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Comparative Analysis of Democratic Transitions through Science and Technology Policies Using Innovation System Functions in the Philippines: 1946-2020

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ABSTRACT

The research aspires to study the emergence of the national technological innovation system in the Philippines through the various political transitions after World War II. In studying the innovation system from emergence to transition and its ideal sustainable practice, it is important to not only layout the narrative of innovation system emergence but also analyze the differences of each leadership regime through the innovation policy implemented and prioritized. This paper will use the innovation system function to elucidate the fundamental nuances of innovation policy per regime and compare each through the most dissimilar system's design to compare each and expose the policy trends and themes that have run across decades of leadership until the present time.

Keywords: *Transition Studies,Technological Innovation Systems, National Innovation Systems, Philippines*

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INTRODUCTION

The COVID-19 pandemic has drastically altered political, economic, and societal aspects that were never thought of happening again. Countries are faced with a long and drawn-outchallenge to gain social balance, mitigate the spread of the virus, and outlast the threat. The study carries out to answer the question of what the ramifications of innovation functions are, their emergence and development and gauge its effects on the current state capacity to respond and anticipate threats through the national innovation systems developed across various administrations and leadership transitions.The Philippines has suffered greatly, and grown so slowly due to its lack of S&T focus and identity.

Statement of the Problem

With the current state of S&T in the Philippines, it begs to be studied further how shifts in innovation policy focus have either improved or hampered state capacity and capability in creating a stable innovation system. By studying policies and institutions, a broad narrative of innovation policy development is therefore created and studied further.

The core puzzle of this research undertaking focuses on the nuances of innovation policy transitions in various presidential regime changes and their innovation policy agendaat the institutional level. The paper puts forth the corollary questions as follows:

- What are the core innovation policy priorities of each administration and what are their long-term effects on national innovation systems and functions?
- What are the fundamental innovation function divergences and convergences in various regimes and how does it affect the development of S&T in the country?
- What is the significance of the history of S&T development on state capacity in the Philippines?
- How can the Philippine government resolve the weaknesses of S&T development?

Statement of the Research Objective

Primarily, the research endeavors to study the progression of state-initiated innovation policy from World War II until the present time. Furthermore, it will be studied under the lens of innovation system functions pinpointing prevalent innovation themes as well as shifts and transitions that are carried through from one regime to another. Most importantly, a direct comparison of the innovation system function profiles with other periods is carried out that ties down the understanding of innovation policy profiles and transitions throughout the years.

Significance of the Study

The study of innovation systems and their functions is due to the evolving

understanding of practitioners and scholars on national innovation systems. The Organization for Economic Cooperation and Development (OECD), acknowledges that the understanding of national innovation systems is integral in facilitating technological change[1].National Innovation Systems are projected to be an important variable for economic growth through innovation-aided industrial expansion.

Emerging economies propose a special case in innovation literature because of the contrasting narrative it has compared to western innovation transitions and established national innovation systems. The application of innovation system literature is necessary for examining the nuances of innovation functions within regimes. Innovation is a complex narrative of intermingling sectors, actors, and causes that create the conditions for technology emergence. The Philippines is a good case study as it provides an insight into how a newly industrializing country and emerging economy has tackled the innovation agenda in the aftermath of World War II in which the whole nation had to rebuild from the ground up. Currently, there is a glaring lack of literature on the topic with the Philippines as a case therefore, there is a gap in the literature that begs to be explored and understood to further analyze innovation emergence and transition build-up towards sustainable innovation ecosystems.

[1]OECD .1997., *"National Innovation Systems"*, Retrieved from:https://www.oecd.org/science/inno/2101733.pdf

The politics of innovation transition is an important narrative to study, compare, and understand the fundamental innovation policy dynamics and its transition through regime changes beyond the rigid assumption of innovation systems as a trend divorced from complexity and other influences specifically at the public policy level.

Scope and Limitations

As an initial foray into the study of S&T policy development in the Philippines. Studying innovation regimes, transitions, and systems requires a stringent tracing of policy focus and execution in each period of leadership. An emphasis on public policy is fundamental in this paper as it sets the base for analysis and comparison for each regime at the macro-institutional levelin parallelwith its functions in aleadership-centric contextto discuss micro relationships and emergent causalities. On the contrary, it will not prioritize the history of S&T policy emergence in each period and will focus more on the aspects of innovation system functions, trends, and themes in comparison to other leadership regimes. Finally, funding for S&T programs and institutions will also not be examined in this study as it is projected to be onlythe initialstep towards further studying S&T policies under the lens of transition studies.

Theoretical Framework

Commonly, innovation systems before the advent of transition studies were

divorced from the complex interactions of political, economic, technological, and industrial factors. While each provides a different lens of inquiry, transition theory has given a multidisciplinary take on the study of innovation and transitions. Studying innovation systems[2]captures the immensity and complexity of innovation regime creation in a multi-actor, multi-sector, and multi-causal understanding of how innovation systems, networks, and institutions are created.

National innovation systems such as that in the Philippines' case provide an exemplary case to which transition theory can be applied. Functions of innovation systems were first introduced in 2007 as a new way of analyzing technological change by Hekkert et al[3]. It was deemed that more traditional studies on innovation systems are limited because of the scope that relies only on the institutional level, therefore, necessitating a deeper understanding of innovation functions embedded in these dynamic spheres of reflexive interactions.

Hekkert et al. have put forth a framework of understanding that captures technological transition[4]as well as changes in the plane of socio-technical shifts[5]. On the policy level, regimes are in an important position to directly affect S&T growth and innovation emergence given its access to resources and political-legal clout. Public policy in practice is key in analyzing the interactions and emergent complexities between actors, institutions, and socio-technical regimes.

The innovation systems that are created in these public policy directives are influential in creating the necessary conditions for technological development through different functions directly affecting and influencing the direction of innovation pathways and trends.For this research, the snapshot method of analysis will be used to study and gauge the profile of innovation systems concerning each regime's S&T policy direction and preferences as well as each regime's strengths and weaknesses. National innovation systems are to be understood in this framework as a result of innovation systems and their functions to reinforce the ecosystem of innovation present within the transition arenas of public policy and governance.

