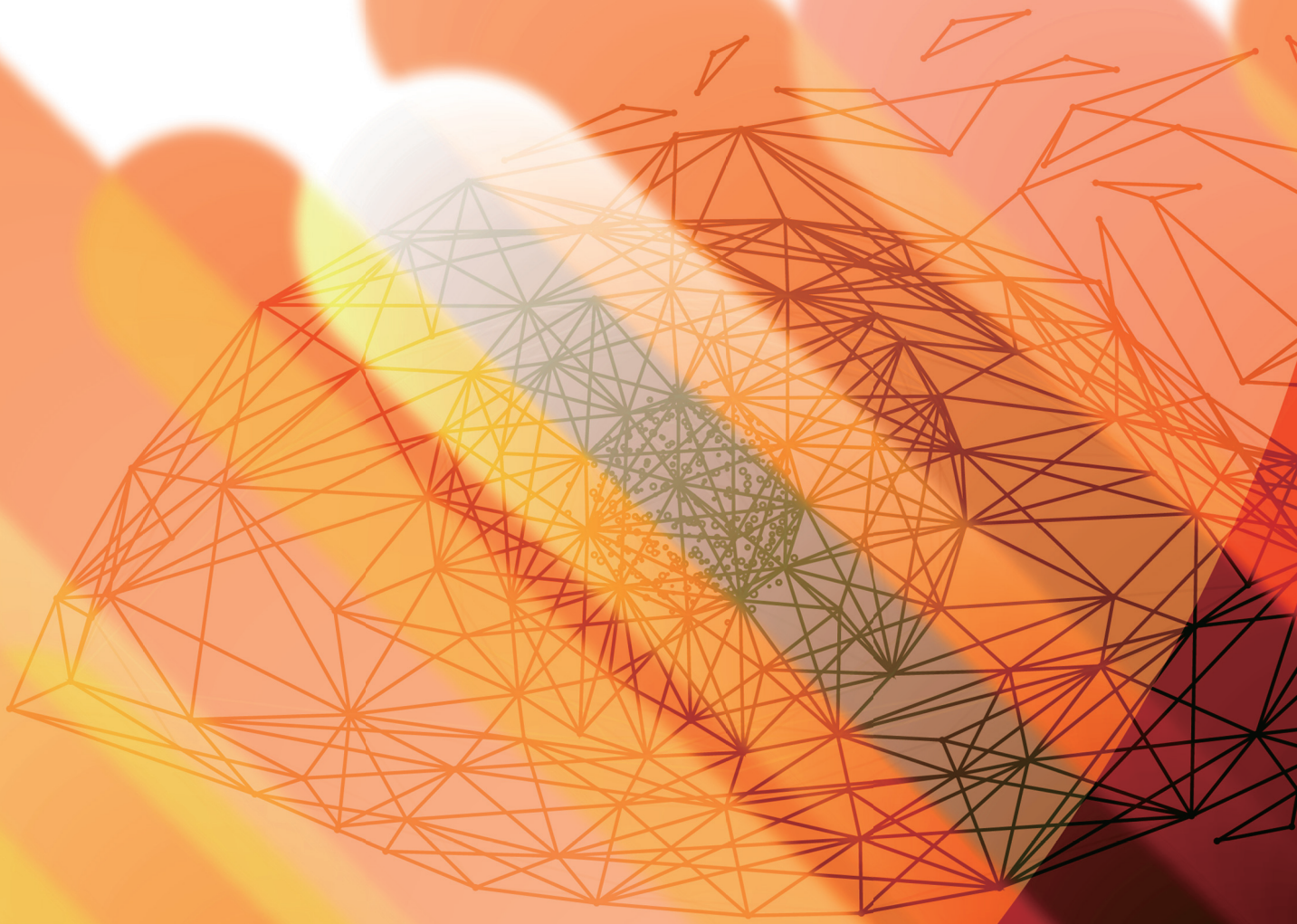

The Future is Now

Q3 2018

Quarterly Emerging Trends Report

ASIAN PRODUCTIVITY ORGANIZATION
APO

The Future is Now, Quarterly Emerging Trends Report (Q3 2018)

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FOREWORD

Why do human beings tell stories? Across the globe, cultures use stories to make sense of the world and communicate that understanding to a wider audience. With strategic foresight and scenario planning, the practice builds on that age-old story-telling tradition, that narrative instinct embedded within us.

By telling stories about the future and what may come to pass, we are able to become better prepared in many ways.

Thinking aloud and crafting narratives about the future allow us to reflect on where we are, the things we value, and what we stand to lose or gain. Our choices and decisions are guided by our view of the world and what we think is possible. Foresight helps us look beyond and expand our perspective.

The value of these stories is not necessarily in how closely they reflect reality. By definition, stories about the plausible future are stories about what is possible. Looking back at the rich human history of myth, literature, and poetry, a good story is not good because it is necessarily true. While we often long for some of our stories to be plausible or internally consistent, we allow for the fantastical and unexpected too.

With the 3rd Quarterly Emerging Trends Report, The Future is Now, the APO Futures Team looks to tell stories about the future that are premised on the events of today and the views of various experts.

At the same time, we seek to expand our view of what is possible, the seemingly outlandish issues that could dominate the landscape of labor productivity and economic competitiveness in the coming decades.

Will artificial intelligence (AI) become as ubiquitous and pervasive as electricity?

Our choices and decisions are guided by our view of the world and what we think is possible.

Foresight helps us to look beyond and expand our perspective.

Will technology and changing norms tear down the constraints of geography and traditional organizational barriers in the world of work? Will human minds and machine intelligence become inextricably linked?

These are just some of the questions and issues that we explore in this report. We examine five emerging trends that have the chance to seriously disrupt our member country economies in the future. The APO Futures Team covers the essentials, the status of each trend, and discusses implications and possible responses that member countries can undertake. In addition, we cover the APO's approach to horizon scanning and foresight in our new methodology section. As we continue to build and refine our approach to strategic foresight, this section will be updated accordingly.

The APO Futures Team uses an AI-driven platform and a range of other foresight tools to regularly scan for emerging trends, drivers, and uncertainties that may affect our member countries. Some of these trends end up being covered in this series of reports, while others are used as the foundation for later research projects and future-oriented initiatives.

Following the successful conclusion of the 59th Workshop Meeting (WSM) of Heads of NPOs in Indonesia this October, the APO is all set to develop new, more impactful programs for our member countries. The organization is now embarking on a range of future-oriented programs to deliver significant, sustainable benefits to our members. This includes efforts to promote agricultural and industrial transformation, develop national productivity master plans, and build foresight capability across the Asia-Pacific.

For member governments looking to prepare themselves for the disruptions to come, the APO is prepared to equip them with the capabilities not only to survive but also to thrive in the future.

