efficiency. Digitalisation will reduce project implementation timelines and enable data analytics that would help in process refinements and compliance with governance protocols.



Exhibit 4: Areas of investment in sustainability – today and in future



source: Frost & Sullivan

APAC presents a massive growth potential, but is also the region with the least technology adoption. In order to sustain the growth and the scale, it is now imperative for the public and the private

sector in the region to be more aggressive in adopting technologies to capitalise on the potential and also achieve the common sustainability goals.



The state of design & manufacturing and AEC industries in the APAC region

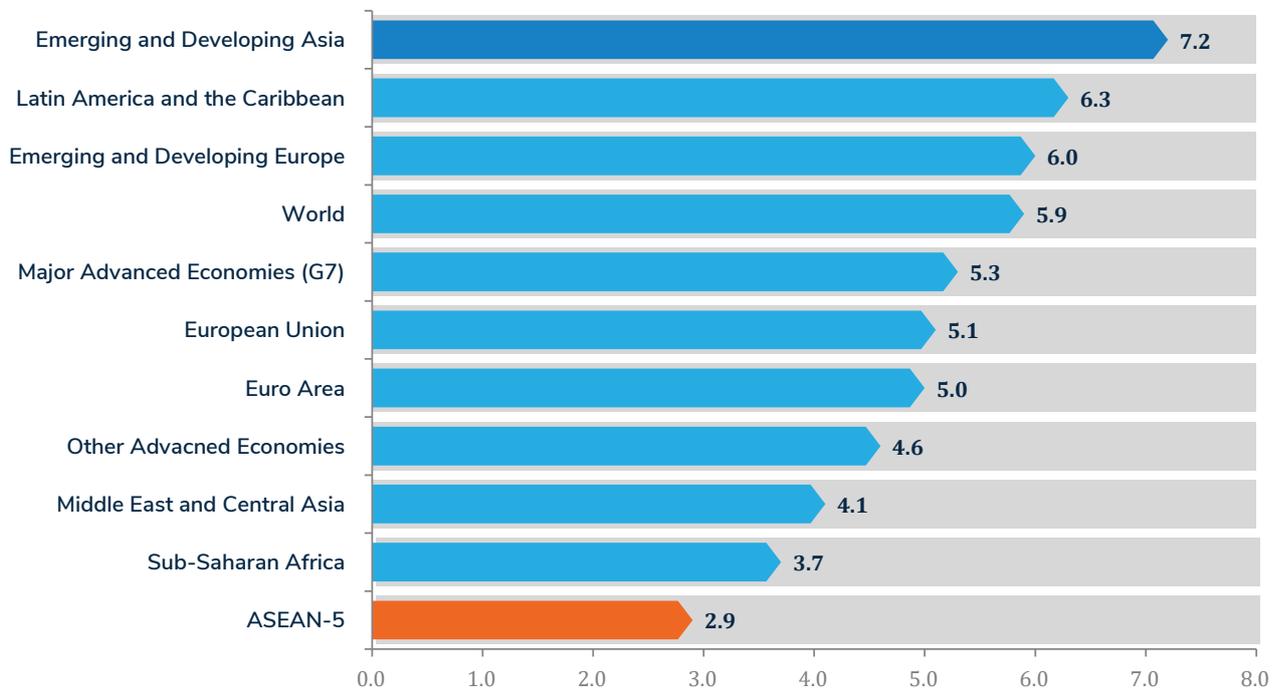
Economic outlook

The APAC region is among the fastest growing regions in the world, and its GDP accounts for around 37% of the world's GDP. The region contains some of the world's largest economies, including China, Japan, India, Australia, New Zealand, Malaysia, the Philippines, and Singapore. The total GDP for 2020 was around \$28 trillion USD, of which China alone contributed to around 55%. Future growth in the region will be driven by the elimination of trade barriers, boosting trade

and exports. Key drivers of growth include:

- Growth in domestic demand
- Increase in the inter-regional and global exports
- Policy support from governments for driving the manufacturing and infrastructure growth in countries
- Economies of scale and relatively cheaper labour force

Exhibit 5: Real GDP growth, Global, 2021



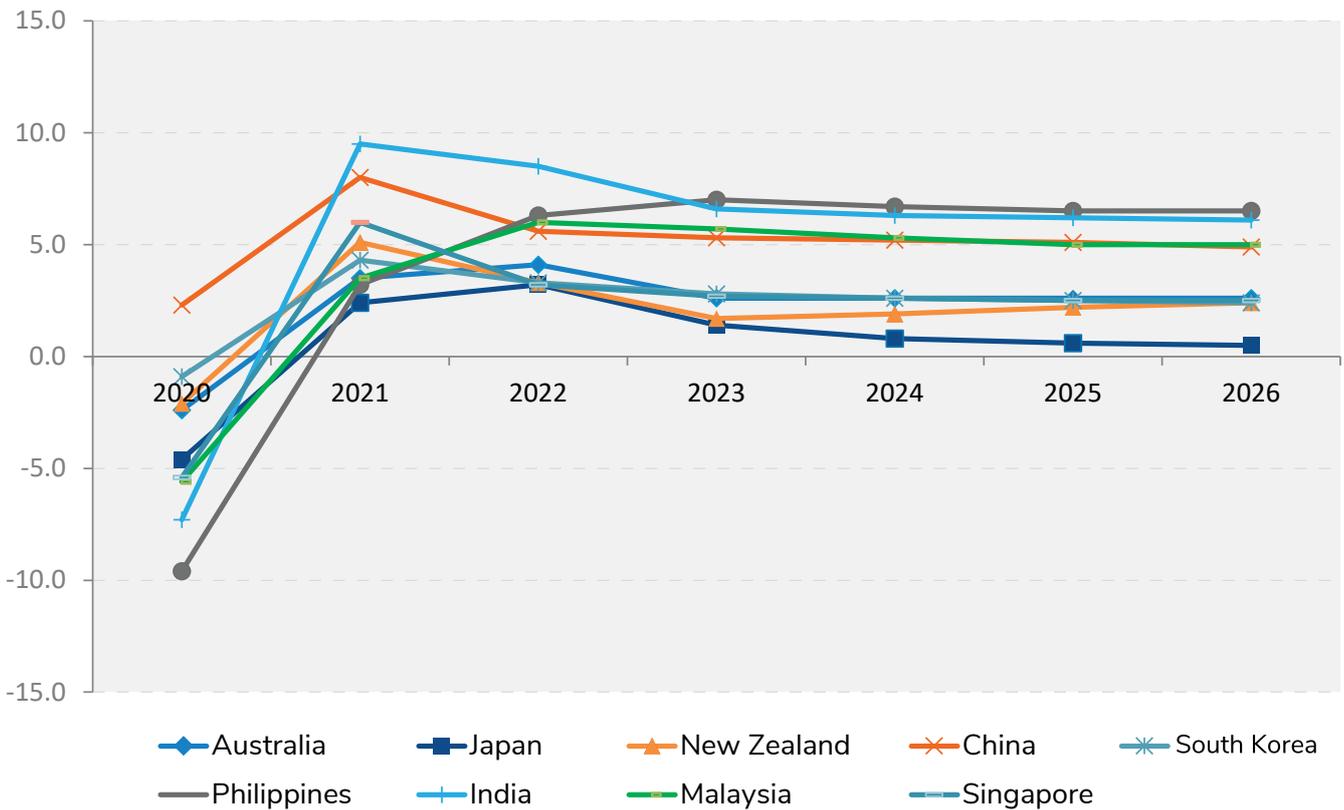
source: https://www.imf.org/external/datamapper/NGDP_RPCH@WEO/APQ, <https://www.imf.org/external/pubs/ft/weo/2021/02/weodata/groups.htm>

Note: Emerging and Developing Asia includes Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, Fiji, India, Indonesia, Kiribati, Lao P.D.R., Malaysia, Maldives, Marshall Islands, Micronesia, Mongolia, Myanmar, Nauru, Nepal, Palau, Papua New Guinea, Philippines, Samoa, Solomon Islands, Sri Lanka, Thailand, Timor-Leste, Tonga, Tuvalu, Vanuatu, and Vietnam. ASEAN-5 is Indonesia, Malaysia, Philippines, Thailand, and Vietnam.

The growth outlook for the near-term scenario would be influenced by COVID-19 vaccination coverage, as well as policy support in APAC. IMF expects India and China to deliver the strongest

growth of 9.5% and 8.0% respectively in 2021, while the GDP growth of APAC is expected to be at 6.5% in 2021. Over the longer-term horizon (till 2026), several initiatives undertaken by governments to boost manufacturing and construction in the region, would keep up the growth momentum. Consequently, over 2022–2026, the GDP is expected to grow at 6.9% for the entire APAC, while the global GDP growth is expected to be slightly lower at 5.5%.

Exhibit 6: Real GDP growth (annual percent change), APAC, 2020 - 2026



source: IMF, World Economic Outlook (October 2021)

The GDP growth across APAC will be driven by growth in the manufacturing and construction segments, as they are significant contributors to the economy in the region. Manufacturing hubs

like China, India, Korea, Japan, and Malaysia are expected to drive growth and contribute to the region’s dominance in the manufacturing segment.

Outlook for the manufacturing sector

Some of the key drivers for growth in the manufacturing segment in the APAC are cost competitiveness and government focus in developing this segment.

- **Cost competitiveness:** APAC has emerged as a global manufacturing hot spot led by its cost competitiveness. China, Indonesia, India, Vietnam, and Thailand are the top five countries for manufacturing cost competitiveness globally, as per the Global Manufacturing Risk Index 2021 report published by Cushman & Wakefield. The report analyses the most advantageous locations for global manufacturing among 47 countries in Europe, the Americas, and APAC.
- **Growth in exports:** Among Australia, China, India, Japan, Korea, Malaysia, New Zealand, Philippines, and Singapore, four economies are the manufacturing superpowers and feature in the list of top 10 countries by share of global manufacturing output in 2018. Collectively, China (28.4%), Japan (7.2%), Korea (3.3%), and India (3.0%) constitute around 41.0% of the global manufacturing output. Owing to the large manufacturing hubs, these countries have high manufacturing exports in comparison to the other large economies and regions of the world.

Manufacturing growth targets

Several APAC countries have set ambitious targets for growth in the manufacturing segment:

- **China:** The country has identified its pathway for achieving manufacturing prowess in high value-added products. China aims to become a self-reliant technological and manufacturing hub under the 14th five year plan (2021-2025). It intends to become a

market leader in the world by 2049, which will also be the centenary of the People's Republic of China.

- **ASEAN:** The key economies including Malaysia, Singapore, and the Philippines, are growing to be the preferred manufacturing destinations for high-value manufacturing, owing to their connectivity in APAC. Singapore has clearly stated its target of growing its manufacturing sector by 50% over the next 10 years. Currently, manufacturing in Singapore accounts for about 21% of the GDP, or around \$78 billion USD⁴.
- **Australasia:** The region is focusing on digitalisation and job creation and intends to be recognised as a high-quality and sustainable manufacturing region through its Modern Manufacturing Strategy. Further, many industries in the manufacturing segment in New Zealand are adopting sustainable operations to achieve the carbon-neutrality. Apart from the support in regeneration of native forests, the manufacturing companies are purchasing the carbon offsets to lower their footprint in an attempt to make the products carbon-neutral.
- **India:** The manufacturing gross value added (GVA) accounts for 15.1% of the country's real GVA in 2019–2020. The country aims to increase the share to more than 20% in the next five years, i.e. up to \$1 trillion USD from the current \$0.4 trillion USD. The key drivers for growth are government initiatives such as the National Manufacturing Policy, Make in India 2.0, and Skills India Initiative, domestic consumption, availability of skilled labour resources, international

⁴Currency conversion rate from Singapore dollars to US dollars: 1 SGD = 0.74 USD

investments, and public-private partnerships.

- Japan:** The manufacturing segment accounted for 20.5% of the GDP in FY2020. Key industries in the country are automobiles, industrial robots, semiconductors, and machine tools. The global economic slowdown due to COVID-19 has impacted the manufacturing segment severely. Manpower availability is another critical challenge in Japan, which are being addressed through several policies and initiatives such as Society 5.0, connected industries, programs for promoting investments in Japan to strengthen supply chains, and amendments to Immigrants Control and Refugee Recognition Act.

Increased government focus on manufacturing segment:

Several initiatives have been launched by different countries in the region to promote their manufacturing segment. A few prominent programmes are Australia's Modern Manufacturing Strategy, India's Make in India, and Malaysia's Domestic Investment Strategic Fund, among others. All these initiatives are expected to boost the local manufacturing sector and increase their contribution to the GDP.

Exhibit 7: Summary of key initiatives in manufacturing segment, APAC, 2021

Region	Country	Key initiatives
ANZ	Australia	<ul style="list-style-type: none"> Australia allocates \$1.1 billion USD⁵ to modernise domestic manufacturing as a part of its Modern Manufacturing Strategy. Of which \$960 million USD will be for the Modern Manufacturing Initiative while \$79 million USD is for Supply Chain Resilience Initiative.
	New Zealand	<ul style="list-style-type: none"> The government's industry transformation plan focuses on the agritech sector and digital technologies. Other focus areas of the government are in transition, owing to COVID-19 and related exigencies.
ASEAN	Malaysia	<ul style="list-style-type: none"> Domestic Investment Strategic Fund (DISF) – Government to provide grants to accelerate the shift to high value-added, high technology, knowledge-intensive, and innovation based industries. The Malaysian Government's Economic Recovery Plan (PENJANA), introduced in June 2020, announced the establishment of the National Technology and Innovation Sandbox (NTIS) to drive talent development. The government is specifically focusing on digital transformation in the industries.

