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Future S&T Human Resource Requirements in the Philippines: A Labor Market Analysis

Jose Ramon G. Albert, Ana Maria L. Tabunda, Carlos Primo C. David, Kris A. Francisco, Charlie S. Labina, Janet S. Cuenca, and Jana Flor V. Vizmanos

CONTACT US:

RESEARCH INFORMATION DEPARTMENT
Philippine Institute for Development Studies

18th Floor, Three Cyberpod Centris - North Tower
EDSA corner Quezon Avenue, Quezon City, Philippines

publications@mail.pids.gov.ph
(+632) 8877-4000

https://www.pids.gov.ph

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Jose Ramon G. Albert
Ana Maria L. Tabunda
Carlos Primo C. David
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Jana Flor V. Vizmanos

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Abstract

As vibrant actors in the innovation ecosystem, the S&T human resources of any country are crucial in developing, adapting, and introducing technological innovations across various sectors in the economy. Given the massive disruptions in business models emerging from the increasing use of emerging technologies of the Fourth Industrial Revolution, we expect corresponding consequences in the labor market and the nature of work. The government needs to ascertain the actual conditions surrounding the cultivation of S&T human resources in the country. This study aims to describe the prevailing supply and demand conditions, patterns and recent trends regarding S&T human capital in the Philippines by xamining secondary data from various data sources. Overall, the results show that although the scientific workforce constitutes only a minute share of the total workforce, and that the variegated occupations across S&T do not have uniform growth potentials as regards employment, both the government and the private sector need to support most of S&T disciplines, especially in the wake of new tasks from emerging technologies of the fourth industrial revolution. Despite an increasing demand for S&T resources and indicators on employability prospects, many of the young do not pursue and persevere in Science, Technology, Engineering and Mathematics (STEM) careers. Government and the private sector should be incentivizing them toward STEM even as early as junior high school. Providing financial assistance or scholarships can be helpful, but this alone may not be enough to produce the needed pool of future S&T human resources. Government is advised to also gain insights on various factors that affect the supply of S&T workers to craft necessary policies for incentivizing S&T graduates to persevere in their disciplines, and actively participating in the economy. The future appears favorable for engineers given our current level of productivity, technology, and projected growth. In contrast, the economy may not be able to accommodate the increasing supply of workers with Computing/IT background, although some if not many of those with computing skills may be accommodated in new jobs. Still, it may be prudent to substantially invest in S&T human resources, and provide supporting mechanisms to make our S&T human resources agile and our innovation ecosystem flourish.

Keywords: Science and Technology, human resources, innovation, labor market

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The Future S&T Human Resource (S&T HR) Requirements in the Philippines: A Labor Market Analysis

Jose Ramon G. Albert, Ana Maria L. Tabunda, Carlos Primo C. David, Kris A. Francisco, Charlie S. Labina, Janet S. Cuenca, and Jana Flor V. Vizmanos[*]

1. Introduction

If the Philippines is to have the ability to develop, adapt, and introduce technological innovations with agility across various sectors of importance, the development of human resources in science and technology (S&T)[1] and the capability building of relevant institutions must be at the top of the socio-economic development agenda. The role of S&T as a key driver of economic growth and development has long been recognized (e.g., Solow 1956; Swan 1956; Rothenberg 1974; Atkinson 1990). The country's S&T human resources are vital actors in the entire science, technology and innovation (STI) ecosystem. With disruptions in production and supply chains resulting from the increasing use of emerging technologies of the Fourth Industrial Revolution (FIRe), the increased globalization of labor markets is expected to result in new and different set of demands, opportunities and challenges in the S&T fields, especially in the next five (5) years (Dadios *et al*. 2018).

In its 2016 Report on "The Future of Jobs: Employment, Skills and Workforce Strategy for the Fourth Revolution", the World Economic Forum (WEF) suggests that disruptions across industries brought about by use of emerging technologies are re-configuring business models and demanding various skills sets for the workforce by 2020 (WEF 2016). This has been echoed in reports by the Asian Development Bank (ADB) and the World Bank (ADB 2018; World Bank 2019). Frontier and emerging technologies are getting more widely used across homes, schools, workplaces, in both urban and rural locales, and moreso amid the novel coronavirus (COVID-19) pandemic. These technologies are driving disruptions of our ways of doing things and and business, thus signalling the debut of the Fourth Industrial Revolution (FIRe) (Schwab 2016; Dadios *et al*., 2018).

Also known as Industry 4.0, FIRe is "characterized by a fusion of technologies that is blurring the lines between the physical, digital and biological spheres" (Schwab 2016). A recent scoping study conducted by the Philippine Institute for Development Studies (PIDS) further describes the emerging landscape of FIRe, and suggests ways that society can prepare for opportunities and risks brought about by these massive changes, and the crucial role of government in helping prepare society for what is to come (Dadios *et al*., 2018).

Without urgent and targeted actions today to manage the near-term transition as well as to build a workforce with future-proof skills, governments will have to cope with ever growing risks of technological unemployment and income inequality, and businesses with the possibilities of a

[*] The first author is a senior research fellow at the Philippine Institute for Development Studies (PIDS). Dr. Tabunda, Dr. David, Dr. Francisco, and Mr. Labina are PIDS consultants for this study while Ms. Cuenca and Ms. Vizmanos are supervising research specialist and research specialist, respectively, at PIDS. The views expressed here are the authors' own.

[1] *S&T Human Resource* refers to the group of professionals who have successfully completed tertiary education in the S&T field and/or those not formally qualified in this aspect but employed in an S&T occupation, where such qualifications are normally required (e.g., S&T professionals with non-S&T function and non-S&T professionals with S&T function).

shrinking consumer base. **Table 1** shows the comprehensive timeframe to impact industries, business models:

Table 1. Timeframe to impact industries, business models

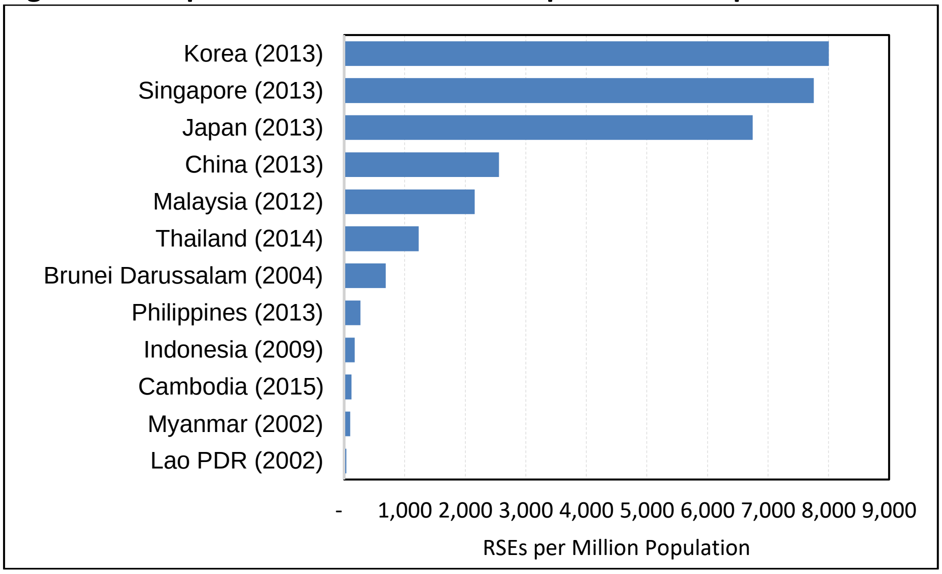
Impact felt already	2015-2017	2018-2020
• Rising geopolitical volatility	• New energy supplies and technologies	• Advanced robotics and autonomous transport
• Mobile internet and cloud technology	• The Internet of Things	• Artificial intelligence and machine learning
• Advances in computing power and Big Data	• Advanced manufacturing and 3D printing	• Advanced materials, biotechnology and genomics
• Crowdsourcing, the sharing economy and peer-to-peer platforms	• Longevity and ageing societies	
• Rise of the middle class in emerging markets	• New consumer concerns about ethical and privacy issues	
• Rapid urbanization	• Women's rising aspirations and economic power	
• Changing work environments and flexible working arrangements		
• Climate change, natural resource constraints and the transition to a greener economy		

Source: World Economic Forum, 2016

Given these scenarios, it is crucial for policy makers, educational institutions as well as current and future learners to anticipate the nature of future demands of the labor market arising from rapid changes in the world economy. According to Cirera and Maloney (2017) countries that are not in the frontiers of STI will find it challenging to implement catch-ups and leapfrogs since innovation requires complementary factors (including strong institutions, human capital, hard and soft infrastructure) that may not be present. While extra spending in Research and Development (R&D) can be helpful, but spending alone is not enough to ensure that a country is FIRe-ready.

In the Philippines, many barriers and bottlenecks are faced by firms as they try to innovate (Albert *et al*. 2017). The country faces challenges in advancing STI with only 2 out of 5 firms in the Philippines being innovation-active, as of 2015 (Albert *et al.* 2017). Part of the reasons for the lack of innovation is the low supply of research scientists and engineers in the country (see **Figure 1**). Furthermore, the country ranks 54th out of 129 economies in the 2019 Global Innovation Index (GII), an overall measure of the innovation climate (Cornell University *et al*. 2019). This rise in the global rank by 19 spots, is partly on account of methodological changes. Out of eight ASEAN member-states assessed with the GII, the country ranks fifth, behind Singapore, Malaysia, Thailand, Viet Nam, but ahead of Indonesia, Cambodia and Brunei. The specific components of the GII that give the Philippines a relatively low rank in innovation (compared to ASEAN member states) include our market sophistication, institutions, human capital, and creative inputs. The country persists in poorly performing regarding ease of starting a business, the regulatory environment (particularly cost of redundancy dismissal), ease of getting access to credit, ease of protecting minority investors. Further, the Philippines spends very low on the education sector (at less than 3 percent of GDP), and the country has had a low number of scientific and technical publications.

Figure 1. Comparison of Number of RSEs per Million Population across Selected Countries



Source: UNESCO Institute of Statistics (UIS)

Local studies conducted on the demands and supply of S&T workers in the country are scarce: the most recent study on the topic was conducted by the Department of Science and Technology-Science Education Institute (DOST-SEI) . This study, commissioned to UP Population Institute, UP School of Statistics, and the University of Asia & the Pacific, projected demands in the S&T human resource for the period 2000-2010 in the government, academe and industry sectors, respectively. On the other hand, the Jobsfits 2022 conducted by the Department of Labor and Employment (DOLE) focused on the demand side in the industry sector, particularly on the industry employment growth, potential investment in industries, in-demand skills and hard-to-fill occupations (local and international), new jobs and their skills requirements, including diminishing jobs. The data used in the study come from results of several rounds of the Labor Force Survey (LFS), conducted by the Philippine Statistics Authority (PSA). The LFS only provided the highest degree completed (e.g., HS Grad/College Grad/MS/PhD degree or unit holder) of members of sampled households. However, data on specific degree courses are not available. On the other hand, the Technical Education and Skills Development Authority (TESDA) which serves as the Philippines' Technical Vocational Education and Training authority has conducted the Skills Demand and Supply Mapping to generate much needed information on the skills requirements of industries as well as the availability of much needed skills in each of the provinces in the different regions in the country.

To address the research gap, the DOST-SEI commissioned the Philippine Institute for Development Studies (PIDS) to conduct of an integrated analysis of specific S&T HR requirements in the country using whatever global/regional/local data available to come up with a holistic picture of the S&T human resource requirements and to be able to recommend specific policies on S&T education. The latter include suggestions regarding the administration of S&T scholarship programs of DOST, as well as the absorption of S&T professionals to match their capabilities with the demands of the labor market. In this sense, this current study serves as basis in formulating strategies and providing policy directions regarding the country's

S&T human resource development efforts, cognizant of their implications for economic growth and development.

The research questions in the study pertaining to future demands on the labor market, particularly in S&T can help implementing agencies, the DOST-SEI, in particular, as well as supporting institutions in the education sector such as the Department of Education (DepED) and the Commission on Higher Education (CHED) to develop the supporting mechanisms for developing the country's S&T human resources. The research questions that the study intends to answer are as follows:

1. Given the many possibilities that could arise from FIRe, what policy frameworks are needed to enable government to become more responsive to meet the future S&T HR requirements of the country?
2. What specific interventions are needed to respond to the challenges, risks and opportunities posed by FIRe?
3. What strategies should the government, through DOST, take with regard to S&T education, especially in the administration of DOST scholarship programs and also, matching of capabilities of S&T professionals with the demands of the labor market?

In this light, the study aims to achieve the following objectives with focus on three sectors, namely, the government sector, private sector, and higher education.

General Objective:

To develop a comprehensive report on the future S&T job requirements in the Philippines to inform policy related to S&T Human Resource Development.

Specific Objectives:

1. To determine the specific S&T fields that are critical to the future job requirements of the various sectors;
2. To determine the specific S&T fields with high, medium, and low demand occupations;
3. To provide estimates on the number of professionals with advanced education on S&T needed by the various sectors;
4. To determine the factors affecting the changing demands and supply S&T human resource in the various sectors; and
5. To recommend policy interventions relative to the development of S&T human resources in the country.

Toward meeting the study objectives, this report is organized as follows. Section II reviews related literature, while Section III presents the data and methodology used in the study. Section IV provides an overview on the Philippine labor force based on available secondary data on jobs and education, sourced from population censuses and several rounds of the LFS. Section V estimates and discusses the future S&T HR requirements in the country, with focus on the government sector, private sector, and the academe. Section VI ends with conclusions and policy recommendations.

2. Review of Related Literature

Frontier technologies of FIRe can be powerful agents for good, but they can also lead to volatilities, uncertainties, complexities, and ambiguities (VUCA) as a result of disruptions in economic activities. Changes can unleash unintended consequences, such as technological unemployment, increased inequality from artificial intelligence (AI), erosion of personal privacy from the internet of things and big data, and weaponization of technology. Even in politics, trolls have become weapons for fake news to distract people from issues that matter.

One of the biggest concerns we all share about VUCA from FIRe technologies pertains to the vastly changing labor market and nature of work. There is growing anxiety about AI taking over jobs. In its 2019 World Development Report, the World Bank (2019) points out that such anxiety is not new; in 1589, Queen Elizabeth I of England was alarmed at the prospects of unemployment when clergyman William Lee applied for a royal patent for a knitting machine. The 2019 World Development Report also narrates that in the 1880s, the Qing dynasty fiercely opposed constructing railways in China, arguing that the loss of luggage-carrying jobs might lead to social turmoil.