I hope you find Q3 2018 The Future is Now stimulating, thought provoking, and most importantly useful. It is also my hope that this report will help you embrace rather than avoid the challenges that lie ahead.

Dr. Santhi Kanoktanaporn
Secretary-General
Asian Productivity Organization
October 2018

EXECUTIVE SUMMARY

AI FOR EVERYONE, EVERYWHERE

Artificial intelligence (AI) is best understood as a "general-purpose technology," like the steam engine or electricity. AI can be integrated in nearly every sector of the economy, resulting in socioeconomic transformation. Currently, it encompasses a set of technologies (machine learning, computer vision, etc.) which allows users to solve novel problems and handle tasks at scales and speeds previously unimagined. In the future, AI may be as ubiquitous as electricity is today, seamlessly integrated with daily rhythms of work and play.

THE TECH-AUGMENTED ALTERNATIVE WORKFORCE

Technology enables the proximity of work to expand beyond a company's walls and balance sheets. The ubiquity of mobile devices, high-speed wireless, videoconferencing, and cloud-based collaboration tools as well as augmented reality expands the possibilities of work. Workplaces, from the office to the factory, can be extended across virtual rather than physical space. Through digital talent platforms, expertise, skills, and manpower can be drawn flexibly and with little regard for distance.

BUILDING RESILIENCE TO CLIMATE DISASTERS

Climate-driven disasters are on the rise, but new tools and approaches are emerging to help communities and governments build resilience. Novel approaches to diaster risk information collection, the use of genetic engineering to boost crop resilience, and adding dual-use features to existing infrastructure are just some of the ways that public–private partnerships are building climate change resilience to extreme weather events.

LINKING MINDS AND MACHINES

Advances in neurotechnology and neural mapping in recent years have led to a number of exciting applications in the medical field. However, the true implications of this emerging technology are difficult to fathom. Using thought to communicate and control machines, brain–computer interfaces may change what it means to be human.

A CHINESE GLOBAL ORDER?

The growing economic, political, and military clout of PR China is considered one of the most significant trends of the modern era. Could PR China some day lead a rules-based international order in the way the USA does now? PR China's growing presence and influence across the Asia-Pacific and beyond are both a source of threat and promise.

AI FOR EVERYONE, EVERYWHERE

In the future, artificial intelligence (AI) may be as ubiquitous as electricity is today, seamlessly integrated with the daily rhythms of work and play.

Imagine you wake up in the morning to head to work. You talk to your smart home as you get dressed, and it orders a car to your door. On the way to the office, you scan through your email inbox and shoot off quick responses based on automatically generated smart replies. The car is fully autonomous, navigating smoothly to your destination and leaving you free to prepare for your upcoming meeting. In your job in private wealth management, you are left to focus on building strong relationships with clients as your communications are translated instantaneously and their portfolios are managed in real time by robo-advisers. Throughout the day, AI is entwined with the fabric of your daily life.

This is just a snapshot of a possible future, and one that only showcases a small slice of what AI technology may do in the future if experts are correct in classifying it as a "general-purpose technology (GPT)," like the steam engine or electricity. GPTs can be applied in many industries and are an important driver of economic growth and national and regional competitiveness [1]. AI can be integrated in nearly every sector of the economy and, as systems using AI match or surpass human performance in more domains, we will see a transformation of the economy and society (Figure 3).

THE ESSENTIALS

AI refers to computer systems that allow machines to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision making, prediction, and planning. AI technology is generally centered around machine learning, which allows us to find patterns in data which are implicit and probabilistic rather than explicit.

The proliferation of AI promises to improve existing goods and services and, by enabling the automation of many tasks, increase the efficiency with which they are produced. AI-driven technologies may even reshape the nature of innovation itself, improving R&D by developing processes and products that humans alone would not invent.

SITUATION REPORT

Currently, AI is mostly used in the tech industry, and many other businesses and sectors have struggled to take advantage of advances in AI. The key players are Amazon, Google, and Microsoft, which are expanding access to AI and machine learning based in the cloud to the wider public [2]. As Figure 1 shows, there are several potential AI applications across sectors.

It may be some time, however, before even the most advanced economies see productivity gains. Until a sufficient stock of AI technology is built and diffused, along with complementary processes and assets, we are unlikely to see macro effects. Organizations and sectors need time to reconfigure themselves to make the most of AI, like other GPTs. We see a vivid example in retail, where e-commerce became a major force only recently, decades after it first emerged in the 1990s dot-com boom [3].

While there are promising examples now, e.g., diagnosing lung cancer and automating factory tasks, the pace of AI adoption will depend on more than technical feasibility. Investment, regulatory barriers, and social acceptance will also play a part.

WHY DOES THIS MATTER TO APO STAKEHOLDERS?

AI and related technologies of machine learning have the potential to be truly transformative for any national economy. McKinsey estimates that AI techniques have the potential to create between USD3.5T and USD5.8T in value across 19 industries annually [4]. Early adopters may gain a disproportionate advantage.

Specific use cases have already demonstrated clear positive results. For instance, a team from Google DeepMind has recently trained an ensemble of neural networks to optimize power consumption in a data center. By carefully monitoring the data collected from thousands of sensors tracking temperatures, electricity, and pump speeds, the system learned how to adjust the operating parameters. As a result, AI was able to reduce the energy used for cooling by 40% compared with the levels achieved by human experts.

In addition to the economic benefits, national governments can also use AI to their advantage. Those advantages may be decisive in winning elections, protecting national assets, and improving public services. Countries around the world have released national AI plans and made large investments in AI [5]. Some analysts have suggested the beginnings of an "AI arms race," with the USA and PR China as the lead competitors [6]. Figure 2 gives estimates of AI gains to be realized by

different regions by 2030, with the largest gains likely to accrue to North America and PR China.

WHAT CAN MEMBER COUNTRIES DO TO RESPOND TO THIS ISSUE?