⁵Currency conversion rate from Australian dollars to US dollars: 1 AUD = 0.74 USD

Region	Country	Key initiatives
	Singapore	<ul style="list-style-type: none"> Resource Efficiency Grant for Energy (REG[E]) (maximum cap of 50% of qualifying costs) provided to manufacturing facilities and data centres to be more energy-efficient and improve competitiveness. The government also intends to boost the energy and chemical industry (refining, olefins production, and chemical manufacturing) by boosting the innovation capability and providing unmatched infrastructural support.
	Philippines	<ul style="list-style-type: none"> The Philippine government's 2021 infrastructure programme will boost the manufacturing sector in the country owing to the rise in economic activities. Around \$20 billion USD⁶ will be spent annually by the government to support the expansion.
Rest of the large economies in the APAC	China	<ul style="list-style-type: none"> Under the 14th five year plan, China is expected to focus on developing an innovative and more reliable industrial supply chain and further implement intelligent and green manufacturing projects. To promote R&D, the government is offering a reduced corporate tax rate of 15% (the standard rate is 25%) to companies with Advanced Technology Service Enterprise (ATSE) status and a 150% tax deduction on eligible R&D expenses incurred during the year.
	India	<ul style="list-style-type: none"> Several initiatives, such as the National Manufacturing Policy, Make in India 2.0, and Skills India Initiative are expected to drive the manufacturing industry to \$1 trillion USD by 2025, up from \$370 billion USD (based on 2019 data).
	Japan	<ul style="list-style-type: none"> Several government initiatives, such as the Smart Factory Promotion Project, as well as local government initiatives—Greater Nagoya Initiative, subsidy for business location for reconstruction of industry in Fukushima, and tax incentives for strengthening local business facilities aim to drive growth in the region.
	South Korea	<ul style="list-style-type: none"> Manufacturing Renaissance Vision was launched in 2019 with the objective of making Korea one of the four largest manufacturing powerhouses by 2030. Korea's manufacturing value-add ratio is expected to reach 30% in 2030 from 25% in 2019. This is expected to accelerate manufacturing innovations and drive investments in new industries and new products over the long-term.

⁶ Currency conversion rate from Philippine peso to US dollars: 1 PHP = 0.02 USD

Outlook for the AEC sector

Asia accounted for 59.5% of the world's population in 2020 and this share will slightly reduce to 54.3% by 2050. The population in 2020 was 4.64 billion and is expected to reach 5.29 billion by 2050; this increase in population would create demand for public infrastructure, real estate, and utilities such as energy, power, and water. This would be a major demand driver for the construction sector in APAC.

- **China:** It is the world's largest construction market and is expected to grow at a CAGR of 5.2% in real terms from 2021 – 2025. China has recently launched New Infrastructure campaign to boost sustainable growth. China is expected to spend approximately \$1.4 trillion USD on a Digital Infrastructure Public Spending program. This campaign will focus on a range of infrastructure improvements, creating demand for a range of new products and solutions such as

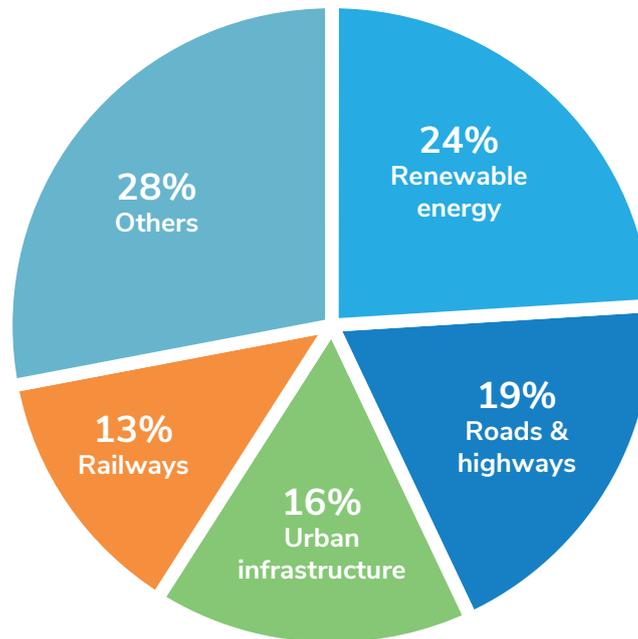
- New energy vehicle charging stations
- Data centres
- Artificial intelligence
- Ultra-high voltage
- Industrial internet
- Inter-city transportation and inner-city rail systems
- 5G networks

- **India:** The country's construction sector accounted for 9% of the GDP in 2020. The real estate segment is expected to reach \$1 trillion USD by 2030 and will account for 13% of the GDP. Key highlights of construction segment are:

- **Smart cities** – 100 new smart cities to be developed in India
- **Industrial corridors** – 11 industrial corridors are expected to be developed
- **Railway stations/ lines** – 600 stations are expected to be redeveloped
- **Mega ports** – 14 coastal economic zones (CEZ) and six new ports are planned
- **Increasing demand for commercial space** – Demand for office space, hotels, retail and entertainment units

The National Infrastructure Pipeline (NIP) for FY2019-2025 is a key government initiative to provide world-class infrastructure to Indian citizens and improving their quality of life. Its objective is to improve project preparation and attract investments into infrastructure segment. Under this initiative, India has an investment budget of \$1.4 trillion USD on infrastructure.



Exhibit 8: Investments under NIP, India, 2019 – 2025

source: <https://www.investindia.gov.in/sector/construction>

- Australia:** The construction sector accounts for around 9% of Australia's GDP and generates over \$266 billion USD⁷ in revenue, and is expected to grow annually at 2.4% over 2021–2025. Key highlights of the construction segment are:
 - As of March 2020, \$28 billion USD of construction projects were in the pipeline with the majority of work in railway construction (\$17 billion USD).
 - The Australian government is expected to invest \$110 billion USD over the next 10 years beginning from FY2021-2022 in transport infrastructure across Australia.
- South Korea:** The country's construction sector grew at a strong pace of 16.9% in 2020 to \$164 billion USD. Key highlights of construction segment drivers in the region are:
 - Green new deal:** In July 2020, the government announced a plan to invest \$134 billion USD over 2020–2025 under the Korean New Deal programme.
- Singapore:** The country's construction sector accounted for 2.7% of the nominal GDP in 2020. Key highlights of the construction segment are:
 - The Building and Construction Authority (BCA) of Singapore is planning to award \$17 billion USD⁸ to \$21 billion USD worth of construction contracts in 2021.
 - Construction of Changi Airport's Terminal 5 and the Kuala Lumpur-Singapore high speed rail project will likely drive demand for civil-engineering projects with the availability of \$8 billion USD⁹ funds.
- This programme includes investments in the areas of renewable energy (RE), electric vehicles, 5G infrastructure, big data, and artificial intelligence.
 - South Korea's Ministry of Land, Infrastructure and Transport (MOLIT) is expecting to invest a total of \$230 billion USD in construction segment by the end of 2021.

⁷ Currency conversion rate from Australian dollars to US dollars: 1 AUD = 0.74 USD

⁸ Currency conversion rate from Singapore dollars to US dollars: 1 SGD = 0.74 USD

- On the back of rising logistics and warehousing demand, rejuvenation of business-park spaces and industrial buildings will drive construction activity.
- Lower interest rates, pent up demand, residential government land sales, and foreign investments will drive up construction in the residential segment.
- **Philippines:** The country's infrastructure spending accounted for 6.3% of the GDP in 2020. Key highlights of the construction segment are:
 - Increase in infrastructure spending: The Philippine government's Build, Build, Build programme focuses on infrastructure projects to reduce bottlenecks with focus on transportation, water resources, and energy.
 - Through a \$15 billion USD investment, a second Manila airport will be designed and constructed to accommodate 200 million passengers annually.
 - The 40 kilometre-long metro Manila skyway system, including an elevated highway, is underway.
- The Philippine liquefied natural gas (LNG) import facility is in the works, at a cost of \$2 billion USD.
- Other large infrastructure projects are underway, such as the metro rail transit (MRT) 4, Davao city coastal bypass road project, Cavite-Tagaytay-Batangas expressway project.
- **Japan:** The construction segment in Japan is forecast to grow at a CAGR of 3-4% from 2021 –2025. The country is focusing on developing their railway network and non-hydro based RE sector in the infrastructure segment. Some of the key projects underway are:
 - Chuo Shinkansen Maglev rail line is under development at an estimated cost of \$19 billion USD; phase 1 of the project from Nagoya to Tokyo is expected to be operational by 2027.
 - Other key investment areas in RE are solar, wind, and biomass projects.

⁹ Currency conversion rate from Singapore dollars to US dollars: 1 SGD = 0.74 USD



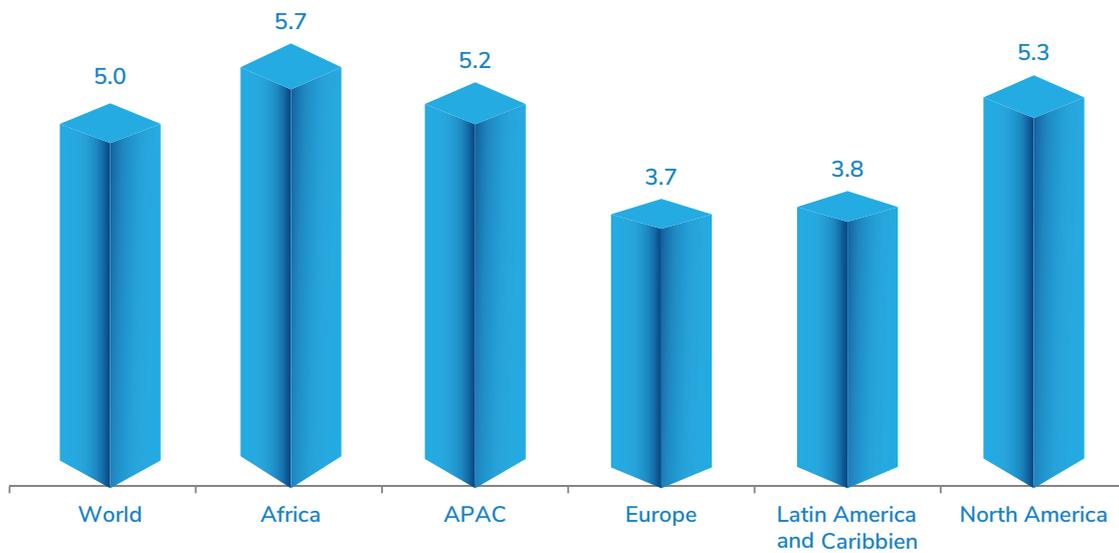
Impact of growth on the environment

Future growth anticipated in manufacturing and construction segments are expected to create a surge in demand for energy and material consumption in the region. In fact, the region's

energy intensity of 5.2 megajoules (MJ)¹⁰ in 2017 is higher than the global average of 5 MJ, which would further spike through anticipated investments in the manufacturing and AEC segments.

¹⁰Energy intensity level of primary energy (MJ/\$2011 PPP GDP) | Data (worldbank.org)

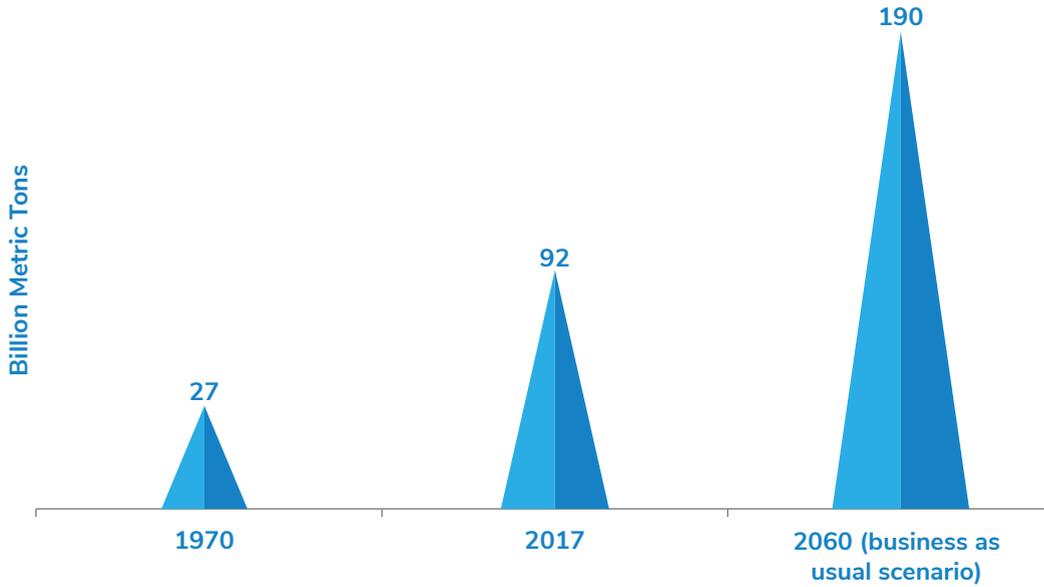
Exhibit 9: Energy intensity, Global, 2020



source: ESCAP based on IEA, United Nations Statistics Division, and World Bank data



Exhibit 10: Global extraction of raw material, Global, 1970, 2017 & 2060

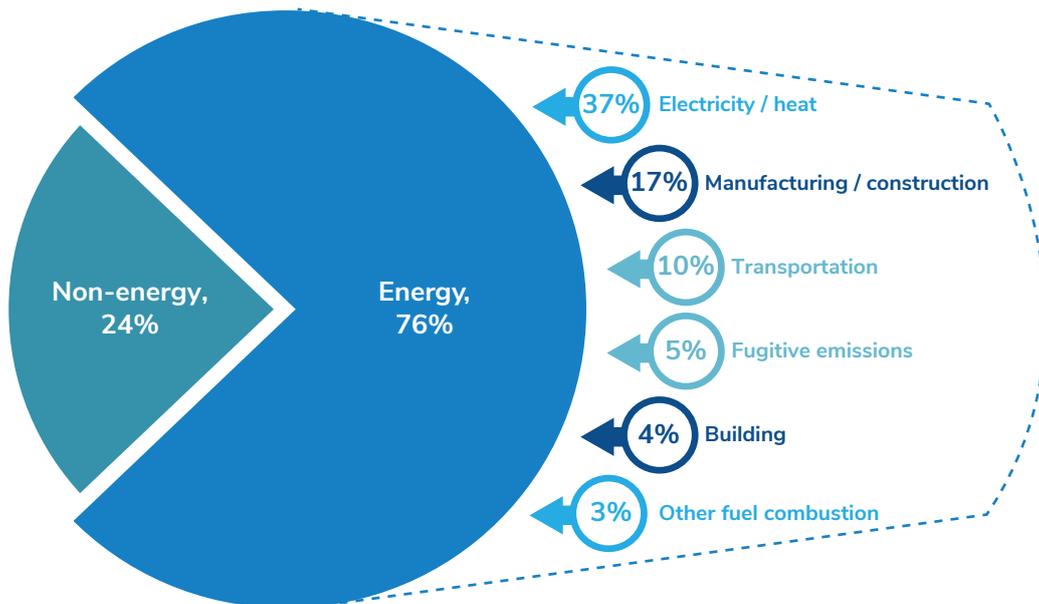


source: Sustainable trade in resources: Global material flows, circularity, and trade

On the flipside of this growth, GHG emissions in APAC have increased more rapidly between 1990 and 2018 compared to global emissions. This is a consequence of rising economic activity and living standards in the region’s developing countries.

