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ADVANTAGE INDIA:

Gateway to Global Engineering R&D and Innovation

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FOREWORD

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In the last two decades, we have made great strides, and India's Engineering R&D sector is expected to reach USD 63 billion by 2025, up from USD 31 billion in 2019 - a growth of over 12 percent. Our current share of the global Engineering R&D outsourcing market is 30 percent, and we aspire to reach 50 percent within a decade. In an era of rapidly accelerating digitization and adoption of Industry 4.0 across all industry verticals, India is uniquely positioned to tap into this opportunity and support global MNCs with their digital transformation efforts.

India has emerged as a global powerhouse for Engineering R&D and is steadfastly committed to ushering future growth and innovation for global enterprises. Across sectors and technologies, India provides excellent Engineering R&D services that drive innovation and digital transformation. India offers a progressive and vibrant start-up environment, boasting the third-largest start-up ecosystem in the world, attracting significant global investment.

India has stood as an example to the world of how a country can do more with less, a unique trait that's only been possible due to our frugal innovation mindset. While low, the R&D expenditure of India has tripled in the last two decades, and its focus on AI, 5G, health tech and other emerging technologies have helped it transition into an innovation hub for the world. The new Science, Technology, and Innovation Policy launched in 2020 further strengthens research capabilities and enhances India's innovative capabilities.

Several factors, including its focus on technology and service delivery excellence, ease of doing business, world-class infrastructure, favourable demographics, a large domestic market, and a skilled pool of engineering and digital talent, make India strategically positioned in Engineering R&D and innovation. Efforts by stakeholders from the ecosystem comprising of global capability centres, engineering service providers, start-ups, industry associations and policymakers have propelled India to become a preferred country for global enterprises.

The purpose of this report is to present the achievements and value propositions of the Indian Engineering R&D ecosystem that has led to India becoming a destination of choice for Engineering R&D. The report will also showcase the benefits that multinational enterprises have received from the Indian ecosystem.

ACKNOWLEDGEMENTS

Advantage India: Gateway to Global Engineering R&D and Innovation report is developed by NASSCOM, with FutureFactor360 as its knowledge partner. This report showcases the Indian Engineering R&D ecosystem's achievements that have enabled India to emerge as the destination of choice for global Engineering R&D companies.

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Global Engineering R&D Context

In 2020, the global Engineering R&D spend was USD 1.2 trillion, with corporate Engineering R&D spend being USD 772 billion.

Global Engineering R&D Market Trends

- Today's era is marked by the rise of technology giants, deep tech start-ups, and innovative disruptors who are radically changing the face of competition. The endless possibilities of digitization and technology adoption have ushered in a paradigm shift in the industry dynamics and competitive landscape.
- The advent of new engineering and manufacturing powerhouses, changes in the consumer markets, and emerging regional financial hubs in Asia have resulted shift in economic centre of gravity to the East.
- Global enterprises are increasingly adopting tech-enabled business models to stay relevant and continue their growth trajectory. Across many industries, there is a massive shift towards outcome-based engagement between customers and suppliers.
- Organizations are also rapidly embracing consortium and co-opetition approaches to address the industry challenges, innovate, generate new revenue streams and stay relevant to their customers.
- The advent of new-age technologies such as AIoT, AR/VR/XR, edge computing, 5G, robotics, blockchain, and drones are driving the digital transformation and presenting numerous use-cases across various verticals and business functions.
- The talent profile and persona are also changing, and there is a rising demand for cross-skilled and diverse engineering and digital talent.
- In recent years, the role of the government has increased to create a favourable ecosystem for the industry by increasing investments in technology, creating fair policies, and ensuring data security and privacy.

Key Engineering R&D Imperatives for Global Enterprises

- Amidst the rapid commoditization of products, evolving customer expectations and technology landscape, and reducing profit margins, enterprises are building intelligent Digital First products. Today, "smartness" and "intelligence" features are not mere add-ons but are the fundamental elements of product design.
- In pursuit of the new era of engineering and manufacturing, enterprises are implementing Industry 4.0 solutions enabled by IT and OT convergence to streamline operations, ensure faster time to market, and provide an efficient supply chain.

- Speed of innovation is of the essence for enterprises to get a sustainable competitive advantage in today's ever-changing industry dynamics and amidst evolving consumer demand. Accelerating innovation is looked at by organizations as the key to survival and unlock multiple growth avenues.
- Cyber security has emerged as a critical focus area for organizations in the face of increasing security breaches and cyber-attacks.
- Organizations are increasingly embracing sustainable business strategies with a high focus on environmental, social, and governance goals.

Engineering R&D: Advantage India

Overview of the Indian Engineering R&D

- The Indian Engineering R&D sourcing market is projected to grow at a 12-13 percent CAGR to reach USD 63 billion in 2025 from USD 31 billion in 2019.
- India's Engineering R&D landscape comprises Global Capability Centres (GCCs), Engineering Service Providers (ESPs), Start-ups, and India-based manufacturing companies

The key pillars/value propositions that fuel India's attractiveness as the destination of choice for global Engineering R&D companies are strategic business impact, a strong focus on innovation, a large and diverse talent pool, and the ability to provide differentiated service delivery.

Strategic Business Impact

- India is well-positioned as an investment destination and a strategic hub for Engineering R&D.
- In India, Engineering R&D players play a crucial role in helping global enterprises create competitive advantage, move to a digital-first paradigm, and create tangible business value.
- India-based GCCs and ESPs have expanded their scope to assume end-to-end ownership of global products. They are playing a central role in charting out enterprise-wide digital transformation strategy.
- In addition, India-based GCCs and ESPs also support customized localization to unlock new market segments for global enterprises and build products that are Made for India and Made for the World. GCCs have evolved from offshore/outsourcing centres into strategic business hubs for their parent enterprises, assuming business and technical leadership roles.
- Engineering R&D players are creating technology Centres of Excellence (CoE) to support the global technology needs of customers.
- Additionally, India's Engineering R&D centres are actively participating in global research initiatives and publications that positively impact technology thought leadership.
- Co-locating Engineering R&D and manufacturing in India is benefitting the companies on multiple fronts.

Innovation Excellence

- India is becoming the destination for innovation and technology. It is amongst the top 50 most innovative countries in the World. For the last ten years, it has continued to retain its position as the most innovative country in Central and South Asia.
- Intending to become the third-largest economy (by GDP) this decade, India is continuing to foster innovation starting from grassroots levels. The impact is visible from the recent improvements in the innovation ranking.
- Indian Engineering R&D players are continuously evolving with emerging technologies, creating cutting-edge next-generation products for local and global markets, further strengthening the innovation excellence story of the country.
- Adding to India's attractiveness as an Engineering R&D destination is the active collaboration of organizations with start-ups and universities.
- India is home to the third-largest start-up base worldwide. Many of the start-ups in India are involved in deep-tech, providing a range of innovative solutions.
- In addition, Indian universities have diversified expertise that is dedicated to solving real-world problems with efficiency.
- Fast and frugal innovation is the hallmark of Indian Engineering R&D. This was evident during the COVID crisis when Engineering R&D organizations implemented innovative solutions in a short period to help India and other nations.
- Indian GCCs, ESPs, and start-ups have embraced the philosophy of frugal innovation, which has been instrumental not only in fighting the pandemic, but also in creating simple, affordable, and accessible solutions for local and global markets.

Talent excellence

- India's talent has played a vital role in changing the narrative of Indian Engineering R&D from cost arbitrage to value creation over the years.
- Today, some global enterprises have built either the largest or the second-largest Engineering R&D hubs in India, in many instances with the headcount higher than their headquarters.
- According to the projections, India is expected to continue having one of the youngest populations in the World until 2030. By 2027, India is expected to have the largest labour force in the World.
- India is a hub for digital talent, with specialised skills in highly demanded technological areas such as IoT, AI, ML, Robotics, etc.
- As one of the most diverse countries globally, India offers a skilled and diverse workforce spread out across the country, making it a popular choice among GCCs and ESPs for setting up R&D facilities.
- Indian Engineering R&D players, government, and industry bodies have taken many initiatives to supplement the growth of the future-ready talent pool.

- The presence of a large number of engineering institutes in the country is enabling the scale of talent that India offers. The robust university ecosystem provides a quality education and skill training to create industry-ready talent. India currently holds 22nd position in the quality of its universities globally.

Service Delivery Excellence

- India remains a dominant player in the global Engineering R&D market. The engineering services landscape in India has evolved significantly, with the nature of work shifting over the years.
- The Indian ESPs are becoming an innovation and strategic partner for global companies by adopting new business models and building the right capabilities through partnerships.
- M&As and partnerships are witnessing a rise as service providers are focusing on building capabilities to differentiate themselves.
- Indian ESPs have continued to stay ahead of the curve even during the pandemic. They have established and implemented robust business continuity plans by leveraging the strong legacy, including remote operations and digital workplaces that enabled on-time project delivery to customers worldwide.
- Indian government's focused efforts and the measures taken by various Engineering R&D enterprises have brought about perceptible changes in the IP landscape. Companies are witnessing increased client confidence and trust as a result of these measures.

India Rising and Shining

India has emerged as a global leader and an economic powerhouse in the last decade. With a rapidly growing consumer base and a growing share of the working-age population, India is steadily moving towards becoming a USD 5 trillion economy by 2024.

A push for manufacturing and a conducive ecosystem for innovative start-ups by the Indian government has prepared India to lead the new era of innovation and transformation.

Why India as an Investment Destination

- The Indian government has introduced numerous ambitious schemes, reformed existing policies, and undertaken multiple progressive initiatives to strengthen the Indian business ecosystem and improve India's attractiveness and business-friendliness quotient.
- During 2014-19, India jumped 79 spots in the "Ease of Doing Business" rankings and moved 33 positions in the "Global Innovation Index."
- India is fast becoming an ideal destination for investment for global enterprises. According to a World Economic Forum report, India is poised to witness 4x growth in consumption spending by 2030.

- India is undergoing a digital revolution and is poised to become a digital economy worth over USD 1 trillion by 2025, up from USD 200 billion in 2018. The Government of India has rolled out various national-level missions and initiatives to foster digital proliferation.
- The Indian government has undertaken various initiatives and reforms such as implementing Goods and Services Tax (GST), introducing Production Linked Schemes (PLI), increasing Foreign Direct Investment (FDI) share to incentivize and promote domestic manufacturing among others.
- In recent years, India's central and state governments have undertaken significant infrastructure spending across various areas such as connectivity (road, rail & water), energy, urban development, smart city programs, and industrial corridors development.
- The Government of India has also initiated the "National Infrastructure Pipeline" (NIP) initiative and has earmarked USD 1.5 trillion for various infrastructure investments from FY 2019 to FY 2025.
- India is undertaking substantial steps to tackle climate change and build a sustainable future by exploring and adopting green and clean energy sources, accelerating electric mobility adoption, and undertaking blue-green infrastructural reforms.

With efforts from all the Engineering R&D ecosystem stakeholders, India is well poised to address the future Engineering R&D imperatives of the global enterprises.

GLOBAL ENGINEERING R&D CONTEXT

This section discusses the global Engineering R&D market trends and key Engineering R&D imperatives for global organizations in the current era.

GLOBAL ENGINEERING R&D CONTEXT

The global Engineering R&D spend in 2020 was USD 1.2 trillion, with corporate Engineering R&D spend being USD 772 billion. Automotive, software & internet, and healthcare comprised of approximately 50 percent of the USD 772 billion Engineering R&D spend by corporates. ***The digital engineering spend is estimated to form 40 percent of global ER&D spend by 2023.***[1]

We are now witnessing a paradigm shift and a whole new era of accelerated growth, innovation, and large-scale digital transformation in global enterprises.

The factors listed below have compelled companies to reimagine their business models and growth strategies to stay relevant and emerge as leaders in this new era.

1. Change in dynamics of competition
2. Data monetisation and privacy
3. Evolving regulatory landscape
4. Increased focus on customer experience
5. Move towards the remote working model
6. Need for efficiency and optimisation in manufacturing and supply chain process
7. Rise of new normal post-pandemic
8. Shrinking innovation cycles

In addition, sustainability has become a key focus, with many engineering organisations pledging to become carbon and water neutral in the next decade.

Global enterprises are looking to address the new imperatives with increased agility and ingenuity. They are increasingly investing in smart connected products, plants (factories), and processes by leveraging Artificial Intelligence (AI)/Deep Learning (DL), Augmented Reality (AR)/Virtual Reality (VR), automation, cyber security, and other cutting-edge digital technologies.

Global market dynamics are also fast-evolving, with boundaries between industry segments getting blurred and companies compelled to develop new strategies to compete with competitors' unique and contemporary profiles. Companies are growing both organically and inorganically, through acquisitions and collaborations, to address the emerging paradigms. Businesses are adopting models like servitisation (as a service model) to stay relevant to drive enhanced customer experience and provide a differentiated value proposition. Every company is increasingly adapting itself to this growing trend to create an impact on the world stage.

The critical global market trends listed below are impacting the Engineering R&D space.

- Adopting new-age technologies
- Changing dynamics of competition
- Increasing talent war
- Rising regulatory changes
- Shifting of the economic focus to the East

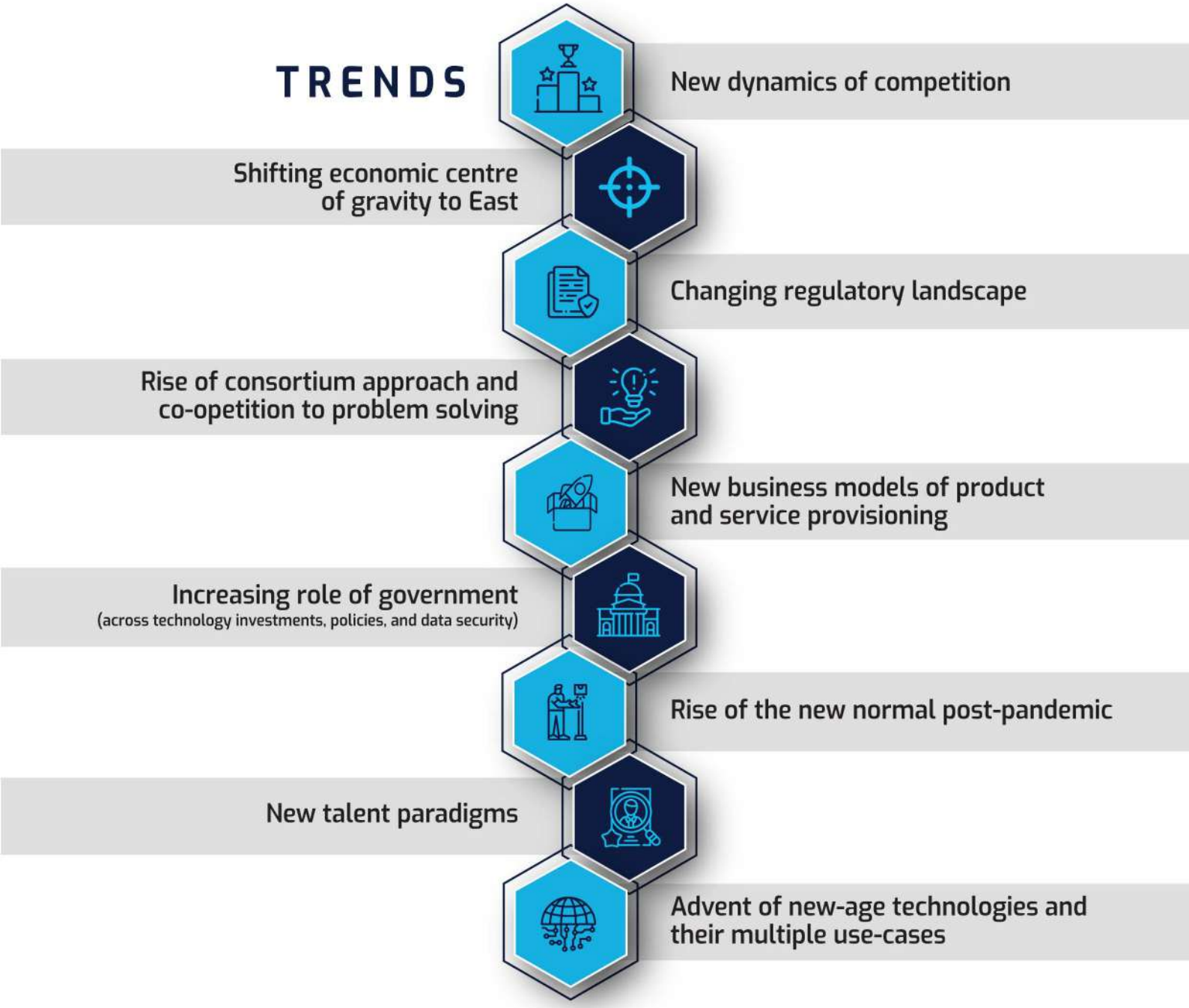
[1] *Technology Sector in India, Strategic Review, NASSCOM,2021*

These trends have led the global enterprises to focus on some crucial engineering R&D imperatives such as:

- Adopting industry 4.0
- Emphasising more on cyber security and sustainability
- Equipping for the unforeseen future and evolving business dynamics
- Localising products to access new markets
- Optimising engineering spend through digital engineering R&D

GLOBAL ENGINEERING R&D MARKET TRENDS

The global Engineering R&D market is witnessing a plethora of trends that are impacting the very way of doing business. The upcoming sub-sections discuss the nine significant trends reshaping the global Engineering R&D markets.



New dynamics of competition

Technology giants, deep tech start-ups, and disruptive innovators are radically reshaping the competitive landscape in today's era.

Over the past decade, a new breed of digital-native companies has emerged and scaled rapidly, transforming both the competitive landscape and time to market. At the same time, technology behemoths like Google and Amazon are increasingly foraying into new industry segments. Their intrinsic use of digital technologies indicates their continuous need to evolve and scale at speeds that threaten large, traditional organisations' current market share and positioning.

Through digitization and technology adoption, enterprises have challenged existing industry norms, thereby entering into a new space and gaining a competitive advantage. The trend has resulted in enterprises competing with an entirely new set of competitors, never thought of before.

Foray of technology behemoths into traditional verticals

Google (Alphabet Inc.) - Seamless customer experience delivered through ross/multi-industry presence

Alphabet Inc., which mainly operated in the online search and advertising space, has forayed into many industry segments. Their presence across multiple industry segments (retail, consumer electronics, banking, healthcare, etc.) has enabled Alphabet Inc. to offer a seamless, integrated, and differentiated customer experience. A few examples have been shared below.

Alphabet Inc.

Waymo	A self-driving car project	**Automotive**
Google Fibre	A broadband service offering high-speed internet	**Network**
Google Assistant and Nest	Smart Connected Home Solutions	**Consumer Electronics**
Verily	A healthcare and life sciences solutions	**Healthcare and Life Sciences**
Google Pay	A payments solution	**Finance**
Sidewalk Labs	One-stop vendor for smart city services and solutions	**Smart City**

Rise of digital native disruptors

- **Tesla - New digital native entrant disrupting a traditional segment**

Tesla, as a disruptive enterprise in automotive, has posed a significant threat to the automotive behemoths. In Jan 2021, Tesla achieved a market capitalization of USD 700 billion, higher than any auto manufacturer.[2] Tesla's market cap is more than Toyota, Volkswagen, Daimler, GM, BMW, Honda, Hyundai, Fiat Chrysler, and Ford.[3]

Examples of differentiation by Tesla include:

Adopted a direct sales model, that ensured a seamless buying experience and eliminated unwanted negotiations that customers detest while making a purchase.
Bundled product offering with various services.
Established a network of charging stations close to hotels, shopping malls, and highways to facilitate hassle-free charging of Electric Vehicles (EVs).
Provided remote servicing and software upgrades that eliminate the need for a Tesla car owner to visit a servicing centre.
Targeted the high-end electric vehicle segment, when most of the automakers were focussing on gasoline-run vehicles.

Advent of cost competitive Chinese alternatives

China's cost-competitive products, coupled with manufacturing capabilities, have adversely impacted the pricing of products of various global enterprises. Global enterprises are building innovative products to differentiate themselves from their competitors and provide customers with differentiated value propositions such as smartness and intelligence embedded in the product.[4]

Currently, the key to an enterprise's competitive advantage and survival depends on its engineering and R&D function's speed of adaptability, agility, innovation, and time to market.

Shift of economic centre of gravity to the East

The dynamics of the global economic activities and power are shifting from the West to the East. The advent of new engineering and manufacturing powerhouses, a growing consumer base, and the rise of regional economic hubs are moving the economic centre of gravity to the East.

The global economic landscape has undergone profound changes since the end of the cold war. Post the war, the US and the North Atlantic countries were at the core of the global economy, with Latin America, Africa, and Asia on the periphery. However, Asian economies have grown much faster than their western counterparts in the last three decades, shifting the gravity steadily to the eastern hemisphere and Eurasia.

[2] *https://www.businessinsider.in/stock-market/news/tesla-jumps-3-after-nearly-hitting-500000-deliveries-in-2020/articleshow/80097467.cms*

[3] *https://www.businesstoday.in/auto/story/tesla-nears-500-billion-higher-than-combined-m-cap-of-ford-bmw-7-other-automakers-279533-2020-11-24*

[4] *https://www.weforum.org/agenda/2015/07/how-innovation-protects-manufacturers-against-cheap-imports/*

Over the years, Asia has increasingly made an impact as an economic and engineering powerhouse. This development can be attributed to a shift in manufacturing activities and services trade, rapid urbanization, industrialization, emerging middle class, and growing consumption. ***By 2040, Asia is expected to account for 40 percent of the world's total consumption and 50 percent of the global GDP[5].*** Asia is home to the six economies, led by countries like India, China, Japan, and Indonesia, which are expected to grow even more in the near future.

Today, many Asian countries produce sophisticated and futuristic products, with India fast becoming one of the foremost global production hubs. Asia is rapidly emerging as a primary international hub for technology, innovation, and consumption, accounting for 30 percent of Fortune 500 companies and one-third of unicorn start-ups. Many venture capital funds are investing in start-ups focusing on AR/VR, autonomous vehicles, 3D printing, robotics, drones, and AI, etc. in Asia.

In the context of global Engineering R&D, it is becoming imperative for global enterprises to build, innovate and localize products to address the needs of the new emerging centre of gravity. For example, companies like General Electric (GE), Renault, Skoda and many more are building localized products specifically for emerging markets in Asia.

Changing regulatory landscape

The volatile geopolitical and trade scenario, age of smart connected devices, data and Intellectual Property (IP) protection concerns, and move towards a sustainable future have necessitated a plethora of regulatory changes by governments of most countries. Countries now are completely rewriting their policies to adapt to the changing times.

Many regulatory frameworks are being drafted in the context of managing import-export parity, promoting local manufacturing, data protection, and transparency, implementing emission controls, attracting foreign investment policy, and regulating the evolving connected ecosystem.

However, the current changes to the regulatory landscape present challenges as well as opportunities to global enterprises. Enterprises are required to make their production and business operations data more transparent to regulators and make continuous changes to their strategies. To ensure compliance, enterprises constantly track the pending and approved laws and regulations and make it an integral part of their strategy formulation.

As a result of the US-China trade war, the COVID pandemic, and regulatory changes in other countries, multinational enterprises are exploring many other Asian countries, in addition to China. Some have also been making strategic investments in their own countries.

On the technology front, with the rise of the Internet of Things (IoT), and related technologies such as robotics, AI, and big data, etc., new regulatory frameworks are deployed, with consumer protection as the end goal, by governments across the globe.

Currently, more than 128 countries have put in place legislation to protect data and privacy.[6] North America and Europe have been at the forefront of formulating some of these laws, with the General Data Protection Regulation (GDPR), and the California Consumer Privacy Act (CCPA) serving as models for global data privacy laws.

[5] *Asia's future is now | McKinsey*

[6] *https://unctad.org/page/data-protection-and-privacy-legislation-worldwide*

Concurrently, laws and regulations are struggling to keep pace with the advancement of technology. For instance, in the automotive industry, the advent of the autonomous car led to a debate on liability, in case of an accident - manufacturer, driver, the software provider.

With new regulations making product manufacturers responsible for protecting consumer privacy and safety, enterprises are increasingly investing in cyber security and other areas of R&D to align with government regulations.

Rise of consortium approach and co-opetition to problem-solving

Organizations are rapidly embracing consortium and co-opetition approaches to address the industry challenges, innovate, generate new revenue streams, and stay competitive.

The commonality of industry challenges, changing dynamics of competition, rising R&D costs, unlimited potential presented by emerging technologies, and ever-changing customer expectations, have resulted in organizations coming together to adopt an "Industry Consortium" approach and "Co-opetition" instead of Competition.

- **Industry-led Consortium approach:** The central tenets of a consortium approach are co-investing, shared IP and ownership, and a not-for-profit approach. Various organizations are coming together, pooling their resources and shared knowledge to conduct research, solve industry problems, and find multiple ways to leverage technologies that can benefit the entire industry as a whole, instead of a particular company. Such consortiums primarily consist of various cross-industry stakeholders such as Original Equipment Manufacturers (OEMs), suppliers, solution/service providers, and other stakeholders like universities, research organizations, and industry bodies.

Examples of industry-led consortium approach:

Consortium led by companies

Airbus launched "Skywise" - an open, integrated, and cloud-based platform for improving the aviation industry's operational performance by consolidating aviation data. More than 80 airlines have signed up on the platform since its launch in 2017.[7]

In 2014, companies such as Cisco, Intel, AT&T, GE, and IBM founded the "Industrial Internet Consortium" - a not-for-profit organization to accelerate the adoption of Industrial Internet of Things (IIoT) and related technologies.[8]

Consortiums formed by alliances of multiple stakeholders

"Mobility Open Blockchain Initiative (MOBI)" is a global not-for-profit consortium working to improve mobility using blockchain, distributed ledgers, and other emerging technologies and intends to make transportation more efficient, affordable, greener, safer, and less congested. Its members comprise of automotive manufacturers, start-ups, governments, non-governmental organizations (NGOs), transit agencies, insurers, e-mobility leaders, and technology companies. Companies like Continental, Denso, BMW, Accenture, and Autodata Solutions are few MOBI members.[9]

[7] *https://www.airbus.com/newsroom/press-releases/en/2017/06/airbus-launches-new-open-aviation-data-platform--skywise--to-sup.html*

[8] *https://www.iiconsortium.org/press-room/03-27-14.htm*

[9] *https://dlt.mobi/*

Co-opetition instead of Competition: To meet the industry challenges, tap into new customer segments, adopt different business models, reduce R&D costs, and most importantly, to innovate continuously and generate more unique revenue streams, the competitor organizations instead of competing are joining hands to co-opete together and leverage each other's strengths. Leading engineering pioneers are co-operating with each other to co-innovate and develop new products/solutions.

Examples of Co-opetition instead of Competition

Apple – Samsung partnership

In 2019, Apple and Samsung announced a co-operation deal wherein Apple would offer iTunes movies and TV shows on Samsung's television sets. This move opened new potential revenue streams for Apple from customers who purchase movies/TV shows from iTunes. For Samsung, its customers get an additional feature wherein they will not have to buy an Apple TV set-top-box to access iTunes content.[10]

Daimler-BMW partnership

In 2019, Daimler and BMW announced long-term strategic co-operation focused on joint development of next-generation technologies for automated driving on highways, driver assistance systems, and automated parking (all to SAE Level-4). The co-operation aims to ensure the faster launch of automated driving technology in the market by 2024. There are 1,200 specialists involved in this partnership, working at different locations, developing a scalable architecture for driver assistance systems, a centre for data storage, administration, processing, and functions and software.[11]

New business models of product and service provisioning

As per McKinsey, 92 percent of companies out of 2000 traditional companies surveyed across 60 countries feel that their business models will no longer be viable in the coming future due to the rapid acceleration of digitalization.[12] Customers are increasingly preferring quality and customized products and services, and a seamless experience from browsing for a product to purchasing it to post-sales service. Across many industries, there is a massive shift towards outcome-based engagement between customers and suppliers.

Global enterprises are adopting tech-enabled business models to remain competitive and continue their growth trajectory. The expectations of the customers and users are constantly evolving with the changing industry landscape. Companies are progressively creating unmatched value for their customers, identifying new revenue streams, and optimizing costs, resources, and assets.

[10] *https://news.samsung.com/us/samsung-smart-tvs-launch-itunes-movies-tv-shows-support-airplay-2-spring-2019/*

[11] *https://www.daimler.com/innovation/case/autonomous/development-cooperation-daimler-bmw.html*

[12] *https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/why-digital-strategies-fail; https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/the-digital-led-recovery-from-covid-19-five-questions-for-ceos*

Companies are creating new business models and reinventing older ones in unprecedented ways, with digital technology at its core. One of the models getting increasing traction across most engineering industries is the Servitization or Anything-as-a-service model.

With the rapid commoditization of products, companies are adopting "as-a-service" models to generate newer revenue streams. The customers are charged in different ways, such as usage/consumption-based pricing or subscription fee. Through this model, companies can generate new revenue streams and establish lasting relationships with customers.

For instance, Sarcos, a manufacturer of industrial exoskeletons, offers its "Guardian XO" exoskeleton in the robot-as-a-service model, including maintenance, support, and upgrades. These exoskeletons help workers/operators across manufacturing, aviation, construction, logistics, and warehouse industries to boost their productivity and minimize the risk of workplace injury by enabling them to lift, move, and manipulate heavier loads by themselves.

Rolls Royce's Power by the Hour program

Rolls Royce is one of the pioneers in introducing servitization models through its "Power by the Hour" program. Instead of charging customers for inputs and services like engine repairs, maintenance, and the provision of spare parts, customers pay a fee per hour based on the number of hours of flying time for an engine. The servitization model helps the customers to reduce their maintenance costs and downtime.

Companies like HP, DELL, Cisco, Seagate, etc., are bundling their products with associated services like utilization, product health monitoring, predictive maintenance, and proactive customer service.

Another variant of the servitization business model is "outcome-based pricing", where the customer pays for the benefit realized by using the product rather than paying for the product. The outcome-based pricing model is made possible by combining servitization with digitization, enabled by IoT, AI/ML, and 5G.

Philips sells lighting

Philips sells lighting – rather than LED bulbs – in an outcome-based model to institutional customers like Amsterdam's Schiphol Airport. The bulb manufacturer manages the airport's lighting through an IoT based system, reducing Schiphol's annual electricity consumption by 50 percent. Philips gets its revenue by providing uninterrupted lighting to the airport and receiving a share of the savings delivered.[13]

Michelin's EFFIFUEL™ – Michelin solutions – especially for trucks

By leveraging technology and adopting an innovative business approach, Michelin has migrated from a product-based company to a service company that guarantees performance, leading to higher customer satisfaction, loyalty and retention, and increased profit margins.

[13] *https://www.bcg.com/publications/2021/value-of-outcome-based-business-models*

Michelin launched EFFIFUEL™, an ecosystem that uses sensors inside vehicles to collect various parameters such as fuel consumption, tire pressure, temperature, speed, and location. The collected data is analysed, and recommendations are made for eco-driving techniques. EFFIFUEL ™ ensures satisfaction or money-back guarantee by delivering the fuel efficiency service risk-free to truckers and refunds those if the pre-defined targets for savings are not achieved.[14]

Impact

By encouraging careful handling of the truck equipment, the company has unlocked significant savings for their customers:

- **It has reduced fuel consumption by 2.5 litres/100 km resulting in annual savings of EUR 3,200 for long-haul transport over 1,20,000 km.**
- **It has reduced the total cost of ownership by 2.1 percent and CO_2 emissions by 8 tonnes.**

In addition to servitization models, enterprises are also adopting co-manufacturing and asset sharing models to increase profit margins and avoid becoming asset-heavy companies.

For instance, Cohealo is a platform that allows healthcare equipment sharing among hospitals, thus maximizing the usage of existing equipment, enabling hospital systems to buy fewer redundant units, reducing rental expenses, improving access to best-in-class surgical assets, and growing surgical case volume by removing equipment constraints at each facility.

To create an unparalleled customer experience and seamless buying, companies are also trying to eliminate the middlemen involved and reaching out directly to the customer through the Direct to Stakeholder or DTX model. An example of this model is when General Motors (GM) introduced its online shopping tool, Shop-Click-Drive, in 2013, for selling cars online in the US. Similarly, Tesla has shifted its cars sales to online-only, with a limited number of stores open for customers to view Tesla's products and buy its merchandise.

Organizations are also focusing on enhancing organizational agility and adopting agile product launch strategies to maintain pace with a dynamic competitive environment through new business and engagement models.

Increasing role of government

In recent years, the role of the government has increased to create a favourable ecosystem for the industry coupled with growing investments in technology, create clear policies, and ensure data security and privacy. The role of the government is shifting from a mere bystander to an active participant in the ecosystem.

Governments across nations are introducing major reforms and framing new policies to improve the business climate of their respective countries while ensuring an environment conducive to enhance innovation, collaboration, and progress.

Government spending has increased on digital-driven services such as the building of smart cities, digitalized nations, unified identity systems, and healthcare systems.

[14] *https://digital.hbs.edu/platform-rctom/submission/michelin-tires-as-a-service/*

For example, the Government of India (GOI) and the Ministry of Electronics and Information Technology (MeitY) are looking to invest in facial recognition, hot-spot analysis, and biometric identification, among other technologies, to enable women's safety, optimize forest revenues, and protect wildlife.[15]

Governments across nations are rolling out new policies which are promoting rapid digitalization. Some examples of new industrial policies introduced by various countries are Industry4WRD: National Policy on Industry 4.0 by Malaysia, Making Indonesia 4.0 (2017) by Indonesia, Make in India by India, Smart Nation Plan by Singapore, and many more.[16]

Apart from launching new policies, governments worldwide are leveraging technology to provide better services to their citizens. The pandemic has also accelerated the global government's digital transformation efforts.

The government is increasingly emerging as a critical contributor to global tech spending. According to a Gartner report, government technology spending globally is expected to be USD 438 billion in 2021, and Engineering R&D spend is expected to constitute a vital portion of the tech spending by the government.[17] Outdoor surveillance, road toll and traffic management, street and outdoor lighting, city asset tracking, and safety and crime prevention, etc., are among the critical applications explored by governments at a vast scale.

Rise of the new normal post pandemic

The onset of the pandemic has compelled organizations to re-think their strategy leading to the acceleration of digital adoption. Many organizations have challenged conventions and norms to drive customer delight and business continuity.

In today's post-pandemic world, the "New Normal" is defined from the perspective of three fundamental tenets - **Sales and Marketing, Operations, and Employees** in this sub-section. Technology is the critical enabler for the wide-scale adoption and continuity of organizations post-pandemic.

Sales and Marketing

Foot-Fall to Eye Balls: Consumer buying behaviour has witnessed an increasing shift from offline to online. The pandemic has forced many offline consumers to transition to online purchases, a trend which is expected to continue. For reasons such as safety and ease of use, customers are increasingly transitioning to digital sales not only for small items, but also for big-ticket items. Major global companies have launched online sales platforms and have digitalized their customer experiences.

For instance, Volvo has developed a new commercial strategy defined by three pillars - electric, online and, growth. It is increasing investments in its online sales channel to increase customer convenience, transparency, and ensure a seamless buying experience.

[15] *Future of Technology Service, Winning in this Decade, NASSCOM, 2021*

[16] *https://irpcdn.multiscreensite.com/81280eda/files/uploaded/WTR2020Government_policies_to_ promote_innovation_in_the_digital_age.pdf*

[17] *https://www.gartner.com/en/newsroom/press-releases/2021-02-18-gartner-forecasts-global-government-it-spending-to-grow-5-percent-in-20210*

Operations

Digital operations: Enterprises have embraced digitalization and automation across various processes to increase efficiencies, meet a growing demand with optimized resources, and reduce costs while maintaining continued and resilient operations.

Companies are seeking to maximize the value of digital technologies in almost every area of their operations, such as product development, production, supply chain management, and other administrative functions. For instance, Freeport-McMoRan, a US-based mining company, has deployed AI to lower operational costs.[18] The AI model provides recommendations, based on which the operations of the mining plants are optimized.

Employees

Work from anywhere: The idea that most work can be done anywhere irrespective of employee's location has gained wide acceptance due to the pandemic. The enterprises are embracing the concept of a remote and borderless workforce. Many technology firms such as Microsoft, Salesforce, Amazon, etc., have introduced a "Work From Anywhere (WFA)" policy for at least 50 percent of their employees as a long-term strategy. Even the traditional enterprises are exploring the concepts of remote work and WFA.

For example, recently, Ford announced a new, flexible, hybrid work model for its employees. About 30,000 white-collar office workers could continue to work from home indefinitely and have flexible hours approved by their managers.[19]

Virtual and augmented workforce: Remote workforce augmented with automation, robots, drones are expected to form workforce in the future, wherein the repeatable, mundane tasks are expected to be performed through AI, Robotic Process Automation (RPA), etc. Employees from the office or home are expected to take on more critical tasks such as decision making, jobs related to creativity, and solving complex issues. Manufacturing, automotive, industrials, financial and banking, and other sectors are expected to reflect this trend.

New talent paradigms

In order to stay competitive, organizations are progressively becoming agile and embracing continuous and incremental innovation, leading to rising demand for cross-skilled and diverse talent. Human capital is one of the most critical assets in today's era for an organization, which has resulted in a rising global war for talent.

The dynamics of the talent have changed dramatically. Today traditional industrial/manufacturing companies are competing with companies like Google and Microsoft to attract talent. Increase in softwerization and digitalization across verticals, coupled with an organization's quest for best-in-class talent has created a digital talent gap. This digital talent gap is continuously widening, with more companies looking for talent with digital skills. Apart from attracting talent, retaining talent continues to remain a top priority for enterprises.

[18] *How six companies are using technology and data to transform themselves, McKinsey, August 2020*

[19] *https://www.forbes.com/sites/jackkelly/2021/05/31/companies-who-focus-on-their-workers-will-win-the-war-for-talent-when-offices-reopen/?sh=7d9f61ec6283*

The critical shifts in talent are:

Emergence of borderless talent

Globalization and digitalization, along with the pandemic, have led to the emergence of borderless talent. Models such as remote work, hybrid work, and work from anywhere, etc., have removed location barriers from hiring and have enabled organizations to look for and employ best-in-class talent across borders.

For example, in more than 200 countries, Siemens employees work remotely in cross-functional teams and collaborate from different parts of the world.

Stellantis has implemented a "New Era of Agility" so that their engineers can work remotely from virtually any location.

Changing persona of talent

Cross-skilled talent in niche technologies – Increasing software penetration in core industry verticals like automotive, manufacturing, energy, and many more, have led to the demand for skilled talent in AI, ML, IoT, blockchain, etc, in these industries. Companies like Ford, GE, Stellantis, etc., are in need of talent skilled in new-age/deep-tech areas, combined with an understanding of core engineering principles.

Rising importance of diversity, and its benefits on productivity, innovation, and profits, has forced organizations to have diverse employees from different regions, cultures, races, and gender, etc.

Workforce comprising of millennials and "Gen-Z" – The new generation of talent entering the workforce have entirely different aspirations and beliefs. The responsibility lies with the organizations to understand and manage these employee aspirations.