- Develop a national AI strategy and roadmap, with cooperation from a range of industry participants.
- Scale up AI development and adoption by creating region-wide rather than local policies, ensuring an open yet secure data environment that is the lifeblood of AI technology.
- Make long-term investments in education and reskilling to address the negative consequences of technological disruption from automation

> "Artificial intelligence, especially machine learning, **is the most important general-purpose technology of our era.**"
>
> *– Erik Brynjolfsson & Andrew McAfee*

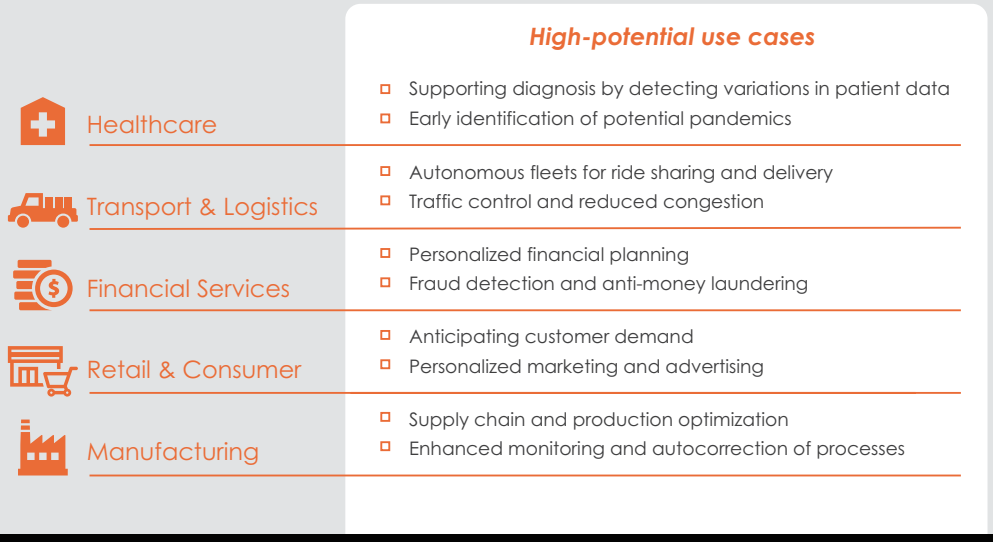


FIGURE 1

Where industries will put practical AI to work

Source: PwC Global AI Impact Index, 2017

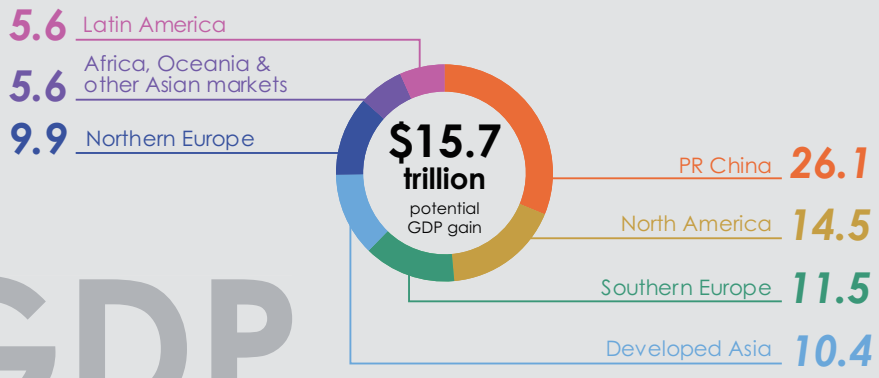


FIGURE 2

Where AI gains will be realized and AI's impact on GDP by 2030

Source: PwC Global AI Impact Index, 2017

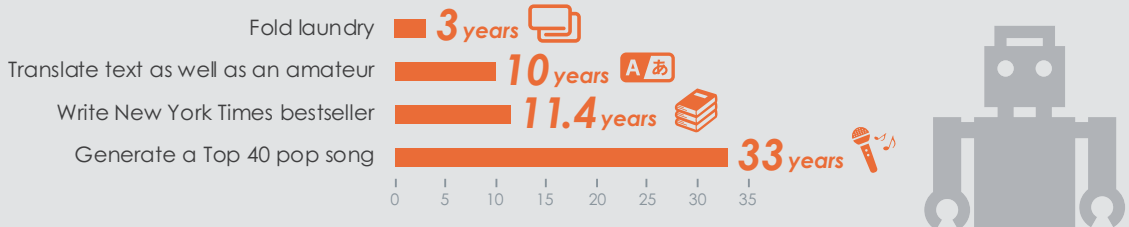


FIGURE 3

When will AI exceed human performance? Predictions from AI experts

Source: Grace et al., 2018

THE TECH-AUGMENTED ALTERNATIVE WORKFORCE

Technology enables the proximity of work to expand beyond a company's walls and balance sheets.

The way humans have collaborated over time is closely linked to technological history. Before phones, we had to be in the same room to communicate in real time. Before the Internet, we had to be in the same building to share our designs and ideas. Before smart phones and groupware, it was very difficult use remote workers. However, new tools that are seeing initial applications today may fundamentally shift the constraints of work in terms of physical space, time, and organizational structures. Imagine a surgeon performing surgery two states away, using a mix of robotics and cutting-edge communication technology, enabled by high-speed data connections. Imagine an engineer able to optimize production from the comfort of home using virtual reality and digital twin technology to create a virtual representation of the factory floor.

THE ESSENTIALS

A suite of technologies may make these scenarios a widespread reality (Figure 1). Mobile devices and high-speed data connections, with the upcoming adoption of 5G, act as the backbone of remote work [7]. Groupware, including shared online work platforms and videomessaging, allows real-time collaboration and project management online. Digital talent platforms allow for expertise and manpower to be drawn flexibly. Virtual and augmented reality (VR and AR) allows team members to collaborate in parallel, independent of location, using mixed reality as a common medium. The network of sensors and devices in the Internet of Things allows virtual environments to update based on changes in real-life workspaces.

Cultural shifts intermingle with these emerging technologies too. Changing attitudes to work by employers and employees have led to the rise of the alternative workforce (Figure 2). This includes freelancers, temps, and on-call and contract workers [8].

SITUATION REPORT

More than half of the world's mobile subscribers live in the Asia-Pacific and service providers are expected to deploy 5G networks, covering a third of the region's population, by 2025 [9]. Enabled by this trend, analysts forecast that 42.5% of the global workforce will be mobile by 2022 [10]. This coincides with increasing numbers of remote workers in countries like the USA and Singapore, and this trend looks to spread to other countries as related technologies diffuse.

Many companies are already experimenting with alternative work arrangements by blending organizational practices and technology. For instance, Ryan LLC, a tax advisory firm, started an initiative called myRyan which enables 100% of employees to work flexibly and tracks performance rather than work hours [11]. This has led to improved employee retention and recruitment, financial performance, and client satisfaction [12].

While there are certainly benefits and opportunities for both individuals and organizations arising from this emerging trend, there are potential pitfalls as well. Alternative work can involve financial insecurity and social isolation for workers and a lack of shared culture within an organization [13]. There will certainly be varied impacts across firms, sectors, and countries. Emerging forms of collaboration can raise challenges of coordinating teams and external partners in disparate geographic locations, protecting intellectual property (IP), and finding ways to communicate meaningfully in lieu of face-to-face meetings.

WHY DOES THIS MATTER TO APO STAKEHOLDERS?

Significant uptake of this trend will lead to a fundamental change in the way individuals and organizations collaborate (Figure 3). This has repercussions in both the public and private sectors, as geography loses importance. Changing work arrangements, in terms of hours spent commuting and at the office, also mean changes in family life. These all could have potentially profound effects on national productivity and society.

