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COMMENTS

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Industrial policy for innovation: why does it matter?

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This paper explores the relationship between industrial policy, innovation, and productivity in the Philippines. It argues that strategic industrial policies can promote innovation by incentivizing market-oriented research and development and commercialization, developing necessary innovation infrastructure, and fostering a skilled workforce equipped to work with new technologies and adapt to changing market demands. The paper also focuses on the importance of connecting innovation and entrepreneurship ecosystems, highlighting the challenges facing the Philippines in this area. It specifically analyzes the country's startup ecosystem and recommends the establishment of Regional Inclusive Innovation Centers (RIICs) to facilitate collaboration among various stakeholders. Finally, the paper discusses the adoption and adaptation of artificial intelligence and Industry 4.0 technologies and their potential to drive productivity gains and transform the Philippine economy.

JEL classification: O31, O32
Keywords: industrial policy, innovation, entrepreneurship, start-up ecosystem

1. Introduction

In recent years, artificial intelligence (AI) has emerged as a transformative focus within the broader realm of technological innovation, reshaping industries, business practices, and economic landscapes. AI, with its capacity to process vast data sets, recognize complex patterns, and automate sophisticated tasks, is being seen as a driver of innovation across diverse sectors. The technology's versatility enables applications ranging from predictive maintenance in manufacturing to personalized recommendations in e-commerce, streamlining operations while enhancing customer engagement.

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Thus, countries around the world are investing in AI infrastructure, education, and regulatory frameworks, aiming to harness the economic potential of AI and position themselves at the forefront of the digital economy. Recognizing the importance of AI, Southeast Asian countries are focusing their efforts on building a robust foundation for AI-driven growth. AI is expected to add USD one trillion representing around ten to 18 percent increase in gross domestic product (GDP) across the region by 2030 [EDBI 2020]. Singapore announced that is investing more than SGD one billion into AI in the next five years focusing on securing access to advanced chips that are crucial to AI development, working with global leading companies to establish AI centers of excellence and boost AI innovation. It will also invest SGD 20 million in scholarships for its students planning to pursue a career in AI.

Malaysia is establishing its National AI Office (NAIO) to enhance the country's capabilities by fostering innovation. Indonesia's strategy called 2045 AI National Strategy (Stratnas AI) aims to strengthen the AI ecosystem and ensure that it is not left behind by other economies that are making extensive use of AI, and drive technological innovation to achieve Indonesia's target of becoming a developed country in 2045. Thailand's national AI strategy and action plan aims to prepare essential infrastructure for AI development and promote economic growth and increase the country's competitiveness. Vietnam's National Innovation Center is tasked with establishing a center for AI training, research, and application and training 7,000 AI experts and support 500 AI startups by 2030. The Philippine Development Plan 2023-2028 emphasizes the strategic adoption of AI and digital technologies as central to advancing economic growth, productivity, and competitiveness. The Philippines also launched its National AI Roadmap as well as the Center for AI Research.

This paper seeks to define how industrial policy can strategically promote innovation to maximize productivity gains across various sectors, address challenges, and support sustainable economic growth and competitiveness. It is structured into four sections. The following section will focus on innovation and how it contributes to productivity gains. Section 3 will evaluate the existing innovation ecosystem highlighting the importance of connecting innovation and entrepreneurship. Finally, Section 4 will present recommendations aimed at enhancing innovation and entrepreneurship within a supportive industrial policy framework.

2. Innovation and productivity

Based on the Oslo Manual [OECD and Eurostat 2018], innovation refers to the implementation of a new or significantly improved good or service, or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations. The minimum requirement for an innovation is that the product, process, marketing method, or organizational method must be new or significantly improved to the firm. This includes products,

processes, and methods. A common feature of an innovation is that it must have been implemented. A new or improved product is implemented when it is introduced in the market. New processes, marketing methods, or organizational methods are implemented when they are brought into actual use in the firm's operations. The definition suggests that innovation is not mainly about generating ideas—the traditional focus of science and research policies—but about putting those ideas into practical use to improve competitiveness and address emerging problems and challenges.

The Oslo Manual highlighted two major reasons for using new-to-the-firm as a minimum requirement of an innovation. First, adoption of innovations involves a flow of knowledge to adopting firms. The learning process in adopting an innovation can lead to subsequent improvements in the innovation and to the development of new products, processes, and other innovations. In other words, adoption of innovations is important for the innovation ecosystem. Second, the main impact of innovation on economic activity stems from the diffusion of initial innovations to other firms. Diffusion is the way in which innovations spread, through market or non-market channels, from their very first implementation to different consumers, countries, regions, sectors, markets and firms. Without diffusion, an innovation has no economic impact. Diffusion is captured in the definition by covering innovations that are new to the firm.

There are four types of innovation:

- *Product innovation*: introduction of a good service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness, or other functional characteristics. Product innovations can utilize new knowledge or technologies or can be based on new uses or combinations of existing knowledge or technologies. A new product can be a source of market advantage for the firm allowing it to increase demand and mark-ups.
- *Process innovation*: implementation of a new or significantly improved production or delivery method which includes significant changes in techniques, equipment and/or software. Process innovations can be undertaken to decrease unit costs of production or delivery, to increase quality, or to produce or deliver new or significantly improved products. Production methods involve techniques, equipment and software used to produce goods or services. Productivity-enhancing process innovations allow the firm to gain a cost advantage over its competitors leading to a higher mark-up at the prevailing prices or, depending on the elasticity of demand, the use of a combination of lower price and higher mark-up than its competitors to gain market share and increase profits.

- *Marketing innovation*: aims to better address customer needs, open up new markets, or newly position a firm's product on the market, with the goal of increasing firm's sales. The new marketing method can either be developed by the innovating firm or adopted from other firms or organizations. Marketing innovations include significant changes in product design that are part of a new marketing concept. Product design changes refer to changes in product form and appearance that do not alter the product's functional or user characteristics.
- *Organizational innovation*: implementation of a new organizational method in the firm's business practices, workplace organization or external relations. Organizational innovations can be undertaken to increase a firm's performance by reducing administrative costs or transaction costs, improving workplace satisfaction and labor productivity, gaining access to non-tradable assets (codified external knowledge) or reducing costs of supplies. Organizational innovations could be a necessary precondition for technical innovation [Lam 2005]. They are not only a support factor for product and process innovations; they can also have an important impact on firm performance on their own.