APAC contributes to 53% of global GHG emissions in 2018, producing 18.3 billion metric tons of CO₂ in 2020, which is more than the cumulative emissions from the rest of the world. The energy sector accounts for three-quarters of these

Exhibit 11: Sector wise GHG emissions, APAC, 2018

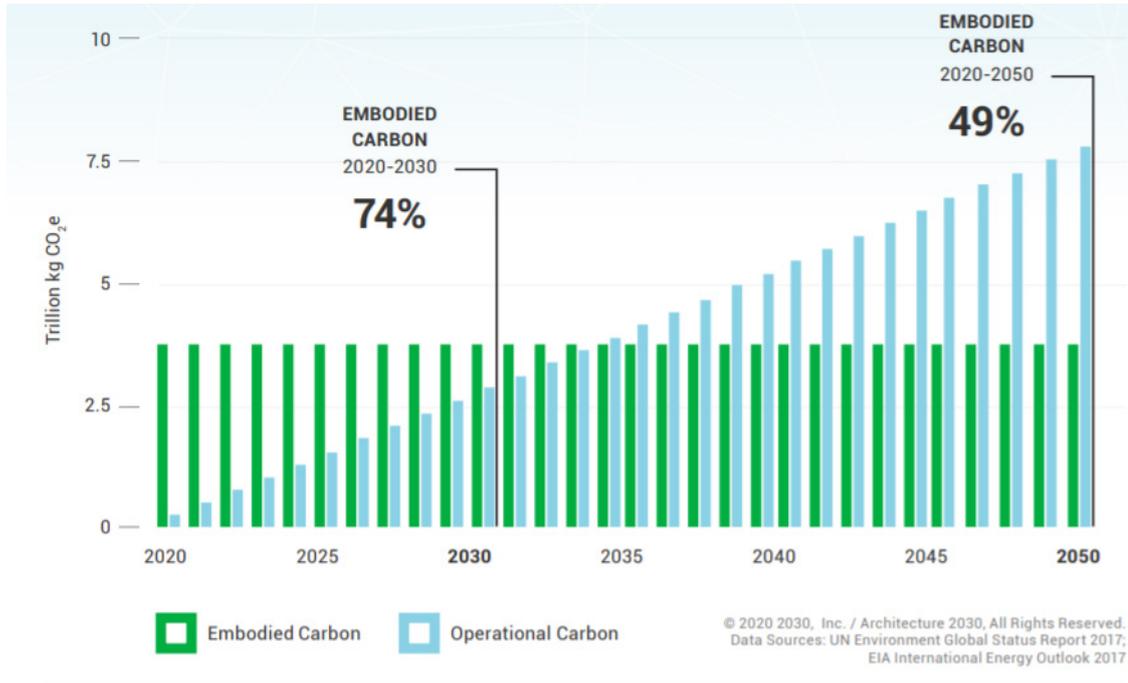


source: World Research Institute, Frost & Sullivan Analysis

emissions. Within energy, the manufacturing / construction and building sectors account for

17% and 4% of GHG emissions in the region respectively.

Exhibit 12: Total carbon emissions from global new construction (business as usual scenario), 2020–2050



source: Adapted from Architecture 2030 “New Buildings: Embodied Carbon”



Sustainability initiatives by countries in the APAC region

The massive impact of climate change, driven by the increasing consumption in energy and materials, is driving the demand for sustainability in the manufacturing and AEC in APAC. Major sustainability trends impacting investments and adoption of technology are:

- Energy efficiency / reducing energy consumption
- Green building initiatives

- Resource efficiency / waste reduction
- Green new deals / green infrastructure support
- Growth in RE adoption

Several initiatives have been launched by countries in APAC to promote sustainability and reduce environmental impact.



Exhibit 13: Summary of key sustainability initiatives, APAC, 2021

Name of the country / region	Initiative	Description of the initiative undertaken
ANZ	Growth in RE adoption	<ul style="list-style-type: none"> • Around 27.7% of Australia’s generation in 2020 is from RE sources. • More than 3 GW of corporate power purchase agreements (PPA) (valuing ~\$3.3 billion USD¹¹) contracted as of 2020 across 83 deals and around 7.8 GW of PPAs are being supported.
	Green building initiative	<ul style="list-style-type: none"> • There is an increased use of low environmental impact material for building construction, such as straw, mud brick, and timber. • Another increasing trend is the voluntary sustainability rating system for green buildings in Australian fit-outs and communities by the Green Building Council Australia.
	Resource efficiency / waste reduction	<ul style="list-style-type: none"> • In Australia, waste products like construction debris, slag from steel plants, etc. are being utilised for building roads. • Australia’s Waste Policy 2018 has been developed for managing trends across states and territories. • Use of virtual twin and lean construction are other two major trends that are driving sustainability.
	Green new deals / green infrastructure support	<ul style="list-style-type: none"> • Green new deals are still in the proposal stage.
	Energy efficiency	<ul style="list-style-type: none"> • Australasian Procurement and Construction Council (APCC) and National Construction Code (NCC) Australia recommends: <ul style="list-style-type: none"> o Designing of buildings to conserve energy and obtain energy from RE sources.

¹¹ Currency conversion rate from Australian dollars to US dollars: 1 AUD = 0.74 USD

Name of the country / region	Initiative	Description of the initiative undertaken
ASEAN (Malaysia, Philippines, and Singapore)	Growth in RE adoption	<ul style="list-style-type: none"> The ASEAN region (including countries other than Malaysia, Singapore, and the Philippines) targets to achieve 23% of RE in the energy mix by 2025 and 35% by 2035.
	Green building initiative	<ul style="list-style-type: none"> In Singapore, the construction of super low energy (SLE) buildings is targeted to constitute 80% of building stock by 2030. Other trends in the ASEAN region are: <ul style="list-style-type: none"> Reducing the building’s embodied emissions by using sustainable materials for floors and walls. Use of carbon-neutral floors, including carpet, vinyl, and rubber tile.
	Green new deal / green infrastructure support	<ul style="list-style-type: none"> Singapore’s Green Plan 2030, launched in February 2021, focuses on five pillars, including a focus on green space, use of cleaner energy fuels, sustainable living, green economy, and building a climate-resilient future.
	Energy efficiency	<ul style="list-style-type: none"> As of January 2020 in Singapore, the submission of energy efficiency improvement plans will be completed annually for existing industrial facilities as per the Mandatory Energy Management Practices.
South Korea	Growth in RE adoption	<ul style="list-style-type: none"> The country intends to increase the share of RE in the energy mix from its current level of 7% to 20% by 2030.
	Green new deal / green infrastructure support	<ul style="list-style-type: none"> As part of its green new deal, announced in July 2020, South Korea has plans to invest \$62 billion USD, mostly enabled the shift to green infrastructure, low-carbon and decentralised energy, and creating innovation in green energy. This would also envisage the development of commercial-scale carbon capture utilisation and storage.

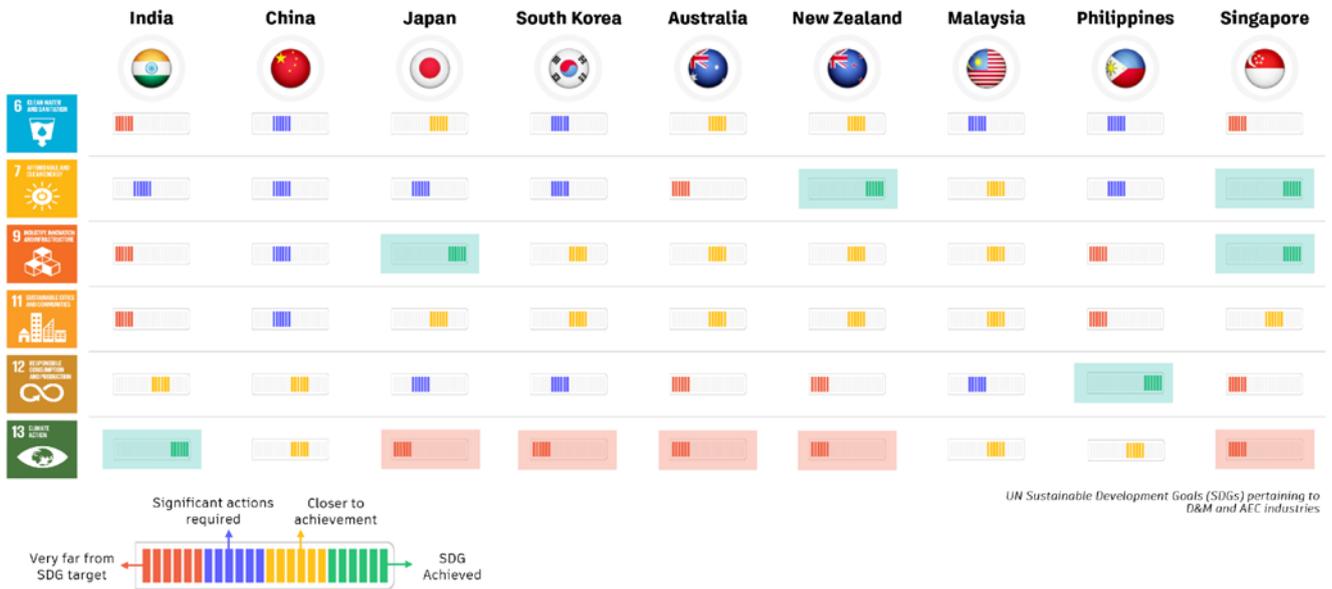
Name of the country / region	Initiative	Description of the initiative undertaken
	Energy efficiency	<ul style="list-style-type: none"> The Building Energy Conservation Code (BECC) launched/ initiated by the Korean government defines the construction standard for buildings. As almost 60% of residential buildings in Korea are high-rise buildings, many measures are suggested for reducing air leakage, improving the thermal efficiency of buildings, etc.
China	Growth in RE adoption	<ul style="list-style-type: none"> By 2030, China aims to lower CO₂ emissions per unit of GDP by over 65% from the 2005 level. It plans to raise the share of non-fossil energy in primary energy use to around 25%. The total installed capacity of wind and solar electricity will increase to more than 1.2 billion kilowatts.
	Green building initiative	<ul style="list-style-type: none"> In China, the use of BIM (Building Information Modelling) for green building and smart-city solutions is gaining traction. The green buildings market has a large financing market through the green financial system/green bonds.
India	Energy efficiency	<ul style="list-style-type: none"> The National Mission on Enhanced Energy Efficiency (NMEEE) focuses on reducing specific energy consumption (SEC) in industries, among other plans.
	Growth in RE adoption	<ul style="list-style-type: none"> India plans to achieve 450 GW of RE capacity by 2030 from 100 GW as of 2021.
	Green building initiative	<ul style="list-style-type: none"> In India, net-zero buildings and usage of alternative or sustainable materials are major sustainability trends among property developers.

Name of the country / region	Initiative	Description of the initiative undertaken
	Resource efficiency / waste reduction	<ul style="list-style-type: none"> • In the automotive segment, 25% of the curb weight of passenger vehicles and commercial vehicles will be from recycled materials by 2030. • India is aiming for 100% recycling of polyethylene terephthalate (PET) by 2025. • It also intends 30% of public procurement for civil construction to be from recycled materials by 2025.
Japan	Energy efficiency	<ul style="list-style-type: none"> • Japan has a top runner programme for commercial and residential consumers that are projected to induce increased savings via adiabatic efficiency, lighting systems, and heat pumps.
	Growth in RE adoption	<ul style="list-style-type: none"> • The country plans to produce 24–25% of electricity from renewables by 2030, up from its current share of 10%.
	Green building initiative	<ul style="list-style-type: none"> • In Japan, the government has set the net-zero energy buildings (ZEB) targets for newly constructed private buildings (by 2030).
	Green new deal / green infrastructure support	<ul style="list-style-type: none"> • The country formulated a green-growth strategy in 2020. • The objective is to create attractive domestic markets, attract investments, and build a competitive and robust supply chain. • The strategy has identified 14 sectors, including offshore wind, fuel ammonia, hydrogen, and nuclear industries.