Member governments may see ways that the changes will be detrimental to their countries. Lack of appropriate regulation and technological and soft skills as well as rigid organizations can magnify negative effects and limit opportunities.

WHAT CAN MEMBER COUNTRIES DO TO RESPOND TO THIS ISSUE?

- Collect data to identify the alternative workforce population to inform policies that promote their welfare and maximize their ability to contribute to national development.
- Develop dynamic digital regulatory frameworks that focus on ex post facto enforcement of rules

rather than detailed ex ante prescriptions and legacy technologies.

- Education will be a key driver to pair creativity with technology to ensure that workers have the capacity to adapt to economic changes over the long term. This will involve not just traditional education but lifelong opportunities for reskilling.
- Ensure that the data infrastructure (4G, 5G, and beyond) is in place in terms of availability, affordability, and consumer readiness.

What **TOOLS** make the transformation to a **new kind of workforce possible?**

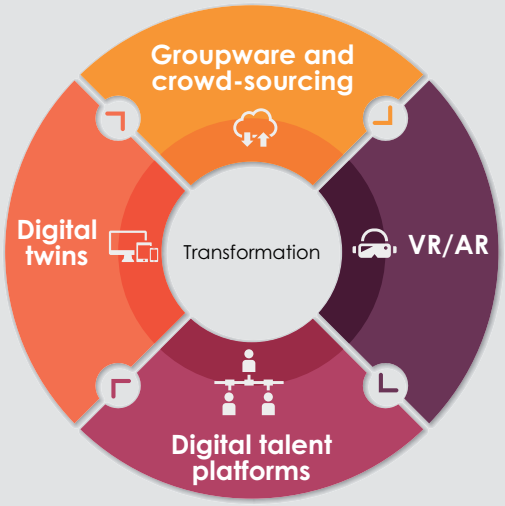


FIGURE 1

Key technologies involved in the transition to a tech-augmented alternative workforce

Source: The Future is Now, Quarterly Emerging Trends Report (Q3 2018)

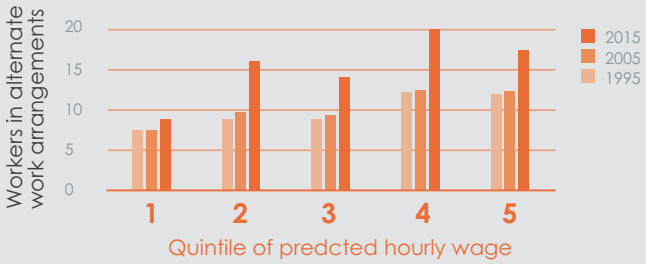


FIGURE 2

The rise of alternative work arrangements in the USA [14]

Source: The Future is Now, Quarterly Emerging Trends Report (Q3 2018)

All around the world, **the way teams work together is changing.**

Instead of being centralized at a local level, teams are adding talent from around the world who bring diverse perspectives and ideas to the table.

The modern organization never sleeps. It has people from different countries, time zones, and cultures all working together to create new designs or products simultaneously.

Collaboration on projects is happening in real time, at all times of the day.

FIGURE 3

Impacts of a tech-augmented alternative workforce

Source: Grace et al., 2018

BUILDING RESILIENCE TO CLIMATE DISASTERS

Climate-driven disasters are on the rise, but new tools and approaches are emerging to help communities and governments build resilience.

The year is 2040, and many countries in the Asia-Pacific have experienced increased incidences of flash flooding and more intense tropical cyclones. At the same time, 5 billion face periodic water shortages, and agriculture yields have decreased by up to 50% in some parts of the world due to lower rainfall [15]. Droughts have decreased the world's hydropower electricity production. Heat waves have proven fatal in major cities throughout the world, and generally warmer, drier conditions lead to frequent fire seasons.

Climate-driven disasters look to have devastating impacts on human security in the coming decades. While the Paris Agreement of 2015 aims to limit the increase in average global surface temperature to less than 2.0°C above preindustrial levels, even at these levels there may be severe shocks. Mitigation efforts must be coupled with adaptation mechanisms to lessen climate-change effects. There is a range of emerging tools and approaches leveraging data and technology to build resilience at scale.

THE ESSENTIALS

Climate change and global warming are largely driven by greenhouse gas (GHG) emissions from human activities [16]. While temperatures on average are rising, there are variable effects in different regions on local climate systems. One prominent effect has been the surge in weather extremes in the last decade [17]. Changes in local climate systems result in both wetter monsoons and devastating floods, as well as low rainfall and more heat waves.

Climate resilience is the capacity of communities, countries, and systems to cope with extreme weather events and transform in the face of sudden or protracted crises.

SITUATION REPORT

Mean global surface temperatures have risen by around 1.1°C since the start of the Industrial Revolution. The Intergovernmental Panel on Climate Change projected four pathways with associated temperature increases ranging from 1.5 to 4.8°C by the end of the century [18]. Even at the lower end, this would result in more heat waves and droughts, flooding, and reduced agricultural yields.

Within the past decade alone, there is robust evidence for significant increases in extreme weather events in Asia. In 2010, Pakistan experienced the worst flooding in its history. This was attributed to changes in the jet stream because of temperature changes. In 2015 and 2016, India suffered severe heat waves linked to a weak premonsoon season and a strong El Niño phase. These types of events are expected to intensify and become more frequent with increased global warming. Similarly, typhoons are likely to become stronger because of higher ocean surface temperatures (Figure 1) [19]. The storm surge associated with typhoon Haiyan, which struck the Philippines in 2013, was exacerbated by elevated sea levels and above-normal ocean heat [20].

Given these challenges, public and private organizations are partnering to develop novel solutions to build climate resilience across different scales. These emerging solutions will help to address the multifarious impacts of climate-driven extreme weather.

The Global Facility for Disaster Resilience and Recovery (GFDRR) uses cutting-edge science and technology to deal with challenges associated with disaster-related risk information. The GFDRR has funded innovative projects such as using flying sensors equipped with ultra-high-resolution cameras to identify flood risks in Mozambique. Another project used Twitter data to inform flood models, improving responses and preparedness in Indonesia.

Given the effects of extreme weather on agriculture, policymakers and researchers are developing both flood- and drought-resilient crops using genetic modification. A team associated with the US Department of Energy has identified a set of genes associated with water-use efficiency in plants, laying the groundwork for future genetic engineering for crop resilience [21].

Critical infrastructure like roads can be designed and built in ways that enhance climate resilience. For example, MetaMeta Research and partners received funding to transform the way roads, which are conduits for modern commerce and life, are planned and built in the Horn of Africa by introducing innovative designs and improved guidelines to harvest rainwater, prevent soil erosion, and improve the use of roadside land [22].