Economists widely agree that innovation, particularly through sustained research and development (R&D), is a powerful catalyst for economic growth [Gilbert 2006]. As Aghion and Howitt [1998] argued, innovation is fundamental to long-term economic growth. Their theoretical framework suggests that innovation fosters economic expansion by enabling continuous productivity improvements and resource efficiency gains, which become crucial as economies evolve and traditional growth drivers diminish. Furthermore, empirical research underscores the high social returns on investment in R&D—returns that typically exceed private gains [Griliches 1992]. This discrepancy underscores the public good aspect of R&D, as innovations yield spillover benefits that enhance productivity and welfare across the broader economy, justifying the importance of supportive policies for innovation. Consequently, investment in R&D becomes not only a driver of firm-level competitiveness but also a cornerstone of national economic resilience and growth.

There exists a huge number of empirical studies measuring the effect of innovation (product and process) on productivity. While earlier studies focused on the use of production-function models that estimate how innovation inputs like R&D expenditures and patent counts impact productivity, the more recent literature shows a shift from innovation input activities[1] to innovation output

[1] Based on the Oslo Manual, innovation activities refer to all scientific, technological, organizational, financial and commercial steps which, or are intended to, lead to the implementation of innovations. These include R&D and non-R&D activities that can be part of innovation such as identifying new concepts for products, processes, marketing methods, or organizational changes; buying technical information, paying fees or royalties for patented inventions, or buying know-how and skills through engineering, design or

activities. Hall et al. [2008] pointed out some limitations in relying on extended production-function methodologies which include R&D (or alternative measures of innovation effort) as another input to production. R&D as an innovation measure does not capture all aspects of innovation which frequently occur through other channels and often leading to an underestimation of the impact of innovation on productivity. These innovation output activities are indicators of the outcome of the innovation process or results of R&D investment like training, technology adoption, and sales of new products new to the market or the firm.

Crépon et al. [1998] introduced a new structural model that links innovation input (mostly R&D), innovation output, and productivity which provides insights into how these elements interact to drive firm performance. The Crépon-Duguet-Mairesse (CDM) model is a multistage econometric framework that sequentially links a firm's R&D investment to innovation output, and subsequently connects innovation output to productivity growth. This framework represents a significant advance in innovation studies, as it moves beyond simple input-output measures to offer a comprehensive view of the pathways through which R&D and other innovation efforts contribute to productivity growth.

The CDM study showed that the probability of engaging in R&D for a firm increases with its size (i.e., the number of employees), its market share and diversification, and with the demand pull and technology push indicators. It also notes that the research effort of a firm measured by R&D capital intensity increases with the same variables, except for size. Furthermore, the firm's innovation output, measured by patent numbers or innovative scales, rises with its research efforts and with demand pull and technology indicators. Finally, the study finds that firm productivity correlates positively with a higher innovation output even when controlling for the skill composition of labor as well as for physical capital intensity.

Hall and Mairesse [2006] reviewed empirical studies on the relationship between innovation and productivity: they found a consistent positive relationship between R&D, innovation output (product and process innovations), and productivity. Innovation activities, especially when supported by R&D investments, are associated with productivity gains at the firm level. They noted that product innovations tend to boost market performance and revenues by differentiating products, while process innovations are more directly linked to cost savings and efficiency, which enhance productivity. They also highlighted the importance of R&D spillovers, where firms benefit from the R&D efforts of others. These spillovers amplify the social returns to innovation, which are often greater than the private returns to individual firms.

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other consultancy services; internal training to develop human skills, tacit and informal learning—learning by doing; investing in equipment, software or intermediate inputs that embody the innovative work of others; reorganizing management systems and overall business activities; and developing new methods of marketing and selling goods and services.

Using the CDM model, Parisi et al. [2006] examined innovation patterns in Italian firms and their impact on productivity, revealing that process innovations have a more substantial effect on productivity than product innovations. This holds across different measures of productivity, with process innovation effects not fully explained by traditional inputs like R&D intensity. Interestingly, R&D spending is closely linked to product innovation but less so to process innovation, which instead correlates strongly with capital investment, suggesting that new technologies are often embedded in new equipment. R&D also enhances a firm's absorptive capacity for external innovations, supporting previous findings at broader levels. Cash flow significantly affects innovation introduction, with persistent effects observed for product but not for process innovation.

Hall et al. [2008] modeled how R&D decisions and innovation outcomes impact firm productivity, particularly in Italian firms, adapting the CDM model. Findings reveal that larger firms are more likely to innovate but invest less intensively in R&D, while subsidies boost R&D, especially in high-tech sectors. Process innovation, often requiring investment in machinery, has a stronger effect on productivity than product innovation. Italian firms show similar innovation levels to other European firms but invest less in R&D, likely due to high capital costs and market structure limitations. A unique aspect in Italy's bank-centered system is that larger firms face high R&D costs, while family-owned firms may prioritize non-profit objectives, limiting overall R&D investment.

Providing a developing country perspective on these dynamics, Benavente [2006] examined the relationship between R&D, innovation, and productivity among Chilean firms using firm-level data and CDM model. He finds that firm size influences the likelihood of engaging in research activities, though it does not impact the amount of resources allocated to these activities after accounting for sectoral differences, thus suggesting a constant return to scale in research investment. Technological opportunities, especially when integrated into machinery and output, significantly affect research activities. Productivity also shows a constant return to scale, with both engineering and administrative labor positively influencing it. The study's econometric methods address data-specific issues like truncation and selectivity biases. However, unexpected findings show that research spending and innovation do not significantly impact innovation sales or productivity, possibly due to assumptions about immediate productivity effects or measurement limitations tied to value-added per worker. This may also indicate that in developing countries like Chile, traditional R&D investment alone may not be sufficient to drive innovation. Broader policy measures, such as improving access to finance, enhancing infrastructure, and addressing skills gaps, are crucial to fostering a more productive and innovative business environment. This indicates the need for tailored industrial policies that support both R&D and other innovation drivers in developing country contexts.

In analyzing the diffusion of AI technologies, Rammer et al. [2021] examined the contribution of AI methods (language/text understanding, image/pattern recognition, machine learning, knowledge/expert systems) and applications (products/services, automation of processes, interaction with clients, data analysis) to product and process innovation outcomes. Using German firm-level data and employing an innovation production function, their findings showed that (i) firms that developed AI by combining in-house and external resources obtained significantly higher original innovation results, i.e. market and especially world first novelties, than firms that mainly used externally developed AI methods; and (ii) firms that apply AI in a broad way and have several years of experience in using AI tend to yield higher innovation outputs.