In the next decade or two, over half (56%) of jobs across the ASEAN-5 (consisting of Cambodia, Indonesia, Philippines, Thailand, Viet Nam) are at high risk of getting automated (Chang and Huynh 2016). The same report points out that in the Philippines, women (more than men) workers, as well as workers with little or no education s, are more at risk from of getting affected by automation. Further, nine out of ten positions across the information technology-business process management sector are likewise at high risk of getting automated. Of course, high risk does not necessarily mean that those n these jobs will automatically lose their jobs, but at the very least, the nature of their work will change with repetitive tasks being taken away.

The main concern about unemployment caused by technological advancements is the effect on routine codifiable jobs. Several studies confirm that computers have superseded the functions of cashiers, telephone operator, bookkeepers, and similar routine codifiable jobs, over the past decades (Bresnahan 1999; MGI 2013). History, however, suggests that while technological innovations and inventions cause some disruptions, these likewise bring new opportunities.

Several studies look into the relationship between technological progress and labor market outcomes. For instance, Aghion and Howitt (1994) cite two ways in which technological progress affect employment opportunities: (1) as new technologies serve as a substitute for labor, workers are forced to reallocate their labor supply –this is referred to as the destruction effect; (2) higher productivity will encourage more industries, expanding employment opportunities for workers –this is referred to as the capitalization effect. Golden and Katz (2009) explain that workers are able to survive such changes in the labor market due to their ability to adapt and retrain themselves through education. Thus, we can conclude that technology has three possible effects on labor: (a) technology can substitute for labor; (b) technology can create new jobs; and, (c) technology can complement labor. The overall net effect of technology in a labor market depends on which of these three effects is strongest.

According to the Asian Development Bank (ADB), jobs created by rising domestic demand in developing Asia have compensated for job losses from automation in the period from 2005 to 2015 (ADB 2018). The same message has been pointed out in the 2019 World Development Report (World Bank 2019), which suggests that employment has grown stronger, in most countries, though in a few countries, such as the United States and a few other advanced economies, employment in industry has decreased.

As problem-solving and other soft skills become more desirable in business, it comes as no surprise that workers are investing in education to reskill, and develop new skills, thus explaining the growth in jobs involving cognitive tasks (Katz and Murphy 1992; Acemoglu 2002; Autor and Dorn 2013). An essential question to ask, however, is whether the technological progress in the 21st century will bring similar challenges and opportunities to the labor market, as it did in the previous decades. Recent findings reveal the weak performance of the labor market in advanced economies, causing researchers' concern about jobless growth to resurface (World Bank 2019; Brynjolfsson and McAfee 2011, McKinsey Global Institute 2011). Charles *et al*. (2013) and Jaimovich and Siu (2012) suggest that the high unemployment rates may be explained by the vanishing demand for routine jobs as well as the low demand for manufacturing employment, though the World Bank (2019) suggests this has been only limited to the US and a few advanced economies.

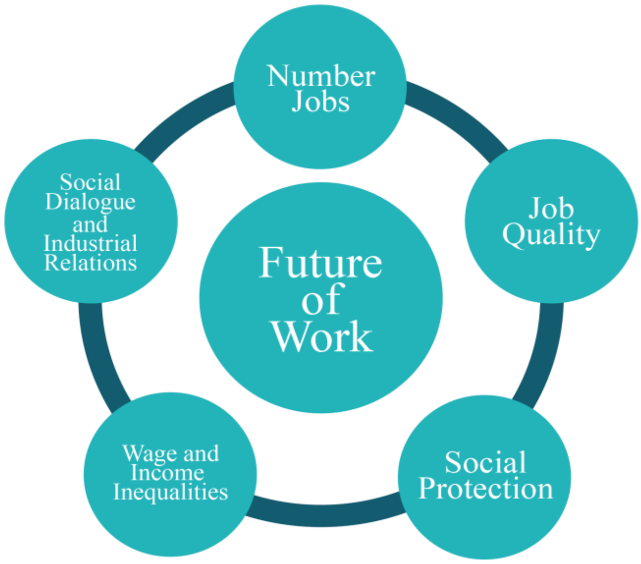
The reality about effects of technology on jobs is that only some tasks and not the entire job is being lost to automation. New jobs are also being created, and some jobs are being re-customized. Thus the net effects of technology on jobs can be quite complex. The shift from steam and water-power to electricity is reported to have caused a reduction in demand for unskilled manual workers performing hauling, conveying, and assembly tasks, in exchange for high skilled workers who are knowledgeable in newly-developed methods (Goldin and Katz 1998). Electrification also created the demand for managerial and clerking tasks, as the transport revolution lowered the cost of shipping domestically and internationally, causing markets to expand, and establishments to grow larger (Chandler 1977). Similarly, the introduction of office machines such as the dictaphones, calculators, mimeo machines, address machines, and the keypunch, facilitated higher demand for educated office workers (Chandler 1977; Beniger 1986; Goldin and Katz 1995; Cortada 2000). In addition, the onset of use of automated teller machines did not actually lead to the elimination of bank tellers; rather, this even increased the number of bank tellers, as new tasks on customer relationship management were given to tellers (Autor 2015). Some studies (Feinstein 1998; Lindert and Williamson 1983) actually argue that unskilled workers, despite employment concerns, ended up largely benefitting from mechanization through the redistribution of technological gains that is evident in higher real wages.

A rather interesting finding of Autor and Dorn (2013) unveils a structural shift in the labor market, noting that workers are shifting their labor supply from middle-income manufacturing to low-income service occupations. Several studies (Autor *et al*. 2003; Goos and Manning 2007; Autor and Dorn (2013) rationalize this shift as an adaptation mechanism of workers since manual tasks of service occupations are less likely to be affected by computerization because they require higher degree of flexibility and physical adaptability. Goos and Manning (2007) primarily highlight this issue as they noticed a rising polarization of work in Britain. Their study shows a growing employment in high-income cognitive jobs and low-income manual occupations; at the same time, they notice the hallowing-out of middle-income routine jobs.

Meanwhile, the study of Beaudry et al. (2013) shows a reduction in demand for skilled labor over the past decade, despite the growth of highly-educated workers. The study notes that as a consequence, high-skilled workers are taking the jobs which are traditionally performed by low-skilled workers, thus displacing the low-skilled workers or driving them out of the labor force. Almeida et al. (2017) reports a similar finding: technology adoption results in the displacement of low-skilled workers and causes a shift towards non-routine cognitive work.

In its report, "The Future of Work: A Literature Review, 2018", the ILO focused on five dimensions of the future of work wherein current changes will impact the world of work: (1) the future of jobs; (2) quality of jobs; (3) wage and income inequality; (4) social protection systems; and (5) social dialogue and industrial relations (**Figure 2**). The future of jobs refers to job creation, job destruction or the future composition of the labor force. In contrast, the future of job quality touches on issues like future working conditions or the sustainability of social protection system (Balliester and Elsheikhi 2018).

Figure 2. Scenarios for the Future of Jobs along Five Dimensions



Source: International Labour Office, The Future of Work: A Literature Review, 2018

Meanwhile, as the Association of South East Asian Nations (ASEAN) continues to progress in meeting its ASEAN Economic Community (AEC) 2025 blueprints, ASEAN member states envision to unite the community through a free movement of goods, services, investment, skilled labor and free flow of capital that would transform ASEAN into a common market and production base (ASEAN 2016). According to the UNESCO Report (Towards 2030), the planned removal of restrictions to the cross-border movement of people and services is expected to spur cooperation in S&T and thereby reinforce the emerging Asia-Pacific knowledge hub. The greater mobility of skilled personnel should be a boon for the region. The magnitude of economic cooperation and integration is expected to open up opportunities for the Philippines. The government, industries, academe and public and private institutions should be better prepared, particularly in terms of its plans for human capacity development.

The advent of FIRe poses a huge challenge to governments in their S&T human resource planning as this would require governments to predict the jobs that will be created or destroyed by new and emerging technologies. Categorizing jobs/occupations according to their susceptibility to automation based on routine vs non-routine as well as manual vs cognitive dimensions, and using a Gaussian process classifier, Frey and Osborne (2013) estimated that about 47 percent of US employment across a wide range of occupations was at risk of being automated over a period of a decade or two. Their model predicts, consistent with technological developments listed in the literature, that most workers in transportation and logistics occupations, as well as the bulk of office and administrative support workers, and labor in production occupations, are at risk. They also found, surprisingly, that a substantial share of employment in the services sector, where much of U.S. job growth has occurred in the past decades, was at risk. On the other hand, science, technology, engineering and mathematics (STEM) occupations were found to have low susceptibility to computerization due largely to the high degree of creative intelligence these jobs require. In addition, the paper found evidence of a strong negative relationship between wages and educational attainment, and an occupation's probability of computerization. The model in this paper guided the work of the ILO projections on the risks to jobs in ASEAN (Chang and Huynh 2016).

Focusing on the impact of digital technologies on routine tasks in Brazil, Almeida, Corseuil, and Poole (2017) conclude that digital technology adoption tends to displace lower-skilled workers and to shift the composition of the workforce toward non-routine, cognitive skills. Rodrik (2015) documents significant deindustrialization, or the shrinking of manufacturing in terms of both employment share and manufacturing value added in Latin American countries (LAC), a phenomenon the author attributes to trade and globalization. These developing countries' opening up to world trade exposed their comparatively weaker manufacturing sectors to a double shock. They became net importers of manufacturing, as the effects of decades-long import-substitution were reversed. In addition, the decline in the relative price of manufacturing in advanced countries resulting from technological change therein exerted pressure on the developing countries' domestic markets. As Raja and Ampah (2016, p.2) aptly put it: "no one is immune." Because of globalization, decisions to invest in S&T in advanced economies affect opportunities in the developing world. Developing economies must learn to adapt to a "global technological playing field".

As pointed out earlier, the actual effects of emerging, frontier and disruptive FIRe technologies on employment in any country will be determined by the absorption of technology, as well as the capability of industries and the available manpower to respond to new demands by consumers. As Driemeier and Nayyar (2018) put it, "The disruptive impact of shifting technologies and patterns of globalization will be greatly ameliorated by the extent to which new businesses, jobs, and markets can be developed." This brings to the fore the importance for countries, particularly the Philippines, to build a critical mass of a future-ready workforce, particularly its S&T human resources that are critical in the STI ecosystem, and also, for governments to formulate labor policies and implement social protection that will help insulate workers from shocks.

Adaptation is key to realizing the employment gains from digital revolution. "Governments, firms, and individuals will need to make choices that will determine how technology will affect employment rates and other deep social challenges, even if the path and the outcome are unpredictable (Raja and Ampah 2016, p.2)." World Bank (2018, p.1) quotes the WB Vice-President for LAC as saying: "We should adopt and promote technology and innovation to boost economic growth, poverty reduction and increase opportunities for all, rather than creating barriers. Better education and training will be key to ensure youth can take full advantage of the digital world and be prepared for the work of tomorrow."

Using the S&T human resource models of Singapore, South Korea, Hong Kong SAR, and Vietnam, Powell and Lindsay (2010) emphasize the importance of skills development strategies for rapid growth and development. In particular, South Korea's growth can be attributed to increase in skills and productivity and also, to capital, skill and R&D intensive industries. South Korea was the most innovative country in 2017 based on a Bloomberg news article (as cited in Choi 2017). For its part, Singapore's priority for economic development determines the process of skills formation. A unit called the Workforce Development Agency is responsible for skills conversion, skill upgrading, and enhancement of employability of lower-skilled workers. It is no surprise that recent data puts Singapore at the top of the Global Competitiveness Index (GCI) among countries across the world, on account of its human capital development, aside from ICT infrastructure (WEF 2019).

In Singapore, some food and drink establishments have started using robots in ferrying plates between customers and kitchens. Hotels and retailers are also exploring the use of robots because highly educated locals avoid late hours and unglamorous work. Based on data from the Ministry of Manpower of Singapore, the number of job vacancies has gone down below the number of jobseekers in 2016. According to Thorp (2016), the imbalance is caused by the changing nature of employment due to the growing number of firms that would like to take greater advantage (i.e., efficiency in terms of labor and cost) of automation and robotics. The government introduced skills training and innovative job fairs as well as transformation plans aimed at the food and beverage, and retail industries, which registered the bulk of layoffs in the final quarter of 2015.

Marouani and Nilsson (2014) argue that skill-biased technological change (SBTC) occurred in Malaysia in recent years and allowed unemployment figures to remain low. Using a model that simulated the absence of SBTC and limited the number of admissions to higher education, the authors show that reduction in wage inequalities could have been greater had there been no SBTC. Adopting an open-door higher education policy (i.e., an education policy that encourages local institutions to forge partnerships with reputable educational institutions overseas) significantly reduced wage inequalities. Thus the authors argue that the open-door education policy can counter the inequality-maintaining effect of SBTC in Malaysia.

Choi (2017) points out that the magnitude of FIRe's impact on employment depends on the worker's skill level. According to the author, some studies predict that lower-skilled jobs will be most affected as routine task is highly vulnerable to automation. Other studies predict that it is the middle-skill jobs that will be most affected. Either way, there is a consensus among the studies that high-skilled jobs will be least affected. Choi (2017) cites a McKinsey study that reveals that "almost half of work activities globally have the potential to be automated." In this light, it is crucial for workers to acquire new skills. In South Korea, the newly elected president proposed various policies that are aimed at advancing technology to enable the country to reap the full benefits of FIRe. The South Korean government also emphasizes the development of skills, computer science skills as well as skills in the fast-developing fields in FIRe, in particular.

Song and Tang (2016, p.5) point to the "need for an industry-oriented approach to develop job-specific skills in key growth industries, on which the success of the national growth strategy hinges." The authors maintain that the private sector should have a bigger role in education and training. As they put it: "There is a pressing need to recalibrate the role of the public and the private sector in skills training. An overburdened public sector as a skills training provider and the absence of an effective framework for tripartite collaboration lie at the root of the skills challenges the five countries face." The five countries referred to by the authors are Singapore, Malaysia, Thailand, Indonesia, and the Philippines.

