

Science and Technology Innovation Program



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Grey Zones:

Emerging Technology Development and Impact in Emerging and Developing Markets

January 2020





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Abstract

Emerging technologies constitute a “grey zone” that occurs between research and development (R&D) and engineering for commercial or mass scale production. The pace of innovation is more rapid than technology knowledge transfer and comprehension by the policy and regulatory community. Just as emerging technologies constitute a “grey zone” between R&D and mass scale or mainstream offerings, the emerging market represents a “grey zone” between a developed market and an undeveloped market in either general economic terms or industry specific terms. Digital emerging technologies deviate from traditional supply chains, involve new business models, create unexpected or unpredictable outcomes, and can bring challenges to governance. Emerging technologies may be a strategic benefit to emerging markets, such as Hungary, and developing countries, such as Suriname, to help expand their economies. Who is responsible for governing the emerging technology solution if multiple countries are part of the development or operating environment, and is there a need for collaborative governance? Who is liable in the case of bad actors or saboteurs?

Emerging Technologies

When we think of emerging technologies or hear references to emerging technologies in conversation, the topic tends to include terms such as blockchain, cryptocurrencies, artificial intelligence (AI), big data, cybersecurity, autonomous vehicles, biosensors, and genetic and genomic technologies. Often, the term Emerging Technology is used synonymously with futuristic or in context to technologies that are very early in the conceptualization stage.

An emerging technology is considered the advanced rollout of new offerings and commercial availability of technology products or services in which there is no current market, or the current market is not mainstream. Emerging technologies are not research and development efforts, rather the output of research and development to a point where the next step is production and scaling of the new offering. Emerging technologies constitute a “grey zone” that occurs between research and development and engineering for commercial or mass scale production.



A current example of a widely recognized emerging technology is the autonomous vehicle. Autonomous vehicles have been envisioned as a futuristic technology since the 1940's. Research has been conducted on autonomous vehicles and automated highway systems for decades. Autonomous cars have been the subject of research and concept demonstrations since the 1980s. For many years, the technology required to create a driverless autonomous vehicle that was not dependent on external factors or systems was out of reach. In 2009, with the introduction of LiDAR, combined with computational algorithms for vehicle control, was tested on roadways by Google in their Driverless Car Project, which ultimately grew to become Waymo.

With basic feasibility demonstrated, the building blocks were in place for autonomous vehicles to become a practical possibility. This spurred development efforts by many companies over the past decade to bring autonomous cars to a point where introduction into the larger mobility market was possible. With many examples of driverless cars in operation, the question about the possibility of driverless cars has been answered. Now, autonomous vehicles are beginning to emerge into a more mainstream reality. The National Highway Traffic Safety Administration (NHTSA) defines levels of autonomy from one to five, with level five being fully autonomous. Questions that exist now concern level five autonomous vehicles, and are largely around uncertainty, unintended impacts, timing and availability, and further investigation of regulatory issues, business models, and liability. A recent study by Rand Corporation indicates that autonomous vehicle are now an important consideration for policy makers due to the maturity and commercial availability of this technology.[1]

WHAT MAKES A TECHNOLOGY AN EMERGING TECHNOLOGY?

Emerging technologies contain concept methods to meet previously unmet needs or overcoming scientific and technological limitations to enable new capabilities. In addition, emerging technologies are not single source developments or one-off concepts. Rather, they may be disrupting a current market, or entering a new market, potentially with competition from other similar technological offerings to be early entrants or fast followers to define, refine, and rollout offerings for market expansion. These technologies are at a stage in the systems development lifecycle beyond empirical testing or proof-of-concepts whereby businesses are seeking early adopters and early customers to explore business opportunities and, in some cases, new market offerings.

Current examples of emerging technologies include, Industrial Internet of Things (IIoT) (advanced, networked sensors), autonomous vehicles, AI applications (robotics, algorithmic data solutions, machine learning, and deep learning solutions), biometric and biosensor technologies, advanced medical applications, cloud-based solutions, smart infrastructure/ buildings/materials, and virtual and augmented environments. Many of these examples have been the subject of research and concepts exploration for quite some time, perhaps even decades. What makes these examples emerging technologies now is the transition

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from being a research project to becoming more widely available solutions, defined industry offerings, or marketable business offerings.