3. Innovation and entrepreneurship ecosystem

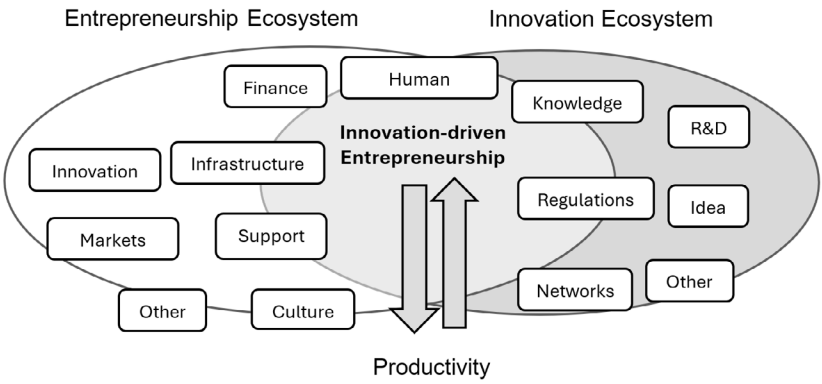
The Philippines has put innovation at the heart of its industrial strategy. This is crucial to propel industries forward, enhance competitiveness, and unlock new opportunities for industrial growth. In implementing an innovation-driven industrial policy, it is important to understand the context that fosters and enhances innovation and entrepreneurship outcomes, particularly ecosystem[2] conditions and the interactions between the innovation and entrepreneurship ecosystems that encourage entrepreneurial innovations and high potential entrepreneurship.

An innovation-driven entrepreneurship enables people and enterprises to pursue global opportunities based on innovative processes, products, or services [Rosiello and Vidmar 2022]. Entrepreneurship is essential in amplifying innovation, creating jobs, satisfying customer demands and other economic impacts. The process of commercializing an idea involves numerous parties and the creation of entrepreneurship and innovation ecosystems has been considered an effective way to nurture and support this process.

Ianioglo [2022] defines entrepreneurship and innovation ecosystems as complex systems representing self-organization, complex components, interdependent relationships between different actors, non-linearity, dynamic nature, and adaptability. In an ecosystem, firms do not just compete with each other using their own resources, but cooperate, interact, and use shared resources, knowledge, networks, infrastructure and support to co-create value. As Figure 1 shows, innovation is central to both innovation and entrepreneurship ecosystems. In fact, innovation is one of the major motivations of entrepreneurship ecosystems. In a successful innovation ecosystem such as Silicon Valley, innovation outputs are commercialized.

[2] Natural ecosystems are defined as communities of living organisms interacting with their environment through unique networks and interdependencies as part of a system. Just as nature's interactions can be defined as an ecosystem, so too can regional and national economies. Much like natural ecosystems, innovation ecosystems are living, changing, evolving; connected and interdependent; and shaped by and shape their environment [RTI International 2017].

FIGURE 1. Innovation-driven entrepreneurship



Source: Adapted from Ianioglo [2022].

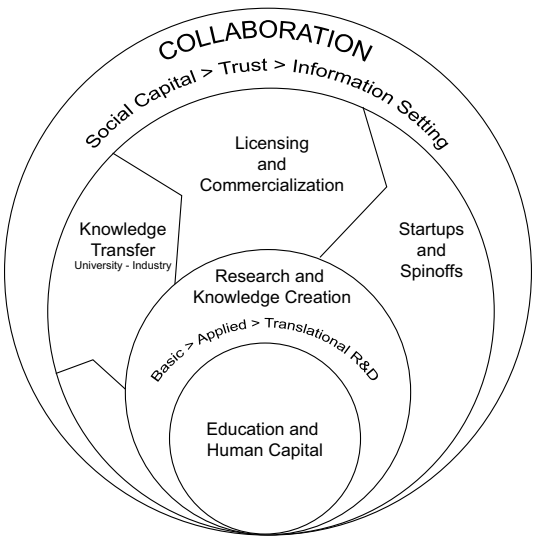
Figure 1 also shows the unique components of an innovation ecosystem including ideas and R&D, and innovation and markets for entrepreneurship ecosystem. Common elements for both innovation and entrepreneurship ecosystems are human capital, knowledge, infrastructure, regulations, finance, support services, networks, and culture. While these ecosystems share common participants, they differ in focus. The innovation ecosystem emphasizes value creation through the development of new ideas and technologies, whereas the entrepreneurship ecosystem centers on nurturing entrepreneurial ventures [Chaudhary et al. 2024].

In Figure 2, research and innovation stem from a strong core of education and human capital. A robust innovation and entrepreneurship ecosystem has four critical components: human capital, research and knowledge creation, knowledge transfer and intellectual property (IP), and infrastructure and culture of trust and collaboration. As the figure shows, academic institutions and research organizations serve as the bedrock of innovation, generating groundbreaking ideas and conducting cutting-edge research. For the ecosystem to function, the knowledge created in the country's colleges and universities must be transferred into commercial applications which could be in the form of direct service agreements, licensing, or startups and spin-offs. This is important to ensure that the potential benefits of R&D investments are not confined within the academia but diffused in the broader economy.

For these dynamic processes to effectively and efficiently take place, there must be an atmosphere of collaboration, which is dependent on social capital, trust, and information sharing. Successful innovation requires the collaboration between academia and industry. The triple helix framework underscores the dynamic interplay between universities, industry, and government, which drives innovation within ecosystems. The knowledge spillover theory suggests that entrepreneurial behavior is fueled by opportunities arising from these spillovers.

The entrepreneurship ecosystem, therefore, thrives on knowledge dissemination and close collaboration between universities, R&D labs, and individual actors. The success of the entrepreneurship ecosystem is measured by its ability to commercialize knowledge and transform it into tangible innovations.

FIGURE 2. Innovation framework linking innovation and entrepreneurship



Source: RTI International [2017].

Within the context of a competitive environment, innovation fuels productivity gains, which, in turn, stimulate economic expansion. This relationship is dynamic and reciprocal with higher productivity growth further fostering innovation. Both the innovation and entrepreneurship ecosystems are composed of largely similar players who interact with one another to foster innovation-driven entrepreneurship. This collaboration contributes to productivity growth and, ultimately, economic expansion.