[2]A.D. Sagar, J.P. Holdren, 2002. Assessing the global energy innovation system: some key issues, *Energy Policy* 30 .6. 465 – 469.
[3]M.P Hekkert, R.A.A Suurs, S.O Negro, S. Khulmann, R.E.H.M Smits. 2007, Functions of Innovations Systems: A new Approach for Analyzing Technological Change, *Technological Forecasting and Social Change*, Elsevier
[4]P. Weaver, L. Jansen, G. Grootveld, E. Spiegel, P. van,. 2000. Sustainable Technology Development, Greenleaf Publishing, Sheffield, UK,
[5]F. Geels. 2002. Technological Transitions as evolutionary reconfiguration processes: a multi-level perspective and a case study, *Res. Policy* 31 1257 – 1274

Innovation system functions[6]:

1. Experimentation and upscaling by entrepreneurs

Entrepreneurs are regarded as primary drivers of knowledge and innovation diffusion through networks and the application of noble technologies into market opportunities. The existence and nurturing of the community enableinnovation systems to transcend from patent to market into economic value. Entrepreneurial activities, therefore,are an important aspect of the progression of an innovation system and its value chains.

2. Knowledge development

Research and Development is another core driver of the innovation system and should be emphasizedwhen analyzing transitions. Indicators for this include products of research such as patents, projects, and knowledge contributions.

3. Knowledge diffusion

Healthy innovation regimes should have mechanisms for networking and knowledge exchange or technological transfer. Having the projects and institutions to bolster diffusion is another key indicator for a stable innovation system.

4. Guidance of the search

It is the confluence of government and market influence on innovation trajectories.

5. Market formation

The creation of markets shows a healthy innovation system by citing the direct relationship between innovations and their impact on the existing market dynamics. The introduction of new technologies sets succeeding changes from existing rules and standards to other sociotechnical regimes directly or indirectly affected by novel innovation.

6. Resource mobilization

As the function suggests, it is about the management of human and financial capital towards the development of the innovation system and the production of knowledge. If it is present, the government shows its commitment to long-term gain and value creation.

7. Creating legitimacy

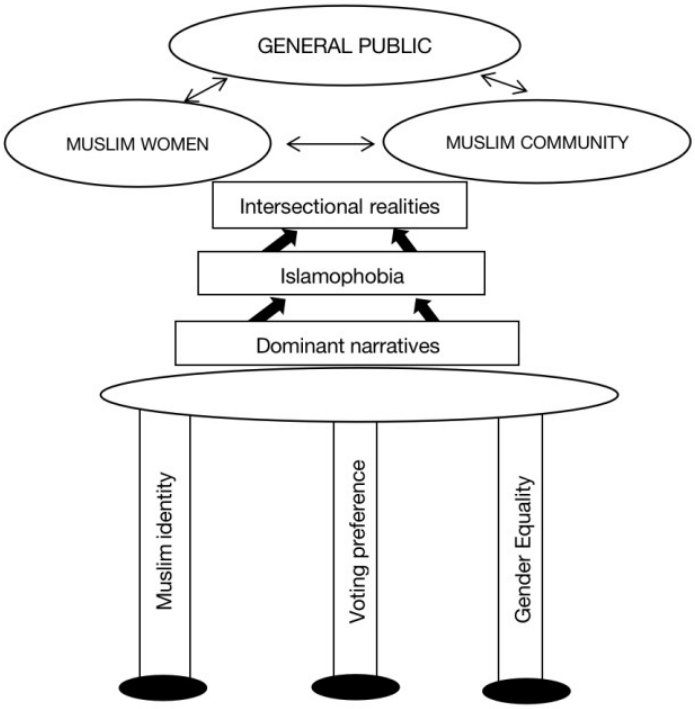
The presence of advocacy or lobby groups helps shape innovation systems by supporting emerging technologies and denouncing prevailing norms.

Using innovation system functions provides the necessary lens of inquiry that exposes the inner workings of innovation systems within regimes that are analyzed and compared. The existence, non-existence, and continuation or discontinuation of projects galvanizes the inquiry on

[6]M.P Hekkert, R.A.A Suurs, S.O Negro, S. Khulmann, R.E.H.M Smits. 2007, Functions of Innovations Systems: A new Approach for Analyzing Technological Change, *Technological Forecasting and Social Change*, Elsevier

specific regime nuances on S&T policy biases. The institutional links between regimes draw critical concern in analyzing the contribution of each policy to the grander scheme of S&T regime improvement. Designing innovation systems through policy direction paves the important foundations in supporting the meso level or the socio-technical regimes to pursue through institutional creation, support, or recalibration.

Socio-technical transition pathways which were elucidated by F. Geels[7]supports the multi-faceted nature of studying transitions with the understanding of the veracity of actors and factors that intermingle in shaping transition trajectory. The pathways in transition differ depending on the context and environment and are never linear. Varying degrees of intervention captures the nature of transition and the causal effects of the macro (Landscape), meso (Socio-technical regime), and micro levels (Niche level)



Geels and Schot's Transformation Pathway

[7]F. Geels, J. Schot 2007. Typology of Sociotechnical Transition Pathways, *Res. Policy* 36 .2007. 399-417

Political leaderships in this model of understanding are capable of re-designing socio-technical regimes to better facilitate technological change by institutional calibration. With simultaneous pressures from the landscape known as the existing norms, beliefs, and standards with the niche or the specific collectives advocating or lobbying, it creates a macro-level transition arena that influences the public policy agenda as a complex adaptive system working towards the goal of advancing S&T.

As a comparative study of various innovation system regimes, the study employs the most different system design[8] as it is assumed that all aspire to expand S&T progression and development and are nuanced.