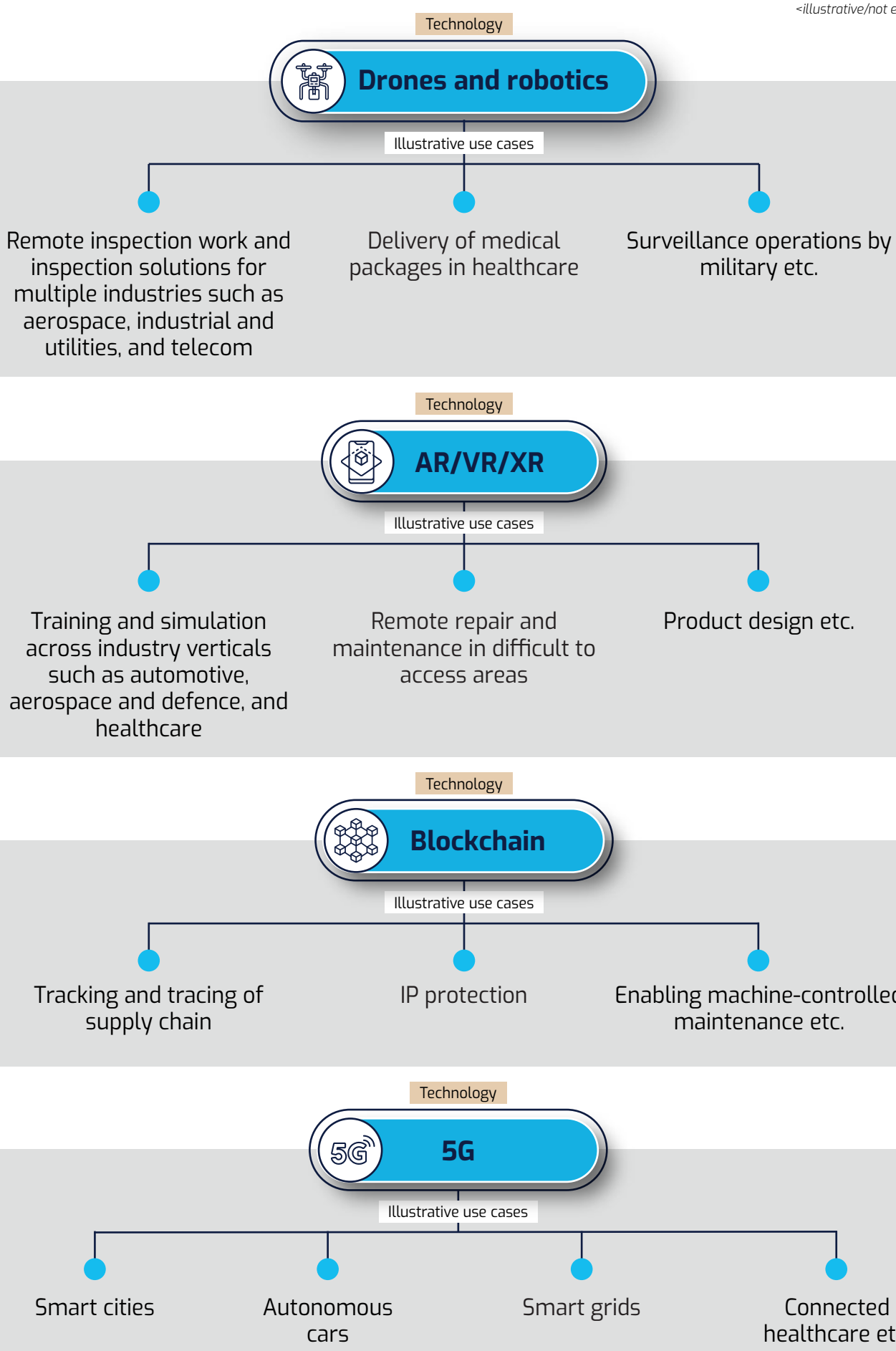
Advent of new-age technologies and its multiple use-cases

The rapid proliferation of new-age technologies is the key enabler of the transformation and evolution being witnessed in Engineering R&D sector. This includes smart connected products, smart factories and enterprises.

The onset of the pandemic has reiterated the pivotal role of technology. Technologies such as Artificial Intelligence of Things (AIoT), edge computing, 5G, AR/VR/XR, robotics, blockchain, drones, etc., are enabling a plethora of use-cases across verticals. These technologies are instrumental in reshaping the future of global enterprises and streamlining operations, improving business processes, assisting the workforce in increasing productivity, and many more. Easy accessibility, affordability, and ease of deployment of new-age technologies have emerged as the key reasons for the shifts in business models, service offerings, and enterprise product development.

Use-cases of some of the new-age technologies across industry verticals

<illustrative/not exhaustive>



Technology

Edge Computing

Illustrative use cases

- Autonomous vehicles
- Smart grids
- Remote monitoring of assets in industrial setup
- Smart homes
- Traffic management
- Virtualized and connected healthcare etc.

Technology

3D Printing/ Additive Manufacturing

Illustrative use cases

- Rapid prototyping of parts
- Lightweight parts for aerospace etc.

Technology

AI

Illustrative use cases

- Advanced data analytics (predictive analytics, sentiment analytics, image analytics, and many more)
- Smart and virtual assistants
- Smart security systems
- Digital twins
- Autonomous vehicles etc.

Industry vertical key focus areas leading to rapid adoption of new-age technologies

<illustrative/not exhaustive>

Industry Vertical

Automotive

Focus Areas

- Connected, autonomous, and electrified vehicle, shared mobility
- Digitalized and omni-channel customer buying experience etc.

Industry Vertical

Aerospace and Defence

Focus Areas

- Electrification of aircrafts
- Digital twins for optimizing aircraft operations and performance
- Surveillance operations by military etc.

Industry Vertical

Industrial and Utilities

Focus Areas

- Industry 4.0 revolution in the manufacturing value chain
- Smart grids in electricity transmission and distribution
- Intelligent oil fields in energy production etc.

Industry Vertical

Medical Devices

Focus Areas

- Telemedicine services for remote healthcare delivery
- Optimized treatments using evidence-based medicine etc.

Industry Vertical

Semiconductor

Focus Areas

- Edge computing driving the need for faster hardware in connected devices
- Application-specific integrated circuits for AI/ML, computer vision, Natural language processing (NLP), etc.

Industry Vertical

Telecom

Focus Areas

- Mainstream implementation of 5G networks across the world
- Self-optimizing networks to ensure network quality across all the connections etc.

Industry Vertical

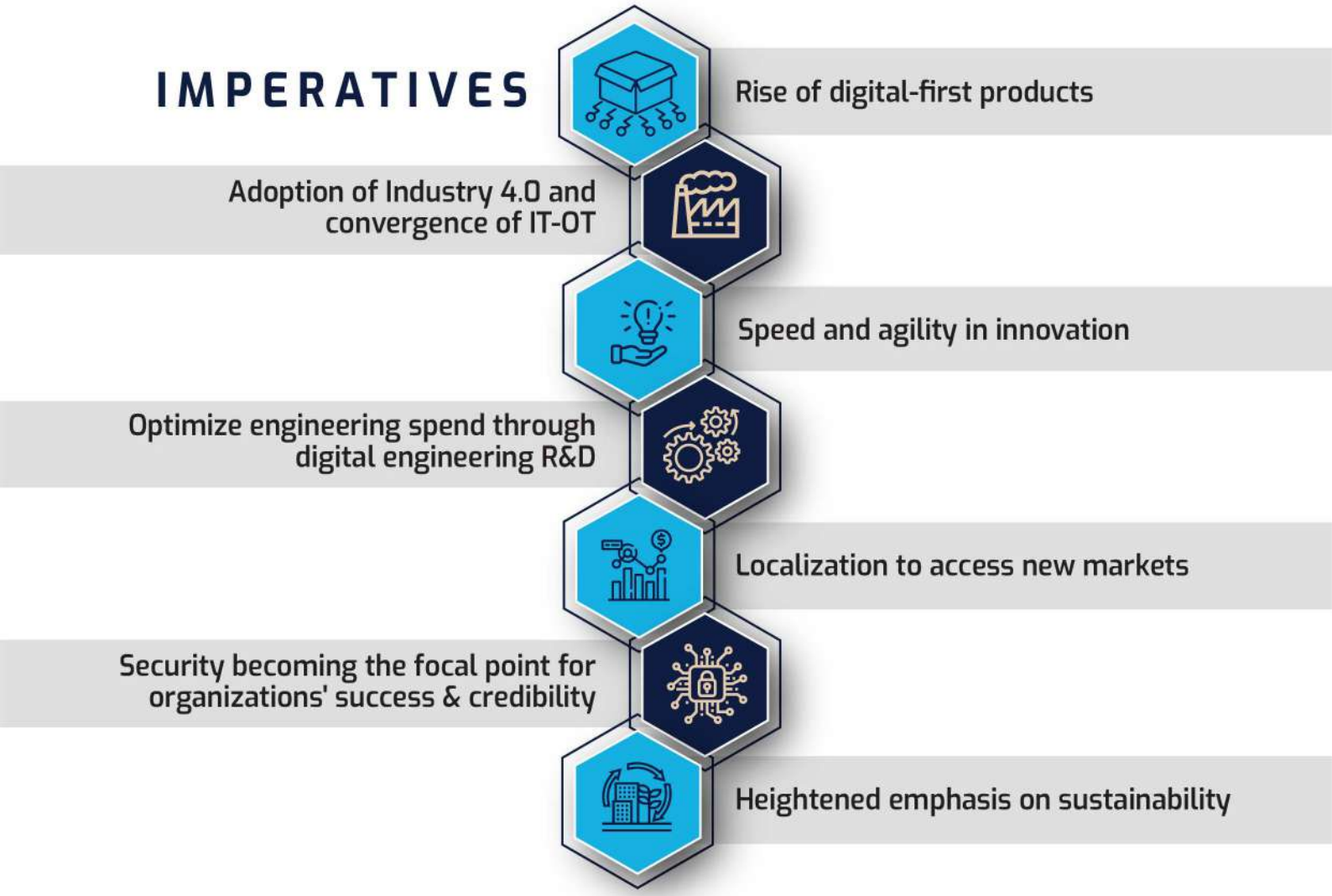
Consumer Electronics

Focus Areas

- Quantified-Self leading to growth in wearable technologies
- Smart home systems driving efficiency
- Foldable screens expanding possibilities of consumer tech etc.

KEY ENGINEERING R&D IMPERATIVES FOR GLOBAL ENTERPRISES

The changes and trends witnessed across the Engineering R&D space is urging the enterprises to rethink their product development, engineering and business strategies, and business models. A few key Engineering R&D imperatives for global enterprises have been discussed below.



Rise of digital first products

The Engineering R&D industry is in the midst of the evolution, wherein pure mechanical and electrical products are transforming into complex multidisciplinary digital-enabled smart and intelligent products. Exponential improvements in computing power, the proliferation of connectivity and cloud technology, and advances in sensor miniaturization have paved the way for smart and intelligent products.

Amidst rapid commoditization of products, evolving customer expectations, reducing profit margins, and uncertain macro-economic environments, enterprises are constantly rethinking their entire product strategy, leading to Digital First products.

Products are being redesigned as "Digital First" to drive product and pricing differentiation. ***Today, smartness and intelligence features are not mere add-ons but are the fundamental elements of the product design.*** There has been a rapid transition of products from physical to smart to smart, connected products. This transition is rapidly creating a new suite of features by integrating the product with external ecosystems which is beyond the conventional functionalities. For instance, an airbag was just a safety component earlier, but today it acts as a crash monitoring system that can predict injury (of driver and passengers of the vehicle) and automatically notify emergency services.

These smart connected products are capable of many functions such as monitoring, controlling, optimizing, and providing autonomy. These products enable enterprises to offer differentiated value propositions to their customers while increasing product lifespan and customer loyalty.

Here are few examples of smart products/solutions:

Hitachi ABB's Smart Digital Substation

Hitachi ABB Power Grids recently launched "Smart Digital Substation", which employs digital technology to provide actionable insights and visibility into asset performance, maintenance history, workforce, and resource location to improve productivity, ensure worker safety, and cost optimization.[20]

Bosch's Interior Monitoring Systems

Bosch's "Interior Monitoring System" enhances safety, comfort, and convenience for all vehicle occupants. Using a combination of sensors, cameras, actuators, software, and processing modules, the system monitors the driver, occupants, and vehicle interior parameters to increase safety and provides optimal user experience. This is a modular, scalable, and cost-efficient solution platform that seamlessly integrates into existing systems. It offers a high degree of flexibility to vehicle manufacturers when adapting to different requirements and vehicle types.[21]

Honeywell's Small and Medium Building Administrator

Honeywell has launched "Small and Medium Building Administrator" - a plug and play solution. This solution aggregates data wirelessly from several devices such as a colour touchscreen thermostat, a smart IO module, and wireless sensors, into a cloud-based dashboard to provide insights on occupant comfort, operational productivity, building energy optimization, and portfolio management.[22]

Medtronic's The Guardian™ Connect CGM System

"The Guardian™ Connect System" continuously measures an individual's glucose levels through a sensor and transmits the data to the user's phone. The Guardian™ Connect App provides users with their glucose levels, trends, and history. The app is connected with a CareLink™ Connect platform that provides anytime access to individuals' glucose levels and sends alerts through text messages to the individual's family members/caretaker.[23]

[20] *https://www.hitachiabb-powergrids.com/in/en/news/global-news/press-releases/hitachi-abb-power-grids-drives-digital-transformation-of-the-power-sector-with-new-smart-digital-substation*

[21] *https://www.bosch-mobility-solutions.com/en/solutions/interior/interior-monitoring-systems/*

[22] *https://inbuildingtech.com/smart-buildings/honeywell-launches-new-solution-for-small-and-medium-sized-buildings/*

[23] *https://www.medtronic-diabetes.in/products/guardian-connect*

Adoption of Industry 4.0 and convergence of IT-OT

Faced with ever-evolving and dynamic customer demands and the pressure of ongoing economic uncertainty – global enterprises are turning to digital transformation to pursue the new era of engineering and manufacturing. Enterprises are implementing Industry 4.0, enabled by IT (Information Technology) and OT (Operational Technology) convergence, to streamline their operations, ensure faster time to market, meet dynamic demands, and ensure an efficient supply chain.

Traditionally the IT and OT systems operated in silos, where OT was considered hardware-oriented and more focussed on reliability to manage machines. In contrast, IT was deemed software-centric to manage business processes such as payroll, financial planning, inventory management, and procurement. The siloed approach of IT and OT lacked a holistic view of business and operations processes to make faster and informed business decisions. However, in recent years, the move towards smart factories and smart enterprises has led to the convergence of IT and OT systems creating robust, smarter, and efficient operations powered by real-time analytics and predictive modelling.

Industry 4.0 is assisting manufacturers meet the business imperatives of the future by creating smart, connected enterprises that support quick and informed decision making, eliminates unplanned downtime of machinery, streamlines processes to optimize costs, manages inventory, and integrates it with suppliers.

Convergence of IT-OT enabled Daimler Trucks to make faster decisions

Daimler Trucks North America combined its IT and automation network into a single and secure environment to get real-time data visibility. This environment enabled the business leaders to make faster decisions for efficient operations, conduct remote equipment troubleshooting to reduce unplanned downtime, and meet customer demands.[24]

Tesla's Gigafactory: Machine building Machine

Tesla has multiple Gigafactories at Fremont, Reno in the US and Shanghai in China that produces Tesla's cars, battery packs, and other energy storage products. All the factories have incorporated a high degree of automation into the manufacturing and assembly process to achieve unprecedented production speeds. Human intervention is required only to maintain and upgrade the machines and deal with anomalies. The production and assembly floor has highly sophisticated, complex and synchronised robots, and machines to perform each task with higher precision and speed. Robots like Autonomous Indoor Vehicles (AIV) can safely navigate the factory floor using digital maps and avoid people/obstacles by detecting them with their sensors to transfer materials between workstations. Similarly, heavy-duty robotic arms are used for assembling purposes.[25] [26]

[24] *https://www.cisco.com/c/dam/en_us/solutions/industries/manufacturing/ITOT-convergence-whitepaper.pdf*

[25] *https://interestingengineering.com/teslas-video-from-inside-its-shanghai-gigafactory-is-a-peek-into-the-future*

[26] *https://electrek.co/2016/07/31/tesla-gigafactory-robots-machines-battery-factory/*

Schneider Electric's smart and integrated factory in Lexington

Schneider Electric's Smart and Integrated Factory in Lexington, that produces load centres and safety switches, is recognized by the World Economic Forum for leading the way in smart manufacturing and designated as Advanced 4th Industrial Revolution (4IR) Lighthouses.

The introduction of Industrial IoT (IIoT) technologies has boosted the plant process efficiency and overall market competitiveness by revolutionizing and reinventing the plant's control, monitoring and management, and business processes. In the process, it has removed siloed data, making it available to the entire team in an easily accessible manner. Connectivity and integration were pivotal to the plant's transformation into a Smart and Integrated Factory.

Schneider Electric leveraged its in-house open, interoperable, IoT-enabled system architecture and platform called EcoStruxure. The architecture provides cloud and edge control technologies needed to enable advanced connectivity, high efficiency, and modern human-machine interfaces for a mobile workforce so that the factory could more effectively compete in the marketplace.[27]

Business impact

The implementation of Industry 4.0 has led to the following results:

- Reduced mean time to repair by 20 percent.
- Reduced system downtime by 5 percent.
- Saved year-on-year energy usage by 3.5 percent.
- Eliminated paper processes.
- Two-year return on investment.

Speed and agility in innovation

Speed of innovation is of the essence for enterprises to achieve a sustainable competitive advantage in today's environment and evolving consumer demand. Accelerating innovation is essential for an organization's growth and for it to remain competitive.

Innovation alone cannot benefit an organization in current times. The pace or velocity of innovation is also critical in determining the success of an organization. The importance of speed of innovation is visible in the way digital natives and start-ups have grown in recent years compared to large enterprises. Innovative start-ups, with more rapid and agile innovation processes, have gained compound returns and exponential growth, in contrast to their larger industry peers.

[27] *https://download.schneider-electric.com/files?p_enDocType=Customer+success+story&p_File_ Name=Schneider+Electric+Lexington+Smart+Factory.pdf&p_Doc_ Ref=998-20655256_GMA-US*

Leading enterprises have adopted agile processes for faster innovation, market entry, and scaling in their quest for speed of innovation. Organizations are tapping into digital technology to innovate faster with optimized resources.

Ford: 10x reduction in product development time

By adopting design thinking principles and agile methodologies, Ford reduced the product development time for Maverick, a compact pickup truck, by two years. The product development team maintained a problem-solving approach and different strategies leading to 10x acceleration in product development time from six to eight weeks incremental improvements.[28]

The Ford team adopted the following strategies:

- Agile methodologies to develop hardware at the speed of software development.
- Worked in four to six weeks long sprints to foster creativity and innovation.
- Used virtual collaboration tools and operated in a large, open, and physical workspace.
- Ensured data transparency and no siloed information.
- Instilled a mindset of iterative experimentation.

SiO2 Materials Science: Pandemic-led speed in innovation

SiO2 Materials Science, a medical products company, created a microscopic layer of medical-grade glass inside plastic vials leveraging plasma technology and scaled production to 10 million vials/month in 90 days to address the shortage of glass vials needed for COVID vaccine transportation. It would have taken 18 to 24 months for any other organization to achieve such a scale in production.[29]

Optimize engineering spend through digital engineering R&D

The emergence of fast-evolving customer needs, disruptive start-ups with innovative business models, and demand for reduced time to market are challenging the traditional product development lifecycles. The older and linear approach to product design is replaced by a dynamic system that focuses on creating continuous feedback loops. Through backward integration and analysis of product usage data, manufacturers are continuously improving their product design and R&D efforts to deliver more successful products in a shorter time frame.

[28] *https://deloitte.wsj.com/cmo/2021/06/08/ford-disrupts-product-development-for-a-new-era/?mod=Deloitte_cmo_editorschoice*

[29] *https://www.fastcompany.com/90600241/manufacturing-most-innovative-companies-2021*

Over the years, organizations have leveraged digital tools and technologies such as Computer Aided Design (CAD) tools, Product Lifecycle Management (PLM), and other software development platforms. However, with the emergence of smart and connected products, paired with the increasing complexity of the products, organizations are increasingly spending on digitalization efforts to streamline the entire product development lifecycle process.

As per a Kearney report, digitalization of R&D increases the efficiency in the requirements, hardware and software design, and testing phases by 15 percent, 30 percent, and 50 percent, respectively for manufacturing and industrial organizations.[30]

As per a survey done by PwC in 2019 consisting of 200 industrial companies in Europe found that by 2025 the digital product development strategy will increase the overall efficiency by 19 percent and reduce time to market by 17 percent.[31]

As components evolve into systems, integrating and testing sub-systems is becoming a challenge. Continuous integration techniques are being used to ensure product information is consistent and complete and to minimize late change requests. The growing complexity of the system as a composition of mechanical, electrical, electronic, fluidic, thermal, and software domains is leading to infinite testing scenarios, that have necessitated the use of AI/ML techniques to simulate and test various methods in an accelerated manner.

Many global organisations realise the need for digitalisation of the product development life cycle and are taking necessary steps to address the same.

Volvo: Implementation of digital thread

For Volvo, high quality is a key differentiator for its products. It is working to implement a digital thread across manufacturing, design, and quality control to have a single source of truth that will help it respond to dynamic customer requirements and customize products accordingly. The digital thread was first piloted at Volvo group's truck operations division.[32]

Whirlpool: Enterprise-wide implementation of PLM solutions

With the enterprise-wide implementation of PLM solutions, Whirlpool could reduce overall product and system complexities while improving product lifecycle processes and making them efficient. In addition, it is experimenting with the concept of digital twins to enable faster validation of prototypes, increase the speed of innovation, and shorten the time to market.[33]

[30] *https://www.kearney.com/communications-media-technology/article/?/a/digital-r-d-when-the-model-becomes-the-product*

[31] *https://www.pwc.de/de/digitale-transformation/pwc-studie-digital-product-development-2025.pdf*

[32] *https://www.ptc.com/en/blogs/corporate/digital-transformation-examples-enterprise*

[33] *https://www.ptc.com/en/technologies/plm/digital-innovation/innovator-spotlight-whirlpool*

Electrolux: Deployment of digital R&D tools

Electrolux has implemented a digital R&D tool, enabling engineers at various locations to access and share information (technical documents, specifications, engineering changes, etc.) relevant to product development. This can help in optimized material resource planning. Moreover, the engineers are able to easily access the digital twin of the product master and modify it into customer-specific requirements for different markets. The company is also considering implementing a super twin, which can produce an overloaded product with all the possible product variations.[34]

Localization to access new markets

Localization is the key to success for global engineering enterprises seeking international market growth. As emerging markets offer huge growth potential, it is becoming critical for global enterprises to build and customize products to specific markets.

Understanding the behaviour, buying patterns, and needs of local consumers is vital to capture market share. Global organizations are increasingly considering entering into new markets by focussing on the localization of the value chain in the context of local sourcing and manufacturing, supply chain, sales, and services.

GE Healthcare's MACi – especially localised product for the Indian market

GE Healthcare developed MACi, a low-cost, battery-operated, easy-to-use ECG machine sold at a price point of INR 25,000, a 50 percent reduction compared to the actual GE MAC 400. MACi was specially developed in India by GE to meet the need for a cost-effective ECG machine by the Indian healthcare system.[35]

ŠKODA KUSHAQ – 95 percent localisation for the Indian market

The production of ŠKODA KUSHAQ (SUV) started in June 2021 at SKODA AUTO Volkswagen India Pvt Ltd (SAVWIPL) plant in Chakan, Pune. To achieve the desired localisation levels up to 95 percent, ŠKODA set up a new MQB-A0-IN production line at its Pune plant. The MQB-A0-IN platform is a locally developed platform specifically designed to meet India's stricter safety and emission requirements. The platform provides the technical basis for the new ŠKODA KUSHAQ. The technology centre opened in Pune in January 2019 contibuted to a significant part of the development.[36]

[34] *https://www.pwc.de/de/digitale-transformation/pwc-studie-digital-product-development-2025.pdf*

[35] *https://economictimes.indiatimes.com/how-ge-got-out-of-the-ge-way-to-create-the-nano-of-ecgs/articleshow/7673404.cms?from=mdr*

[36] *https://www.skoda-auto.co.in/news/news-detail/start-of-production*

Global organizations have realized the value and business impact of localization to access new markets. Engineering R&D plays a crucial role in the customization of products as per the local market's needs.

Security becoming focal point for organizations' success & credibility

As per a Gartner forecast report, the spending on information security and risk management services will touch USD 150.4 billion in 2021.[37] ***In 2020 alone, more than 3,932 data breaches where reported which compromised over 37 billion records.***[38] Rising threats of cyber-attacks and regulations have compelled organizations to strengthen their cyber security measures, thus leading to the emergence of cyber security as one of the most critical focus areas for organizations.

Smart connected products, the convergence of IT and OT, and the shift to Industry 4.0, etc., have made organizations vulnerable to numerous cyber threats, including data breaches, hacking, industrial espionage, unauthorized access to sensitive information, etc., resulting in overwhelming financial losses. Additionally, IP theft can lead to endless legal disputes for an organization and can dilute its brand image as well.

For example, Renault Nissan experienced a cyber-attack in 2017 involving WannaCry ransomware, which halted the production at its five plants. Recently, aircraft manufacturer Bombardier experienced a cyber-attack, that compromised personal and other confidential information relating to its employees, customers, and suppliers.

Tackling cyber-attacks, protecting IP, and avoiding data breaches are increasingly becoming a priority for organizations.

Heightened emphasis on sustainability

Rising concerns on climate change, global warming, and pollution have led organizations to increasingly embrace sustainable business strategies with a high focus on environmental, social, and governance (ESG) goals. The heightened emphasis on sustainability has led to the emergence of new business models and opportunities for organizations.

Multiple organizations are realizing the benefits of sustainability and taking steps to implement a circular economy-based business model. ***There is a rapid shift from the linear business model, which involves "take-make-waste", to the "circular economy" based business model.*** The focus is on eliminating the concept of end-of-life product disposal and replacing it with restoration while eliminating waste. The circular economy principle involves 6Rs: Recycle, Repurpose, Refurbish, Remanufacture, Repair, and Reuse.

[37] *https://www.gartner.com/en/newsroom/press-releases/2021-05-17-gartner-forecasts-worldwide-security-and-risk-managem*

[38] *2020 Year End Report - Data Breach QuickView, RiskBased SECURITY, 2021*

French-based Schneider Electric's commitment to sustainable development

Schneider Electric uses recycled content and recyclable materials to prolong product lifespan through leasing and pay-per-use and has introduced take-back schemes into its supply chain. It has helped its customers to save 134 million metric tons of CO_2 since 2018. Through its ECOFIT and take-back programs, Schneider Electric avoided 157,000 metric tons of primary resource consumption in 2020.[39]

RE: Factory

Groupe Renault has established RE: Factory, Europe's first circular economy dedicated factory for vehicles. The factory intends to create mobility solutions with a negative CO_2 balance by 2030 while at the same time generating employment for 3,000 people.[40]

The emergence of new carbon-removing technologies such as decarbonisation, is helping organisations reduce carbon emission, reuse captured carbon for different engineering/manufacturing processes, and generate value. These techniques are assisting many organisations to go carbon negative, which is of utmost importance in today's degrading climatic conditions.

With the evolving global market trends, enterprises worldwide are adapting to new Engineering R&D imperatives to stay competitive and deliver differentiated value to their customers.

[39] *https://download.schneider-electric.com/files?p_Doc_Ref=SustainabilityReport2020EN#page=7*

[40] *https://www.renaultgroup.com/en/news-on-air/news/re-factory-the-flins-site-enters-the-circle-of-the-circular-economy/*

ENGINEERING R&D: ADVANTAGE INDIA

This section discusses the Engineering R&D landscape of India and the value propositions it has to offer to global enterprises.

- Overview of Indian Engineering R&D
- Strategic Business Impact
- Innovation Excellence
- Talent Excellence
- Service Delivery Excellence

ENGINEERING R&D: ADVANTAGE INDIA

Overview of Indian Engineering R&D

Over the years, India has emerged as the destination of choice for the global Engineering R&D segment. Home to the world's best Engineering R&D organizations and one of the best-in-class talent, India holds the key to drive the Engineering R&D innovation of the future.

Currently, Indian Engineering R&D sourcing market accounts for nearly 34 percent of the global sourcing. The Indian Engineering R&D market is projected to grow at a 12 percent CAGR to reach USD 63 billion in 2025 from USD 31 billion in 2019.

The global enterprises operating across automotive, aerospace, consumer electronics, medical devices, industrial, energy, semiconductor and telecom industry verticals are spearheading this growth by tapping into Indian Engineering R&D's ability to leverage the think-force of the future for powering innovation and driving high impact service delivery.

India's Engineering R&D landscape comprises Global Capability Centres (GCCs), Engineering Service Providers (ESPs), Start-ups, and India-based manufacturing companies.

GCC landscape in India

The total number of GCCs in India is growing at a rate of 20 percent since 2015. India has come a long way from being an offshore centre for support to a hub for product innovation driving end-to-end ownership for global enterprises. Today India is home to over 1,430 GCCs across verticals that employs over 1.3 million people. Engineering R&D is leading the GCC growth story of India with 55 percent market share. The revenue from GCCs is expected to reach USD 35.9 billion by 2021 from USD 33.8 billion in 2020. Continuing the GCC growth story, India is expected to have over 1900 GCCs, employing over 2 million people by 2025.[1]

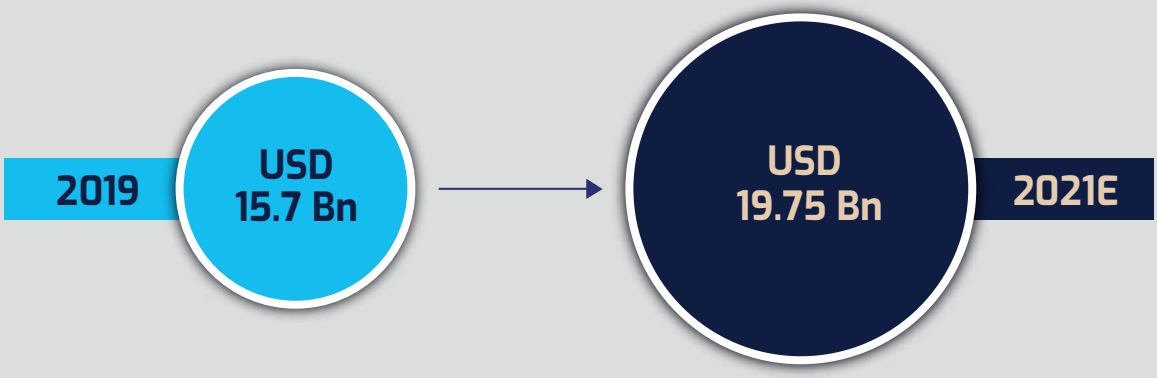
As of 2020, more than 180 innovation centres in India belong to Fortune 500 companies, and 48 out of the top 50 Engineering R&D spenders have their centres in the country, reiterating India as a destination for engineering and innovation.

GCCs in India: At Glance

Total number of GCCs in India (as of FY 2021)	*Expected annual revenue from GCCs in FY 2021*	*Total number of employees (GCC)*
1,430+	**USD 35.9 billion**	**1.3 million+**

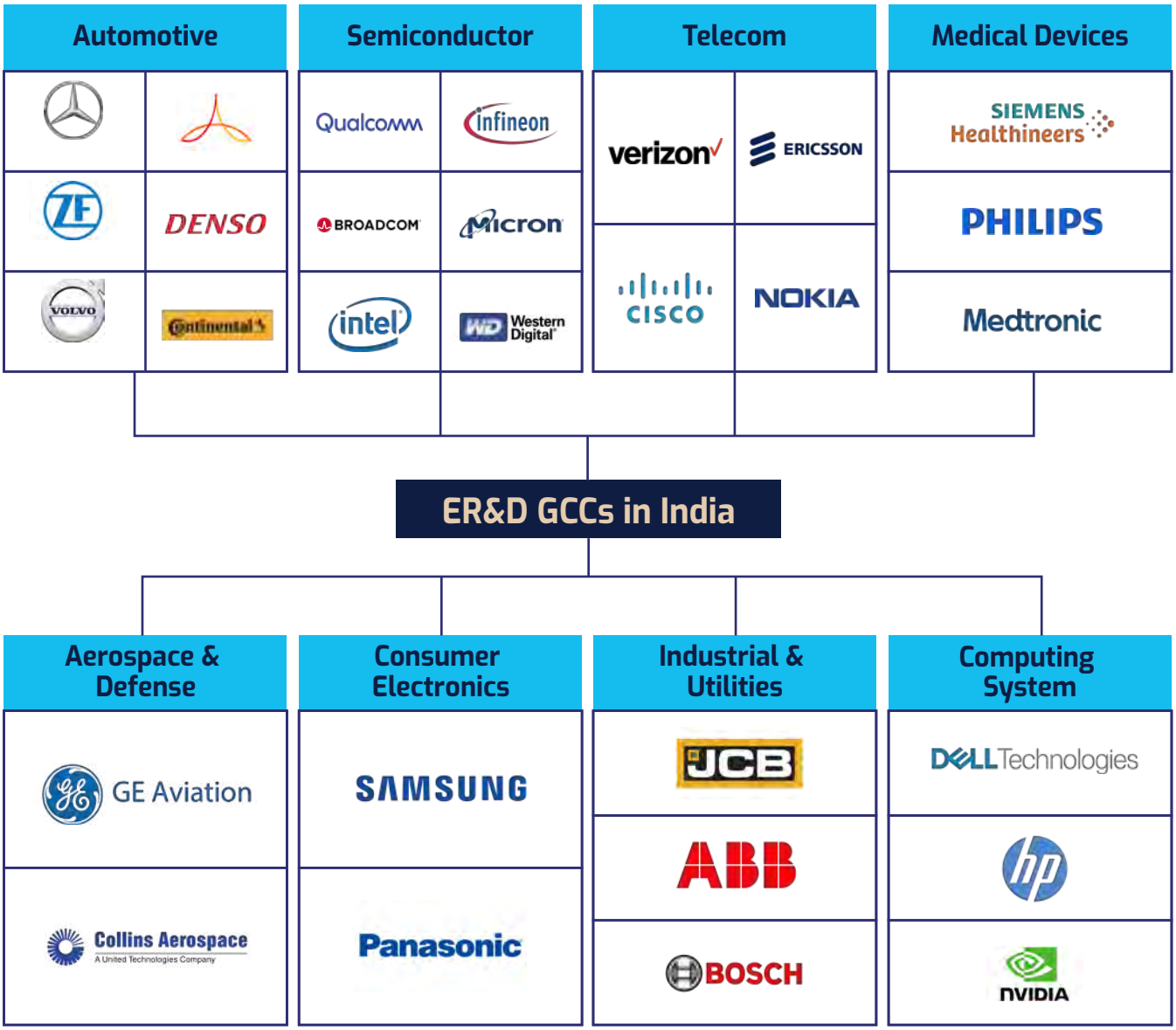
[1] *GCC India Landscape 2021 & Beyond, Zinnov- Nasscom, September 2021*

Market Size of Engineering R&D GCCs in India



Industry vertical-wise GCCs in India

<illustrative/not exhaustive>



HQ-wise distribution of GCCs in India

Region	Percent of GCCs in India
Americas	~65 percent
Europe, Middle East, and Africa	~25-27 percent
Asia Pacific (APAC)	~7-10 percent

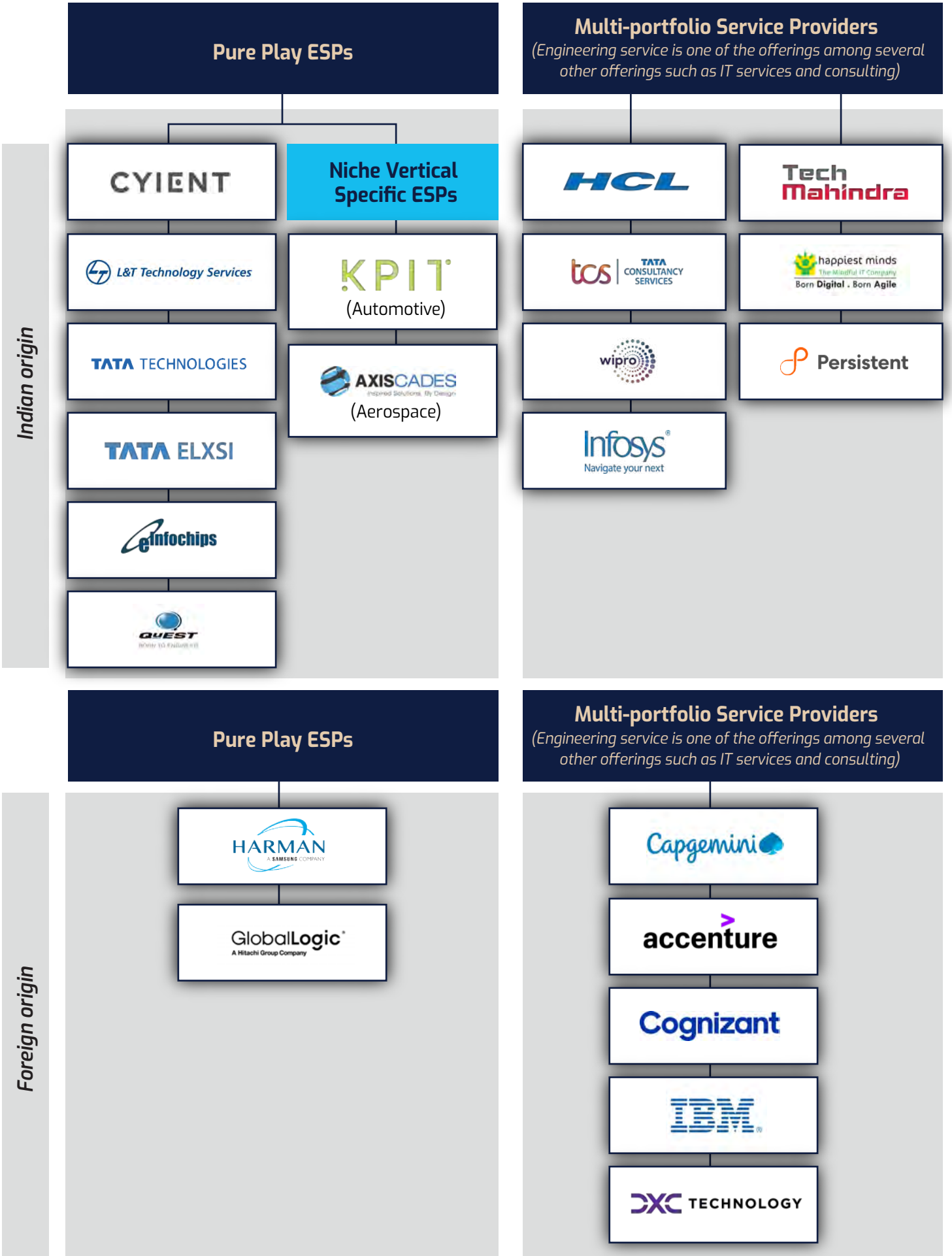
ESP landscape in India

In addition to GCCs, India is home to multiple ESPs working seamlessly to deliver differentiated services to their global customers across locations. The two broad categories of the ESPs in India can be:

- Pure play ESPs: Service providers who focus only on engineering services.
- Multi-portfolio Service Providers: Service providers who provide engineering services in addition to IT services, consulting, etc.

