BACKGROUND NOTE

Vertical Innovation Industry Development to Enable Leapfrogging, Superior Competitiveness and Innovation

René Rohrbeck, Olga Kokshagina, and Susann Roth

VERTICAL INNOVATION INDUSTRY DEVELOPMENT

To Enable Leapfrogging, Superior Competitiveness, and Innovation

René Rohrbeck, Olga Kokshagina, and Susann Roth[1]

A. Background (key messages in bold)

Innovation is seen as a key component for developing countries to move through the middle-income trap. There are multiple reasons for this. First, labor-saving technologies and World Trade Organization rules restrict the ability of developing countries to growth through export-led and low-labor cost-fueled growth (Asian Development Bank 2019). Second, the harmonization of trade rules increases competition in sectors where competencies are widely distributed and reinforces leading positions of countries with a highly specialized sectors, like the Software industry in India, the automobile industry in Germany, or the Soccer Ball Industry in Pakistan (Rodrik 2007). Third, we now know that countries that move from low to middle to high income are late in the development of a high-level of specialization, which inhibits their ability to become competitive in global markets (Imbs and Wacziarg 2003).

In consequence, **traditional mechanisms to develop national innovation systems such as structural reforms and investments in research and development may not be enough to overcome the middle-income trap** (Rodrik 2007). Structural reforms and other horizontal development mechanisms have long time lags from implementation of the mechanism to benefits for the national economy and benefits might also never materialize (Rodrik 2007). **A *vertical industry development (VID)* model (Figure 2), which can be applied to create, shape, and promote specific industries, can be a helpful tool to accelerate innovation in developing countries.** By building on four case studies, key success criteria and suggestions for process, tools, and governance can be identified. **Success criteria include flexible investments; problem-centricity, lead market characteristics, and active ecosystem governance.** Some of these criteria are in line with the natural barriers to industrialization relevant to market imperfections inherent in low-income environments that might block investments in nontraditional activities. The first one related to failure of learning by doing that is external to individual firms or cannot be internalized properly due to the market structure (Matsuyama 1992) or learning about countries cost structure that differ from

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incumbents to later entrants (Hausmann and Rodrik 2003). **These models suggest that propagation of modern, nontraditional activities to drive innovation at the country level is not a natural process and requires coordination** (Rodrik 2007).

B. Innovation for growth and global competitiveness

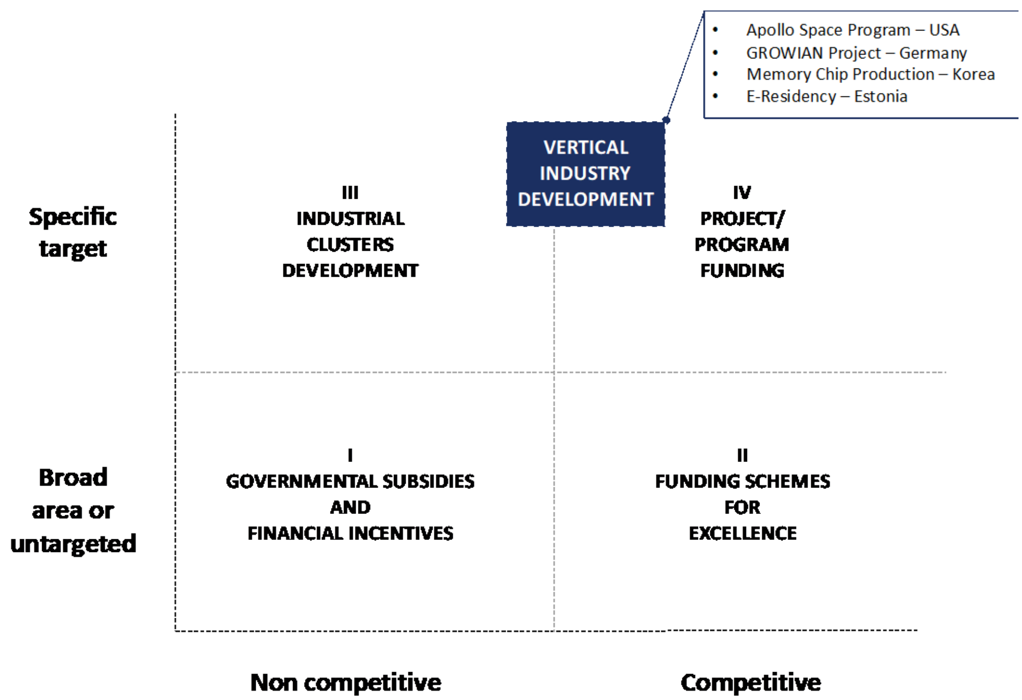
Global spending on research and development (R&D) and innovation capabilities have reached a record high of almost $1.7 trillion in 2018 (United Nations Educational, Scientific, and Cultural Organization [UNESCO] 2018). How such investments are made differs significantly and also results in different outcomes (Figure 1). While rich countries can afford a wide portfolio of development support mechanisms, financially more constrained economies can be expected to profit more from focusing the available resources on prioritized actions.