Research Methodology

The research theme will center on the comparison of innovation system functions after the fallout of World War II. Being a comparative case study based in the Philippines it will use secondary data sources available online through journals and other pertinent sources. Primarily, official proclamations, laws, policies, and other directives from agencies are also factored into the gathering of data. The paper itself will be anchored in historical institutionalism which highlights the chronology, and path dependence that has molded the current institutional governance landscape of S&T policy in the Philippines while the use of the theoretical foundations of transformation studies endeavors to decipher and understand the nuances of S&T policy governance between regimes.

Review of Related Literature

Philippine Regimes and Innovation System Development

As the root of discussion in this paper is the intersection of public policy and functions within innovation systems, the history of innovation policy of all succeeding elected presidents after World War II is presented along with the notable S&T policy achievements within their tenure of office. Deriving the functions from the snapshot analysis from the institutional policy initiatives of each regime, the broad spectrum of innovation system development and progression is examined using innovation system functions.

Manuel Roxas (1946-1948)

Focused on laying the foundations for essential resource management towards agriculture, food, and medicine as influenced by America as its focus on war reconstruction efforts. Given that Roxas was a transitionary leader, it was during his regime that the initial efforts in establishing working agencies and institutions that would revive the country after the war.

[8]Anckar, C .2008.. "On the Applicability of the Most Similar Systems Design and the Most Different Systems Design in Comparative Research." *International Journal of Social Research Methodology* 11.5 .2008.: 389–401.

A landmark law was put into place affecting land reform to bolster agriculture fromthe Rice Share Tenancy act of 1933 to the Tenant act in 1946[9]. Focusing on post-war rehabilitation, Roxas re-established the Department of Health[10]which handles the health planning and coordination in the country as well as the mobilization of resources and public health innovations.

Elpidio Quirino (1948-1953)

After the untimely death of Pres. Roxas, Vice-President Quirino took over to finish the S&T legacy carrying over the influence of the Americans and the legacy of his predecessor. Quirino regime had a marginal impact on S&T development and focused more on institutions that center on quelling corruption, expanding social services to the people, and the agrarian reform agenda while pushing back local rebellions by granting amnesty and social amelioration packages to rebels.

Quirino in his short stint established the Commission on Volcanology[11]in response to threats posed by natural disasters and has enabled farmers with the Agricultural Credit Cooperatives Financing Administration for loans and extending credit to farmers from far-flung areas[12]

Ramon Magsaysay (1953-1957)

Known as a man of the people, his agenda extended the focus on agrarian land reform to again bolster rural area development and jumpstart post-war reconstruction. With the danger looming with growing tensions from communist insurgents, the Magsaysay administration focused on quelling rebels and establishing policies in aid of the masses through supporting agrarian reform policies as well as forming alliances with regional neighbors with the Southeast Asia Treaty Organization (SEATO). Magsaysay's main contribution was the proclamation of

[9]Congress of the Philippines.1946. "*The Philippine Rice Tenancy Act"*, Retrieved from https://lawphil.net/statutes/repacts/ra1946/ra_34_1946.html

[10]Office of the President .1947., *"Reorganizing the Different Executive Departments, Bureaus, Offices, and Agencies of the Government of the Republic of the Philippines, Making certain Readjustments of Personnel and Reallotments of Funds in Connection Therewith, and for Other Purposes*". Retrieved from https://www.officialgazette.gov.ph/1947/10/04/executive-order-no-94-s-1947/

[11] Congress of the Philippines .1952., *"An Act to Safeguard Life and Property Against Volcanic Eruptions and Dangers by Creating a Commission on Volcanology and Providing Relief for the Victims of Such Calamity, and For Other Purpose".* Retrieved from https://laws.chanrobles.com/republicacts/8_republicacts.php?id=770

[12] Congress of the Philippines .1952*., "An Act to Establish an Agricultural Credit and Cooperative Financing System to Assist Small Farmers in Securing Liberal Credit and to Promote the Effective Groupings of Farmers Into Cooperative Associations to Enable them to Market Efficiently Their Agricultural Commodities, and to Place Agriculture on a Basis of Economic Equality With Other Industries, and For Other Purposes".* Retrieved from https://www.officialgazette.gov.ph/1952/08/14/republic-act-no-821/

November 21 to 27, 1954 as Philippine National Science Week[13].

Carlos P. Garcia (1957-1961)

The death of Magsaysay transitioned presidential power to Garcia as vicepresident. Another transitionary reign further supported the momentum gained by Magsaysay's policies as well as an attempt to put local interest first with his landmark initiative called "Filipino First Policy[14]" which calls to favor national interest first in commerce, industry, and knowledge development.

Garcia's administration also formed the National Science Development Board,through the "Science Act of 1958[15]" to handle the following areas of scientific development. The focus of the initiative falls on industrial research, agricultural research, medical and pharmaceutical research, biological research, atomic energy research, food and nutrition research, engineering research, research on social science and the humanities, and pure and fundamental science studies. Among its major contributions of Garcia was the creation of the Philippine Atomic Energy Commission[16] and the passing of thePhilippine Nuclear Energy Act of 195 to administer and harness nuclear energy use and development[17]

Diosdado Macapagal (1961-1965)

Diosdado Macapagal defeated Garcia in his re-election campaign and advanced public interest beyond agrarian but also into fisheries development, financial industry, and social security. With the economy and social security as his focus, he was a pioneer in his time by institutionalizing reforms and opening the economy in anticipation of growth. However, major steps towards S&T were not apparent under his administration where the focus lies oninternal administration reforms in curbing corruption, stabilizing international trade, and fostering regional cooperation and relations.

