# Examining Processes in Research and Development at the Department of Science and Technology

Jose Ramon G. Albert, Ph.D., Donald B. Yasay and Raymond E. Gaspar

**June 2015**

# Table of Contents

## List of Tables and Figures

**Table**



**Figure**

## List of Acronyms

| | |
|---|---|
| AHP | Analytic Hierarchy Processes |
| ASEAN | Association of South East Asian Nations |
| ASPBI | Annual Survey of Philippine Business and Industry |
| ASTI | Advanced Science and Technology Institute |
| DA | Department of Agriculture |
| DBM | Department of Budget and Management |
| DOST | Department of Science and Technology |
| FNRI | Food and Nutrition Research Institute |
| FPRDI | Forest Product Research and Development Institute |
| GAA | General Appropriations Act |
| GDP | Gross Domestic Product |
| GIA | Grant-in-Aid |
| HEIs | Higher education institutions |
| ITDI | Industrial Technology Development Institute |
| M&E | monitoring and evaluation |
| MIRDC | Metal Industry Research and Development Center |
| NOAH | Nationwide Operational Assessment of Hazards |
| OECD | Organization for Economic Cooperation and Development |
| PAGASA | Philippine Astronomical, Geophysical and Atmospheric Services Administration |
| PHIVOLCS | Philippine Institute for Volcanology and Seismology |
| PNRI | Philippine Nuclear Research Institute |
| PTRI | Philippine Textile Research Institute |
| R&D | Research and Development |
| RDIs | R&D institutes |
| S&T | Science and Technology |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| ZBB | Zero-based budgeting |

# Examining Processes in Research & Development at the Department of Science and Technology (DOST)

Jose Ramon G. Albert, Ph.D., Donald B. Yasay and Raymond E. Gaspar[1]

## Abstract

Research and development (R&D) activities have long been recognized as one of the critical components to improve a country's productivity and competitiveness as well as people's well-being. Notable advancements in agriculture (for the development of new variety of crops), health (to improve nutrition and combat various diseases), industry (to develop new products and services), as well as in climate change adaptation and mitigation are products of R&D.

The DOST, chiefly through Sectoral Councils and R&D performers, has been successfully undertaking or supporting a considerable share of R&D activities in the country, while noting limited resources available. However, there is a need to improve the thrust for R&D, which may require the conduct of an R&D summit to finalize the scope of government's R&D medium and long-term agenda. The DOST also needs to re-examine the distribution of GIA funds to RDIs and identify breakdowns of R&D funding for basic research, applied research, and development. The DOST may need to pilot test scientific methods, such as Analytic Hierarchy Processes (AHP) for selection of R&D proposals for funding by its sectoral councils.

Equally important is the need to strengthen the Department's monitoring and evaluation of R&D activities, and set up mechanisms to determine whether expected outcomes of projects, particularly physical and financial accomplishments, have been completed, partially completed, or not completed. There may also be value in having routine independent third party monitoring across DOST to complement in-house monitoring. Budgets manager will need to re-think "one-size-fits-all" strategies that have led to underspending in R&D.

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## I. Background

Policymakers and researchers are recognizing that research and development (R&D) is a critical component for improved productivity, competitiveness and well-being. In addition, it has a potential to address some global challenges on climate change and public health.

The 1987 Philippine Constitution espouses the vital role of R&D in economic development. It even stipulates provision of incentives to further encourage participation in R&D activities, especially from the private sector. Government has specifically provided these incentives to the private sector. In the Philippines, R&D is meant toward improving productivity in some sectors of the economy, notably in agriculture (for the development of new variety of crops that can withstand undesirable weather conditions), health (to improve nutrition and combat various diseases), and industry (to develop new products and services). In private businesses, R&D activities are typically geared toward directly developing new products, or into applied research in scientific or technological fields that may facilitate future product development. In some countries, such as the United States, Russia, and China, R&D is also into sectors, such as national defense (to develop new weapons), energy (to create new and alternative sources of energy), and even space exploration.

In this paper, we examine R&D programs, activities and projects of the Department of Science and Technology (DOST)[2], the government institution responsible for the coordination of science

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[2] The DOST, established in 1958 by Republic Act No. 2507 as the National Science Development Board (NSDB), was originally mandated to monitor the state of science and technology development in the country. In 1982, the NSDB got reconstituted by Executive Order 784 into the National Science and Technology Authority (NSTA). In 1987, the NSTA was elevated by Executive Order 128 into a full-fledged department to become the present-day DOST. The Department currently has a number of attached agencies to include (a) *Collegial and Scientific Bodies*, such as the National Academy of Science and Technology (NAST), National Research Council of the Philippines (NRCP); (b) *Sectoral Planning Councils*, such as the Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development (PCAARRD), the Philippine Council for Health Research and Development (PCHRD), the Philippine Council for Industry, Energy and Emerging Technology Research and Development (PCIEERD); (c) *Research and Development Institutes*, viz., the Advanced Science and Technology Institute (ASTI), the Food and Nutrition Research Institute (FNRI), the Forest Products Research Development Institute (FPRDI), the Industrial Technology Development Institute (ITDI), the Metal Industry Research and Development Center (MIRDC), the Philippine Nuclear Research Institute (PNRI), the Philippine Textile Research Institute (PTRI); and, (d) *Scientific and Technological Services*, such as the Information and Communications Technology Office (ICTO), the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), the Philippine Institute of Volcanology and Seismology (PHIVOLCS), the Philippine Science High School System (PSHS), the Science and Technology Information Institute (STII), the Science Education Institute (SEI), the Technology Application and Promotion Institute (TAPI), and the Technology Resource Center (TRC).

and technology-related projects in the country and for the formulation of policies and projects in the fields of science and technology in support of national development. The findings and recommendations of the study will serve as an input to the budget decision-making of the DBM particularly on zero-based budgeting (ZBB), and the DOST as well as other agencies that are engaged in R&D.