How *long is it going to be* before I ride in or own an autonomous vehicle? *When* will I have a robot assistant? *When* will I be able to interact with a generated non-human avatar in a virtual environment? Questions such as these are oftentimes associated with hypothetical research questions on possibility, but in the case of emerging technologies, these are questions of availability.

At some point in the past, nearly all systems that were emergent or new to the world were emerging technologies, including personal computers, automobiles, telephones, and even electricity. Although the idea of an emerging technology may seem intuitive, a precise definition remains elusive. Halaweh (2013) states that, "There is no widely agreed-upon definition of emerging technologies." [11] Rather, an emerging technology is described as having certain characteristics that help define it as emergent. According to Halaweh, the characteristics for an emerging technology are:

- **Uncertainty:** Unknown or unpredictable values or outcomes, such as maturity, business model, customer acceptance, or standards
- **Network Effect:** The greater the number of users or customers an emerging technology has, the greater the chance of mass-scale adoption
- **Cost of ownership:** Cost of ownership of an emerging technology can be a significant factor, and cost of failure for emerging technology adoption without alternate options can be high





- **Unobvious impact:** Social and ethical impacts of emerging technologies can be unknown, unseen, or unexpected
- **Availability:** Availability of an emerging technology can be severely limited, and is often limited to the market or country in which it is produced. In some markets a non-emerging technology is considered emerging if limited availability is a key factor
- **Not being fully investigated:** Emerging technologies are often based on new models or inventions for which there is limited availability of academic research, industry standards, or governing policies [11]

Examples of current emerging technologies, coinciding with those discussed in this document, are listed below by Gartner Inc., a leading research and advisory company (2019). Each year, organizations such as Gartner publish trends on technology in various industries that are swiftly developing.[16] To present an idea of the maturity of development, perceived expectations, and timing of emerging technologies for 2019, the Gartner hype cycle for 2019 is shown in Figure 1.

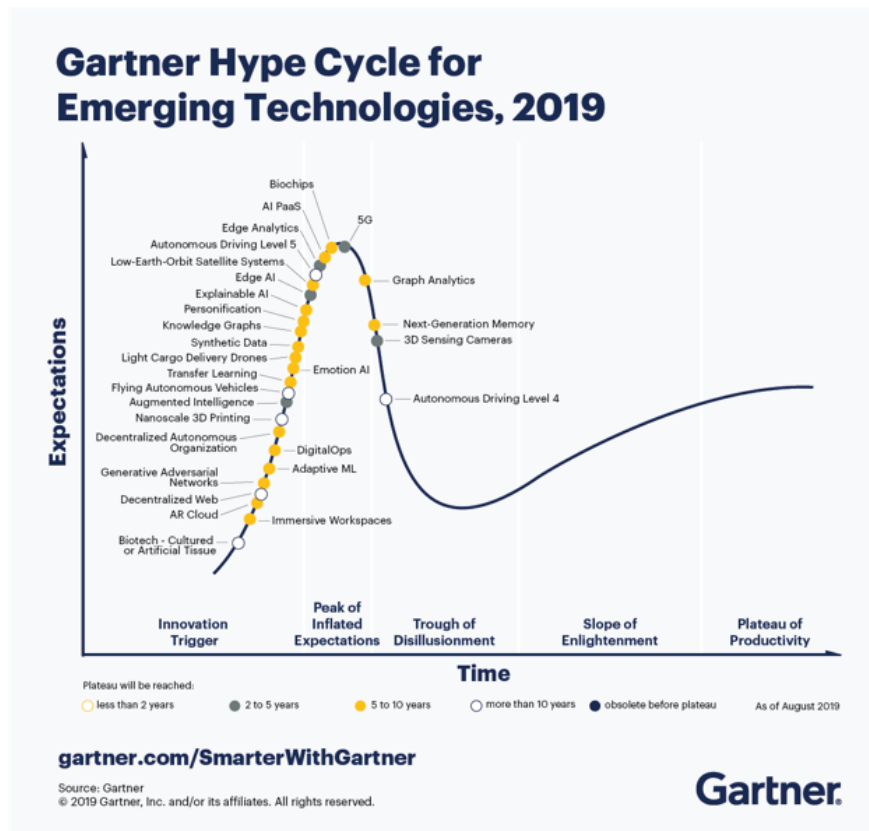


Figure 1: Reproduced from Gartner Inc. via: https://blogs.gartner.com/smarterwithgartner/files/2019/08/CTMKT_741609_CTMKT_for_Emerging_Tech_Hype_Cycle_LargerText-1.png



SYSTEM LIFECYCLE

Emerging technologies follow a systems lifecycle. All new systems, whether new inventions or iterative improvements of well-defined solutions, follow a development lifecycle.[3] An emerging technology is a unique occurrence whereby the mass market or mass-scale deployment of the system is unknown, or in the process of defining its own market. For emerging technologies, the demonstration and validation stages overlap significantly with production and deployment and can be vulnerable to unpredictable outcomes and/or acceptance criteria.