Significantly, it was also under his regime thatthe Philippines had a historical presence in international relations by joining one of the first intergovernmental organizations in the

[13] Office of the President .1954., "*Declaring the Period from November 21 to 27 as Philippine Science Week and Creating a Committee to Take Charge of the Observance Thereof",* Retrieved from: https://lawphil.net/executive/proc/proc1954/proc_79_1954.html

[14] Office of the President .1960., "Carlos P. Garcia, Thrid State of the Nation Address", Retrieved from: https://www.officialgazette.gov.ph/1960/01/25/carlos-p-garcia-third-state-of-the-nation-address-january-25-1960

[15] Congress of the Philippines .1958., *"Science Act of 1958*", Retrieved from: https://lawphil.net/statutes/repacts/ra1958/ra_2067_1958.html

[16] Ibid

[17] Congress of the Philippines .1957., "*An Act to Create the Philippine Nuclear Energy Commission to Administer, Regulate, and Control the Use, Application, and Disposition of Fissionable Materials; to Authorize the Establishment and administration of an Atomic Energy Reactor; to Determine the Manner of Development, Use and Control of Atomic Energy, to Provide Funds Therefore, and Other Purposes",* Retrieved from: https://www.lawphil.net/statutes/repacts/ra1957/ra_1815_1957.html

region (MAPHILINDO), a precursor to the ASEAN as developing nations break from their colonial masters' control and influence. Macapagal despite his divergent priorities provided incentives to inventors with the "Philippine Inventors Incentives Act"[18] to harness local talents in the field of S&T.

Ferdinand Marcos (1965-1986)

While the notoriety of Ferdinand Marcos' dictatorship will forever associate with his regime, he was able to craft an image through his political machinery of mythmaking. Various claims have long been debunked but it was also under his reign that momentous S&T support was projected to be the nation's catalyst toward economic growth under his long and tenuous regime.

Marcos' major contribution was the reorganization of the National Science Development Board and reorganizing it with the National Science and Technology Authority whereas the following agencies will be under the authority[19]

- The National Institute of Science and Technology[20]
- The Food and Nutrition Research Institute[21]
- The Philippine Institute of Volcanology
- The Forest Products Research Institute[22]
- The Philippine Invention Development Institute[23]
- The Science Foundation of the Philippines
- The Materials Science Research Institute
- The National Academy of Science and Technology[24]
- The Philippine Atomic

[18] Congress of the Philippines .1964., "Philippine Inventors Incentives Act", Retrieved from: https://www.lawphil.net/statutes/repacts/ra1964/ra_3850_1964.html

[19] Congress of the Philippines .1982., "Reorganizing the National Science Development Board and its Agencies Into a National Science and Technology Authority and For Related Purposes". Retrieved from: https://lawphil.net/executive/execord/eo1982/eo_784_1982.html

[20] Congress of the Philippines .1958., *"Science Act of 1958*", Retrieved from: https://lawphil.net/statutes/repacts/ra1958/ra_2067_1958.html

[21] Office of the President .1947., *"Reorganizing the Different Executive Departments, Bureaus, Offices, and Agencies of the Government of the Republic of the Philippines, Making certain Readjustments of Personnel and Reallotments of Funds in Connection Therewith, and for Other Purposes*". Retrieved from https://www.officialgazette.gov.ph/1947/10/04/executive-order-no-94-s-1947/

[22] Office of the President .1974., *"Creating the Forest Research Institute in the Department of Natural Resources"*. Retrieved from: https://lawphil.net/statutes/presdecs/pd1974/pd_607_1974.html

[23] Congress of the Philippines .1964., "Philippine Inventors Incentives Act", Retrieved from: https://www.lawphil.net/statutes/repacts/ra1964/ra_3850_1964.html

[24]Office of the President .1978.. *"Amending Sections 5 and 6 of Presidential Decree No. 1003-A Creating the National Academy of Science and Technology"*. Retrieved from: https://lawphil.net/statutes/presdecs/pd1978/pd_1557_1978.html

Energy Commission[25]
- Philippine Science High School
- National Research Council of the Philippines
- Philippine Council for Health Research and Development
- Philippine Council for Industry and Energy Research and Development
- Philippine Council for Agriculture and Resources Research and Development

Marcos supported these by encouraging industry development through the Philippine Textile Research Institute[26] and promoting S&T knowledge transfer by sending scientists abroad for nuclear research[27] as one of its marquee projects. Coinciding with his social programs were the establishment of various S&T regimes from agriculture (National Grains Authority[28] and Philippine Council for Agricultural Research) under the Department of Agriculture and the formation of the Philippine's foremost department on geophysical and Astronomical research with (PAGASA)[29]

The Marcos regime had also initiated to protect intellectual property and promoted research through a decree on the protection of intellectual property in 1972[30] in response to the increase of S&T focus. Controversially, the administration also instigated oil exploration with the creation of the Philippine National Oil Company (PNOC)[31] which was started amid heightened territorial tensions with ASEAN neighbors in the said period.

[25]Congress of the Philippines .1958., *"Science Act of 1958*", Retrieved from: https://lawphil.net/statutes/repacts/ra1958/ra_2067_1958.html

[26]Congress of the Philippines .1964., "*An Act to Promote the Textile industry of the Philippines By Exempting, Under Certain Conditions, Importations of Needed Raw Materials, Chemicals, Dyestuffs, and Spare Parts, and the Subsequent manufacture and Sale of Products Derived Therefrom, From Duties and Taxes, By Creating a Special Fund for Vital Other Purposes",* Retrieved from: https://lawphil.net/statutes/repacts/ra1964/ra_4086_1964.html

[27]Office of the President .1970., *"Ferdinand E. Marcos, Fifth State of the Nation Address",* Retrieved from: https://www.officialgazette.gov.ph/1970/01/26/ferdinand-e-marcos-fifth-state-of-the-nation-address-january-26-1970/

[28]Office of the President .1972., "*Providing for the Development of the Rice and Corn Industry and Creating for This Purpose the National Grains Authority",* Retrieved from: https://www.officialgazette.gov.ph/1972/09/26/presidential-decree-no-4-s-1972/

[29]Office of the President .1972., *"Establishing the Philippine Atmospheric Geophysical and Astronomical Services Administration"*, Retrieved from: https://www.officialgazette.gov.ph/1972/12/08/presidential-decree-no-78-s-1972/