Research and innovation funding is allocated in different ways and is often influenced by tradition in National Innovation Systems (Larrue and Guellec 2018). Traditionally the main distinction was made between competitive and noncompetitive funding mechanisms. The former allocates funding, typically by funding agencies, councils, or ministries based on a formal competition or selection based on the application.

Noncompetitive funding mechanisms include annual allocations to universities, public research institutes, but also tax breaks or other subsidies for research performing institutions, and companies. The most common mechanisms are tax breaks for R&D spending, investing money into research institutes, and setting up industrial clusters. These mechanisms are often used to support existing industries at the national level. For example, semiconductors, nano- and biotechnology industries are often subsidized.

More recently, national funding bodies have become more active in the allocation of the funding, directing funds through strategic priorities to specific areas (e.g., biotechnology) or even to very specific targets (e.g., bringing internet connectivity to rural areas). Thus, we can make a second distinction between broad area/untargeted funding and funding which is aimed at a specific targets or designated challenges.

Figure 1: Four Ways to Promote National Innovation Systems



Source: Authors.

Traditional funding allocated to broad areas following noncompetitive schemes is losing importance as many countries grow impatient of waiting for structural benefits on the overall economy to produce results in the areas where innovation is most needed (Larrue and Guellec 2018). In Europe, the smart specialization strategy, allocates €67 billion to support regions that have identified their strengths and comparative assets, specialize in a competitive area, and have a clear and shared innovation vision (European Commission 2017).

Traditional funding, in particular for developing countries, has failed to enable leapfrogging and helping developing countries to catch up and overcome the developed country dominance (Asian Development Bank [ADB], 2014). Nevertheless, other strategies are gaining ground. In the Organisation for Economic Co-operation and Development, in particular the broad-area, competitive schemes are receiving an increased attention. Within the Organisation for Economic Co-operation and Development 31 countries (61% of the total of 51 countries) report to have initiatives that are based on excellence funding schemes that allow to allocate large-scale and long-term funding to initiatives that are or aim to become internationally outstanding (Larrue and Guellec 2018). The principal advantage is to support high-level expertise in a

variety of regional areas. Excellence funding includes also the European Research Council which has contributed to breakthroughs in different scientific domains such as Life Sciences, Social Sciences and Humanities, and Physical Sciences and Engineering. (European Research Council 2018). Excellence funding schemes are, however, more useful to drive early stage technology developments and are less relevant for developing countries that need to emphasize speed to innovation and impact.

Recently, the recognition of the importance of the United Nations Sustainable Development Goals has led to a proliferation of targeted research funding through projects, thematic research units, or national research programs. While governments aim to further promote specific desired impacts, they start to experiment with reengaging in the governance of innovation projects and programs blurring the line between purely noncompetitive and competitive allocation models that are in line with the idea of modern industry policy (Rodrik 2007). These schemes have historical roots in projects such as the Apollo Space Program in the United States or the Memory Chip Industry development in the Republic of Korea (ROK).

In the following section, different historical cases to develop a model for the funding mechanism that we call **vertical industry development (VID)** will be discussed**.** These cases were chosen based on their focus into specific industries or challenges and their rather competitive nature. Also, all fours cases are rather well documented, which allowed us to collect extensive archival data in order to research the nature of exploration; success criteria; difficulties, and lessons learned in each case.

C. Cases on Vertical Industry Development

For developing countries, it is worth considering a competitive **focused strategy** within the broader framework of the modern industry policy. These strategies proved to be successful at the national level. For example, by combining industry policy, government R&D programs and the creation of an innovation ecosystem focused in one particular sector, the ROK changed its position from a supplier to the world-leader in memory chip production. Chaebol[2] coordinated governance (Kang 2010) allowed to leverage on the specific tech-innovation characteristics of the industry and enabled markets to growth exponentially. Initially started as a foreign investment, the ROK was, first, able to transfer technology from oversees and, second, leverage on it to build a new industry in a coordinated way by **leveraging local market characteristics** and **forcing leading companies** like Samsung, Hyundai, and Goldstar **into a coopetition to win the race towards a new technology generation** (Kim 1998). This strategy also played positively in the context of the Growian project when the Government of Germany attempted to reduce the dependence on fossil fuels and energy imports and handed these challenges to three companies, electing

[2] The word chaebol is a combination of the Korean words chae (wealth) and bol (clan or clique). The ROK's chaebol are family-owned businesses that typically have subsidiaries across diverse industries (Kang 2010).