The development lifecycle for each emerging technology follows a different cadence. For example, the development lifecycle of software-based solutions is often measured in months (many software solution examples are approximately 6 – 18 months), whereby, development of an autonomous vehicle, or complex hardware technology, is measured in years (vehicle programs tend to be 5 years or longer and incorporation of new technology into a new vehicle can take 5 – 10 years).

In each of these examples, the emerging technology is either a supplement or a replacement for an existing solution, a new offering altogether in a new market, or at the intersection with another, more mature industry vertical. If the emerging technology or service is a supplement or a replacement for an existing solution, the period of development of this technology or service coordinates with the existing product development cycle and launches at the appropriate time. The timing of development and product launch is often iterative and can lengthen the development lifecycle substantially.

If the emerging technology is a new offering and has no existing market or is not meant to supplement or replace an existing product, then the development cycle can be dependent on unpredictable variables. Furthermore, these types of emerging technology can involve many pivots in product definition and in development timing.

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MARKET FIT AND CUSTOMER ACQUISITION

Research and development drives exploration of new ideas and applications. Emerging technologies, on the other hand, are the testing, refinement, and development of new ideas and applications (research products) into saleable solutions comprising technical efficacy, business model innovation, market knowledge, and customer acquisition. Emerging technologies are essentially the period of development it takes for a series of “science projects” to mature from initial demonstration to a viable business or market offering.

Emerging technologies are offerings that are no longer concerned with whether or not a concept is possible. In many cases, the research efforts undergone to explore and validate concepts have been extensively tested. As an example, the idea of autonomous vehicles has been envisioned, explored, and researched for decades. In fact, the earliest examples of prototyped autonomous vehicles occurred in the mid-1980s.[1] Since this time, advancements in computing, imaging, and sensing technologies have made autonomous vehicles a more feasible



reality. Now, the focus has shifted to technology testing, refinement, and enhancement in attempt to provide wide scale deployment and availability.

An emerging technology has progressed to a point where demonstration and documentation of possibility exists and, in some cases, practicality of the concept or new offering has also been assessed and tested. This technology is now emergent in the sense of rollout and marketization and is mainly concerned with product feasibility, viability, customer acquisition, adoption, and addressing unknown or unexpected outcomes. Offerings in the emerging technology space attempt to answer the following: how will businesses make money with the new offering? What risks accompany the new product or solution? How will consumers of the products or services interact and accept the new technology? How will the competitive landscape develop and unfold? What does the new product of solution spell for new market growth? In some cases, defining the market of the new emerging technology space is a challenge faced by multiple competitors concurrently entering this environment.

Just like any new offering, customer acquisition and market response to a product offering are essential to growth. Emerging technologies are at a stage where adoption by customers is being explored. Emerging technologies must prove value addition beyond what is currently available. If there is not yet a mainstream market for the emerging technology, then the technology must demonstrate the success of the problem being solved, or customer pain point being addressed. If there exists a significant problem to solve or, in some cases, no legacy systems with which to contend exist and pose no barriers to technology rollout, an emerging market or developing country could help fast track the adoption of an emerging technology solution.

Emerging & Developing Markets

A market, in the context of a business environment, can refer to a specific industry vertical or subset of an industry vertical. A market can also refer to a geographic region, a geopolitical boundary, or a country.

Therefore, the idea of an emerging market is in actuality quite broad. The emerging market is a market that is still in its nascence or undergoing growth but not yet becoming mainstream.

When referring to an industry or industry vertical, the concept of an emerging market refers to an offering that is growing to become more mainstream with wider commercial availability. In this regard, cloud computing, internet of things, cryptocurrencies, and autonomous vehicle all constitute emerging markets or emerging sectors within their domains.

In terms of investment, finance, trade and economics, emerging markets refer to geopolitical or geographic regions or countries. In this context, an emerging market is a market that is experiencing significant growth and becoming more mainstream.