ESPs in India: At Glance

<illustrative/not exhaustive>



Start-up Landscape in India

India currently has the third-largest ecosystem globally for start-ups, with close to 11,000-12,500 tech start-ups incepted between 2015 and 2020. The Indian landscape is exceptionally vibrant, and there is a rapid increase in the number of start-ups working on deep tech and niche tech in the past couple of years. Indian entrepreneurs have developed their India-specific business models to suit India's unique challenges. The maturity of the entrepreneurs and investors has also become world-class, as evidenced by the complexity of the solutions created by second-and third-time founders. India is steadily emerging as a unicorn hub with 12 unicorns in 2020 alone.[2]

[2] *Indian Tech Start-up Ecosystem – On the March to Trillion Dollar Digital Economy, NASSCOM-Zinnov, January 2021*

INDIA'S KEY VALUE PROPOSITIONS

Strategic Business Impact

- Driving end to end ownership of products
- Enabling localization of products to tap into vast market opportunities
- Accelerating market access by co-location of Engineering R&D and manufacturing facilities in India
- Execution of global leadership roles by Indian Engineering R&D leaders

Innovation Excellence

- Driving innovation with business and societal impact
- Deploying policies and undertaking initiatives to foster innovation
- Increasing contributions by Indian GCCs/ESPs towards global patents and researches
- Leveraging the robust ecosystem of India for co-creation

Talent Excellence

- Addressing the scalability needs of global enterprises
- Increasing investments by the Indian Engineering R&D ecosystem in upskilling and reskilling programs
- Creating a strong pipeline of talent through presence of a robust university ecosystem

Service Delivery Excellence

- Driving best-in-class service excellence via solution accelerators
- Implementing robust business continuity plans to ensure on-time and seamless service delivery
- Ensuring IP protection
- Creating service delivery differentiation via deployment of new business & engagement models

LEADERSHIP INTERVIEW

LEADERSHIP INTERVIEW

Mr. Ken Kang

SAMSUNG

Samsung South West Asia President & CEO

From a global perspective, how has Samsung delivered strategic impact (e.g., competitive differentiation, revenue growth, technology, market access). Samsung has completed 25 years in India. Over the years, how has the role of R&D centres evolved in terms of fostering innovation for Samsung?

Samsung came to India in 1995, and we believed in the India story right from the beginning. That is why Samsung set up its first manufacturing facility in Noida and first R&D centre in Bengaluru in 1996, just a year after entering the country. India has grown since then, and we have grown with the country.

The world's largest mobile factory in Noida, the world's largest mobile experience centre, three R&D centres, and one of the largest retail networks spread across 200,000 retail points is a testimony to our commitment to India.

Over the last 25 years, our R&D facility in Bengaluru, Samsung R&D Institute Bangalore (SRI-B), our largest R&D centre outside Korea, has contributed to research around 3G, 4G, 5G networks as well as camera technology over the years.

These R&D centres have also worked on made in India innovations that better address the needs of Indian consumers. Take, for example, Curd Maestro refrigerators, the world's first refrigerators that can make curd. This was developed based on consumer insights around the pain points of daily curd making. Consumers have loved these innovations over the years, allowing us to lead in the market.

India is known for the availability of large and diverse talent. What are your views on the available talent in SRI-B and India? How do you think this talent has enabled Samsung to foray into new-age technology areas/create futuristic products and solutions?

India is known for its talent pool, and our R&D centre in Bangalore is an innovation powerhouse because of the top talent that we have. Samsung has three R&D centres in India with engineers working on cutting-edge technology areas such as AI, ML, semiconductors, wireless communication, and camera tech. Samsung is committed to R&D in India, and our engineers work closely with global teams to innovate for India and the world.

Over the years, our R&D centres have recruited talent from top Indian institutions such as the IITs and groomed them to work in cutting-edge technology domains.

We have built a strong innovation-driven culture that has enabled our engineers to file patents and papers across domains.

Over the last five years, around 80 percent of patents have been filed by Gen Z and millennial engineers who have filed patents for the first time in their careers.

What is your vision for Samsung in years to come?

At 25, Samsung India is as young and vibrant as New India. Millions of our consumers, partners, and employees have loved Samsung over the years to make us the country's biggest, most trusted, and most admired brand of mobile phones and consumer electronics, with almost every home in India having a touch of Samsung. Our new vision of 'Powering Digital India' sets the course for India's future growth, in which Samsung will continue to be the country's strongest partner.

We are committed to work with the Government of India and various state governments to realize their vision of nation-building, digital inclusion, digital empowerment, and bridging the digital divide through multiple initiatives in manufacturing, R&D, creation of jobs and entrepreneurship, responsible citizenship, and transformational innovations.

As part of this new vision, we have a refreshed R&D strategy. Samsung's R&D centres in India will continue to work on advanced R&D areas such as 5G, AI, IoT, and cloud services and embrace end-to-end thinking to take projects from research to development to the commercialization stage.

In addition to this, we are expanding Open Innovation with startups, students, and universities to help strengthen India's innovation and startup ecosystem and augment its in-house innovation capabilities. The culture of innovation at Samsung R&D centres will allow thousands of engineers to create patents and leave their mark in the fields of technology and user experience.

LEADERSHIP INTERVIEW

Dr. Henk van Houten

Chief Technology Officer and Head of Philips Research, Royal Philips

Could you please shed some light on Philips' technology roadmap for the next decade (key new-age technology focus areas)? What role is the Philips Innovation Campus, Bengaluru, currently playing in advancing Philips's global technology and innovation charter?

Philips' purpose is to touch 2.5 billion lives by 2030. As a leading health-tech company, we focus on precision diagnosis, image-guided therapy, connected care, and consumer health providing care across the health continuum.

From a technology perspective, each of these areas will be moving forward in the next decade by adopting key concepts such as IoT, cloud, AI, and Big Data. All medical devices will be connected and provided with sensors generating functional as well as contextual data. Cloud-based solutions will enable tele-X approaches to radiology, pathology, and ubiquitous monitoring. AI will provide smart workflow solutions, quality control, and a degree of automation, taking out the more mundane repetitive tasks and freeing up precious clinical staff for higher value-added patient care. In combination with AI and automation, miniaturization will bring advanced technologies such as ultrasound imaging in the hands of less specialized staff, such as primary care physicians.

Philips Innovation Campus (PIC) plays a strategic role across all the areas mentioned above, creating customer-centric products & solutions, leveraging digital technologies, and advanced SW engineering. As PIC celebrates 25 years, it is shifting gears from an acknowledged software powerhouse to a Digital Solutions partner playing a key role in the solution transformation journey of Philips.

From a global perspective, how has Philips Innovation Campus, Bengaluru helped deliver strategic impact (e.g., competitive differentiation, revenue growth, technology, market access) to Philips? Could you highlight some success stories?

Philips Innovation Campus, Bengaluru, has helped deliver strategic impact through many of our New Product Innovations (NPI's). Some recent highlights include the Radiology Command Centre, our HealthSuite Digital Platform, digital solutions in the personal health space like oral healthcare, mother and childcare, AI-based applications in Image-Guided Therapy, Compressed Sense Solution for faster diagnosis, Mobile Obstetrics Monitoring Solution to manage high-risk pregnancies and many more. The Centre has extensive expertise in cutting-edge technologies and works on solutions based on AI and ML, telehealth, and cloud-based solutions.

In addition, Philips Innovation Campus, Bengaluru, is also the innovation hub for Philips International Markets (operating in Japan, MET, APAC, Africa, and India). Philips Innovation Campus, Bengaluru, has an established working model that leverages strengths across innovation & strategy and business teams, enabling value creation for our customers, scaling the solutions. This hub is ably supported by a front-end research team, creative design team, and a strong Intellectual Property & Standards (IP&S) group. It is also playing a vital role in addressing societal healthcare challenges by leveraging the ecosystem through strategic clinical partnerships with hospitals and academia, thus, combining the strength of Philips and our partners to co-create patient-centric healthcare solutions. Working in tandem with hospitals and academia, it is leading the efforts to move from a transactional relationship to focus on customer life-time value.

How do you see the role of Philips Innovation Campus, Bengaluru evolving in the coming years in context to Philips' overall mission and vision i.e., to make the world healthier and more sustainable through innovation, with the goal of improving the lives of 2.5 billion people a year by 2030? What is unique about Philips Innovation Campus, Bengaluru's role in driving innovation for Philips?

Philips Innovation Campus, Bengaluru, was started with an emphasis on software engineering. It is now becoming more and more a powerhouse for Philips digital innovation. What is unique is that PIC has R&D teams across Philips businesses under one roof. This is a crucial advantage, as Philips will need to innovate more and more across businesses to create the integrated solutions that our customers and the world's health systems require to improve outcomes at lower cost while reducing staff overload and improving patient experience. Future innovation is about platform-based SW, systems, and services design, with reusable HW and SW modules. In addition, more and more of our solutions will be delivered to our customers via the cloud, using XaaS based business models. This requires a DevOps way of working and a mindset of continuous customer value delivery. For all these topics, Philips Innovation Campus, Bengaluru, will play a pivotal role in leading Philips into the future. It is also one of our global innovation hubs chartered with facilitating innovation with our Market Organizations in India and surrounding countries (Africa, MET, Australia, Japan). For example, in India, PIC is focusing on access to care and working on affordable solutions.

India has a robust ER&D ecosystem. How do you plan to leverage India's ER&D ecosystem and large talent pool to meet Philips' future business and technology strategy?

The talent pool and ER&D ecosystem in India will be leveraged through PIC in Bengaluru, as well as our engineering and manufacturing site in Pune – both sites being positioned for future growth in state-of-the-art facilities. In addition, we are increasingly collaborating with partners in India – from suppliers to customers and solution partners. Our focus is on hiring talent across scalable platforms, digital technologies like cloud, edge, AI, cyber security, enterprise solutions, and more. We are also keeping a close eye on the evolving start-up community in India through our Ventures branch (Philips HealthTech Ventures).

LEADERSHIP INTERVIEW

Tanja Rűckert

BOSCH

Chief Digital Officer, Bosch Group

Digitalization is a mega-trend that is proliferating across industries. In this context, what does "digitalization" mean for Bosch, and what is RBEI Bangalore's role in defining and executing Bosch's digital strategy?

For Bosch, digitalization is a huge and exciting opportunity to keep customer focus at its core. Step by step, we are evolving from a traditional hardware manufacturer into a data-based AIoT company that connects products in all domains and continuously makes them smarter– in mobility, industrial technology, consumer goods, and building and energy technology.

In recent years, we have created the technological, organizational, and structural basis for this. For example, we have established the Bosch Centre for Artificial Intelligence, set up an AI training program for more than 20,000 associates, and introduced the Bosch AI code of ethics. This exciting phase of our pioneering work is now complete. Our sole focus will be on consistently applying AIoT in our products and business models in the years to come. We want to provide value for our customers and users with AIoT – combining AI and IoT – and become a leading global AIoT company.

One example of this application of AIoT is our self-learning AI sensor for fitness trackers, which allows sports watches, for instance, to be personalized to their users and to learn new things constantly. Another example is the connected car, which enables drivers to control their smart homes by voice command.

Robert Bosch Engineering and Business Solutions (RBEI) plays a pivotal role in our digitalization strategy. Its sensors, software, and services portfolio are relevant for many units in our mobility solutions, industrial technology, and consumer goods business sectors.

Apart from carrying out IT and digital projects for customers within Bosch, RBEI also performs enterprise-wide digital and business transformation projects for external clients. Its experience working with other Bosch Group entities and its expertise are valuable assets in the global marketplace.

Considering the accelerating focus on digitalization, there is an increasing demand for talent skilled in digital/new-age technologies. India, on the other hand, is known for its availability of highly skilled talent. So, in your view, how well-poised is India and RBEI Bangalore to address the digital talent demand?

The Indian talent market is undoubtedly burgeoning – not just in the core sectors of

economy but also in advanced technologies. A recent report by NASSCOM indicates that India's IT-ITES talent base has been growing annually by 20 percent. The country now has 260,000 cloud computing professionals along with 185,000 professionals in each of the areas of big data, analytics, social media, and mobile platforms, and more than 170,000 IoT-trained professionals. Moreover, demand for digital talent is expected to increase at an average annual growth rate of 35 percent between 2019 and 2023.

RBEI has more than 21,000 skilled technologists and cross-domain experts working in diverse fields such as data science, AI, blockchain, Industry 4.0, embedded engineering, cloud, and cyber security across industries such as automotive, hi-tech, manufacturing, agriculture, healthcare, and home appliances. Within RBEI, we have set up many skill development programs to provide our associates with structured platforms for learning advanced technologies such as AI and ML. This is in line with RBEI's ***#FitForFuture*** strategy. Today, over 10,000 associates have already been certified in the AI program, and another 1,200 associates have qualified as expert practitioners in either AI, ML, data, or IoT. With its growing number of partnerships with universities of repute, RBEI is also creating opportunities for further research alliances with the academic world.

How do you see the role of RBEI evolving in the coming years in context to Bosch's overall mission and vision?

Software is and will continue to be one of our USPs. It is what will keep us ahead of the competition and allow us to continue to provide our customers with solutions that are "**Invented for life**." We are using IoT and AI to merge the physical and digital worlds. RBEI is at the forefront of the AIoT journey that Bosch sees itself pursuing on a global level. Through its software and engineering capabilities, extensive skills base, and global reach, thanks to delivery centres located in India, Vietnam, Mexico, and Poland, RBEI is an invaluable partner for all Bosch operations. In January 2021, RBEI created a new business unit - known as Software and Digital Solutions (SDS) that will focus on the direct marketing of digital business offerings. The SDS portfolio is geared to future demand, whether for IoT solutions such as network-connected intelligent products and digital twins or AI and data science, automation, Industry 4.0, core business transformation, and so on.

Our vision for 2025 is that all our products and solutions will either feature AI or AI will have been used in the process of creating them. With RBEI's help, we are already well on the way to achieve it. Customer and user-centricity are at the core of everything we do – whether products, solutions, or services. RBEI will continue to develop the talent and skills needed to make this vision a reality and provide solutions for the enterprises of the future.

In your view, when it comes to Bosch's GCCs worldwide, what unique factor sets apart RBEI Bangalore?

Each Bosch GCC is unique in terms of its context and customers. With regards to RBEI, Bosch has reinforced its capabilities by tapping into one of the world's most extensive software talent hubs and added significant value to the organization by cultivating future-oriented niche skill sets. RBEI's global delivery network is the basis for seamless delivery at scale to our customers worldwide. The breadth of available talent, a vast range of project expertise, and an innovation-driven start-up culture puts RBEI in a unique position of strength.

India has a robust Engineering R&D ecosystem. How do you plan to leverage India's Engineering R&D ecosystem to meet Bosch's future business and digital strategy?

According to a recent report by NASSCOM, the Indian ER&D space is expected to grow to USD 63 billion by 2025. Growth is also expected to come from automotive,

aerospace, consumer electronics, machinery, and semiconductors, where India is becoming an engineering & design hub. With strategic partnerships such as the **DNA_Nxt Start-up Alliance program**, which aims to nurture promising start-ups in RBEI's focus sectors and focus on the competencies needed for advanced technologies, we expect growth to pick up on the back of India's robust Engineering R&D ecosystem. RBEI's exposure to projects in these industries will allow us to continue to utilize this opportunity to create additional benefits for our customers.

What is your vision for RBEI in years to come?

There is no set blueprint for the transformation at Bosch. Instead, it is unfolding in an agile process and differs from business area to business area. Common to all these endeavours is the goal to provide the best technology and customer solutions invented for life. RBEI's continued focus on sensors, software, and services means it will continue to play a key role in realizing this Bosch vision and be the nerve centre of expertise and engineering for internal and external needs. In addition, I would also mention the following four strengths at RBEI:

- Agility that helps it adapt nimbly to changing market dynamics
- Competitiveness that allows it to deliver the best solutions for our customers
- Customer-centricity that is at the core of all the projects it carries out
- An evolving talent landscape that is continuously being upskilled, keeping the workforce fit for present and future requirements.

LEADERSHIP INTERVIEW

Christin Eisenschmid

MD, VP, and General Manager, Intel Germany

What role has Intel's India Centre played in driving strategic business impact for Intel?

Intel India has been accelerating innovation and advanced engineering in the country over the last 22 years. Today, it is Intel's largest design and engineering centre outside the US, with state-of-the-art design facilities in Bengaluru and Hyderabad. Intel has invested over USD 7 billion in India to date and continues to expand its R&D and innovation footprint in the country.

Intel India plays a strategic role in Intel's growth, with significant contributions to Intel's technology and product leadership. Intel India is engaged in cutting-edge engineering work such as SoC design, 5G networks, graphics, software, and platform for the data centre, client, and IoT markets involving advanced technology areas like AI, 5G, and autonomous systems.

In addition to engineering programs, Intel India has been working with the vibrant technology ecosystem, including industry, start-ups, academia, and government in the country. It is committed to accelerating innovation, research, technology advancement, and adoption to improve people's lives.

What are some of the high-impact engineering initiatives delivered by the Intel India Centre? Can you share few examples with us?

Intel India has been contributing to several generations of Intel's leadership products across client, server, IoT segments. Alongside our global teams, engineers in India make significant contributions to design and engineering, with a few recent examples being the 11th Gen Intel® Core™ processor (code-named "Tiger Lake") for the client segment and 3rd Gen Intel® Xeon® Scalable Processor-based on 10 nm (code-named "Ice Lake") for the data centre.

In addition, innovations from the India team have contributed to several key technologies, including Intel's Foveros 3D packaging technology, innovative form factors for client products such as dual screen, and core IP for the AI inferencing product.

How has the talent in India helped Intel to bring agility and velocity in innovation and product development?

Since the inception of our innovation and engineering journey in India, we have been constantly encouraged by the growing capabilities of technical talent in India. This has enabled the growth of Intel India's engineering footprint and our ability to contribute to Intel's leadership products and innovative technologies. In addition to Intel's design facilities in India, we also leverage the local R&D ecosystem to further innovation and engineering.

Intel deeply values and is committed to collaboration with the government, academia, and industry to develop world-class engineering talent in the country.

Intel has made strategic investments in India to date and continues to expand its R&D and innovation footprint in the country. What is your vision/plan for the Intel India Centre?

Intel India is a microcosm of Intel with the growing presence of key engineering groups here. It's a critical engineering centre to help Intel realize its purpose of creating world-changing technology that improves every person's life on the planet.

I see Intel India reaching greater heights with its engineering prowess by delivering breakthrough technologies and innovations, enabling leadership products for Intel across clients, data centre, IoT, 5G, and AI through engineering excellence. We are at the forefront of innovation, bringing together the ecosystem to collaborate and accelerate technology adoption for India's digital transformation.

LEADERSHIP INTERVIEW

Marco Croci

SVP, Systems & Optics

Could you please share your views on Cisco's future technology roadmap for next decade in the context of your Business Unit (BU) /Cisco? What role is the India centre playing in advancing the global technology and innovation charter of your BU?

There is an unprecedented opportunity of technology innovation in the areas of Silicon, Optics, Software, and Systems for the Internet for the Future. We continue to see increasing growth in internet data driven by worldwide demand for Video, Cloud, 5G, and IoT enabled devices. Cisco plays a significant role in simplifying end to end connectivity between users through its vast portfolio of networking, security, and automation products. From the access layer to the core of the network, Cisco continues to modernize the network to transform economics and bring a new era of network experiences for our customers.

Our BU in Cisco India plays a vital role in the advancement of global technology and innovation across various areas of networking. Our business unit in India is one of our major centres of innovation, product development, and extended support.

Could you please highlight some success stories delivered by the India Centre with respect to your BU?

Our India team has come a long way in Cisco's journey of technology, innovation, and product development. Initially, the India team was a contributor to product development, which was owned by the other teams around the globe. Today, our team in India owns the entire product development lifecycle for certain product families of Service Provider Routing solutions. Having our engineering, product leadership, and support teams in India makes us more efficient and agile to customer needs.

India is known for the availability of large and diverse talent. How do you think this talent has enabled Cisco to foray into new age technology areas/create futuristic products and solutions?

Cisco places tremendous value on the availability of skilled resources in India for functional areas of hardware systems development, silicon development, and software development. Cisco continues to leverage the India Centre to work on futuristic product development with the opportunity for innovation and technology growth.

What is the roadmap you have envisioned for the India Centre regarding your BU?

Our business unit in India for Service Provider Routing would continue to focus on key technologies enabling solutions such as 5G, mobile back-haul, aggregation/core routing to transform networking for our customers.

LEADERSHIP INTERVIEW

Scott J. DeBoer

Executive Vice President, Technology and Products, Micron Technology

Could you please share some context on Micron's Product & Technology roadmap (key new-age technology focus areas and futuristic products) for the next decade?

We're very proud that, for the first time in our history, Micron has technology leadership in both DRAM and NAND simultaneously. This is the result of accelerating our technology roadmap in DRAM and NAND over the past few years and our laser focus on memory and storage technologies. Now that we are leading the industry in technology capability, going forward, we expect to maintain this competitive position through a more typical cadence for node transitions consistent with the rest of the industry.

For applications, there is a classic performance vs. capacity/cost triangle for memory and storage technologies. DRAM is located at the top of the triangle, which is optimal for latency and endurance for the most demanding volatile applications. At the base of the triangle are flash technologies (TLC, QLC) which are optimal for block storage applications. With a combination of innovative designs and massive capital investment, we see DRAM and NAND continuing in their roles at the top and bottom of the hierarchy for the next decade.

That said, we continue to explore emerging memory technologies that have the potential to disrupt or augment the performance vs. capacity/cost landscape described above. Our research shows that DRAM, and advanced DRAM integrated products such as HBM, will continue for many years as an exceptionally reliable fit for low-latency applications. MRAM, such as STTRAM, can be suitable for embedded applications due to its easier integration with logic semiconductor processes. However, STTRAM has higher latency and energy than DRAM and lower endurance and has design implementation challenges in achieving density leading to a substantially higher cost than DRAM. As such, the industry adoption of Logic + STTRAM remains to be seen. Many RRAM varieties have been investigated over the years at Micron and by numerous startups and other competitors. RRAM, in general, offers lower latency block storage technology compared to NAND. However, it remains to be seen if the economics of the areal density will lead to broad market deployment. There are, of course, many other novel technologies that have some potential, and Micron is focused on ensuring that we are in a leadership position in terms of identifying and commercializing the best ones!

Earlier in 2021, we made a strategic pivot in our portfolio strategy with increased investment in new memory products that leverage the Compute Express Link™ (CXL™), the recently introduced industry-standard interface that enables flexible connection between compute, memory and storage. CXL has the potential to enable the use of both existing and new

memory technologies to provide new high-performance solutions to the data centres of the future.

Overall, it is an exciting time to be researching and innovating on many new memory technologies!

What are the areas where the India Centre has delivered strategic business impact (revenue growth, competitive differentiation etc.)? Can you share some success stories?

With the state-of-the-art lab infrastructure set up in both Bengaluru and Hyderabad, our India-based engineering teams have already been supporting and, in many cases, leading significant portions of ongoing product roadmaps across our entire portfolio. Furthermore, the teams have overcome pandemic-related operational challenges and successfully delivered critical projects over the last 18 months. We have an amazing team in India, and of course, we are very proud of the accomplishments they have enabled despite the challenges.

What are the unique strengths (highly skilled talent, innovation mindset, strong cultural orientation etc.) that India Centre has leveraged to deliver impact to Micron?

With 2,500 team members, Micron's India operation exemplifies our people value by investing and innovating in programs that attract and engage top talent. From day one, we have focused on building a creative, diverse, and inclusive team that can positively impact and influence our communities.

In India, we look to engage with talent early through Micron's University Research Alliance. We seed interest and enquiry into the frontiers of memory and storage design with students from 20 of India's top universities. Once we bring the talent on board, we leverage the strength of Micron's innovation ecosystem to nurture, develop and mentor every individual towards realizing their potential. With over 44,000 patents and several of the world's leading inventors like Micron veteran Gurtej Sandhu, we have a tried and tested method of helping our engineers innovate. We were ranked as the Best Place to Innovate by Zinnov Consulting last year and recently won Zinnov's Diversity & Inclusion Award in the category for women.

With a 28 percent diversity score for women, we rank above the industry average. Woman represent approximately 50 percent of our new college graduates in 2021 and a 92 percent retention rate for women over the last two years. A host of other measures have contributed to our diversity mix. While we have had some early wins, we are constantly looking at ways to drive fairness, provide equal opportunity, and champion equity. India's culture is a complex tapestry, so our leadership team works tirelessly to evangelize and contextualize Micron's core values in day-to-day operations.

How do you envision Micron's India Centre's contribution in the future with respect to Micron's technology roadmap?

Our teams in India have really done well in the first generation of product roadmaps that they have been involved with. We will double down on what has worked well, course-correct where needed, and look to deepen integration with Micron's global research and development network. As we begin to standardize our operational frameworks, a focus on execution excellence is paramount. As the various groups reach critical mass, I hope to see our India teams take on a more significant role and own product roadmaps from end to end.

LEADERSHIP INTERVIEW

Dean Halter

Executive Director, Engineering Effectiveness, Collins Global Engineering

What role has Collins India Centre played in driving the global engineering initiatives of Collins Aerospace?

Our Global Engineering & Technology Centre in India is an integral part of our mission as a company – **to redefine aerospace**. Collins is one of India's largest exporters of aerospace products, supporting major airlines, airports, and commercial manufacturers. Our Engineering Centre is a critical element of our dynamic engineering workforce and an essential product and technology development partner for all Collins' strategic business units, helping to propagate best practices across the organization and develop key solutions and technologies that redefine our industry.

What are some of the high-impact initiatives delivered by the India Centre?

Collins Aerospace India provides a wide range of systems services for key military and commercial aviation customers. High impact engineering projects include flight control and cabin systems, interiors technology development, landing gear, simulation and training solutions, power & controls general design/management, and more.

We were thrilled to be recently recognized for two key projects by NASSCOM's *Engineering & Innovation Excellence Awards 2021* as winners of **Next-Gen Product of the Year** (for the Wiper NT windshield wiper system for cleaning aircraft windows) and **Service Delivery Excellence of the Year** (for work on Ascentia® Analytics Services for prognostic health monitoring of aircraft systems).

What are the unique strengths of the India Centre?

We have a significant presence in India that is representative of products and capabilities across all of our strategic business units. The engineering team works closely with our large manufacturing facility to give customers and business units end-to-end project/program capability. This work supports multiple disciplines, including software, hardware, mechanical electrical/electronics, and skills like data analytics and AI/ML.

The diversity of capabilities and core competencies is a unique strength of our presence in India. It helps serve our large customer base with shorter times to market, lower program and project costs, and the highest quality innovative solutions. The team's immense technical knowledge, creativity, and diversity is reflected in the production of several hundred patents covering inventions across all Collins' business and disciplines.

During the pandemic, how did Collins Aerospace India manage business continuity?

During the pandemic and the resulting impact on the aerospace industry, we've shown our collective dedication and focus by coming together, remaining productive, and meeting customer needs by working in new and creative ways.

We adopted a "safety first" approach. We made rapid adjustments to put the needs of our employees first, including a large-scale transition to WFH and critical changes to protocols to support those working on-site, including many industry-leading policies and practices.

In addition to maintaining business continuity, there have been countless examples of our team stepping up to help in the fight against COVID-19 through financial contributions, on-site vaccination clinics for employees and families, donations of goods and supplies, and volunteering in local communities to support those in need.

Going forward, how does Collins Aerospace plan to leverage the India Centre?

India remains a growing and strategic market for Collins. We will continue to utilize our highly skilled global engineering workforce to develop the next generation of cutting-edge aerospace and defense solutions. Our focus lies in investing in maturing our capabilities and infrastructure for increased proficiency and domain knowledge and developing our people and culture to continue offering outstanding products and capabilities to support our partners across the entire aviation ecosystem. This includes working closely with our customers in India to build capability and structure to support the "Make in India" initiative and country indigenization goals.

LEADERSHIP INTERVIEW

Srinivas Siripurapu

Executive VP, Chief Innovation and R&D Officer, Prysmian Group

What role has the ESP Partner played in driving the global engineering initiatives of Prysmian Group?

Prysmian Group is the global leader in the energy and telecommunication cables systems industry. With a 140-year heritage of innovation, annual revenues of USD 13 billion, about 28,000 employees in over 50 countries, the Group has a strong focus to accelerate energy transition, digitalization & sustainability of our communities. We believe in an open innovation model to accelerate new product introductions collaboratively. We have built an innovation ecosystem with 50 top universities and research centres worldwide. We are glad to have Infosys as a member of this innovation ecosystem to drive new solutions to modernize the electricity grid for sustainable power transmission and distribution.

What are some of the high-impact engineering initiatives delivered by the ESP Partner? Can you share few examples with us?

Grid modernization is essential for the resilience and reliability of the energy systems that power our lives and the global economy. Renewables and electrification power the upcoming energy transition to a zero-carbon transformation. With the confluence of several technologies that positively impact this transition, there is a need for automated solutions that can safely augment human activity, such as working on high-power transmission lines.

Robotics, Automation, Autonomous Mobility, and Value Engineering are examples of disciplines on which we are working with Infosys.

What makes the ESP Partner stand out when it comes to bringing agility and speed in innovation and product development?

Infosys is a global leader in digital services and consulting. Firstly we worked with Infosys because it is consistently rated as one of the world's most ethical companies with excellent corporate governance. Secondly, Infosys is a thought leader when it comes to transformations and new product development. It is a one-stop shop for innovation with an uncanny ability to bring traditional and advanced engineering disciplines together. Finally, it is the quality of people at Infosys that makes the key difference. Its global footprint and ability to connect the dots both internally in terms of new technologies and externally in terms of changing customer needs make Infosys stand out.

How has the ESP Partner helped Prysmian Group to provide differentiated service and experience to its customers?

Prysmian Group has pioneered E3X® Technology, the electric utility industry's first heat dissipating overhead conductor. E3X® features a thin, durable coating that enables higher power capacity, lowers energy losses, and avoids sag-related safety issues when applied to the surface of overhead conductors. This technology was first commercialized using factory application of the coating for new overhead conductor orders. Infosys has helped Prysmian to develop a robotic solution to apply the coating on existing power lines. This new application of E3X® technology is groundbreaking as it can enable more power, including from renewables, to be delivered across in-service transmission grids.

In the future, how does Prysmian Group plans to leverage India's robust Engineering R&D ecosystem and available talent pool?

Prysmian's current focus of work with Infosys is the next-generation automated solution needs of our energy customers. Apart from Infosys, we have collaborated with premier universities such as the IITs and research laboratories such as National Chemical Laboratory, Pune. We will continue to look for opportunities to leverage India's talent pool, especially in areas of material science and advanced automation systems.

How do you envision to leverage the relationship of Prysmian Group with the ESP Partner in the future?

For Prysmian, it is vital to strengthen its relationship with Infosys. Both companies have unwavering values, a global talent pool, and a strong commitment to help our electric utility customers with the energy transition.

Working on the E3X® robot project allowed us to work together closely with Infosys. I was pleasantly surprised with our shared passions for solving complex problems and delighting our customers at the end, contributing to a more sustainable world.

STRATEGIC BUSINESS IMPACT

This sub-section discusses the strategic business impact delivered by the Indian Engineering R&D ecosystem to global enterprises.

- India based GCCs and ESPs are taking an increased end-to-end ownership of global products.
- Indian Engineering R&D players are supporting localized customization and ideation efforts.
- Indian Engineering R&D players are creating technology centres of excellence to support the global technology needs of customers.
- Indian Engineering R&D centres are influencing global technology thought leadership.
- India based GCCs are creating leaders assuming global leadership roles.
- India is emerging as an Engineering R&D led manufacturing hub.

STRATEGIC BUSINESS IMPACT

India provides a unique blend of substantial domestic market opportunities, competent engineering and digital talent pool, a robust and thriving start-up ecosystem, cost-effective operations, and proactive government support. The Indian Engineering R&D industry has all the key ingredients to bolster its profile as a lucrative investment destination and a strategic hub for Engineering R&D across the globe.

From taking ownership of global product development, to driving product localization or customization efforts for domestic and international markets, Indian Engineering R&D players are playing a strategic role in:

- Helping create a competitive advantage
- Transitioning the enterprises into a digital-first paradigm
- Creating tangible business value for the enterprises

India based GCCs and ESPs are taking end-to-end ownership of global products

Many global enterprises are increasingly looking at India as the key hub for developing their global products. Initially, the Indian GCCs and ESPs' scope was limited to delivering engineering support for their global headquarters and customers. However, GCCs and ESPs have expanded their range to assume end-to-end ownership of global products over the years. They are now playing a central role in charting out the global enterprise strategy, centred around digital transformation.

India's prowess in engineering, combined with its manufacturing capabilities, provides numerous benefits to the global enterprises in managing the products over their entire lifecycle.

[1] *GCC India Landscape 2021 & Beyond, Zinnov- Nasscom, September 2021*

Examples of how GCCs have undertaken end-to-end ownership of global products:[3]

GCCs

NCS 540 Fronthaul

Common Public Radio Interface (CPRI) capable 5G fronthaul router for service operators to seamlessly integrate 5G architecture options and existing technology interfaces.

Cisco developed a converged cell site and aggregation router to introduce a unified interface concept. It allows operators to connect 3G or 4G radio interfaces using a CPRI and carry the mobile traffic over ethernet. The same interfaces are used to connect 5G radio interfaces and regular ethernet interfaces to support 5G industry vertical use cases of massive IoT, mission-critical applications, or enterprise solutions. The platform offers low latency, deterministic jitter, and strict synchronization features over various interface types. The solution deploys structure-aware radio packet transmission, optimizing transport bandwidth.

LAUNCHED	REGIONS SOLD	INDUSTRY
2021 In 2020 successful lab trials were concluded with select customers	APAC, Americas and Europe	Telecom

BUSINESS IMPACT

NCS 540 FrontHaul is targeted at telecom enterprises. This fully re-programmable and flexible platform offers a way to simplify network architecture with the benefits of:

- Optimized overall operational cost and Total Cost of Ownership (TCO) savings up to 65 percent.
- Enhanced capacity of up to 900G per system to support converged use-cases.
- Reduced 5G Radio Access Network (RAN) transport bandwidth need up to 80 percent.

For Cisco, the platform enabled it to extend its lead IP technology/ethernet-based packet transport solution to the 5G fronthaul network.

Affiniti 30

A cost-effective ultrasound system built on a scalable platform for the traditional ultrasound shared service market.

Philips leveraged its high-end ultrasound system assets to value-engineer Affiniti 30, an ultrasound product with segment-leading image quality and reliability. The system comes with an easy-to-use workflow, ten different transducers for different clinical applications, and an enhanced software platform. The software platform provides flexibility to customers to purchase certain software features as per their requirements. The product is designed for echo-imaging abdominal, vascular, cardiovascular and cerebrovascular, foetal, and muscle-skeletal system examinations. It is also helpful in intervention and elastography.

[3] NASSCOM-FutureFactor360 Primary Research

LAUNCHED	REGIONS SOLD	INDUSTRY
2018	US, China, Latin America, Russia, Middle East and Africa, European Economic Area, India, and Canada	Healthcare

BUSINESS IMPACT

Affiniti 30 is targeted at imaging centres, small to medium hospitals, and small Obstetrics/Gynecology offices. This system addresses the market need/gap for a cost-effective ultrasound system with high performance and image quality.

The product has enabled Philips to tap into the performance value segment market, valued at EUR 60 million.

PHILIPS

Radiology Operations Command Centre (ROCC)

A multi-vendor, multi-modality, multi-site virtualized imaging solution that seamlessly connects imaging experts at a command centre with technologists at scan locations across their organization to enable real-time collaborations.

Philips used a hub and spoke model in ROCC to connect imaging experts at a command centre with technologists at scan locations across the imaging network. It is a complex collaborative TeleHealth solution catering to multi-vendor, multi-modality scenarios encompassing software and hardware components deployed in a hybrid model (cloud + on-premise). Key features of the solution include remote access to console screens and peripherals, seamless multi-room context switching, multi-level access based on credentials, two-way in-workflow communication, in-workflow one-touch collaboration and analytics for customer insights. The solution is offered as a subscription-based model.

LAUNCHED	REGIONS SOLD	INDUSTRY
2020	North America	Healthcare

BUSINESS IMPACT

ROCC is targeted to cater to integrated delivery networks, hospitals with diagnostic imaging facilities, and large diagnostic centres. The benefits are:

- Improved quality of service and access for patients.
- Addressed talent gap.
- Maximized the value of top staff without compromising imaging quality, privacy, safety, and security.

For Phillips, ROCC acts as a foundational base to develop solutions that integrate, optimize and streamline imaging workflows in the Radiology department and also helps to improve pull-through revenue via the additional sale of imaging modalities.

PAG1S

A scalable Type-C AC/DC, power adapter solution to design power adaptors of different power levels with minimal to no system architectural changes for cell phone charger applications.

Infineon developed PAG1S - an integrated secondary side where voltage and current regulation are handled on the secondary side. It offers a scalable system architecture that enables customers to develop different power level solutions by tweaking only the power components such as power transformers, MOSFETs, and capacitors. The rest of the critical parameters can be configured through programmable firmware.

LAUNCHED	REGIONS SOLD	INDUSTRY
2019	Six Countries	Semiconductor

BUSINESS IMPACT

PAG1S is targeted towards charger adapters for mobile and notebook applications. With a secondary side-controlled approach, the advantages are:

- Faster response time
- Improved monitoring of load conditions
- Improved control of the SR controller

The product has helped Infineon secure market share in the rapidly growing Type-C controller for power adapters market and become a world-class leading supplier of silicon for mobile AC/DC applications.

3DX ecoXpert backhoe loader

A new intelligent backhoe loader with an Intelli-performance management system to improve asset efficiency for Off-Highway applications.

JCB developed 3DX ecoXpert that addresses the key demands by optimizing the power consumption within the system while delivering the same performance. The product has replaced the 55kW engine with a 36kW engine powered by JCB proprietary power management control while achieving the same productivity and performance. It consists of an intelligent engine management system that enables interaction with transmission and hydraulic systems to adjust the power delivery based on the requirement. The inbuilt auto-stop feature automatically shuts the engine off after a period of inactivity, thereby saving fuel and money.

LAUNCHED	REGIONS SOLD	INDUSTRY
2020	India	Construction

BUSINESS IMPACT

3DX ecoXpert is targeted at construction operators and fleet owners to provide ease of use and reduced cost of ownership. Key impacts are:

- Increased fuel efficiency by 12 percent.
- Reduced maintenance cost by 22 percent.
- Reduced carbon emission – 75,000 ton per year.
- Increased hydraulic oil change interval from 2,000 hrs. to 4,000 hrs.

The product helped sustain its construction equipment leadership in a highly competitive market and protect segment growth for JCB.

BOSCH

Phantom

An Artificial Intelligence + Internet of Things (AIoT) platform enables real-time monitoring and management of assets and physical workspaces.

Bosch developed an AIoT based asset monitoring platform. The platform uses non-intrusive sensors to collect power signatures from the electrical supply. The AI algorithms running at the edge analyse them to provide insights on energy consumption, asset health, and productivity. It has two variants:

- **Phantom Energy Monitoring:** Enables real-time asset-level energy monitoring and analysis of supply-side electrical parameters of spaces.
- **Phantom Connected Machines:** Enables real-time sustainable asset performance that is, Overall Equipment Effectiveness (OEE) and energy consumption monitoring.

LAUNCHED	REGIONS SOLD	INDUSTRY
2020	US, Mexico, UK, EU, India, Singapore, Indonesia, and Romania	Industrial

BUSINESS IMPACT

Phantom is targeted at residential, retail, commercial spaces, and manufacturing industries. The key benefits for its customers are:

Phantom Energy Monitoring:

- Delivered over 40 percent energy savings on power backup systems to a retail customer.
- Achieved 17 percent reduction in energy consumption for a retail giant's store through anomalous assets and correcting behavioural patterns.