MAN Group[3] to conduct the project. Funded directly by the Ministry of Education and Research, Growian resulted in erecting the first large-scale wind energy turbine, ultimately resulting in a globally leading position for the wind energy industry of Germany and Denmark, which even after 40 years has not yet lost its superior position. The Growian case also illustrates the innovative power that can be unleashed if highly ambitious goals are pursued by leading industry firms (Frankfurter Allgemeine 2013 and Pulczynski and Jörn 1991). **Flexible investment decisions in multiple stages to privilege learnings and facts and metrics to support radical innovation need to be put in place.** For example, subsequent projects investment strategy can be a condition to facts both positive and negative (i.e., following lean approaches). Projects can first be financed for a period of 6 months–12 months and, based on the results, have opportunity to pivot and apply for the second stage of funding adapted to their needs. Metrics in this process should be project-specific and designed to reduce uncertainties (i.e., number of signed letters of intention from the potential clients to use technology; local partners interest even before the solution is implemented). **Overall prior cases demonstrate that the leapfrogging is enabled and stabilized through demand-side governmental support (supported through tax breaks, subsidies, or direct demand from the government).** For example, in Singapore a specific governmental agency is coordinating efforts on automotive vehicles development (KPMG 2019). They have also taken upon a flexible framework for regulations by limiting the actual regulatory sandbox of automotive vehicles to 5 years in order to test how effective is the legislation in order to improve and build a more permanent one or make another cycle of improvement at the sandbox stage. Supportive and proactive regulatory frameworks can create an important lead-market advantage, which both supports local companies and attracts leading international companies.

Verticals are often motivated by precise problems or challenges like in the Apollo project that aimed to land humans on the moon. These challenges are also linked to clear high-level visions. Such a vision can be built by leveraging strategic foresight tools. To enable leapfrogging planning for industry development needs to start with a clear understanding of how the target industry will look like in the future and how a national innovation system needs to be structured to create a leading position. Private sector that applies strategic foresight to build superior positions in markets of the future have been shown to achieve superior profitability and growth (Rohrbeck and Kum 2018). Similarly, the Korean success in the memory chip industry was driven by the clear vision that the new technology generation would allow redistributing the power in the value network and would enable private sector actors to leapfrog and displace the incumbents from Western countries. Despite many obstacles and extremely high costs involved, the Apollo project successfully achieved its mission and in addition resulted in many scientific breakthroughs in different disciplines and creating a new market of space tech. The project also led to the development of new materials and

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[3] German mechanical engineering company. It is a subsidiary of automaker Volkswagen AG.

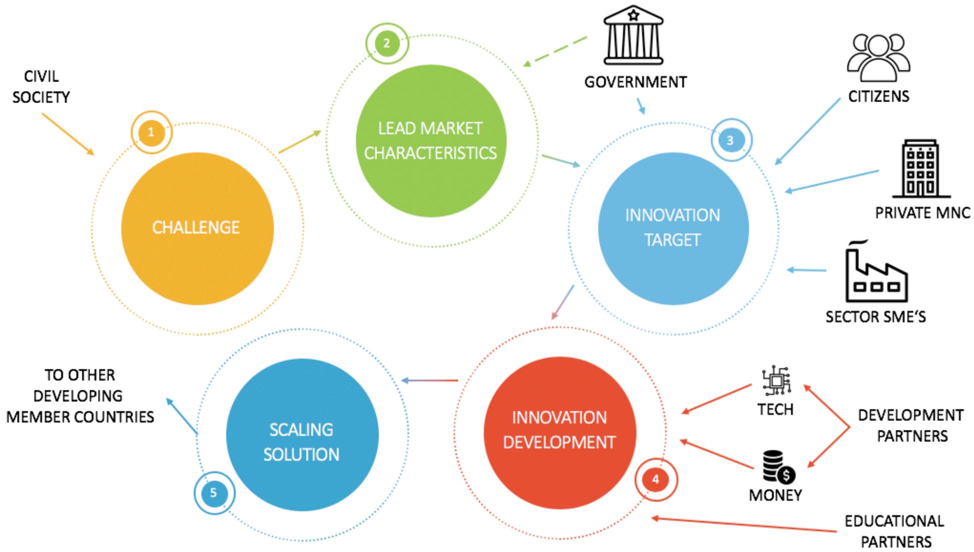
technologies, sparking (digital) innovations in the United States and, subsequently, to a huge appetite to found and fund tech-based ventures. **This challenge was able to energize the whole generation of tech entrepreneurs** (Andrews 2016 and Nasa.gov 2007).