## II. Scope of R&D and Methodology for Assessment

While the term R&D often connotes new high-tech firms with cutting edge technologies, the Frascati Manual, that was prepared and published by the Organization for Economic Cooperation and Development (OECD) defines R&D in a much more broader sense: "any systematic and creative work undertaken in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this knowledge to devise new applications" (OECD, 2002). This definition has been subsequently adopted by various organizations associated with the European Union as well as the United Nations System, including the United Nations Educational, Scientific and Cultural Organization (UNESCO). This has also been used by countries in the conduct of R&D surveys. The Frascati manual classifies R&D activities into three:

- **Basic research** – any experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular or specific application or use in view.
- **Applied Research** - any original investigation undertaken in order to acquire new knowledge; it is directed primarily towards a specific practical aim or objective.
- **(Experimental) Development** - any systematic work, drawing on existing knowledge gained from research and/or practical experience that is directed to producing new materials, products, and devices, to installing new processes, systems and services, and to improving substantially those already produced or installed.

While studies on R&D and related matters have discussed the importance of R&D in the context of the rates of return to R&D investments (see, e.g., Cororaton, 1999), and the state of innovation activities in Philippine business and industry (Albert *et al*., 2011), we focus here on describing the processes for R&D activities at the DOST, the leading public institution that monitors R&D in the country. The process evaluation undertaken here focuses on the implementation of R&D in the DOST in fiscal years 2010-2013.

To examine overall processes undertaken within the DOST in formulating R&D activities, and to assess gaps between planned and realized outcomes, government expenditures on R&D, including grants provided to higher education institutions as well as private institutions, was firstly looked into. The 2011 (Frascati-based) Survey on R&D[3] conducted by the DOST, coupled with information on R&D expenditures obtained from the 2011 Annual Survey of Philippine Business and Industry (ASPBI) that was conducted by the Philippine Statistics Authority, provides an aggregated picture of R&D expenditures in the country. Gaps will be assessed by comparing the survey results to the allotted budget on R&D from all government agencies reflected in the GAA reports from the Department of Budget and Management (DBM).

Information was also secured from the DOST (in the websites of its R&D performers) regarding the 1,366 R&D projects implemented by DOST from 2010 to 2013. Initially, the researchers planned to make use of budget data to take a sample of some projects where the samples would be chosen with probability proportional to budget cost, and then request experts to evaluate these R&D projects. However, upon inspection of said information, while a standard format[4] was available for these R&D projects, project budgets was not always given in the available information. Consequently, given time constraints for the study, it was decided to focus on conducting key informant interviews of selected officials of the DOST and its R&D performers, examining DOST reports on its R&D agenda, accomplishment reports, and other available information to obtain knowledge on the processes for the selection of these projects, and monitoring of these R&D activities.

[3] As was pointed out in Estella (2013), the DOST has been measuring and monitoring in government and the higher education sector through its R&D Survey, which it conducted in 2002, 2003, 2005, 2007, 2009 and 2011, following the Frascati manual. The latest survey had for its population 981 institutions comprising 214 government agencies, 52 private non-profit institutions, as well as 715 higher education institutions. Among the latter, more than half (400) were public HEIs, while the rest (315) were private HEIs. The survey respondents included R&D consortia members of DOST sectoral councils, DOST-accredited S&T foundations, CHED-identified Centers of Excellence and Centers of Development, universities with research centers and previous respondents of past R&D surveys.

[4] The standard format include Program Title, Project Title, Project Objectives, Project Description, Project Start, Project End, Project Beneficiary(ies), Project Location(s), Project Accomplishments, Project Status, KRA Code, MFO No., PAP Code, DOST Priority Thrust, R&D Priority Thrust, Sector Total Project Cost (Budget), Program Leader, Project Leader, Project Staff, Funding Source, Implementing Agency, Cooperating Institutions, Monitoring Unit, Calendar Year Funded, PS, MOOE, CO, Total Project Cost, Date Released, Amount Released, Amount Previous, Years Releases, Amount GAA 2013, Amount GAA 2014, Amount GAS 2015, Amount GAS 2016, Total Released, Balance for Release, Savings, Budget Allocation, Budget Expenditures, Balance (Funds Available)

## III. Results of Assessment

Low R&D Intensity in the country

Available indicators reflecting the level of R&D activities across countries, viz., R&D expenditure-to-GDP ratio as well as the number of scientists, engineers and other professionals (relative to total population) involved in R&D activities show that the Philippines lags behind its peers in Association of South East Asian Nations (ASEAN), such as Singapore, Malaysia, Thailand and even, Viet Nam.

As far as the share of R&D expenditures to Gross Domestic Product is concerned (see Table 1), the ratio in the Philippines has been estimated at around 0.1%, which is much lower than the global average of 2.04% of GDP, and what UNESCO suggests developing countries must spend for R&D (1% of GDP).