WHY DOES THIS MATTER TO APO STAKEHOLDERS?

The Asia-Pacific is exceptionally exposed to extreme weather events, as the region is strongly influenced by monsoon system dynamics (Figure 2). Countries in the region top the list of those most affected (in terms of economic losses and fatalities) between 1996 and 2015. Outside of the immediate fatalities associated with these events, there are disruptions in economic activity and social cohesion as well. Many regions are expected to experience a decline in agricultural productivity and yields from heat stress, drought, and floods. In an extreme example, floods and drought caused 90% of rice production losses from 1996 to 2001. Those living in informal settlements in cities as well as rural populations look to be the most vulnerable to these dangers.

Extreme weather events can even affect energy security by destroying grid infrastructure and affecting hydropower capacity. There are thought to be links between extreme weather events and negative health outcomes, particularly in children and the elderly, in terms of heat stress, diarrhea, and insect-borne illnesses. Over the longer term, this can result in increased migration flows from areas under high stress.

Adapting to and mitigating against these effects require significant and rapid technological and societal changes, and Asia looks to be a major source of emissions in the coming decades (Figure 3). Despite this, public concern about climate change is lower in Asia than in most other regions [23].

WHAT CAN MEMBER COUNTRIES DO TO RESPOND TO THIS ISSUE?

- Countries can fund innovations and collaborations between international agencies, research units, the private sector, and local communities that have a chance to build climate resilience at scale.
- Countries can improve capacity for water resource adaptation including water-saving technology, changing to drought-resilient crops, and building water reservoirs.
- Countries can reduce exposure to extreme weather via effective land-use planning and reducing the vulnerability of lifeline infrastructure and services.
- Countries can invest in functioning early-warning systems for disasters that leverage social media and other novel data sources.

There are now **more frequent tropical cyclones** in the Asia- Pacific, with East and Southeast Asia being hardest hit.
(1980–2014)

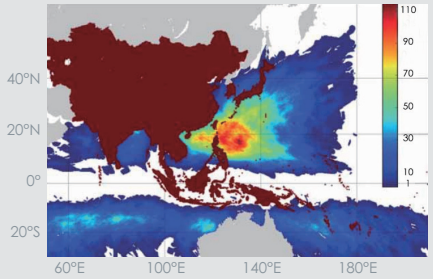


FIGURE 1

Heat map of tropical cyclones with winds over 40 km per hourin the Asia-Pacific

Source: Asian Development Bank (2017)

Much of the Asia-Pacific coastline and island regions are **vulnerable to climate change-related sea-level rise and flooding.**

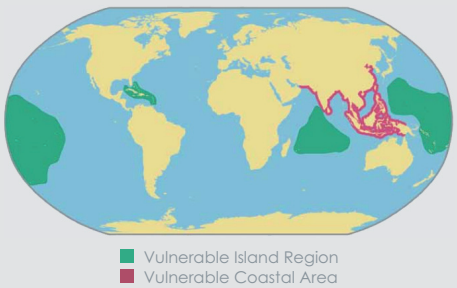


FIGURE 2

Island and coastal regions in the Asia-Pacific vulnerable to climate-related sea-level rises and flooding

Source: Asian Development Bank (2017)

The **cost of adaptation in the Asia-Pacific is estimated to be around USD50B**, with the bulk of this going to infrastructure costs.
In East Asia, there are large costs associated with coastal zone protection.

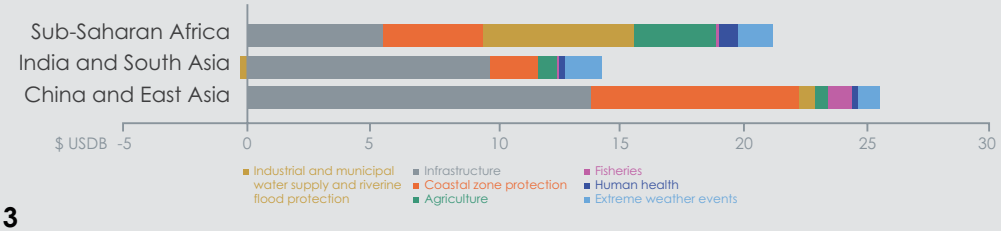


FIGURE 3

Cost of climate adaptation

Source: Grantham Research Institute, based on World Bank, 2009

LINKING MINDS AND MACHINES

Using thought to communicate and control machines, brain–computer interfaces may change what it means to be human.

Entrepreneurs and researchers envisage a world in which people can communicate telepathically, with each other and with machines, or acquire superhuman abilities, such as hearing at very high frequencies. These powers, if they ever materialize, are decades away. But well before then, brain–computer interfaces (BCIs) could open the door to remarkable new applications. Imagine stimulating the visual cortex to help the blind see, forging new neural connections in stroke victims, or monitoring the brain for signs of depression.

These are just some possibilities emerging from the current neuroscience research agenda and their practical applications. As governments, academia, and private organizations explore one of the last frontiers of science, the more than 90 billion neurons making up the human brain, the real-world impacts of their efforts may be truly transformative.

THE ESSENTIALS

Neurotechnology is the set of technologies created based on the principles of the nervous system, such as neural networks. Neural mapping is one of the main fundamental research pathways driving neurotechnology development. Neural mapping involves mapping the biological properties of the human brain onto spatial representations [24]. The most well-known effort is the Human Connectome Project, where scientists are trying to create a complete detailed map of the entire human brain. This may unlock economic opportunities, much like the mapping of the human genome did for genomics.

BCIs are technologies that will allow humans to communicate, using brain signals alone, with hardware and software, e.g., computers, wheelchairs, prostheses, and other devices [25].

SITUATION REPORT

There remains a great deal that humans, even leading experts, do not know about their own brains. We know even less about how to develop interfaces that transmit information in and out of our brains. The effort to map the entire human brain at the level of synapses has barely begun and we likely will not have a general map for another 20–30 years [26].

Despite these gaps in theoretical and practical knowledge, emerging neurotechnologies may see practical applications in the coming decades.

Currently, rudimentary BCIs are being employed in medical fields. For example, cochlear implants help people hear by converting sound into electrical signals and sending them to the brain. The BrainGate system uses an array of microelectrodes implanted in the motor cortex to allow people with spinal cord injury, brainstem stroke, and amyotrophic lateral sclerosis (usually referred to as ALS or Lou Gehrig's disease) to control a computer cursor by thinking about movement of their paralyzed arms [27]. Early clinical research has shown that such systems allow intuitive control of advanced prosthetic limbs and mobility devices. NeuroPace, a Silicon Valley firm, monitors brain activity for signs of imminent epileptic seizures and delivers electrical stimulation to prevent them [28].