Phantom Connected Machines:

- Realized six percent decrease in downtime within three months of adoption for a global auto parts manufacturer.
- Reduced energy consumption by three percent for a global spring manufacturer.

For Bosch, the product has played a significant role in helping it achieve its sustainability targets.

SanDisk Extreme® 1 TB microSDXC™ UHS-I card

World's fastest 1TB capacity microSD card released in 2019, designed for storing high-definition photos and videos from the next generation of smartphones and cameras.

Western Digital India developed the SanDisk Extreme® microSDXC ™ UHS-I card in three months. With 17 dies (controller and memory) packaged in a 1 mm thick card, it was the world's fastest 1TB capacity microSD card when released in 2019. It continues to be a leader in the world retail market, with blazing fast sequential read speeds of up to 160MB/s and an A2 rating for fast application performance, achieved with cutting edge design and IPs developed in India.

LAUNCHED	REGIONS SOLD	INDUSTRY
2019	Global	Semiconductor

BUSINESS IMPACT

SanDisk Extreme® microSDXC™ card is targeted at the current generation of smartphone and camera users. Some of the benefits to the users are:

- Future proof users' storage requirements as the needs shift towards higher resolution cameras.
- The SanDisk Extreme® microSDXC™ card enables mobiles, AR/VR sets, drones, etc., to store tons of Apps, FHD/4K/8K content, and high-resolution photos.

SiteCom® Discovery Portal

A digital oilfield solution with lightweight, intuitive apps to monitor Drilling & Evaluation (D&E) activity and recall data for providing real-time drilling and decision support to facilitate remote operation.

Kongsberg Digital developed an app ecosystem with independent, intuitive, and platform/device-independent apps tailored to specific business tasks or workflows, all on a SaaS offering tool for seamless uptake. These apps aim to improve predictability and automation on complex business workflows to eliminate or reduce manual work processes, thereby helping oil companies accelerate towards their green energy targets. The apps also provide real-time data visualization with context-sensitive in-app chat for enhanced communication within the drilling community and with operators. It has a scalable and modularized architecture that allows quick turnaround on apps. The ecosystem will enable third parties to utilize the framework to build and host their apps on the portal as plug and play.

LAUNCHED	REGIONS SOLD	INDUSTRY
2020	India, Norway, US, Saudi Arabia, and Singapore	Oil & Gas (O&G)

GCCs

BUSINESS IMPACT

The product is targeted towards O&G companies, operators and oilfield service companies and helps them drill safely and reliably while optimizing operations costs. The key benefits for its customers are:

- Safely moved a real-time operations centre to an isolated staff house in less than 24 hours without interrupting service for a large international oil company.
- Transitioned over 200 wells for real-time data visualization and seamless communication for a sizeable middle-eastern oil company.

For Kongsberg Digital, the solution helped build the brand of being the data aggregator of choice for the drilling functions and build presence in newer markets.

Examples of how ESPs have undertaken end to end ownership of global products[4] :

ESPs

TATA ELXSI

QoEtient

A proactive quality-of-experience improvement platform that enables the telcos and content owners to improve the streaming performance of video (Over the Top-OTT) contents and thereby deliver high QoE to users.

Tata Elxsi developed QoEtient to address the last yard challenge by proactively predicting QoE issues. The product offers a Video DevOps platform to proactively validate all the components of service providers E2E pipeline, including the apps/video players on the end-user devices for the desired QoE delivery. Platform's key functionalities include non-intrusive measurement and validation of QoE Key Performance Indicators (KPIs) accurately across all the OTT device and different versions of Operating System/Firmware, App and player of end users, 60 FPS frame accurate performance measurement from an end user perspective, and focus on faster issue rectification rather than faster issue identification.

LAUNCHED	REGIONS SOLD	INDUSTRY
2020	Global	Telecom

BUSINESS IMPACT

QoEtient is targeted at telcos and content owners. It provides automated identification of issues.
The key benefits for its customers are:

- Reduced "Content Delivery Network" costs by up to 50 percent by optimizing the player and streaming infrastructure.
- Reduced customer churn linked to QoE up to 60 percent.
- Saved up to 5 percent in capital expenses.
- Saved up to 80 percent on automation infra expenditure.

For Tata Elxsi, the product has improved its credibility as a niche/differentiated product and service provider. It has helped the company create non-linear revenue streams.

[4] NASSCOM-FutureFactor360 Primary Research

CYIENT

Smart Power Distribution Panel (SPDP)

Completely in-house developed product for highly efficient and reliable software-controlled distribution of primary and secondary power in aircraft.

Cyient built a smart panel considering the highest level of commercial aviation safety requirements using model-based system engineering. SPDP distributes primary and secondary power for the intended aircraft in a single panel based on switch technology. It allows the same switch to function for various power supplies and are easily re-configurable. There are 140 microcontroller switches and a quad-core processor. It interfaces with the power source of both generators and batteries. It distributes power to various loads while at the same time monitoring the source and loads for any fault to provide safe power distribution. The panel has an ethernet interface for software control of the switch from the cockpit. Apart from the core switch technology, the panel has advancements in magnetics, power back-plane, and power conversion. The panel has a provision for advanced AI ML-based analytics to provide health monitoring and prognostics of all the connected loads.

EXPECTED LAUNCH	TARGET REGIONS	INDUSTRY
2023	US and Europe	Aerospace

EXPECTED BUSINESS BENEFITS

SPDP is targeted towards aircraft Original Equipment Manufacturers (OEMs). The key benefits for its customers are:

- High reliable system with advanced features.
- Low cost of ownership.
- Future-ready with prognostics and health monitoring based on AI/ML algorithms.

For Cyient, the launch of SPDP provides an opportunity to establish itself as lead solution provider in the semiconductor power technology domain.

CYIENT

Software Defined Radio (SDR)

An indigenous tactical communication solution in manpack and handheld variants for Indian military operations.

Cyient exploited a balanced fusion of advancements in digital networking, embedded systems, re-programmability of hardware, and microwave technology to achieve a communication platform that is modular and re-configurable through software modules called waveforms. Using a similar set of components, the system architecture transforms into hand-held, manpack, ground station, vehicular, airborne, and ship borne form factors, encompassing a wide range of power outputs, frequency bands, and standards of operation. The Mobile Adhoc Networking feature enables the formation of a master-less, self-forming, and self-healing network for interoperability with advanced digital radios of contemporary technology to support multi theatre operations on the field.

EXPECTED LAUNCH	TARGET REGIONS	INDUSTRY
2022	India	Defence

EXPECTED BUSINESS IMPACT

SDR is developed keeping in mind the requirements of the Indian Army to be used as a tactical communication system both in times of peace and war. The key benefits are:

- Seamless and secure communication with both legacy and contemporary digital radios.
- Establish communication with friendly forces despite hostile terrain and enemy actions.

For Cyient, SDR positions it in the select league of domestic manufacturers and one among global leading OEMs.

Infosys® Navigate your next

Infosys Radiant Panels

A proactive A cooling/air-conditioning product designed using radiative heat transfer principle for commercial buildings/office spaces.

Infosys, with the aim of taking radiant cooling technology mainstream in the commercial space air-conditioning market, developed radiant panels at a 50 percent cheaper price than the ones available in market. Radiation is the fastest mode of heat transfer. The product leverages this new age cooling principle in its design which provides twice the cooling capacity and reduces energy consumption compared to conventional systems.

LAUNCHED	REGIONS SOLD	INDUSTRY
2019	India	Industrial

BUSINESS IMPACT

Radiant Panels is targeted at commercial buildings and office spaces. Key benefits are:

- Reduced Heating, Ventilation, and Air conditioning (HVAC) energy use in buildings by 30 percent.
- Lessened air usage by 75 percent when compared to conventional products.
- Increased seating capacity by 5 percent due to smaller installation space.
- Enhanced indoor air-quality owing to no recirculation of air-conditioned air making it great for infection control post COVID.

For Infosys, the product strengthened and complemented its sustainability business offerings.

Robotic Endotrainer Kit

A low-cost real-time training system with a control algorithm and integrated VR for robot-assisted surgery to aid global surgeons training.

LTTS developed an ingenious and cost-effective Endotrainer kit which is a surgical robot for affordable yet advanced laparoscopic and endoscopic surgical training. It has a novel design of a three-axis force/torque sensor with a surgical simulator for various surgical situations. It consists of Master Tool Manipulator (MTM), Patient Side Manipulator (PSM) with instrument and camera arms, seven Degree of Freedom (DoF) on each manipulator, and four DoF on camera arm and master console for VR. MTM has master arms designed to have passive gravity compensation for static equilibrium state. PSM, with its instrument and camera arm, mimics the MTM based on the surgeon's control. Surgeons get live visual feedback from the camera through VR.

EXPECTED LAUNCH	TARGET REGIONS	INDUSTRY
2021	Under evaluation in five countries - India, Bangladesh, Vietnam, Malaysia, and Sri Lanka	Healthcare

EXPECTED BUSINESS IMPACT

Robotic Endotrainer Kit is targeted at hospitals and healthcare firms. Key benefits are:

- Reduced training cost for surgeon by 80 percent.
- Projected to double the growth rate of robotic surgery in India.
- Reduced per surgery duration leading to faster attention to patients.

For LTTS, the development of Endotrainer helped it make a foray into healthcare domain. It showcased company's capabilities in AI and competency to build non-competing products with their customer.

Innovative Solution for Dual Powertrain Platform Structure

Innovative and cost-effective steel dominant Battery Electric Vehicle (BEV) and Internal Combustion Engine (ICE) compatible body structure solution enabling dual powertrain platform/s and supporting multiple vehicle types ranging from compact Sports Utility Vehicle (SUV) to large Multi-Purpose Vehicle (MPV). This helps OEMs rapidly launch new products at a competitive cost without compromising on safety standards.

Tata Technologies has developed an innovative body structure solution that enables dual powertrain platform/s to deliver the requirements of BEV and ICE vehicles while meeting the highest safety standards. The platform structure has been developed on steel dominant architecture, which helps reduce the cost of manufacturing and overall cost of vehicles. Its flexibility and scalability support a wide product portfolio with 6 vehicle types and 16 variants, ranging from a compact SUV to a large MPV with the highest commonality to enable quick product launch and optimized product development cost. It also offers increased roominess achieved by reducing machine space while retaining vehicle dimensions, thereby offering a better experience to end customers.

LAUNCHED	REGIONS SOLD	INDUSTRY
2020	APAC	Automotive

BUSINESS IMPACT

The innovative dual powertrain platform structure solution is targeted at automotive OEMs that are aiming to launch new electric vehicles, optimize platform/s and optimize product development time and cost.

- Tata Technologies is in discussion with multiple OEMs for implementation of this innovative solution which is likely to cover at least 2-3 projects in the next two years.

For Tata Technologies, the product has helped the company meet the requirements of its customers and improve its brand positioning as an innovative ESP.

Telediagnostics device

All-in-one handheld modular medical device kit for remote patient monitoring and treatment based on accurate medical examination and real time diagnostics (assisting healthcare ecosystem amid COVID breakout)

eInfochips developed a Telediagnostics device for remote health monitoring and patient care. The device is based on the Qualcomm Snapdragon 410 processor with features such as built-in ability to capture high-resolution digital images and video with an 8MP camera for diagnosis, battery operated to make it portable, multiple adapters to use with external ports for sensing, and an integrated mobile application to connect the patient with the doctor. The device provides remote monitoring and diagnosis of multiple organs/bodily functions. It examines the heart, lungs, throat, ears, skin, abdomen, heart rate, body temperature, and diagnoses and treats many of the most common medical conditions such as fever, ear infection, congestion, allergies, respiratory issues and more.

LAUNCHED	REGIONS SOLD	INDUSTRY
2019	US, Mexico, and Canada	Healthcare

BUSINESS IMPACT

The Telediagnostics device is targeted towards patients, healthcare providers, and caretakers. The key benefits are:

- Trusted physicians' network that enables availability of 24/7 expert help without a need for patient to leave home.
- Clinical-quality consultation that goes beyond just phone or video chat.

For eInfochips' client, the launch of the device helped close a USD 50 million Series-D round and form 10+ partnerships with insurance companies, healthcare providers, and universities to offer remote on-demand medical examinations.

Indian Engineering R&D players support customized localization and ideation efforts

Made for India and Made for the World

The Indian Engineering R&D centres are not only serving as development centres for India-specific products that support the enterprises' expansion in the local market, but they are also helping to unlock new market segments in both developing and developed markets worldwide.

Some case studies providing a glimpse of cutting-edge products designed in India for local and global markets:

GCCs

PRODUCT	TARGET MARKETS (DOMESTIC/GLOBAL)
Hybrid Distributed Power units	**India, Ethiopia, Australia, and other markets with similar needs**

DETAILS

GE's power division teamed up with Tata Power to develop Hybrid Distributed Power units, consisting of an integrated system of solar panels, battery, and diesel generators to provide electricity in rural India.

The unit can help provide a village of about 1,000 people with electricity to meet their basic needs such as lighting bulbs, running fans and charging mobile phones.

The success of the product has encouraged GE to expand to other markets with similar needs. The product has also been installed in Ethiopia to support medical centres on the outskirts of the main town and in Australia to provide energy to remote mining sites operating outside of the primary grid.

PRODUCT	TARGET MARKETS (DOMESTIC/GLOBAL)
Renault KWID	**India, Emerging markets such as Africa, Middle East, and Latin America**

DETAILS

Renault KWID was launched in India with over 98 percent localization, a testament to the Make in India mission.

After a successful launch in the domestic market, the company also exported the KWID to other international markets, including SAARC countries and Brazil.

PHILIPS	PRODUCT	TARGET MARKETS (DOMESTIC/GLOBAL)
	• ROCC • Affiniti 30	Domestic, Emerging and Developed markets

DETAILS

Philips is leveraging its innovation campus in Bengaluru to design and develop customized products for the healthcare segment for the global markets, considering the industry pain areas and opportunities across the target market.

ROCC and Affiniti 30 are some of the products designed and developed at Philips Innovation Campus, Bengaluru.

JCB	PRODUCT	TARGET MARKETS (DOMESTIC/GLOBAL)
	JCB Telehandler	India and other Emerging Markets

DETAILS

With 100 percent product development ownership from its Indian entity, JCB India launched JCB Telehandler in 2020, a tractor/truck mounted Forklift that can place material on platforms at different reaches and heights. It can also be used as a Tool Carrier to handle different types of attachments and material based on customized requirements as per specific needs.

The product was sold in the Indian market and other emerging markets, namely Bangladesh, Myanmar, Nepal, and Africa, in the first 12 months of the launch.

ESPs[5]

wipro	PRODUCT	TARGET MARKETS (DOMESTIC/GLOBAL)
	Health COV-ER	Indian and global markets

DETAILS

Launched in 2020, Health COV-ER is a cloud-based comprehensive IoT solution for COVID pandemic management system supporting key features such as social distancing, contact tracing, occupancy management, rostering, asset management, and others.

The product was designed in India for both the Indian market as well as global markets that include the US, EU, UK, Middle East, and APAC.

[5] *NASSCOM-FutureFactor360 Primary Research*

PRODUCT	TARGET MARKETS (DOMESTIC/GLOBAL)
Infosys Radiant Panel Product	Indian market and Global markets such as US, Europe, and Singapore

DETAILS

Infosys Radiant Panel Product, a patented radiant cooling product, was designed, developed and manufactured by the Infosys Engineering team in India.

The product was launched in India in 2019 and has been installed and used across 7 large office buildings totalling about 2 million square feet of installation, already in operation.

With the successful outcomes in India, the company is also looking to promote and install the product in global markets that include the US, Europe, and Singapore.

Indian Engineering R&D players are creating technology Centres of Excellence

Apart from product ownership, global organizations are also looking at India to drive a technology roadmap for the enterprise. Engineering R&D players are setting up global CoEs, which play a crucial role in conceptualizing and developing innovative next-gen products, accelerating its market adoption, and enabling the enterprises to meet their business goals.

Examples of the CoEs established in India by the Indian Engineering R&D players to drive the technology strategy for the enterprise:[6]

Philips Innovation Campus, Bengaluru

AI CoE

CoE FOCUS AREA Data Science and Artificial Intelligence

OVERVIEW

Philips Innovation Campus, Bengaluru, launched Data and AI CoE to strengthen Philips's data science and AI capabilities, reduce time to market, and create significant customer value.

[6] NASSCOM Primary Research

OBJECTIVES

- To prioritize meaningful AI-enabled solutions that will scale, including adapting/shifting business models.
- To ensure quality in data science and AI.
- To reduce time-to-market.
- To leverage platforms, standards, and proven (external and internal) components.
- To strengthen data science and AI capabilities and drive craftsmanship.

BUSINESS IMPACT DELIVERED

- Significant customer value and revenue contribution with data and AI.
- Measurable impact on Quadruple aim with data and AI propositions.

The CoE has leveraged AI to improve real-time operational decision making, asset tracking, patient flow predictions, advanced staff scheduling, real-time task distribution and standardizing care delivery. One of the examples of projects worked on by the CoE includes Compressed SENSE that can increase the image resolution up to 40 percent within the same scan time or reduce the scan times by up to 50 percent compared to current examinations. The algorithm uses a priori information from system calibration data, anatomical knowledge and general Magnetic Resonance Imaging (MRI) principles, which is carefully balanced to reconstruct the best possible MRI image quality whilst keeping it consistent with the measured MRI data.

SAMSUNG

Samsung R&D Institute India-Bangalore (SRI-B)

SRI-B is contributing to the vision of powering Digital India through four CoE's Advanced Communication, Rich Multimedia, Artificial Intelligence and AI-infused Internet of Things.

ADVANCED COMMUNICATION CoE

CoE FOCUS AREA

Wireless technology, Networks and Terminals, 4G, 5G, 6G

OVERVIEW

Started as a team responsible for the productization of legacy, 3G, and 4G technologies, have now transformed into the Advanced Communications CoE. The centre is responsible for advanced research in the latest fields of 5G, 6G, future generation Wi-Fi technologies, etc.

BUSINESS IMPACT DELIVERED

The Advanced Communication CoE by SRI-B enables the delivery of Communication Protocol Software in mobile Phones and network devices. The CoE commands global leadership amongst standard bodies and has made a significant contribution to Samsung's first 5G mobile phone.

RICH MULTIMEDIA CoE

CoE FOCUS AREA

Camera Technology, Image and Video Processing, AR, and VR

OVERVIEW

The centre started with an aim to improve Image quality in Samsung mobile phones, camera systems Integration and features development by using possible IP from HQ/3rd party. The Rich Multimedia CoE is now undertaking AI integration in image enhancement and processing to deliver new consumer experiences.

BUSINESS IMPACT DELIVERED

The Rich Multimedia CoE has enabled continuous improvement of camera image quality and innovated many new camera features. This CoE has also collaborated for multiple local and global innovations while contributing to multiple product lines towards the former Make for India vision and is continuing the innovation journey with Powering Digital India now.

ARTIFICIAL INTELLIGENCE CoE

CoE FOCUS AREA

Voice Intelligence, Vision Intelligence, and Text Intelligence

OVERVIEW

The Artificial Intelligence CoE has been championing Voice Recognition software feature development and productization alongside language expansion. The centre also covers the development and productization of framework solutions (like Samsung Neural Accelerator Platform, Intelligent Keyboard, Gallery Search, etc.).

BUSINESS IMPACT DELIVERED

The CoE has played a pivotal role in the enhancement and deployment of the Bixby Voice assistant in Samsung mobile phones, consumer appliances. It has contributed in the development, productization and continuous improvement of the Samsung keyboard, S-Pen Handwriting, and others that provide the best experience to end-users.

INTERNET OF THINGS CoE

CoE FOCUS AREA **AI-infused IoT, Data Intelligence, Automation, and Recommendation**

OVERVIEW

The IoT CoE has been a more recent entrant in the SRI-B CoE list. The centre looks after research and productization of software features related to inter-networking of physical devices and ecosystem expansion by on-boarding consumer devices.

BUSINESS IMPACT DELIVERED

The CoE has made significant contributions for the development and productization of the SmartThings cloud service responsible for monitoring and controlling devices. The centre specializes in the development and enhancement of SmartThings App, connectivity, edge processing, data analytics for the connected platforms, and application of AI in intelligent process automation.

NOKIA

Nokia

NETWORKED ROBOTICS CoE

CoE FOCUS AREA **Robotics, AI, and Advanced Communication Technologies**

OVERVIEW

In August 2020, Nokia's India R&D centre announced a collaboration with the Indian Institute of Science (IISc) to establish a centre of excellence for networked robotics in partnership.[7]

OBJECTIVES

- To develop an array of use cases in disaster management, agriculture and industrial automation, among others, leveraging next-gen communication technologies, robotics and artificial intelligence.
- To foster engagement between ecosystem partners and start-up community in developing end-to-end use cases by hosting symposia for academia and industry and organizing hackathons for start-ups.
- To play a crucial role in identifying technological solutions which will enrich and improve lives globally.
- To support and align with the Government's initiatives of Start-up India.

[7] *https://www.nokia.com/about-us/news/releases/2020/08/04/nokia-to-set-up-robotics-lab-at-indian-institute-of-science-for-research-on-socially-relevant-use-cases-based-on-5g-and-emerging-technologies/*

EXPECTED BUSINESS IMPACT

The collaboration is expected to help IISc build capacity and develop human resources in the cutting-edge technology of robotics, 5G, and autonomous systems.

In addition to global enterprises, Indian ESPs have significantly invested in setting up CoEs focusing on digital technologies and vertical-specific new-age technologies.

Below are some examples of CoEs set-up by Indian ESPs

HCL Technologies

HCL has established CoEs focused on niche skills and emerging technologies to drive technical excellence and help customers make the best out of their technology investments. The company has launched more than 25 common next-gen CoEs across the globe, serving multiple customers across various segments.

5G CoE

CoE FOCUS AREA **5G Technologies**

OBJECTIVE OF THE CoE

- To define micro-vertical strategy and develop thought leadership, solutions and value propositions for new business growth.
- To provide highly differentiated offerings and solutions in Core Network, RAN, and Management and Applications.
- To increase automation in RAN and reduce time in onboarding 5G network function.

INDUSTRIES/CUSTOMERS SERVED

Telecom service providers, OEMs, Cloud Service Providers, Semi Chip, Original Design Manufacturer, Independent Software Vendors (ISVs) and Manufacturing Customers

Business Impact Delivered by the CoE

- Helped generate multiple patents and IPs in 5G space.
- Improved time to market by 30 percent for 5G cloud-native network function onboarding.
- Partnered with customers to save up to 35 percent of the cost by leveraging 5G test automation framework.

NEXT. AI CoE

CoE FOCUS AREA **Artificial Intelligence**

OBJECTIVE OF THE CoE

- To develop and demonstrate early adoption of AI Technologies covering ML, DL, Reinforcement Learning and Big Data. The CoE envision, strategize, and implement industry-leading AI solutions.

INDUSTRIES/CUSTOMERS SERVED

Serves multiple customers in Automotive, Aero, Medical, Semi, Industrial, Online, ISV, and Telecom.

Business Impact Delivered by the CoE

- Partnered with multiple customers to leverage AI to address some of the most complex business problems and built IP solutions.
- Helped a leading insurance company create customized and personalized vehicle insurance products for their customers by monitoring driving behaviour and assessing the potential risk. The solution helped to create a highly personalized product - *Pay for how you drive*.

AR/VR - EDGE - EXPERIENCE DESIGN & ENGINEERING CoE

CoE FOCUS AREA **AR/VR**

OBJECTIVE OF THE CoE

- To build AR/VR competency and capacity to solve specific business problems and create broad level use cases.

INDUSTRIES/CUSTOMERS SERVED

Industry/domain agnostic, serving leading global enterprises.

Business Impact Delivered by the CoE

- Helped in developing multiple interesting Proof of Concepts for enterprise customers leveraging AR/VR technology.
- Developed a solution on HoloLens platform from Microsoft that helps service technicians visualize and identify problems with elevators ahead of a repair job. Technicians have remote access to expert information when on-site resulting in significant savings in service maintenance time, improved safety for maintenance engineers, and increased customer satisfaction.

ADDITIVE MANUFACTURING CoE

CoE FOCUS AREA **Additive Manufacturing/3D Printing**

OBJECTIVE OF THE CoE

To provide additive manufacturing solutions across new product development, factory solutions, digital inventory of spare parts/on-demand manufacturing and advanced printed electronics.

INDUSTRIES/CUSTOMERS SERVED

Medical Devices, Industrial, and Aerospace.

BUSINESS IMPACT DELIVERED BY THE CoE:

- Developed Additive manufacturing solutions on AM Costing and AM Portfolio Analysis.
- Helped a leading medical device manufacturing factory save USD 3-4 million through additive manufacturing factory solutions.

Infosys

To build the capabilities in new technology domains for its enterprise customers, Infosys relies heavily on the CoEs built uniquely for its customers or common COEs built to cross-leverage the experience across multiple customers. Infosys has set up approximately 10 next-gen CoEs for its customers and approximately 20 common next-gen CoEs. These CoEs are playing a critical role in supporting Infosys's efforts in the digital transformation of its customers with more than 950 resources working across these technologies.

5G AND EDGE CoE

CoE FOCUS AREA

5G technology

The focus areas fall under two broad categories:

- Accelerating 5G adoption
- Monetizing 5G investments

OBJECTIVE

To build competency and create solutions to serve customers in the 5G domain.

INDUSTRIES/CUSTOMERS SERVED

Targets OEMs that are building 5G technology and Communications Service Providers (CSPs) that are deploying 5G and taking the technology to the market.

BUSINESS IMPACT DELIVERED

- Created and developed more than 10 solutions, IPs, and patents that have brought unique value proposition to the end customers.

- The 5G and Edge CoE has worked on multiple projects creating unique solution IPs to accelerate 5G adoption and monetize 5G investments for clients of Infosys such as OEMs, CSPs and enterprises.

CoE projects include enterprise use cases that help enterprises find new revenue streams. A VR-based remote sports viewing system was used at the Australian Open, for example. Infosys' 5G Living Labs also serve as a co-innovation and incubation centre for new 5G applications. Infosys Smart Network Assurance leverages AI/ML capabilities to reduce the operating costs of networks by up to 30 percent for several telecom customers.

Furthermore, productizing hardened versions of open-source software is a focus of this group. Infosys has contributed significantly to the OMEC project of ONF (which is the heart of the open-source wireless network - Aether). The cost of a millimetre-wave deployment site survey and periodic drive tests can be cut by up to 20 percent by a planning tool for building radios. Another example is a framework to secure 5G networks.

INDUSTRY 4.0 CoE

CoE FOCUS AREA

Industrial Automation, Operations Technologies, Manufacturing Execution System, Industrial Cyber Security, Cloud, Edge Computing, Real-time data processing, 5G, Vision Analytics, Digital Quality Assurance, and others.

OBJECTIVE

To develop industry frameworks for defining the industry maturity model for clients to adopt the framework to adapt industry 4.0.

INDUSTRIES/CUSTOMERS SERVED

Focus on the digital transformation of manufacturing, mining, pharma, and O&G industries.

BUSINESS IMPACT DELIVERED BY THE CoE:

Provided unique business value for the organization and customers. For example, KRTI4.0, a RAMS (Reliability, Availability, Maintainability, Safety) based solution for extensive system modelling with end-to-end data acquisition and processing, has helped the customer reduce the system downtime by over 5 percent and reduced environmental impact by around 4 percent.

The CoE works on projects developing industry frameworks and solutions. One of the formative projects was partnering with acatech to define the Industry 4.0 Maturity Model for clients to adopt Industry 4.0. Since then, multiple solutions and IPs have been built and taken to clients.

For example, Infosys Recipe Management Platform (iRMP) is an AI-based data digitization solution from Infosys for automated formulation and recipe management. iRMP helps bring the recipes from R&D to manufacturing in fast and efficient manner, enabling rapid tech transfer and simplified business process execution resulting in up to 80 percent client FTE effort saving and up to 30 percent increase in throughput for a major pharma company.

EMERGING TECHNOLOGIES CoE

CoE FOCUS AREA

Robotics, Autonomous, Computer vision, AR/VR, and Additive Manufacturing/3D printing.

OBJECTIVE

- To design and deploy autonomous systems to amplify human's potential, enhance human safety and security, and alleviate them in a 3D environment by leveraging next-generation platforms built with AI, ML, and DL.
- To develop framework and accelerators to enable clients in immersive experiences to realize their objectives faster, better and cheaper, through design, development and testing of visualization technologies.
- To drive complete Additive Manufacturing Solution.

INDUSTRIES/CUSTOMERS SERVED

Over twenty customer engagements including Finance, Retail, Locomotive, Automotive, Aero, Pharma, O&G, Energy, Utilities, Mining, Manufacturing, and Logistics.

BUSINESS IMPACT DELIVERED BY THE CoE:

- Developed more than 12 patents and 4 commercial platforms on emerging technologies.
- Undertook projects such as India's first autonomous buggy (launched at WINGS India 2020), which stems from collaborations with Indraprastha Institute of Information Technology (IIIT), Delhi and Maini.
- Developed the solar panel cleaning robot, commercialized with Kaynes Technologies.

The technology CoEs established in India are helping global enterprises to deliver on their technology roadmap and address the need for innovative/next-gen solutions for the customers.

With a vision to build industry-capable talent, promote the start-up community, and enable India as an innovation powerhouse in emerging technologies, the Government, in partnership with industry bodies and associations, is proactively setting up global technology CoEs.

- MeitY has partnered with NASSCOM to set up a CoE for IoT at the Andhra University in Vishakhapatnam, Andhra Pradesh. Innovation in HealthTech, AgriTech, robotics, mobility, among others, will be promoted at the CoE.
- In line with the government's Digital India push, the Software Technology Parks of India (STPI) is in the process of setting up around 21 CoEs across the country to promote next-gen technology, which includes AI/ML, robotics, AR/VR. Previously, in 2019, STPI launched IoT CoE (IoT OpenLab) in Bengaluru. The solutions developed are expected to find their use-cases in defence, aeronautics, industrial, agriculture, health, automotive and education, among others.

Indian Engineering R&D centres are influencing global technology thought leadership

Apart from IPs/Patents, Indian Engineering R&D players are also active contributors to research initiatives and publications.

These publications are widely recognized by industry and academics worldwide. They are providing significant value to the global Engineering R&D ecosystem by bringing in innovative thinking and practical solutions to address some of the pressing problems in the organizations.

Some of the most significant research contributions from GCCs in thought leadership in India:[8]

COMPANY	TITLE OF THE PUBLICATION	NAMES OF RESEARCH PUBLICATIONS/SYMPOSIUMS IN WHICH THE PAPERS WERE PRESENTED
PHILIPS Philips Innovation Campus, Bengaluru	• Analysis of Factors Influencing Accuracy of Ultrasound-based Fetal Weight Estimation • Automated follicular assessment using a novel 2D Ultrasound-based solution • Impact of a Computerized Decision Support Tool Deployed in two Intensive Care Units on Acute Kidney Injury Progression and Guideline Compliance: A prospective observational Stud	• Indian Journal of Radiology and Imaging, 2020 • Journal of Medical Ultrasound, 2021 • Journal of Critical Care, 2020

[8] *NASSCOM-FutureFactor360 Primary Research*

COMPANY	TITLE OF THE PUBLICATION	NAMES OF RESEARCH PUBLICATIONS/SYMPOSIUMS IN WHICH THE PAPERS WERE PRESENTED
Intel Technology India Pvt. Ltd.	• Look-Up-Table based Energy-Efficient Processing-in-Cache Support for Neural Network Acceleration • SIGMA: A Sparse and Irregular GEMM Accelerator with Flexible Interconnects for DNN Training • Auto-Predication of Critical Branches (ACB) (an end-to-end hardware-based solution that intelligently disables speculation only on branches that are critical for performance)	• MICRO 2020, IEEE/ACM International Symposium on Microarchitecture • HPCA 2020: The 27th IEEE International Symposium on High-Performance Computer Architecture • ISCA-2020, IEEE/ACM International Symposium on Computer Architecture
SRI-B	• Millimetre-Wave Beam Selection in Time-Varying Channels with User Orientation Changes • Adaptive Recalibration Algorithm for Removing Sensor Errors and Its Applications in Motion Tracking • Coupled electrochemical thermal modelling of a novel Li-ion battery pack thermal management system	• IEEE Transactions on Wireless Communications, 2021 • IEEE Sensors Journal, 2018 • Applied Energy, 2016

Indian ESPs are also driving technology thought leadership through research articles and publications.

Some of the most significant research publications by the ESPs:[9]

COMPANY	TITLE OF THE PUBLICATION	NAMES OF RESEARCH PUBLICATIONS/SYMPOSIUMS IN WHICH THE PAPERS WERE PRESENTED
Infosys	• Predictive Maintenance of mining haul trucks using oil sampling and telemetry data (to reduce the operating costs of truck engines and the risk of production impact) • AnyPlace 4.0 IoT Localization Architecture (exploits signal fingerprinting to organize under the same roof a wide range of different localization technologies) • IoT based Framework for Smart Campus: COVID .Readiness	• IOSR Journal of Engineering (IOSRJEN) • 21st IEEE International Conference on Mobile Data Management, France, 2020 • IEEE World Conference on Smart trends in Systems, Security and Sustainability (WS4) Conference, 2020
HCL Technologies India	• Medical Image Augmentation using Spatial Transformations for Convolutional Neural Network (that aims to address the data shortage in image analysis) • Eye Gaze Estimation Invisible and IR Spectrum for Driver Monitoring System (that covers the various aspects of eye gaze estimation for a driver monitoring system including sensor choice and sensor placement) • Modelling of Aircraft Arresting Gear System by Multibody Dynamics Approach and Co-Simulation of Multibody Dynamics with Hydraulic System Using ADAMS and EASY5	• ICMLA 2020: Internal Conference on Machine Learning Healthcare Applications • Signal and Image Processing: An International Journal • Springer Link Conference - Advances in Engineering Design and Simulation, October 2019

[9] *NASSCOM-FutureFactor360 Primary Research*

COMPANY	TITLE OF THE PUBLICATION	NAMES OF RESEARCH PUBLICATIONS/SYMPOSIUMS IN WHICH THE PAPERS WERE PRESENTED
L&T Technology Services	• Design and Simulation of Online Uninterrupted Power Supply • Augmented reality in broadcasting (aims to integrate AR with broadcasting which will, in turn, boost the Marketing strategy to reach the customer effectively and efficiently) • Automation processes-accelerators-tools for enriching integrated asset information	• International Journal of Emerging Technologies in Engineering Research • IEEE Explore

Indian leaders are assuming global leadership positions

GCCs in India have transformed from being offshore/outsourcing centre centres to strategic business enablers for their parent enterprises. Today, Indian leaders at GCCs are assuming both business and technical leadership roles at the global level and are playing a crucial role in driving their organization's growth strategy.

PHILIPS — Philips Innovation Campus, Bengaluru

ARVIND VAISHNAV

DESIGNATION AND ROLE

Solutions and Market Innovation Leader, Philips

Leads a team of 50 members, which is focused on customer engagement in developing/scaling E2E solutions in five global markets (India, Japan, APAC, MET, and Africa).

PHILIPS

Philips Innovation Campus, Bengaluru

PRADEEP KUMAR SK

DESIGNATION AND ROLE

Personal Health Digital Solutions and Infrastructure Leader

Leads a team of 122 that focuses on preventive health care in the health continuum and caters to all the 17 markets of Philips.

SATHISH BALAKRISHNAN

DESIGNATION AND ROLE

Senior Director, IGT-S R&D

Leads a team of over 160 members spread across India, the Netherlands, and China, which is focused on end-2-end software for all MR product segments, including Value, Performance, and Premium segments covering the full spectrum of all SW sub-systems.

SARAVANAN NARAYANSWAMY

DESIGNATION AND ROLE

Senior Director, R&D Image Guided Therapy Systems

IGT cluster comprises a headcount of 250 focusing on the treatment part of the health continuum.

intel

Intel Technology India Pvt. Ltd.

NIVRUTI RAI

DESIGNATION AND ROLE

Country Head, Intel India and VP, Intel Foundry Services, Intel

Responsible for Intel India operations, design and engineering, ecosystem engagements. Also leads engagements with national and local governments and policymakers, and collaboration with ecosystem players to enable innovation and entrepreneurship.

Intel Technology India Pvt. Ltd.

SAMBIT SAHU

DESIGNATION AND ROLE

VP, Network and Edge Group and GM of IOT Engineering Group, Intel

Leads the worldwide engineering team responsible for product design and development across IoT, Intelligent Edge, AI, Client, and Networking products.

GOKUL SUBRAMANIAM

DESIGNATION AND ROLE

VP, Client Computing Group & GM, Client Platform & Systems, Intel

Leads the global organization, which is responsible for delivering validation platforms, reference designs, and system technologies for the client roadmap. In addition, responsible for extending India PC TAM through engineering innovation and solutions.

AVINASH CHAKRAVARTHY

DESIGNATION AND ROLE

VP, Client Computing Group & GM, System Integration & Validation, Intel

Leads global teams based in India and the US, which are responsible for system integration, validation and power, and performance optimization for all Windows-based client platforms.

SUBEER PATEL

DESIGNATION AND ROLE

VP, Design Engineering Group & GM, IP Engineering Group Asia Pacific, Intel

Leads the IP Silicon Development and Firmware/Software teams in India, Malaysia, and China.

SAMSUNG

Samsung R&D Institute, Bengaluru

MOHAN RAO GOLI

DESIGNATION AND ROLE

Vice President

With association of 24+ years with Samsung, Mohan has been leading the Communication Protocol Platform Team in India and the US.

DR ALOKNATH DE

DESIGNATION AND ROLE

Vice President, CTO

Spearheads the cutting-edge work in the intersection space of AI, IoT, and Big Data Team space in India and Korea.

BALAJI SRINIVAS HOLUR

DESIGNATION AND ROLE

Vice President

Leads the One Camera team covering geographies beyond India, extending to Vietnam and China.

Mercedes Benz Research and Development India

MANU SAALE

DESIGNATION AND ROLE

MD & CEO – MBRDI, Head – MBC and Vans

Heads the entire business units of MBC, Trucks and Buses, and IT out of MBRDI. In addition, he is responsible for MBC's Connected, Autonomous, and Electric activities.

Mercedes Benz Research and Development India

PRASANNA GONUGUNTLA

DESIGNATION AND ROLE

Head – RD

Leads the focused business of RD related to product development and validation for Mercedes – Benz Cars and Vans.

RAGHAVENDRA VAIDYA

DESIGNATION AND ROLE

Head – Trucks and Bus

Leads the Truck and Bus operations that also includes the IT business related to this function with ~ 1000 employees.

India is emerging as an Engineering R&D led manufacturing hub

Government initiatives and policies such as AtmaNirbhar Bharat Abhiyan (Self-reliant India Mission), Make in India 2.0, and the establishment of production-linked incentives across 13 sectors, with a high focus on electronics system design and manufacturing, are opening the country's manufacturing sector to large-scale foreign investors.

The Indian government, in its Union Budget 2021-22, announced a slew of multiple policies for the growth of the country's manufacturing sector under its AtmaNirbhar Bharat program. The allocation of INR 0.5 trillion to the National Research Foundation for five years is expected to spur innovation and strengthen the R&D ecosystem. Many schemes focusing on improving connectivity and logistics, such as an expansion of national infrastructure pipeline, allocation of INR 1 trillion for capital expenditure to the railways, and INR 1 trillion to the Ministry of Road Transport and Highways, are expected to strengthen the country's manufacturing capabilities and boost the supply chains across the country.[10]

The manufacturing industry is transforming with the advent of the fourth industrial revolution. India's rich talent availability across emerging technology areas such as AI/ML, Cyber Security, and IoT is further bolstering India's position as an attractive hub for new-age manufacturing compared to competitors such as Vietnam and Thailand compared to other countries.