Finally, **the "price" needs to be sufficiently high and/or the entry barriers sufficiently low to attract the best innovators**. In addition, tools that promote learning and provide frameworks to adjust to the changing circumstances can enable the involvement of larger crowds. The case of e-residency in Estonia is a good example of this. After the fall of the Soviet Union, the government invested in digitalizing the public sector. This led to an e-residency program where anyone could register and operate their business in Estonia online and avoid the burden of long bureaucratic processes. It was not just a good marketing strategy for a country, but also resulted in creating new jobs and generate tax revenue (Patricolo 2017, Pickup 2018, and e-estonia.com 2019).

In all four cases, we see industry verticals emerge that enjoy a lasting competitive advantage at the global level. In some cases, this competitive advantage has already lasted decades, illustrating both the appeal of proactive vertical development and the hopelessness of attempting to catch up with the dominance of leading regions, countries, or clusters. In addition, all cases have created spillover effects to other industries. For example, the Apollo with its demand for latest computer technology for solving complex mathematical problem has led to the American dominance in hardware and software development. The digitalization push in Estonia has placed the Tallinn firmly on the map as a center of excellence on cyber security, hosting also the North Atlantic Treaty Organization Cyber Defense Center of Excellence. The ROK push for global leadership in the memory chips industry has contributed also the position of the ROK as the lead market for advanced information and communication technology.

From the case studies, we have identified five steps through which industry verticals can be developed systematically: (i) identifying and anticipating challenges to be tackled; (ii) understanding lead market characteristics; (iii) designing innovative solutions for lead markets; (iv) developing innovations, and (v) scaling solutions (Figure 2). Throughout the process, the leveraging of various stakeholders is key for success. Successful VID initiatives not only leverage on the educational, governmental, and private sector, but involve also the citizens, development partners, and the civil society.

Figure 2: Vertical Industry Development Model



Source: Authors.

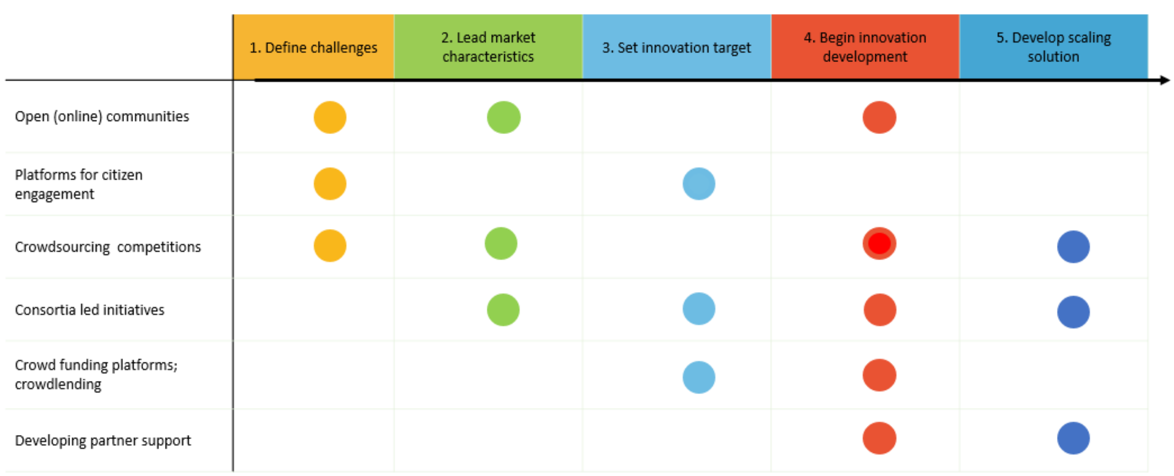
VID can be further enhanced by leveraging on foresight, modern information technology tools and agile innovation platforms. Such tools can drastically reduce communication and transaction costs thanks to digital technologies and increase the impact of investments. Broadening the access to knowledge creates additional opportunities to strengthen the role of a developing country like Indonesia and leverage on skills and expertise available elsewhere.