Tables 1 and 2 provide innovation input and intellectual property rights indicators, respectively. A strong intellectual property rights system is important in facilitating innovation and commercialization. In general, for both sets of indicators, the Philippines ranks low vis-à-vis its neighbors in Southeast Asia. In terms of researchers per million inhabitants, the Philippines is the lowest followed by Indonesia while Indonesia is at the bottom in terms of R&D expenditure as a proportion of GDP. The two countries are investing far less than other countries on activities that drive innovation. Moreover, their base support for innovation and commercialization remains comparatively weak. Their patent applications are also low, the two countries have the lowest patent applications per million inhabitants. The Philippines is the lowest in terms of trademark per million inhabitants and industrial design per million

inhabitants. For utility model applications, Indonesia and Thailand are the highest while Malaysia followed by Vietnam registered the lowest.

TABLE 1. Innovation input indicators

Country	Researchers (in full-time equivalent) per million inhabitants		Research and development expenditure as a proportion of GDP	
	2018	2020	2018	2020
Philippines	172.0	…	0.32	…
Indonesia	217.5	399.6	0.23	0.28
Malaysia	2,139.5	726.5	1.04	0.95
Singapore	6,786.7	7,224.7	1.81	2.16
Thailand	1,718.5	1,699.1**	1.11	1.21**
Vietnam	765.5*	779.3**	0.42*	0.43**

Note: * 2019; **2021
Source: UNESCO [n.d.].

TABLE 2. Intellectual property rights indicators, 2023

	Philippines	Indonesia	Malaysia	Singapore	Thailand	Vietnam
Total patent applications	927	1,727	1,649	9,313	1,308	1,119
Resident applications per million inhabitants	6.7	6.1	24.6	273.9	10.5	10
Trademark applications	37,832	120,883	27,616	54,958	40,544	87,038
Resident applications per million inhabitants	312.7	424.5	584	2,244.3	469.9	831.7
Industrial design applications	874	4,949	778	1,982	4,219	2,168
Resident applications per million inhabitants	7.3	17.3	15.3	81.5	55.5	20.2
Utility model applications	1,968	4,368	156	1,769	3,836	602

Source: WIPO Statistics Database [2024].

The development of the ecosystem requires the collaboration between the knowledge economy (driven by research) and the commercial economy (driven by the marketplace). It is in this intersection that most countries, like the Philippines, are facing difficult challenges [RTI International 2017]. In assessing the country's innovation and entrepreneurship ecosystems, Aldaba [2018], RTI International [2017], and RTI International [2014] identified the constraints faced

by the country in building the connections and linkages between the innovation and entrepreneurship ecosystems. Academe-industry collaboration continues to be limited and in general, universities do not see research collaboration as part of their core mission, as opposed to teaching and publishing journal articles. University faculty seem to have a sense of aversion to consulting services or work for hire due to issues with IP ownership. To exacerbate these issues, financial gains from academe-industry collaboration do not accrue quickly to faculty members, as these are highly taxed and are relatively small when compared to the financial gains from independent consulting arrangements.

There are prevailing perceptions from industry that dealing with the academe is too complicated. With limited public information about their expertise, research interests, and innovation projects; businesses commonly do not perceive the academe as potential partners. The lack of a legally sanctioned payment mechanism for financial contributions also erodes the interest of companies to support government-funded research. The academe's desire for full control of IP and their lack of familiarity and trust on legal mechanisms for licensing likewise discourages companies to pursue such collaboration. Overall, relations between the academe and industry are characterized more by competition rather than collaboration. This limits the commercialization of potentially useful research outputs and seriously impacts the overall innovation performance of the country.

With some exceptions, Philippine universities generally remain detached from problems as signaled by the market and often fail to appreciate the importance of commercialization. Some institutions are also unable to respond in a timely manner to the commercialization intent of some businesses because of their lack of mechanisms or preparedness to deal with such. University researchers normally do not consider commercialization as part of their core mission because their performances are evaluated based on the number of their research publications.

Moreover, research activities in universities usually do not end up being commercialized due to the lack of personnel with the capability to deal with technology transfer and commercialization. Researchers are also not well-versed with business plans, conducting market research and feasibility studies, and valuing technology. Additionally, financial constraints limit the commercialization of university technologies because IP registration entails high transaction costs and consumes much time due to the complexity of the process and requirements.

3.1. Philippine startup ecosystem

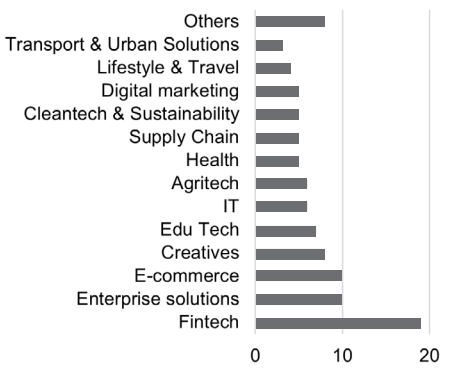
Startups are ventures led by founders with an idea, invention or research that has a potential for significant business opportunity and impact. Startups have two important characteristics: their potential to grow and expand rapidly and their capacity to disrupt the market through innovation. Globally, the startup sector has created significant, sustaining companies that generate high-value jobs and drive economic growth. Startups support the growth and development of innovative

ideas, technologies, emerging high-impact business and a huge pipeline of startups is important to catalyze disruptive innovation and foster inclusive growth and development.

With a valuation of around USD 6.4 billion, the country's startup ecosystem is still young with over 1,000 startups, 60 incubators and accelerators, 50 angel investors, 200 co-working spaces, and 50 venture capitalists. Startup Genome [2024] ranked Manila among the top 81-90 emerging ecosystems in the world, top 20 for funding in Asia, and top 15 for Bang for Buck among Asian ecosystems, which measures the amount of runway tech startups acquire.

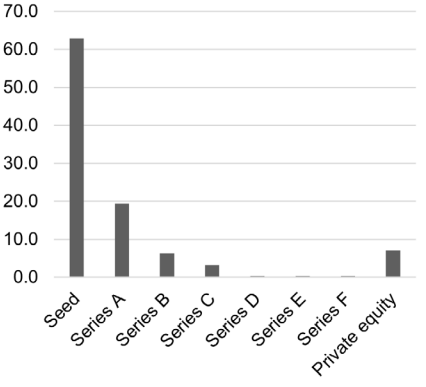
Figure 3 shows that fintech (with share of 19 percent), e-commerce (ten percent), and enterprise solutions (ten percent) are among the ecosystem's sub-sector strengths. Eight percent of local startups are engaged in the creative industries and seven percent in edu tech. IT-enabled services also account for a share of seven percent. As a young ecosystem, majority of local startups are still in seed-level funding accounting for about 63 percent of the total. Startups in Series A level account for 19 percent, those in Series B represent six percent, three percent in Series C, while those that exited through merger or acquisition account for 20 percent (see Figure 4). [3]

FIGURE 3. Startups by industry (in percent)



Source: DTI-CIG.