[30]Office of the President .1972., *"Decree on the Protection of Intellectual Property"*, Retrieved from: https://www.officialgazette.gov.ph/1972/11/14/presidential-decree-no-49-s-1972/

[31]Office of the President .1973., *"Creating the Philippine National Oil Company, Defining its Powers and Functions, Providing Funds Therefor, and for Other Purposes",* Retrieved from: https://www.officialgazette.gov.ph/1973/11/09/presidential-decree-no-334-s-1973/

To ensure the future of S&T education, it pushed to bolster the public education system by pioneering the S&T-focused initiative with the National Academy of Science and Technology in 1976[32] as well as expanding Philippine Science High schools in Visayas and Mindanao to encourage the youth towards research alongside the establishment of the Research Institute for Tropical Medicine[33] whose main task is to develop contingencies and plan to study tropical diseases. Finally, in support of Filipino scientists, the "Balik-Scientist Program" gave incentives to Filipinoresearchers to return and practice in the Philippines[34].

Corazon Aquino (1986-1992)

Dawning a new constitution after the fall of Marcos and his oppressive regime, the Philippines once again fell back on its drive towards S&T development and had to refocus initiatives on developing institutions that were held back during the Marcos dictatorship. Aquino had the rare opportunity to redesign the country's institutions and was able to re-establish its agencies in line with the Philippine Development Plan under her administration where S&T was sought to be one of the catalysts for economic development yet again.

Aquino's major legacy was the reorganization of the S&T regime with the Department of Science and Technology as the central governing body for S&T development in the country[35]. The DOST was mandated to govern and oversee the following newly created and existinginstitutions for research and development.

- Philippine Council of Industry and Energy Research and Development(Existing)
- Philippine Council of Agriculture and Forestry Research and Development (Created)
- Philippine Council for Health Research and Development (Existing)
- Philippine Council for Aquatic Marine Research and Development (Created)
- Philippine Council for Advanced Science and Technology Research and Development (Created)
- Industrial Technology Development Institute (Created)

[32]Office of the President .1976., *"Creating the National Academy of Sciences".* Retrieved from: https://lawphil.net/statutes/presdecs/pd1976/pd_1003_1976.html

[33]Office of the President .1981., *"Establishing the Research Institute for Tropical Medicine",* Retrieved from: https://lawphil.net/executive/execord/eo1981/eo_674_1981.html

[34]Office of the President .1975., *"Declaring a Balik-Scientist Program, Allowing Any Foreign-Based Scientists, Professional, Tecnicial, or Any Person With Special Skill or Expertise Who is of Filipino Origin or Descent to Practice His/Her Profession or Expertise in the Philippines and Aligning incentives for Him/Her and For Other Purposes",* Retrieved from: https://www.lawphil.net/statutes/presdecs/pd1975/pd_819_1975.html

[35]Office of the President .1987*., "Reorganizing the National Science and Technology Authority",* Retrieved from: https://www.officialgazette.gov.ph/1987/01/30/executive-order-no-128-s-1987/

- Philippine Nuclear Research Institute (Created)
- Food Nutrition Research Institute (Existing)
- Forest Products Research and Development Institute (Existing)
- Philippine Textile Research Institute (Existing)
- Advanced Science and Technology Institute (Created)
- Science Education Institute (Created)
- Science and Technology Information Institute (Created)
- Technology Application and Promotion Institute (Created)
- Philippine Atmospheric, Geophysical, and Astronomical Services Administration (Existing)
- Philippine Institute of Volcanology and Seismology (Existing)

Aquino, supported the S&T regimes and promotes it as a tool for economic recovery as part of the regime's top three priorities under the Philippine Development Plan 1987-1992[36]and formed aspecial department dedicated to focusing on the S&T masterplan until the year 2000 however faced headwinds with increasing internal political turmoil and dwindling support from congress. Funding for S&T was increased but was affected by the financial crises that put more pressure on the government which led to the abolishment of the "Philippines Investors Incentive Act" as part of their austerity efforts.

[36]National Economic Development Authority .nd., "Philippine Development Plan", Retrieved from: http://pdp.neda.gov.ph/devt-plans/

Fidel V. Ramos (1992-1998)

On the early onset of globalization after the cold war, Ramos' leadership ushered transitionary changes toward regime transformation and reconfiguration. Domestically, Ramos initiated holistic advancement of government-aided initiatives from health, agriculture, and research for sustainable development on energy/ power and the environment. By also opening the economy and large-scale regime transition by the privatization of formerly state-owned companies and assets such as water and energy, the Ramos administration perceived that innovation and management of these resources are best left to private corporations because of the bureaucracy that may impede its efficiency and growth.

Under the Ramos administration, the regime boosted efforts and rural development with the Science and Technology Agenda for National Development and the signing of the "Magna Carta for S&T Personnel[37]"which helps in fostering talents and manpower for S&T that were empowered with the Marcos and Aquino S&T policy focus. On the contrary, the Ramos administration answered the call for energy security which was one of the problems of the

[37]Congress of the Philippines .1997., "*An Act Providing a Magna Carta for Scientists, Engineers, Researchers and Other Science and Technology Personnel in the Government",* Retrieved from: https://lawphil.net/statutes/repacts/ra1997/ra_8439_1997.html

Aquino government[38]with the organization Department of Energy[39]to reorganize the energy sector with the "Department of Energy Act of 1992.

Continuing the initiative of Marcos and Aquino, Ramos expanded S&T scholarships with the "Science and Technology Scholarship Law of 1994[40]"to further push S&T into public education and re-established the "Inventors and Inventions Incentives Act" after it was stopped under the Aquino administration to aid in austerity efforts to curb government spending. Finally, Ramos also reinforced intellectual property with the "Intellectual Property Code of the Philippines[41]" and improves on the safety nets given to innovation pioneers and companies who pursue novel scientific pursuits.