In addition, Song and Tang (2016, p.5) identify ten (10) common skills challenges confronting these countries. To wit:

1. Inability of the educational institutions to meet industry demands
2. A lack of a comprehensive skills development roadmap to support economic growth
3. Inadequacy in English proficiency and other soft skills
4. Weakness in STEM and Technical and Vocational Education and Training (TVET) programs
5. Over-reliance on the public sector to meet the skills challenges
6. Lack of lifelong learning opportunities for mid-level workers
7. Seriousness of youth unemployment
8. Skills challenges arising from intra-regional labor flows
9. Skills challenges posed by disruptive technology
10. Skills challenges coming from industrial restructuring in China

According to the authors, with disruptive technology, some jobs in many industries (e.g., information and communications technology (ICT), tourism, electronics manufacturing, and financial services) might become obsolete. A paradigm shift in the thinking of policy makers, employers, and employees is necessary to be able to manage disruptive technologies. There is need for policymakers and employers to find new ways in developing a skilled but flexible workforce that recognizes the importance of continuous and lifelong learning.

To address these challenges, Tang and Song (2016) recommend the following:

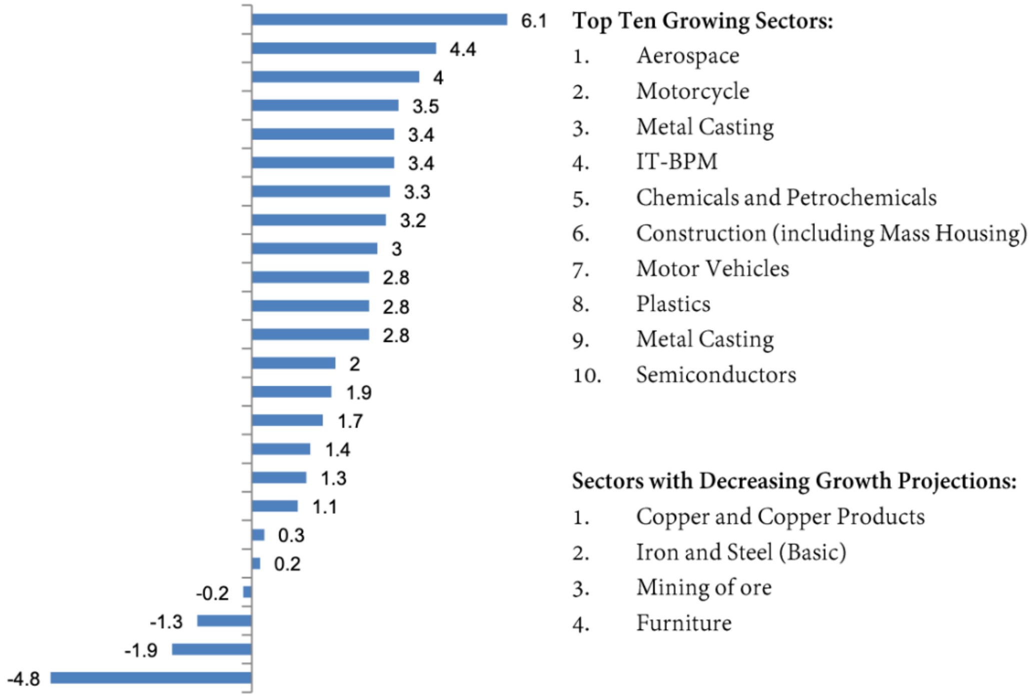
1. Give the private sector a bigger role in meeting the skills challenges
2. Provide a clear roadmap to meet skills challenges
3. Revamp curriculum to emphasize STEM, TVET and soft skills training
4. Deepen school-industry links to improve employability of graduates
5. Expand and strengthen continuous and lifelong learning
6. Policy coordination on cross-border labor flows

Another challenge that governments will have to deal with is skills matching in the context of dynamic and complex labor markets. Bakule *et al*. (2016, p.5) describes skills matching as "a complex and dynamic process involving multiple stakeholders making multiple decisions at different times: individuals and their families, as they make decisions regarding their own education and training; education, training and labour market policy makers, as they decide on the configuration of education and training systems, employment policies and investments; training institutions, as they make decisions on the type and content of the training courses to be delivered; and employers, as they take decisions on how to train workers and utilize skills." The authors underscore the need for policy makers to be conscious of the "importance of reducing the risk of creating large skills gaps that undermine the employability of individuals and impede the productivity of enterprises and the growth of economies." In response to the challenge, the authors developed a compendium of methodological guides on anticipation and matching of skills supply and demand.

In Singapore, the Manpower Research and Statistics Division uses econometric forecasting to determine the country's skill needs for the medium term (i.e., 3 to 5 years) and the long term (i.e., 5 to 10 years). The Economic Development Board decides on which sectors to investigate. The forecasts are based on inputs from the various sector committees. This strategy helps the Ministry of Manpower generate a skills map that indicates which skills are in demand and the degree to which Singapore is able to produce the right supply of skills. Matching skill supply and demand is important to Singapore. The government conducts a cross-Ministerial committee meeting every six months to determine whether the country's skill requirements are met (Powell and Lindsay 2010).

As pointed out earlier, studies on the impact of technological advances on the Philippine labor market, meanwhile, remains limited. Some of the few studies include the "2000-2010 S&T Human Resource Projected Demands in the Government, Academe and Industry", which was commissioned to the University of the Philippines (UP) Population Institute, UP School of Statistics, and the University of Asia & the Pacific (UA&P). This study was conducted almost a decade ago and may no longer be reflective of current trends in the labor market, especially in the wake of the emerging impact of disruptive FIRe technologies. A similar report conducted by the Department of Labor and Employment (DOLE), the Jobsfit 2022, discusses the demand side, particularly, industry employment growth, potential investment in industries, in-demand skills and hard-to-fill occupations (local and international), new jobs and their skills requirements, including diminishing jobs. This DOLE report identified the top ten growing sectors among 72 sectors with 18 industry roadmaps based on the Philippine Employment Projections Model 2013-2022, developed by the Institute for Labor Studies with technical support from the ILO (**Figure 3**).

Figure 3. Employment Projections, 22 HRD Roadmap Sectors, 2013-2022



Source: Jobsfit 2022

In addition, the Technical Education and Skills Development Authority (TESDA) has likewise initiated a skills demand and supply mapping to generate much needed information on the skills requirements of industries as well as the availability of needed skills in each of the provinces in the different regions in the country.

Given the shifts in economic activities and the labor market in the Philippines away from the agriculture sector toward industry and services in recent years, there has been interest in the country's development prospects. A recent study by AlphaBeta (2019) suggests that while about ten percent of jobs in the country may be affected in the near to medium term future from AI with the country's most affected sectors being agriculture, wholesale and retail, and manufacturing, the likely overall effects of FIRe to the economy appear positive. The same study reports that, overall, the increases in the number of jobs and labor participation rate can be as much as much 1.4 million and 2.9 percent, respectively by 2025 in the Philippines. Further, productivity gains are expected, and AI could add an additional 8 billion USD to the Gross Domestic Product (GDP) by 2021 and increase the country's GDP growth rate by 0.4 percent annually. The fundamental objective posed in this study is to determine the prospects in both the supply and demand of S&T human resources in the country.

3. Data and Methodology

In the Philippines, information on the supply and demand of S&T human resources is quite scant. The analysis and projections undertaken in this study are not straightforward for a number of reasons. First, historical estimates of the supply of S&T workers need to be gathered from various data sources, e.g. LFS, 2010 CPH, 2015 POPCEN, government administrative records, etc., which also needs to be harmonized in order to be useful. Second, even if these records are available at an appropriate scale required for the study, historical trends do not necessarily imply future trajectories, especially with regard to potential disruptive technologies that are yet to be developed. Finally, the supply and demand of S&T workers very much depend on many different factors, including training costs and expectations about future prospects, which may not be easily captured in any single model. That said, this study employ a number of quantitative models and analysis, coupled with examinations of qualitative data obtained from interviews of industry associations and experts to provide ways of correcting potential future employment imbalances in S&T personnel in the medium-term.

To project supply of S&T human resources, the study makes use of mixed methods, though largely quantitative projection models. A matrix projection model developed by Leslie (1945) was used to estimate the supply of S&T personnel making use of data from the 2010 Census of Population and Housing and the 2015 Population Census (for baselines), as well as 2010 census-based projections. In this projection model, the future supply of S&T personnel depends on age-specific probabilities of non-S&T personnel transitioning into S&T, and of previous S&T personnel continuing to be in the S&T sector. The Leslie model is a linear population projection model where, in our study, the period supply of S&T workers, L_t^S, is based on a baseline population of S&T and non-S&T workers, L_{t-1}^S and L_{t-1}^N, respectively, and age-specific transition probabilities to/from being S&T workers, F and S. The column-vectors L_t^S and L_t^N sum to the age-specific total population, i.e., $L_t = L_t^S + L_t^N$. The transition probability matrix **F** describes the propensity of the non-S&T population in a previous period to become part of the S&T workers population in the current period. The transition matrix **S**, on the other hand, captures the propensity of S&T workers to continue being part of the S&T workers population in the next period. In matrix notation, the projected age-specific supply of S&T workers at period t may be calculated from the matrix operation

$$L_t^S = \mathbf{F} \cdot L_{t-1}^N + \mathbf{S} \cdot L_{t-1}^S$$

As a baseline case, the transition probabilities are kept constant throughout the projection period. These baseline probabilities and supply of workers will be calculated from the 2010 and 2015 Census of Population. Individual decisions on non S&T human resources shifting to the sector and on S&T human resources persevering in their disciplines highly depend on opposing market forces, including the costs of training and labor market prospects in S&T.

Meanwhile, the demand for S&T personnel is projected based on an input-output model of the economy. Based on some projected level of economic output, the S&T personnel requirement will be calculated using estimates of the skill mix and output-per-worker in each economic sector. This requires, first, the projection of the country's gross output, q_t, based on projected sectoral gross value added (in a Ghoshian model), y_t, and some baseline input-output technology, A_0. In the gross output projections, we will employ the 2012 Input-Output Matrix estimated by the Philippine Statistics Authority. Throughout the projection horizon, the input-output technology is fixed at baseline as is common in the literature. The sectoral gross value added, on the other hand, will be projected based on the sectoral historical trends, and using national growth target from the World Bank. In matrix form:

$$q_t = (\mathbf{I} - \mathbf{A_0})^{-1} \cdot y_t$$

Once the sectoral gross outputs have been calculated, these are then converted to its equivalent labor requirement, $\mathbf{L_t^D}$, based on some estimate of output-per-worker assuming a Leontief production technology. In a baseline case, we will fix the output-per-worker equal to the base year rates throughout the projection period.

The use of an input-output model allows us to capture the different inter-industry linkages in the economy. Gaps in the projected demand and supply will be disaggregated to whatever extent possible, at the very least by broad S&T occupations. The 65-Sector Transactions in the 2012 Input-Output Tables of the PSA, that shows inter-relationships of the different processes of production, and the uses of the goods and services (or products) as well as the income generated by production, were reduced to 12 industries of the 2009 Philippine Standard Industrial Classification (PSIC).

This report seeks also to identify the Science and Technology (S&T) occupations / fields that are crucial to future job requirements by examining trends in S&T occupations using met demand data sourced from the LFS in the period 2010-2018. The premise of the investigation is that projected growth in employment in a given occupation is indicative of market demand for that occupation in the future.

Projections made with quantitative models, when possible, were validated with other data sources, including qualitative data, mainly interviews with select industry associations and experts from select higher education institutions (HEIs). The latter include faculty, department chairs, and deans of colleges of sciences, computer sciences, and engineering. Key Informant Interviews and/or Focus Group Discussions with hiring personnel of industry associations and industry experts from HEIs can provide a context on opportunities and challenges in hiring S&T workers, and their implications on business. Further, the qualitative data can validate the projected demands from quantitative analysis of secondary data on S&T workers and skills.

It should be stressed that the main limitation of the study is lack of good quality data on many S&T occupations. As S&T professionals / practitioners constitute a small proportion of the country's employed population, the usual sample size of the LFS of the PSA is not sufficiently large to provide high-precision estimates of number employed in S&T occupations. Moreover, the LFS data obtained is only for the period 2010 to 2018, or for only 36 quarters; this limits the forecasting procedures that can be applied to the data, since most procedures require time series lengths of at least 50 observations to produce accurate and reliable estimates (e.g., making use of autoregressive integrated moving average or ARIMA models).

In addition, the shift from the 1992 Philippine Standard Occupational Classification (PSOC) to the 2012 PSOC codes, which were implemented in April 2016, resulted in a structural break in many of the existing data series. Changes in levels, trends or patterns and/or variability in the series after the structural break necessitated studying the series from the break onward, leading to an effective series length at most 11 quarters. Other series were monitored beginning April 2016, most of the Information and Communications Technology occupations (ICT) series, for example, and were thus also at most 11 quarters long. Hence, projections in this report for such data had to make use of exponential smoothing (ES) methods and historical growth rates. Some of the series have observations from 2010 to 2018 but do not have observations for certain quarters during the period.

The series for physicists and astronomers, in particular, has only four observations as seen in **Table 2**. Series with sparse data, i.e., data are available intermittently from January 2010 to October 2018 such as the biologists, botanists, zoologists and related scientists series and the mining engineers, metallurgists and related professionals series, were first interpolated using cubic splines.

Table 2. Characteristics of the Occupations Series

OCCUPATION	LENGTH OF SERIES	PRESENCE OF STRUCTURAL BREAK
Information and Computer Technology Professionals		
Applications programmers	2016-2018	
Computer network programmers	2016-2018	
Database designers and administrators	2016-2018	
Software developers	2010-2018	yes
Systems administrators	2016-2018	
Systems analysts	2010-2018	yes
Web and multimedia developers	2016-2018	
Architects, Planners, Surveyors and Designers		
Building architects	2010-2018	yes
Cartographers and surveyors	2016-2018	
Graphic and multimedia designers	2016-2018	
Landscape architects	2016-2018	
Town and traffic planners	2010-2018	
Engineering Professionals		
Chemical engineers	2010-2018	
Civil engineers	2010-2018	
Electrical engineers	2010-2018	

OCCUPATION	LENGTH OF SERIES	PRESENCE OF STRUCTURAL BREAK
Electronics engineers	2010-2018	
Environmental engineers	2016-2018	
Industrial engineers	2010-2018	yes
Mechanical engineers	2010-2018	yes
Mining engineers, metallurgists	2010-2018, intermittent	
Telecommunications engineers	2010-2018	
Life Scientists		
Biologists, botanists, zoologists and related scientists	2010-2018, intermittent	
Farming, forestry and fisheries advisers	2010-2018	
Environmental protection professionals	2016-2018	
Physical Scientists		
Chemists	2010-2018	
Geologists and geophysicists	2010-2018, intermittent	
Meteorologists	2010-2018, intermittent	
Physicists and astronomers	4 observations	
Mathematical Occupations		
Mathematicians and actuaries	2010-2018, intermittent	
Statisticians	2010-2018	

Source: LFS, PSA.