**Table 1. Share of R&D Expenditures to GDP (%) among ASEAN economies: 2001-2012**

| Country | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brunei Darussalam | | 0.02 | 0.02 | 0.04 | | | | | | | | |
| Cambodia | | 0.05 | | | | | | | | | | |
| Indonesia | 0.05 | | | | | | | | 0.08 | | | |
| Lao PDR | | 0.04 | | | | | | | | | | |
| Malaysia | | 0.65 | | 0.60 | | 0.61 | | 0.79 | 1.01 | 1.07 | 1.07 | |
| Myanmar | 0.07 | 0.16 | | | | | | | | | | |
| **Philippines** | | **0.14** | **0.13** | | **0.11** | | **0.11** | | | | | |
| Singapore | 2.06 | 2.10 | 2.05 | 2.13 | 2.19 | 2.16 | 2.36 | 2.64 | 2.20 | 2.05 | 2.23 | 2.10 |
| Thailand | 0.26 | 0.24 | 0.26 | 0.26 | 0.23 | 0.25 | 0.21 | | 0.25 | | | |
| Vietnam | | 0.18 | | | | | | | | | | |

Source: World Bank Development Indicators

The Philippines underspends compared to Singapore (2.09%), Malaysia (1.07%), and Thailand (0.25%). In addition, while the ratio of R&D spending to GDP has been increasing in most of ASEAN, the spending ratio in the Philippines has remained practically the same.

Available human resources in conducting R&Ds in the country also show a rather bleak picture. Tables 2 and 3 show that in ASEAN economies, only Lao PDR (16 per million people) and Cambodia (18 per million people) have a lower aggregate number of researchers in R&D, compared to the Philippines (80 per million people). Even Viet Nam, as of 2002, has had more researchers (112 per million people), and Indonesia (92 per million people) is slightly ahead.

The Philippines does not even reach 10 percent of the average number of researchers across developing economies of East Asia and the Pacific (1020 researchers per million population).

**Table 2. Researchers in R&D (per million population) among ASEAN economies: 2001-2012**

| Country | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brunei Darussalam | | 286 | 277 | 282 | | | | | | | | |
| Indonesia | 202 | | | | | | | | 90 | | | |
| Cambodia | | 18 | | | | | | | | | | |
| Lao PDR | | 16 | | | | | | | | | | |
| Myanmar | 12 | 17 | | | | | | | | | | |
| Malaysia | | 293 | | 499 | | 368 | | 599 | 1065 | 1459 | 1643 | |
| **Philippines** | | | **71** | | **80** | | **78** | | | | | |
| Singapore | 4161 | 4381 | 4706 | 4882 | 5292 | 5425 | 5769 | 5742 | 6150 | 6307 | 6494 | 6438 |
| Thailand | 281 | | 281 | | 313 | | 324 | | 332 | | | |
| Vietnam | | 113 | | | | | | | | | | |

Source: World Bank Development Indicators

**Table 3. Technicians in R&D (per million pop'n) among selected ASEAN economies: 2001-2012**

| Country | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cambodia | | 13 | | | | | | | | | | |
| Myanmar | 77 | 132 | | | | | | | | | | |
| Malaysia | | 56 | | 63 | | 43 | | 68 | 71 | 130 | 158 | |
| **Philippines** | | | **11** | | **10** | | **11** | | | | | |
| Singapore | 357 | 383 | 403 | 465 | 528 | 519 | 501 | 588 | 549 | 461 | 465 | 462 |
| Thailand | 113 | | 204 | | 160 | | 143 | | 227 | | | |

Source: World Bank Development Indicators

The low number of researchers in the Philippines reflects the tendency of the educational system in the country to produce graduates outside of science and engineering, and this condition has hardly changed since one and a half decades ago (Cororaton, 1999), when a high percentage of doctoral degree holders were concentrated in social sciences, and not in the physical and applied sciences, engineering and technology, which tend to be the disciplines where R&D flourishes.

Limited resources for R&D

One can partly attribute the low R&D intensity with limited resources allotted for R&D activities both from the public and private sector, but the paper focuses on the public sector.

In 2011, the Philippine government spent around ₱2.1 billion for conducting R&Ds (see Table 4). This was 17.3 percent of estimated total R&D expenditures in the country, while the private sector accounted the bulk or 60.5 percent of total R&D expenditures.

**Table 4. R&D Expenditures (in million ₱) by Sector, 2011**

| Sector | Amount | Share to Total (%) |
|---|---|---|
| Government* | 2,081.96 | 17.3 |
| Higher Education* | | |
| Public | 2,064.72 | 17.1 |
| Private | 563.08 | 4.7 |
| Private Non-Profit* | 46.65 | 0.4 |
| Private Industry** | 7,289.28 | 60.5 |
| TOTAL | 12,045.69 | 100.0 |

Source: *DOST R&D Survey; ** NSO ASPBI Survey

Most R&D activities by higher education institutions are funded by the government through the Sectoral Councils of the DOST. Table 5 shows that more than half of total R&D spending of public HEIs were funded by the government. Government also granted R&D funds for private HEIs as well as private non-profit sector, i.e., ₱92 million and ₱12 million, respectively.