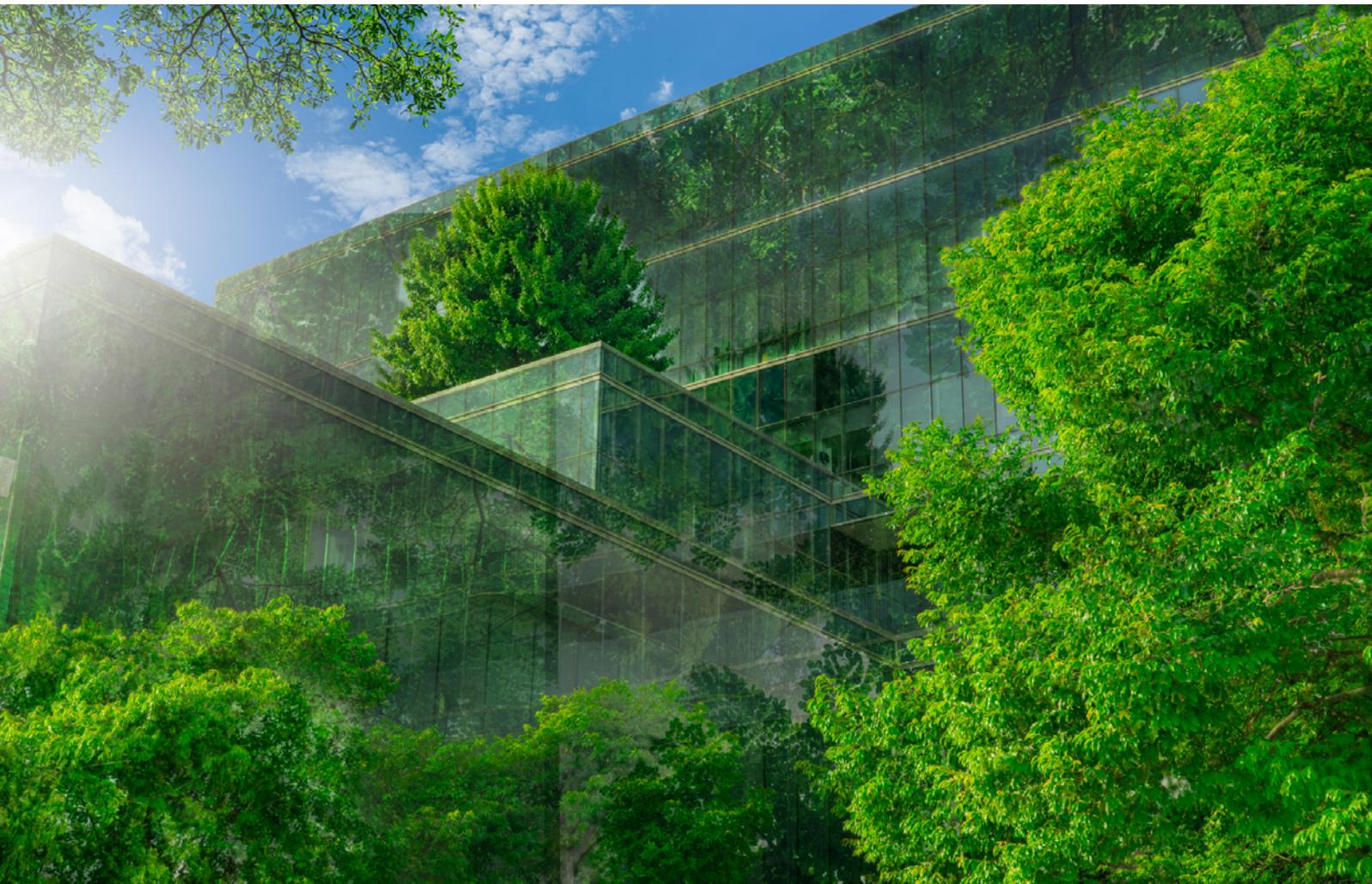
Despite significant progress in areas such as sustainable cities & communities, and industry, innovation and infrastructure, accelerated efforts are required to meet the sustainability targets / commitments by countries in the region.

Countries need to make concerted and enhanced efforts to foster partnerships in sustainable financing, inclusive and sustainable trade, digital technologies, and capacity building.

Exhibit 14: Status of SDGs related to design & manufacturing and AEC segments, APAC, 2021



source: UN SDG Progress; Frost & Sullivan Analysis



Digitalisation and its role in driving sustainability

Digital technologies focus on sustainability elements such as energy efficiency, material efficiency, value chain optimisation among others. Traditionally operational cost savings was the prime factor that created demand for digital technologies. However, with increasing focus on achieving the sustainable development goals and gaining competitive advantage, digital technologies are bringing in the convergence necessary for achieving balanced growth between business and environment, and therefore have topped the strategy agenda for numerous countries worldwide. To stay competitive and profitable in the ever-evolving market landscape today's organisations are focusing on triple bottom

line benefits of economic, social, and environment by adopting digital solutions.

Role of digitalisation in the design & manufacturing segment

Digital technologies are widely seen as a critical step to achieve sustainable manufacturing and to address the challenges related to triple bottom line. For example, key environmental issues such as climate change, resource depletion, and environmental protection are being addressed through the convergence of several digital solutions.

Exhibit 15: Key digital technologies adopted in manufacturing segment, Global, 2021



source: Frost & Sullivan Analysis

Sustainable manufacturing can be achieved when digital technologies converge with sustainability objectives through both horizontal and vertical integration of end-to-end business processes such as production process and supply chain. Transparency in business processes is critical today and this can be significantly improved by adopting

digitalisation. Digital technologies provide information on behavior, usage, failure models, performance indicators, emissions, performance under stress among others. Analysis of such data can then be formalised and involved in developing competition and sustainability strategies.

Exhibit 16: Digital solutions and their sustainability benefits, Global, 2021

Digital technology	Sustainability benefits	Triple bottom line impact
IoT and IIoT (Sensors, data analytics etc.)	<ul style="list-style-type: none"> • Prevents unwanted steps in production process • Waste reduction • Improved inventory management • Energy management/reduction • Improves asset life • Increases manpower safety 	<ul style="list-style-type: none"> • Economic • Social • Environment
Simulation systems (Virtual replication of process or service such as digital twins)	<ul style="list-style-type: none"> • Energy management/reduction • Improves process efficiency • Preventive and predictive maintenance 	<ul style="list-style-type: none"> • Economic • Environment
System integration (Integrated supply chain)	<ul style="list-style-type: none"> • Increases process transparency which enables waste reduction and energy reduction 	<ul style="list-style-type: none"> • Economic • Environment
Virtualisation	<ul style="list-style-type: none"> • Enables remote management of assets through remote maintenance and training, etc. • Reduces cost 	<ul style="list-style-type: none"> • Economic • Environment
Additive manufacturing (3D printing)	<ul style="list-style-type: none"> • Decreases waste generation • Reduces product development time 	<ul style="list-style-type: none"> • Economic • Social • Environment
Autonomous robots/cobots	<ul style="list-style-type: none"> • Improves manpower efficiency • Empowers smart and intelligent factories with high energy and material efficiency 	<ul style="list-style-type: none"> • Social • Environmental

source: Frost & Sullivan Analysis

“ At TATA Projects, digitalisation in construction monitoring is a sustainability KPI aligned to the SDGs. We also have service offerings integrated with digital technologies and we use many IoT-based applications, for example, we have the IoT-based technology solutions to measure consumption of water, energy, and air quality.” - Sashidhar Karamballi, Head-Project Services (Services SBG), Tata Projects Limited

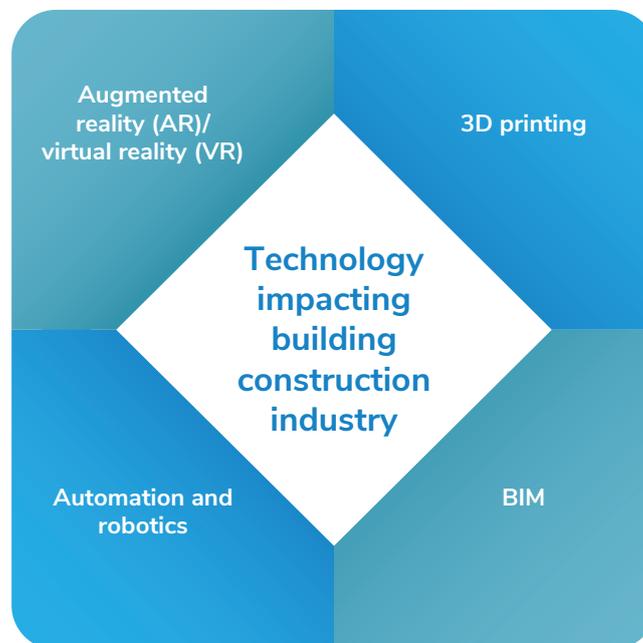


Role of digitalisation in the AEC segment

Technological advancement and the global concern for a sustainable built environment are gradually transforming and modernising the AEC industry to cope with the high volume of construction demands and the challenges it encounters. In 2018, construction technology investment grew by 30% globally. Companies adopting state-of-the-art technology and construction methodologies have an

advantage in terms of productivity, workplace safety, profit margin, and sustainability, thus maintaining their competitiveness. As the industry progresses towards modernisation and digitalisation, it tends to attract the younger, technologically-savvy, generation.

Exhibit 17: Top digital technologies impacting the building construction sector, Global, 2021



source: Frost & Sullivan Analysis

“ We believe digitalisation is the key enabler of sustainability in the AEC industry, and our company is one of the leading companies in this area. Central South Architectural Design Institute Co., Ltd (CSADI) was successfully selected by the State owned Assets Supervision and Administration Commission of the State Council as a key state-owned company, out of the top 200 benchmarking enterprises in China, to recognise its achievement in business concept and performance which includes its successful digital transformation. CSADI is the only construction design company in the list.” - Fan Hua Bing, BIM Director, Central South Architectural Design Institute

Augmented reality (AR)/virtual reality (VR): Both AR and VR aid in the 3D modelling of buildings and improve visualisation. AR superimposes digital content on top of the user's real world.

- Architects use AR to improve designs and detect errors, thus avoiding material waste.
- With the help of AR, project staging and virtual walkthroughs can be created for project stakeholders.
- The AR lens can display warnings (e.g., indicate hot or electrified surfaces).
- The AR market is expected to reach \$90 billion USD by 2020 globally.

3D printing: This is the most disruptive technology in the construction industry to date. It is used to print prototypes and build geometrically complex structures. It provides benefits such as customisation (i.e. design flexibility that can understand complicated architectural geometry and diverse material

selection), improved functionality, and aesthetics. There are labour and material cost benefits over traditional building methods, as the process is automated, can prevent material waste, and improve material efficiency.

BIM: BIM provides a digital representation of the physical and functional characteristics of a facility or building. This is an intelligent, 3D model-based process that connects and allows coordination between architects, engineers, and contractors (AEC professionals) in creating and managing project information from start to finish in an efficient and optimised manner. Computer-generated images can help contractors visualise the construction process before it is built. The data generated from various phases of the project through its lifecycle enables faster and more efficient construction, resulting in less waste in construction projects. Adoption of BIM provides material, time, and cost savings, thereby increasing the sustainability quotient of construction projects.