A Country's economic environment can be classified into three broad categories:

- "Advanced Countries: Countries with high levels of income per person that are well integrated into the global economy



- Emerging Markets: mainly middle-income countries that are growing and becoming more integrated into the global economy
- Developing Countries: mainly low-income countries that are not yet well integrated into the global economy.”[6]

EMERGING MARKETS

The definition of the emerging market is essentially a middle ground between developing countries and advanced countries, or rather, between countries that are not integrated with the global economy and those that are well integrated into the global economy. In regard to the geopolitical environment and international trade relationships, emerging markets are growing nations that are making significant strides but are not yet part of the mainstream global economy. The defining factors of emerging markets are broad and vary by region, by business market sector, and by trade relations. These countries are advanced, but still contain factors that prevent them from being categorized as fully developed.

Emerging markets, much like emerging technologies, are markets that are developing, refining their economic models and iterating their offerings, and consist of their own unique development cycle, the length of which varies by market offering or by country. In the context of countries, the emerging market represent an area that is becoming a mainstream market for development, trade, import/export, or capacity expansion for a specific market sector.[6,10,17,19]

Just as emerging technologies constitute a “grey zone” between R&D and mass scale or mainstream offerings, the emerging market represents a “grey zone” between a developed market and an undeveloped market in either general economic terms (when describing a country or region) or industry specific terms (when describing a medium of exchange for a specific technology sector).

The definition of the emerging market is essentially a middle ground between developing countries and advanced countries.

DEVELOPING MARKETS

Developing markets are markets that are in the earlier stages of growth. Developing markets in the country context, refer to countries that do not have sizable economies, face challenges with currency, stability, or government, and/or are not key purveyors of international trade. The developing market is less advanced in terms of market maturity than emerging or developed markets. As an analogy to emerging technologies versus research and development, an emerging market represents a “grey zone” that is farther along in the journey of scaling its economy and productivity, whereas a developing market, or developing country, is at the beginning of this journey.



Intersections of Emerging Technologies with Emerging and Developing Markets

Good ideas and technology innovation can happen anywhere.[15]. In developing nations, entrepreneurs have to overcome challenges in their business environment that entrepreneurs in well developed markets may not have to face. This often involves a mindset change working with government offices in collaboration to enable development. Mistrust can hamper, or in some cases sink, technology development. Finding ways to work with governing bodies can improve trust relationships and enable development, as long as the governing bodies support the business development.

Emerging and developing markets could be strategic to the development, adoption, or facilitation of emerging technologies. As mentioned previously, if a significant client need exists, or no legacy systems create a barrier, an emerging technology development and adoption could be fast-tracked in an emerging market or developing country.

An important factor to keep in mind: technology development and rollout will not stop, nor slow down, for the policy and regulatory community. Rather, technology development and rollout will move or pivot into areas where it can grow. As stated previously, availability of emerging technologies is a defining factor and limited availability typically contains the emerging technology to its home market where it is developed and produced. If the home market is not open to the technology, then the technology has to move, pivot, or face demise. This is especially true for startup companies creating new solutions. The environment in which these companies are incubated or accelerated plays a huge role in the startup's trajectory and chances of survivability.

The development of software-based solutions can lower barriers to entry for new entrants into the innovation space. In addition, markets without a legacy of past technologies that may prevent emerging technology rollout can be very attractive for testing markets and gaining customers.

TECHNOLOGY DEVELOPMENT

Emerging markets and developing countries with strategically focused research and education can create and nurture technology development in advanced application areas. This can put a country that is striving to develop its own economy at the forefront of cutting edge applications and solutions. These countries have established educational and research environments and are beginning to create and nurture new technology development focused in sectors with an eye on future market development and investment returns. These are countries that have an established strategy and are seeking economic expansion of businesses and scaling of businesses to international markets. Cost of ownership of this strategy can be high if the emerging technology fails.

TECHNOLOGY CONSUMPTION

Countries in this category include developing countries that have a strategy and desire for attracting new businesses and capabilities into the country for export or economic expansion. In this example, new and emerging technologies have a pathway into the country for rollout, consumption, or utilization. The country itself may not have the educational and research infrastructure or means to nurture technology development but



are open to be a market entry point. These countries may also possess strategic assets for certain emerging technology sectors. Countries included in this subset include those with access to raw materials, manufacturing capabilities, agriculture available for export, education, and have established (or are establishing) a strategy for economic growth to include technology inclusion.