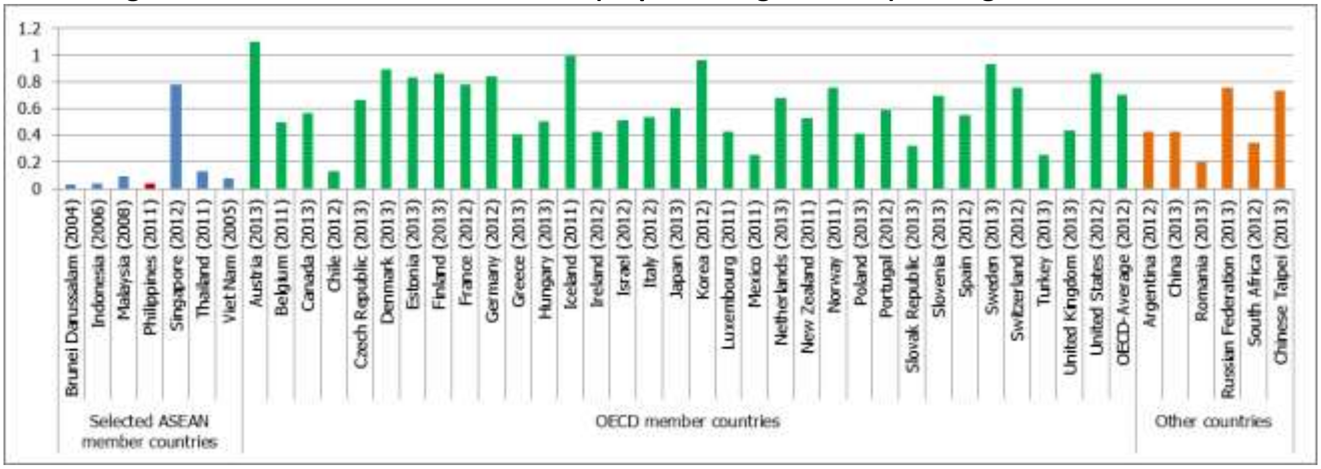
**Table 5. R&D Expenditures (in million ₱) by Funding Source and by Sector, 2011**

| Funding Source/Sector | Government* | Higher Education* | | Private Non-Profit* | Private Industry** |
|---|---|---|---|---|---|
| | | Public | Private | | |
| Institution's Own Funds | 957.73 | 241.43 | 310.53 | 13.79 | 7289.28 |
| Government Funds | 947.79 | 1202.82 | 92.37 | 12.45 | |
| Private Funds | 5.16 | 40.88 | 137.55 | 4.54 | |
| Foreign Funds | 72.24 | 334.72 | 12.99 | 15.69 | |
| Other Sources | 0.68 | 1.02 | 0.63 | 0 | |
| Not classified | 98.97 | 243.85 | 9 | 0.19 | |
| TOTAL | 2081.96 | 2064.72 | 563.08 | 46.66 | 7289.28 |

Source: *DOST R&D Survey; ** NSO ASPBI Survey

Despite own spending and grants for R&D activities, government-financed R&Ds (as percentage to GDP) in the Philippines is relatively low compared to other countries, but as can also be shown in the Figure 1, the ratio is close to other ASEAN member countries except Singapore.

**Figure 1. Government-financed R&D (as percentage to GDP) among selected countries**

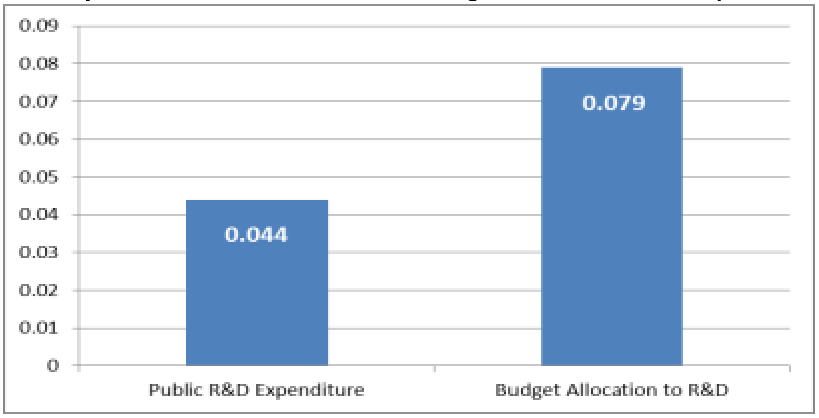



Source: DOST R&D Survey (Philippines), Indonesian Institute of Sciences (Indonesia), OECD Main Science and Technology Indicators (OECD-member countries), APEC-ISTI Database (Brunei Darussalam, Thailand, Malaysia and Viet Nam)

Actual R&D Budgets vis-à-vis estimated R&D Expenditures

After looking at estimated public expenditures on R&D based on the survey, it is equally important to compare those figures with the actual budget on R&D as reflected in Government Appropriations Act (GAA) 2011. Figure 2 shows that budget allocated for R&D in 2011 vis a vis the budget allocation on R&D. If the public R&D budget were the actual R&D expenditures of the government, it appears to be comparable with public R&D expenditures of Viet Nam and Malaysia, i.e., 0.08% (2008) and 0.09% (2005), respectively. However, they still fall short of desirable R&D expenditures.  In addition, it must be noted that budget figures are not fully comparable with survey results, which measures expenditures. The DOST will need to examine the extent of coverage of participants in the R&D survey.  What should be examined further is whether R & D activities are fully accounted for.  For instance, government has made much investments in DOST's Project Nationwide Operational Assessment of Hazards (NOAH).  How much of Project NOAH's expenditures are currently accounted for as R&D, and how much may not be?

**Figure 2. Expenditure and Allocated Budget on Public R&D (as % GDP), 2011**




Source: DOST R&D Survey and 2011 GAA (DBM website)

<u>Government or public research institutes as partners of firms towards innovation</u>

Table 6 (a) and (b) reflects the vital role of public R&Ds to enhance the innovative capacity of firms. Half of respondent manufacturing firms (a) considered the government and public research institutions their partners for innovation. Cooperation involves horizontal collaboration, with firms working jointly with public research institutions. Linkages, however, should be further improved. Only a handful of firms recognize the government or public research institutes as sources of knowledge, technology and innovation (Albert, *et al.*, 2011). As one of the major agents in the innovation system, which include government laboratories, universities, policy departments, regulators, competitors, suppliers and customers, the government needs to exert more effort in informing relevant stakeholders, such as firms, of the available information derived from public R&D activities.