Automation and robotics:

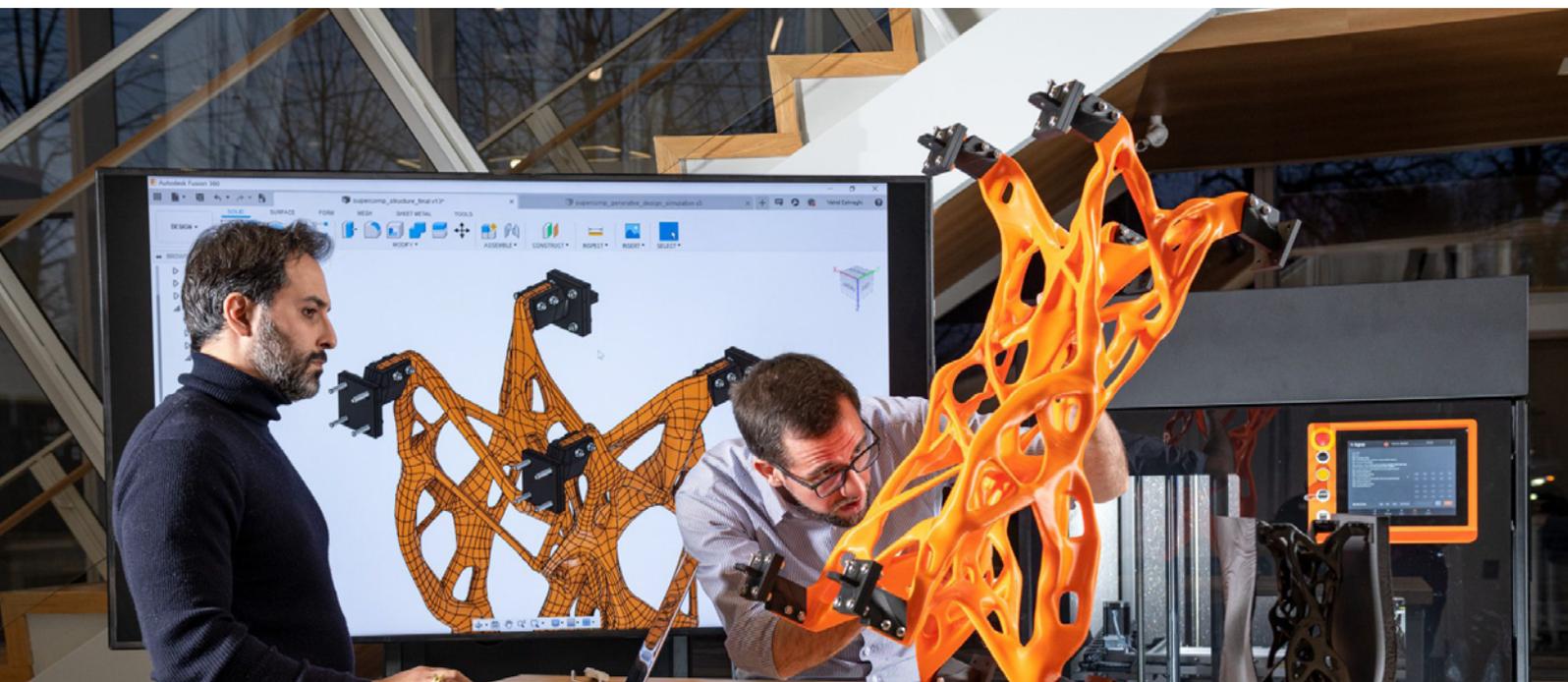
- **Drones:** Currently, drone usage doubles each year due to affordability and varied product options with different features available in the market. They can be used for large-area mapping, collecting data, jobsite supervision and inspection (especially at remote locations), and inventory tracking and reporting.
- **Autonomous construction vehicles and remote-controlled heavy equipment:** This equipment is capable of performing repetitive and high-risk work on a jobsite. Examples of such equipment include driverless dozers, cranes, excavators, and dump trucks.
- **Construction robots:** These are used to replace manual tasks such as bricklaying, scaffolding assembly, rebar tying, welding, forklifting, window cleaning (maintenance), and building demolishing.

These technologies save time, improve building quality, and can prevent site injuries. Equipped with IoT sensors / radio frequency identification (RFID) tags / global positioning system (GPS) tracking and other telematics, these

devices can be connected to artificial intelligence or cloud-based platforms. Collected data can be quickly and accurately processed to help in real-time monitoring and efficient decision-making.

Increasing adoption of digital technologies would increase sustainability in the manufacturing and AEC segments in APAC, where several initiatives are already underway.

- **Japan:** Connected industries is Japan's concept framework in which industries will create added value and solutions to various problems in society and the environment through the connectedness of various facets of modern life, including humans, machines, systems, and companies.
- **China:** Smart manufacturing development plan by the Ministry of Industry and Information Technology aims to digitise 70% of the country's major manufacturing companies by 2025.
- **India:** The government of India has been implementing initiatives such as green corridors and Make in India supported by Industry 4.0.



“ Thunder Mountain Hospital is a good example to show the importance of the role digitalisation plays in the design and construction of buildings. By adopting BIM to simulate the prefabrication process, the entire construction cycle was reduced to 10 days for a 70,000m² modular hospital. If adopting the traditional approach, design will take half a year, and construction will take half a year. We also adopted the Computational Fluid Dynamics technique to test the indoor air quality in order to reduce the nosocomial cross infection rate.” - Fan Hua Bing, BIM Director, Central South Architectural Design Institute

Another area where digital solutions are expected to make an impact is in ESG reporting. There is a growing need for ESG data reporting, driven by the investor community. As companies with strong ESG indicators have demonstrated an increase in investment returns and better resilience during a crisis such as the COVID-19 pandemic, the need for ESG reporting is expected to grow. Though ESG reporting is not mandatory in all countries today, a few have already taken measures to increase the practice of reporting them. For example, in 2021, India implemented new sustainability-related reporting requirements for the top 1,000 listed

companies by market capitalisation by FY2023. Similarly, the Sustainable Finance Disclosure Regulation (SFDR) was launched by the European Union (EU) in 2021, which has an emphasis on corporate disclosure of climate and sustainability-related information. While this is applicable for companies in the EU, it also has implications for outside companies conducting business in the EU. With the growing focus on sustainability, ESG reporting is only expected to increase in the future and digital technologies would enable easier compliance.



Insights: end-user speak

Research design

Critical insights for the study have been obtained through a quantitative survey and qualitative discussions with private sector AEC and design & manufacturing companies across six regions within APAC: Japan, China, South Korea, India, ANZ, and ASEAN. A total of 566 quantitative and 39 qualitative discussions have been carried out across these regions. The following areas were investigated during the discussions:

1. What are major sustainability trends the company is aware of?
2. What are the key factors to embrace sustainability by the organisation?
3. What are the main influencers for sustainability in the company?
4. What are the most important sustainability initiatives undertaken by the company?
5. What are the biggest benefits of sustainability initiatives for the company?
6. What are key challenges faced by the company in achieving sustainability?
7. Which are the areas of investment in sustainability the company is interested in?
8. Which are the areas where the company needs assistance from software providers to support sustainability efforts?

In the quantitative survey, approximately 20% of the samples have been covered from both Japan and China. The rest of the samples have been equally divided among the remaining four regions. Australia and New Zealand have been considered as a single region: ANZ. Within ASEAN, three English-speaking countries—Singapore, Malaysia, and Philippines were covered as part of the quantitative survey. Qualitative discussions have been equally divided among all the six regions.



Exhibit 18: Sample design for quantitative survey; by region and industry segments

Country	Total	Design & manufacturing	Architecture & engineering	Construction
Japan	112	45	45	22
China	111	45	44	22
South Korea	85	34	36	17
India	87	34	36	17
ANZ	86	35	34	17
ASEAN	85	34	34	17
Grand Total	566	227	227	112

source: Frost & Sullivan

Exhibit 19: List of companies that participated in the qualitative discussions

Country	Customer account name	Industry	Country	Customer account name	Industry
ANZ	Surbana Jurong	AEC	India	River Engineering	D&M
ANZ	Orica	D&M	India	Tata Projects	AEC
ANZ	Aurecon	AEC	India	Hero Motocorp	D&M
ANZ	Architectus	AEC	India	Titan Industries	D&M
ANZ	Warren & Mahoney	AEC	India	Adani Group	AEC
ASEAN	Gamuda	AEC	India	Infosys	AEC
ASEAN	AEDAS	AEC	Japan	Miho Technos	AEC
ASEAN	CPG	AEC	Japan	Tokyu Construction	AEC
ASEAN	AECOM	AEC	Japan	Kai Corporation	D&M
ASEAN	Axiata Group	AEC	Japan	Shimizu Corporation	AEC
ASEAN	Sime Darby	AEC	Japan	NGK Insulators	D&M
China	Guangzhou Urban Planning Survey and Design Institute	AEC	Japan	Mitsui	D&M
China	Zhaoshen Mechanical and Electrical Engineering	AEC	Japan	Hitachi	D&M
China	Central South Architectural Design Institute	AEC	Japan	Comany Corporation	D&M
China	TY Lin International	AEC	South Korea	SAMOO	AEC
China	Jinko Solar	D&M	South Korea	DRB	D&M
China	Dongfeng Design & Research Institute	AEC	South Korea	SK ecoplant	AEC
China	Foxconn	D&M	South Korea	Samsung	D&M
India	TCE	AEC	South Korea	Hyundai	D&M
India	Raychem RPG	D&M			

source: Frost & Sullivan

Distribution of sample structure by company size:

To ensure the sample is representative of the sectors, companies from each sector were further divided into three categories: very large, large, and medium. Design & manufacturing companies are the largest ones in the mix, followed by engineering and construction companies, then architecture companies. Hence, separate

categorisation criteria were followed to segment the companies from these sectors. For example, Design & manufacturing companies with more than 5,000 employees were considered as very large, while the criteria for engineering and construction companies was 1,000+ employees, and for architecture companies, it was 100+ employees, further explained in the table below.

Exhibit 20: Sample design for quantitative survey; by company size

Design & manufacturing	Total	Architecture	Total	Engineering	Total	Construction	Total
Medium (250-499)	114	Medium (10-49)	85	Medium (100-499)	76	Medium (10-49)	65
Large (500-4,999)	79	Large (500-99)	7	Large (500-999)	24	Large (599-999)	30
Very Large (5,000 & above)	34	Very Large (100 & above)	21	Very Large (1,000 & above)	14	Very Large (1,000 & above)	17
Total	227	Total	113	Total	114	Total	112

source: Frost & Sullivan



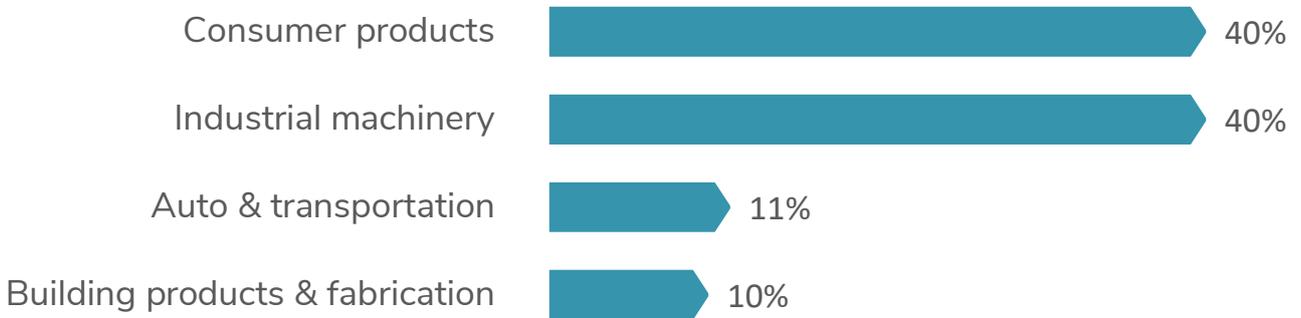
Distribution of sample structure by subsegments within manufacturing & AEC:

Within the manufacturing segment, similar weightage was given to consumer products and industrial machinery and these two subsegments account for 80% sample coverage. The rest of the sample were from the automotive and

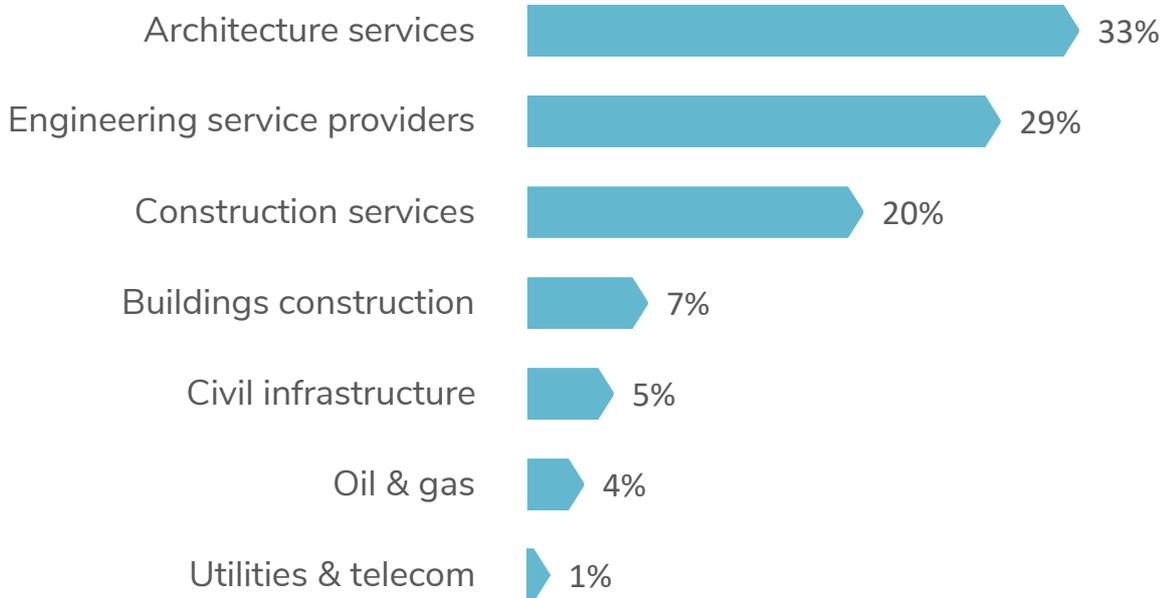
transportation, and building products and fabrication subsegments. Within the AEC segment, the majority of the sample coverage was from architecture services, engineering service providers, and construction services subsegments.