FIGURE 4. Startups by funding stage (in percent)

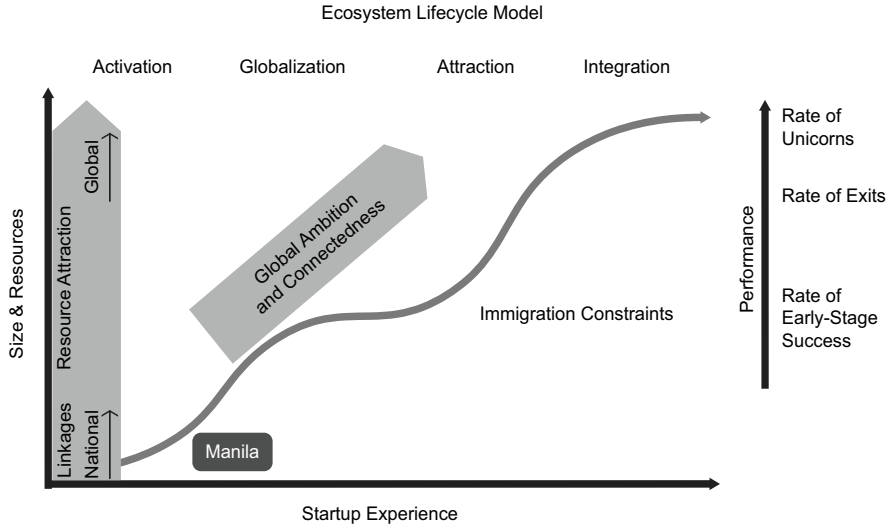


Source: DTI-CIG.

[3] Startups gain funding for their companies through funding rounds beginning with a seed round and continue with A, B, and C funding rounds. The earliest stage of funding a new company is known as pre-seed funding with funders consisting mostly of the founders, close friends, and supporters.
Seed funding: first official equity funding stage which helps a company finance its first steps including market research and product development.
Series A: raise approximately USD 2 million to $15 million, Series A investors are looking for companies with great ideas and strong strategy to turn the idea into a successful, money-making business
Series B: companies undergoing a Series B funding round are well-established, have substantial user bases, and with valuations between around USD 30 million and USD 60 million
Series C businesses that raise Series C funding are already quite successful and are looking for new funding to develop new products, expand into new markets, or acquire other companies [Reiff 2024].

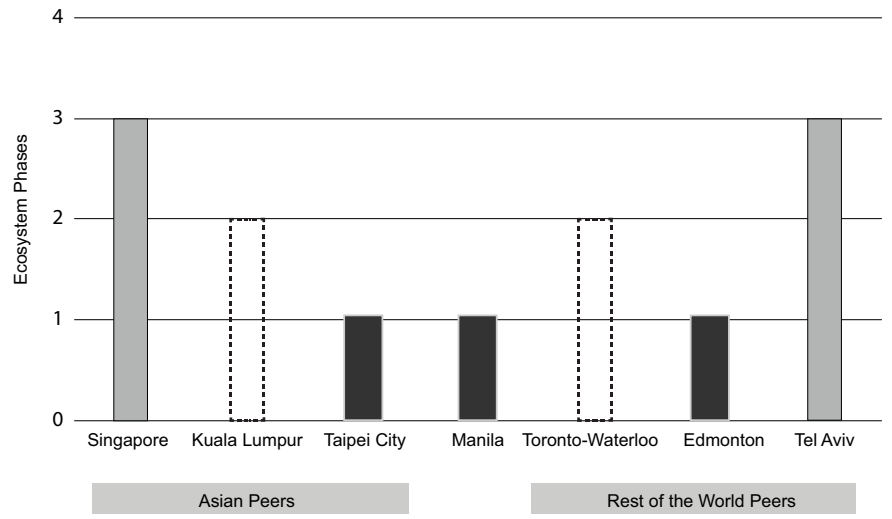
Startup ecosystems are seen as a new type of industry cluster. The Startup Genome ecosystem lifecycle model covers four stages: activation, globalization, attraction, and integration which are determined by the ecosystem's size and resources, startup experience, and performance. Figure 5 shows that based on the Genome classification, Manila is in the initial stage or the activation phase.

FIGURE 5. The Philippine startup ecosystem



Source: Startup Genome [2024]

FIGURE 6. Benchmarking with peers



Source: Startup Genome [2024]

Within Asia, Manila and Taipei are both in the activation phase (see Figure 6). The Philippines is behind Malaysia which is in early globalization stage as well as Singapore which is already in the attraction phase. Outside of Asia, Edmonton is also in the activation phase like Manila and Taipei. Toronto is in early globalization while Tel-Aviv is in the attraction stage like Singapore.

In 2021, the Philippine startup ecosystem had grown in both deal value and volume amounting to USD 1.03 billion [Foxmont and BCG 2022]. Composed of almost a hundred deals, this amount represented a 179 percent increase compared to the funds raised in 2020. In terms of deal value by sector, fintech contributed the largest accounting for a share of 65.7 percent with Mynt (GCash) emerging as the country's first double unicorn in November 2021. This is followed by media and entertainment with a 13.45 percent share with a deal value amounting to USD 142.5 million. Blockchain contributed a share of 8.88 percent while e-commerce registered a share of 8.51 percent and a deal value of USD 88 million. Food and beverage tech accounted for 0.85 percent while logistech contributed a share of 0.8 percent.

Amid the pandemic, both fintech and e-commerce startups increased their volume of transactions and raised funding for expansion. Three Series B funding rounds were announced in 2021: media entertainment company Kumu and e-commerce companies Great Deals and GrowSari. Kumu thereafter became the first startup to raise Series C funding amounting to USD 73.6 million in October 2021. Great Deals was able to raise USD 12 million funding in a Series A round in 2020 and USD 30 million in a Series B funding in 2021, while GrowSari raised USD 77.5 million.