**Table 6. (a) Cooperation partners and (b) Highly important sources of manufacturing firms towards innovation across selected economies**

(a)

| | Cooperation partner | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *Any type of co-operation partner* | Other enterprises within your enterprise group | Suppliers of equipment, materials, components, or software | Clients or customers | Competitors or other enterprises in your sector | Consultants, commercial labs, or private R&D institutes | Universities or other higher education institutions | Government or public research institutes |
| Brazil | *9.7* | 1.1 | 5.0 | 3.5 | 1.0 | 1.9 | 1.9 | n.a. |
| China | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| Colombia | *47.8* | 18.3 | 31.8 | 24.9 | 5.8 | 20.7 | 14.9 | n.a. |
| Egypt | *7.5* | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| Ghana | *n.a.* | 28.1 | 21.1 | 31.6 | 17.5 | 22.8 | 12.3 | 8.8 |
| Indonesia | n.a. | 37.8 | 66.3 | n.a. | 18.4 | 24.5 | 19.4 | 11.2 |
| Israel | *33.4* | 8.3 | 19.6 | 21.3 | 14.4 | 17.3 | 12.6 | 8.2 |
| Malaysia | *n.a.* | 65.5 | 55.1 | 56.1 | 30.0 | 84.0 | 45.0 | 37.0 |
| Philippines | *n.a.* | 91.2 | 92.6 | 94.1 | 67.6 | 64.7 | 47.1 | 50.0 |
| Russian Federation | *37.3* | 12.6 | 16.9 | 10.9 | 3.9 | 5.1 | 9.1 | 15.6 |
| South Africa | *33.0* | 14.2 | 30.3 | 31.7 | 18.6 | 21.1 | 16.2 | 16.2 |
| Uruguay | *n.a.* | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| EU-27 | *n.a.* | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| Eurostat min | *12.9* | 2.4 | 7.1 | 4.2 | 2.7 | 4.4 | 4.3 | 1.1 |
| Eurostat max | 56.2 | 23.0 | 41.5 | 36.0 | 30.8 | 33.9 | 30.8 | 26.3 |

(b)

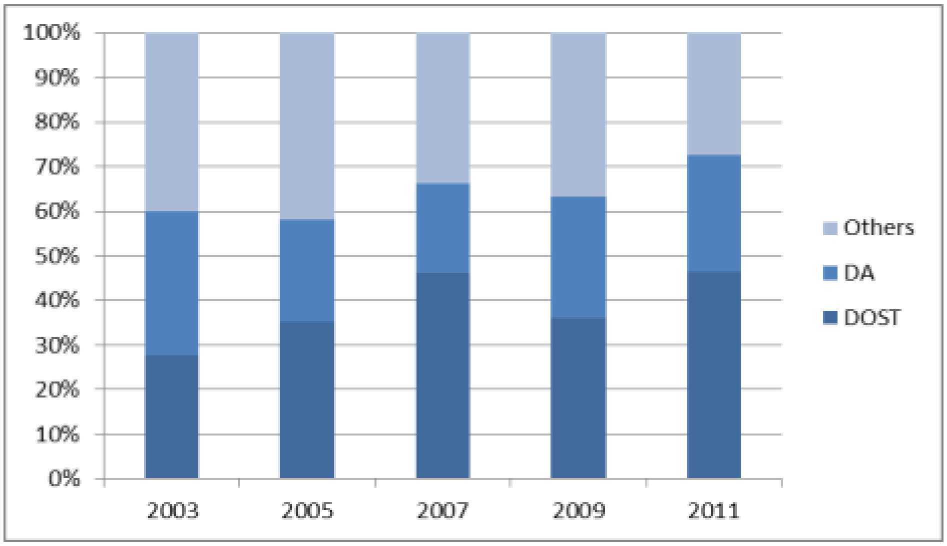
| | Sources of information | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Internal | Market | | | | Institutional | | Other | | |
| | Within your enterprise or enterprise group | Suppliers of equipment, materials, components, or software | Clients or customers | Competitors or other enterprises in your sector | Consultants, commercial labs, or private R&D institutes | Universities or other higher education institutions | Government or public research institutes | Conferences, trade fairs, exhibitions | Scientific journals and trade / technical publications | Professional and industry associations |
| Brazil | 10.0 | 38.3 | 46.0 | 22.7 | 10.8 | 6.3 | 4.9 | n.a. | n.a. | n.a. |
| China | 49.4 | 21.6 | 59.7 | 29.6 | 17.1 | 8.9 | 24.7 | 26.7 | 12.0 | 14.8 |
| Colombia | 92.2 | 40.7 | 51.0 | 34.1 | 30.0 | 16.7 | 10.8 | 49.0 | 43.0 | 21.6 |
| Egypt | 84.4 | 32.5 | 20.0 | 20.0 | 2.9 | 1.9 | 1.0 | 24.8 | 16.2 | 6.7 |
| Ghana | 43.9 | 29.8 | 35.1 | 17.5 | 5.3 | n.a. | 3.5 | 14.0 | 7.0 | 14.0 |
| Indonesia | 45.5 | 45.0 | 81.0 | 51.0 | 9.0 | 7.0 | 6.0 | 25.0 | 15.0 | 14.0 |
| Israel | 66.3 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 23.9 | 13.4 | 4.5 |
| Malaysia | 72.0 | 39.0 | 39.6 | 33.9 | 39.6 | 17.1 | 17.3 | 25.1 | 22.9 | 23.2 |
| Philippines | 70.0 | 49.5 | 67.0 | 37.9 | 21.2 | 10.1 | 7.1 | 21.7 | 16.7 | 15.7 |
| Russian Federation | 32.9 | 14.1 | 34.9 | 11.3 | 1.7 | 1.9 | n.a. | 7.4 | 12.0 | 4.1 |
| South Africa | 44.0 | 17.9 | 41.8 | 11.5 | 6.9 | 3.0 | 2.2 | 12.9 | 16.7 | 8.4 |
| Uruguay | 39.4 | 21.7 | 36.1 | 17.1 | 13.1 | 7.0 | n.a. | 16.5 | 14.1 | n.a. |
| EU-27 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| Eurostat min | 22.3 | 11.2 | 13.9 | 6.2 | 0.8 | 0.9 | 0.3 | 5.1 | 3.3 | 1.4 |
| Eurostat max | 85.3 | 71.1 | 41.8 | 36.8 | 25.7 | 8.8 | 7.8 | 59.7 | 27.0 | 21.2 |