Exhibit 21: Sample design for quantitative survey; by subsegments

Design & manufacturing



AEC



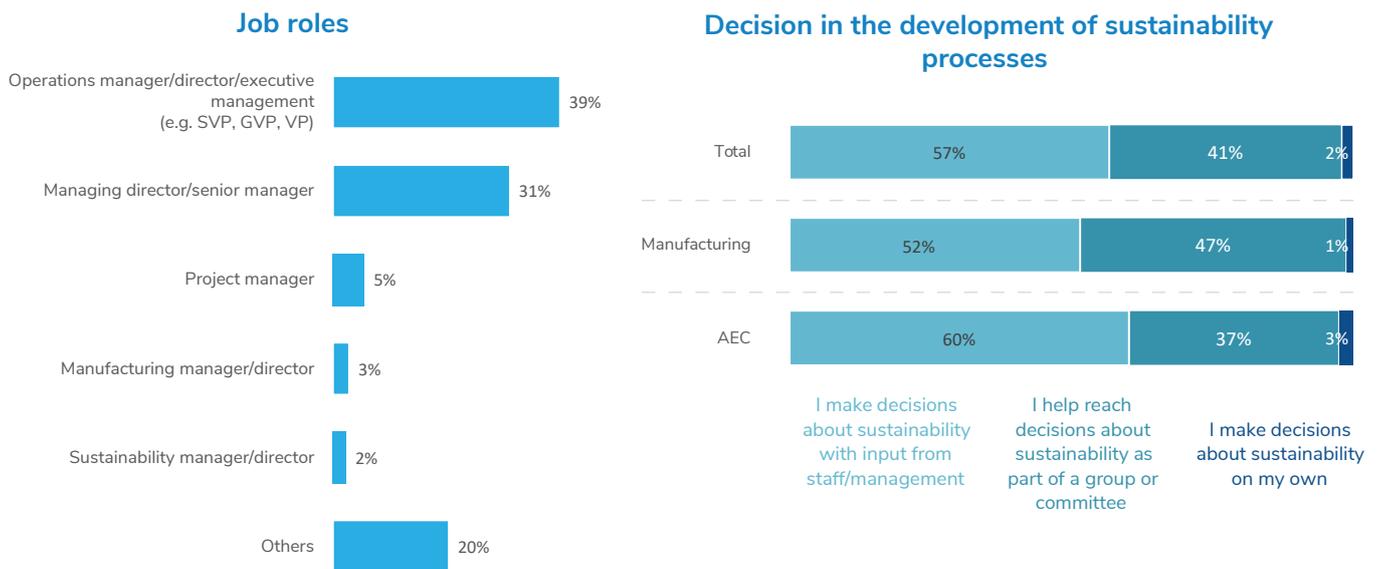
source: Frost & Sullivan

Role of respondents and influence on decision making regarding sustainability:

The research indicates that sustainability decisions are often taken through discussions with or inputs from designated cross-functional teams. Although sustainability initiatives are driven from the top,

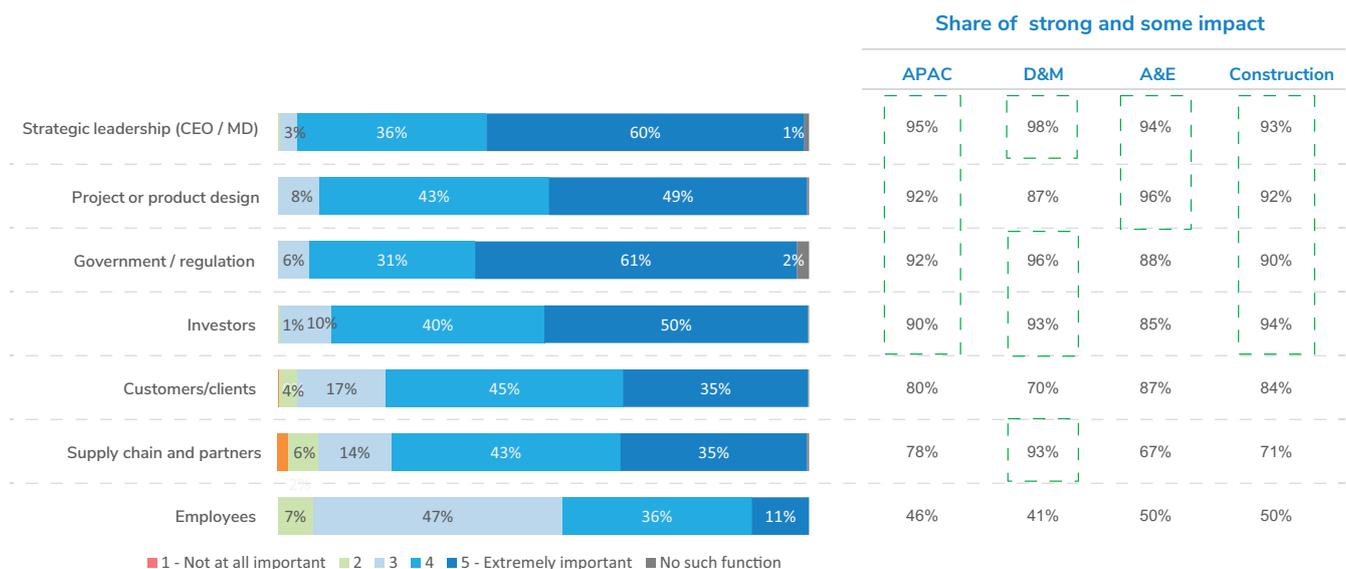
it is the collective effort that helps the company to achieve the desired results. Almost one-third of the respondents are in the leadership position within the company, which indicates the growing strategic importance of sustainability within the region.

Exhibit 22: Respondent job role and decision making authority



source: Frost & Sullivan

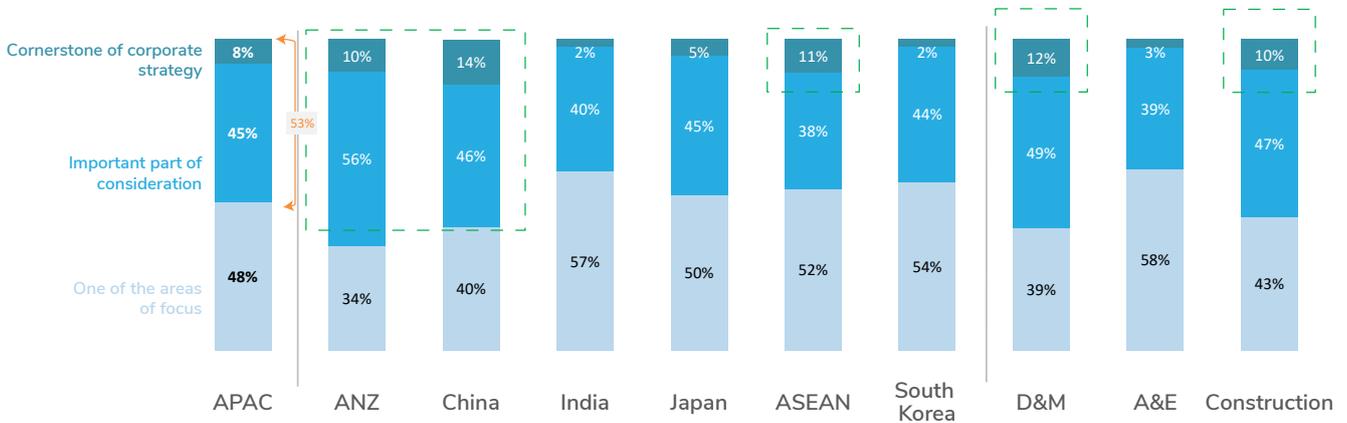
Exhibit 23: Influencers of sustainability



source: Frost & Sullivan

Sustainability as an integral part of corporate strategy

Exhibit 24: Sustainability maturity by region and industry



source: Frost & Sullivan

About half (53%) of the companies mentioned sustainability as an important part of the of their strategies. The manufacturing and construction sectors have demonstrated higher sustainability

maturity in comparison to architecture and engineering. ANZ, China, and ASEAN appear to be relatively more mature regional markets in terms of sustainability.

Exhibit 25: Approach of the companies towards sustainability



source: Frost & Sullivan

Of the companies surveyed, 65% consider sustainability a formal strategic vision in their leadership approach. In addition, 21% of the companies plan to design a strategic approach towards sustainability in the future. Over 70%

of design & manufacturing and construction companies and 75% of companies in China have sustainability as part of their leadership’s strategic vision. Only 1% of respondents view sustainability as less of a priority for their leadership.

“We have a corporate-governance mandate that is driven from the top, starting from the board of directors, and this is all disclosed in our sustainability report. We started this journey about 4–5 years ago, and we have done the material assessment and maturity matrix. We acknowledge that having an ESG-driven strategy, beyond following requirements from regulators and clients, is definitely a competitive advantage, and it is also becoming prevalent given that we are a public listed company.” - Ong Jee Lian, Group Chief Sustainability Officer, Gamuda

“Our sustainability goal is in line with Chinese government strategies: “Dual Carbon” and “Digital Economy.” To achieve this goal, we will be implementing more “green” projects such as green building, zero carbon building, old city and old factory renovation, and water and wastewater management. We will be dedicated to embracing a digital solution to provide value-added services to our customers.” - Wang Yang, Vice President, T.Y.LIN International

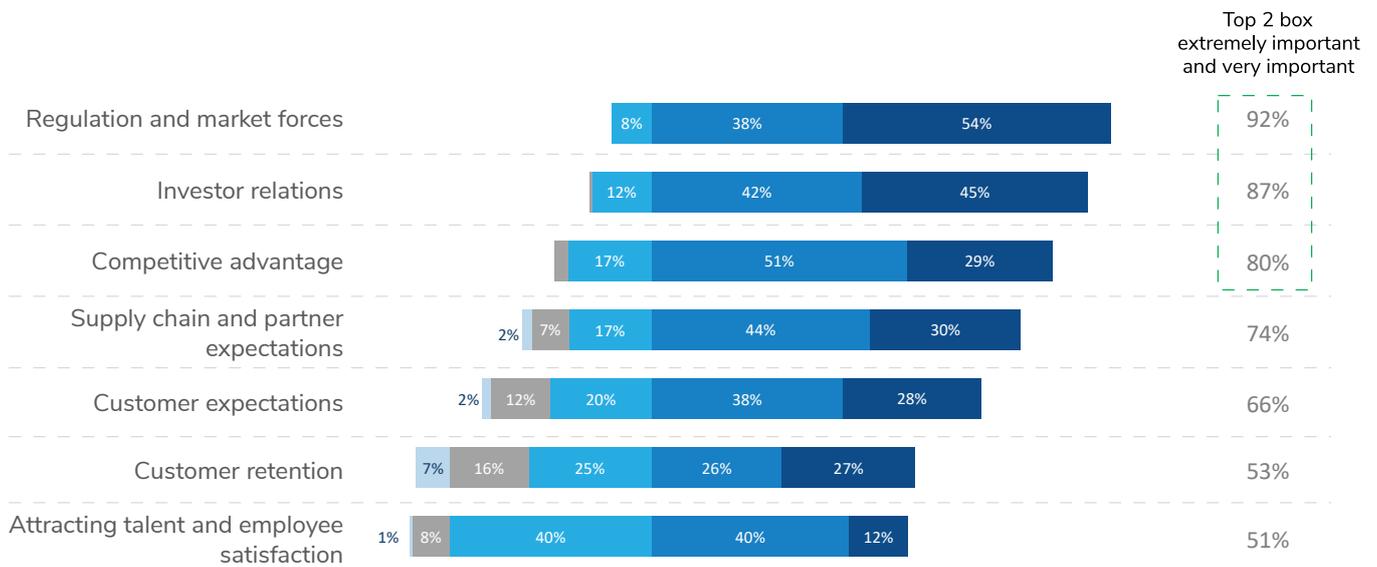


Drivers of sustainability for the companies in the APAC region

Regulations and market forces, investor relations, and competitive advantage are the key drivers for sustainability across the companies interviewed. Improving overall customer experience and ensuring customer retention by meeting their

expectations and garnering employee satisfaction are relatively less important triggers for driving sustainability for the companies in APAC. Survival in the market is what mostly drives their efforts towards sustainability.

Exhibit 26: Reasons for companies embracing sustainability at corporate level



source: Frost & Sullivan

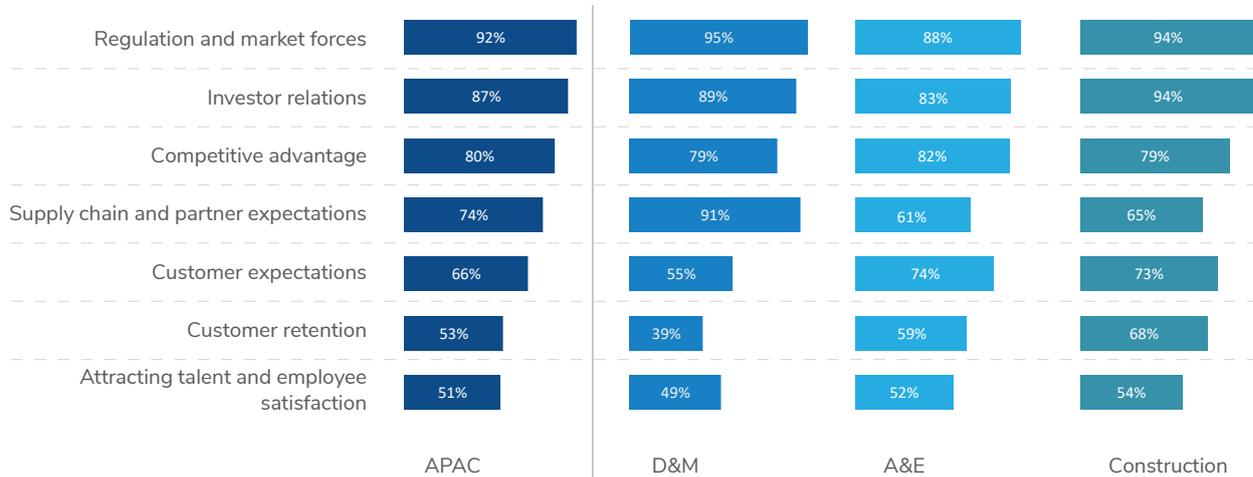
“As a company, Miho Technos is paying more attention to compliance than ever before, and we have also started to work on sustainability in construction business. However, sustainability initiatives increase costs and require a long-term perspective. In Japan, even if the cost increases, it is quite difficult to reflect that in the construction prices. Thus, construction companies are under pressure to maintain prices by reducing the construction costs and labour costs.” - Kenichi Nozu, CEO/President, Miho Technos

“Customers expect companies to do all of these things associated with sustainability but are not willing to pay more for the end products.” - Kaushik Merchant, General Manager, Raychem RPG

Supply chain and partner expectations have emerged as key drivers in the manufacturing

industry. On the other hand, customer expectation is a relatively stronger driver for AEC companies.