[10] *https://pib.gov.in/PressReleasePage.aspx?PRID=1693908; Union Budget 2021-22*

Few success stories of two renowned healthcare organizations in India:

Philips Healthcare Innovation Campus

OVERVIEW

Philips Healthcare set up its Healthcare Innovation Campus in Pune that integrates all functions of the Healthtech imaging business, including Engineering R&D, manufacturing and other functions such as marketing, customer services, procurement, quality and regulatory under one roof. The BV Vectra mobile C-Arm system, primarily used in orthopaedic surgeries, was one of the first products developed from the centre. Its assembly plant in Chakan manufactures these products giving Philips a complete view of the entire product life cycle.

BENEFITS REALIZED

- Successfully delivered 1,000+ systems to customers in more than 90 different countries worldwide, including the US and Europe.
- Houses team of experts and best-in-class talent from top educational institutes competent in System Architecture, Industrial Transfer, and Lead architecture, among others, to deliver solutions addressing the customers' needs.[11]

Siemens Healthineers

OVERVIEW

Siemens Healthineers has set up a next-gen medical imaging manufacturing facility in Bangalore, India, that is strategically co-located with its Engineering R&D centre to better leverage synergies while developing offerings aligned to the future needs of its customers.

The facility has two production lines.

- One for manufacturing Cios Fit C-arms, which was conceptualized, designed and developed entirely in-house in its Engineering R&D centre.
- Other for manufacturing Computed Tomography (CT) scanners.

BENEFITS REALIZED

- The company has already invested about EUR 300 million in R&D in the country. With about 50 percent of all the software engineers in Siemens Healthineers, the R&D centre at Bangalore plays a strategic role in developing cutting-edge software products and platforms for all three segments of the company – Imaging, Diagnostics, and Advanced Therapies.[12]
- With the manufacturing facility in place, these entry-level products/systems are also manufactured in India. They are sold to emerging markets, including South-East Asia, Africa, Eastern Europe, and South America.

[11] *https://www.philips.co.in/a-w/about-philips/healthcare-innovation-campus.html*

[12] *https://www.siemens-healthineers.com/en-in/press-room/press-releases/pr-20201020-hc.html*

Global corporations from other sectors are also leveraging India as their worldwide Engineering R&D and manufacturing hub.

Volkswagen

Volkswagen started its Engineering R&D centre in its Pune facility in 2019 to achieve 95 percent localization of the cars supplied in the Indian markets. The Pune plant has a manufacturing capacity of 2,00,000 vehicles per year.[13]

Schindler India

Schindler India houses a global R&D centre, elevator, and escalator manufacturing factory and Schindler University at its Chakan facility in Pune. With its R&D centre and its production site, Schindler is producing cutting-edge products and services for the elevators and escalators industry. The company is a renowned leader in the development of the Internet of Elevators and Escalators.[14]

Co-locating Engineering R&D and manufacturing in India is benefitting the companies on multiple fronts.

- Delivering value to the customers faster with shorter lead times and improving time to market for their products and services without compromising quality.
- Augmenting their innovation/R&D activities to develop next-gen sustainable products (duly addressing the resource conservation), thereby providing a unique edge and boosting their leadership position in their industry.
- Expanding their products and services portfolio for global markets.
- Strengthening the commitment to the Indian market, thereby aligning with the vision of AtmaNirbhar and Make in India policy.

To conclude, the Indian Engineering R&D ecosystem is currently playing a pivotal role in delivering strategic impact for global enterprises and is expected to play an even more prominent role across crucial dimensions such as business growth, operational excellence, and competitive differentiation.

[13] *INDIA 2.0 Project: ŠKODA and Volkswagen Group India open new Technology Centre in Pune (volkswagenag.com)*

[14] *https://www.schindler.com/com/internet/en/media/behind-the-scenes/stories/pune---a-showcase-campus-for-schindler.html*

INNOVATION EXCELLENCE

In this section, we discuss India as the global hub for innovation.

- Indian Engineering R&D ecosystem is at the forefront of innovation.
- Indian Engineering R&D players are investing in initiatives and formulating policies to foster innovation.
- GCCs and ESPs are partnering with the vibrant start-up ecosystem to drive cutting-edge innovation.
- Indian Engineering R&D has also been at the forefront of driving innovation for social impact.
- Universities are playing a key role in driving innovation as a part of Indian Engineering R&D.
- Indian Engineering R&D industry's role in patent contribution and research publications has significantly increased.
- The government is playing a pivotal role in fostering innovation through initiatives and schemes.

INNOVATION EXCELLENCE

India is playing a decisive role in serving as an innovation partner for global enterprises

While talent is the lifeline for all organizations, innovation forms its core. With decreasing cycle time for technology advancements and increasing competition, innovation is no longer an option but a survival necessity for global organizations. The onset of the COVID pandemic has further forced organizations to rethink their innovation strategy. With the world moving towards an experience point of view than just a product or service, Engineering R&D needs to continue to innovate to meet this demand or risk fading away into oblivion.

Indian GCCs and ESPs continue to move up the value chain and increase contribution to global technology initiatives' design, development, and innovation. ***India has retained its position as the most innovative country among the Central and South Asia region every year since 2011.*** India has also consistently outperformed on innovation relative to its GDP per capita for eight years in a row, a record only matched by three other countries.[1]

Indian Engineering R&D ecosystem is at the forefront of innovation

India's uniqueness lies in its mature and diverse ecosystem comprising start-ups, universities, GCCs, ESPs, Indian manufacturing companies, and defence and public sector units.

India, today, has more than 1,430 GCCs.[2] More than 180 innovation centres in India belong to Fortune 500 companies, and 48 of the top 50 Engineering R&D spenders have their centres in the country, supporting the narrative that India is one of the leading destinations for innovation and technology.[3, 4] With a robust ecosystem, the Indian Engineering R&D industry offers tremendous advantages to drive the innovation excellence story further.

A multitude of next-gen products are being developed across industry verticals by GCCs and ESPs

Emerging technologies are powering next-gen product development. Technology is constantly evolving, offering a steady stream of possibilities for product innovation. With new-age technologies like AI/ML, IoT, and analytics, penetrating various industry verticals, organizations are enhancing their offerings by building cutting edge next-generation products. It is expected that AI alone could generate an additional USD 15 trillion by 2030 globally.[5]

GCCs and ESPs have developed innovative products across verticals by leveraging these futuristic technologies.

[1] *Global Innovation Index News, 2019*

[2] *GCC India Landscape – 2021 & Beyond!, NASSCOM-Zinnov, Sep 2021*

[3] *https://www.theweek.in/wire-updates/business/2020/09/12/pwr1-nexdigm.html*

[4] *NASSCOM Research*

[5] *Sizing the Price, PwC, 2017*

Next-gen products developed by GCCs[6]

Healthcare

Bosch Hemoglobin monitor

Bosch Hemoglobin monitor is a non-invasive, portable point of care solution powered with AI and ML which enables quick hemoglobin testing and provides results in ≤ 30 seconds.

It is a comprehensive solution that consists of a hardware device, software-based intelligence, and cloud connectivity platform to effectively screen conditions like anaemia. The device is embedded with intelligence which enables getting test results in ≤ 30 seconds. It has connectivity and easy interfaces, which helps in effective population management and enables clinical practice by widening access to anaemia screening at the periphery.

The product has reduced costs by 65 percent compared to traditional methods of evaluation, improved turnaround time by ten times for arriving at results and improved affordability for tests by making it ten times cheaper.

ROLE OF GCC:

The India centre owned complete product development efforts. It is also responsible for the end-to-end product management, project management, and system integration effort.

Philips Compressed SENSE

Philips Compressed SENSE is a Magnetic Resonance Imaging Reconstruction solution that increases the productivity of the scanner by reducing the scan time, increases the diagnostic confidence by improving the image quality, and enhances patient comfort by avoiding re-scans.

The solution leverages compressed sensing, a signal processing technique built on MRI signals that contain redundant information. This technique is used to reconstruct a complete image from severely under-sampled data (in k-space) while maintaining virtually equivalent image quality with a 50 percent reduction in scan time. The solution applies to all anatomies and all scan types (2D/3D).

The solution accelerated scanning by 50 percent with the exact resolution, created higher resolution images in the same scan time to increase diagnostic confidence and enabled better patient comfort, especially for those who experience claustrophobia or have considerable apprehension about entering the MRI scanner space.

ROLE OF GCC:

The India centre owned over 50 percent of the product development and program management efforts.

[6] *NASSCOM-FutureFactor360 Primary Research*

Aerospace

Collins Aerospace

Wiper NT

Wiper NT is a software-controlled, direct driven, configurable and reliable, cost-effective wiper solution for cleaning aircraft windshields.

The solution includes a software-driven control of operating parameters based on aircraft platform and intelligent control for ease in sweep angle and speed configuration. It also has a built-in test, fault logging, and diagnostic capabilities to improve reliability and reduce downtime. To optimize weight, it contains an inflight load prediction system which also optimizes the aerodynamic drag, resulting in lower fuel consumption. In addition, composite material-based arms and blades are used to reduce the weight without affecting strength.

The solution reduced downtime owing to its built-in test, fault logging, and diagnostic capabilities. It ensured competitive pricing as the solution is built by leveraging the local ecosystem in India.

ROLE OF GCC:

The India centre owned over 90 percent of the product development efforts. It is also responsible for over 75 percent of product management and system integration efforts while collaborating equally in the project management efforts.

Telecom

CISCO

NCS 1004 Multi-haul transponder

NCS 1004 is the industry's first multi-haul coherent transponder that allows for high-capacity fibre-optic transmission between data centres for metro, long-haul, and submarine applications while being simple to deploy and manage.

The optical transport platform maximizes capacity while having minimum space and power footprint. The platform is fully automated throughout its operational life cycle. The NCS 1004 solution is a 2-rack unit, 600mm rack depth pizza box-style shelf with four traffic card slots, a field-replaceable controller card, and redundant power supplies. It encompasses carrier-class software with several features such as machine-to-machine APIs based on YANG data models, streaming telemetry agents for real-time, granular device monitoring, and infrastructure for third-party applications.

The product Improved long haul fibre capacity by 37 percent and submarine link (10,000 km) capacity by 43 percent, 600G in metro applications with NCS 1004 – this is 2.4x of previous-generation 250G line rates and reduced operating costs towards supporting fibre optic transport networks by complete automation of the platform.

ROLE OF GCC:

The India centre owned over 80 percent of the product development efforts and worked in collaboration with teams from Italy and the US. It is also responsible for end-to-end project management and system integration efforts.

AIROC™

AIROC™ is a highly integrated Wi-Fi combo device aimed at media, IoT and automotive applications to deliver robust performance with minimal latency.

Infineon developed the AIROC™ family, including the industry's first highly integrated 1×1 Wi-Fi 6/6E and Bluetooth 5.2 with embedded Power Amplifier, Low Noise Amplifier, and Power Management Unit. The device operates in the new greenfield 6 GHz spectrum to deliver robust performance with minimal latency. It has features such as multiple power-saving modes in Wi-Fi and Bluetooth subsystems to conserve energy and save battery life, a more extended range (40 percent improvement from Wi-Fi 6), and multi-stream audio with faster switching times.

The product improved network efficiency with a fast data rate at 1.2Gbps, doubled wireless range compared to Wi-Fi 5 and 40 percent improvement in wireless range compared to Wi-Fi 6, improved power savings of close to 20 percent, and improved connection robustness.

ROLE OF GCC:

The India centre drove the complete project and global teams for definition, innovation and execution. The India centre owned 55 percent of the product development efforts. It is also responsible for 60 percent of program management efforts and 70 percent of system integration efforts.

Network

Catalyst IE3400 Rugged Series

Catalyst IE3400 Rugged Series is an Industry 4.0 ready rugged series switch that provides advanced high-speed gigabit ethernet connectivity across industry verticals while withstanding harsh industrial environments.

The product is an industry 4.0 compatible, Catalyst Switch capable of supporting the automation of traditional manufacturing and industrial networks while providing secure access. It leverages edge/fog computing and Cisco Secure cloud analytics support to provide automatic threat detection, real-time industrial process visibility, hybrid network security, and advanced redundancy protocols to avoid network downtime. It provides functionalities such as delay-sensitive applications support and time-sensitive networks, extends geographical scalability where long-distance connectivity is required and offers integrated network visibility through Cisco Cyber Vision.

The product minimized network downtime, reduced Total Cost of Ownership (TCO) by enabling integrated network security, and reduced Operating Expense (OPEX) with a simplified user interface and single management pane for IT and OT.

ROLE OF GCC:

The India centre owned 80 percent of the product development efforts. It is also responsible for end-to-end product management and system integration efforts.

Consumer Electronics

McAfee® Secure Home Platform

McAfee® Secure Home Platform (SHP) is a router-integrated solution that provides seamless home network security for everyone on a home network.

The solution provides automatic security for the whole home network by bringing together intelligent security features and tools. SHP is a router-integrated solution, co-located on home routers, protecting all connected devices—even those without a display or traditional user interfaces. SHP is powered by McAfee Global Threat Intelligence, which handles 62.7 billion Domain Name System (DNS) queries every day and discovers roughly 375 new threats every minute. It performs on-path traffic inspection and off-path network traffic telemetry analytics to detect malicious network traffic and isolate infected devices. SHP provides:

- Cloud-based protection.
- Accurate device printing with ML.
- High scalability (ability to handle 200 million DNS queries per month).

The solution protected 140 million devices in 4.2 million homes and locked 250 million malicious websites on intelligent devices and 180 million malicious activities on IoT devices.

ROLE OF GCC:

The India centre owned 75 percent of the product development efforts. It is also responsible for end-to-end product management, project management, and system integration efforts.

Next-gen products developed by ESPs

Industrial

Infosys® Navigate your next

Global Telematics Solution

Global Telematics Solution (GTS) is a cloud-native, multi-browser, multi-device, and IoT Telematics product for material handling equipment OEMs moving towards connected, autonomous, shared, and electric solutions.

GTS has connected vehicle features for the material handling industry. It transforms non-connected legacy assets into next-generation smart assets. The product collects and analyses the telematics data of each asset over the cloud with the help of a connected vehicle platform. The data is then leveraged to deliver management insights on asset parameters such as utilization, operator usage, impacts, geo-fencing, and safety adherence.

The solution improved utilization by 15 percent, operational efficiency by 10 percent and reduced safety-related costs by 15-20 percent.

ROLE OF ESP:

Infosys has contributed 95 percent of the efforts towards product development and 90 percent towards product management and project management.

Telecom

Tech Mahindra

Distributed Ledger Do Not Disturb

Great one billion telecom subscriber problem: Blockchain-based solution to prevent unsolicited commercial communication.

This solution includes off-chain management of scrubbing preference data, effectively monitoring all commercial communications from all registered telemarketers, creating a dashboard and reports for service providers, and facilitating Telecom Regulatory Authority of India (TRAI) to perform audit trails at ease. The solution prevents the unauthorized access of subscribers' data, makes the system non-repudiate, and enhances confidentiality. It is developed and deployed on Hyperledger Fabric and includes a custom web application.

The solution reduced cycle time for subscriber's Do Not Disturb (DND) preferences registration and complaint handling processes. It increased transparency through an immutable recording of subscriber's data, consent and preferences across telcos in real-time. Also, enhanced traceability of anomalies leading to improved resolution of subscribers' complaints and enhanced security by enabling only authorized personnel to view subscriber records through tokenization.

ROLE OF ESP:

Tech Mahindra has contributed 80 percent of the effort towards product development, 80 percent towards product management and entirely managed the project.

5G NR RAN

5G NR RAN and 5G Core Network (5G ViNGC) are solution frameworks designed to help global telecom equipment and service providers accelerate their field deployment of 5G.

Capgemini has developed the 5G NR RAN and 5G ViNGC as an end-to-end reference solution for customers. The solution provides customers with multiple options, such as deploying a complete end-to-end 5G Core Network or RAN solution from Capgemini, adding their own components and label, or kick start and develop their own 5G network components using Capgemini's source code. It provides flexibility to customers who want to base their solution on a specific SOC or for customers looking for any form factor or from micro to macro deployment options.

The solution significantly reduced time to market for 5G field deployment and enabled the reduced cost of ownership, enabled support of multiple form factors and architecture splits, Network Functions Visualization (NFV) support and cloud deployability, and rich roadmap allowing the customer to continue their technological progress and expansion of 5G SW/HW vendor ecosystem with our partners to help create innovative solutions.

ROLE OF ESP:

Capgemini has entirely contributed its effort towards the development and management of these solutions.

Smart Network Assurance

Infosys Smart Network Assurance is an AI/ML-based Closed Loop Assurance solution for telecom and enterprise networks that predicts, automatically identifies root causes and self-heals network issues.

The solution is developed with the primary intent of reducing manual effort and automating network operations. The solution combines the ability to predict network outages and to self-heal the issues in a single platform. The solution's key features include ML for fault pattern identification, automated root cause analysis, data-driven analytics, correlation and visualization, automated workflows and ticket life cycle management, and multi-network technology data model and interface.

The solution reduced mean time to repair by 60 percent, incident ticket life cycle by 30 percent, and operation costs by 30 percent, and improved overall operator efficiency by 50 percent.

ROLE OF ESP:

This is Infosys IP, and the product is fully developed and managed by Infosys.

Computing Systems

PowerStore

PowerStore is a midrange infrastructure platform developed to support traditional and modern computing workloads for enterprises.

The solution is a single scale-up and scale-out architecture for any workload - physical, virtual, and container-based apps and databases. Designed for 6 9s availability, it can provide storage capacity for applications running throughout the enterprise and a VMware-based environment for hosting business applications directly on the appliance. This capability makes it ideal for data-intensive workloads in core or edge locations where infrastructure simplicity and density are required, and the latency from a data centre or cloud is unacceptable. Administrators can move storage and compute seamlessly between PowerStore and other VMware targets (edge, core, and cloud) using already familiar tools.

The solution increased responsiveness by 7x faster and 3x more responsive over Dell's previous midrange arrays improving performance experience for clientele. It reduced administrative costs up to 99 percent with a built-in AI/ML engine and guaranteed reduction of 4:1 data with hardware-accelerated data reduction and no performance impact.

ROLE OF ESP:

Dell has contributed 100 percent of the effort towards developing two key differentiating features of the product - seamless migration from legacy storage arrays and NAS integration.

Automotive

Tether

Tether is a cloud-based and IoT enabled Connected Vehicle Platform that enables automotive OEMs to offer customer-centric and digitally enhanced features.

The product is a cloud-based Connected Vehicle IoT platform that is vendor agnostic. Hyper-scale platform available as a service uses cloud computing for device on-boarding and data aggregation. The platform enables OEMs to monetise the vehicle data by collecting, monitoring, and analysing performance details from the vehicles on the road. In addition, it also allowed the OEMs to maintain complete ownership over the data and provided them with technology-agnostic control over their data monetisation roadmap.

The product saved 30 to 40 percent in cost and time-to-market, reduced connectivity cost per vehicle by 10x, and increased the OEM's market share delivered through sales of 100,000 plus vehicles with the connected car features.

ROLE OF ESP:

Tata Elxsi has wholly handled the development and management of the connected vehicle platform, Tether.

Electric Vehicle Charging Station

Electric Vehicle Charging Station is an EV charging infrastructure for eMobility with a mobile app for charging status and device control.

eInfochips developed the turnkey next-generation Electric Vehicle Charging System for a world-leading energy solutions provider. The product has a new ergonomic design, enhanced functionality, faster charging, and increased reliability and safety. The product comes at an affordable price, making it suitable for multiple customers across geographies. To boost user adoption, the hardware is coupled with a mobile app that enables end-users to view charging status, send notifications, access charging stations from anywhere over IP, data security, amongst others.

The product increased ease of use and quick setup by its intuitive design, robust and reliable with industry-leading safety features and flexible demand response profile.

ROLE OF ESP:

eInfochips has contributed 90 and 30 percent of efforts towards product development and management, respectively and 70 percent towards program management.

Consumer Electronics

HARMAN Amplify

HARMAN Amplify is a small femto cell-based solution that offers enhanced LTE data coverage while also serving as a smart voice-based digital assistant.

The solution provides integrated personal voice assistant and control of smart devices using the Amazon Alexa eco-system. The solution enables multiple use cases such as smart home, touch-less retail, and innovative enterprise. The solution includes HARMAN Kardon audio, including 2x8 Watt speakers, an embedded amplifier, three built-in far-field microphones, Bluetooth, and noise and echo cancellation. It is an industry-first product that combines HARMAN Audio, edge AI board with IoT capabilities, and Alexa and HARMAN Voice AI capabilities with femtocell box.

The solution enhanced customer loyalty by a 200 percent increase in indoor network coverage and increased Average Revenue Per User (ARPU) for its telecom service provider customers by providing higher bandwidth and faster speed resulting in higher data consumption.

ROLE OF ESP:

The India centre owned over 80 percent of the product development efforts. It was also responsible for end-to-end product management and program management efforts.

Next-gen products developed by Engineering R&D start-ups

Start-ups have been at the forefront of developing innovative products and solutions, similar to the GCCs and ESPs. Start-ups have introduced a plethora of innovative solutions that leverage deep-tech, and new-age technologies to solve the existing industry/customer challenges

Energy

MinionLabs

Minion Energy Management Solution

Minion Energy Management Solution is an AI-based real-time device-level energy monitor for commercial buildings that provides energy usage data along with energy-saving recommendations and bill forecasts.

This single device energy management solution leverages AI and ML to provide real-time energy-saving recommendations. It created labelled data patterns/energy signatures for every device in real-time at a rate of four million data per second by sensing the noise signature of each device. The solution senses all these energy signatures at the EDGE and streams the detected appliances logs and energy consumption to the cloud server, which has predefined labelled data. To provide energy-saving recommendations, the solution predicts building consumption data, energy bill forecast, climate risk ranking, and individual appliance energy usage. It also provides, amongst others, predictive maintenance along with asset health monitoring and early fault detection.

The solution saved energy by 12-18 percent on top of Capital Expenditure (CAPEX) and OPEX savings per annum and improved operational efficiency and appliance productivity.

Agriculture

Fasal

FASAL

FASAL is an IoT based agritech solution with an intent to assist farmers in precision agriculture, thereby enabling cost savings in disease management and water usage.

FASAL is a subscription-based plug and play IoT stack that can be farm deployed in just under five minutes. The solution produces farm level, crop-specific and crop stage-specific actionable intelligence. The IoT device is equipped with more than 13 sensors to monitor various macro and micro parameters of farming, such as weather conditions, wind speed and direction, soil wetness, humidity, soil temperature, etc. Based on real-time data from these sensors, FASAL provides recommendations and alerts to farmers in vernacular language through an app or SMS and helps them in precise irrigation, crop disease, and pest management. It also provides weather forecasts and helps farmers with expense management through its expense management system that keeps digital records of all bills.

The solution reduced diseases management costs by 50 percent, pest management costs by 60 percent, water usage by 30-50 percent, and overall cost of cultivation by 20-25 percent. It also enhanced the quality of produce in terms of fruit/vegetable size, consistent shape, sweetness, etc.

Energy

HELIOS
The Energy Analytics Company

Apollo™

Apollo™ is a patented digital twin performance intelligence and health analytics solution that generates actionable closed-loop insights to optimise assets and portfolios, increase yield, and improve solar plant's performance.

The solution consists of eight modules that capture the digital replica of the plant and its assets to monitor and benchmark real-time performance while discovering failures and underperformances. The solution provides performance and health analysis with an asset failure prediction, analyse trends, and streamlines operations and maintenance activities. Apollo™ is further powered by patented digital twin technology, ML models, IoT-based KPIs and event discovery, advanced decision-making engine, and closed-loop insights.

The solution reduced the Operations and Maintenance (O&M) cost of plant operations by up to 25 percent for a large utility power plant (the industry average is 15 percent). It increased energy generation (yield) by up to 10 percent from the previous baseline number (the industry average is 7 percent) and the performance and health life of the assets by up to 2 years from the last number baseline.

Indian Engineering R&D players continue to invest in initiatives to foster innovation

Innovation is a necessity for companies to survive, thrive, and grow in a fast-changing world. Through innovation focus and sustained excellence, companies can differentiate themselves, create value for their clients and themselves, and stay relevant in an ever-changing market.

Successful organizations view innovation as a continuous journey in which the destination shifts in response to the changing market conditions. GCCs and ESPs have invested in several initiatives and formulated various policies to sustain and drive the culture of innovation.

GCC's innovation initiatives[7]

GCC	Innovation Initiatives
SAMSUNG	• **In-house Innovation:** To focus on core aspects of building stable platforms and value-adding solutions which has more long-term strategic benefits for the organization. Samsung's In-house Innovation is powered by: ***1. Incubation/Technology Lab*** ◦ Advanced Technology Lab – Aimed at creating a long-term indigenous research platform. ◦ Creative Lab - Enabling intrapreneurship to build innovative products and solutions. ***2. Innovation Coaching and Counselling:*** Invention creation and top-quality patent creation training for fresher and seasoned inventors in CoE areas, Assisted Brainstorming Sessions via design thinking and theme-based ideation, Technology Familiarisation Sessions in emerging technology areas. • **Open Innovation:** To aid in further in-house solutions, faster go-to market and also create a scope of new product development. This involves active collaboration with third-party service providers, product and technology vendors, maturity of strategic investments and partnerships, collaboration with international universities through government-based initiatives (Indo-French: CEFIPRA).
	• **Dedicated IP Team:** An innovation platform was set up, processes were defined and identified internal employees were chosen as Inno ambassadors. The subject matter experts come together to help refine and reshape the ideas, thereby fuelling innovation and value creation for the business. • **Firefly:** Forum developed for leaders to rekindle their passion for innovation and work on ideas that drive business impact. • **Fatboy:** Innovation inspired intrapreneurship ideas to further business innovation and lead into new age product development. • **Celebrating Innovation Week at the Centre Level:** Each year during February, one week is dedicated to commemorating the spirit of innovation by organizing keynotes, panel discussions, innovation skills workshops, contests, a showcase of top inventors and inventions, followed by rewards and recognition ceremony. • **Idea Generation Workshops:** Organizing crowd-ideation based workshops, Hackathons, and TRIZ/design thinking workshops.

[7] *NASSCOM-FutureFactor360 Primary Research*

GCC	Innovation Initiatives

intel	• **External:**
	  ◦ ***Intel Start-up Program:*** Program focused on engaging with high impact innovative start-ups leveraging deep-tech. The program provides the best of technology mentorship from Intel and coaching from leading industry and business experts, access to advanced technologies, enablement of design, and solving real industry problems that would help shape their growth path and scale. Over the past three years, the Intel Start-up Program has enabled over 80 start-ups in data-centric areas like AI, IoT, vision, speech, simulation, robotics, platforms, and security.
	• **Internal:**
	  ◦ ***Intrapreneurial programs:*** The Intel Incubation Program is an intensive 12-week innovation cycle, where selected venture teams work as a start-up within Intel and develop the next big business. Selected teams receive funding, business guidance, technical support, and mentorship from Entrepreneurs-in-Residence and leaders.
	  ◦ The site Innovation and IP team also conduct organization-wide IP harvesting sessions, patent/IP – training, mentoring sessions, and practical invention disclosure writing sessions.
	  ◦ The annual Innovation and Career Fair showcases the teams' innovations and inventions, posters, demos, and technical talks.

ESP's innovation initiatives[8]

ESP	Innovation Initiatives
Infosys® Navigate your next	• **Infosys Innovation Network:** A well-orchestrated partnership between select start-ups to provide innovative services to clients of Infosys. • **Infosys Innovation Fund:** A Venture Capital (VC) initiative to support innovation and purposeful solutions that are relevant to the strategic priorities of Infosys' clients. • Partner with start-ups integrating their solutions as a part of Infosys' broader service offerings.

ESP	Innovation Initiatives
wipro	• **Wipro Ventures:** A strategic investment arm of Wipro Limited, established to invest in early to mid-stage companies building innovative enterprise software solutions. The portfolio is diverse and includes niche technologies such as cloud, security, automation, AI/ML, robotics, IoT, big data, etc.
HCL	• **Start-up Ecosystem Program:** HCL's in-house start-up accelerator program and open innovation platform, eSTiP™, are at the centre of a strategy to draw upon a global ecosystem of start-ups, academic researchers, venture capitalists, trade commissions, and other industry forums. Together, they provide ways to funnel unique ideas, build prototypes, and commercialize solutions. • **Hackathon:** A platform for engineering students to showcase their ideas/prototypes and get inspired to start their venture.

GCCs and ESPs are partnering with the vibrant start-up ecosystem

One of the many reasons for India's attractiveness as an Engineering R&D destination is its robust and thriving start-up ecosystem. ***India is home to the 3rd largest start-up base globally, that includes 11,000-12,500 tech start-ups (incepted during 2015-20) and 520+ active tech incubators and accelerators.***[9] [10] [11]

Global enterprises are increasingly partnering with vendors, academia, and start-ups to co-create and co-innovate. In this regard, GCCs and ESPs are actively collaborating with start-ups to tap into the advantages of this ecosystem and establish a symbiotic relationship.

Companies like Airbus BizLab, Dassault Systèmes, Schneider Electric, Sodexo, and Ubisoft have set up start-up accelerators in India to scout, accelerate, and partner with start-ups.

AIRBUS BizLab Aerospace Accelerator

Airbus BizLab

Airbus BizLab, the Airbus group accelerator, has a campus in Bengaluru that runs innovation programs to foster collaboration between Airbus intrapreneurs and start-ups in the aerospace sector.

[9] *Technology Sector in India, Strategic Review, NASSCOM, 2021*

[10] *NASSCOM Research*

[11] *Start-Up Catalysts – Incubators & Accelerators, NASSCOM, 2020*

Cisco LaunchPad

Cisco Launchpad brings together Cisco technologies, start-ups, and the partner community to deliver tech solutions. Cisco LaunchPad's mission is to propel deep-tech start-ups working in disruptive technologies.

Microsoft Accelerator

Microsoft Accelerator is a global program built to empower new businesses. Microsoft works closely with market-ready start-ups and provides the tools, resources, knowledge, and expertise required for the start-ups to succeed.

Bosch DNA

Bosch DNA aims to discover, nurture, and align the start-ups with Bosch business units. Through this program, Bosch works with innovative start-ups and explores the opportunity to co-create the product/solution or explore a partnership to go-to-market through potential engagement models.

Shell E4

Shell E4 is a program to accelerate India's transition to a sustainable energy future by becoming a prominent actor in the entrepreneurial ecosystem by linking talent, technology, capital and know-how for energy entrepreneurs in the country. The program provides a platform for collaboration and conversation around valuable energy transitions, offering start-ups an opportunity to bring their ideas to life with Shell's guidance and support.

Key focus areas of collaborations

India has over 2,100 deep-tech start-ups, with AI and IoT accounting for two-thirds of it.[12] AI, ML, and IoT are the top technology focus areas for enterprise and start-up collaborations.

Collaborations by GCCs[13]

Samsung and Indus OS

Samsung partnered with OSLabs (Indus OS) as part of its start-up collaboration. OSLabs has developed a curated app store, Indus App Bazaar, which has a collection of over 4,00,000 mobile apps in multiple Indian languages.

[12] *India's Deeptech Start-ups, NASSCOM, Mar 2021*

[13] *NASSCOM-FutureFactor360 Primary Research*

Samsung and DMI

Samsung partnered with DMI Finance to launch Samsung Finance+ in India. DMI Finance is a pioneer in the use of technology for the transmission of credit to the end customer.

Samsung and Inmobi

Samsung partnered with Inmobi to offer a personalized lock screen content service powered by Glance.

MBRDI and Noumenon Multiphysics

MBRDI collaborated with Noumenon Multiphysics to develop and implement the NXadd-on, which integrates an algorithm for determining the routing and model of the torsion bar based on the surrounding/packaging environment.

MBRDI and Get My Parking

Under the flagship Start-up Autobahn India programme, MBRDI has worked closely with the IoT-driven digital parking platform - Get My Parking. The effort is to embed this feature into all Mercedes-Benz cars to assist end-users in searching and navigating to an available parking lot.

Collaborations by ESPs[13]

Infosys and Fluxa

Infosys and Fluxa, a digital collaboration platform, partnered to create the Infosys Recipe Management Platform by combining the Fluxa solution with an AI-based data digitization solution from Infosys. The iRMP helps in bringing the recipes from R&D to manufacturing in a fast and efficient manner.

Infosys and IdeaForge

Infosys worked with IdeaForge, manufacturer of advanced UAV/drones that can be used for Defence and Homeland Security and enterprise operations, to provide Drone-As-a-Service to enable the customers to avail the Drone Services on a pay-as-per-use model.

[13] *NASSCOM-FutureFactor360 Primary Research*

Infosys and Parallel Wireless

Infosys partnered with Parallel Wireless, one of the most successful start-ups in the 5G and Open RAN space, to provide the telecom service providers E2E Mobile Access Edge and Open RAN solutions. Infosys completed the first fully integrated 5G O-RAN and MEC trial in Australia.

Wipro and Asia Pacific-based electric vehicle manufacturing start-up

Wipro works with the Electric Vehicle manufacturing start-up as an engineering partner in engineering design, Product Lifecycle Management (PLM), and validation services.

Indian Engineering R&D organizations are driving innovation for social impact

Organizations are looking to leverage technology and drive innovation to solve critical issues and positively impact society.

The emergence of digital tech has become synonymous with the transformation in the enterprise and business landscape. Technologies such as IoT, 5G, sensors, data analytics, AI/ML etc., have delivered exponential benefits in operational excellence, customer experience, and new revenue channels. Their numerous implementations have received widespread recognition, inspiring the technology community to ideate new products and services for customers.

However, these technologies also have the potential to deliver exponential value by addressing the social issues affecting humankind. From using drones to plan water supply schemes in hard-to-reach locations, deploying satellite imagery to enhance land usage, or using mobile phones to track health, technology is changing the way we live.

Be it healthcare, education or clean energy, Indian Engineering R&D players are capitalizing on technologies such as AI, cloud, blockchain, automation, VR, digital and more to develop unique products to meet social needs.

GCCs' social impact innovations[14]

Healthcare

Eye Health Diagnostics Suite

Eye Health Diagnostic Suite is an AI-powered affordable and portable smartphone-based solution. It leverages previous-generation smartphones under the Samsung Galaxy Upcycling program. A VR-based smartphone system is developed to perform visual perimetry and advanced data analytics techniques to help detect any abnormality in the visual field (glaucoma, diabetic retinopathy, multiple sclerosis, etc.). The displayed results are in a format that is familiar to ophthalmologists.

The solution detected eye ailments early on and prevented blindness in low-medium-income countries. EyeLike is deployed in India, Vietnam, Morocco, and Papua New Guinea with the main goal of creating a circular economy by maximizing the output of smartphone manufacturers.

Automotive

Interior Cabin Sensor

Interior Cabin Sensor (ICS) is a radar-based system designed and developed in India. It classifies the occupants (adult/child) and warns users when they leave a child behind in their vehicles. This avoids heatstroke and the death of children. A major North American car manufacturer has identified Veoneer as a development partner for ICS.

The product ensures safety of vehicle occupants and prevents the death of children who are left behind in the vehicle or enter unoccupied vehicle independently.

ESPs' social impact innovations[15]

Healthcare

AccuAlertMe

AccuAlertMe is an enterprise-grade secure contact tracing and social distancing enablement platform. It offers enterprises a comprehensive solution to enable a safe return to work.

The product offered a secure, scalable, and comprehensive framework for Safe Return to Work. It promoted social distancing behaviour and real-time alerts in case of violations, aided in automated contact tracing up to three levels – primary, secondary, and tertiary and ensured employee privacy and data security.

[14] *NASSCOM-FutureFactor360 Primary Research*
[15] *NASSCOM-FutureFactor360 Primary Research*

Healthcare

Gazelle

Gazelle, a point-of-care diagnostic platform, is a portable and easy-to-use diagnostic device for malaria and sickle-cell anaemia screening. The integrated platform provides affordable, accurate, and life-changing medical diagnostics for under-served people everywhere. Gazelle places the power of a high-end laboratory into remote healthcare settings.

The product enabled faster diagnosis and screening leading to affordable treatment and better life. The geo-tagged reporting helped with better clinical interventions in affected regions.

Assisto

Assisto is an affordable, intelligent device that assists differently-abled people in vocal communication and can be worn on any moving part of the body. It uses sophisticated AI algorithms to synthesize and convert sensory inputs to the near-natural voice of the person in the native language.

The product reduced communication time by 65 percent, increased the communication speed by 3x, reduced the dependency of special needs children on their parents and enhanced the accessibility of the solution with affordable pricing of less than USD 20.

Energy

Clever Energy™

Clever Energy™ is enterprise-level energy and emission management system. It facilitates organizations to achieve carbon-neutral goals by reducing carbon emissions.

The product reduced energy consumption (a steel major saved ~1.4 million Mcal of energy), reduced carbon emission and increased costs savings (one of the starch manufacturers saved EUR ~200,000 annually in a single process).

India's role in driving innovation during the COVID crisis

Indian Engineering R&D ecosystem rose to the occasion and came up with multiple innovations to help India and other countries to deal with the pandemic effectively during the COVID crisis. Apart from developing solutions to tackle the pandemic, the Indian Engineering R&D industry also helped governments with digital solutions that enabled them to monitor and control the spread and deliver critical information and updates to the public.

Cyient developed the TrueNAT solution that helped the healthcare sector by creating a first-of-its-kind portable RTPCR testing kit. This solution allowed timely testing of COVID for millions globally at the pandemic's peak. TrueNAT is a chip-based point of care multi-disease platform with over 25 tests and is globally used to detect and diagnose COVID.

The product reduced test results time from 1-2 days to 35-60 minutes and helped more than 20 million people test for COVID.

Capgemini and a leading blood management devices company partnered to accelerate the launch of automated blood collection and apheresis systems. This system enabled convalescent plasma therapy for treating COVID patients.

Convalescent plasma therapy provided an effective and affordable treatment and better disease management. It enabled speedy recovery and improvements in clinical symptoms of those suffering from COVID.

Lam Research developed ***Suraksha Kiosk***, a COVID sample collection box equipped with three key features: safety, speed, and improved ergonomics, to ensure a higher number of samples collected during the test kit shortage in the country.

The product ensured safety by reducing the risk of catching COVID infection at test centres, decreased the waiting time for testing and most importantly, made COVID testing available and accessible to people during the resource shortage. To date, 17 Surakasha Kiosks have been installed in 15 districts of Karnataka, and 23,912 individuals have been tested for COVID across the state.15

Indian universities are playing a key role in driving innovation

The collaboration between industry and academia is a step in enabling innovation. The last decade has seen an increased partnership between Indian universities and the Engineering R&D community.

Indian universities offer access to the best scientific and engineering minds across multiple technology domains. Indian Institutes of Technology (IIT), the prestigious engineering university, was considered the fourth-largest producer of unicorn start-ups globally (after Stanford University, Harvard University, and the University of California) in 2017.[16] Overall, India has more than 900 universities, 39,000 colleges, and 10,000 standalone academic institutions.[17]

Enterprises are tapping into a growing pool of academic talent to develop innovative solutions in partnership with the universities. The partnerships with universities have helped enterprises in fundamental and applied research projects and augment engineering and innovation initiatives within the organization.