Source: 2011 UNESCO Institute for Statistics pilot data collection of innovation statistics (http://www.uis.unesco.org/ScienceTechnology/Documents/Innovation-statistics-en.pdf)

Low R&D efforts towards agricultural productivity

Meanwhile, Figure 3 shows that from 2003 to 2011, among R&D expenditures for government institutions outside of public HEIs, between a fourth (27.8%) to about half (46.3%) goes to the DOST, and about a fifth (20.2%) to about a third (32.1%) goes to the Department of Agriculture (DA). Cororaton (2003) points out that in agriculture, while the ratio of budgetary outlay for price stabilization programs has been in the range of 10 percent, the total public expenditure for agriculture that has been allocated for R&D has been only around 5 percent. A future study examining processes at the DA may be worthwhile to undertake.

**Figure 3. Share of DOST and DA on Government R&D Spending, 2003, 2005, 2007, 2009, and 2011**




Source: DOST R&D Survey

Distribution of R&D expenditures within DOST

As regards DOST, a breakdown of the R&D expenditures in 2011 by R&D performers is provided in Table 7, which shows that the more than half of R&D expenditures at DOST goes to two agencies (ASTI and PHILVOCS), and about two fifth of the budget on R&D goes to three other agencies, viz., PNRI, ITDI and FNRI.

**Table 7. Share of R&D Expenditures in the DOST by R&D Performers, 2011**

| R&D Performers | Share to DOST R&D Expenditures (%) |
|---|---|
| 1. Office of the Secretary (OSEC) | 1.15 |
| 2. Food and Nutrition Research Institute (FNRI) | 7.49 |
| 3. Industrial Technology Development Institute (ITDI) | 13.03 |
| 4. Philippine Textile Research Institute (PTRI) | 1.92 |
| 5. Metal Industry Research and Development Center (MIRDC) | 0.90 |
| 6. Philippine Astronomical, Geophysical and Atmospheric Services Administration (PAGASA) | 4.47 |
| 7. Philippine Institute for Volcanology and Seismology (PHIVOLCS) | 21.95 |
| 8. Philippine Nuclear Research Institute (PNRI) | 16.55 |
| 9. Advanced Science and Technology Institute (ASTI) | 32.06 |
| 10. Forest Product Research and Development Institute (FPRDI) | 0.48 |

Source: DOST R&D Survey

Yielding outputs and outcomes with big impact to society

Despite the limited resources made available for R&D, the DOST has managed to identify relevant R&D projects with big impact to society, from starting up the email and internet infrastructure in the country in the late 1980s and early 1990s[5], to its recent establishment of the Project NOAH, a comprehensive disaster prevention and mitigation program tasked to: (a) create a 6-hour flood early warning system; (b) enhance geohazard maps. This flagship DOST project originally started with the NOAH website, a visualization tool to help disaster managers have a picture of an expectant weather disturbance. Currently, Project NOAH has expanded into the addition of nine sub-projects[6] into a common repository (website) that is accessible to all. Much of the improved preparation of government, and the people to climate hazards, has been attributed to the availability of near-real time information from the DOST, PAG-ASA and Project NOAH. A bulk of the scope of work in Project NOAH is clearly R&D, and will need continued support from government. The increases in budget for DOST for fiscal year 2015 are largely to finance Project NOAH, but it will be important for budget managers to understand how much of planned R&D activities at DOST will need to be supported.

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[5] Internet in the Philippines formally started in 1994 with the establishment of Philippine Network Foundation (PHNET), supported by DOST, which was conceived by computer buffs such as Glen Sipin of DOST, Arnie del Rosario and Richie Lozada, both of Ateneo de Manila University, Kelsey Hartigan Go of De La Salle University, and Rodel Atanacio and Rommel Feria of UP Diliman. This was pilot-tested and further had foundations from email gateways and services in 1990 to 1993.