There is a range of public- and private-sector activity behind the development of more advanced BCIs (Figure 1). The most prominent and ambitious example is Neuralink, backed by Elon Musk, the CEO of Tesla Inc. and Space X, with the aim of a "closer merger of biological and digital intelligence" [29]. Researchers at the University of Washington have developed the world's first brain-to-brain network, allowing three people to play a collaborative Tetris-like game using only their thoughts [30].

WHY DOES THIS MATTER TO APO STAKEHOLDERS?

Even at their current rudimentary stage, BCIs have the possibility of making a significant difference in the lives of individuals, particularly those with disabilities. As the underlying knowledge of the human brain and BCIs becomes more advanced, it may fundamentally change what it means to be human.

While initial applications focus on restoring functionality, future BCIs will augment human capabilities. A whole-brain interface would allow your brain to communicate wirelessly with the cloud, computers, and the brains of anyone with a similar interface. Brain-to-brain interfaces could dramatically enhance cooperative problem solving, allowing the direct transmission of concepts and emotions. This sort of system would make the flow of information between your brain and the outside world so effortless, it could feel just like your thinking today. This would lead to a transformative increase in the speed (Figure 2), nuance, and accuracy of communication, an innovation on par with the development of language.

The possibilities are extraordinary: someone with this interface could access and absorb knowledge directly from the cloud, pump images from one person's retina into the visual cortex of another, create new sensory abilities such as high-frequency hearing, and allow the manipulation of networked machines through thought alone.

However, as applications move to enhancement, a host of concerns will arise. One's own thoughts may become the final form of privacy to be stripped away. Security is another: if a brain can be reached on the Internet, it can also be hacked. Inequality is a third: access to superhuman cognitive abilities could be beyond all except a self-perpetuating elite. Ethicists are already starting to grapple with questions of identity and agency which arise when a machine is in the neural loop.

WHAT CAN MEMBER COUNTRIES DO TO RESPOND TO THIS ISSUE?

- Member governments may fund fundamental research related to neural mapping in universities and research institutes at the national and international levels. This research is the foundation for advances in BCIs.
- Governments may fund research on the development of advanced BCIs and encourage the private sector and academic partners to collaborate and compete to meet specific development targets.

There is **growing investment in and research activity** on the development of BCIs by governments and the private sector.

Kernel	Bryan Johnson, founder of payments service Braintree, has committed USD100M to a BCI startup called Kernel
Facebook	Facebook Inc. is developing a thought-to-text device allowing people to compose emails and posts silently
Neuralink	Elon Musk is backing the startup Neuralink that will allow brains to connect with computers at ultra-high bandwith
DARPA	DARPA is funding nine BCI projects expected to enter US FDA clincal trials in three to five years

FIGURE 1

Current R&D activity in advanced BCI technology

Source: The Future is Now, Quarterly Emerging Trends Report (Q3 2018)

Communication speeds would be accelerated by **whole-brain interfaces** in addition to **improving the accuracy and nuance** of communication.

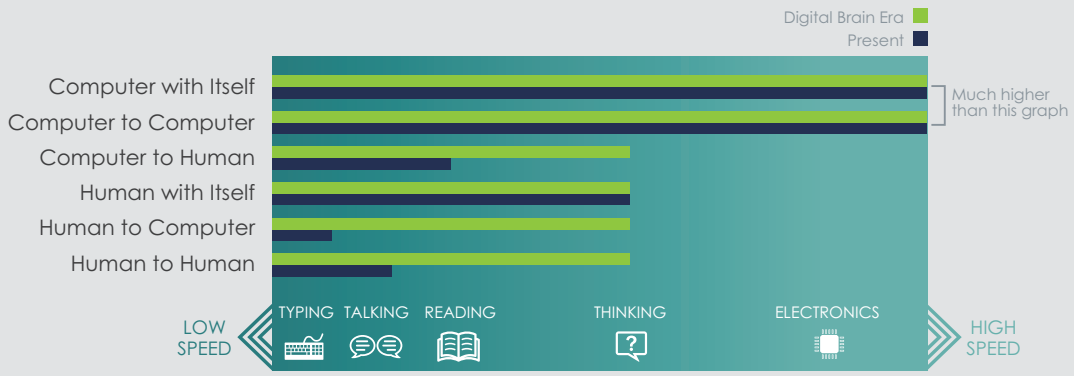


FIGURE 2

Current communication speed compared with the digital brain era

Source: [31]

A CHINESE GLOBAL ORDER?

PR China's growing presence and influence across the Asia-Pacific and beyond are both a source of threat and promise.

The year is 2050, and PR China has overtaken the USA as the world's largest economy by a significant margin (Figure 1) [32]. It has forged closer relationships in the region, leading to the establishment of an Asian Economic Region, allowing the free movement of goods, capital, and labor. Networks of high-speed rail, shipping lines, and roads stretch out from the country's heartland across the continent as a result of the largely successful Belt and Road Initiative. At the same time, growth in military capabilities has allowed the government to expand its territorial claims in the seas and on land. Alongside expertise in AI, biotech, and high-tech industry, PR China has also exported a model of techno-authoritarianism to other countries.

The scenario above may never come to pass, as PR China's trajectory is marked by complexity and deep uncertainty, but it is plausible. Regardless of how the future unfolds, countries large and small will be watching PR China with great interest. In coming years, managing a beneficial relationship with PR China through bandwagoning or balancing will be a major geopolitical challenge for most countries.

THE ESSENTIALS

PR China is currently the world's most populous country, and the second-largest economy in terms of GDP [33]. It has extensive economic and political ties with countries in the Asia-Pacific and elsewhere, with the Chinese domestic market and industry acting as major consumers of foreign commodities and goods. It is ranked as the third-most powerful military in the world, with growing capabilities to project its power across both land and sea [34].

While Chinese foreign policy has traditionally been characterized by "biding one's time" since Deng Xiaoping, under Xi Jinping, PR China has become more active and assertive. While continuing massive investments in military and technological capabilities, it has also sought to project more hard and soft power abroad.

SITUATION REPORT

PR China's trajectory and strategic implications involve numerous complex issues to consider. Its large and still-growing market has created sustained demand for exports and sent millions of Chinese abroad as tourists. This has entwined the economic fate of much of the region with that of PR China.

As its economy chugs along steadily, even during trade disputes with the USA, PR China has made long-term investments in renewable energy, biotech, and information technology. The Made in China 2025 policy blueprint aims to develop capabilities in growth industries such AI, electric vehicles, and robotics (Figure 2) [35]. Many of these technologies have dual uses in military applications, raising tensions with foreign powers.

PR China's growing confidence on the international stage shows itself clearly with increasingly assertive territorial claims, especially with regard to the Taiwan Strait, East China Sea, and South China Sea. These theaters are potential flashpoints for Great Power conflicts and threaten key shipping lanes.