Five of the seven series for ICT occupations are short, with observations from 2016 to 2018 only, while the two longer series have structural breaks. Meanwhile, three of the series for the plots of the occupations under the broad category of architecture, planners, surveyors and designers are short, with observations starting from April 2016. Of the two longer series, the architect series has a structural break, while the series for town and traffic planners does not.

Three series, the ones with the larger number of professionals in the engineering group, namely the series for civil, industrial and mechanical engineers have structural breaks. The series for environmental and telecommunications engineers are short, while that for mining engineers and metallurgists has gaps. On the other hand, the series for biologists, botanists, geologist and related scientists belonging under the life scientists occupation group has gaps, while the series for farming, forestry and fishery advisers has a structutral break. Meanwhile, the series for environmental protection professionals is short. Only the series for chemists is unbroken for physical science occupations.

Exponential smoothing (ES) methods – single ES (SES), double ES (DES), and Holt-Winters - no seasonal (HW) ES were used to estimate the growth rates (GRs) for occupations. Exponential smoothing methods are a collection of forecasting methods that use weighted averages of past values of a series to forecast new values. These methods can be used even if the time series is short (i.e., has less than 50 observations).The SES, DES and HW exponential smoothing methods were applied to the data and the forecasts they produced were compared on the basis of root mean squared error (RMSE). The method that produced the smallest RMSE is used as the projected GR. For series that exhibit a structural break (which usually occurs in April 2016), ES is applied to the tail part of the series rather than the entire series.

Given the many data limitations, the forecast horizon is constrained to be short as well, necessitating the successive application of the projected 2019 growth rate to each of the years in the forecast horizon. This approach does not allow for reversals or shifts in trend. Use of low, medium and high growth rates addresses this limitation only to a limited extent. The sample size of the LFS should be increased in order to ensure good quality data for the purpose of projecting future S&T human resource requirements. In addition, PSA should include in the LFS four digit codes for cross-cutting and emerging occupations.

It should be pointed out that the LFS data on occupation corresponds to "met demand", though such analysis and projections is similarly undertaken by other countries, particularly the US in projecting its S&T human resource needs (see, e.g., Sargent, 2017). That is to say, they are based only on those employed at the time of the survey (with work or has a job). Based on the ILO (and PSA) definition of unemployed, there were no unemployed S&T professionals in October 2018. Similar results were obtained for the other survey rounds. However, unlike in the corresponding surveys of the US, the occupation of the unemployed is apparently not asked of the respondents in the LFS, as it is not available in LFS microdata.

The LFS being the main source of data for this analysis on met demand in section 4.3, projections can be made only for occupations that have separate four-digit codes in the survey. S&T occupations for which the LFS does not have separate codes, but which have existed in the country for some time, likely in small numbers, and which are identified by the Bureau of Local Employment (BLE) in its Jobsfit 2022 report (BLE, 2017) as cross-cutting occupations are listed in **Table 3** under the codes they are currently classified. A cross-cutting occupation is one that is both in-demand and hard-to-fill as evidenced by recurrent advertising or posting of the position and a long recruitment or hiring period before the position is filled up.

Table 3. Cross-cutting occupations not tracked separately in LFS

Occupation classified under / *Cross-cutting occupation*
Web and multimedia developers
Game developer
Civil engineer
Geodetic engineer
Mechanical engineer
Agricultural engineer
Marine engineer
Engineering professional not elsewhere classified
Sanitary engineer
Biologists, botanists, zoologists and related scientists
Plants and animal taxonomist
Farming, forestry and fisheries advisers
Agriculturist
Forester
Soil scientist
Chemist
Food chemist

Table 4 lists cross-cutting occupations that are not even mentioned in the LFS codebook. In addition to data scientist, genomicist and nanotechnologist, the JobsFit report identifies two other S&T occupations as emerging occupations – design engineer (different from industrial design engineer) and mobile app developer. These are also not mentioned in the LFS codebook.

Table 4. Cross-cutting occupations not tracked in LFS

Cross-cutting occupation
Big data researcher
Bioinformatics specialist
Data scientist
Genomicist[2]
Nanotechnologist[3]

ES projection methods, viz., single ES (SES), double ES (DES), and Holt-Winters - no seasonal (HW) ES, were used to estimate the growth rates (GRs) used for the low, medium and high growth scenarios. Specifically, the resulting 2019 annual GR obtained from applying a particular ES method to the data was used as the low, medium or high GR depending on the level of the 2019 forecasts it produces compared to the 2018 values of the series or the 2019 forecasts produced by other ES methods. The GRs for the two other scenarios were determined from other ES procedures, annual GRs of the historical, or the average of these annual GRs, usually for 2016-2018.

For series that exhibit a structural break (which usually occurs in April 2016) and for which application of ES methods yields forecasts that are inconsistent with the discernible trend or pattern in the 2016-2018 portion of the series, ES is applied to merely the tail part of the series rather than the entire series.

For some series that are too variable as to produce negative forecasts despite a discernible upward trend in the tail end of the data or as to produce GRs that are extreme in absolute magnitude (whether positive or negative), the following approaches were tried to obtain feasible GR estimates:

a. In the case of series that were separated from a previous "mother" series (e.g., landscape architects, which was assigned a separate code in April 2016), the series was first added back to the "mother" series, (architects series in the example) to which it belonged prior to implementation of the 2012 PSOC codes. The summated series was then forecast using ES. Forecasts of the mother (architects) series were then subtracted from the forecasts for the summated series to obtain the forecasts for the newly separated series (landscape architects series).

b. For series whose starting values (April 2016 or all 2016 values) are relatively too high or too low as to yield forecasts that are inconsistent with the emerging trend/pattern in 2017-2018, ES was applied only to the tail end of the series (beginning July 2016 or January 2017 as the case may be). This was the approach used for computer network programmers, database designers and administrators, and systems analysts, among others.

2 Per the JobsFit report, a genomicist is a researcher who analyzes DNA data using computer software.

3 A nanotechnologist is a person who manipulates materials on the nanoscale (one billionth of a meter) developing new materials and new equipment as well as drugs and diagnostic tools.

For sparse data, i.e., data available intermittently from January 2010 to October 2018 such as the biologists, botanists, zoologists and related scientists series and the mining engineers, metallurgists and related professionals series, the series was first interpolated using cubic splines. Negative values resulting from interpolation were set to the minimum value in the observed series. The interpolated series was then forecast to produce the 2019 growth rate.

If the interpolated series had a structural break, the portion of the interpolated series after the break was used to produce the forecasts.

GRs in number of takers and qualifiers of relevant PRC examinations during the period 2013-2017, if available for the given occupation, were used as proxy variables to confirm trends in demand and supply for particular disciplines. These were also used to project the yearly additions to the labor force for the given occupations so as to determine if the projected supply of manpower could meet the additional manpower requirements implied by the ES forecasts.

Interviews with industry associations, reports and articles on highest paying jobs, and jobs that are most in demand or are projected to be in demand were also examined to help validate the estimated projections as well as the feasibility of GRs produced by exponential smoothing and/or annual GRs.

4. Overview of the Philippine Labor Force

Most of the S&T fields are critical to future job requirements in industry and government and consequently in the academic sector. This section identifies the occupations / fields for which there is high demand based on literature search as well as indications from the LFS conducted from January 2010 to October 2018 and trends/patterns in number of examination takers and qualifiers in the licensure examinations administered by the Professional Regulatory Commission (PRC).

Data on educational attainment and occupation from the 2015 Census of Population were also examined to analyze the labor force participation among S&T graduates. Following the Philippine Standard Classification of Education (PSCEd) codes of the PSA, we were able to group the entire S&T workforce based on five broad classifications, namely: (1) Life Sciences, (2) Physical Sciences, (3) Math and Statistics, (4) Computing/IT, and (5) Engineering.

4.1. Supply Estimation

As pointed out in Section 3 of this report, the supply of S&T graduates is estimated in this study using data sourced from the 2015 Census of Population by considering

a. the propensity of the non-S&T population in a previous period to become part of the S&T worker population in the current period, which we call as *production rate*; and,

b. the propensity of S&T workers to continue being part of the S&T worker population in the next period, which we call as the *survival rate*.

Before we provide the results of the projections on the supply of S&T human resources, it may, however, be informative to first show the share of S&T graduates among the country's work force. **Table 5** shows that S&T graduates comprise around 5 percent of the labor force, as of

2015. Note that this is much higher than the estimate from the LFS earlier since the latter considered only those who are in professional S&T occupations, irrespective of degree finished, i.e., whether S&T or not, and did not consider clerical support workers, technicians and associate professionals.

In Table 4, we consider five broad classifications of S&T fields, namely: (1) Life Sciences, (2) Physical Sciences, (3) Math and Statistics, (4) Computing/IT, and (5) Engineering. We note that the highest concentration of S&T graduates is from the Engineering field (about 3 percent), followed by Computing/IT (about 2 percent). Higher labor force participation is also observed among S&T graduates of working age 20-39.

Table 5. Share (%) of S&T Graduates in the Labor Force by Age: Philippines, 2015

Age Group	Total in the labor force	Life Sciences	Physical Sciences	Math and Statistics	Computing/IT	Engineering	All S&T
15	1,984,019	0.005	0.001	0.004	0.359	0.107	0.476
20	5,372,095	0.095	0.037	0.078	3.753	2.021	5.985
25	5,786,983	0.099	0.042	0.073	3.318	2.658	6.189
30	5,214,543	0.108	0.049	0.072	2.926	3.148	6.304
35	4,853,814	0.099	0.042	0.054	2.180	3.215	5.590
40	4,238,394	0.095	0.036	0.050	1.106	3.251	4.537
45	3,810,532	0.090	0.032	0.050	0.519	3.380	4.071
50	3,111,774	0.066	0.050	0.039	0.248	3.613	4.015
55	2,397,585	0.059	0.068	0.027	0.156	3.055	3.365
60	1,508,449	0.036	0.047	0.019	0.093	1.838	2.033
All age groups	**38,278,188**	**0.09**	**0.04**	**0.06**	**1.93**	**2.78**	**4.89**

Note: Authors' calculations from the 2015 PopCen, PSA.

Meanwhile, **Table 6** shows that the common occupation of S&T graduates are Professionals (around 25%), Clerical support workers (around 17%), and Technician and Associate Professionals (around 14 %). It can also be noticed that the percentage of Professionals among S&T graduates is more than three times than the national average.[4]

[4] If the percentage of S&T professionals to all employed graduates S&T (24.7% in Table 5) is applied to the share of All S&T graduates in the Labor Force (4.89% in Table 4), the resulting percentage of 1.2% is not necessarily inconsistent with the 1.1% estimate yielded by the 2018 LFS, even as the LFS estimate does not take into account the degree finished by the professional. Those with non-S&T degrees that are captured in the LFS estimates may simply be filling in the void left by those with S&T degrees who shift to managerial and other occupations. In addition, the LFS estimates are based largely on "met demand".

Table 6. Share (%) of Employed S&T Graduates by Usual Occupation: Philippines, 2015

Classification of Occupation	Philippines	Life Sciences	Physical Sciences	Math and Statistics	Computing/IT	Engineering	All S&T
Total Employed	**31,018,533**	**27,714**	**13,773**	**16,859**	**532,464**	**960,770**	**1,551,580**
Armed Forces	0.3	0.5	0.6	0.5	0.5	0.7	0.6
Managers	8.7	17.9	16.9	15.9	11.5	13.3	12.8
Professionals	6.8	23.6	35.1	27.7	13.3	30.9	24.7
Technicians and Associate Professionals	5.5	14.4	14.7	12.5	14.6	12.8	13.5
Clerical Support Workers	6.1	21.3	13.7	26.5	33.6	8.1	17.3
Service and Sales Workers	15.0	11.3	6.2	9.0	12.5	5.7	8.2
Skilled Agricultural, Forestry & Fishery Workers	16.9	2.3	1.5	1.5	1.5	3.5	2.7
Craft & Related Trades Workers	9.9	1.6	1.9	1.5	3.4	7.8	6.1
Plant & Machine Operators and Assemblers	10.9	2.5	6.0	2.0	3.9	13.9	10.1
Elementary Occupations	20.0	4.7	3.3	3.0	5.3	3.4	4.0

Note: Authors' calculations from the 2015 PopCen, PSA.

Table 7 paints a general picture of the employment status of S&T workers in the country. Firstly, we note that labor force participation among S&T graduates is substantially higher (87%) than the national average (71%). In the same table, we observe the high labor force participation among male S&T graduates, at around 93 percent. However, we do not observe the same behavior for female S&T graduates. Based on the 2015 PopCen data, only 73 percent of female S&T graduates entered the labor force in 2015. This implies a need to take a closer look at the labor force participation rate of S&T graduates to draw some useful insights about gender disparities in labor participation that are also observable across the entire population.