TECHNOLOGY EXPANSION AND TRADE

Countries in this subset include those with trade relationships and ecosystems that allow businesses to relocate from one country to another, to take advantage of testing or development environments that allow technology incubation – oftentimes not previously supported by the entrant’s home country. Openness of countries in this category necessitate that businesses entering the market can flourish and continue to scale. This subset also includes businesses seeking to leave home countries due to instabilities, suboptimal economic climates, or trade limitations that hinder development, marketization, and expansion.

Current Examples

When thinking about the leaders in emerging technology development and advancements in research, one may not consider developments stemming from places such as Eastern Europe - Hungary, Poland, Slovakia, Czech Republic, Estonia, and Latvia, Latin America - Columbia, Panama, Honduras, Suriname, Africa - Kenya, Ethiopia, Ghana, Tunisia, Southeast Asia - Vietnam, Laos, Indonesia, or other smaller regional markets. The reality is that emerging markets and developing countries may be aggressively seeking to expand their economies, may be significant growth markets for new business development, and may also attract new companies from developed economies.

Hungary

Hungary has developed a significant plan for digital innovation and market development to focus on education, research and production, and manufacturing of advanced technologies. [4] Hungary is beginning to create its own regional market for emerging technology development and adoption and is scaling rapidly into global markets.

Two examples of emerging technology development in Hungary’s emerging market space are:

- **Autonomous vehicle research and development.** The ZalaZone, which will be Europe’s largest test facility and proving grounds for connected and autonomous vehicles, is currently under development in Hungary. The ZalaZone already has significant funding and automotive industry presence from European automotive original equipment manufacturers (OEMs), and autonomous vehicle technology suppliers.





The ZalaZone test facility will also be home to autonomous vehicle research and scientific development. The first phase of the ZalaZone test track was opened in May 2019.[21]

- **Advanced medical and healthcare technologies.** One such example is the application of robotic neurosurgery (Rosa), which is currently being tested in the Hungarian market. The first robot-assisted brain surgery was performed in Hungary in 2018.[12]

Hungary is also working with other EU nations to develop governance standards for artificial intelligence and 5G.

HUNGARIAN STARTUP ECOSYSTEM

A common theme for startups from many countries is that the regional market in which they are operating is limited and thus they are forced to consider global or international expansion early on. Having a plan to scale outside of the startups home country may be critical to the long-term survival of the company. When considering expanding into other markets, only 5% (of startups) consider Hungary as their primary market.[2,22]

Hungarian Startups comprise 506 companies, with 2,913 investors. The Digital Startup Strategy of Hungary has a goal of making Hungary much more competitive in the EU and in other world markets.[4] There is a tremendously high growth potential of startups in digital and technological services relevant to the global market. However, these startups are in need of external financing to continue growing and ultimately to succeed. The Digital Startup Strategy of Hungary also identifies that entry to the international market is difficult - a weakness that Hungarian startups are facing. There is also another limitation involving only a minimum level of cooperation between large Hungarian companies and startups. There is a competitive need for the ability to attract foreign investors and capital investment. Most Hungarian startups are in the early stages of company growth and have yet to demonstrate longevity and the ability to scale. Funding, clients, partners, and customers are critical to the survival of these companies. Companies in the validation, or startup stage, have a developed minimum viable product (MVP) and have either generated revenues or registered users. Growth and expansion are critical for these companies to thrive and the U.S. market provides opportunities for startups to grow. A structured program for acceleration in the U.S. market can give Hungary and Hungarian startup companies a strategic and competitive advantage.

By Comparison: Norway

Technology innovation has tremendous access to funding via venture capital, angel funds, private equity, grants, and other funding vehicles in the United States. In other areas of the world, funding is not as readily available. This can significantly impact early stage business growth for new companies. This is true even in highly developed markets.

Oslo, Norway is touted as being one of the happiest cities in the world, as listed by Virgin Group. Additional sources claim Oslo to be one of the world's best startup hubs. Oslo is one





of the fastest growing cities in Europe and ranks as one of the most business-friendly cities in the region. At large, Norway is among the wealthiest economies in the world. Although the startup culture in Norway promotes significant opportunities for aspiring entrepreneurs, access to investment opportunities can be challenging for startup ventures. Access to venture capital funding, angel funding, and private equity are very limited for many startups in Europe - with some regional markets being more challenging than others. This can significantly affect the path and time a venture has toward achieving success.