[15] *NASSCOM-FutureFactor360 Primary Research*

[16] *https://economictimes.indiatimes.com/small-biz/startups/iits-fourth-largest-producer-of-unicorn-startups-in-the-world/articleshow/56827780.cms?from=mdr*

[17] *India's Innovation Ecosystem: Mapping the Trends, Observer Research Foundation, Feb 2021*

IISc

Wipro IISc Research and Innovation Network, a hybrid industry-academia collaboration unit to drive idea discovery, research and innovation in technology and product design. The technology focus areas of this collaboration are in:

- Cognitive Computing and AI
- Visual Computing
- Data Science and Analytics
- Deep Learning Algorithms
- Autonomous Systems

Boeing and IISc partnered to form Aerospace Network Research Consortium, India's first public-private aerospace research consortium.

Key projects/Key focus areas

- Aerospace Network Synthesis Platform
- Network Partitioning and Transparency systems
- IPV4/IPV6 transparency techniques

Indraprastha Institute of Information Technology, Delhi (IIIT, Delhi)

Infosys Centre for Artificial Intelligence, a centre established in IIIT, Delhi to be the premier centre in India for the development of AI.

Key projects

- Autonomous golf carts using open-source technologies
- Swarath: Autonomous Last Mile Connectivity for Commuters
- Aurora: Intelligent Unmanned Aerial Vehicle Design

IIT, Madras

Samsung and IIT, Madras employed a unique model in their research collaboration where Samsung developed the algorithms for protein modelling and engineering, and IIT, Madras validated these models.

These algorithms were incorporated by Samsung in pilot projects to develop biopolymers and methods to design biodegradation of industrial effluents. One paper in Nature Scientific Reports was jointly published apart from papers in top journals such as Bioinformatics and BMC Bioinformatics describing the algorithms and systems developed by Samsung.

The Intel India team worked with IIT, Madras to develop India's first indigenous microprocessor design – ***Rise Creek SoC***. A key architectural consultancy role and intensive on-site support were provided by Intel to demonstrate silicon proof of the microprocessor.

IIT, Kanpur

HCL Technologies and IIT, Kanpur have signed MoU to carry out joint initiatives and research in Cyber Security. HCL will work with C3i Hub, a specialised Cyber Security research centre at IIT, Kanpur.

C3i Hub was created to address the issue of Cyber Security of Cyber-physical systems in its entirety, right from analysing security vulnerabilities and developing tools to manage them at various levels of the system architecture.

IIT, Patna

Samsung collaborated with IIT, Patna to develop a Natural Language Generation (NLG) system that dynamically generated responses customized to the user. This opened new areas of research using AI for a natural response from NLG systems.

The results were incorporated in voice interface, and Bixby enabled devices. The work was published in top NLP conferences.

KLE Institute of Technology, Hubli (KLEIT)

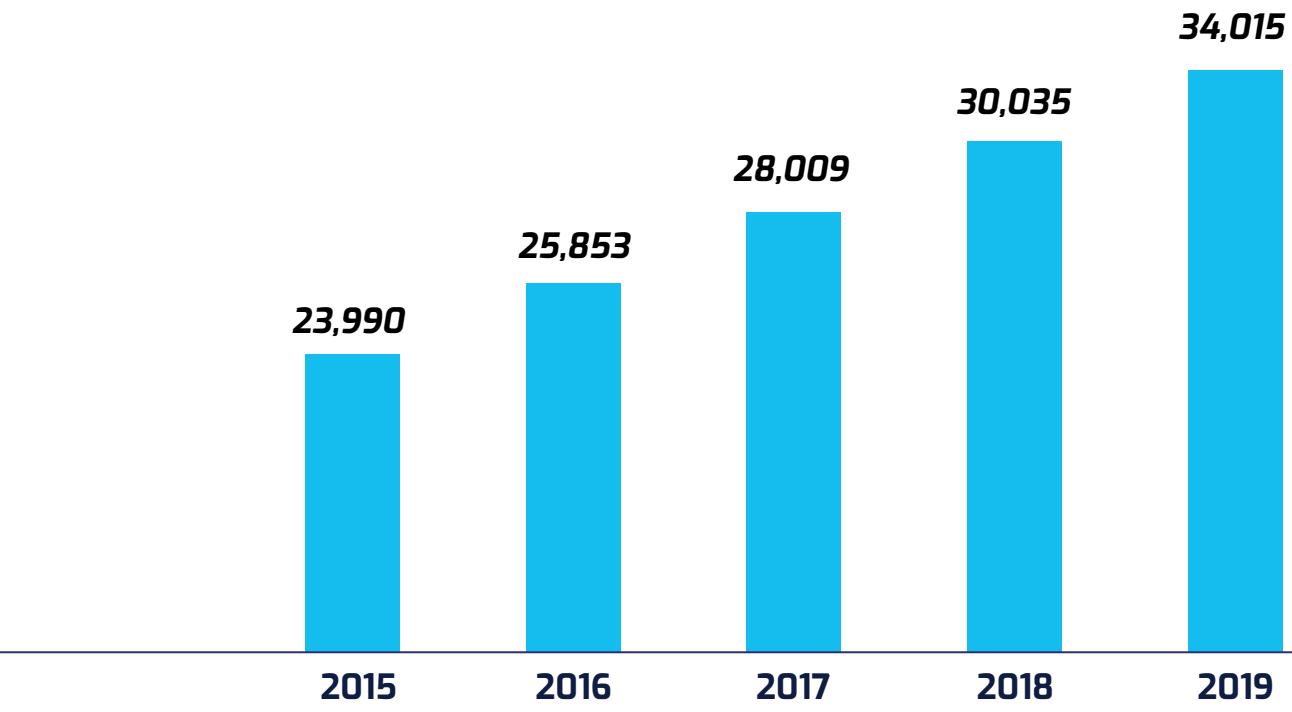
SRI-B established a Data Lab at KLEIT Hubli after a successful collaboration between Samsung and KLEIT. The focus of the Data Lab is on developing algorithms and systems for 3D reconstruction and modelling of large objects based on drone-based data capture. The collaboration also generated more than 100 data sets.

The 3-D image processing systems developed were integrated in Samsung's 3D imaging system. A number of internships of faculty and students from KLEIT refined the system, and the results were published in top domestic computer vision conferences.[18]

India Engineering R&D contribution in patent and research publications has increased

Patents filed is a measure of a country's innovation. In India, the presence and continued expansion of hundreds of research and development centres and corresponding growth in patent filings is a testimony to the abundance of intellectual prowess in the country.

Patents filed by India



(Includes patent filed by Indian resident at Indian and foreign offices[19])

[18] *NASSCOM-FutureFactor360 Primary Research*

[19] *WIPO Statistical Country Profiles*

India has seen significant growth in the number of patents filed over the years. Between 2015 and 2019, the figure has grown approximately at a CAGR of 10 percent. The increased awareness about patents among Indian organizations and various initiatives taken by the government to improve the IP landscape in the country has played a significant role in the growth story.

Indian GCCs too are contributing in fostering innovation. SRI-B, the global capability centre of Samsung, is the largest R&D centre outside South Korea and has alone filed over 3,200 patents to date in India. Over the last three years, there has been a 4x increase in patents being filed annually.[20]

As of 2020, IBM India was granted 930 patents and has been the second-highest contributor to IBM's global tally for four years.[21]

Indian Government's initiatives to improve the patent system

Kalam Program for Intellectual Property Literacy and Awareness

The Indian Government launched the program in 2020 to create and increase IP literacy and awareness. Under this initiative, various awareness programs will be organised to create awareness about the system and the importance of applying for a patent. As a first step under this program, the week from 15 to 23 October 2020 was celebrated as *Intellectual Property Literacy Week.*

Patent Prosecution Highway programmes

The programme was launched to speed up the examination process for corresponding applications filed in participating intellectual property offices. The programme allows applicants to reach the final disposition of a patent application more quickly and efficiently than standard examination processing. It also permits each participating patent office to benefit from the work previously done by the other patent office to reduce examination workload and improve patent quality.

The first pilot programme between Japan Patent Office and Indian Patent Office has commenced for three years, from November 2019. Inventors will enjoy expedited prosecution in India if they have been granted a patent in Japan and vice versa.

Recruitment of examiners

Indian Patent Office has been aggressively recruiting patent examiners intending to reduce the backlog and time taken for the first examination of patent applications from about five to seven years to 18 months. This recruitment had reduced the number of pending applications from over 232,000 in 2017 to 115,750 in 2020.

[20] *https://telecom.economictimes.indiatimes.com/news/samsungs-bengaluru-rd-centre-to-explore-multi-device-intelligence-beyond-5g/80783367*

[21] *https://www.timesnownews.com/business-economy/companies/article/india-second-highest-contributor-after-us-to-ibms-9130-global-patents/706569*

Technology and Innovation Support Centres

India is also currently engaged in opening World Intellectual Property Organization (WIPO)-supported "Technology and Innovation Support Centres". These centres will help innovators access locally based, high-quality technology information and related services, allowing them to exploit their innovative potential and create, protect, and manage their IP rights.

Rebate on patent filing

The initiative was taken to promote awareness and adoption of IPRs by start-ups and facilitate them in protecting and commercializing the IPRs. The Government has provided fast-track examination of patent applications and rebates in fees for start-ups. Start-ups are also provided with an expedited review of patent applications to reduce the time to grant patents.

As of 2021, 510 patent facilitators and 392 trademark facilitators have been empanelled under this scheme to provide free-of-charge services to start-ups. During 2016-20, 2,785 patent applications have been granted an 80 percent rebate on the filing fee, and 5,494 trademark applications have been given a 50 percent rebate on the filing fee.[22] [23]

Key highlights of patents filed

Indian Engineering R&D organizations have been actively focused on research initiatives and contributing to the research community. The patents filed and granted are a testimony to the innovation potential of these organizations.

GCCs[24]

Company Name	Industry Vertical	Total Patents Filed in India*
Philips Innovation campus, Bengaluru	Healthcare	350
Mercedes Benz Research & Development India	Automotive	1,100 (2010-2020)
Samsung R&D Institute India- Bangalore	Telecom and Consumer Electronics	3,200+ Patent families[1]

[1]A patent family is the same invention disclosed by a common inventor(s) and patented in more than one country.

[22] *https://pib.gov.in/PressReleseDetail.aspx?PRID=1738170*
[23] *https://dpiit.gov.in/sites/default/files/lu2166.pdf*
[23] *NASSCOM-FutureFactor360 Primary Research*

ESPs[25]

Company Name	Total Patent Filed*
Infosys® Navigate your next	95
wipro	1,500+
HCL	1,900+

*Number of patents filed since the company was established, unless mentioned otherwise.

Indian Engineering R&D is serving as an inspiration for fast and frugal innovation

Frugal innovation has been one of the hallmarks of Indian engineering and innovation over the years. Indian Engineering R&D has been at the forefront of building ingenious yet effective solutions through frugal approaches.

Frugal innovation is becoming more critical in the post-pandemic world, where companies are increasingly looking at cost-effectiveness. Also, as 97 percent of global population growth is expected to happen in developing regions by 2030, creating products and services for the cost-conscious emerging middle class in these countries is expected to become an engineering and R&D imperative.[25]

A prime example of frugal innovation in India is the Mars Mission or Mangalyaan by Indian Space Research Organization. Through this mission, India became the first country to reach Mars in its maiden attempt and at the least expenses of USD 74 million. The cost was less than making the movie Gravity (USD 100 million). It was approximately one-tenth of what NASA spent on its Maven explorer, and about a fifth of the European Space Agency's Mars Express orbiter. This initiative represented a great leap for India and highlighted its ability to build home-grown technologies across many aspects such as engine, propulsion system, altitude control, thrusters, and antenna.

Many GCCs, ESPs, and start-ups in India have imbibed the philosophy of frugal innovation that has involved building simple, affordable, and accessible solutions.

[25] *Trend Compendium 2030: Demographic dynamics, Roland Berger, 2014*

AlgoSurg

AlgoSurg, a medical device start-up in India, is developing algorithms for 3D simulation of orthopaedic surgeries for various applications ranging from AR-based surgical training, cloud-based 3D surgery planning, automatic patient-specific instrument/implant design, AR-based surgical navigation, and robotics. The solution from AlgoSurg eliminates the need for expensive CT scanners and MRI machines.

Phoenix Medical Systems

Phoenix Medical Systems, a neonatal and maternal-care equipment manufacturer, re-engineered their legacy Continuous Positive Air Pressure machines in 100 days to create Numo, a critical care ventilator to provide ventilatory support for patients suffering from chronic respiratory distress. Numo is designed to provide all the essential modes required for treating and recovering patients with COVID, such as invasive, non-invasive ventilation, and high flow oxygen therapy. The product is a low-cost solution that served significant benefits when India faced the challenge of a lack of indigenous products available at an affordable price to support the enormous demand.[26]

Renault

Renault Nissan Technical Business Centre India (RNTBCI), in partnership with Trivitron, developed Kiran Life Vent-100 by taking the existing ventilator design and improving it for large scale domestic production as a response to the sudden and quick demand increase in India during the pandemic. RNTBCI team utilized all the modern technologies of remote communication and automotive manufacturing such as computer-controlled 6-axis controlled machining for manufacturing ball-screw system and assembly covers for developing a made in India ventilator in a record time of three weeks.[26]

GE Healthcare

GE Healthcare's R&D Centre in India has been leveraging frugal principles to develop affordable products targeted at the low-income segments in India. Notably, the world's first Positron Emission Tomography/CT scanning system that can scan an entire organ with its 26 cm field of view with the highest National Electrical Manufacturers Association (NEMA) sensitivity. The solution can perform more scans in a day, and each scan takes considerably lesser time.

The government is playing a key role in fostering innovation

India is expected to overtake Japan to become the third-largest economy in terms of GDP within this decade. The Indian government is working tenaciously to achieve this goal through various initiatives to improve ease of doing business, encourage Make in India, invite foreign companies with schemes like production-linked incentives, and implement favourable labour laws and agricultural policies, among others. These initiatives have placed India amongst the most preferred countries for the ease of doing business.

[26] *Technology Sector in India, Strategic Review, NASSCOM, 2021*

India has constantly created an environment for innovation to flourish at all levels, including at the grassroots level. Both central and state governments' recent investments and initiatives have significantly contributed to establishing the country as an attractive destination for Engineering R&D.

Central government initiatives related to Engineering R&D/Digital Engineering

Make in India

The initiative is targeted at Indian and foreign companies across different sectors to manufacture in India and boost the Indian manufacturing industry and foster research and innovation in the country. The initiative aims to increase the manufacturing sector's growth rate to 12-14 percent per annum, create 100 million additional manufacturing jobs by 2022, and ensure that the manufacturing sector's contribution to GDP is increased to 25 percent.

Innovate India

It is a platform built in collaboration with Atal Innovation Mission - National Institution for Transforming India (NITI) Aayog and myGov that is open to citizens from all parts of the country to display, promote, and recognize innovations happening across the nation.

Skill India

The initiative was launched to train over 400 million Indians in different industry-related jobs. Skill India seeks to create an empowered workforce by 2022 with the help of various schemes and training courses. *Pradhan Mantri Kaushal Vikas Yojana* is the flagship skill development scheme of this initiative.

Digital India

The initiative seeks to transform India into a digitally empowered society and knowledge economy. The programme is centred on three key areas - digital infrastructure as a core utility to every citizen, governance and services on demand, and digital empowerment of citizens.

As a result of this initiative, as of 2021, India has over 1.3 billion Aadhaar digital biometric identity cards, 676 million smartphone users, 750 million internet subscribers (up by 34 percent since 2018), and 160,000 Gram Panchayats with Optical Fiber Cable connections.[27]

Start-up India

The initiative aims to build a solid ecosystem that will drive sustainable economic growth and generate immense scale employment opportunities. The government, through this initiative, seeks to empower start-ups to grow through innovation and design.

Since the inception of this initiative, over 50,000 start-ups spread over 623 districts from 30 States and 7 Union Territories have been recognised by the government. This initiative created 290,000 jobs across the country, with 45 percent of them having a base in tier-2 and tier-3 cities.

[27] *Technology Sector in India, Strategic Review, NASSCOM, 2021*

Task Force on Innovation

India created a high-level task force on innovation comprising members from the industry and the government to improve its innovation system based on the Global Innovation Index (GII) metrics. This initiative had the mandate of assessing India's position as an innovation destination and suggest measures to enhance the innovation ecosystem to improve India's ranking in the GII.

In collaboration with WIPO, the first India Innovation Index focusing on ranking Indian states was released.

State government initiatives related to Engineering R&D

Karnataka Launches New Engineering R&D Policy

The policy aims to make Karnataka the *Destination of Choice and Powerhouse of Knowledge*. The objective is to foster innovation and increase international Engineering R&D presence in Karnataka by providing subsidies to global organizations looking to establish new R&D facilities or expand existing ones.

Through this policy, Karnataka aims to contribute approximately 45 percent to India's Engineering R&D and create an additional 50,000 new jobs (direct and indirect) approximately, for the skilled workforce in the Engineering R&D sector by 2025. The state intends to grow regional economies by promoting innovation and Engineering R&D across the state, develop a research-oriented professional talent pool, and foster a knowledge economy.

Telangana State Innovation Policy

The policy encourages entrepreneurs and start-ups. The key focus areas of the policy include IoT, health-tech, sustainability, and fintech. The policy aims to develop physical infrastructure and program management capabilities, sustainable funding models, human capital for learning, experimentation, and innovation, and promote and identify innovation by proactive engagement with industry.

Under this policy, 1 million sq. ft. of workspace dedicated to start-ups will be developed, and a 3 million sq. ft. facility to house 900 start-ups will be completed by 2022. It also encourages universities to introduce the concept of Student Entrepreneur in residence.

The contributions of GCCs, ESPs, and Start-ups with the government's interventions have put India on the global map of innovation.

TALENT EXCELLENCE

In this sub-section, we discuss India's vast talent pool

- India has one of the largest Engineering R&D talent pools in the world to address the scalability needs of global enterprises.
- Indian Engineering R&D talent is well distributed, enabling global companies to set up multiple bases to address talent availability and business continuity risks.
- India is fast emerging as the talent hub for new-age digital technologies.
- Indian Engineering R&D ecosystem is investing in programs to drive up-skilling and re-skilling of talent.
- India has a diverse workforce that addresses the evolving needs of global enterprises.
- India has a robust university ecosystem to create a strong pool of talent, further propelled by partnerships with Indian Engineering R&D GCCs and ESPs.

TALENT EXCELLENCE

Talent represents an organization's most valuable asset. This is truer now, more than ever before, with high competition, led by an increasing digital skills shortage, generational shifts, and the shifting dynamics around the nature of work in the current era.

Many megatrends such as globalization, technology advancements, changes in the business environment, and the onset of new standards due to pandemic have given rise to a new world, where talent has become the primary determinant of the success of the organisations.

According to the PwC CEO Survey 2019, 55 percent of CEOs stated that the number one impact of the availability of talent with key skills is the inability of their organization to innovate effectively.[1] Therefore, acquiring the right talent has become an essential factor in achieving growth and the organization's goals.

India has one of the largest Engineering R&D talent pools

Currently, global companies are facing a severe talent shortage. As the technology evolved, it contributed to a change in the nature of work, reducing talent availability and creating a talent imbalance. A study conducted by Korn Ferry across 20 major economies in 2018 showed that the lack of skilled workers would result in an 85 million worker shortage worldwide by 2030. The biggest threat is to the developed economies like the US, Germany, Japan, and France. Meanwhile, ***India, one of the fastest-growing economies globally, will have a talent surplus by 2030 due to a growing, younger workforce, while countries like China, Japan, or the US, face the issue of ageing populations.***[2] With its extensive English speaking and skilled workforce, India is expected to become the world's leading provider of skilled talent.

Global enterprises have built either the largest or the second-largest Engineering R&D hubs in India

In the past, India was traditionally chosen as the destination of cost-effective talent. However, Indian Engineering R&D has redefined its narrative to value-creation and breakthrough innovation rather than cost arbitrage with changing times. This has spurred many companies to expand their operations in India. Today, these Engineering R&D centres are developing high-tech products and solutions that are disrupting the global market.

[1] *22nd Annual Global CEO Survey, PwC, 2019*
[2] *The Global talent Crunch, Korn Ferry, 2018*

Many global enterprises have built either the largest or the second-largest ER&D hubs in India, often with a headcount exceeding that of their headquarters.[3]

Company Name	Industry Vertical	Engineering R&D Headcount (2020)	Highlights
SRI-B	Telecom and Consumer Electronics	3,000 -5,000	Largest centre for Samsung outside Korea.
Philips Innovation Campus, Bengaluru	Healthcare	3,500-4,000	Base for end-to-end development and management of multiple product lines such as ultrasound, MRI, and personal health, among others.
Intel Technology India Pvt. Ltd.	Semiconductor	9,000	Largest design and engineering centre outside the US, with state-of-the-art design facilities, located in Bengaluru and Hyderabad.
MBRDI	Automotive	5,500-6,000	Largest R&D centre for Daimler outside Germany, working seamlessly for all business units of MB cars, vans, trucks, and buses.

[3] *NASSCOM-FutureFactor360 Primary Research*

Ability to drive quick talent ramp-up

India offers the unparalleled ability for enterprises to scale up their talent requirements. Approximately over 750,000 engineers are engaged in the Engineering R&D sector in India across various mechanical, embedded, and digital domains.[4] With technology being the defining factor for all the sectors, India has highly skilled talent and the scale to meet the increasing demand. The scale of India's skill in Engineering R&D is unrivalled by any country in the world.

For instance, Micron Technology, Inc. presents an excellent example of a quick scale-up in India. Within three years of incorporation in India in 2018, the India centre scaled up its headcount by 40x. The company recently announced that it targets to increase its headcount from 2,000 to 5,000 in the next couple of years.[5]

India comprises of a vast young demographic with the highest percentage of working-age adults

India is the second-most populous country in the world, with a population of 1.38 billion.[6] India has a favourable and young demographic as compared to other countries. In 2020, the average age of India's population was 28.4 years.[7] According to United Nations Population Fund (UNFPA) projections, India will continue to have one of the youngest populations in the world till 2030.

The share of the working population of India is on the rise. According to Bloomberg News analysis of the UN population-projection data 2017, ***India's millennial generation is larger than China's or the US, which will boost the nation's labour force to the world's largest by 2027.***[8]

In addition, India produced around 9.4 million graduates in FY 2020, which included 2.2 million in the Science, Technology, Engineering, and Mathematics related disciplines.[9]

Indian Engineering R&D talent is well distributed across the country

India's tier-1 cities and metros are known for their talent availability and have been popular choices for global enterprises for many years to set up their GCCs. Bengaluru, Hyderabad, Pune, Chennai and National Capital Region (NCR) have been key destinations to tap into the Engineering R&D talent pool.

Concurrently, other metro and tier-2 cities have also attracted many companies due to their conducive ecosystem, talent pool, and lower cost of doing business. Metro cities like Kolkata and tier 2 cities like Ahmedabad, Coimbatore, Kochi, Trivandrum, are some of the cities that are fast emerging as preferred destinations for Engineering R&D.

According to Talent500, a recruitment agency, there has been a 30-40 per cent increase in demand for workforce in tier-2 cities within tech teams across sectors in 2020.[10]

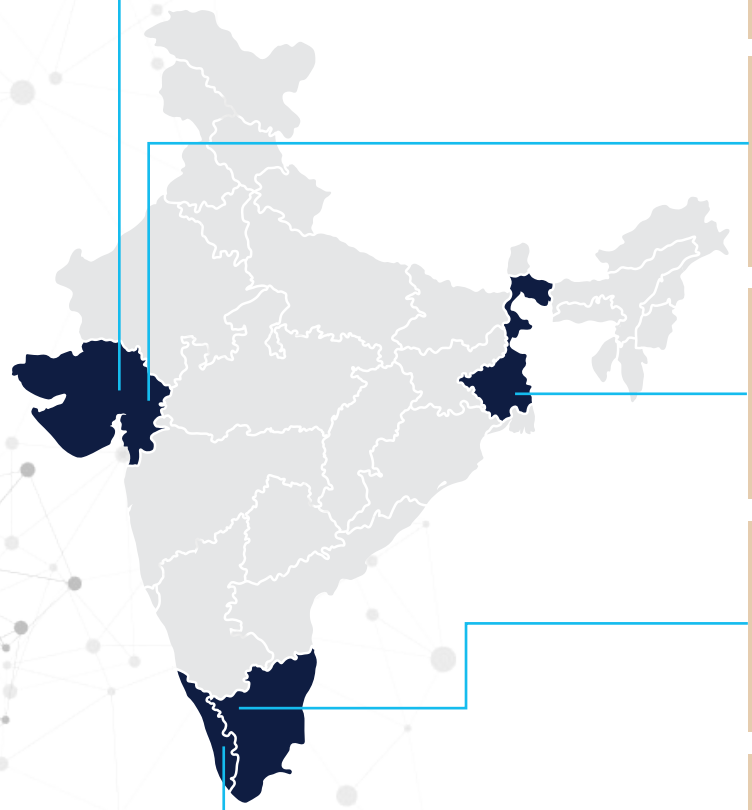
[4] *NASSCOM Research*
[5] *https://hr.economictimes.indiatimes.com/news/industry/micron-india-to-increase-its-staff-strength-from-2000-to-5000-in-two-years/80618880*
[6] *The World Bank*
[7] *Statista (https://www.statista.com/statistics/254469/median-age-of-the-population-in-india/)*
[8] *https://www.financialexpress.com/economy/indias-millennial-generation-bigger-than-china-to-boost-nations-workforce-to-worlds-largest-by-2027/836248/*
[9] *All India Survey on Higher Education 2019-2020, GoI Ministry of Education*
[10] *https://hr.economictimes.indiatimes.com/news/trends/wfa-promotes-tier-2-towns-as-talent-hubs/82736332*

Tier-1 cities

LOCATION	FOCUS AREAS	KEY GCCs	KEY ESPs
Bengaluru	Automotive, Telecom, Semiconductor, Consumer Electronics	Dell Technologies, Samsung, Bosch, Philips, GE, Boeing, Mercedes-Benz, IBM, Cisco	Infosys, Wipro, TCS, Mindtree, HCL, Tech Mahindra, KPIT
Chennai	Automotive, Industrial	Daimler, Ford, ABB, KONE, Flowserve, Renault Nissan	Capgemini, Infosys, Wipro, Tech Mahindra
Hyderabad	Semiconductor	Collins Aerospace, Micron, Intel, Qualcomm, NVIDIA	CYIENT, Infosys, TCS, Tech Mahindra
Pune	Automotive, Industrial, Electrical, Chemicals	JCB, John Deere, Volkswagen, FCA	Tech Mahindra, KPIT, Infosys
Mumbai	Industrial, Energy	Siemens Healthineers, Johnson Controls, Schneider Electric, Schlumberger	TCS, CYIENT, KPIT

LOCATION	FOCUS AREAS	KEY GCCs	KEY ESPs
NCR	Telecom	AXALTA, Sprint, Rockwell Collins, AT&T, YAMAHA	HCL, wipro

Other Metros and Tier-2 cities



KEY GCCs AND ESPs	KEY GCCs AND ESPs
Ahmedabad	PANAMAX, wipro, TCS TATA CONSULTANCY SERVICES
Vadodara	xylem, TCS TATA CONSULTANCY SERVICES, L&T Technology Services
Kolkata	Lexmark, Hyland, Tech Mahindra, wipro
Coimbatore	BOSCH, CAMERON, wipro, TCS TATA CONSULTANCY SERVICES
Thiruvananthapuram	NISSAN, Infosys Navigate your next, TCS TATA CONSULTANCY SERVICES

India is fast emerging as the talent hub for new age digital technologies

Digitalization has brought in significant changes in the way organizations function. While it simplifies and reimagines products, plants and processes, it also demands specialized skills. With an increase in digitalization, the demand for digital talent AI, ML, robotics, blockchain, NLP, cyber security, and other high-tech skills has seen an uptrend despite the pandemic. And this demand vis-a-vis supply gap is expected to further increase to 20 times by 2024.[11]

India has one of the largest digital talent pools, with nearly 1.17 million categorized as digitally skilled. The digital talent pool is expected to grow at a CAGR of 28-32 percent (FY 2020-2024).[12] According to NASSCOM's demand-supply analysis, the installed talent base of digitally skilled professionals in India across emerging technologies stood at 884,000 in FY 2020. The installed base is expected to increase to about 2.4–2.6 million by FY 2024.[13]

Digital Technology	Installed talent (FY 2020) (percent)[14]
IoT	7-9
AI and Big Data Analytics (BDA)	13-15
Cloud Computing	20-22
Cyber Security	4-6
RPA	3-5
Other (includes AR/VR, Blockchain and 3D Printing)	~3

[11] *FutureSkills Talent in India: Demand-Supply Analysis, NASSCOM, Oct 2020*
[12] *Technology Sector in India, Strategic Review, NASSCOM, 2021*
[13] *FutureSkills Talent in India: Demand-Supply Analysis, NASSCOM, Oct 2020*
[14] *NASSCOM-FutureFactor360 Primary Research*

India offers a huge "Product Management" talent pool

With the world moving towards digital transformation, another skill that has become most sought after is product management. Product managers are the front-riders of the wave of digitalization, and their role has emerged as one of the most pivotal to the organization's core strategy. Product management is the interlock between engineering teams, business heads, and the customers. This intersection has made the function a core requirement for today's global enterprises. With the pandemic affecting businesses in unexpected ways, organizations are driven to accelerate their digital transformation processes, creating a demand for a workforce with skills and the ability to take accountability for an end-to-end product or service delivery. This has made product management one of the most in-demand roles.

With increasing levels of autonomy and ownership of platforms/products for the tech teams in India, the number of product management role is on the rise in the country. ***Many MNCs are increasingly creating product management functions that they are leveraging to manage the entire product development process within the country.***

Examples of the cutting-edge products developed with complete ownership by GCCs in India:[14]

Company	Product developed with 100 percent ownership in India
Western Digital	**SanDisk Extreme® 1 TB microSDXC™ UHS-I card:** World's fastest microSD card released in 2019, enables Mobiles, AR/VR sets, Drones, etc., to store tons of Apps, FHD/4K/8K content, and high-resolution photos.
BOSCH	**Phantom:** An AIoT platform that enables real-time monitoring and management of assets and physical workspaces.
PHILIPS	**Affiniti 30:** A high performance and low-cost ultrasound system based on the scalable architecture of high-end ultrasound systems developed for the traditional ultrasound shared service market.
Infineon	**PAG1S:** A scalable type-C AC/DC power adapter solution to design power adaptors of different power levels with minimal system architectural changes for cell phone charger applications.
JCB	**3DX ecoXpert backhoe loader:** A new intelligent backhoe loader with an Intelli-performance management system to improve asset efficiency for construction operations.

[14] *NASSCOM-FutureFactor360 Primary Research*

There are multiple initiatives to enhance the product management capabilities in the Indian Engineering R&D ecosystem.

NASSCOM Product Connect is one such initiative that endeavours to develop partnerships with various stakeholders i.e., industry, research institutions, academia, and subject matter experts to build a network of product management evangelists to drive the innovation, upskilling, and reskilling agenda across the Indian software product ecosystem.

Indian Engineering R&D ecosystem is investing in talent up-skilling and re-skilling programs

The Engineering R&D industry is undergoing a massive transformation. The growing proliferation of new-age technologies such as AI, automation, IoT, and robotics is redefining the Engineering R&D industry with a need for new-age skills and competencies. The nature of work is changing quickly with the advent of automation. Each year, the industry is witnessing new job titles such as *data scientist, machine learning engineer, and experience architect*, etc., requiring new technical skills and expertise in specific domains. To develop a talent pool of future-ready employees, companies have deployed various initiatives to re-skill and up-skill their employees to keep up with modern technology and industry trends.

GCCs' talent initiatives[15]

GCC	INITIATIVES

SAMSUNG	• **Higher Education**
	  – Collaboration with International Institute of Information Technology Bangalore (IIIT, Bangalore) – Sponsored 180 graduates for their Masters at the institute.
	  – Sponsored part-time PhDs with IISc, Bangalore and IIT, Madras.
	  – Sponsor full-time M.Tech at any IIT based on Graduate Aptitude Test in Engineering (GATE) score and selection of employees.
	  – Collaboration with IISc for their upcoming part-time M-Tech program.
	• **Software competency program:** A global program for all the software category engineers with three certification levels, Advanced, Professional and Expert. The program's objective is to build algorithms, write code most efficiently, and leave no *technical debt*. At any point in time, an engineer spends 4-6 hours per month practising for the test to move to the next level and another 4-8 hours per month taking the test in person at Samsung premises. It's one of the most rigorous and respected certifications in the industry, which does not have an equivalent amongst Samsung competitors.

[15] *NASSCOM-FutureFactor360 Primary Research*

GCC	INITIATIVES

SAMSUNG	• SRI-B also focuses on building domain expertise via:
	  ◦ AI/ML Centre of Excellence through collaboration with Texas University Austin and Great Learning program (Post Graduate diploma in AI/ML – 11 months program).
	  ◦ Working with IISc for short term courses (2-4 months).
	  ◦ Free availability of all Coursera/Udemy courses to employees to pick up anything of their interest.
	  ◦ Sponsorship for Amazon Web Services certification for select employees.
	  ◦ Multiple internal webinars from Subject Matter Experts (SMEs) for cross organization learning.

	• **Online learning platforms:** To enable and facilitate anytime/anywhere learnings for employees (tailor-made courses specific to functional requirements).
	  ◦ **One for IT:** To meet the needs of all learners with interactive learning, live online training courses, books, videos, and more.
	  ◦ **One for Engineering Org:** To provide the best-in-class content in the automotive space for the employees.
	• **M.Tech and PhD course support:** To enable employees to pursue academics in fields of mutual interest for company and individual by fully funded and customized courses.

PHILIPS	• **Boot camp for campus hires:** To expose software engineers, fresh graduates from college, and interns less than three months in the system to the real-world live scenarios through gamified and simulated case studies and agile workflows.
	• **Crafting code quality:** To orient junior technologists and specialists to:
	  ◦ Understand the importance of clean coding practices.
	  ◦ Distinguish between clean and dirty code.
	  ◦ Understand how dirty code can generate more technical debt.
	  ◦ Appreciate the adoption of Test-Driven Development, Continuous Integration, and other software best practices to improve code quality.

GCC	INITIATIVES
PHILIPS	• Realize the cost savings for organizations through clean coding practices. • Internalize the passion required to practice clean code. • **Philips architecture programs:** To develop and instil architectural style thinking in Junior and Senior Architects and become an effective technology leader.
intel	• **Leadership xPO for leaders:** A customized program to build well-rounded leaders with 21st century skills. • **Leading Edge for managers:** Immersive learning sessions for managers to connect, share and learn from peers and subject matter experts. • Technical leadership development programs for technical talent. • **Data-centric skills:** AI, security, cloud computing for all employees, and customized technical modules for domain experts.

Talent initiatives by ESPs[16]

EPS	INITIATIVES
wipro	• **Talent Transformation group:** A 100+ strong faculty team supports upskilling and cross-skilling employees in various emerging technologies and management studies. In FY 2021, thousands of Engineering R&D employees attended 8,000 sessions of proactive training as part of their upskilling and cross-skilling. • **Immersive programs:** These programs help employees build excellent skills. They equip employees to develop end-to-end solutions using polyglot technologies and help to understand the emerging technologies and contribute faster. Hundreds of employees completed immersive upskilling programs in FY 2021 that included deep-dive learning of cutting-edge digital skills like micro services, DevOps, ML, front end development, IoT engineering, 5G and wireless, data science, and cloud-native.

[16] *NASSCOM-FutureFactor360 Primary Research*

EPS	INITIATIVES
wipro	• **TrendNxt:** A skill-based learning framework, which aims at enhancing employees' technical knowledge year on year. It follows a credit point approach wherein credits are earned by undertaking technical certifications and attending technical training.
Infosys® Navigate your next	• **Lex-Infosys Digital Learning Platform:** The platform enables learners to learn anytime, anywhere, and through any device by providing personalized learning content, sandbox environments for practice, and secure certification assessments. Employees can receive on-demand education based on their performance reviews and feedback from managers and clients on the platform. Over 100 new courses and certifications relevant to engineering skills are developed and launched on the platform every year. • **Account-specific Academies:** To facilitate faster onboarding and to meet continuous talent needs and skill improvement of focus/key accounts, delivery leadership and academy SPOCs established account-specific academies to train talent on required technologies, domains, processes, and behavioural skills. Also provided are client-specific training sessions on techniques and tools. • **Manager and Leadership Enablement Programs:** Leaders and managers are continuously led through master classes, technology manager training programs and certifications, and MaQ programs on digital skills. First-time managers, experienced managers, as well as high-potential managers, can participate in MaQ programs. Harvard, Stanford, IIM, Cornell, and Purdue partnerships are utilized to provide leadership, strategy, and program management training.

Talent initiatives taken by the government and industry bodies

The Government of India has taken various initiatives to re-skill and up-skill the talent. The Indian government is focusing its efforts on getting the young population trained in the skills required to increase employability and reduce the talent gap. Even various industry bodies and government think-tanks such as NASSCOM and NITI Aayog have come up with multiple initiatives that aim to skill students in different new-age technologies and make them future-ready.

Central Government of India	**Pradhan Mantri Kaushal Vikas Yojana** Through this unique initiative, the government aims to train 2.4 million Indian youth as per industry standards and their requirements.
NITI Aayog	**AI Step-Up Module** NITI Aayog's Atal Innovation Mission, in collaboration with NASSCOM, launched an AI-based module to empower 2.5 million students to learn various concepts of AI. The government directs the module in building citizens and a workforce aware of AI and can work with AI.
NASSCOM	**FutureSkills Prime** A skilling ecosystem focused on emerging technologies, powered by a partnership between the MeitY, Government of India, NASSCOM, and the IT industry. In this initiative, the B2B FutureSkills model was extended to cater to individuals' re-skilling/up-skilling needs through a B2C offering. The platform would provide interested candidates with multiple options for their skilling needs. Through this initiative, the government and industry aim to re-skill/up-skill about 1.4 million employees over five years (1 million from a company supported (B2B) skilling and another 0.4 million from this government supported/facilitated (B2C) scheme).
National Skill Development Corporation of India (NSDC)	**Skill India** Under the Ministry of Skill Development and Entrepreneurship guidance, NSDC has introduced the initiative to allow aspiring candidates to register for skill training/learning and employment opportunities through the online portal. Launched in 2015, Skill India aims to train over 400 million people in India in different skills by 2022.
MeitY, GoI	**Indian Nanoelectronics Users Programme** Implemented at Centre of Excellence in Nanoelectronics at IISc and IIT, Bombay and has provided an excellent opportunity for the R&D community all over the country to access the state-of-the-art nanofabrication facilities for undertaking research and skill development in Nanoelectronics. About 400 researchers are being imparted hands-on training in Nanofabrication at these centres every year.

Industry and government collaborations

NSDC	Microsoft	Microsoft collaborated with the NSDC to skill more than 100,000 under-served women in India. This partnership is focused on enhancing women's workforce participation by equipping them with the skills required to thrive in a digital economy.
NSDC	IBM	IBM and NSDC collaborated to offer a free digital education platform focused on emerging technologies and professional development skills. As a part of the collaboration, IBM curates online courses from the *Open P-TECH* platform and offers them to users through NSDC's eSkill India portal to empower the country's youth with various skills to succeed in their future careers.
GoI, NITI Aayog	intel	Intel India collaborated with the government, NITI Aayog, and other local partners to design and build tinker labs in schools and community organisations. These labs provide youth with an opportunity to learn technology skills, develop a design mindset, and be inspired to innovate. The plan is to use the first ten prototype labs as the model for building hundreds more across the country.
National e-Governance Division, MeitY, GoI	intel	Intel India collaborated with National e-Governance Division, MeitY, and Government of India to design a national program for government schools, *Responsible AI for Youth*, to empower the youth to become AI-ready and help reduce the skill gap.