[6] These nine sub-projects include (1) **UP DREAM Light Detection and Ranging Acquisition (LiDAR)** which involves the use of remote sensing data (by UP NEC) to generate high-solution topographic maps that are in turn used to develop hazard maps; this has a Flood Modeling Component that is responsible for the creation of Flood Maps; (2) **LANDSLIDE HAZARD MAPPING** (managed by UP NIGS), a low-cost, locally developed and sensor-based early monitoring and warning systems for landslides, slope failures, and debris flow that has relevance up to the barangay level; (3) **STORM SURGE HAZARD MAPPING** (of PAG-ASA); (4) **NOAH Weather Information-Integration for System Enhancement** (WISE) managed by UP MSEI that aims to enhance the weather predicting capabilities of PAGASA's current numerical weather prediction model High-Performance Computing (HPC) and smart analytics, to generate weather forecast seven days ahead; (5) **CLIMATE-X** (under Dr. Carlos Primo David) which translates Doppler data to forecast every 15 minutes the chance of rain, and the amount of rain that comes along with it whenever applicable; (6) **HYDROMET SENSORS DEVELOPMENT** which involves installation of automated rain gauges (ARG) and water level monitoring stations (WLMS) especially along the country's 18 major river basins (RBs) to provide a better picture of the country's surface water in relation to flooding by the Advanced Science and Technology Institute, which, to date, has established over 1,400 sensors throughout the country; (7) **THE INTELLIGENT OPERATIONS CENTER (IOC) FOR EMERGENCY MANAGEMENT** (under the DOST and headed by Dr. Carlos Primo David ) that aims to help government better manage ongoing and future disaster response and recovery efforts through an Integrated Communications Center (IOC) that provides emergency managers critical information such as advance warning for extreme weather events, feedback from first responders on the number of casualties and affected families, and conditions of buildings and infrastructure among others; (8). **STRATEGIC COMMUNICATION AND INTERVENTION** (under DOST's Science, Technology, and Information Institute ) that conducts Information, Education, and Communication campaigns for NOAH.; and, (9) **WebGIS FOR DISASTER MANAGEMENT** (under UP NIGS) that provides a visualization of all data coming from all the other sub-projects.

The DOST has also been implementing an outcome-based framework. The Sectoral Councils and RDIs have their respective R&D agenda and roadmaps aligned with DOST outcome-based framework. These agenda and roadmaps are products of wide consultations with various stakeholders.

Need to improve thrusts for R&D agenda

For the period 2013-2017, the DOST has prepared a "Harmonized National R&D Agenda" that is linked with the government's thrust for accelerating poverty reduction and inclusive growth. This agenda includes research themes revolving around the Resurgence of the Manufacturing Sector, Climate Change Mitigation & Adaptation Strategies, together with Disaster Risk Reduction that have been articulated in the Philippine Development Plan Midterm Update 2011-2016, the National Science and Technology Plan 2020, the Presidential Coordinating Council for Research and Development priority areas, and the National Unified Health Research Agenda and supports the President's five (5) Key Result Areas. Among the specific priority themes for this Harmonized National R&D Agenda include:

1. Agriculture and Food
2. Disaster Mitigation and Management
3. Environment and Natural Resources
4. Health and Health Products
5. Manufacturing
6. Biotechnology
7. Electronics
8. Energy
9. Information & Communication Technology
10. Nanotechnology

The Sectoral Councils take a centerstage in the implementation of R&D at DOST, and are tasked to address DOST's priority themes under the Harmonized National R&D Agenda in their respective fields.

While priority themes identified in the agenda have clear implications to economic development, the identification of key priorities for R&D could have been better developed if there were wider consultation with stakeholders, especially the scientific community, rather than an in-house development of the agenda. At the PIDS, a medium term Research Agenda is typically drafted by a three-person committee of research experts, who develop this agenda based on consultations with PIDS Fellows and other stakeholders in the policy research community.

In addition, mini-roadmaps for implementing R&D among specific R&D performers within the DOST, such as PNRI's R&D roadmap, have also been developed but to what extent these mini-roadmaps are synchronized to the harmonized agenda is unclear, and if processes are underway toward better top-down and bottom-up convergence of the DOST R&D agenda, and the R&D agendas of the various DOST Sectoral Councils.

DOST may benefit from improving its R&D Agenda by identifying with key R&D stakeholders and experts a list of topics and themes that are either not funded or under-funded by the private sector and government-sponsored R&D. The DOST can also work with academia and industry (and even those in the defense establishment) to link basic research with pressing applied problems, especially given the perception of business and industry that there is a lack of required expertise in academia for the pursuit of innovation activities (Albert *et al.*, 2011). For instance, one emerging and pressing problem faced in the national security sector pertains to risks on the external front and on cyber security. This clearly need R&D support.  Stakeholders need not reach a consensus, but they can work together with DOST to identify long term goals in R&D so that key problems are identified, and then DOST can advocate with budget managers who can allocate funds appropriately (especially given the current fiscal space), and decision-makers can understand current challenges, limitations and opportunities in R&D.

<u>Protocol for Grants-In-Aid Funds for R&D</u>

When R&D institutes (RDIs) and HEIs, mostly from the University of the Philippines System, and the state universities and colleges (SUCs), would be in need of funds, these are coursed through the DOST Special Projects Division (SPD), which, in turn endorses the R&D proposal to the appropriate Sectoral Council for evaluation and approval. The Sectoral Councils would either approve the proposal or find an appropriate funding agency within the DOST, and monitor the implementation of these approved R&D Projects.  The Sectoral Councils, which clearly take the centerstage in R&D at DOST, are guided by their specific R&D agenda which is aligned to the National R&D Agenda.

Information obtained from the Sectoral councils suggested that approved R&D proposals are subject to scrutiny from experts regarding scientific merit, and alignment to priority R&D agenda, and that in practice, duplication of R&D activities is avoided. In consequence, limited budgets made available to DOST are very effectively utilized to produce the expected R&D outputs.

Criteria for Assessing R&D Proposals

The DOST suggests that proposals on R&D projects/activities are selected by Sectoral councils based on the following evaluation criteria:

1. Capacity of the Proponent – competence to undertake the project based on experience, training, and track record.
2. Scientific Merit – commitment to create new knowledge or innovatively apply existing ones.
3. Feasibility – tenability of the undertaking both financially and technically.
4. Implementation Strategy – efficiency of design, methodology, or strategy in project implementation to attain objectives
5. Socio-economic Impact – potential to provide employment, increase income, generate foreign exchange savings, or address any current national problem.
6. Environmental impact – project should not have any adverse effect to the environment.
7. Timeframe – project duration should be within reasonable time limits.
8. Adopters – identification of potential adopters or co-funders of the developed technology
9. Utilization Plans – inclusion of plans on how the results will be utilized by the target end users.
10. Institution Capacity – commitment to upgrade S&T facilities and database infrastructures.
11. Cultural Sensitivity – adaptability of the project to Philippine culture and tradition.