According to information from Inside Scandinavian Business, *“The rise and fall of startups undoubtedly affect the economy, and in order to help improve and develop innovation Norway established Innovasjon Norge in 2004, which every year supports selected innovative startups with millions of Norwegian Kroner.”*

“Despite it being an attractive proposition to create a startup and be your own boss, reality is that the survival rate for startups are not great. In 2009 more than 40,000 new startups were founded in Norway. A year later, half of these had ceased to exist. In this particular statistic only 27% were still operational five years later.”[13]

According to data in Angel List (*From November, 2018*), Norwegian startups consist of 566 companies, 2,923 investors, have an average valuation of \$3.2MM, and pay an average salary of \$61K.

Anne Worsoe, Founder of Innovation House and Director of Innovation Norway, described in an interview to Virgin Group, Ltd., *“...The capital market for start-ups is undersized and includes a handful VCs and a fragmented Business Angel community, partly compensated through public support and soft funding. Since there are only five million people in Norway, high growth companies need to go global early and be prepared to incorporate abroad.”*[23]

Norway represents a wealthy market with a growing startup ecosystem. Even in Norway, startups need to consider scaling outside of Norway early on for survival. By Comparison, Hungary has a digital startup strategy with high growth potential and rates of success but lacks broader access to external funding and domestic funding. Consideration of international scaling for startups is even more critical to a country like Hungary where availability of seed funding is less and operating in a small regional market is a significant factors for company survivability.

SURINAME

Suriname, formerly a Dutch colony, gained its independence in 1975. According to data from the Inter-American Development Bank, Suriname is coming out of a multiyear recession dating back to 2014, and inflation and currency are stabilizing. This creates an opportunity for new growth and new business expansion. This also sets the stage for Suriname to become a destination for international business seeking to expand to the South American Region. Business growth from companies entering Suriname is critical to growth and strengthening of the Suriname economy.

According to Forbes, *“Suriname’s economy is dominated by the mining industry, with exports of oil and gold accounting for approximately 85% of exports and 27% of government revenues. This makes the economy highly vulnerable to mineral price volatility.”*[8] In this regard, Suriname’s economy could greatly benefit from strengthening in other market sectors including, but not limited to, education and education technologies,



agriculture and life sciences, agricultural and wellness products, and energy. Suriname's ease of doing business ranking by the World Bank currently stands at 165, which is near the bottom, meaning that doing business in Suriname is more difficult. [14,24]

The Central Bank of Suriname identified mining and oil as growth sectors on the basis of recent investment trends. Additionally, import statistics and information gathered from business organizations indicated the following sectors as the most promising for foreign investment:

- Mining and mineral products
- Energy, oil, gas
- Building products
- Forestry
- Agriculture
- Healthcare and Medical
- Eco and Wellness Tourism

Suriname has abundant natural resources including land, water, tropical forests, and fish. Agricultural production and exports are limited and concentrated on a few products, primarily rice and bananas. However, the government of Suriname promotes agriculture and animal husbandry with the goal of capturing a greater share of the CARICOM market. Suriname's abundant rainforest contains many valuable hardwood tree species and covers approximately 94% of the country.[5]

Suriname Digital Innovation and Startups

Even Suriname, with a relatively small population of less than 600,000 people is nurturing a technology startup ecosystem. This ecosystem is at the beginning stages. Suriname is in the process of expanding its airport to become an international hub and is already developing plans for incubating and growing technology development. For example, one such startup (PIEDATA) has developed a disaster relief and emergency management blockchain solution for the Caribbean called Sonar.[18] This coincides with the recent launch of the Caribbean Climate Smart Accelerator, and the Clinton Global Initiative Action Network spurring activities across the region.





Policy and Regulatory Environment

When analyzing the policy and regulatory environment of emerging technologies in emerging markets, the breadth and scope of the analysis can be difficult to narrow. Everything from tax incentives, to incubator and educational programs, to macroeconomic investment policy can have a profound effect on the success of startups in a given country. Nonetheless, certain government structures and policies are commonly referenced as having a consistent effect in guiding their country's innovation ecosystem. These policy and regulatory environments often include the following larger, more structural changes: large scale national strategies for technology innovation, fostering financial and investment support in emerging technologies and altering regulations and standards on a broad scale. Specific policies oftentimes include, but are not limited to, the following: incentives for angel investors and tax incentives for investment, less tax regulation and fewer administrative burdens on innovation and market entry, clear legislation and investment policy, avoidance of a complicated financial system, and a framework for attracting talent and innovation through technology incubators and educational programs. As we dig deeper into this research area, specific policy programs and frameworks will undoubtedly emerge as we continue to look for direct links between government policies and emerging technology innovation.