Joseph Estrada (1998-2001)

Following Ramos' rule in the 90s, Joseph Estrada started his career as Mayor and then became Senator. Estrada's S&T agenda was not substantial and did not show a clear political will to push for research and development. Rife with scandals and corruption issues, Estrada's populist rule was cut short following public protests and a call for impeachment, later to step down as president after fervent public clamor. Estrada's only contribution was the protection of the interests of businesses with the "Electronics Commerce Act of 1999[42]" which outlawed hacking.

Gloria Macapagal-Arroyo(2001-2010)

Macapagal took over Estrada's shortened tenure as president and won a controversial re-election in her almost-decade reign. With the economy in the doldrums, Arroyo tackled long-entrenched insurgencies, questions about charter change, and a post-9/11 scenario that has drastically altered international relations. Given the challenges during her tenure, Arroyo was able to revitalize the economy through infra-based pump priming with support from S&T and local markets. Having been able to be in leadership for a second term, Arroyo was also able to establish and institutionalize councils in response to growing concerns such as disaster resilience and climate change.

[38]"Brownouts Darken Outlook for Aquino : Philippines: Power Outages Cripple Industry and Snarl Traffic. Criticism Has Focused on the President." *Los Angeles Times*, Los Angeles Times, 24 Apr. 1990, https://www.latimes.com/archives/la-xpm-1990-04-24-mn-336-story.html.

[39]Congress of the Philippines .1992., *"Department of Energy Act of 1992".* Retrieved from: https://lawphil.net/statutes/repacts/ra1992/ra_7638_1992.html

[40]Congress of the Philippines .1997., *"Science and Technology Scholarship Act of 1994"*, Retrieved from: https://lawphil.net/statutes/repacts/ra1997/ra_8248_1997.html

[4141]Congress of the Philippines .1997. "*Intellectual Property Code of the Philippines",* Retrieved from: https://www.lawphil.net/statutes/repacts/ra1997/ra_8293_1997.html

[42]Congress of the Philippines .2000., *"Electronic Commerce Act"*, Retrieved from: https://www.officialgazette.gov.ph/2000/06/14/republic-act-no-8792-s-2000/

Arroyo's contribution to S&T was with her pioneering "One Town, One Product" national initiative to fund local products and MSMEs that focus on identified products of value within municipalities which was first implemented in 2001. Further emphasizing Macapagal-Arroyo's strategy, her regime pushed for the National Science and Technology Plan 2002-2020[43]through the DOST that emphasizes the areas of health, biotechnology, microelectronics, information and telecommunications, aquaculture and fisheries, materials science, engineering, processing and manufacturing to bolster S&T and market synergies for development. Coinciding this was the passing of the "Biofuels Act of 2006[44]", promoting the research, development, and use of biofuels in the country which reinforces the call for more sustainable sources of power and energy. Furthermore, the "Climate Change Act of 2009[45]" in response to the call to address the growing problem posed by extreme weather conditions brought upon by climate change as well as the National Disaster Risk Reduction and Management Council[46] as an interagency body in coordinating and managing matters on disaster risk and reduction recovery under the Department of National Defense (DND). To support the next generation, the National Science Complex, and Incubation Park in 2006[47]as a hub for science and technology in the country.

Benigno Aquino III (2010-2016)

Experiencing renewed interest from investors, the Philippines has accelerated its economic boom during the Aquino leadership marking a turning point for the country. However, his leadership was bombarded with controversy just as his predecessors with often diverging and inconsistent focus on S&T development while leaning towards solving the long-entrenched problem of corruption within the government ranks.

Aquino continued the "One Town, One Product" after it was discontinued in the late years of the Arroyo administration due to its projected project lifespan. Under the Aquino government, the S&T strategy was diversified with the development of fishing and farming sectors by endorsing its mechanization

[43]Department of Science and Technology .2002., *"National Science and Technology Plan 2002-2020",* Retrieved from: http://www.nscb.gov.ph/statref/pub_info.asp?call_no=NSTP+2002-2020

[44]Congress of the Philippines .2007*., "Biofuels Act of 2006".* Retrieved from: https://www.officialgazette.gov.ph/2007/01/12/republic-act-no-9367/

[45]Congress of the Philippines .2009., *"Climate Change Act of 2009".* Retrieved form: https://lawphil.net/statutes/repacts/ra2009/ra_9729_2009.html

[46]Congress of the Philippines .2009., *"Philippine Disaster Risk Reduction and Management Act of 2010".* Retrieved from: https://www.officialgazette.gov.ph/2010/05/27/republic-act-no-10121/

[47]Office of the President .2006., *"Establishing the National Science Complex and Technology Incubation Park in the University of the Philippines Diliman".* Retrieved from: https://www.officialgazette.gov.ph/2006/12/08/executive-order-no-583-s-2006/

and automation using renewable sources of energy[48]. To provide an additional boost to government projects the Aquino administration relied heavily on Build-Operate and Transfer projects which were later renamed to Public-Private Partnerships[49] that tap investments from the private sector.

Further down his leadership, there was a shift to modernize the education sector with the move towards the K-12 education system in line with global standards with focused strands on business, science, and humanities[50] as well as supported the education by prioritizing entrepreneurship through the "Youth Entrepreneurship Act"[51]. In tandem with the support for education is the reorganization of the Department of Transportation and Communication (DOTC) to decouple its communications arm and create a new department now known as the Department of Information and Communications Technology to improve telecommunications delivery and oversight in the country.

Rodrigo R. Duterte (2016-2022)

Duterte and his administration's national science policy strategy had a promising start but eventually faded to obscurity also due to externalities such as the COVID-19 pandemic as of this writing in 2021. His administration also leaned heavily towards infrastructure pump-priming through "Build, build, build" to help jumpstart the local economy and improve public infrastructure across the country. Though faced with a black swan event such as the COVID-19 pandemic, there were still notable achievements under his current leadership despite the challenges the administration has faced.

The banner of the Duterte admin in its S&T policy is the spearheading of the Philippine Space Agency in 2019 through the "Philippine Space Act of 2018. Under Duterte, it was also the return of the "Balik Scientist Law[52]" which is a rehash of the "Balik-Scientist Program" under the Marcos Regime as well as revitalizing the "One Town, One Product" program from the past administrations that continue to help local markets to find their niche.