Table 7. Employment Status of S&T Graduates by Sex (in `000): Philippines, 2015

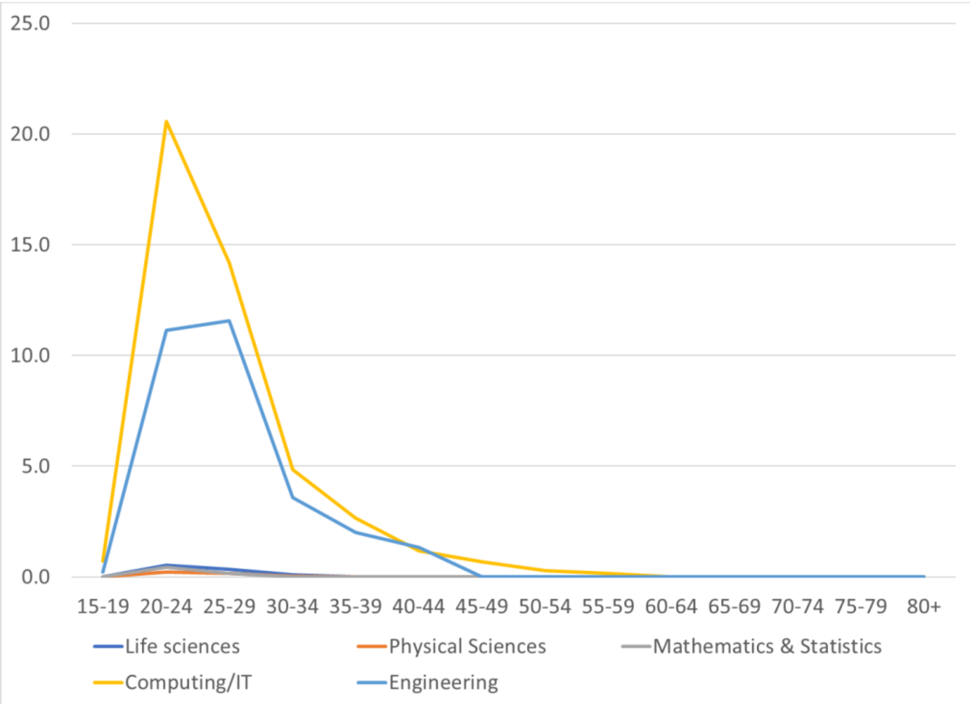
	Philippines	Life Sciences	Physical Sciences	Math and Statistics	Computing/IT	Engineering	All S&T
All							
Population 25 to 64 years old	44,143	36	18	20	657	1,071	1,802
In the Labor Force	31,119	28	14	17	537	965	1,560
% In the Labor Force	*70.5*	*77.0*	*78.8*	*84.7*	*81.7*	*90.0*	*86.6*
Employed	31,019	28	14	17	532	961	1,552
% Employed	*99.7*	*99.4*	*99.5*	*99.6*	*99.2*	*99.6*	*99.5*
Males							
Population 25 to 64 years old	22,278	12	7	8	329	901	1,257
In the Labor Force	20,672	11	6	8	306	834	1,165
% In the Labor Force	*92.8*	*90.0*	*89.6*	*93.3*	*93.1*	*92.6*	*92.7*
Employed	20,618	11	6	8	304	831	1,160
% Employed	*99.7*	*99.5*	*99.4*	*99.5*	*99.2*	*99.6*	*99.5*
Females							
Population 25 to 64 years old	21,866	24	11	12	328	171	545
In the Labor Force	10,448	17	8	9	230	131	395
% In the Labor Force	*47.8*	*70.4*	*71.8*	*78.5*	*70.3*	*76.6*	*72.5*
Employed	10,400	17	8	9	228	130	392
% Employed	*99.5*	*99.4*	*99.6*	*99.6*	*99.1*	*99.5*	*99.3*

Note: Authors' calculations from the 2015 PopCen, PSA.

Further data disaggregation of labor participation by sex and by age shows a spike in labor force participation rates among male S&T graduates around the age of 15 to 24, which is the usual age of joining the labor force. A higher labor force participation among graduates of Math and Statistics, and Computing/IT, relative to other S&T fields can also be noticed. From age 20 to 50, the labor force participation of male S&T graduates is stable and flat, then, a noticeable decline is observed around age 55. Similar to males, female S&T graduates join the labor force at age 15 to 24. At the outset, the labor force participation of females from the fields of Mathematics and Statistics, as well as in Computing/IT is slightly higher than that of males. However, a general decline in female participation can be observed after the age of 25, (when females start to marry). Additionally, a noticeable dip in the labor force participation of females, especially those from the Computing/IT field, is observed around the age of 35. The decline in labor force participation for female S&T graduates persists until the age of 55. Interestingly, both male and female graduates of Computing/IT stay longer in the labor force, as compared with other graduates from different S&T fields. These observations should lead to insights on behavioral changes that can influence the supply of S&T human resources in the country.

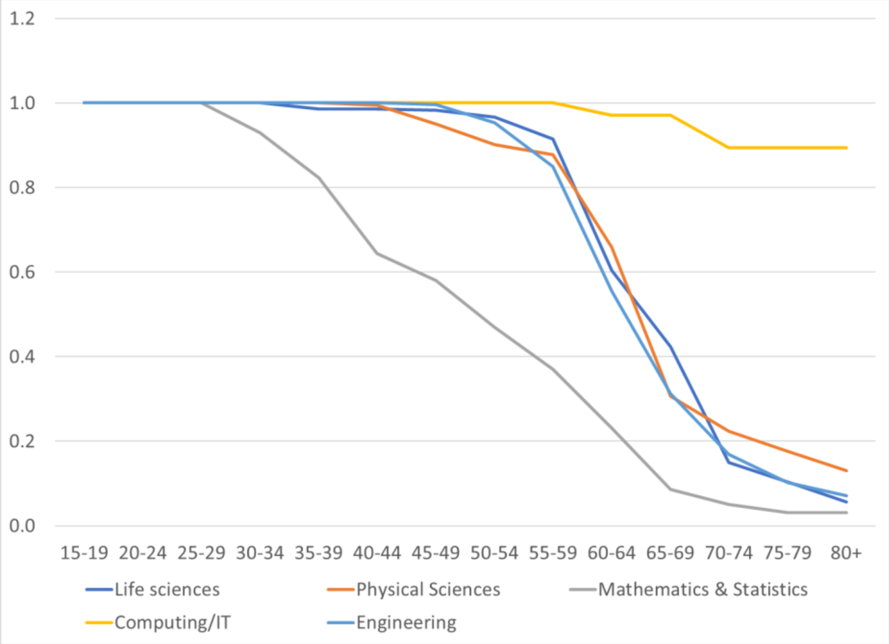
Figure 4 exhibits the production of new S&T workers by age group, per thousand non-S&T population. It can be observed that the highest production of new S&T population occurs around the age of 19 to 24, which is the onset of the tertiary level education. The figure also implies the popularity of Computer Science/IT, as well as Engineering fields among the population. In fact, the production of new S&T workers in these two fields is still relatively high even after the age of 30, suggesting that some non-S&T population are still transitioning to these S&T fields later in their careers.

Figure 4. Production Rate of New S&T Workers at Age *t* (per '000 non-S&T population)



Additionally, we present the propensity of S&T graduates to continue being part of the S&T workers population in **Figure 5**.

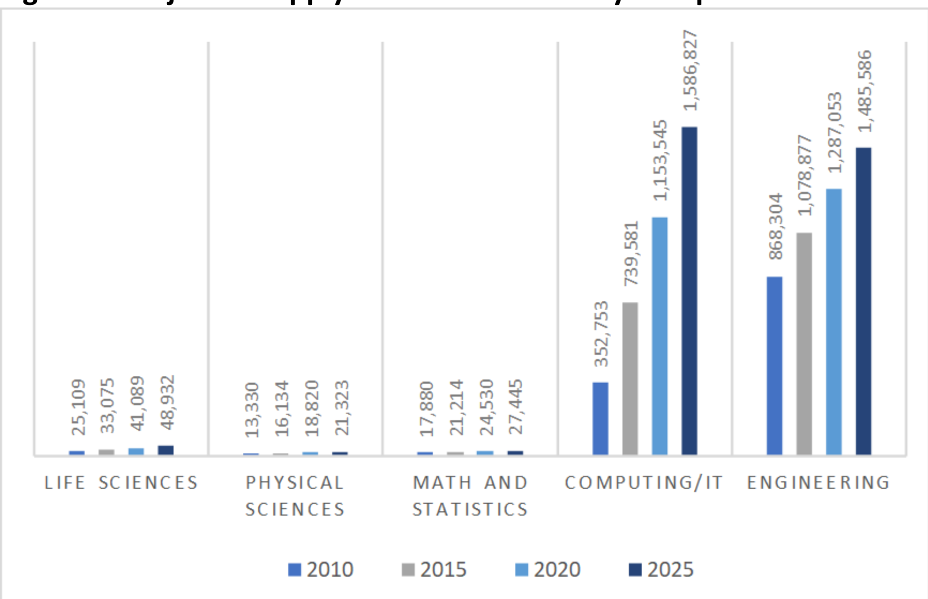
Figure 5. Survival Rate of S&T Graduates in the Labor Force at Age *t*



It shows that workers with Mathematics & Statistics background have the highest tendency to exit the labor force earlier, as compared with other S&T graduates. In contrast, workers with Computer Science/IT background stay in the labor force longer. Workers with background in other S&T fields such as Life Sciences, Physical Sciences, and Engineering on the other hand, follow the usual behavior, wherein they stay in the labor force until their retirement age.

In **Figure 6**, we sum the *production rate* and *survival rate* estimates to get the projected level of supply for S&T workers. Based on the figure, we can expect that the supply of workers with S&T background will generally increase in the coming years.

Figure 6. Projected Supply of S&T Graduates by Discipline



By 2020, Engineering will remain as the field with the highest supply of S&T graduates. However, by 2025, most S&T workers will be from the Computing/IT field, reflecting the emerging popularity of this field. Meanwhile, the supply of workers with background in Life Sciences, Physical Sciences, Mathematics and Statistics, will also increase but at a relatively much slower rate as compared to those with Computing/IT and Engineering backgrounds.

4.2. Demand Estimation

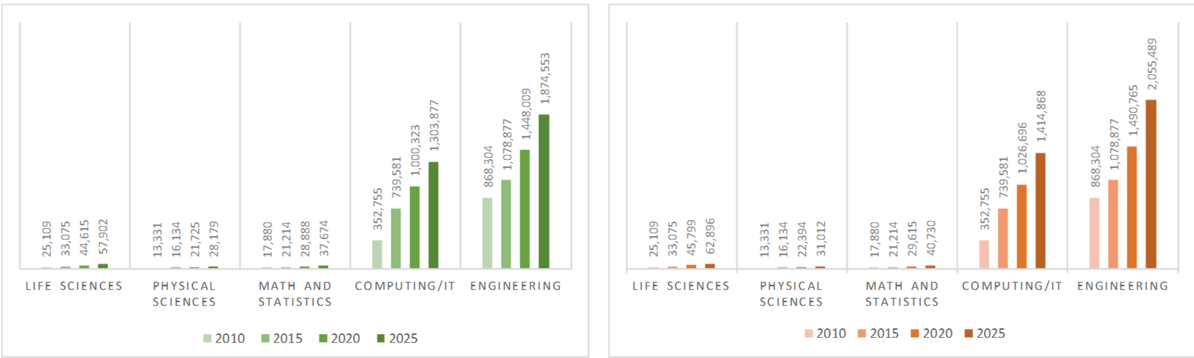
The demand for S&T workers is projected based on the PSA's Input-Output table. We estimate the country's gross output using historical data on sector-specific gross value added, wherein technology is assumed fixed at baseline. We then translated this gross output into output-per-worker using our supply estimates. To determine how our country will grow in the medium term, we adapted the World Bank's Global Economic Prospects (June 2019) forecast for the Philippines. Given the country's projected growth, we similarly computed for its equivalent labor requirement.

To determine how much more the Philippine economy will grow in the medium term, we utilized two different sources of growth forecast: (1) the average historical growth of sector-specific GVA for the past 20 years (1998-2018 data), and (2) the sector-specific target growth outlined in the Philippine Development Plan 2017-2020. we adapted the World Bank's Global Economic Prospects (June 2019) forecast for the Philippines. Given the country's projected growth, we similarly computed for its equivalent labor requirement.Using this information, we calculate for the equivalent number of S&T workers that will be required to achieve the additional growth.

The use of two sources of growth forecast will also lead to two different sets of estimates for the demand for S&T workers. Our first set of estimates based on the average historical growth of sector-specific GVA for the past 20 years, will serve as our conservative estimate. On the other hand, the second set of estimates based on the targets outlined in the Philippine Development Plan 2017-2020, will serve as our more optimistic estimate.

The results of our projection are shown in **Figure 7**. Both our conservative (Panel A) and optimistic estimates (Panel B) seem to suggest that the future demand will be highest for workers with Engineering background. Although we previously shown that the supply of S&T workers with Computing/IT background will overtake the supply of Engineers by 2025, our demand projections suggest that the job market is still likely to favor engineers, at least in the Philippines. We note that our demand projection pays sole attention to domestic demand, i.e., the demand for overseasworkers with S&T background is not accounted for in this analysis. We also note that the domestic demand for workers with background in Life Sciences, Physical Sciences, Math and Statistics will similarly increase in the future, though not as high as the demand for Engineers or workers with Computing/IT background.

Figure 7. Projected Demand of S&T Graduates by Discipline



We take our demand estimation a step further, by presenting the breakdown of demand by specific industry in **Table 8**. Interestingly, our estimates show that the future demand for S&T graduates will be highest for industries currently categorized under "Other Services" in the 2009 PSIC classification scheme. A review of the PSIC 2009 handbook reveals that "Other Services" serves as a residual category, which absorbs all other activities that are not yet covered by other existing categories. This finding is unsurprising given the rapid increase of new types of work driven by technological advances.