Some of these criteria, e.g. utilization plans, socio-economic impact, seem to assume that most, if not all, R&D activities are development activities, with little focus on both basic and applied research. Basic research, in particular, often does not have a specific direct commercial/socio-economic impact. Such types of research are actually not intended to yield immediate profit, even in cases when they may be financially supported by the private sector, and these research activities may generally carry risk, and even an uncertain return on the investment or expense. Some of the most elegant mathematical research, for instance, is also undertaken because of its "beauty" and while such research activities may not have a specific application in improving productivity directly, yet they may have "spillovers" into an economy because the knowledge they produce may be useful not only to researchers in other fields, but also to businesses seeking to develop new products and production processes. However, information is scant on how much of budgets of total R&D expenditures go into the three tracks of basic research, applied research, and development.

It is also evident that some of the criteria above, e.g., socio-economic impact, environmental impact and cultural sensitivity, may occasionally be in conflict with each other, and it is unclear which is to be given priority over the other as there is no specific scientific methodology, such as Analytic Hierarchy Processes (AHP), useful in rating R&D proposals and making a final selection. The final selection of R&D projects relies on the concerned Sectoral Council decision. The decisions at the Sectoral Councils are collegial in nature. The Chair, as presiding officer, is not allowed to vote, except in case of tie. However, there is a need to examine whether other R&D themes, from traditional as indigenous knowledge and processes to advanced such as satellites and space technology, should be given more attention.

Need to Improve Monitoring & Evaluation of R&D Activities

The DOST SPD reportedly maintains a database of the projects approved for Grant in Aid (GIA) funding, although strictly speaking, not all GIA-funded projects are R&D activities. Currently, monitoring & evaluation (M&E) of R&D projects is decentralized. It would be ideal for the SPD database to have complete information, and for DOST's Planning and Evaluation Service (PES) to strictly examine the expected outcomes of R&D activities based on this SPD database. In addition, the database may need to be extended to R&D activities not supported by GIA funds, and to make all these databases available for transparency and for purposes of independent third-party evaluation.

Some third-party evaluation is currently being undertaken at DOST. For instance, PCAARRD hires technical experts to conduct M&E of its programs and projects, including DOST funded projects. This mechanism could be further enhanced and systematically made across all projects, especially those above a certain budget threshold.

Need for Clearer Rationale and Focus of RDIs and Research Councils

To efficiently allocate research grants and funds especially coming from the GAA, it is important for R&D performers to clearly define what market failures their R&D activities address. R&D activities, by their complex nature, should be managed and organized in order to solve pressing problems faced in the country. Unfortunately, right now, even some R&D institutes within the DOST do not clearly communicate what problems they try to address. While there are existing policies and Constitutional provisions centering on S&T (Sections 10-13) with the Philippine Development Plan also mentioning the importance of Science, Technology and Innovation, there should be a clearer communication of the idea why government should be investing in R&D activities, and in what specific R&D activities should we be investing on. Every sector, from education, to health, to defense, to transportation and communications, to tourism, requires more public spending. While government also need to invest more in R&D, these investments should have a clearer framework and articulation, so that whether or not more fiscal space is available, spending on R&D activities could be sustained.

## IV. Summary and Recommendations

The DOST has been successfully undertaking or supporting a considerable share of R&D activities in the country. The DOST, chiefly its Sectoral Councils and R&D performers, have developed R&D roadmaps, although the extent of synchronization and convergence of these roadmap need strengthening, including the identification of key thrusts, by involving wider consultation from R&D stakeholders, especially Science and Technology (S&T) experts, and representatives of the private sector.

The DOST and other government agencies that conduct R&D activities, together with the DBM, will need to conduct an R&D summit to finalize the scope of government's R&D medium and long-term agenda, and to improve the linkage of priority R&D activities with requirements of major industries and sectors. The DOST will need to re-examine its distribution of GIA funds within its R&D institutes, and advocate with DBM towards improved GIA funding. Although resources for R&D have been limited (with only less than 0.1% of GDP being spent on R&D throughout the country, and recently, a third of this is spent by government), DOST has managed to be effective in utilizing and harnessing meager resources made available for R&D.

The DOST may however need to identify breakdowns of R&D funding for basic research, applied research and development, and assess whether adjustments may be necessary in allocation of R&D funds. The current criteria used to evaluate R&D proposals that require GIA suggests that there may be more attention given to development activities than to basic and applied research. The DOST may need to pilot test scientific methods, such as Analytic Hierarchy Processes (AHP), for selection of R&D proposals for funding by its sectoral councils.

While the DOST has a standardized template of R&D activities supported by GIA, it appears that the centralized database of information on R&D activities has incomplete information, particularly regarding project budgets. The DOST will clearly need to strengthen its monitoring and evaluation (M&E) of R&D activities, and set up mechanisms to determine whether expected outcomes of projects, particularly physical and financial accomplishments, have been completed, partially completed, or not completed. There may also be value in having routine independent third party monitoring to complement in-house monitoring.

Resources for R&D have been scarce. The DBM will need to re-think its "one-size-fits-all" strategies that have led to underspending in R&D, especially given the current fiscal space and the government underspending that has slowed down GDP growth. While understandably, the DBM will need to ensure that money is well spent, it will also need to recognize that the track record of DOST and that the nature of R&D activities cannot always guarantee returns on all investments.

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