[48]Congress of the Philippines .2012., *"Agricultural and Fisheries Mechanization .AFMech. Law",* Retrieved from: https://lawphil.net/statutes/repacts/ra2013/ra_10601_2013.html

[49]Office of the President .2015., *"Reorganizing and Renaming the Build-Operate Transfer .BOT. Center to the Public-Private Partnership Center of the Philippines and Transferring its Attachment from the Department of Trade and Industry to the National Economic and Development Authority and for Other Purposes".* Retrieved from: https://ppp.gov.ph/wp-content/uploads/2015/01/ExecutiveOrderNo8.pdf

[50]Congress of the Philippines .2012., *"Enhanced Basic Education Act of 2013",* Retrieved from: https://www.lawphil.net/statutes/repacts/ra2013/ra_10533_2013.html

[51]Congress of the Philippines .2014. *"Youth Entrepreneurship Act",* Retrieved from: https://www.lawphil.net/statutes/repacts/ra2015/ra_10679_2015.html

[52]Congress of the Philippines .2017., *"Balik-Scientist Act".* Retrieved from: https://www.lawphil.net/statutes/repacts/ra2018/ra_11035_2018.html

Tradition and Tragedy of Innovation Policy in the Philippines

Post-World War II, the Philippines was in a period of rebirth after being subjected to being the main battleground in the pacific. Because of this, institutions must start from scratch, with little to continue and advance, the new republic opted to emulate the institutional design of the Americans. In having a democratically elected leader, three main branches of the government, and a bicameral house under a single constitution, the newly created system hopes to ensure representation and equal distribution of power with effective checks and balances.

Theoretically, democracy is only as strong as its institutions, and specifically, S&T history post WWII in the Philippines has not fully matured since it was hastily created after the war because of the weakness of its S&T institutions that lacked continuity through the various regimes that ruled the Philippines.

Legend:

1. Experimentation and upscaling by entrepreneurs
2. Knowledge development
3. Knowledge diffusion
4. Guidance of the search
5. Market formation
6. Resource mobilization
7. Creating legitimacy

	1	2	3	4	5	6	7	Score
Roxas	Y	N	N	N	N	Y	Y	3/7
Quirino	Y	N	N	N	N	Y	Y	3/7
Magsaysay	Y	N	N	N	N	N	Y	2/7
Garcia	N	Y	Y	Y	N	Y	Y	5/7
Macapagal	N	N	N	N	N	Y	Y	2/7
Marcos	Y	Y	Y	Y	Y	Y	Y	7/7
C. Aquino	Y	Y	Y	Y	Y	Y	Y	7/7
Ramos	Y	Y	N	Y	N	Y	Y	5/7
Estrada	N	N	N	Y	N	N	Y	2/7
Macapagal-Arroyo	Y	Y	Y	Y	Y	Y	Y	7/7
B. Aquino III	Y	Y	N	Y	Y	Y	Y	6/7
Duterte	N	N	Y	Y	Y	N	Y	4/7
Total	8/12	6/12	5/12	8/12	6/12	10/12	12/12	

Table 1. Innovation Systems Function Per Regime

Notably, after the war, the concentration and focus of S&T were guided by the executive branch and the President's agenda. Because politics in the Philippines is more personalistic than party-dominated, political agendas can vary greatly with each change of leadership. Exemplifying this will be the table which shows, in brief, what the central S&T focus with each Philippine President after WWII and how it was shaped by not only domestic factors but as well as political, economic, and technological shifts in various forms and magnitude. The innovation system in this research is understood and assumed to be a product that is from multi-actor, multi-sector, and multi-causal variables. The emergence of innovation and the speed of technological change is continually reinforced, promoted, and in some cases curtailed or diverted due to eventualities and unexpected changes.

Analyzing the innovation system policies from the onset of post-war rehabilitation to the present day shows the thematic differences and shared characteristics in innovation policy-making among regimes. It is found that political regimes and their inclination towards S&T policy preferences are influenced commonly by economic pursuits for growth and development for all presidents. It is important to pinpoint that it was Garcia's groundbreaking "Science Act of 1958" that shaped and enabled the mold of institutions for succeeding regimes. With this focus, Garcia was able to start the development of the national innovation agenda and therefore creating the first significant institutional push in addressing the lack of S&T

development toward a functioning national innovation system.

From the table, the game-changers in innovation who were able to embody innovative foresight and had major contributions to the development of the Philippines' innovation system can easily be identified. The contributions of Marcos, C. Aquino, and Arroyo in including S&T as part of the core economic agenda were critical turning points that have vast influences on the public scoring a perfect score in all innovation system functions. Being able to layout the foundations of innovation functions improved the continuous advancement of S&T policy and capacity in the country. Identified across the front-runners is their willingness to support and enable entrepreneurs, develop knowledge by supporting research, and development initiatives by recalibrating and creating agencies to evolve alongside societal needs. Also, the innovation-centric regimes were willing to mobilize key resources to develop talent, diffuse innovation, and bolster the industry.

Mid-tier innovation regimes such as that of Aquino (6/7), Garcia (5/7), and Duterte (4/7) have played critical roles in supporting the innovation regime but did not accomplish all the necessary functions to be considered champions of innovation in the Philippines. For Aquino, it was about the integration of market forces with innovation by continuing Arroyo's "One Town, One Product" for both and the promotion of sectoral synergies with "Public-Private Partnership" for B. Aquino. Duterte directly mirrors Aquino's innovation emphasis with his large-scale infrastructure projects under "Build, build, build" and also continuing the "One Town, One Product" initiative. Another project that Duterte was able to revive was the "Balik Scientist Program" which was first seen under the Marcos regime. Garcia, however, separates himself from both by being able to solely influence the country's innovation pathway with his landmark "Science Act of 1958".