Whether PR China becomes the next global superpower depends on whether it can sustain its growth and avoid serious economic crises. PR China's rise has occurred in the context of rapidly accumulating debt, amounting to around USD2.8T (Figure 3). Some economists suggest that its startling GDP growth may reflect wasteful and unproductive spending rather than actual wealth [36].

PR China's Made in China 2025 initiative along with other high-tech national roadmaps aims at making it a world-leading smart manufacturer.

FIGURE 1

Share of world GDP (PPPs), 2016–2050

Source: IMF estimates for 2016 and PwC

PR China's innovation in Industry 4.0 focuses on robots, industrial communications, and sensors.

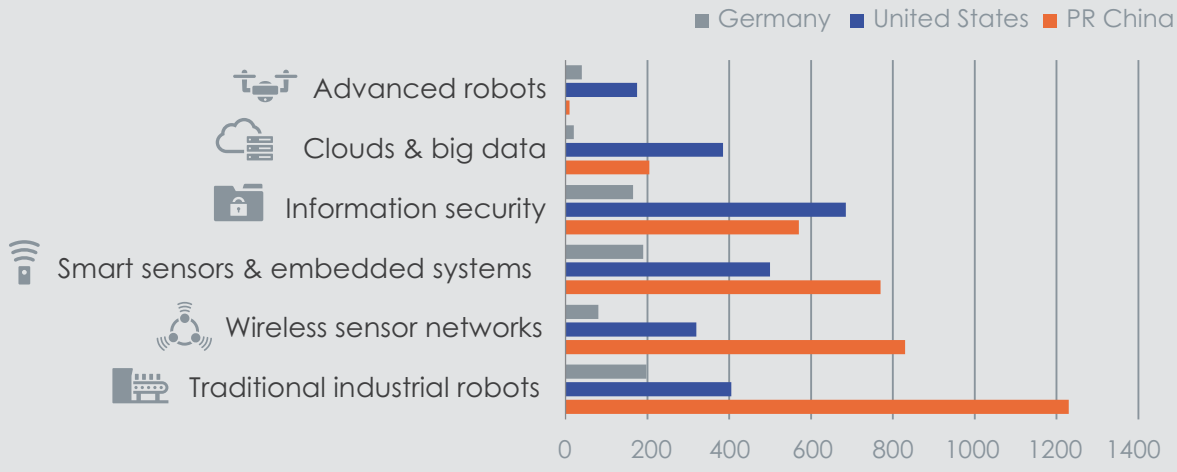


FIGURE 2

National patent families (priority applications) by technology (process and use patents not included)

Source: Wubbeke et al. (2016) Made in China 2025. MERICs Papers on China No. 2

PR China faces a rising "**Great Wall of debt**" that threatens its growth prospects.

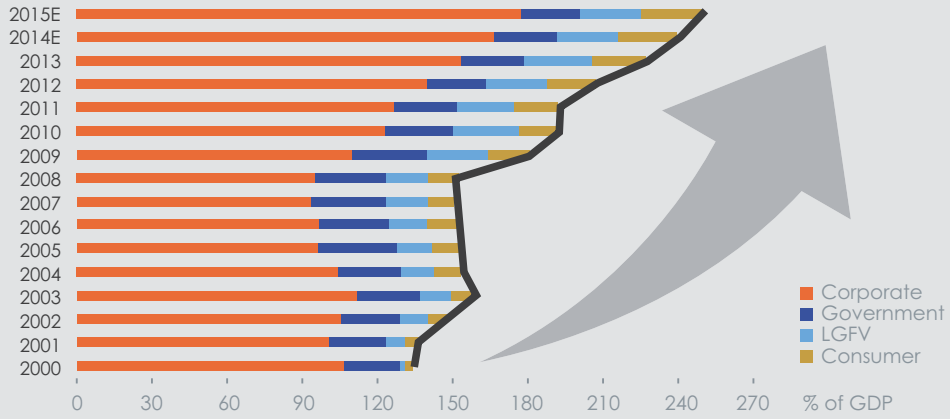


FIGURE 3

Debt by major borrower segment as % of GDP. LGFV, local government financing vehicle

Source: People's Bank of China

The Belt and Road Initiative creates a **global infrastructure network**.
PR China uses, acquires, and builds railroads, ports, and pipelines.

FIGURE 4

Belt and Road Initiative routes

Source: Digital Silk Road Project (Financial Times), Economist Intelligence Unit

Economic engagement with PR China has **strategic implications.**

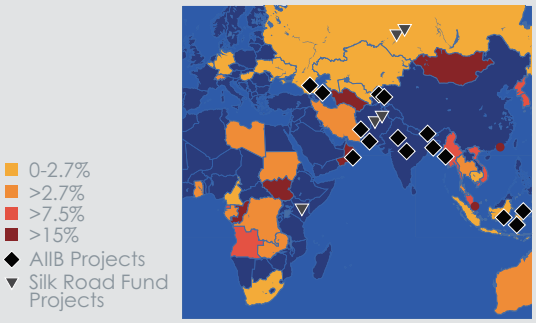


FIGURE 5 (left)

Export dependency as share of GDP and projects financed] by the AIIB and Silk Road Fund as of April 2017 [38]

Source: People's Bank of China

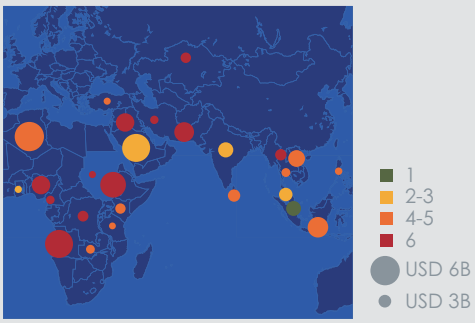


FIGURE 6 (Right)

Value of PR China's "contractual projects" abroad, 2013–16 (size) and Euler country risk assessment as of Q1 2017 (color)

Source: Wubbeke et al. (2016) Made in China 2025. MERICs Papers on China No. 2

METHODOLOGY

OUR APPROACH TO FORESIGHT AND SCANNING

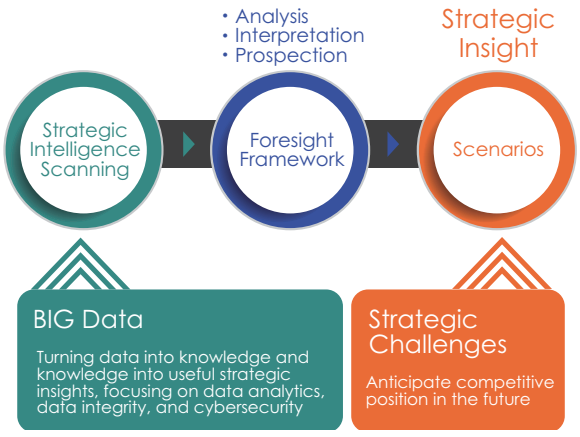
The Futures Team at the APO Secretariat has developed its own set of foresight tools to identify and analyze emerging trends as well as to understand their implications for our member countries. These tools allow us to anticipate the future, one component of the APO's wider Transformative Strategic Planning Model (TSPM).