India has a diverse workforce that addresses evolving needs of global enterprise

Diversity across culture, gender, and other parameters have proven to deliver organizations with a host of intangible benefits. Various studies have shown that companies that focus on diversity and inclusion as part of their corporate strategy perform better, hire better talent, have more engaged employees, and retain professionals better than companies that don't. The diversity of views has become integral to the organizations in their quest to build solutions and products that can cater to the diverse market and evolving customer needs. Creating a microcosm of the natural world within the organization helps bring out different perspectives and nuances.

India is one of the world's most diverse countries. There are many benefits that Indian organizations enjoy from having access to a skilled, diverse workforce. With the passage of time, companies have developed environments of inclusion for their workforce by embracing all cultural and social backgrounds, regardless of size and other parameters, while gaining an organization's benefits from diversity.

Companies in India are also witnessing progress in gender diversity and making the workplace safer and inclusive for women and the LGBTQIA+ communities. The structured gender diversity programs in India's IT sector have enabled the diversity ratio to reach 35 percent, which is an improvement of more than 10 percent over the last decade. In the IT industry, women accounted for 44 percent of total net hiring, and executive-level roles held by women doubled in 2020.[17] In addition, larger companies like Intel, Uber, Ford Motor, and Goldman Sachs participated in India's first-ever job fair focused on the LGBTQIA+ community in Bengaluru in July 2019, paving the way for greater inclusivity for others to follow.[18]

The Engineering R&D GCCs and ESPs understand the need, importance, and benefits of having a diverse workforce. These GCCs and ESPs have taken several crucial steps to increase the gender diversity in their workforce and retain them for the long term.

Initiatives taken by GCCs[17,19]

GCC	INITIATIVES
SAP	Introduced a program in 2011 to increase the number of women leaders in its senior leadership from 18 percent to 25 percent by 2017. The program has been a success and is extended to increase diversity to 30 percent by 2022.
intel	Set organizational targets for improving gender diversity in their technical workforce. The company's *2020 Corporate Responsibility Report* aims to increase the representation of women in the technical workforce from 27 percent to 40 percent by 2030. The initiative had significant support from the Intel board, 40 percent of whom are women.

[17] *India's Tech Industry: Women for the Techade, NASSCOM, Mar 2020*
[18] *https://edition.cnn.com/2019/07/12/business/india-first-lgbti-job-fair/index.html*
[19] *NASSCOM-FutureFactor360 Primary Research*

GCC	INITIATIVES
Texas Instruments	The *Women for Technical Leadership* program has helped the company retain and provide a technical career path for its employees. In 2019, the one-year program saw a 71 percent increase in enrollments from 69 to 118, thus helping the organization internally build a diverse portfolio of technical leadership.
Mercedes	*Mercedes in Mech* is a scholarship program for women in mechanical engineering. Through their network of 10 engineering colleges across Bengaluru, Mysore, Pune, Belgaum, and Coimbatore, it offers an annual scholarship of INR 100,000 to eligible women, who are then placed as *Graduate Engineer* Trainees at MBRDI on successful completion.
BOSCH	Multiple initiatives are undertaken such as *Womentoring*, *Winning with Women*, *Diversity Week*, and *Diversity Quiz*.
PHILIPS	*Back in the Game* is an initiative to encourage women on a break, due to personal or professional reasons, to resume their corporate career, where women returnees get to work on live strategic projects. As part of this initiative, Philips provides structured on-boarding, focused mentoring, flexible work options and on-the-job learning to women returnees.

Initiatives taken by ESPs[20,21]

ESP	INITIATIVES
wipro	*Women of Wipro Framework* is a unique life stage-based approach tailored to nurture/groom women at each stage of their life and work as the needs and expectations of women employees are different.
HCL	• L1 mandate ensures there is a representation of women leaders in the upper echelons of leadership. • *ASCEND* and *Stepping Stones* are career development programs for women leaders and focuses on mentoring them for their aspired roles.

[20] *India's Tech Industry: Women for the Techade, NASSCOM, Mar 2020*
[21] *NASSCOM-FutureFactor360 Primary Research*

ESP	INITIATIVES
Infosys® Navigate your next	• *Women Wizards Rule Technology* is a unique initiative, in partnership with NASSCOM, designed to skill 10,000 women in the new and emerging technologies for the Indian industry. • *Infosys Women's Inclusivity Network* is an initiative to promote a gender-sensitive and inclusive work environment in Infosys offices across the world, help women in their career lifecycles and train women for managerial and leadership roles.
L&T Technology Services	*Wings* is a gender diversity and inclusion campaign aimed at building a culture that promotes hiring women, developing their careers, and retaining top talent.

Women in the Indian Engineering R&D space have served as ambassadors for the industry, not only within their own companies, but also across Engineering R&D as a whole.

Women leaders from GCC[22]

Dr Pallavi Vajinepalli
Principal Scientist and Group Leader

PHILIPS

Dr Pallavi Vajinepalli holds a PhD in Computer Science and Engineering from IIT, Kharagpur and is a Principal Scientist and Group Leader at Philips. She is responsible for creating and driving roadmaps for innovation in ultrasound and industrial research to enable meaningful innovation. She has developed multiple medical device solutions such as automated colposcopy, automated 2D fetal biometry, and follicle counting. Her innovation activities include filing 35 international patents, 18 of which were granted, and publishing over 20 research articles.

Rupa Kamoji
Director R&D

SYNOPSYS® Silicon to Software™

Rupa Kamoji, Synopsys' Director of R&D, has over 20 years of experience working on CADNAV products. In coordination with the cross-functional core team, she is responsible for managing the product's life cycle and planning SRM releases. Additionally, she works closely with the sales team to drive business growth. On the innovation front, she has contributed to four international patents and published six international articles.

[22] *NASSCOM-FutureFactor360 Primary Research*

Kala Sampathkumar

Director

Kala Sampathkumar has over 25 years of experience, leading over 80 professionals at Dell Technologies, where she currently serves as Director. She is responsible for delivering high-quality projects, which contribute to innovation, quality, and productivity across the organization. She has 13 authorized patents, and one of her patents was selected by Dell as the top 3 inventions in India.

Dr Deepika Sachdeva

Customer Support Manager and
Technology Leader APAC

Dr Deepika Sachdeva leads GE Aviation's Materials Engineering and Advanced Services Technologies Team in India. Recently, she was inducted into GE's prestigious Accelerated Leadership Program. Under this program, she manages the deployment of advanced technologies to improve performance and operations in GE Aviation's Customer and Product Support organization. Deepika has filed six Indian and international patents and published eight journal articles and 12 conference proceedings on the innovation front.

Women leaders from ESP[23]

Sindhu Ramachandran S

Principal Architect

Sindhu Ramachandran leads the Artificial Intelligence Centre of Excellence for the Electronics and Embedded Systems service line at QuEST Global. Her work focuses on computer vision in the software and digital space. Her primary responsibility is to provide the best AI solutions to customers and end-users using ML and deep learning. She has been instrumental in setting up competency frameworks, certifications and defining best practices for AI and analytics across the organization. She also drives an 'innovative culture' by implementing QuEST's hardware and software solutions through CoEs and labs for partners at the QuEST premises.

[23] *NASSCOM-FutureFactor360 Primary Research*

Saraswati Thippaiah
Principal, Advanced Engineering

Saraswati Thippaiah is the Principal of Advanced Engineering in Infosys. She is responsible for emerging technology incubation, automation strategy definition, architecture design team and stakeholder management, and new business development. She has worked on multiple technical projects in robotics automation. On the innovation front, she has filed four patents and published two research articles.

Ashwani Nandini
India Head, Delivery and Digital Assurance

In her current role as India Head, Delivery and Digital Assurance at GlobalLogic, Ashwani Nandini is responsible for predictable delivery at scale, thus ensuring customer delight and industry leading NPS. She has set up several nimble, globally recognized frameworks to enable delivery and digital assurance. She was recognized as the Global Capability Champion 2018 for *Predictable Measurement Framework for Agile* in the Capability Championship 2018 by SEI. She has been instrumental in establishing the Noida centre of GlobalLogic as the largest engineering centre globally for delivering complex digital transformation engagements and setting up large product engineering labs and the "India Design Studio" that enabled India to deliver design-led engineering engagements.

India has a robust university ecosystem

According to Global Innovation Index 2020, India ranks 61st in the innovation input pillar "Institutions", a jump of 16 places compared to the previous year. ***India holds top positions in the quality of its universities (22nd globally), and the quality of scientific publications (21st globally) due to the presence of top universities*** such as the Indian Institute of Science, Bengaluru and the Indian Institutes of Technology.[24]

A robust university ecosystem enables the scale of talent. India has 6,163 engineering institutes with 2,541,152 enrolled students.[25] It has 23 Indian Institutes of Technology, 31 National Institutes of Technology and 3,175 Government Industrial Training Institutes, along with private-run engineering colleges and industrial training centres.[25] [26] To ensure the graduates to be industry-ready, the GCCs, ESPs, and universities have collaborated to design an effective and industry-relevant curriculum together.

[24] *Global Innovation Index 2020 report*
[25] *Ministry of Education, Government of India*
[26] *Ministry of Skill Development and Entrepreneurship*

To stay updated with changing industry requirements and technologies, many educational institutions are incorporating new and niche streams/branches of specializations.

College/Universities	New age technology courses offered in India
IIT, Hyderabad	India's first B.Tech in Artificial Intelligence Programme. Globally, it is the third institute to offer a B.Tech program in AI, after Carnegie Mellon University, and MIT in the US.
IIT, Delhi	Set up "School of Artificial Intelligence" and is offering PhD from January 2021. The institute is also planning to offer postgraduate level degree courses.
IIT, Madras	Free courses for electrical engineers. The 12-week course helps to specialise in signal processing, stochastic control, communications, networks, ML, and related areas.
IIT, Jodhpur	A new undergraduate programme in AI and Data Science from the academic session 2020-21.
IIT, Roorkee	An online course in data science. The course aims to boost career through the foundations of Python scripting and principles.
IIT, Guwahati	An online course on "Fundamentals of Artificial Intelligence". The course will help to develop reasoning and various learning methods of AI.
IIT, Ropar	B.Tech programme on computational data sciences. The programme will mainly emphasise on AI.
IIT, Kharagpur	A free online course on Industry 4.0 and IIoT.

University and industry collaboration

Organizations are partnering with Indian universities to develop industry-specific curriculum that helps create a pipeline of the industry-ready and quality talent pool. Apart from jointly creating course curriculum, few companies also offer elective courses to university students on emerging new-age technologies and are also mentoring PhD students.

Manipal Academy of Higher Education (MAHE)	PHILIPS	Philips collaborated with MAHE in developing the *Design and Definition of AI and Data Science* curriculum and joint mentoring programmes for PhD candidates.[27]
National Institute of Engineering, Mysore	PHILIPS	Philips conducts an elective course on *Data Science and Machine Learning* for final semester B.Tech students at the National Institute of Engineering, Mysore.[27]
IIT, Guwahati	SAMSUNG	Samsung India set up a digital academy at IIT, Guwahati to train more than 300 engineers in the next three years on cutting-edge technologies like AI, ML, IoT, among others.
IIT, Roorkee	NVIDIA	Nvidia collaborated with IIT, Roorkee to develop high-performance computing programming and deep learning skills to bridge the gap between academia and industry.
IIT, Kharagpur	SAMSUNG	Samsung has signed a MoU with IIT, Kharagpur to set up a digital academy on the institute's campus to train students for job readiness.

[27] *NASSCOM-FutureFactor360 Primary Research*

SR UNIVERSITY **SR University**	CYIENT	Cyient partnered with SR University to improve its engineering curriculum, address skill gaps, and prepare students for the industry. [28]

In addition, Intel Technology India Pvt Ltd partnered with the Central Board of Secondary Education (CBSE) through its "AI for Youth Program". The collaboration has led to several major milestones in improving AI readiness in the country, including the introduction of an AI curriculum for students, the establishment of AI skill labs for students, and the training of AI facilitators for CBSE schools. Intel has trained 111,183 young people about AI in an inclusive manner through this program. A Guinness World Record was set last year by Intel and CBSE for training 13,000 students in artificial intelligence (under Intel's AI for Youth Program) in 24 hours.[28]

With a young workforce, well-trained, and quality education at a reasonable cost, India has the potential to become one of the world's top talent sources. A focus on identifying and developing the right skills for the future and training India's current talent has placed India on the right path to achieving a supply-demand balance for talent.

[28] *NASSCOM-FutureFactor360 Primary Research*

SERVICE DELIVERY EXCELLENCE

In this section, we discuss the excellent service delivery provided by Indian GCCs and ESPs.

- Indian Engineering R&D players are driving excellence in service delivery for their customers by leveraging best-in-class talent, solution accelerators, etc.
- New innovative business and engagement models are being explored and deployed to drive enhanced impact
- Indian Engineering R&D ecosystem players have put in robust business continuity plans that were demonstrated during the global pandemic
- Robust processes ensure that IP is protected

SERVICE DELIVERY EXCELLENCE

In the current era of emerging technologies, global businesses are undergoing a paradigm shift. Technology has influenced significant changes across all the industry verticals, and Engineering R&D players are no exception to this. With growing customer expectations and the increasing need for differentiation, Engineering R&D players are driving high-quality service delivery in the quickest time, at the most optimal cost, through differentiated engagement models.

Indian Engineering R&D players are driving excellence in service delivery

India remains a dominant player in the context of global Engineering R&D. The engineering services landscape has evolved significantly over the years, reflecting maturity, diversification, and specialization to address the emerging needs of global enterprises. Today, Indian engineering services providers are becoming innovation partners for multinational companies to develop cutting-edge products and solutions.

The Indian service providers are gaining a competitive advantage by building capabilities and partnerships that provide the ability to deliver at speed and scale. With an ever-increasing demand for innovation and faster delivery of services to meet market demands, faster time to market has become one of the essential elements of service delivery. Indian Engineering R&D players are investing in creating IPs, platforms, and solutions accelerators to reduce time to market and costs and increase the quality of delivery.

Key service delivery initiatives -ESPs[1]

CYIENT

Service Delivered	Approach - Accelerators and IPs	Impact
Enabling 5G access to 20 percent of Australia's population Cyient helped a major communication service provider roll out the 5G technology through a 'maximum coverage with minimal infrastructure' network design principle to provide nearly 20 million Australians network access.	• Advanced RAN engineering for superior coverage planning • Workflow automation for optimized throughput • Digital twin for the superior design output	• One site delivered per day, enabling 50 percent population coverage ahead of target. • One out of five Australians got access to 5G network.

[1] *NASSCOM-FutureFactor360 Primary Research*

KPIT

Service Delivered	Approach - Accelerators and IPs	Impact
Development of Advanced Driver Assistance Systems and Autonomous Driving technology KPIT helped a leading automotive client develop Advanced Driver Assistance Systems (ADAS) and Autonomous Driving (AD) technologies for their vehicle by leveraging its expertise in end-to-end software integration and technology partnerships.	• Feature and functions IP to share the feature development • Automated SIL framework for virtual simulation and validation • Automated reprocessing and cloud applications • MBD CI, virtualization tools • Advanced technologies used - AI, ML, DL, DevOps, software industrialization, software refactoring, model-based development, virtual simulation, continuous integration, and continuous development	• Achieved ADAS (Level-2) and AD (Level-3) autonomous vehicle production. • KPIT is a partner for all programs for the last 4-5 years until 2030, delivering 5-model year vehicle programs. • Reduced product development costs . • 99.5 percent defect-free delivery.
Software development and integration for Charger Control Unit KPIT helped a German automotive OEM and their tier-1 supplier resolve existing issues with their Charging Control Unit software for their electric vehicle product line to become a tier-1 software supplier.	• The newest global charging protocols for electric cars, such as CHAdeMO, GB/T and ChaoJi • AUTOSAR-based development on multi-core ECU • Remote software update • Security and 128-bit encryption on embedded processors using HSM • Agile software development	• Software on-demand, allowing maximum software re-use and cost control. • Advantages of conventional tier-1 model with benefits of a scalable and flexible team. • Faster development and debugging of the software.

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Service Delivered	Approach - Accelerators and IPs	Impact
RXR Digital Workplace Infosys helped a real-estate company transform their office spaces into smart workplaces, which enabled over 2,000 tenant businesses and 1,25,000 employees to return to work safely.	• Infosys Wingspan (LEX) platform to re-skill engineers on cloud and applied AI to accelerate design and build • Infosys tools in DevSecOps, UI test automation, and software analysis helped scale the solution to 27 properties in three months • Sensor discovery bots which enhanced efficiency by 22 percent • Smart Space Dashboard Accelerator with reusable UI components, which improved velocity by 15 percent	• Operated at significantly higher occupancy rates compared to the other buildings in the area • Adherence to all the New York's health operating guidelines • Huge potential for onboarding new clients for smart space conversion

wipro

Development of next gen turnkey Automotive Infotainment System Wipro helped an Asian automotive OEM develop an Android-based infotainment system for its luxury SUV in half the development time.	• Wipro's in-house validation automation and CI/CD tool *DevAssure* and its repository of over 40,000 test cases • Wipro's in-house *Tarang* lab for multiple pre-certification and certification testing • Wipro's Android CoE repository resources for Android framework customization and integration	• Fifty percent reduced time to market (from 5 years to 2.5 years) • Forty percent reduced engineering cost • Complete software ownership, which will be used for subsequent generations of products

Tech Mahindra

Service Delivered	Approach - Accelerators and IPs	Impact
Top hat development Tech Mahindra helped a European automotive OEM develop eight new vehicle top hats for both Indian and international market.	• Aggressive front loading of simulation and digital technologies resulting in approximately 40 percent saving on several prototypes • Cloud-based computing for leveraging simulation techniques, execution and data management resulting in approximately 20 percent saving • Remote testing for electronics resulting in zero delays even during COVID	• 25-30 percent reduced OEM engineering development budget. • Saving of prototype testing for main topics, alternate tooling strategy, and alternate suppliers to get cost advantage of approximately 10 percent. • Set up of testing capabilities and a build-up of new supplier base in India. • Increased interest of OEM to set up R&D centre in India.

Capgemini

Connected Care eco-system – enabling digital Capgemini helped an American medical devices company to introduce new-age connectivity features in its Class-II and Class-III legacy products, transforming it into a connected care ecosystem.	• Effective use of DevOps and TestOps solutions across programs to increase efficiencies and effectiveness • Effective EDC governance framework setup to mitigate risks/ challenges • A core-flex model to ensure key resources are retained for their leadership and SME knowledge and flexible enough to expand and contract per client's needs	• Thirty percent reduced treatment costs for cardiac implant patients through connected and remote care features. • Improved satisfaction scores among patients and their families. • Reduced cost of operations through remote upgrades and remote maintenance. • Twenty percent reduced regulatory compliance process costs.

HARMAN
A SAMSUNG COMPANY

Service Delivered	Approach - Accelerators and IPs	Impact
Connected Life Safety Services HARMAN helped an industrial products manufacturing company develop a new IoT solution for connected life safety devices that enables system integrators and facility managers to deliver enhanced fire safety products.	• IoT expertise in building connected product ecosystems and delivering complex solutions • Establishing agile processes for faster time to market with customer domain competency and HARMAN's technology competency • Advanced architectural decisions – built first of its kind, a cloud platform with high scalability and reliability • Test automation approach resulting in a reduction in the release cycle and arresting quality issues early in the life cycle • Faster ramp-up of teams with niche skills in a short period	• On-time product launch that was way ahead of the competitor's product launch timelines. • Thirty percent reduced release timeline and opened SMB (Small and Medium-sized Business) segment business opportunities with direct impact on top line for customer. • Business continuity during the pandemic with support across different geological locations. • Solution extension to other divisions with minimal customization.

Key service delivery initiatives - GCCs[2]

PHILIPS

Service Delivered	Approach - Accelerators and IPs	Impact
Service Work Bench / RADAR for zero unplanned downtime and First Time Right (FTR) Philips helped its healthcare product lines customers to reduce unplanned downtime, improve the FTR fix ratio, and service personnel productivity through remote monitoring, diagnosis, and maintenance services.	• Machine learning algorithm stack • Advanced decision support system using Drools, on top of the Vertical/Redshift DWH, and visualization using the angular stack adhering to the Philips Design principles • For the prescriptive diagnostics, search engines powered by ELK stack • To speed up the development, the standard frameworks like Spring • CI-CD based on Jenkins to speed up the deployment	• Thirty percent of customer cases identified and resolved remotely. • Fourteen percent less downtime. • Eighty-two percent of the cases solved at the first interaction with the customers.

Collins Aerospace

Ascentia® Analytics Services Collins Aerospace helped airlines by developing Ascentia® Analytics Services to identify predictive maintenance opportunities in aircraft systems to reduce delays, cancellations, and unscheduled maintenance to the airlines.	• Using DevOps on Azure cloud for planning service delivery activities • Connected PowerBI dashboards to DevOps and Databrick notebooks for real-time monitoring of analytic performance	• Saved around 10 hours of delays and cancellations and associated costs for the year 2020. • Converted raw airlines data to actionable intelligence to enable airlines to take data-driven decisions. • Ascentia engagement with the GETC –India became success model of engagement within the organization. • Refinement and maturation of predictive analytics by evaluating historical data and field performance data.

[2] *NASSCOM-FutureFactor360 Primary Research*

Service Delivered	Approach - Accelerators and IPs	Impact
High-Speed Satellite Internet Hughes Systique Corporation helped one of the largest telecom service providers undergoing a radical transformation that involved design, development, and deployment of the high-speed satellite internet using Software Defined Network (SDN)/Network Function Visualization (NFV).	• Vector Packet Processing platform from fd.io, for segment routing over IPv6 support in data path • Clustering support of open source SDN controller ONOS for high availability in a production environment	• Complete product ownership. • Code contribution to the open-source community – bug fixes and feature enhancements. • New account win in the SDN/NFV domain based on this real-time project execution.

Accelerators/Solutions/Platforms built by ESPs for application across verticals[3]

Accelerator/Solution	Target Customer Segment	Benefits/Impact
Wipro Nuage An innovative orchestrator powered by AI/ML that accelerates silicon design through the prediction and optimization of resources using cloud-native services.	**Semiconductor**	• Shorter tape-out cycles. • Increased productivity. • Enhanced customer experiences. • Optimized High-Performance Computing (HPC) costs for Electronic Design Automation (EDA) workloads. • Improved asset utilization.

[3] *NASSCOM-FutureFactor360 Primary Research*

wipro

Accelerator/Solution	Target Customer Segment	Benefits/Impact
Native HMI Studio (NHS) An end-to-end automation solution for Human-Machine Interface (HMI) requirement, verification, development, and testing for in-vehicle infotainment systems. NHS is capable of developing high fidelity prototype with HMI screen flow from HMI specification.	**Automotive, Aerospace, Storage, and BFSI**	• Thirty-eight percent reduced time to market. • Forty percent overall engineering effort savings in HMI development and testing . • Ten percent more issue finding due to accurate spec verification.
Pipe Sleuth Uses elements of AI, deep learning neural networks, advanced image processing to automatically identify, grade anomalies, and score the overall pipe segment using the industry standards. In addition, Pipe Sleuth produces the final assessment report and an output file of the results that can be imported into a ranking model for prioritizing maintenance and repair activities.	**Water and Utilities**	• Seventy-five percent reduced inspection cost. • Over 350 percent Return on Investment (ROI) over 5 years.
ATSC 3.0 Next Gen TV Digital Receiver SW A next-generation hybrid TV standard includes all-new features starting from 4K video, immersive audio, broadband, interactivity, broadcaster applications, personalization, companion screen, etc. It is a hybrid standard and its advanced broadcasting methods makes it ideal for fixed and mobile reception.	**Media and entertainment, Automobile, Mobile, Education, Sport Entertainment, Emergency Services, and IoT - Smart City**	• Reduced time to market to 7-8 months for OEM products

wipro

Accelerator/Solution	Target Customer Segment	Benefits/Impact
MiQ - Manufacturing Intelligent Quotient *Next-Gen Connected Business Analytics* platform for rapid digital transformation. One-stop-shop of end-to-end analytics, cognitive, and performance management solution. This platform allows one view for all multi-geo business areas globally from anywhere remotely. A generic solution architecture that supports rapid digital transformation to the cloud with inbuilt analytics and a predictive analytics platform drives decisions that improve productivity and profitability using scattered disparate data from anywhere anytime.	**Manufacturing, Oil & Gas, Consumer Electronics, Consumer, Goods Supply Chain, and Logistics**	• 116.8 percent ROI. • Design/build once, deploy multiple principles, and enabling faster rollouts across plants and regions. • ROI realization within 4-6 months with rapid deployment. • Data consolidation saves time and effort in going through multiple data sources. • Early detection and action over the root cause with built-in alert management and monitoring. • Automated key performance indicator (KPI) calculation and status determination. Avoids any human error for KPI calculation.

tcs | TATA CONSULTANCY SERVICES

Embedded Code Analyzer Helps deliver zero-defect code by streamlining defect validation workflows, leveraging a web-based integrated code review platform.	**Manufacturing (automotive, industrial, medical devices, and defence)**	• Increased collaboration between development and testing teams. • Quick and effective identification of complex concurrency issues in multi-core architectures. • Boosted programmers' productivity by automating the code compliance checking process, thereby guaranteeing stable, secure, and reliable code.

HCL

Accelerator/Solution	Target Customer Segment	Benefits/Impact
iDoRAN – Intelligent Document Automation A document automation solution that applies advanced computer vision IP and AI to turn static documents into business operation resources.	**Manufacturing, Supply Chain, Insurance, Medical, Retail, and Finance**	• 10-15 percent reduced manual efforts in all of its implementation. • Manufacturing: Optimized procurement processes with substantial cost saving. • Insurance: 25 percent increased fraud detection. • Banking: 25 percent reduced digitization time. • 2.5 billion document images processed to date.
HCL Cloud Bridge The *HCL Cloud Bridge* helps enterprises reimagine and modernize on-premise monolith platforms to cloud-ready/cloud-native platforms in an accelerated and automated way to cater to dynamically evolving business needs at speed and scale. Leveraging HCL's strong engineering expertise, proven solutions built with low code/no code principle, rich partner ecosystems, HCL helps in robust business transformation with a cloud-first strategy.	**Software and Internet, Telcos, Automotive, Aerospace, Medical, and Manufacturing**	• Comprehensive assessment with an intelligent insight of monolith platforms/services helps make an informed decision on the digital transformation journey, thus reducing assessment effort by 35 to 50 percent. • End to end automation led modernization powered by AI-led toolsets helps in faster go-to-market by 20 to 25 percent. • Cloud-native engineering with innovative code to deploy automation built on low-code/no-code principles help businesses embrace digitalization faster by 15 to 25 percent. • Cloud migration powered by the containerization factory approach enables cloud adoption faster by 25 to 35 percent.

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Navigate your next

Accelerator/Solution	Target Customer Segment	Benefits/Impact
Network Design Creator (design component of iNLCM) The open source-based solution generates fiber network design adhering to Universal Fiber Architecture (UFA) and 100+ configured design rules. The solution works on Geographic Information Systems (GIS) data and has multiple components like data validations, auto-data corrections, quality engine to validate and uplift the accuracy of network design.	**Telecom and Network sector**	• One hundred percent FTR compliance. • Eighty percent reduced cycle time, enabling faster rollout. • Eighty percent reduced defect injection with automated design rules and quality engine.
Live Engineering Platform Combines scaled agile DevOps and AI/ML-based insights platform, digital workplace, and data-led practices to continually *learn, adjust, respond, decide.*	**Multiple industries and verticals**	• Forty percent reduced rework • Twenty percent cost optimization by improved team productivity

CYIENT

Accelerator/Solution	Target Customer Segment	Benefits/Impact
Aerospace Parts Delivery Assurance Accelerator Aims to reduce engine production lead time by resolving all non-conformances during manufacturing and assembly, ensuring part quality and availability to meet engine delivery milestones.	**Aerospace and Defence, Automotive, Transportation, and Energy**	• Twenty percent increased on-time engine delivery performance. • Twenty percent elimination of all non-conformances. • Forty percent Turnaround Time (TAT) improvement.
NextGen Technical Publication Solutions Deliver interactive electronic technical manuals and immersive content using AR to assist technicians in aircraft maintenance, repair and training.	**Aerospace, Building Automation, Consumer Goods, and Rail Transportation**	• Forty percent cost benefit to the customer for legacy data transformation. • Fifty percent reduced cycle time for the transformation of legacy manuals.
Aftermarket Digital Transformation Journey Transform the existing discrete processes by integrating/augmenting data and re-engineering business processes to align with the new technology.	**Aerospace**	• Ten percent improved product performance metric (mean time between failure).

New innovative business and engagement models are being explored

Indian Engineering R&D service providers are moving beyond the traditional engagement models like fixed price and time material to a model that involves increased stakes/ownership. Outcome-based models such as revenue share, gain share, etc., are increasingly becoming popular as engagement models between global enterprises and engineering service providers.

Cyient's risk sharing program model for product take out

Cyient invested in engineering changes to reduce the cost of the products for an OEM through design simplification, material change, manufacturing process improvement, etc. On successful re-design incorporation, Cyient received a share of the savings for few years.

The model was extended to weight take-out, quality improvement, customer satisfaction improvement, and other outcome-based projects.

Infosys's outcome-based model contract

Infosys leveraged an outcome-based business model in its contract with one of the water-utility companies to improve its asset efficiency and forecast the overall demand based on historical and real-time consumption data. The revenue would be recognized only if Infosys delivered the committed outcome to its client.

HCL's risk-reward model

HCL was engaged with a leading semiconductor company in a risk-reward model concerning design, pre-silicon validation, synthesis and physical design on a derivative System on a Chip (SoC) for the automotive industry.[4]

Mergers & Acquisitions and partnerships are also increasingly being used as approaches for companies to build capabilities and differentiate themselves.

Mergers & Acquisitions

Service providers are building their business and digital capabilities through acquisitions of niche engineering services firms. Owing to the reduction in valuations due to the pandemic, organizations are investing in ramping up crucial skillsets by acquiring the right assets to drive the growth.

[4] *NASSCOM-FutureFactor360 Primary Research*

Key acquisitions in Indian Engineering R&D space in 2020-21:

<illustrative/not exhaustive>

Acquirer	Target	Focus Areas
wipro	Ampion	Cyber security, DevOps, and quality engineering services
wipro	Eximius	Engineering services in semiconductor, software, and systems design
KPIT	PathPartner	Operating system software, low-level software, and design services
CYIENT	IG Partners	Enterprise asset management, Mining 4.0, and operational efficiency
Infosys® Navigate your next	Kaleidoscope Innovation	Medical, consumer, and industrial markets
Tech Mahindra	Cerium Systems	Semiconductor design and embedded systems
L&T Technology Services	Orchestra Tech	Telecom OEM
Mindtree	NxT Digital Business	Cloud based IoT and AI platform for Industry 4.0

Partnerships

Indian service providers are forging strategic partnerships with a focus on augmenting new-age capabilities.

Service Provider	Enterprise Partner	Objective
Tech Mahindra	ThoughtSpot	Offer scalable and AI-driven analytics that enable enterprises to instantly analyse data with the same ease as using a consumer app, unearth meaningful insights, and drive business actions.
L&T Technology Services	Aspen Technology	Offer a complete suite of digital engineering solutions across global enterprises that empowers customers to optimize the performance of their assets and achieve operational excellence through cloud hosting and virtualization.
Infosys® Navigate your next	BP	Develop an integrated energy as-a-service offering to manage energy assets, provide low carbon power, low carbon heating/cooling, and low carbon mobility to campuses, driven by an AI-based digital platform.
happiest minds The Mindful IT Company Born Digital . Born Agile	Ilantus Technologies	Deliver next-gen "Identity and Access Management" security services that can manage and safeguard customers' intellectual property from identity and access theft while enhancing their risk and regulatory governance landscape.

Service Provider	Enterprise Partner	Objective
HCL	Intel	Create joint industry reference architectures along with vertical-specific solutions that gives organizations the building blocks to deploy transformational solutions faster and with greater success.
wipro	Exaware	Create engineering solutions that foster innovation in the networking industry, streamline 5G technology upgrades, and future 6G compatibility.
tcs | TATA CONSULTANCY SERVICES	LACChain	Create blockchain platforms, standards, and marketplaces to innovate and co-create solutions in the areas of healthcare, energy, education and financial services.

Indian Engineering R&D ecosystem players established robust business continuity plans

The pandemic demonstrated Indian Engineering R&D industry's inherent strength and tenacity to stay resilient in times of crisis. Indian service providers continued to stay ahead of the curve by focussing on the core strengths they established, nurtured, and evolved during the last few decades.

The strong legacy of these Engineering R&D players has enabled them to implement robust business continuity plans that ensured on-time project delivery with almost no loss in productivity. Some companies saw customer confidence go up by 10 percent during November-December 2020. The parent organizations/customers have continued to trust India and its ability to stand firm during uncertainties. For instance, Bosch India centre received an increased budget allocation of 8-10 percent from their headquarters despite the pandemic.[5]

[5] *NASSCOM ER&D CXO roundtables*

The pandemic also gave rise to a new way of working – a decentralized and distributed workforce that companies quickly adopted. GCCs and service providers reimagined their delivery models, including remote working, increased digitalization, and automation and re-skilling for changing roles. Engineering R&D firms focused on delivering active projects by setting up remote operations and digital workplaces to ensure business continuity for their customers worldwide. Ninety percent of Indian IT and ER&D companies achieved more than 80 percent work from home. Eighty percent of the companies accomplished work from home models in less than 2 weeks.[6]

ESPs[7]

Cyient successfully deployed Akamai and Global Protect VPN solutions for work from home and clean systems to access engineering data from the office.

Wipro enabled in-home access to engineering infrastructure. Wipro solution ensured that users get seamless access to the authorized applications sitting at cloud and private cloud data centres and with the same security and access rights irrespective of their location, office or home. Access to labs and embedded systems were also made available for home users.

GCCs[5]

The Renault-Nissan India office transitioned to 90 percent work from home in eight weeks, whereas the other countries were operating at 50 percent work from home. They even launched two models from India during this period.

Verizon India enabled work from anywhere within two weeks for its employees. The company also provided a one-time allowance to set up a home office for employees.

[5] *NASSCOM ER&D CXO roundtables*

[6] *Technology Sector in India, NASSCOM, 2021*

[7] *NASSCOM-FutureFactor360 Primary Research*

Below are few examples of how ESPs ensured continuity of their ongoing projects for global customers during the pandemic:[8]

To enable continuous product development and testing support for its multiple customers during the pandemic, the company set up remote lab connectivity for testing, enabling access to lab infrastructure through secure connections. Apart from allowing work from home, rapidly deployed additional accessories and controls for various test environments.

KPIT supported Verification and Validation (V&V) for functional safety in an *Autonomous Level-3* program for a Japanese automotive OEM. To ensure continuity of V&V, KPIT quickly developed a tool that enabled engineers to access test benches remotely and execute tests remotely without interruptions.

Wipro provided a mobile platform-based solution for monitoring implant devices for a global supplier of medical devices. To enable continuity in product testing during COVID, Wipro's team conducted elaborate end-to-end development and testing remotely. The project team was engaged on a rotational basis when physical presence was critical such as accessing the lab environment.

L&T Technology Services (LTTS) was testing software solutions with strong interdependency on hardware components for a German company specialising in imaging devices. During the pandemic, the testing team did not have access to hardware components. To enable continuity in device testing, LTTS set up a remote connection on hardware. Using a webcam, the team monitored X/Y/Z axes movement and leveraged the IT team's help to switch on/off the hardware at fixed intervals.

As companies are working to ensure business continuity, they also focused on employee health and well-being. They implemented robust systems for employee welfare. These included voluntary teams to help with any COVID-related issues, COVID helplines, active vaccination programmes, COVID centres, enhanced insurance coverage, etc. The mental well-being of employees was made a top priority. Companies organized sessions with experts and focused on reducing stress and improving overall well-being.

[8] *Resiliency of the Indian ER&D ecosystem in the wake of COVID-19, NASSCOM-ZINNOV, May 20*

The Company launched various employee engagement programmes to drive team spirit and ensure belonging while working remotely.

They conducted webinars, in association with an external partner, for anxiety and stress-related issues. They also started a guided meditation series for their employees.

Other Initiatives

- **Revive in Five:** An initiative where leadership reached out to the entire team about topics other than well-being, productivity improvement, and health every day to help spread positivity and team bonding.
- **Capgemini Big BossS challenge:** Employees and their families or friends participated in a series of tasks or contests. This initiative included creativity challenges, showcasing a unique talent of family or friend, an online quiz contest, a fitness challenge, and a theme-dressing challenge, among others.

The company built several resources, including 24/7 telemedicine services, care-at-home services, enhanced insurance coverage, virtual childcare, mental health support, and help for testing and vaccinating over 2,00,000 employees and their families in India.

The company provided COVID-related medical treatments under the group employee insurance. The company also set up COVID centres in Pune and Bengaluru.

Robust approaches for IP protection

The Government of India has formulated many policies to bring about a perceptible change in the IP landscape of the country. Since the 2016 National Intellectual Property Rights (IPR) Policy release, the government has made focused efforts to support investments in innovation and creativity through increasingly robust IP protection policies. India ratified the agreement for establishing the World Trade Organization (WTO), which contains the agreement on "Trade Related Aspects of Intellectual Property Rights (TRIPS)". Indian statutes, enforcement provisions, and dispute resolution methods concerning IP protection are now fully TRIPS-compliant.

In addition, the government undertook a massive digitization exercise and recruited many examiners to clear the backlog of patent and trademark applications. It also appointed facilitators to encourage start-ups to file patent applications and seek the protection of their IP.

Various steps taken by government over the last five years

The government has played a crucial role in stimulating creativity and innovation across sectors, facilitating a stable, transparent, and service-oriented IPR administration in the country, and creating awareness about the economic, social, and cultural benefits of IPRs among all sections of society.

National Intellectual Property Rights Policy

The policy aims to push IPRs as a marketable financial asset, promote innovation and entrepreneurship, while protecting the public interest. The approach encompasses and brings to a single platform all IPRs, taking into account all inter-linkages and thus aims to create and exploit synergies between all forms of IP, concerned statutes and agencies. It sets in place an institutional mechanism for implementation, monitoring, and reviewing. It aims to incorporate and adapt global best practices to the Indian scenario.

The Cell for IPR Promotion and Management was set up and tasked with implementing the IPR Policy.

International treaties signed/acceded

In July 2018, India acceded to the WIPO Internet Treaties, namely the *WIPO Copyright Treaty and WIPO Performances and Phonograms Treaty.*

In 2019, India took steps to ratify the Lisbon, Nice, and Locarno WIPO Agreements. In June 2019, India further deposited its instruments of accession concerning three WIPO treaties, namely the *Nice Agreement*, *Locarno Agreement*, and the *Vienna Agreement.* These agreements each provide for the classification of certain types of IP.

United States Government (USG) Engagement

The government and USG are engaged in dialogue across various platforms, such as the *US-India IP Dialogue*, and routine bilateral interactions on specific IP issues.

The US-India IP dialogue aims to share technical knowledge and expertise between both countries in the IP domain while providing a platform to experts from both countries to develop a stronger understanding of the need for uniform IP frameworks and arrive at a solution collaboratively.

The Designs Act

This Act allows for the registration of industrial designs. The designs rules, under the act, conform to the international system and are intended to address the proliferation of design-related activities in numerous fields.