Tier three leaders were composed of Roxas (3/7), Quirino (3/7), Magsaysay (2/7), Macapagal (2/7), and Estrada (2/7). The lowest cohort is populated mostly by the immediate regimes after the war with only Estrada coming from the post-Marcos era. Roxas as the first Philippine president after the war was concentrating on reconstruction efforts while Quirino's regime emphasized social services. Magsaysay was pre-occupied with providing support to farmers and galvanizing regional alliances as well as the tragedy of his regime being cut short he also shares with Roxas and his successor Quirino as well as Estrada who stepped down after growing public clamor and an impeachment case. Estrada also did not fare well in harnessing innovation functions with minimal policy impact on contributing to the national innovation system and its functions.

The Conundrum of State Capacity and Policy Action

From where the country stands today, the national innovation system agenda

and its functions have yet to reach their full potential. From the generated table based on the policy progression from each regime, there it can be drawn which innovation functions were prioritized by the former regimes and which were. This enables us to infer a deeper understanding of what functions should be improved and strengthened.

The highest innovation function present in all regimes is the creation of legitimacy that underscores and acknowledges the importance of people's organizations on the innovation pathway. The Philippines being a democratic country has been reaping the benefits of a strong society that is free to pursue its interests, ideals, and beliefs. Throughout the regimes, it is the only constant in all presidents by giving ample voices to interest groups and movements on S&T.

Placing on the second tier are functions on resource mobilization (10/12), the guidance of the search (8/10), and upscaling of entrepreneurs (8/10). Having the power to funnel resources, regimes were able to mobilize resources to much-needed areas of development. Public funds were allocated to sectors such as knowledge development and transfer as well as access to capital that helps entrepreneurs, therefore, aiding other functions of innovation. Philippine leaders were also influential in creating institutions that guide innovation trajectories with the establishment of councils, and partnerships with the academic sector. Finally, by giving financial support and incentives, entrepreneurs were able to pursue projects that add to the development of the innovation ecosystem.

The Areas of development on innovation function fall into the category of knowledge development (6/12), knowledge diffusion (5/12), and market formation (6/12). The third cohort shows the areas of importance the Philippines must focus on in improving the current innovation system. Throughout all the administrations discussed, education is the least emphasized and improved with only notable emphasis from Marcos, C.Aquino, Ramos, and B.Aquino III. The erratic support for education has only crippled the momentum of forming the talent bank for local S&T development. Diffusion of knowledge also fell behind with minimal effort across the regimes to improve knowledge transfer and sharing with other nations or institutions. Most troubling is the failure of the regimes to push for market formation as part of the national innovation agenda. Without the exposure of innovations to the market, value cannot be achieved which could impact national economic development. Developing products, supporting local businesses, and setting the safety net for innovators are proving to be elusive from administration to administration.

Solving the S&T Innovation Puzzle

The study suggests that the pathway toward improving state capacity in the Philippines remains to be a great task. This research cites three major problems

that are hereby identified as important facets that need intervention through public policy intervention.

Overall the first overarching problem is due to the inconsistency and lack of continuity across regimes, the national innovation strategy is left hanging and wanting for reforms. Indications of the obstacles to national S&T capacity growth and capacity building are due to the lack of consistent state support and these can be seen in the functions of innovation systems in guidance for the search and creating legitimacy. Past administrations are found to lack continuity because of varying political targets and agendas weakening its influence on guiding innovation and galvanizing policies to reinforce the national innovation system. Because the Philippines lack strong political parties, platforms by administrations lack the important ideologically driven policy direction and are more personalistic and reactive therefore impede the development of the national innovation system and its functions. Without a clear long-term and unified national innovation agenda to reconcile and aid all innovation functions, the Philippines will remain to be a laggard in innovation as its neighbors are now progressing and starting to reap the benefits from their efforts.

The second obstacle is the absence of inter-agency coordination andsupport. The institutional design of S&T institutions needs a drastic overhaul to streamline R&D processes, support, and coordination. The DOST needs to elevate the status of its attached agencies by initiating knowledge development and diffusion which was shown in this study as the three innovation functions that need to be improved at the institutional level. Strengthening ties with universities, private institutions, and niche-level innovation actors such as start-up communities and inventors will vastly improve these tasks with emphasis on another innovation function which is resource mobilization. By helping in enabling the education and S&T sectors with the needed resources through manpower, and finance, among others, the Philippine national innovation system will build on its future capacities by investing in education.

Lastly, market support is lagging which is key in creating value from S&T development. Market formation and upscaling of entrepreneurs as a part of innovation systems cannot be overlooked. Policies should be lobbied and pursued to provide the necessary legal, financial, and institutional safety nets for innovation to prosper. The lack thereof will prevent individuals and groups to take necessary risks to pursue novel ideas for the sake of advancing S&T. Market formation can only happen when entrepreneurs can form the networks and communities to harness knowledge diffusion and capacity building which can only happen once the right policy interventions are put into effect. Once these are achieved, it will be possible for the state to gain the economic benefits of S&T development in pursuit of national interest.

CONCLUSION AND RECOMMENDATIONS

Currently, the Philippines is still having an underwhelming S&T initiative. Moreover, it is without a doubt that the Philippines is still running without a rudder in their S&T development with the lack of focus and political will from the leadership. There are instances of growth and promise through the decades but, have yet to be utilized fully to create a significant impact on national growth and development. The manifestation of innovation lock-in due to the lack of agenda continuity and its effect on S&T indicate the long-term effect of political transitions without the base of stability that can be had with strong party affiliations and institutions. Adherence to political ideologies and identities has created a policy identity quandary on S&T development which to this day has not been addressed by the various administrations. Erratic S&T support has made the trajectory of the national innovation system into gridlock with minimal development from the time of Marcos until the present day.

In the post-WWII world, the Philippines remain ail from the lack of setting the right foundations for ideological and societal transformation that are needed for S&T development; the Philippines remain without an identity and only the right public policy intervention can make the functions of innovation systems work in realizing a robust national innovation system.