The methodology used by the Futures Team in compiling this report primarily involves the first two steps in the anticipate stage of the TSPM, strategic intelligence scanning and foresight. The core of these two steps is systematic collection of data on the external environment to understand the nature and pace of change and distill the data into knowledge about possible futures. This is best understood as distinct components:

- Defining Focus
- Strategic Intelligence Scanning
- Sense Making
- Monitoring

This process is carried out quarterly, allowing for a process that is sensitive to ongoing developments and can inform policy in a timely matter.

ANTICIPATE



DEFINING FOCUS

The Futures Team, with direction from senior management at the Secretariat, has focused on a general area of risk and opportunity: the future of labor productivity in the Asia-Pacific. Issues, trends, and drivers relating to this area have been selected and analyzed based on their potential impacts 10–30+ years from the present.

The following themes were determined to be of interest to the APO based on their connection to the organization's overarching mission to promote labor productivity and enhance the competitiveness of:

- Politics and Geopolitics
- Trade and Migration
- Emerging Markets
- Population and Demographics
- Environment
- Agriculture
- Technology
- Industry
- Labor
- Work and the Workplace

While more specific to the organizational challenges, these areas overlap with the standard STEEP areas employed in other foresight practices: social; technological; economic; environmental; and political.

STRATEGIC INTELLIGENCE SCANNING

Futures Team analysts conducted systematic environmental scanning based on the themes specified above.

The main tool used for this was an AI-driven platform that collects information on trends and forecasts from online sources. This, in conjunction with traditional online research, allows the Futures Team to review thousands of forecasts across our areas of interest.

From this bank of forecasts, Futures Team analysts distilled them into more general trends. These trends were then analyzed further and classified as predetermined issues and uncertainties.

SENSE MAKING

Sense making refers to the process of piecing together raw information to form a comprehensive, comprehensible picture of an issue. This involves the two processes of:

- Synthesizing, by combining disparate ideas into surprising insights
- Prioritizing, by determing which issues merit focused attention

Within the TSPM, this involves analysis, interpretation, and prospection of the data collected in the strategic intelligence scanning process. Once this is done, the knowledge can be used to develop scenarios and gain strategic insights.

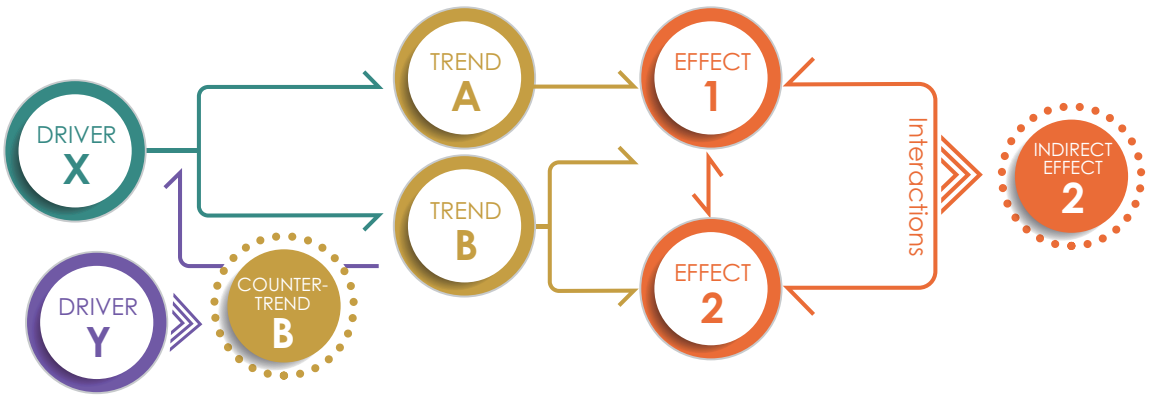
We analyze trends based on time frame, scope, impact, and likelihood of occurrence under the framework below. Based on the total score for trend relevance from the perspective of how trends impact organizational stakeholders, a decision is made on how to react to the trend.

Trends included in this report are not necessarily the highest scoring in terms of relevance but are selected based on whether they qualify as an emerging trend, sometimes referred to as an "emerging strategic issue." Emerging trends have not yet surfaced as critical but could have significant impact if they occurred. The following criteria are used by the Futures Team to assess whether a trend could be an emerging strategic issue:

- Relatively high uncertainty (regarding direction or timing of change)
- Possibility of major impact on organizational stakeholders
- Level of institutional surprise or disruption each issue would cause if it occurred

Consider trend relevance and impact on organizational stakeholders							
Time frame		Scope		Impact		Likelihood*	
When will a mainstream impact begin to appear?		How widely will this trend impact stakeholders?		How strong will the impact of this trend be on stakeholders?		What is the likelihood of this trend having an impact on stakeholders?	
Assessment	Rating	Assessment	Rating	Assessment	Rating	Assessment	Rating
1–5 years	5	Global	5	Significant	5	Almost certain (93%)	5
6–10 years	4	Many countries	4	Major	4	Likely (75%)	4
11–20 years	3	Single country	3	Moderate	3	Even chance (50%)	3
21–30 years	2	Niche sector/ market	2	Minor	2	Unlikely (30%)	2
30+ years	1	Organizations	1	Insignificant	1	Remote (7%)	1
Never	0	Individual or nonexistent	0				

Assessment total	Decision: What might the APO do?
16–20	**Act now**
12–16	**Manage**
7–11	**Watch**
Less than 6	**Monitor**



We use system mapping and cross-impact analysis to classify trends into drivers and effects as well as to understand their interrelationships.

Along with system mapping, tools like the future wheel are used to think through the first-, second-, and third-order effects of key drivers. This allows for structured thinking about the future development of trends and uncertainties with an eye toward understanding their implications for our stakeholders. It is generally difficult to think through the range of possible outcomes for any change, and most analysts end up focusing mainly on immediate consequences. The future wheel encourages thinking through indirect consequences and implications to identify possible strategic responses.

MONITORING

Monitoring involves tracking the trends and drivers collected and analyzed in the previous steps of the process. This allows the APO to stay informed and aware of changes in its contextual environment and respond accordingly. Every quarter, trends from previous scanning iterations are tracked and revised based on new information.

THE FUTURES TEAM

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SUSTAINABLE PRODUCTIVITY

THE NEW FRONTIER FOR PRODUCTIVITY


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