Table 8. Projected Demand for S&T Workers, by Discipline and Industry

	2020					2025				
	Life Sciences	Physical Sciences	Math & Statistics	Computing/ IT	Engineering	Life Sciences	Physical Sciences	Math & Statistics	Computing/ IT	Engineering
Projection based on average historical growth of sector-specific GVA										
Agriculture and forestry	2,090	564	695	26,899	65,425	2,497	674	830	32,137	78,164
Fishing	215	48	45	2,365	8,139	251	57	52	2,768	9,528
Mining & Quarrying	200	306	33	3,742	10,631	276	423	45	5,171	14,692
Manufacturing	2,838	4,861	1,339	91,499	172,065	3,651	6,253	1,722	117,696	221,329
Electricity, Gas and Water Supply	189	179	188	6,654	43,464	247	234	245	8,660	56,568
Construction	494	384	255	19,055	276,004	634	493	327	24,433	353,906
Trade and Repair of Motor Vehicles, Motorcycles, Personal and Household Goods	8,023	2,776	3,524	168,030	155,435	10,689	3,698	4,695	223,857	207,076
Transport, Storage & Communication	1,814	870	1,049	46,428	232,338	2,414	1,158	1,396	61,800	309,264
Financial Intermediation	1,289	306	3,018	56,696	23,054	1,777	422	4,163	78,197	31,797
Real Estate, Renting & Business Activities	273	111	233	5,333	6,928	364	148	310	7,113	9,239
Public Administration & Defense; Compulsory Social Security	6,280	2,498	4,408	107,783	167,787	7,815	3,108	5,485	134,124	208,793
Other Services	20,910	8,821	14,101	465,839	286,740	27,288	11,512	18,402	607,921	374,197
TOTAL	**44,615**	**21,725**	**28,888**	**1,000,323**	**1,448,009**	**57,902**	**28,179**	**37,674**	**1,303,877**	**1,874,553**
Projection based on PDP 2017-2020 growth targets										
Agriculture and forestry	2,115	571	703	27,217	66,198	2,596	700	863	33,405	81,247
Fishing	219	49	46	2,413	8,305	269	60	56	2,959	10,183
Mining & Quarrying	205	314	34	3,843	10,918	297	455	49	5,562	15,800
Manufacturing	2,972	5,090	1,402	95,813	180,177	4,221	7,230	1,991	136,077	255,895
Electricity, Gas and Water Supply	200	189	198	7,022	45,869	291	276	289	10,232	66,838
Construction	512	398	265	19,750	286,080	711	553	367	27,409	397,011
Trade and Repair of Motor Vehicles, Motorcycles, Personal and Household Goods	8,174	2,828	3,591	171,199	158,366	11,303	3,910	4,965	236,726	218,981
Transport, Storage & Communication	1,841	883	1,065	47,124	235,823	2,526	1,211	1,461	64,654	323,546
Financial Intermediation	1,288	306	3,017	56,678	23,046	1,763	419	4,130	77,573	31,543
Real Estate, Renting & Business Activities	276	113	235	5,396	7,010	377	154	321	7,369	9,573
Public Administration & Defense; Compulsory Social Security	6,541	2,602	4,591	112,264	174,763	8,946	3,558	6,279	153,534	239,009
Other Services	21,455	9,051	14,469	477,976	294,211	29,597	12,486	19,960	659,369	405,864
TOTAL	**45,799**	**22,394**	**29,615**	**1,026,696**	**1,490,765**	**62,896**	**31,012**	**40,730**	**1,414,868**	**2,055,489**

To supplement our results, we conducted a Key Informant Interview, particularly with a high-level official from a group of employers in the Philippines to solicit insights about our findings. He confirmed that over the past 5 years, the demand for workers with S&T background has increased in the country. He adds that the transition of some companies to digitalization and automation have naturally increased the demand for workers with S&T backgrounds. He laments, however, although there exists an increasing demand, STEM courses do not seem to appeal to students as business-related courses remain popular with students and parents. Therefore, he suggests that the government continue to give emphasis on STEM and support, including advocacy campaigns, should be introduced earlier, specifically, in the junior high school level.

The respondent added that the move of companies towards digitalization, automation, and AI should not be feared because although some jobs will be lost, new types of jobs, especially in S&T, will also be created. Ultimately, he believes that humans and machines play complementary roles.

When asked about the likely change in labor requirement of the industry in the next 5 years, he shared that they are expecting the business landscape to continuously evolve as more companies are embracing technology; hence, they are anticipating an even higher demand for S&T workers in the next few years. The interviewee advocated that the government and the private sector work together to come up with a comprehensive roadmap in addressing the challenges and opportunities brought by FIRe. He added that there should be an institutionalized dialogue mechanism between the government and the private sector. He particularly mentioned improving the Labor Management Information System (LMIS) to enhance the linkage between the supply and demand of workers in the country. Moreover, he suggested to strengthen the work immersion component of the senior high school to provide the necessary experience to students in order to incentivize them for S&T careers as well as to prepare them for the actual work environment.

4.3. Projected gap between demand and supply of S&T workers in the Philippines

To achieve a complete scenario, we summarize our projected future supply, demand, and associated gap of S&T workers in the Philippines (**Table 9**). Our supply projection only combines the estimates calculated from the production rate and survival rates of S&T graduates; hence, we have the same set of estimates for both major columns A and B. In contrast, our demand projection is estimated using two sources of growth forecast that leads to two different sets of estimated future demand for S&T workers. The growth forecast used in Panel A is just the average historical growth of sector-specific GVAs. We treat this as our conservative estimate. In Panel B, we utilized the growth target outlined in the Philippine Development Plan 2017-2020, which our economic managers hope to achieve. We treat this as our optimistic estimate. Using our supply and demand projections, we compute for the future gap. This gap estimate will help policymakers foresee which fields of S&T will our economy be needing in the future, as well as identify possible issues that will need support and intervention.

Table 9 generally shows that both the supply and demand of S&T workers will grow in the future. What is crucial however, is whether the future supply of S&T workers will be able to match the demand of the domestic economy, given our current productivity and level of technology. Looking at the gap estimates from both conservative (Panel A) and optimistic

(Panel B) perspective, we sense an impending domestic oversupply of S&T workers with Computing/IT background. This finding is reminiscent of our previous experience with Nursing courses that gained popularity in the country. Meanwhile, the neat to immediate future is favorable for engineers as these workers comprise most of the future demand for S&T workers in the country. In addition, our economy will be likewise in need of Life Scientists, Physical Scientists, as well as Mathematicians, Statisticians. We emphasize though, that our projections only capture domestic demand and supply of S&T workers, and is unable to predict how the international labor market will behave in the medium-term.

Table 9. Projected Supply, Demand and Gap of S&T Workers

	(A) Based on Average Historical Growth of GVA		(B) Based on PDP 2017-2020 Growth Targets	
	2020	**2025**	**2020**	**2025**
Supply				
Life Sciences	41,089	48,932	41,089	48,932
Physical Sciences	18,820	21,323	18,820	21,323
Math and Statistics	24,530	27,445	24,530	27,445
Computing/IT	1,153,545	1,586,827	1,153,545	1,586,827
Engineering	1,287,053	1,485,586	1,287,053	1,485,586
Demand				
Life Sciences	44,615	57,902	45,799	62,896
Physical Sciences	21,725	28,179	22,394	31,012
Math and Statistics	28,888	37,674	29,615	40,730
Computing/IT	1,000,323	1,303,877	1,026,696	1,414,868
Engineering	1,448,009	1,874,553	1,490,765	2,055,489
Gap (Demand - Supply)				
Life Sciences	3,526	8,970	4,710	13,964
Physical Sciences	2,905	6,855	3,575	9,689
Math and Statistics	4,357	10,229	5,085	13,285
Computing/IT	-153,223	-282,950	-126,850	-171,960
Engineering	160,956	388,967	203,713	569,903

4.4. Projected growth rates of occupations

Application of the exponential smoothing methods to the occupations series leads to the projected growth rates shown in **Table 10**. The average annual growth rate for the period 2016-2018 are also shown for comparison. Most of the projected growth rates obtained are large in absolute magnitude and reflect the large variability in the data series owing to the small sample sizes on which the data are based. Many of the average annual growth rates for the period 2016-2018 are also large in absolute magnitude. The projected growth rates for the broad categories of occupations are somewhat better.

Table 10. Projected Annual Employment Growth Rate

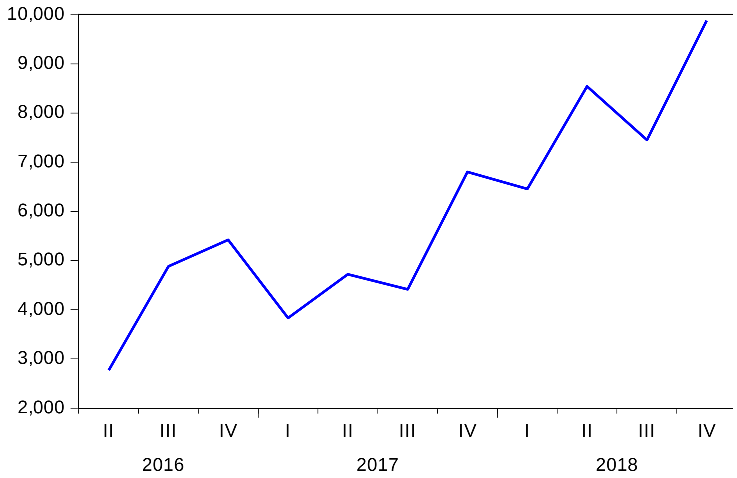
OCCUPATION	EXPONENTIAL SMOOTHING GROWTH RATE (%)	2016-2018 AVERAGE ANNUAL GROWTH RATE (%)
Information and Computer Technology Professionals	**10.8**	**22.6**
Applications programmers	36.0	13.9
Computer network programmers	-18.0	27.2
Database designers and administrators	-9.7	28.3
Software developers	-4.6	-23.0
Systems administrators	29.0	63.5
Systems analysts	-15.9	-7.4
Web and multimedia developers	-14.3	52.7
Architects, Planners, Surveyors and Designers	**-4.1**	**40.4**
Building architects	25.3	18.4
Cartographers and surveyors	-4.8	8.3
Graphic and multimedia designers	-0.4	-8.1
Landscape architects	29.1	-30.1
Town and traffic planners	31.7	0.4
Engineering Professionals	**13.4**	**14.1**
Chemical engineers	54.5	-2.0
Civil engineers	14.3	15.8
Electrical engineers	-10.5	11.2
Electronics engineers	12.3	-12.0
Environmental engineers	-0.6	70.3
Industrial engineers	-0.3	46.3
Mechanical engineers	-7.7	10.6
Mining engineers, metallurgists	-2.8	26.4
Telecommunications engineers	3.5	-31.2
Life Scientists	**2.4**	**3.6**
Biologists, botanists, zoologists and related scientists	-19.1	114.8
Farming, forestry and fisheries advisers	-31.1	17.6
Environmental protection professionals	-37.2	130.3
Physical Scientists	**1.1**	**0.4**
Chemists	-2.4	-10.1
Geologists and geophysicists	25.1	30.2
Meteorologists	87.4	29.1
Physicists and astronomers		
Mathematical Occupations	**25.1**	**3.8**

Mathematicians and actuaries	240.1	-0.6
Statisticians	41.1	-4.3

Note: The projection is based on the scenario growth rate best supported by the data.
Source of basic data: LFS, PSA

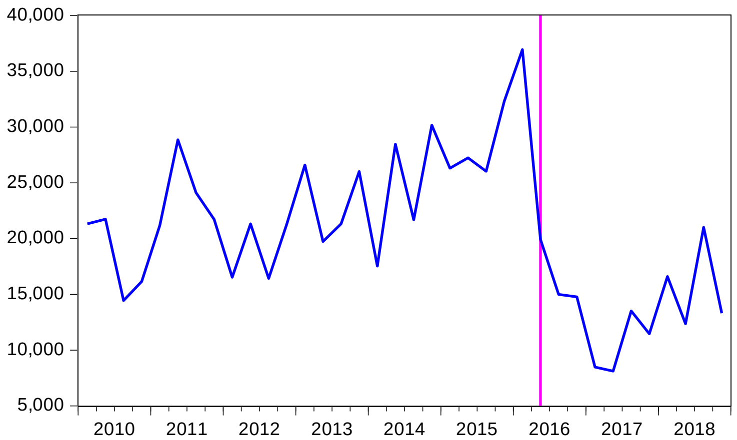
All ICT occupations, were assigned four-digit level PSOC codes of their own beginning April 2016. These series are, thus, short. In three of the longer series, structural breaks are evident. These series are systems analysts, industrial engineers and civil engineers.