POLICY STRUCTURES AND LEGISLATION IN EMERGING MARKETS

In years past, conventional wisdom held that market forces primarily drove innovation and economic growth. Recently, however, data driven evidence has increasingly pointed to the importance of government policies, initiatives, and structures in driving tech innovation. This can be seen in the nascent stages of tech development, as well as before and during the customer acquisition and the commercialization stage.[7]

Oftentimes, legislation and policy decisions have profound effects on the startup ecosystem. Looking at Hungary as an example, "legislation and administrative burdens" hampered SME growth and potential, as well as the economy as a whole. The Hungarian digital startup strategy stated that "from a regulatory point of view... clear legislation and little administrative burden on businesses," as well as avoiding "complicated financial systems," are key drivers in creating an innovative startup ecosystem.[4]

Oftentimes, legislation and policy decisions have profound effects on the startup ecosystem.

Furthermore, investment strategies on the policy front can significantly contribute to early-stage financing and provide fiscal incentives for emerging technologies to get off the ground. Incentive plans structured through government policies and laws are oftentimes pivotal to incentivizing angel investors to support startups.[4] Among low-income countries, monetary policies and the strengthening of fiscal management strategies have helped lead to growth amongst African nations. For instance, "*fiscal policies such as medium-term debt management strategies, more flexible exchange rates, targeting low domestic inflation, and increased resilience to external shocks*" have helped boost productivity and growth in developing/low-income countries.[20] Larger, structural policy changes such as the ease of starting a business or obtaining credit, augmented trade and partnerships, strengthening the rule of law, and improvements in regulatory quality were cited by the World Bank as primary contributors to the low-income country (LIC) economic expansion



from the 1990s to 2010s.[20] On average, the “2001 LICs that became MICs [middle-income countries] had stronger policy frameworks, better governance and business environments, better-developed infrastructure, larger improvements in human capital, and more fiscal resources.”[20]

INTERNATIONAL TRADE RELATIONSHIPS

Trade partnerships and relationships play a vital role in expanding the market size of emerging technologies. These strategic relationships can help SMEs and startups scale accordingly and become more profitable on an international level. Trade integration among countries via free trade agreements has the ability to boost intra-regional trade, support FDI inflows and industrialization, and encourage integration into global value chains.[20] International trade relationships can also have cascading effects on reforms relating to governance, financial sector policies, and the overall business environment of a nation.

The ease at which businesses can expand internationally or a home market can adopt new ventures have the potential to impact innovative technology sectors. Take Suriname, for instance, who in 2016 reduced the time for documentary and border compliance for exports and imports. [24] Specifically, the nation implemented an automated customs data management system, abbreviated ASYCUDA, which helped promote a more efficient, transparent and open flow of goods and services to and from the country. In this instance, the integration of technology was aimed at assisting the growth and development of future new innovations in the marketplace. In addition, the ability to obtain trade licenses also impacts the nature of trade relationships and business growth. Here again, Suriname made headway by introducing an online system for obtaining trade licenses, with the goal of making it easier to both start a business and expand trade.[24]

Several studies have cited the effectiveness in building connections and communities for growing urban technology and innovation. One study specifically noted that “positive effects of cooperation and networking on innovation” have demonstrated an ability to boost productivity and growth in the emerging technology field.[9] These variables are often boiled down to financial culture and knowledge sharing both within the domestic market and abroad.

OPENNESS OF REGULATORY ENVIRONMENTS

The openness of regulatory environments has consistently emerged as a driving factor behind both integration into global markets and technology innovation growth. The topic generally has two fronts: inward investment and outward scaling internationally. Less regulation oftentimes encourages investors to invest in a home country’s technology market by reducing barriers and strict tax policies that stifle investment opportunity. As well, this also typically affords domestic businesses greater access to resources, funding, and potential to scale to other markets. However, this does not imply that government take a back-seat, hands-off approach. A more open regulatory environment is typically complemented by a “forward-thinking catalytic” industrial policy that helps promote technology incubation and market growth.[7]