The fast-growing use of mobile banking, an enabling regulatory environment, and the high number of unbanked and underserved Filipinos allowed the growth of more fintech startups. Other notable fintech deals include companies such as PayMongo which secured USD 12 million in a Series A financing round; Squidpay secured USD two million also in Series A while NextPay raised USD 1.6 million in a seed round of funding. Tonik Digital Bank rasied USD 17 million, Uploan raised USD ten million, while crypto platform Philippine Digital Exchange Asset raised USD 12.5 million. Data driven logistics company Inteluck was able to secure more than USD five million in a pre-Series B funding round. For the first two months of 2022, the total capital raised totaled USD 310 million. After raising USD 210 million, fintech company, Voyager Innovations (PayMaya) became the country's second company with unicorn status.

With the COVID-19 pandemic, 2020 was a challenging year for startups as the crisis affected their financial stability, market dynamism, and talent productivity. Despite this, many Filipino startups were able to quickly pivot to new activities and using new technologies provided solutions to help government in addressing issues arising from the public health emergency. Based on a PWC [2020] survey,

49 percent of Filipino startups explored new products/services and more than 20 percent of the startups said that they experienced an increasing demand for their services and products particularly in logistics, education technology, enterprise services, financial technology, and healthcare.

Table 3 provides a list of Filipino tech-startups that provided support to government through contact tracing apps, personal and community health monitoring, chatbots, along with apps for social distancing and online marketplaces. Innovative startups also emerged to provide tech solutions to address issues in health, agriculture, education, finance, multimedia, supply chain and logistics issues.

TABLE 3. Startup companies that emerged during the pandemic

Startup Company	Description
RC 143	a contact tracing app developed for the Philippine Red Cross
DWARM AI	uses drones as non-contact thermal scanners at expressway checkpoints; originally these were designed for search and rescue operations in calamities
DATOS	uses geographic information systems, remote sensing, AI and data science to provide maps and other information for disaster risk reduction applications
Dashboard Philippines	uses Google Cloud and Google Maps platforms to show relevant COVID-19 information
RapidPass	system that facilitated vehicle inspection along checkpoints through QR code scanning
Senti AI	developed an AI knowledge management tool with the Department of Health (DOH) and Google; Senti AI fed inputs to chatbots being utilized by the DOH to answer questions related to COVID-19
AIDE	a home healthcare platform providing services like e-consultations, vaccinations, nursing care, laboratory tests, and diagnostics
Hybrain, Medcheck	provides hospital information system; Medcheck offers telemedicine, electronic medical records, and data analytics
Farmwatch	offers IOT solutions to farm owners
Cawil	uses AI to automatically record fishermen's catch and location
InsightSCS, Inteluck	a platform that provides real time digital shipment records; Inteluck is a logistics optimization platform
Zayls, FAME	provides warehouse inventory management system services, and FAME provides vehicle tracking solution
Kumu	entertainment platform
CloudEats, Mad Market, CloudSwyft	cloud-based platforms

While the country's startup ecosystem continues to grow and evolve, the following issues and challenges have continued to affect the growth and development of Filipino startups:

- Startup quality has three main dimensions: founder know-how, customer access, and talent access. Filipino founders have limited knowledge on high potential technologies and business models as well as on latest business models and technologies preventing them from building access or connections to global knowledge. The lack of global connections creates gaps in founder knowledge of leading and failed products and business models. As a result, startups in Manila are not creating globally leading products compared with peers.
- In terms of talent access, despite a strong presence of tech talent in the country, experienced engineers working in startups are few. The percentage of experienced engineers and percentage of growth employees are below the activation average for both 2019 and 2021. The technical talent pool also needs to improve to match other countries in the region.
- Appropriate mentors and extensive networks are necessary for startups to scale up and acquire new opportunities. In the Philippines, experienced mentors are still lacking.
- Lack of early-stage funding and small number of angel investors and venture capitalists.

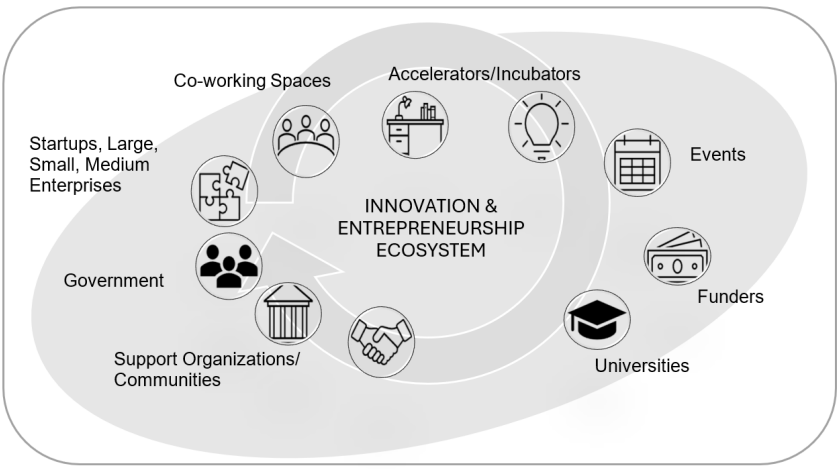
Addressing the above challenges must be prioritized to strengthen the Philippine startup ecosystem, especially initiatives and programs to build quality startups, strengthen founder know-how, deepen their market reach, and increase talent quality along with increasing early stage funding and expanding the global connectedness of startups. With the passing of two important innovation legislations, the Philippine Innovation Act (PIA) and the Innovative Startup Act (ISA), more comprehensive innovation and startup support is expected to be provided to accelerate the growth and development of startups and address the gaps in the innovation and entrepreneurship ecosystem. PIA is creating an innovation fund of USD 20 million while ISA focuses on supporting startups through the following measures: implement ease of doing innovation initiatives to remove barriers to innovation; establish innovation centers and business incubators; provide financial subsidies for startups (tax breaks, grants, exemption from registration and application fees); startup visas; creating startup grant fund and innovative startup venture fund; and building startup ecozones.

3.2. Regional Inclusive Innovation Centers

The establishment of Regional Inclusive Innovations Centers or RIICs has emerged as top recommendation of the focus group discussions and stakeholder consultations that were conducted all over the country by the Department of Trade

and Industry (DTI).[4] As Figure 7 shows, the RIICs are envisioned to be at the core of the country's economic transformation and serve as the linchpin of productive collaborations between and among industries, universities, government agencies, local government units, startups, micro, small, and medium enterprises (MSMEs), R&D laboratories, science and technology parks, incubators, fabrication laboratories, shared services facilities, business centers, and investors, among many other local players.