Exhibit 27: Sustainability drivers at the industry level (Share of extremely important and very important)



source: Frost & Sullivan

“Market forces are the most important driver in sustainability for the electric two wheeler market. Traditionally, low quality offerings have had an adverse impact on customer mindset and in turn the market forces. The starting point of sustainability for any product is when the customer recognises the offering to be far better than anything available out there.” - Aravind Mani, CEO, River Engineering

“In order to promote sustainability, we must not only work on our own, but also involve our supply chain in a unified effort.” - Akira Sugawara, Chief Manager, Sustainability Promotion Dept., Kai Corporation

As mentioned by the respondents across regions, sustainability is still a cost driver for most companies as customers are not willing to pay for it. However,

the situation is changing, and customers will soon start finding value in sustainable products.



Sustainability initiatives and investment outlook

At present, sustainability teams across regions and industries are primarily working on environmental, health, and safety (EHS) initiatives, implementing project workflows, carbon accounting, and purchasing offsets. These are short-term initiatives and targeted towards meeting the compliance initiatives. Initiatives such as sustainability

measurement and reporting and R&D related to sustainability are still at infancy in the APAC region.

Reductions in material and energy usage in the manufacturing lifecycle and low-carbon innovation have emerged as the top two initiatives.

Exhibit 28: Responsibilities of the sustainability teams across regions



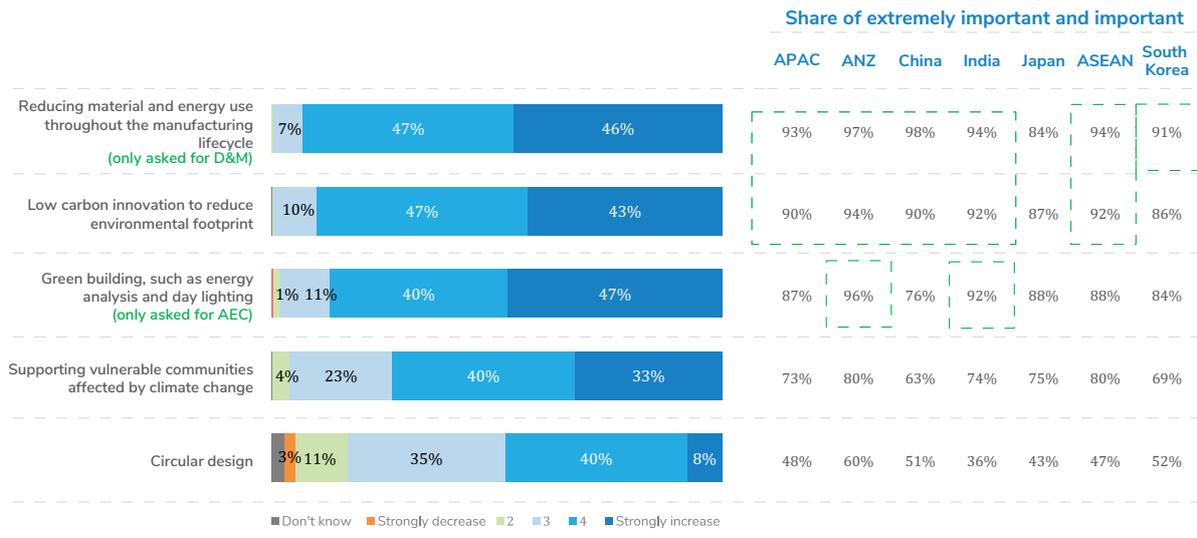
source: Frost & Sullivan

“Hero Motocorp constantly endeavours to source non-fossil fuel based energy and enhances its renewable energy portfolio through solar / wind / hybrid power plants.” - Nihal Kaul, General Manager, Hero Motocorp

“Our corporate policy is to give sustainability its due importance in all business decisions. We create positive impact through our products and services, without causing harm to health and environment, continuously enhancing and improving safety throughout product lifecycles.” - Palani Kumar, VP-IRSG (Retail group at Titan)

“ There is a clear message from the government to become plastic free - many of the company’s units have already become single-use-plastic-free units. For example, 640 MW Kamuthi Solar Park has already been certified by the CII to be a single-use plastic (SUP)-free plant, and other projects are subsequently turning plastic free.” - Praveen Anant, CSO, ATL and Head - ESG, Adani Energy

Exhibit 29: Importance of sustainability initiatives



source: Frost & Sullivan

When it comes to specific actions related to carbon emission reduction, priorities change across the industries. Key focus areas for carbon emission reductions are:

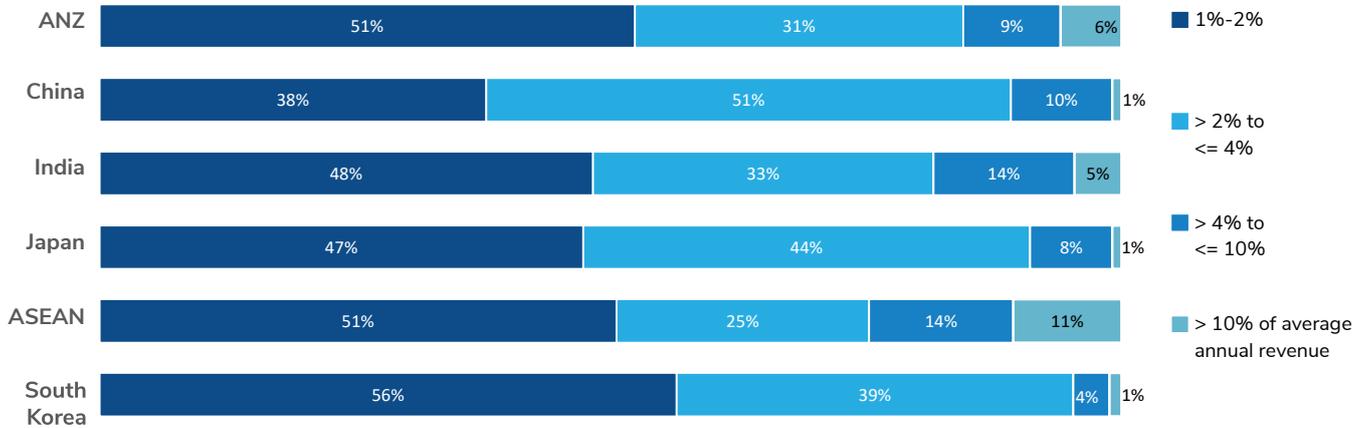
- **Design & manufacturing:** Better material choices are most important, followed by waste minimisation, and energy efficiency
- **Architecture & engineering:** Materials innovation
- **Construction:** Improved BIM implementation for error minimisation, building retrofit, and lean construction

Initiatives such as circular design are still in their infancy and will take some time to be prominent across industries and regions.

Moving forward, switching to RE sources, identifying the most sustainable materials, and improving processes to reduce energy usage are the top three identified opportunities for the design & manufacturing industries. As most of the manufacturing companies are trying to become carbon-neutral and moving towards net-zero, adoption of RE has become one of the foremost important initiatives across the region. RE, especially solar, has become an integral part of the energy policy for many governments in the region, and it’s an important tool to meet the country’s NDC. Usage of RE including distributed renewables such as rooftop solar, are gaining popularity across the manufacturing industries. Companies interviewed are planning to spend about 2.8% of their average annual revenues on sustainability over the next 5 years.

Exhibit 30: Investment plan in sustainability over next 5 years - by country

Countries:



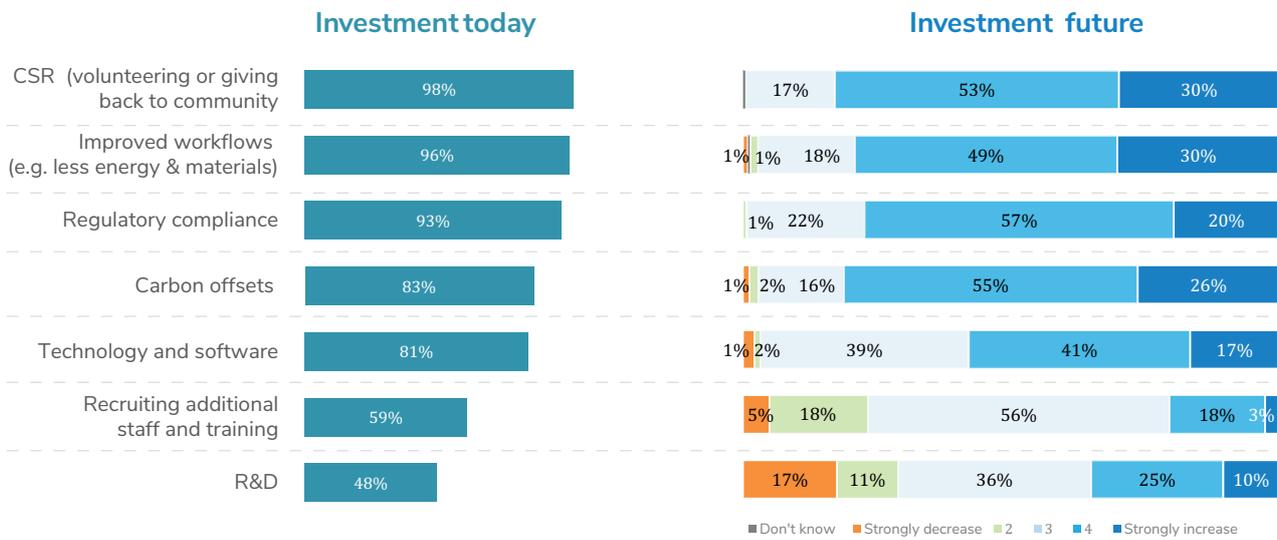
source: Frost & Sullivan

Companies were also asked about the areas they are investing in today and where they expect to invest in the future. The majority of the companies have highlighted four areas that are expected to

be the backbone for future investment: improved workflows, regulatory compliance, carbon offsets, and technology and software.



Exhibit 31: Areas of investment in sustainability



source: Frost & Sullivan

“ We are maximising opportunities to participate in carbon markets; they can help incentivise greenhouse gas emissions reduction projects. Optimising processes, deploying technology and developing smarter solutions help enhance our global competitiveness through lower embedded carbon in our products, more use of renewable energy, and use of non-virgin materials.” - Troy Powell, Head of Sustainability, Orica



“ DRB has been cooperating with the Pusan National University to improve the workflow at a smart factory as part of its investment plan. This R&D project will further initiate the use of emerging technologies (e.g., AI, machine learning, and big-data management).” - Jung Woon Park, Manager, ESG, People & Culture, DRB

“ Our future investment area and roadmap are to participate more in formulating green building codes and standards with government agencies, such as the evaluation criteria and approaches for being carbon-neutral, carbon emission regulations, zero-carbon factory standards, green-factory evaluation criteria, and the Sponge City regulation.” - Zhu Kaiqun, Director of Green And Healthy Building, Dongfeng Design Institute

“ Many companies generally think that sustainability initiatives are hardly helpful to improve profitability of the firms in the short term. However, SK ecoplant believes that its various initiatives to enhance sustainability leads to the company's profitability. For example, we have recently developed and deployed AI algorithms and digital applications for waste-to-energy plants to reduce CO and NOx emission, incineration residue and other pollutants by reducing temperature deviation of the incinerators. Such effort to digitalize the waste-to-energy plants operation has certainly made positive environmental impact, and at the same time, we have been able to increase operating profit by improving energy recovery and steam supply, decreasing landfills and extending regular maintenance interval. That being said, SK ecoplant has a strong belief that sustainability initiatives do not necessarily make negative short-term financial impact but help in garnering profit in both short-term and long-term.” - Jae Yeon Cho, Vice President, Digital Transformation, SK ecoplant



Role and essence of technology in supporting sustainability and a circular economy

A report titled “The Sustainability Future for Energy and Chemicals” from a survey conducted among global energy and chemical companies by the ARC Advisory Group found that 90% of the companies in the energy and chemical segments have sustainability initiatives in place. According to the companies surveyed, organisations face two key challenges in their journey towards sustainability: a lack of skills and a lack of resources, which are being compounded by the ageing of assets.

Technology adoption is the key to overcoming the critical challenges of skill and resource and making an impact towards sustainability. Several technology solutions are available in the market that enables companies in the AEC and manufacturing segments to embrace their sustainability journey. Autodesk, through its software platforms, supports the AEC and design & manufacturing industries to understand and optimise the environmental performance of businesses, products, services, and solutions, and it aids in the increasing adoption of sustainability in these segments.

Technology solutions for the AEC segment

Key solutions can broadly be grouped under two themes:

- Building design
- Lean construction

Building design: This includes solutions for:

- Building performance analysis
- Optimising building systems such as façade and heating, ventilation, and air conditioning (HVAC) Systems
- Material choices
- Healthy buildings

Technology solutions for design offer various benefits, such as enabling architects to model and simulate multiple designs early, which lead to the evaluation of various options before finalising the plan. This would allow for cost and performance comparisons between different design options and thereby help in improving the asset performance.