Figure 8. Number of Systems Administrators, April 2016 - October 2018



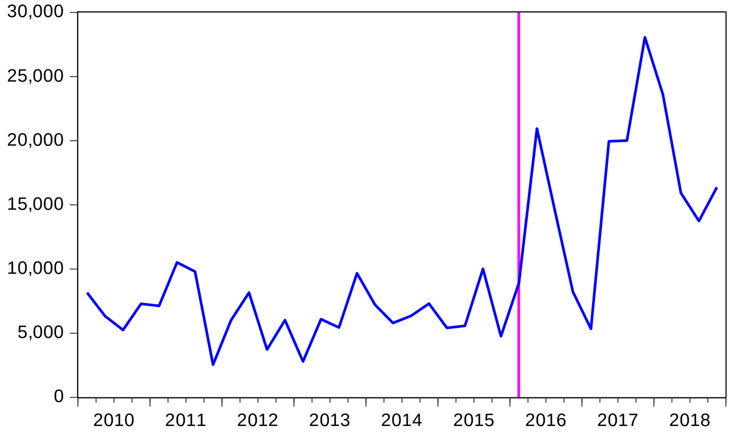
Source: LFS, PSA

Figure 9. Number of Systems Analysts, 2010-2018



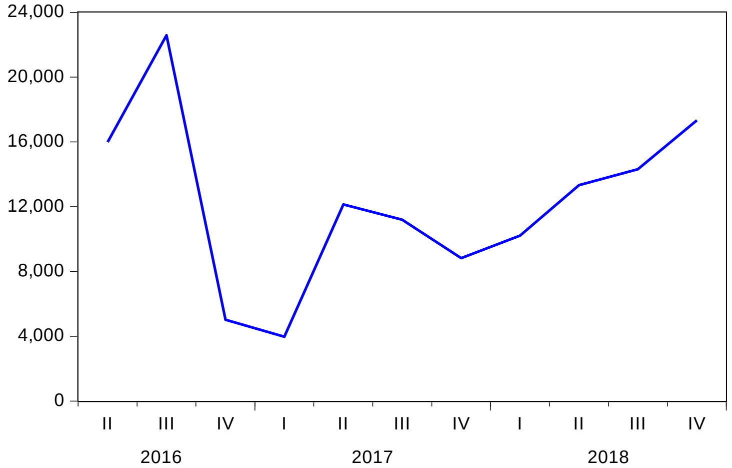
Source: LFS, PSA

Figure 10. Number of Industrial Engineers, 2010-2018



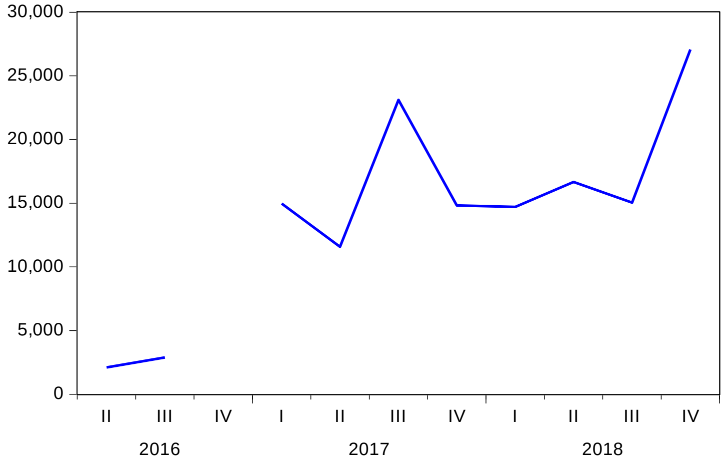
Source: LFS, PSA

Figure 11. Number of Web and Multimedia Developers, April 2016 - October 2018



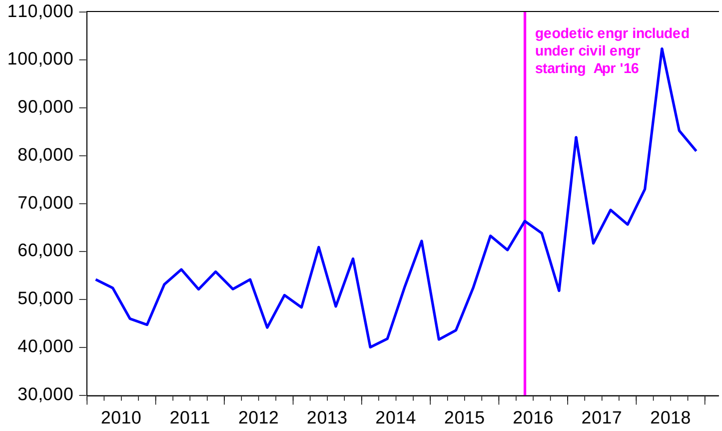
Source: LFS, PSA

Figure 12. Number of Applications Programmers, April 2016 - October 2018



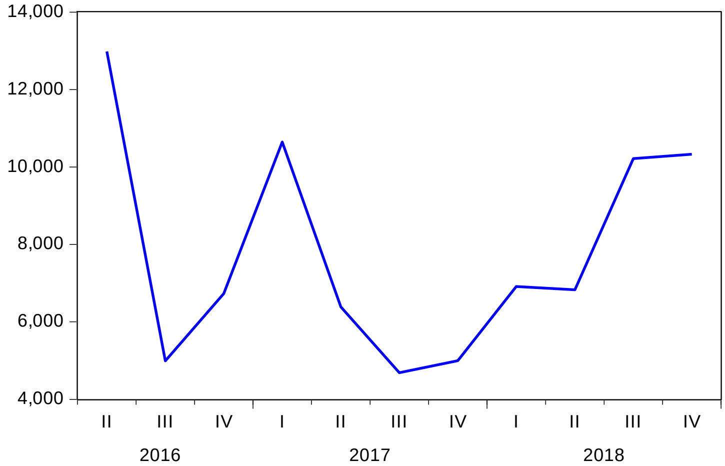
Source: LFS, PSA

Figure 13. Number of Civil Engineers, 2010-2016



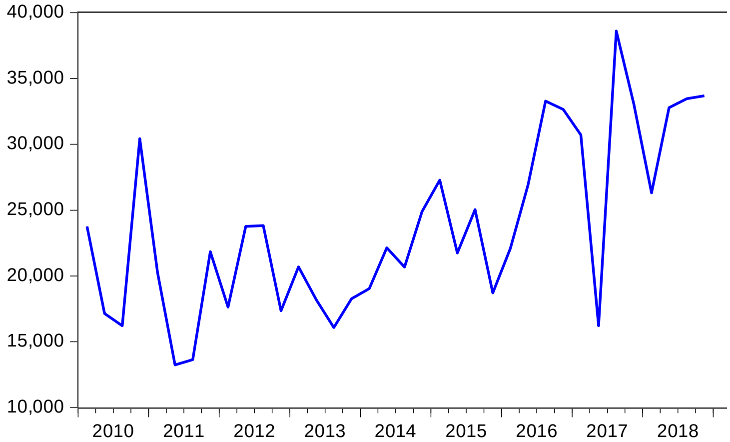
Source: LFS, PSA

Figure 14. Number of Database Engineers and Administrators, April 2016 - October 2018



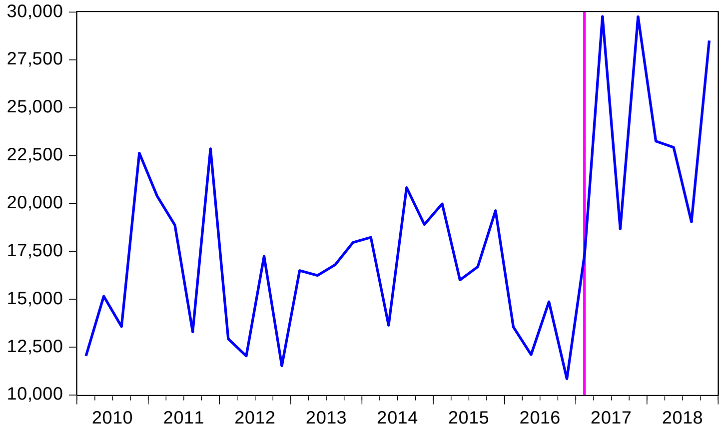
Source: LFS, PSA

Figure 15. Number of Electrical Engineers, 2010-2018



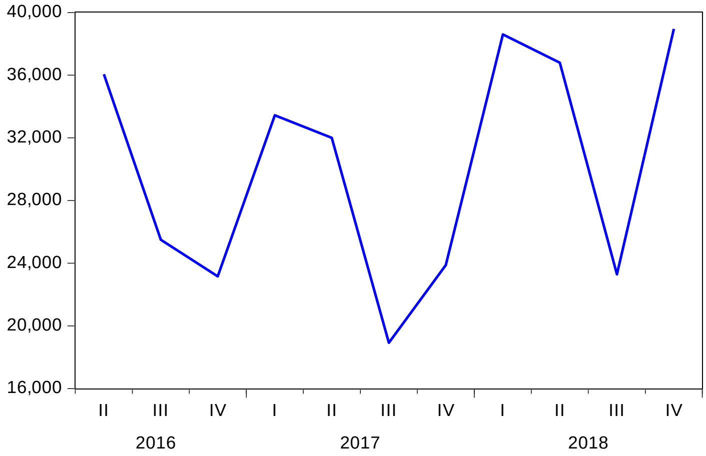
Source: LFS, PSA

Figure 16. Number of Building Architects, 2010-2018



Source: LFS, PSA

Figure 17. Number of Computer and Network Programmers, April 2016 - October 2018



Source: LFS, PSA

It may be noted that most of these series are on the uptrend or at a higher level in the latter part of the observation period even if the series initially declined after the structural break, as in the case of **Figure 9**.

Professional Regulatory Commission (PRC) data in 2013-2017 could be examined for validation purposes for only the three occupations requiring licensure examinations – architecture, civil engineering and electrical engineering. The PRC data indicate that the number of examination takers grew on average by 6.7%, 17% and 8.8% for architecture, civil engineering and electrical engineering, respectively. This is an indication of growing demand for these disciplines. Qualifying rates for these professions likewise grew by annual average rates of 7.2%, 17.7% and 11.0%, respectively. Calculations of the additions to the workforce implied by these rates show that the increments do not outpace the projections for these occupations even for the high growth scenarios, a possible indication that supply exceeds demand for these occupations.

Yet architect, civil engineer, computer programmer, electrical engineer and web and multimedia designer[5] are among the occupations classified as cross-cutting for 2017-2022 in the JobsFit 2022 Labor Market Information Report (BLE, 2017). There is likely a mismatch

[5] *Website designer* and *website developer* are listed separately as cross-cutting occupations in the JobsFit 2022 report.

of labor supply and demand possibly due to disparities in geographic location, skills set/number of years' experience required and so on. In terms of skills sets, there are 14 types of engineering occupations listed alphabetically under civil engineer – from aerodome construction engineer to geodetic engineer to structural engineer. It may also be the case that some of the workforce have moved on to related or more lucrative jobs. In the U.S., for example, where the number of electrical engineers has been falling apparently since 2006, it is conjectured that the electrical engineers have been shifting to software engineering or to Wall Street for work, among other reasons (Thibodeau 2015).

Five of the 20 occupations with the highest projected growth rate in employment in 2018-2028 in the U.S. (BLS 2017) belong to S&T (**Table 10**). Except for *software and applications developer*, none of the other four occupations appear in the Philippines' top 10 S&T occupations in terms of growth in employment. Nevertheless, there are indications that *actuaries* and *statisticians* are also in demand here in the country. The two rank fourth and tenth, respectively in the top 10 highly paid occupations per the 2016 Occupational Wages Survey of the PSA. The other S&T occupations in the OWS list are: *civil engineers* (third), *computer programmers* (fifth), *systems analysts and designers* (sixth) and *computer engineers* (seventh).

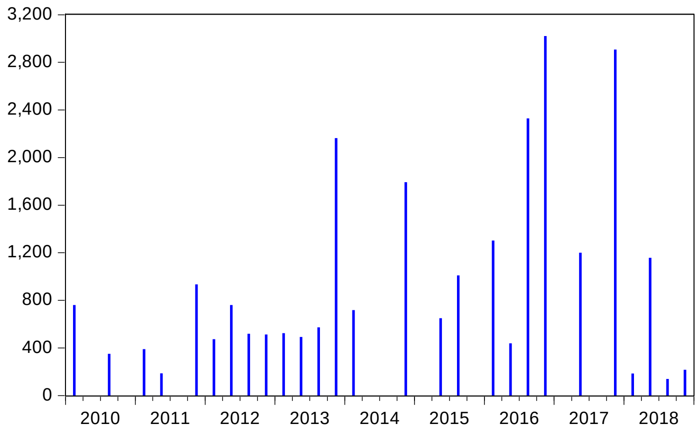
Table 11. S&T occupations in top 20 occupations in U.S. with highest projected growth rate in employment in 2018-2028

Occupation	Rank in Top 20	Projected Growth Rate
Information security analyst	6th	32%
Statistician	8th	31%
Mathematician	13th	26%
Operations research analyst	14th	26%
Software developer, applications	15th	26%

Source: U.S. Bureau of Labor Statistics

The OWS data in conjunction with LFS data suggest that there are supply constraints where *actuaries* and *statisticians* are concerned. *Mathematicians and actuaries* constitute a small group in the labor force so much so that the series is sparse (see **Figure 18**).

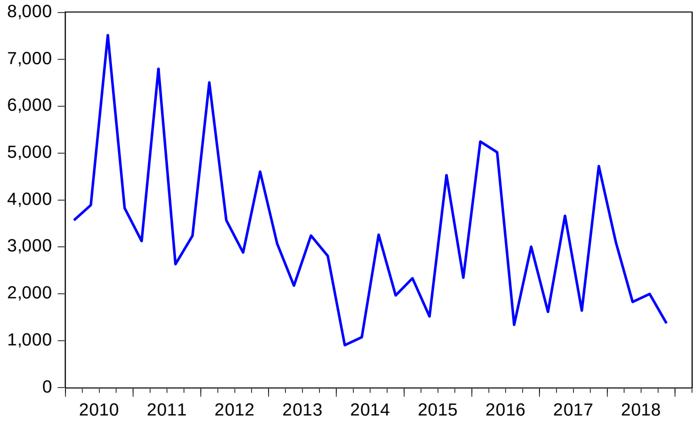
Figure 18. Number of Mathematicians and Actuaries, 2010-2018



Source: LFS, PSA

On the other hand, the number of statisticians shows a declining trend in 2010-2013 that stabilized somewhat from 2014 onwards (**Figure 19**).

Figure 19. Number of Statisticians, 2010-2012



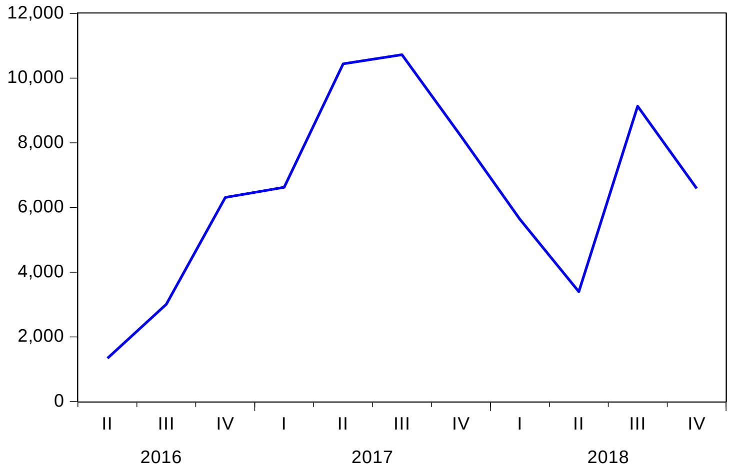
Source: LFS, PSA

Yet demand for statisticians is projected to be relatively high because of increasing demand for data analytics in the country. Industry associations and S&T experts confirm this given the increasing prominence of data science, which entails the use of statistical thinking, and the deluge of data being collected, including big data especially in the still emerging era of FIRe.

As in the case of architecture, civil engineering and electrical engineering, calculations made of the additional number of mechanical engineers joining the workforce implied by PRC data on number of examination takers and qualifying rates in 2013-2017 indicate that supply of mechanical engineers outpace the additional workforce required even under the high growth scenario.