FIGURE 7. Regional Inclusive Innovation Centers



The RIICs will constitute an innovation network or platform of creative communities in various regions of the country, propelled by innovative and entrepreneurial Filipinos, who are driven by their desire to do things better, provide solutions, make better products, and address market demands. The RIICs will focus on market-oriented research providing solutions to societal issues and industry needs through the development of new products and services.

RIICs will be nurtured by policies, programs, and projects that continuously develop human capital; ensure access to funding and other sources of financing; and provide the needed support mechanisms and services for commercialization.

[4] During the 2016 Manufacturing Summit, stakeholders agreed to foster a dynamic innovation ecosystem through government-academe-industry collaboration. In the 2017 Inclusive Innovation Conference, the Department of Trade and Industry and the Department of Science and Technology signed a Memorandum of Understanding to pursue inclusive innovation dialogues. In the 2017 MSME Summit Round Table Discussion on Innovation, stakeholders recommended fostering an innovation culture through the educational system. Through the 2018 Gearing Up the Regions for Industry 4.0, a series of consultations and seminar workshops was conducted with stakeholders from government, academe, and industry across different regions in the country. Recommendations focused on steps to strengthen government academe industry linkages, human capital development towards innovation and entrepreneurship, enabling environment to accelerate innovation and commercialization of research, entrepreneurial culture and support for MSMEs and startups, funding and financing, and industry clusters.

All these activities, interactions, and partnerships will be fostered in an environment in which institutions, infrastructure, intellectual property rights system, culture, and customers enable more and better innovation and entrepreneurship throughout the country.

The RIICs initiative was piloted as a virtual platform connecting stakeholders from government, academe, and industry in Cebu, Legaspi, Cagayan de Oro, and Davao. The DTI and the Department of Science and Technology have worked together with community stakeholders such as startups, industry, farmer cooperatives, and researchers to build the capacity of stakeholders in R&D ideation and design-thinking process and carry out studies and adapt new technologies to address socio-economic problems in the pilot areas. Cebu has focused on advanced manufacturing, particularly in electronics and semiconductor. Legaspi has targeted pili nuts to find ways to add value to the product, while Davao and Cagayan de Oro have prioritized coffee, cacao, and fruits and nuts. In Davao, an interactive application has been developed to help MSMEs access government services and innovation programs. To support these agricultural areas, researchers and other stakeholders are focusing on providing technology solutions to problems such as low productivity, insufficient postharvest facilities, lack of quality of planting materials, pests and diseases. In Cebu, R&D in advanced manufacturing will be crucial to leapfrog to Industry 4.0. To pursue this, Cebu-based companies are partnering with academe to conduct joint R&D and formulate training programs to improve worker capabilities.

3.3. AI and other Industry 4.0 technologies

Traditional manufacturing is being disrupted as operations are undergoing digital transformation using AI, machine learning (ML), big data analytics, cloud computing, 3D printing, and other technologies towards smart manufacturing. To successfully move up the innovation ladder, latecomer countries should take into account factors such as capabilities, endowments, organizational characteristics, technological efforts, and infrastructural and institutional conditions [UNIDO 2019]. One important historical insight is that latecomers need not invent new technologies; instead their main entry point could be to rapidly adopt emerging technologies or adapt them to local conditions through innovation.

New technologies could serve as drivers to achieve an inclusive, resilient, and sustainable industrial development. Through the use of AI, for example, new products and services can be created leading to jobs and income opportunities, as well as new activities. Adopting smart manufacturing could increase productivity; new technologies could reduce material and energy use. The use of Internet of Things (IOT) for asset management could generate the following benefits: increase operational efficiency and productivity, more efficient safety and compliance checks, automation of maintenance and repair operations, more efficient use of resources, better control over the sales lifecycle, easy identification of growth opportunities, and a responsive smart ecosystem [Incisiv Inc. and Siemens 2021].

Innovation is a complex and systematic phenomenon. New knowledge is created and diffused through innovation, expanding the economy's potential to develop new products and more productive methods of operation. By automating routine processes, enhancing data-driven decision-making, and enabling novel product development, AI has spurred productivity gains and opened new frontiers for economic growth.

Moreover, AI's potential as an innovation catalyst lies in its ability to support and augment R&D efforts. AI-driven tools can accelerate research processes by identifying promising avenues in scientific research, optimizing experimental designs, and simulating outcomes, thus reducing the time and cost associated with traditional R&D. This accelerated innovation cycle allows businesses to bring products to market more rapidly, fostering competitive advantage and market responsiveness. Additionally, by enabling data-driven insights, AI provides companies with a deeper understanding of consumer behavior, operational inefficiencies, and emerging trends, facilitating agile, informed decisions that further enhance productivity and innovation.

For instance, in the IT-business process management (ITBPM) sector, which has long been feared to be displaced by machines, the business process outsourcing (BPO) sector is already on the cusp of digital transformation from automating simple tasks to applying big data and analytics [Aldaba forthcoming]. The BPO industry has been adopting new technologies like metaverse which is applied in call centers to enable quick and efficient response to customer inquiries. Companies have also been adopting hyper-automation, a strategy which uses not only robotic process automation (RPA)[5] but also AI, machine learning (ML), integration platform as a service (IPAAS) and other automation tools and software. The industry is also utilizing remote and cloud-based call centers which enable BPO employees a seamless transition to remote work. To achieve a successful digital transformation process, the industry has also been providing total experience (TX) which requires innovative technology focusing on a strategy to improve all the outsourcing players and stakeholders from employees to end-users. According to Gartner [2020], organizations that provide TX are more likely to outperform their competitors.

The case of Concentrix, a customer experience solutions company established in the Philippines in 2007, demonstrates the successful journey of a BPO company. Concentrix has grown remarkably with about 100,000 workers and a total of 50 sites located in 20 cities. It provides support services to more than 40 countries across six continents and ten industry verticals: automotive, banking and financial services, insurance, media and communications, consumer electronics, retail and e-commerce, technology, travel and transportation, energy and public sector, and healthcare. The company requires its employees to have qualifications in business and management, engineering and mathematics, IT and computer science, teaching

[5] Robotic process automation is used by companies to streamline their workflows and reduce the burden for employees who are performing repetitive and tedious tasks.

and education, creative arts, humanities, arts and social sciences, law, legal studies and justice, medical and health sciences, property and built environment, and sciences. In 2021, it partnered with the University of the Philippines to conduct a massive open online course on contact center services.