Building-design technology provides early-stage design analysis, which enables fundamental decision making such as orientation and form, sizing and placement, envelope constructions, and shading designs. Following this, a detailed design analysis can be done to estimate the energy consumption of various applications such as lighting and HVAC. Performance of RE planned to be deployed in the building can also be analysed in the design phase itself, which allows for real-time feedback. This would enable architects to envisage and design high-performance buildings with multiple sustainability features that could have minimal impact on the environment.

Advanced technology for design eliminates the need for redesign, streamlines the design process, optimises energy resources, and improves material and energy efficiency. This also allows architects to quantify the environmental impact of building materials by conducting life cycle assessments.

Lean construction technology solutions focus on:

- **Preconstruction:** This focuses on maximising efficiency by improving coordination to reduce rework and waste, streamlining logistics, and scheduling through value engineering to procure accurate quantity of materials, thus improving material efficiency.
- **Site execution:** Technologies allow companies to track progress against

plans, which enable better predictability, on-time delivery, and better management of materials.

- **Construction:** This focuses on productivity, efficiency, and lean production. Such technologies increase performance, reduce waste, and improve worker safety.

- **Supply-chain management**
 - o Better production control
 - o Compliance
- **Circularity**
 - o Better design
 - o Better materials
 - o Better management

Technology solutions for design & manufacturing segment

Key solutions in this segment could broadly be grouped under these themes:

- **Material productivity**
 - o Generative design, which enables material reduction and lightweighting
 - o Material exploration
 - o Optimisation of additive manufacturing
 - o Reduction in material usage and energy usage
 - o Improving material productivity
- **Energy productivity and advanced manufacturing**
 - o Increasing energy efficiency
 - o Reducing cooling loads
 - o Thermal management
 - o Airflow management

The above technology solutions would allow manufacturing companies to:

- Increase material productivity by lightweighting, reducing waste, and reducing energy consumption
- Allow material exploration to understand a material's environmental impact through its lifecycle
- Gain higher energy efficiency due to lower machinery energy consumption and reduction in cooling time
- Prevent deployment of oversized systems, which would result in lower design cost, reduce energy consumption, and improve efficiency
- Reduce cost of inefficiencies such as cost of rework, lack of quality, etc.
- Increase regulatory compliance



Software usage by the companies and support required

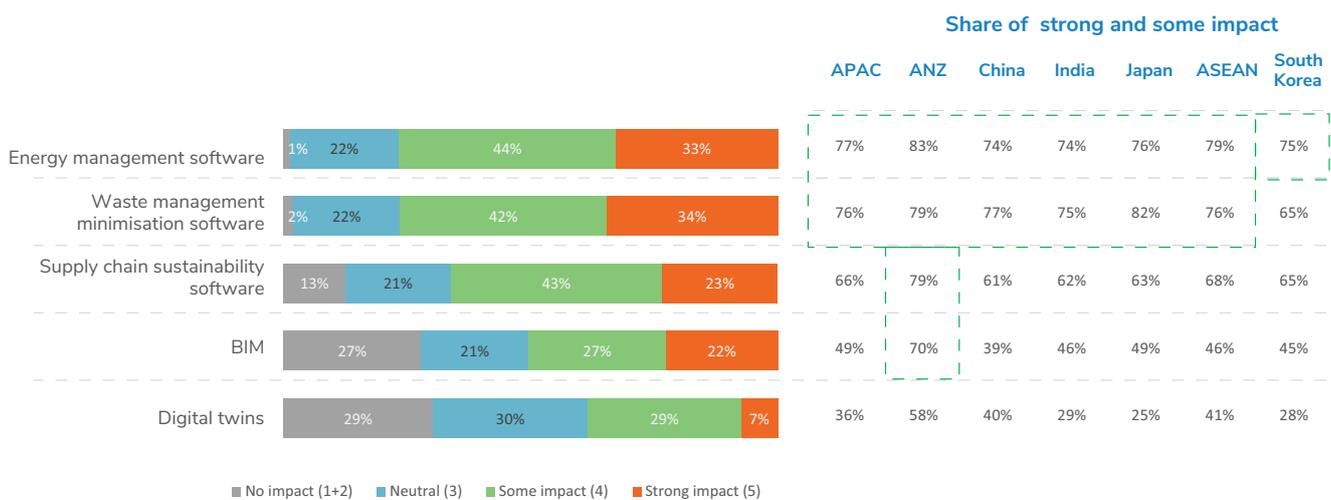
Energy management software and waste management minimisation software are the most widely used software tools currently across

segments. This is reflective of the higher attention energy consumption and RE receives in the AEC and manufacturing sectors.

“ Moving towards a green recovery requires a major shift in the way we design and build infrastructure. We’re helping companies design for sustainability and resilience in both greenfield and brownfield projects. This requires careful evaluation of assets and investing in the right technology, skills and of course, partnerships.” - Eugene Seah, Managing Director, Smart City Solutions, Surbana Jurong

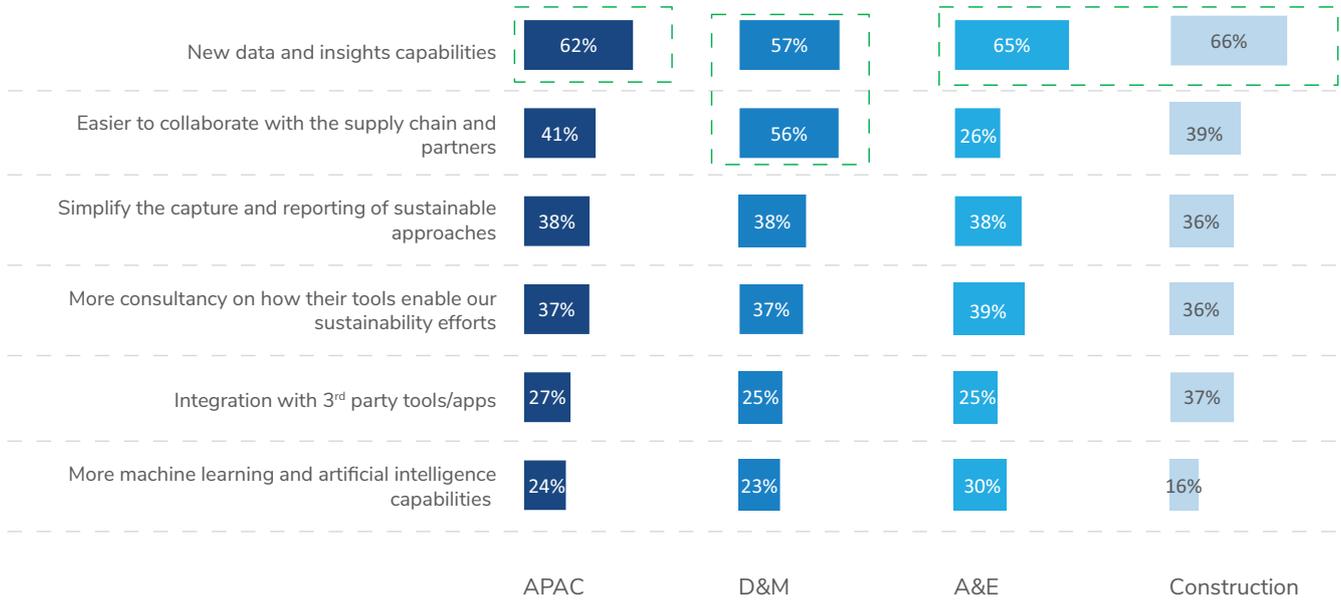
“ There is an opportunity for businesses to take on software technology and build in-house expertise; the sustainability concept itself is very new to most people. So there is a lot of intensive learning, and there are a lot of questions on how to integrate sustainability in a role. In the last three years, we have embarked on programmes like SAP and supply-chain management that allow us to get things quicker, knowing market returns in a more transparent manner.” - Ong Jee Lian, Group Chief Sustainability Officer, Gamuda

Exhibit 32: Tool & software by region



source: Frost & Sullivan

Exhibit 33: Support from software providers by industry



source: Frost & Sullivan

Companies are looking to software solution providers for new data insights and capabilities, easy collaboration with supply-chain partners,

data on low-carbon materials, and machine learning and artificial intelligence capabilities for improving their sustainability quotient.

“ We are looking forward to using some advanced software with machine-learning and AI capabilities such that can help us do the review and proofreading of the draft design. This is very tedious and mechanical work; we hope software can do this so that we can free the workforce to do more value-added jobs.” - Fu Nan, Director of BIM Center, Guangzhou Urban Planning Institute

“ We are committed to leveraging technology to support the transition to a low-carbon world. We have a number of projects that are currently being executed for our clients to facilitate climate-change actions in FY2021.” - Swapnil Joshi, Smart Spaces & Sustainability, Infosys



Conclusion

Necessity for change – organisations across the APAC region need to relook at their approach towards sustainability, to convert aspirations into achievements

APAC is the fastest-growing economic region in the world, and hosts some of the world's largest economies including China, Japan, India, and South Korea.

The pace of urbanisation, manufacturing activity and improvements in standard of living, are exerting pressure on land and natural resources in the region, posing a significant challenge to sustainability. The result can be seen in the fact that the APAC region now contributes to 53% of global GHG emissions (2018), producing 18.3 billion metric tons of CO₂ in 2020, which is more than the cumulative emissions from the rest of the world¹².

Manufacturing / construction and building sectors account for 17% and 4% GHG emission in the region respectively. For the world to progress towards the net-zero goal, it is critical for these

sectors in APAC to make a change in how they approach sustainability. With the emergence of comprehensive digital solutions, such a transition can be made easier, leaving no excuse to continue with status quo.

Sustainability initiatives are gathering pace in APAC

Governments across the region have acknowledged the impending threat from climate change and pledged to contribute to this global cause while balancing for the imperative of economic growth. Their actions are varied but reflect an improvement in commitments – as seen through the declaration of carbon-neutral goals (China, Japan, and Korea), a transition towards RE (India), and other green initiatives (Singapore's Green Plan 2030, ANZ's Green Investment funds).

However, progress has been uneven. The region has struggled to suppress the increase of GHG emissions driven by high economic growth. Substantial effort is required to counter the negative impact being witnessed on account of economic development. Relying on regulations

¹² Source: WRI, Climate Watch, Statista



and mandates is not sufficient considering the magnitude and complexity involved – industry and civil society initiatives and involvement is a must to achieve the desired impact.

The industry is required to increase contribution

In the quantitative survey conducted by Frost & Sullivan (with 566 companies across the region), a significant 48% of the respondents brought up sustainability as an important part of their strategy, citing market forces, investor relations and perceived competitive advantage as key drivers for this increase in adoption.

Decarbonisation across the entire value chain is a critical focus area for attaining sustainability mandates. From a supply point of view, a range of new products / solutions / services have evolved at a rapid pace in the last decade, delivering outcomes revolving around resource conservation and reduction in material consumption, waste reduction, circularity, and usage of alternate (and more sustainable) materials.

Companies need to direct future investments to support aspirations and strategies – increasing the focus on R&D – aiming for an outcome to achieve long term sustainability goals.

Digital adoption is a critical enabler, but significantly underleveraged

Complying with stakeholder mandates and government regulations (specifically related to energy consumption and emissions reductions) will result in an increasing requirement for monitoring, measuring, reporting, and verification of sustainability achievements.

The underlying thread that binds this together is efficient and structured management of data – which highlights the need for increased digital adoption. A range of solutions already exist (software for energy management, waste minimisation, supply change sustainability, measurement and reporting of sustainability initiatives etc.) that can assist in the sustainability journey – from design to decommissioning. Investments in these solutions can assist in not just compliance, but also in cost reduction and efficiency improvement, presenting a clear ROI-based business case for adoption.

Action must now be taken, to embrace digitalisation as an enabling pillar, and increase the commitment towards sustainability – contributing to the global cause, while upholding often divergent stakeholder interests.



Appendix: key government initiatives

Australia:

- [Modern Manufacturing Strategy](#)
- [Supply Chain Resilience Initiative](#)

New Zealand:

- [Industry transformation plan](#)

Malaysia:

- [Domestic Investment Strategic Fund](#)
- [Economic Recovery Plan \(PENJANA\)](#)

Singapore:

- [Resource Efficiency Grant for Energy](#)

Philippines:

- [Infrastructure program](#)

China:

- [14th five year plan](#)

India:

- [National Manufacturing Policy](#)
- [Make in India 2.0](#)
- [Skills India Initiative](#)

Japan:

- [Smart factory promotion project](#)
- [Greater Nagoya Initiative](#)

South Korea:

- [Korean New Deal Initiative](#)
- [Korean New Deal 2.0](#)
- [Manufacturing Renaissance Vision](#)

About Autodesk

Autodesk is changing how the world is designed and made. Our technology spans architecture, engineering, construction, product design, manufacturing, media and entertainment, empowering innovators everywhere to solve challenges big and small. From greener buildings to smarter products to more mesmerizing blockbusters, Autodesk software helps our customers to design and make a better world for all. For more information visit autodesk.com or follow @autodesk.

F R O S T  S U L L I V A N

Frost & Sullivan is the Growth Pipeline Company™. We power our clients to a future shaped by growth. Our Growth Pipeline as a Service™ provides the CEO and the CEO's growth team with a continuous and rigorous platform of growth opportunities, ensuring long-term success. To achieve positive outcomes, our team leverages over 60 years of experience, coaching organisations of all types and sizes across 6 continents with our proven best practices. To power your Growth Pipeline future, visit Frost & Sullivan at <http://www.frost.com>.

The contents of these pages are copyright ©2021 Frost & Sullivan.