DEVELOPMENT AND DEPLOYMENT OF NEW TECHNOLOGIES

When it comes to the development and deployment of new technologies in innovative areas or business ecosystems, a variety of factors come into play. Many of the structural, policy and legislative factors, as well as macroeconomic forces mentioned above effect whether or not a country or market has the capacity and effectiveness of integrating new technologies in a specific industry. However, when looking at the case study on the integration of digital technologies in developing markets, a few primary factors begin to emerge. The expansion of broadband infrastructure, growth of ICT skills and literacy, use of digital finance and e-commerce by a home population, and digital applications to government services were a few of the primary drivers behind digital technology integration. [17] These structural and policy components had effects on countries from Malaysia and Thailand to West Africa and Latin America.[17]

Emerging Technology Issues and Governance Challenges

Data sharing, data mining, and data transmitting applications accompany many of the solutions being developed for digital emerging technologies. Whether the application is autonomous vehicles, biological sensors, cryptocurrencies and financial applications, or cloud-based artificial intelligence applications, governance inherently becomes a challenge. In many capacities, the pace of innovation is more rapid than technology knowledge transfer and understanding by the policy and regulatory community.

For example, supply chains for digital emerging technologies deviate from traditional supply chains, which can bring new challenges to governance. For physical products, the supply chain consisted of physical materials, refinement and production of those physical materials, then to assembly, subassembly, manufacturing and shipping of products. The physical nature of the supply chain is relatively easy to keep track of as the product, or any part of it crosses a political border or particular region. When a product is software-based, or virtual, the supply chain for this product becomes more difficult to oversee and, in some cases, to understand.

The development environment for a solution can span political borders seamlessly and effortlessly. For example, multinational product development teams working together collaboratively can span multiple countries and consist of members based in the U.S., EU, India and China. Application architecture, design, and wire framing





may occur in one country, software development may occur in another, and testing and validation may occur in a separate region altogether. When the application, or part of the application is deployed, it may be to a server environment in a separate country, region, or across multiple countries simultaneously. The challenge to governance includes oversight, risks, liabilities, and unintended outcomes but also lies in not only the development of these solutions, but deployment of them as well.

As an example of imminent governance challenges in the long term, one emerging solution involves generated digital assistants, whereby cloud-based artificial intelligence (a computer-based non-human presence, or avatar) is created in a virtual environment. Use of this solution can aid in understanding inputs and parameters of complex or very large-scale virtual environments. The processing required to run such an application, especially if it is partially reliant on regional or country-specific data, will occur in a shared computational environment that may span multiple cloud-based applications. When such a system becomes available, who is responsible for governing the solution? And if multiple countries are part of the data lake(s) and processing environment, is there a need for collaborative governance?

The use environment for a product or solution can span political borders for a single application as well. An example of this could be drone operators, algorithmic software applications for autonomous vehicles, and ride sharing and mobility applications generating data. In this example, a physical solution is in one location and the operator or monitor of the output is in another location. Again the challenge of governance arises - who assumes responsibility here? And if multiple countries are part of the operating environment, is there a need for collaborative governance? Who is liable in the case of bad actors or saboteurs?

Corruption and non-transparency of processes, information flow, and finances can be significant issues in developing countries as well. Without an understanding and operational knowledge of new emerging technologies, the governing environment can become even more susceptible to abuse. One such example is the use of cryptocurrencies. Cryptocurrencies, without proper oversight, can easily be used by knowledgeable actors to facilitate corruption and money laundering. With proper use, the technology behind cryptocurrency development could help streamline supply chain and ledgers for difficult-to-track materials, such as indigenous agricultural products naturally harvested in small clusters throughout the country. Both circumstances would require an understanding of the technology by the governing body, and an operational knowledge and openness to allow the technology could help the country add clarity to supply chains.

THE NEED FOR UNDERSTANDING EMERGING TECHNOLOGY IMPACT

Digital technology creation, especially regarding software or cloud-based solutions development, does not require significant overhead in terms of raw materials or infrastructure development. If governments support and nurture company growth focusing in technology innovation, they may be able to attract talent, investment, and partners from developed nations. This means that developing countries and emerging markets may be strategic investment opportunities to advancements in emerging technology development in years to come.

Better understanding is needed now more than ever before on how developing markets can impact the growth of emerging technologies and what this means for a global marketplace. There is a significant strategic opportunity for the U.S. regarding emerging technology development and adoption in emerging and developing markets. This is especially true for our increasingly digitally-connected and virtual world.



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