Today, open innovation tools, together with foresight and futures research tools, create a more even playing field, enabling also less-developed countries to leverage the same innovation resources that were traditionally reserved for developed countries that have leading research and educational institutions, a highly skilled workforce and leading private sector actors. Different open innovation tools such as open innovation communities, innovation competitions, crowdfunding, and citizen engagements can be used to leverage on different stages of the VID model (Figure 3). Some of them were used successfully by private sector firms and government agencies to explore which challenges need to be tackled by engaging citizens (Kokshagina et al. 2017). Strategic foresight tools include strategic radars, that allow government agencies to monitor drivers of change and trigger industry development in sectors in which opportunities for leapfrogging exist. Scenario based planning can also be considered to form a consistent future outlook and direct innovation efforts of private actor companies. Entirely new industry sectors often require a combination of scenario planning and systems dynamics modelling to avoid that uncertainty is preventing

action. These and other strategic foresight tools can enable innovation in new areas and support the catalyzing of innovation efforts of the participants in the innovation ecosystems (Rohrbeck 2014).

For example, Dream for Sweden was organized in 2019 to ask Swedish citizens to imagine the future of Sweden resulting in a list of challenges for a hackathon organized in April 2019. Different platforms for citizen engagement like the Goals.org, Crowdcity allow to engage citizens at various stages of VID process. For instance, the Government of Brazil used Crowdicity to explore ideas for the Rio Olympic Games. Crowdsourcing competitions are often used to solve pressing issues with the help of crowds. In the United States, Challenge.gov was established to engage the public in solving pressing issues facing federal agencies. The main motivation was that most agencies do not have skills to innovate as quickly as crowds. The costs are higher for large bureaucracies and some solutions are typically overlooked by agencies. Consortia led initiatives are often used to facilitate collaboration among a number of interdisciplinary partners. Consortia are often problem driven like CIMIT that aims to improve patient care (https://cimit.org/) or a United Kingdom-based consortium weavr (http://weavr.tv/) that develops new concepts for viewing e-sport. Some consortia like CDI labs aim to facilitate collaboration between stakeholders in different industries where they aim to investigate needs together, select some innovative solution, and develop pilots to text them (http://science2society.eu/). Consortia-led projects are beneficial when the list of targeted organizations is predefined to identify market-led characteristics, set industry targets, and begin with exploration. Developing partner support is crucial at the later stages of VID to start with industrialization of innovation; initiate deployment of the solutions with local partners, or access skills and expertise that some of these partners hold (Figure 4).

Figure 3: Open Innovation Tools



Source: Authors.

Different options can be put in place at various stages of VID. Based on our analysis, we suggest three ways to engage in the VID cycle (Figure 5) building principally on open (online) communities, platforms for citizen engagement (in case of option A), crowdsourcing competitions (in case of option B), and crowdfunding and crowdlending for option C.

(i) **Option A** (for stages 1 and 2 of the model): **Imagine future of a specific country**. This option consists of leveraging on crowds' (or targeted stakeholder groups) ideas to identify priorities for industry development (and using foresight) and starting to identity and test for favorable market characteristics. To do that, an open contest can be organized to ask anyone for ideas. These ideas can be clustered and based on crowds voting and "heat maps" for the most popular ideas can be generated. This open competition can be hosted by the government with the help of ADB and external experts. The analysis can be combined with more targeted context analysis in the market to identify the most pressing challenges to be tackled.

(ii) **Option B** (for stages 3 and 4): **Solving major industry challenge**. Once priority areas are identified (i.e., using option A or based on prior analysis), the government can host an open or closed crowdsourcing competition. This competition can be organized with the help of a specialized agency or, in government-based open innovation contests like Malaysia foresight agency (MIGHT) or Singapore Enterprise, with the help of external specialists. In case of open competition, solvers in the countries and abroad can provide ideas for a particular industry vertical. An open competition is typically used to collect ideas for early stage innovation initiatives that develop concepts and early stage prototypes. Closed competition (inviting preselected organization) to answer is typically used for later stages, for implementing solutions for innovation targets. In this case, solvers will already have a working prototype or even a working product, but they will have to bring it to the Indonesian market and perhaps adapt the underlying solution to the local context.

(iii) **Option C** (for stages 4 and 5): **Leapfrogging for a specific industry**. In this option, the goal is to support innovation development and prepare for scaling the solution. In this case, development partners or government can support a tax breaks/funding program for technology leapfrogging for a predefined industry to bring to the country. In addition to this, certain projects can be financed using crowdlending platforms.

Figure 4: Vertical Industry Development Process and Tools

Source: Authors.

All three options can be used for the development of an industry vertical. The three options can be used in combination or separately (Figure 4). They are designed to support innovation in a focused problem space in which new capabilities are built iteratively (as we have seen across our case studies).

Using open innovation tools to initiate the VID cycles will enable increased competitiveness in predefined areas; identify quick wins, and make informed strategic decisions in the Indonesian context.

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