Change to customs rules on IPR

A change made in 2018 to the customs rules on IPR removed patents from the scope of customs protection. Accordingly, the new customs system permits owners of the trademark, designs, copyright, and geographical indications to record their IPR with customs and seek affirmative enforcement action in the event of counterfeit activity at the ports.

IP protection approaches by service providers[9]

Companies have significantly invested in ensuring that their customers' IPs are protected and retain their competitive edge. They are working relentlessly to build 'trust' with the clients through dedicated measures taken for IP protection.

CYIENT

Deployed the work from home client system, which was fully insulated from copying and storing data locally. Customer provided or Cyient generated technical data remained safe and secure in the office at all times, ensuring IP protection.

[9] *NASSCOM-FutureFactor360 Primary Research*

Established very robust confidentiality and IP protection mechanism that helps organisations assess and scale their existing remote working capabilities. HCL Technologies became the first IT company in India to achieve the *Prevention of Spread of Infection certification* from Intertek, the world-renowned quality assurance leader.

With the changing ER&D landscape, Indian service providers are focusing on strengthening their capabilities by quickly adopting new business models, forging partnerships to differentiate their services, and enabling robust business continuity plan. In addition, they are adopting IP protection mechanisms to ensure quality service delivery in a dynamic environment. Companies have demonstrated a strong track record of excellence in service delivery by value creation for their clients, which continued even during the pandemic.

INDIA RISING AND SHINING

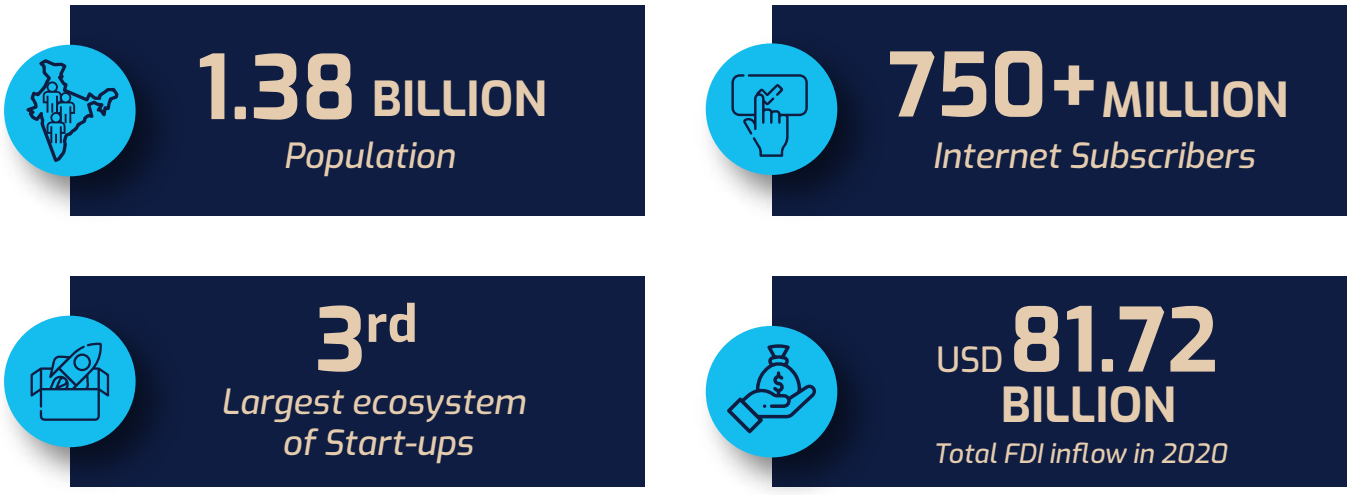
This section discusses the present and future prospects for India, several key focus areas, and major reforms and policies launched or planned to make India an investor-friendly destination.

INDIA RISING AND SHINING

India is the world's largest democracy, with a population of over 1.3 billion. In 2019, with a nominal GDP of USD 2.87 trillion, India surpassed France and the UK to become the fifth-largest economy globally in terms of GDP.[1] In addition to its rapidly growing consumer base and increasing working-age population, which is projected to reach 64.9 percent of the total population by 2036, India is steadily moving toward becoming a USD 5 trillion economy by 2024.[2]

Despite the pandemic, India's GDP growth forecast remains optimistic and is projected to record a growth of 11 percent in the FY 2021-22.[3] India received USD 6.24 billion in FDI in April 2021, up 27 percent over last year for the same month.[4]

By 2025, India is poised to become the nation with a maximum young population, with an average age of 25 years. This makes India uniquely positioned to address the workforce and talent needs of global enterprises. With the recent push for manufacturing and a conducive start-up ecosystem, India is ready to lead a new era of innovation and transformation.



Source: GOI Press Release

Government as an enabler

Through various national and state-level schemes and policies, such as Digital India, Make in India, Skill India, Start-up India, Stand-up India, and Atmanirbhar Bharat, in addition to infrastructural investments such as National Infrastructure Pipeline (NIP) and reforms in taxation policy and implementation of GST, the government aims to further strengthen the Indian business ecosystem.

[1] https://www.imf.org/external/datamapper/NGDPD@WEO/WEOWORLD/IND/FRA/GBR

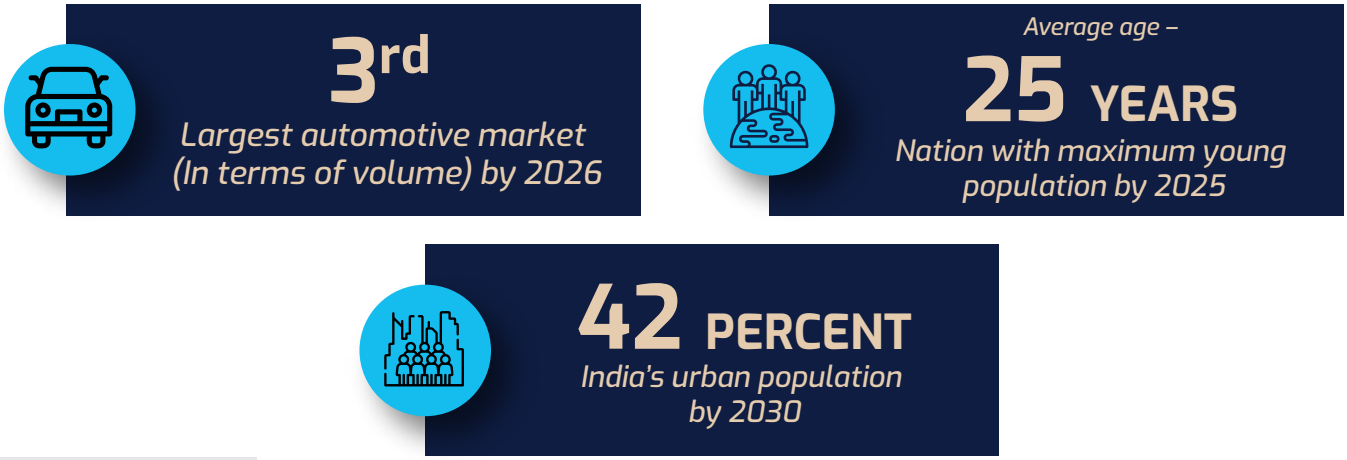
[2] https://main.mohfw.gov.in/sites/default/files/Population%20Projection%20Report%202011-2036%20-%20upload_compressed_0.pdf

[3] Economic Survey 2020-21

[4] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1729819

Several initiatives have been implemented to boost India's business-friendliness and attractiveness. The reforms and initiatives taken up by the Indian government have delivered a significant impact. In five years (2014-19), India jumped 79 spots in the *Ease of Doing Business* rankings and moved 33 positions in the Global Innovation Index.[5,6] By receiving FDI amounting to USD 81.72 billion during 2020-21, a 10 percent increase compared to 2019 -20, India became the fifth-largest recipient of FDI globally in 2020. The rise in FDI investments proves that the global economies recognize India's growth potential. India remains a viable and attractive investment destination and is taking significant strides towards becoming USD 5 trillion economy by 2024.

India's Future



Source: Invest India, World Bank

Why India as an investment destination

Numerous advantages make India an ideal destination for global enterprises. From a macro-economic perspective, some of the benefits listed below make India a perfect destination for investment.

- India is in the midst of a digital revolution.
- Growing consumption base.
- High infrastructure spending.
- High commitment to sustainability and green energy.
- Significant reforms to improve the ease of doing business and develop India as a global manufacturing hub.

India in the midst of digital revolution

India is poised to become a digital economy worth over USD 1 trillion by 2025, up from USD 200 billion in 2018.[7] According to a World Economic Forum report published in 2019, India will have more than 1 billion internet users by 2030.[8]

[5] *World Bank "Doing business 2020"*

[6] *World Intellectual Property Organization*

[7] *https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1565669*

[8] *World Economic Forum "Future of Consumption in Fast-Growth Consumer Markets: INDIA", 2019*

The digitalization wave is rapidly spreading across the country with a subscriber base of 750+ million internet subscribers. As per a Reserve Bank of India report, India witnessed over 55 percent growth in digital transactions from 2016 to 2020.[9] Digitalization has touched every aspect of the day-to-day life of the average Indian. Indians are increasingly becoming adept with technology, and the pandemic has hastened the adoption of various digital technologies across multiple sectors such as shopping, education, and healthcare.

With the Digital India initiative launched in 2015, the government aims to transform India into a digitally-empowered society and knowledge economy. This vision is multifaceted and includes initiatives such as providing digital infrastructure as a core utility to every citizen, digitally enabling on-demand governance and services, and ensuring citizens' digital empowerment. The initiative aims to secure internet connectivity across the nooks and corners of India, facilitate secure, convenient, and paperless payments while improving the digital literacy of its citizens.

As part of its efforts to provide financial inclusion and safe, seamless, and quick digital transactions, the Government of India launched Unified Payments Interface (UPI) in 2016. In June 2021, UPI transactions hit an all-time high of 2.8 billion transactions worth INR 5.58 trillion.[10]

The Government of India has rolled out various national-level missions and initiatives to foster digital proliferation. One such mission is National Broadband Mission, which aims to provide *broadband for all.*

Name	Brief Description
National Broadband Mission[11] (Rashtriya Broadband Abhiyan)	The National Broadband Mission was launched in 2019 with a three-fold vision of universality, affordability, and quality to: • Fast-track growth of digital communications infrastructure. • Bridge the digital divide. • Facilitate digital empowerment and inclusion. • Provide affordable and universal access to broadband for all. The mission aims to operationalize *Broadband for All* with these objectives: • Provide broadband access to all villages by 2022. • Provide infrastructure capable of delivering higher broadband speeds up to 50 Mbps in a phased manner. • Increase the present route length of 2.2 million km optical fiber cable to 5.0 million km.

[9] *https://www.business-standard.com/article/economy-policy/digital-payments-rise-at-55-cagr-vy-volume-in-five-years-to-fy20-rbi-data-120101100400_1.html*

[10] *https://www.indiatoday.in/business/story/upi-transactions-hit-all-time-high-in-june-as-economic-activity-rebounds-1823036-2021-07-02*

[11] *https://dot.gov.in/sites/default/files/National%20Broadband%20Mission%20-%20Booklet_0.pdf?download=1; https://www.makeinindia.com/national-broadband-mission-connecting-india*

Name	Brief Description
National Broadband Mission[11] (Rashtriya Broadband Abhiyan)	• Increase tower density from 0.42 towers per thousand population to 1.0, by setting up additional one million towers. • Address high bandwidth required for deployment of 5G network. • Facilitate deployment of 5G networks.

Initiatives to improve the digitalization quotient

Name	Brief Description
myGov	myGov initiative, launched in 2014, is the most prominent digital democracy platform to create and increase engagement between the citizens and the government to promote participative governance. Through collaboration with several government bodies and ministries, myGov seeks to engage with citizens for policy formulation and gather their opinion on public interest and welfare issues. To date, the myGov has 18,596,570 subscribers who make their suggestions on a variety of issues. myGov created a dedicated portal for COVID information dissemination and built a Chatbot on WhatsApp to help disseminate information about vaccination.[12]
Aadhar	Aadhar is India's unique digital identity program, launched in 2010, to provide a unique and biometrically-verifiable identification number to every citizen. To date, Aadhar has covered more than 1.3 billion citizens. By using Aadhaar, the government has streamlined its welfare delivery system, ensuring good governance, and transparency.[13]

[12] *https://www.mygov.in/overview/*
[13] *https://uidai.gov.in/my-aadhaar/about-your-aadhaar/usage-of-aadhaar.html*

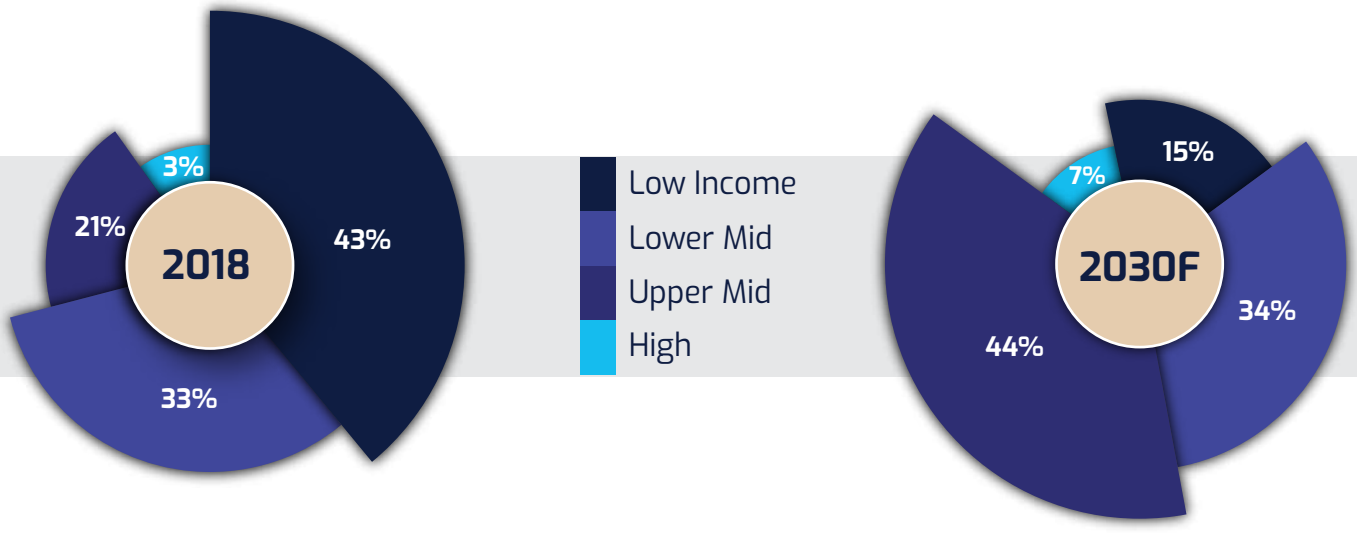
Name	Brief Description
CoWIN	CoWIN is a portal launched by the government to enable people to register for COVID vaccinations. It displays the location and date-wise slots available for vaccination registration. The government intends to make CoWIN a scalable, inclusive, and open platform for universal vaccination by 2022. In less than four months since its launch in January 2021, CoWIN recorded more than 200 million registrations.[14]

Growing consumption base

India is on the path to becoming a significant consumption economy driven by the middle-class, with 80 percent of households forming the middle class by 2030.[15] According to a World Economic Forum report, India is poised to witness 4x growth in consumption spending by 2030.[16]

The consumption base of India is flourishing and is already one of the highest in the world. The exponential rise of the middle-class population, rapid urbanization, upsurge of e-commerce and digital payments, digital connectivity, extensive financial inclusion, and rising aspirations of the populace are the vital factors to achieve consumption growth. This increase in consumption and development in the consumer base provides a vast market opportunity for global enterprises.

Evolution of household profiles



Source: World Economic Forum "Future of Consumption in Fast-Growth Consumer Markets: INDIA", 2019

[14] *https://www.cowin.gov.in/*

[15] *https://www.weforum.org/agenda/2019/01/10-mega-trends-for-india-in-2030-the-future-of-consumption-in-one-of-the-fastest-growing-consumer-markets/*

[16] *World Economic Forum "Future of Consumption in Fast-Growth Consumer Markets: INDIA", 2019*

Increased infrastructure spending

Building a world-class infrastructure is one of the top priorities for the government. It has rolled out the NIP initiative and has earmarked USD 1.5 trillion for significant infrastructure investments from FY 2019 to FY 2025.

The Central and state governments have undertaken significant infrastructure spending across various areas, such as connectivity (roadways, waterways, railways, and airways), energy, urban development, smart city programs, and industrial corridors development.

The ambitious NIP initiative comprises 7,400 projects, spanning sectors such as energy, communication, logistics and transportation, social, and commercial infrastructure, to provide and build world-class infrastructure in India. One of the government's key priority areas is to improve physical connectivity and multimodal transportation for seamless movement of freight and passenger by building road networks, rail and metro rail networks, airports, and seaports. The government is also planning to expand the national highway network to over 2,00,000 km by 2022.[18]

In March 2021, the government passed a bill in the parliament to set up the National Bank for Financing Infrastructure and Development (NaBFID). NaBFID is set up as a principal development financial institution for infrastructure financing to provide long-term finance for such economy segments, where the risks involved are beyond the acceptable limits of commercial banks and other ordinary financial institutions.

Apart from the initiatives and investments mentioned earlier, the government is making policy changes related to land acquisition, building permits, and public-private partnerships. The government is also formulating incentive programs to attract FDI to expedite infrastructure development.

Source: Invest India (sector-roads & highways)
Source: National Highways Authority of India
Source: Department for Promotion of Industry and Internal Trade, GoI

[18] *https://www.investindia.gov.in/sector/roads-highways*

Major infrastructure initiatives under NIP

Name	Brief Description
 **Bharatmala Pariyojna**	Bharatmala Pariyojna was launched in 2017 to optimize the efficiency of freight and passenger movement across the country by bridging critical infrastructure gaps through effective interventions. The government has plans to build approximately 34,800 km (including 10,000 km of NHDP remnants) of roadways at an estimated cost of INR 5 trillion.[19] At the end of August 2020, 2,921 km have been constructed and 322 projects totaling to 12,413 km have been awarded under Bharatmala Pariyojana.[20]
 **Sagarmala**	Sagarmala is a national initiative to change India's logistics sector performance by harnessing and developing India's 7,500 km long coastlines and 14,500 km of potentially navigable waterways through port-led developments such as port modernization and connectivity, port-led industrialization, and coastal community development by 2035. More than 574 projects at an estimated cost of INR 6 trillion have been identified for implementation in 2015 -2035. By September 2019, 121 projects at a cost of INR 300 billion had been completed, and 201 projects at a total cost of INR 3 trillion were in the process of being implemented.[21]
 **Smart Cities Mission**	Smart Cities Mission was launched in 2015 to drive economic growth and improve the quality of life of people by enabling local area development by harnessing technology. Some of the salient features of a *Smart City* include adequate water and assured electricity supply, sanitation, efficient urban mobility and public transport, affordable housing, robust IT connectivity and digitalization, good governance, sustainable environment, among others.

[19] *https://www.india.gov.in/spotlight/bharatmala-pariyojana-stepping-stone-towards-new-india*

[20] *https://www.pib.gov.in/PressReleasePage.aspx?PRID=1663471*

[21] *http://sagarmala.gov.in/*

Name	Brief Description
 **Smart Cities Mission**	Key highlights of the Smart Cities Mission: • Covers 100 cities. • 5,151 proposed projects. • INR 2 trillion proposed investments. To date, 2,987 projects worth INR 0.5 trillion have been completed.[22]
 **Atal Mission for Rejuvenation and Urban Transformation (AMRUT)**	The AMRUT mission was launched in 2015 to provide essential services to households and build amenities in cities to improve the quality of life. The key focus areas of the mission include capacity building, reform implementation, water supply, sewerage and seepage management, stormwater drainage, urban transport and development of green spaces, and parks, etc. The mission spans 500 cities, covering more than 60 percent of the urban population. As part of the mission, the *Online Building Permission System* has been implemented in 439 cities to reduce the time needed to approve the building plans.[23]
 **National Industrial Corridor Development Programme (NICDP)**	NICDP is India's infrastructure programme aimed at the development of futuristic industrial cities, which can compete with the best manufacturing and investment destinations of the world. The program has identified 11 industrial corridors with 30 projects in four phases until 2024-25.[24]

Focus on sustainability and green energy

India is building a sustainable tomorrow by exploring and adopting green and clean energy sources, accelerating the adoption of electric mobility, and undertaking blue-green infrastructure reforms.

[22] *https://smartcities.gov.in/*
[23] *http://amrut.gov.in/content/*
[24] *https://www.nicdc.in/about-DMICDC*

India is undertaking significant steps to tackle climate change. The government formulated *National Action Plan on Climate Change* in 2008 and included eight missions covering several interrelated domains. These include energy, industry, agriculture, water, forests, and urban cities to meet India's vision of sustainable development.[25]

India's energy landscape

5th
Largest installed capacity of renewable energy in the world

4th
Largest installed capacity of wind energy in the world

5th
Largest installed capacity of solar energy in the world

Source: https://www.investindia.gov.in/sector/renewable-energy

Missions rolled for sustainability and move towards green future

Name	Brief Description
National Hydrogen Energy Mission (NHEM)	NHEM was announced in the Union Budget 2021-22 to establish an ecosystem of clean energy from hydrogen. The aim is to make India a global manufacturing hub for hydrogen and fuel cell technologies across the value chain and set regulations to ensure safety and quality. Following the mission's announcement recently, 4-year short-term and 10-year long-term roadmaps are planned to achieve the mission's objectives.[27]
National Solar Mission (NSM)	NSM was launched in 2010 to harness abundant availability of sunshine to build a clean energy system to address energy demand. The focus of this initiative involves the building of solar parks and ultra-mega solar power projects with a combined capacity of 40 gigawatts by 2021-22. The initiative targets to achieve 100 gigawatts of solar energy generation by 2022. As of March 2021, the total installed capacity was 40 gigawatts.[28]

[25] *https://dst.gov.in/climate-change-programme*

[27] *https://pib.gov.in/PressReleasePage.aspx?PRID=1696498*

[28] *ACCELERATING CITIZEN-CENTRIC ENERGY TRANSITION – The India Story Report by Government of India, 2021*

Name	Brief Description
National Electric Mobility Mission Plan 2020 (NEMMP)	NEMMP aims to achieve national fuel security by promoting electric and hybrid vehicles in India. Under NEMMP, the Faster Adoption and Manufacturing of Hybrid & Electric Vehicles in India (FAME-India) scheme was launched in 2015 to promote the manufacturing of electric and hybrid vehicles. The second phase of the FAME-India commenced in April 2019, for three years, to support the electrification of public and shared transport. The first phase of the FAME-India saw the installation of 427 charging stations, and in its second phase, 2,877 electric vehicle charging stations worth about INR 5 billion were sanctioned. The country has allocated INR 10 billion to develop its charging infrastructure.[29] As of July 2021, about 0.37 million xEVs have been supported with a total incentive of INR 6.34 billion and 862 hybrid/electric buses have been sanctioned to various cities/states.
Green India Mission	The national mission for a green India, commonly called Green India Mission, is one of the eight missions under *National Action Plan on Climate Change.* The mission was launched in 2014 to safeguard the biological resources and associated livelihoods. It aims to protect, restore, and enhance India's diminishing forest cover.[30] Various mitigation measures undertaken under the mission are: • Increase forest cover area to five million hectares. • Revive wetlands and grasslands. • Increase forest-based livelihood income of about three million households. • Increase forest cover in urban areas.

[29] *https://www.pib.gov.in/PressReleseDetailm.aspx?PRID=1741569*

[30] *https://mpforest.gov.in/img/files/GIM_Implementation_Guidelines.pdf*

Name	Brief Description
National Water Mission (NWM)	NWM has been undertaken to ensure better water resources management, including water conservation, less wastage, and equitable distribution of water across different states. NWM aims to develop a framework to optimize water use, by increasing the usage efficiency by 20 percent through regulatory mechanisms with differential entitlements and pricing. In 2021, a campaign called *Jal Shakti Abhiyan: Catch the Rain* was launched to encourage various states and stakeholders to create appropriate rain water harvesting structures.[31]
National Clean Air Programme (NCAP)	In 2019, the Ministry of Environment, Forest and Climate Change (MoEFCC) launched NCAP to tackle air pollution.[32] NCAP has a midterm 5-year action plan to reduce particulate matter concentrations in the air by 20 to 30 percent by 2024, keeping 2017 as the base year for comparing the concentration.[33] 102 non-attainment cities (cities that failed to meet the air quality standards) across 23 states and union territories have been identified based on the air quality data from 2014-2018. NCAP's objectives are to implement mitigation measures to control and prevent air pollution, strengthen the air quality monitoring network, and increase public awareness.
National Mission for Sustainable Agriculture (NMSA)	NMSA is one of the eight missions of NAPCC that aims at making agriculture more productive, sustainable, and climate-resilient by promoting location-specific integrated/composite farming systems, soil and moisture conservation measures, comprehensive soil health management, efficient water management practices, and mainstreaming rainfed technologies, among others.[34]

[31] *http://nwm.gov.in/*

[32] *https://moef.gov.in/wp-content/uploads/2019/05/NCAP_Report.pdf*

[33] *https://pib.gov.in/PressReleasePage.aspx?PRID=1655203*

[34] *https://nmsa.dac.gov.in/Default.aspx*

Name	Brief Description
National Mission for Sustainable Agriculture (NMSA)	NMSA consists of four primary focus areas: • Rainfed area development. • On-farm water management. • Soil health management. • Climate Change and Sustainable Agriculture: Monitoring, Modelling and Networking.
National Mission on Sustainable Habitat (NMSH)	NMSH is also one of the eight missions of NAPCC. It aims to make cities sustainable and resilient to face the aftermath of climate change. The key objectives of the mission are :[35] • Improve building designs to ensure optimized energy demand and increase energy efficiency. • Ensure efficient and convenient public transport through better urban and transportation planning. • Improve the management of solid and liquid waste through recycling. • Enable requisite regulatory and legal changes. • Improve the infrastructure and introduce advance warning systems for extreme weather events.

In addition, new policies are being formulated by the government to tackle environmental pollution and maintain sustainability. One such policy announced in March 2021 is the *Vehicle Scrapping Policy*, which aims to create an ecosystem for phasing out unfit and polluting vehicles.[36]

Also, the Ministry of Railways has pledged to become *plastic-free* by banning single-use plastic materials to minimize the generation of plastic waste.[37]

As a significant focus on sustainability, India is exploring new technologies like green hydrogen, wind-solar hybrids, and others for developing clean energy sources.

[35] *http://cpheeo.gov.in/cms/national-mission-on-sustainable-habitat.php*

[36] *https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1705811*

[37] *https://pib.gov.in/Pressreleaseshare.aspx?PRID=1582494*

Reforms to enhance business climate

India has undertaken various initiatives and reforms, such as implementing GST and introducing production-linked schemes. These initiatives provide incentives to companies to promote domestic manufacturing. In addition, enabling 100 percent FDI in major sectors is another step to ensure a conducive environment for doing business.

The 79 spots jump in *Ease of Doing Business* rankings in 5 years (2014-19), the emergence of India as a global manufacturing hub, and the presence of start-ups, which include 11,000 - 12,500 tech start-ups incepted from 2015-2020, provide testimony to India's business climate.

Among the significant reforms in introducing GST in 2017 was a unified, uniform, harmonized, and technology-based indirect tax system to simplify the earlier tax regime. Reforms in the supply chain have increased efficiency, increased transparency among companies, and ensured ease of starting a business and compliance with regulations.

Explained below are the major initiatives, schemes, and reforms, stepping stones to making India the global manufacturing and engineering hub.

Major initiatives

Name	Brief Description
Make in India	Make in India was launched in 2014 to transform India into a global design and manufacturing hub. The initiative aims to: • Boost domestic manufacturing. • Make India a global manufacturing hub. • Promote innovation. • Improve skills development. • Augment investment into the country. • Build modern and efficient infrastructure. • Open up new sectors for foreign investment. • Foster partnerships between government and industry. Through this initiative, manufacturing is expected to grow at 12-14 percent per annum and by 2022, create 100 million additional manufacturing jobs and increase its contribution to GDP to 25 percent.

Name	Brief Description
 **Make in India**	The initiative includes 27 focus sectors that include aviation, defence manufacturing, automobile, medical devices, ports and shipping, railways, electronics systems, pharmaceuticals, biotechnology, space, renewable energy, food processing, textile and garments, media and entertainment, and tourism and hospitality, among others.[38] **Impact of Make in India** Total FDI between April 2014 and March 2017 amounted to approximately 33 percent of cumulative FDI in to India. In 2015-16, FDI inflow crossed USD 50 billion for the first time in any year, and further in 2020-21, FDI reached USD 81.72 billion. Measures to improve business confidence have led to progressive improvements in India's rank in the World Bank's E*ase of Doing Business* rankings - 79 spots jump in 5 years (2014-19).
 **Aatmanirbhar Bharat Abhiyan (Self Reliant India)**	Aatmanirbhar Bharat, launched in 2020, makes India self-reliant across different vital areas. The government announced the unique economic and comprehensive package of INR 20 trillion - equivalent to 10 percent of India's GDP. The government has taken several reforms such as supply chain for agriculture, rational tax systems, simple and straightforward laws, capable human resource, and a robust financial system. The Atmanirbhar Bharat stimulus package announced by the government consists of the five key focus segments - businesses including MSMEs, poor including migrants and farmers, agriculture, new horizons of growth, and government reforms and enablers.[39]

[38] *https://www.makeinindia.com/about*

[39] *https://www.investindia.gov.in/atmanirbhar-bharat-abhiyaan*

Reforms to improve the ease of doing business

Reform Area	Brief Description
 **Amendments in paying taxes**	• Implementation of a favourable tax rate of 15 percent (17.01 percent inclusive of surcharge and cess) for new manufacturing companies incorporated on or after 1st October 2019 and 22 percent (25.17 percent inclusive of surcharge and cess) for domestic companies to boost investment and transform India into a manufacturing hub.[40] • Implementation of GST to simplify the tax regime. • Implementation of online tax filing system and e-verification, eliminating the need for physical touch points.

 **Starting a business[41] (Indicators from Delhi and Mumbai)**	• Integrated E-Form (SPICe - Simplified Proforma for Incorporating a Company electronically) for five integrated services:
	  – Incorporation of all companies up to seven promoters.
	  – Obtaining Director Identification Number.
	  – Application for Permanent Account Number (PAN).
	  – Application for Tax deduction/collection Account Number.
	  – Simplification of the process for reserving the company name.
	• Central Processing Centre for incorporation forms and re-engineering of processes.
	• Reduction in time for completion of processes listed below to approximately 24 hours through real-time and online processes:
	  – Application for Employee State Insurance and Employee Provident Fund registrations.
	  – Registration for Value-added Tax for establishments
	• Reduction of time for generation of Corporate Identification Number from approximately 7 days in April 2014 to almost 0.7 days in Mar 2017 and disposal rate of over 90 percent.[42]

[40] *https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1585641*

[41] *https://dpiit.gov.in/sites/default/files/dobReforms_04May2017.pdf*

[42] *https://dipp.gov.in/sites/default/files/SaB_Reforms_24March2017.pdf*

Reform Area	Brief Description
Procurement of construction permits[43]	• One-stop solution with provision for single online application and online single window system for building plan approval. • Approval of building plan in 30 days and completion/occupancy certificate in less than 21 days. • Complete digitization of process, including online fee calculator, digital signing, online payments, and request/ issuance of the certificate. • Implementation of technology to ensure speed and transparency in the entire process and streamlining the issuance of No Objection Certificates (NoC).
Resolving Insolvency	• Fast-track corporate insolvency resolution process to ensure completion of insolvency for mid-sized companies within 90 days, with a maximum grace period of another 45 days. • Operationalization of the "Insolvency and Bankruptcy Code" for faster resolutions of insolvency.[44]

Sector-specific missions and schemes

Name	Target Sector	Brief Description
Automotive Mission Plan 2026 (AMP)	**Automotive**	AMP 2026 was launched in September 2015 to establish the Indian automotive market among the top three in the world in engineering, manufacturing and export of vehicles, and auto components and increase exports to reach 35-40 percent of the overall manufacturing output. The mission intends to increase the automotive sector's contribution to over 12 percent of GDP and generate an additional 65 million jobs by 2026. AMP 2026 envisages that the Indian automotive industry will quadruple to about INR 16 trillion to 19 trillion by 2026.[45]

[43] *https://dpiit.gov.in/sites/default/files/EoDB_MoUD_26April2017.pdf*

[44] *https://www.mca.gov.in/Ministry/pdf/Notification_14122016.pdf*

[45] *https://www.siam.in/uploads/filemanager/47AUTOMOTIVEMISSIONPLAN.pdf*

Name	Target Sector	Brief Description
Schemes for electronics manufacturing[46] • Production Linked Incentive Scheme (PLI) • Promotion of Manufacturing of Electronic Components and Semiconductors (SPECS)[47] • Modified Electronics Manufacturing Clusters (EMC 2.0)	 • **Electronic & Semiconductors** • **Electronics**	The schemes were launched on 1st April 2020 to position India as a global hub for electronics system design and manufacturing and strengthen the ecosystem across the value chain. These incentives have been launched in the backdrop of previous schemes such as National Policy on Electronics 2019, Modified Special Incentive Scheme, Electronics Development Fund, and Electronics Manufacturing Clusters, that saw India's electronics market increase from USD 29 billion in 2014 to USD 70 billion in 2019. In addition, India is also the second-largest mobile phone manufacturer in the world. The PLI scheme is linked to large scale electronics manufacturing in India. Under this scheme, 4 to 6 percent incentive will be provided on incremental sales of electronics goods manufactured in India, valid for five years, after the base year 2019-20. SPECS aims to strengthen the value chain for India's design and manufacturing of electronic products. Target segments include electronic components, semiconductor/display fabrication units, ATMP units, and many more. Under this scheme, financial incentives of 25 percent will be provided on capital expenditure for five years, after the base year 2019-20. To attract major global electronics manufacturers and their supply chains to set up units in the country, the EMC 2.0 scheme is meant to foster quality infrastructure development with shared facilities and amenities.[48]

[46] *https://www.investindia.gov.in/schemes-for-electronics-manufacturing*

[47] *https://www.meity.gov.in/esdm/SPECS*

[48] *https://www.makeinindia.com/schemes-electronics-manufacturing-india*

Name	Target Sector	Brief Description
Indian National Space Promotion and Authorization Centre (IN-SPACe)	 **Space**	IN-SPACe was established to encourage and promote the participation of private investment in the space sector. This entity will act as an intermediary between ISRO and the private space sector in India. IN-SPACe will provide private players with technical support, cash incentives, infrastructure, and partnership opportunities in science and space exploration missions. Under IN-SPACe, private players can access Department of Space facilities and equipment for space missions.[49]
Promotion of Medical Device Parks	 **Medical Devices**	The scheme intends to develop common infrastructure facilities to reduce the production cost of medical devices manufactured in the country. A total outlay of about INR 4 billion with a grant per park up to INR 1 billion or 70 percent of the project cost will be incurred from 2020-21 to 2024-25.[50] Along with the PLI in the medical devices scheme, this scheme is expected to generate 33,750 jobs over five years.[51]

As India advances, the country is well poised to address the needs and imperatives of global enterprises. As a result of numerous initiatives and reforms, the business climate continues to improve.

[49] *https://pib.gov.in/PressReleasePage.aspx?PRID=1657766; https://www.isro.gov.in/indian-national-space-promotion-and-authorization-center-space/roles-and-responsibilities*

[50] *https://www.investindia.gov.in/schemes-for-medical-devices-manufacturing*

[51] *https://pib.gov.in/Pressreleaseshare.aspx?PRID=1607485*

CONCLUSION

Today's era is marked by the rise of technology giants, deep-tech start-ups, and innovative disruptors, who are radically changing the face of competition. The endless possibilities of digitization and technology adoption, coupled with evolving customer needs, have ushered in a paradigm shift in the industry dynamics and competitive landscape. The rise of "digital first" products, adoption of Industry 4.0, speed and agility in innovation, and heightened focus on cyber security and sustainability are some of the key Engineering R&D imperatives for global enterprises.

India is in a unique position to address the key Engineering R&D imperatives of global enterprises of today and the future. The Indian Engineering R&D landscape comprises of GCCs, ESPs, and India-based manufacturing companies. Complementing the Indian Engineering R&D landscape is a vibrant start-up ecosystem and renowned universities that have driven significant impact to the Engineering R&D.

The key pillars and value propositions that fuel India's attractiveness as the destination of choice for global Engineering R&D companies are ability to drive strategic business impact, a strong focus on innovation, a large and diverse talent pool, and focus on differentiated service delivery.

The Indian Engineering R&D players continue to play a crucial role in driving the digital strategy for global enterprises. In addition, they have moved ahead in the value chain and are taking end-to-end ownership of products/solutions designed both for Indian and global markets.

India has constantly emerged in the top position for innovation among other countries in Central and South Asia. The robust Indian Engineering R&D ecosystem, with a strong focus on collaboration, has truly nurtured the culture of innovation, which has placed India as a global hub for innovation and technology.

India's young skilled talent is unmatched by any other country. It has one of the largest education systems globally, which has enabled the country's scale of talent. Apart from the specialised talent skilled in some of the high growth technology areas, a culturally diverse workforce is an inherent attribute of the talent available.

Indian Engineering R&D players have assumed the role of strategic partners to their parent companies and customers, to become the innovation partners to global enterprises by adopting new business models, and building the right capabilities through partnerships and mergers and acquisitions. Even during the pandemic, Indian organizations demonstrated their resilience and continued to offer differentiated service to global customers.

Complementing India's Engineering R&D value propositions are numerous ambitious schemes, policies, and progressive initiatives launched by the Indian government to strengthen the business ecosystem and improve the country's attractiveness and business-friendliness quotient. In addition, India has undertaken substantial steps to tackle climate change and build a sustainable future by exploring and adopting green and clean energy sources, accelerating electric mobility adoption, and undertaking blue-green infrastructural reforms.

The presence of GCCs, ESPs, vibrant start-up ecosystem, large and diverse talent pool, and multiple initiatives by governments and industry bodies have led to India's emergence as a **gateway to global Engineering R&D and innovation.** With all the necessary building blocks, India is well poised to address key Engineering R&D imperatives of the organizations of the future and lead the industry into the future.

ABOUT US

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NASSCOM is the industry association for the IT-BPM sector in India. A not-for-profit organization funded by the industry, its objective is to build a growth led and sustainable technology and business services sector in the country with over 3,000 members. NASSCOM Research is the in-house research and analytics arm of NASSCOM generating insights and driving thought leadership for today's business leaders and entrepreneurs to strengthen India's position as a hub for digital technologies and innovation.

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Founded in 2017, FutureFactor360 is a boutique consulting firm based in Bengaluru (India) & Detroit (Michigan, USA) supported by a global team of analysts and consultants. At FutureFactor360, we enable our customers in driving globalization, market growth, digital transformation, and building a winning talent culture. Our service offerings across each of the areas include:

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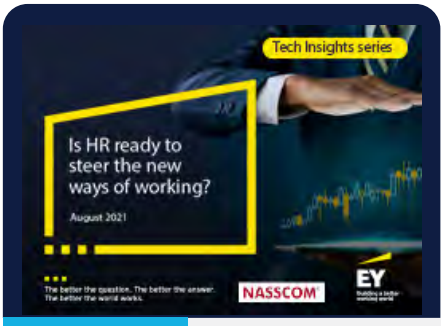

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