Its Philippine operations evolved from BPO call center services to providing technology-infused, omnichannel customer experience management, marketing optimization, digital, consulting, analytics, and back-office solutions. As it moved towards offering high value-added services, its business process methodologies also shifted towards the more optimized application of AI, IOT, robots, cloud computing, smart machines. Its adoption of RPA reduced average handling time by 20 percent, rework by 50 percent, increased their return on investment by 11 to 15 percent while AI speech analytics led to ten times increase in quality assurance (QA) coverage, 20 percent increase in QA cost efficiency, and 20 percent increase in productivity.

4. Developing effective industrial policy for innovation

Industrial policy plays a pivotal role in promoting innovation, which in turn drives productivity gains essential for sustainable economic growth. By strategically targeting resources and support towards high-potential sectors, industrial policy can create an environment where innovation thrives. One way industrial policy achieves this is by incentivizing market-oriented R&D and commercialization through more effective measures beyond generic instruments such as tax credits or income tax holiday and more towards targeted and transparent grants and subsidies, including the use of government procurement and regulations to affect the demand for innovative solutions and reduce financial barriers. These incentives encourage firms to invest in new technologies, processes, and products that can enhance productivity and competitive positioning, particularly in sectors where initial costs might otherwise hinder innovation.

The creation of the National Innovation Council under the PIA underscores that innovation policymaking is a collective responsibility involving all relevant government agencies at every level. This will require building capabilities among policymakers, particularly in developing a deep understanding of systemic bottlenecks that impede the generation and diffusion of innovations. Simultaneously, the roles of Council members should be clearly defined, with program implementation delegated to other government agencies. This structure will enable the Council to maintain its strategic role as advisor and facilitator within the national innovation ecosystem, focusing on policy, strategy, coordination, and funding oversight.

Another critical aspect of industrial policy is developing the infrastructure necessary for innovation. Investment in digital infrastructure, such as broadband networks, data centers, and AI laboratories, allows businesses to access the technological resources they need to innovate efficiently. By building innovation

hubs such as the RIICs, fostering partnerships with research institutions, and supporting technology transfer initiatives, industrial policy can enhance collaboration between the public and private sectors, creating ecosystems that drive technological advancement and productivity improvements. For example, many countries establish technology clusters or science and technology parks to encourage collaboration among tech firms, research institutions, and startups, leading to cross-pollination of ideas and faster commercialization of innovations.

One challenge for Filipino companies that are keen to embrace automation is the lack of experience or relevant skills particularly innovation, data analytics, and leadership skills. Industrial policy can play a significant role in building a skilled workforce, which is fundamental to realizing productivity gains through innovation. By supporting education and training programs, especially in fields like AI, data science, and engineering; industrial policy ensures that the workforce is equipped to work with new technologies and adapt to changing market demands. These policies also help address skill mismatches that can stymie productivity by fostering continuous learning and upskilling.

To strengthen the innovation and entrepreneurship ecosystem and address the gaps therein, the Department of Trade and Industry [2018] and Aldaba [2018a;2018b] proposed the following measures:

1. Fostering government-academe-industry linkages

a. Expanding student internship programs to provide students with industry-relevant knowledge and competencies along with faculty immersion in industry
b. Capacity building of faculty-researchers in solutions-driven and market-driven research as well as business development, customer discovery, and customer development
c. Establishing techno-parks, hubs, or innovation centers focusing on entrepreneurship, innovation, and technology and business incubation
d. Setting up of common innovation and support facilities catering to local industry needs

2. Enhancing education, human capital development, and workforce training

a. Integrate innovation and entrepreneurship in basic education
b. Technical Education And Skills Development Authority (TESDA) to support local MSMEs, startups, and industries of specific regions through dynamic and customized tech-voc innovation and entrepreneurship programs
c. TESDA to accredit private providers that offer re-skilling and upskilling courses like coding, data analytics, leadership, entrepreneurship, business communication, etc. to produce

knowledge workers/professionals in the new digital and knowledge economy

d. Commission on Higher Education to support initiatives by universities, public or private, to promote innovation and entrepreneurship/technopreneurship as part of university coursework

3. Creating an enabling environment to accelerate innovation and entrepreneurship

a. Capacitate state universities/higher education institutions to establish pathways for university publications and patents to be translated into industry solutions or to pass on university researches to industry for adoption
b. Strengthen IP system to facilitate the commercialization process, including the use of services offered by the Intellectual Property Satellite Offices (IPSOs), Innovation and Technology Support Offices (ITSOs), and the IP Depot
c. Simplify and reduce the cost of IP filing; provide support and assistance to facilitate the process of IP filing and management
d. Ease regulatory policies and administrative burden in starting up businesses to facilitate the introduction of ideas into market

4. Developing more innovative MSMEs and startups

a. Strengthen and expand one-stop-shops for MSMEs, which provide services such as certification, licensing, capability training, production, and marketing of products/ services; services can be expanded to provide business mentorship, particularly for startups, as well as creative and design services that aid in transforming ideas/ prototypes into commercially viable products and services
b. Establish regional startup offices or hubs that can serve as a platform for MSMEs to connect and network with industry experts as well as function as business incubators for stakeholders in the regions
c. Foster greater cooperation among actors in the MSME support network (i.e., incubators, accelerators, small business development centers, export assistance centers) by deepening and strengthening their involvement and engagement with stakeholders, including industry experts
d. Build and/or strengthen MSME partnerships with academe and larger players in industry for mentorship programs for innovation and technology-related training programs and activities
e. Strengthen the Startup Ecosystem Development Program to provide more comprehensive assistance to startups and other members of the startup community

5. Financing for innovation and entrepreneurship

a. Increase government expenditure on R&D towards reaching the UNESCO benchmark of one percent of GDP
b. Strengthen the Startup Grant Program to provide financing for commercially viable projects to bridge the gap between commercialization and R&D
c. Create an investment environment that encourages more private sector participation in financing enterprises, including angel investors, venture capital, and crowd fund-sourcing

6. Establishing more RIICs to promote the growth and development of industry clusters

a. Build and expand the operations of RIICs in collaboration with local state universities and colleges and industry groups and use these as platform for
b. Open innovation and technical partnerships between industry and academe (foreign and local) for market-driven research
c. Build rapid prototyping and demonstration, testing equipment, and reliable ICT networks and communication platforms
d. Improving the supply chain, value adding, and agro-processing, as well as systems for food and agricultural research, access to technologies, financing, regulation, and certification particularly for high-value crops
e. Deepening and upgrading the regions' participation in global value chains particularly for agro-processing, electronics, automotive, aerospace, chemicals, IT-BPM, and renewable energy.

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