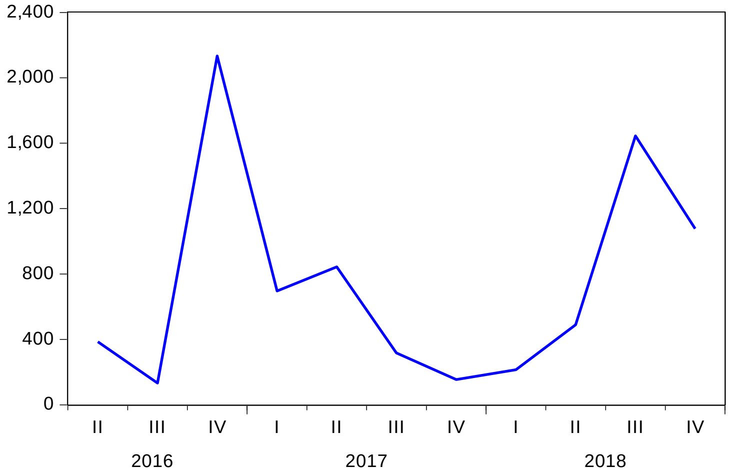
Calculations of the additions to the workforce implied by these rates show that the increments do not outpace the projections for these occupations even for the high growth scenarios. But there is likely a mismatch in the specific skills required, there being 13 types of engineers listed under *mechanical engineer*.

Figure 20. Number of Telecommunications Engineers, April 2016 - October 2018



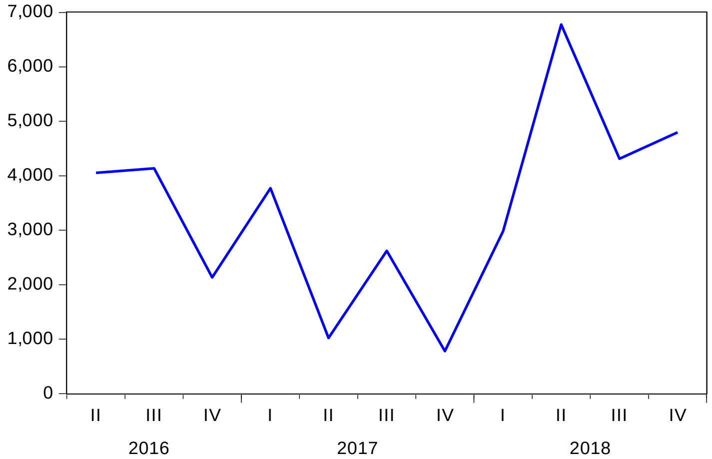
Source: LFS, PSA

Figure 21. Number of Environmental Engineers, April 2016 - October 2018



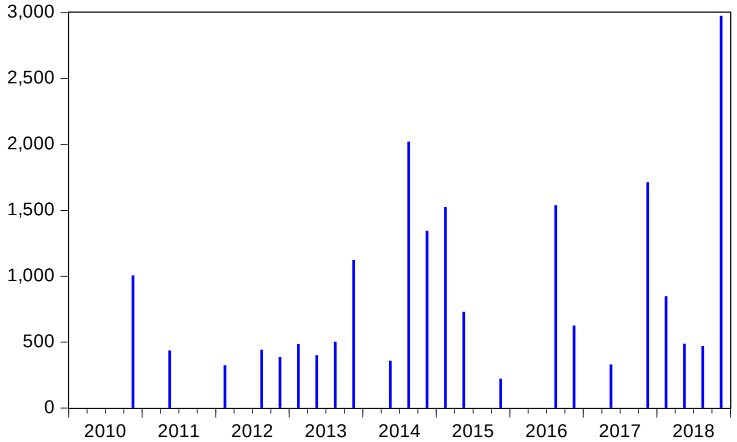
Source: LFS, PSA

Figure 22. Number of Environmental Protection Professionals, April 2013 - October 2018



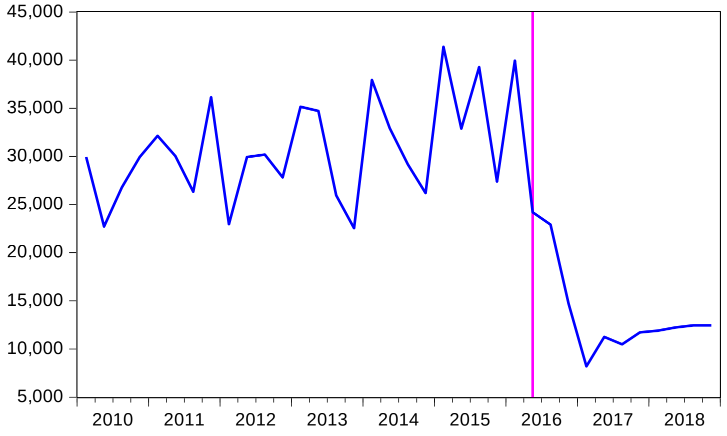
Source: LFS, PSA

Figure 23. Number of Geologists and Geophysicists, 2010-2018



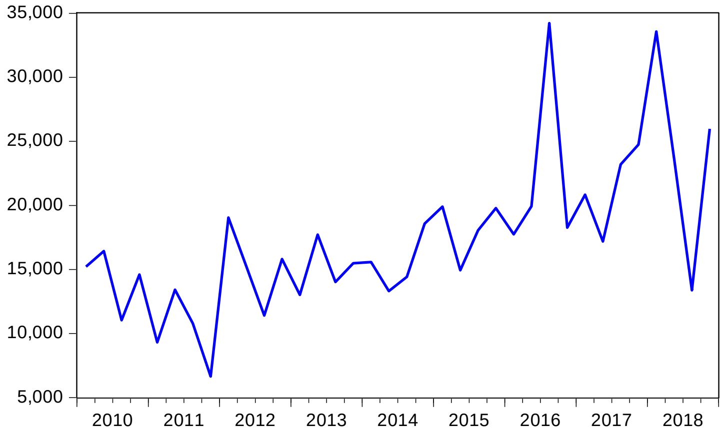
Source: LFS, PSA

Figure 24. Number of Software Developers, 2010-2018



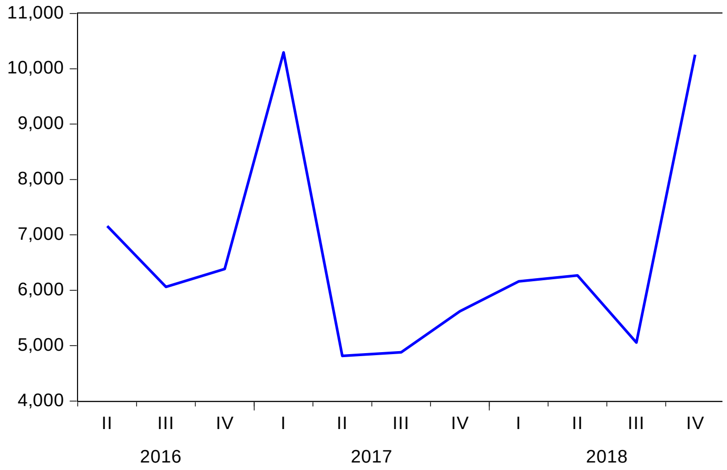
Source: LFS, PSA

Figure 25. Number of Mechanical Engineers, 2010-2018



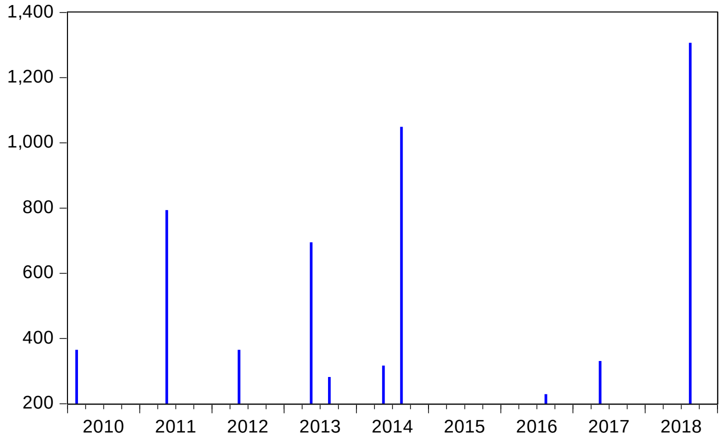
Source: LFS, PSA

Figure 26. Number of Cartographers and Surveyors, April 2016 - October 2018



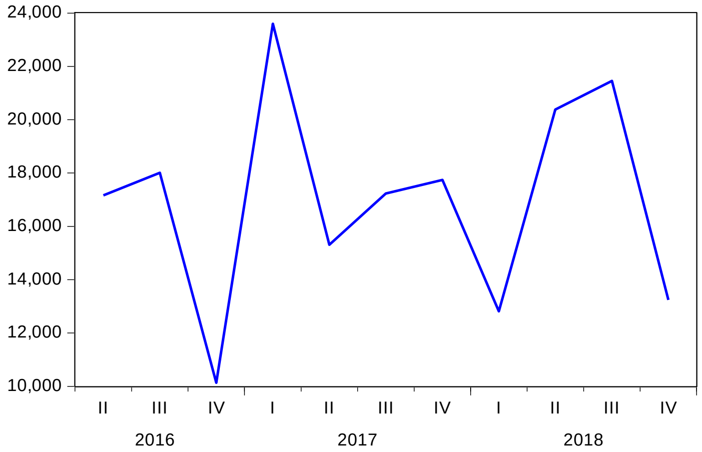
Source: LFS, PSA

Figure 27. Number of Meteorologists, 2010-2018



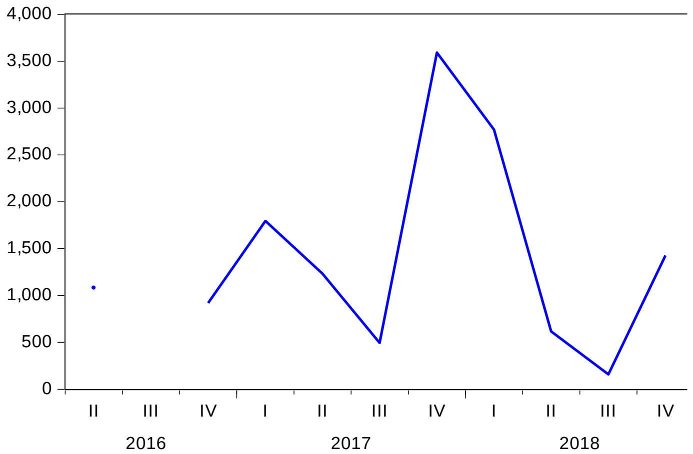
Source: LFS, PSA

Figure 28. Number of Graphic and Multimedia Designers, April 2016 - October 2018



Source: LFS, PSA

Figure 29. Number of Landscape Architects, April 2016 - October 2018

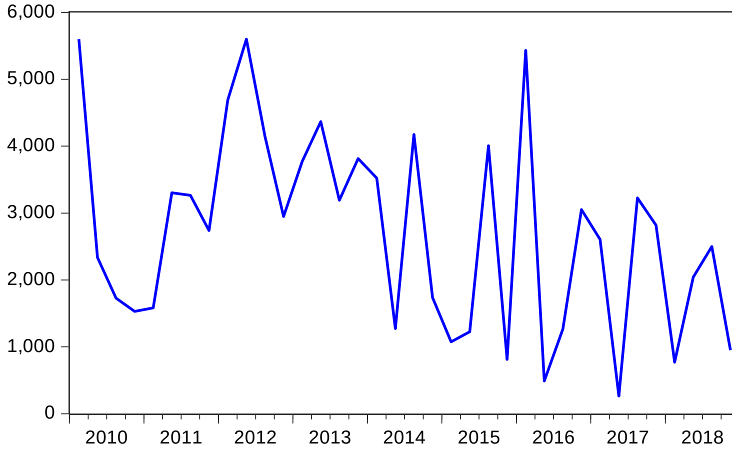


All nine series for the ff. occupations are comparatively long, but two are sparse – *mining engineers, metallurgists and related professionals* and *biologists, botanists, zoologists and related scientists*.[6] The projected declines by the end of 2025 are rather large for some of these

[6] The series *physicists and astronomers* is not projected because it has only four observations in 2010-2018.

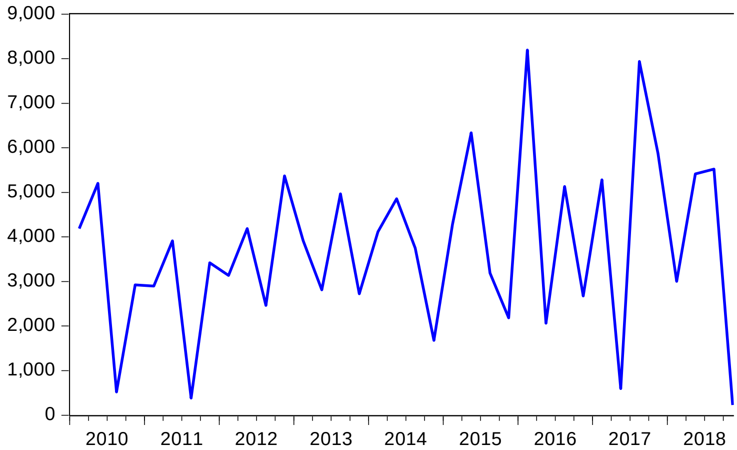
occupations partly because of the limitation of applying an annual rate successively. But all series exhibit declining trends and/or lower levels particularly at the latter part of the series. The declining trend in *farming, forestry and fisheries advisers* is most noticeable. (See **Figures 30-36**. The plot for mathematicians and actuaries is **Figure 18** shown earlier).

Figure 30. Number of Town and Traffic Planners, 2010-2018



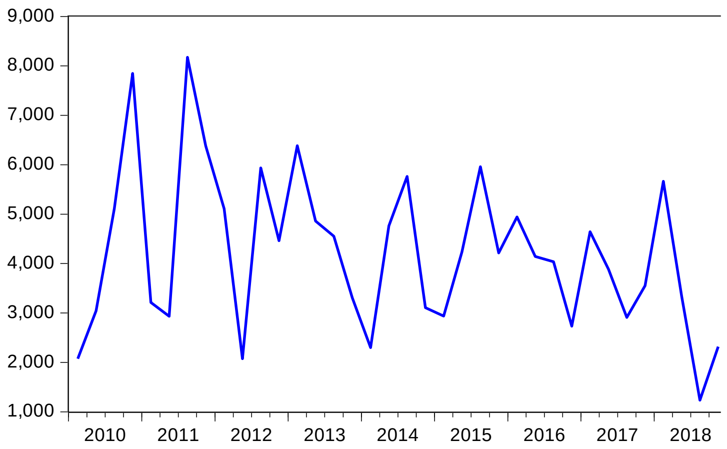
Source: LFS, PSA

Figure 31. Number of Chemical Engineers, 2010-2018



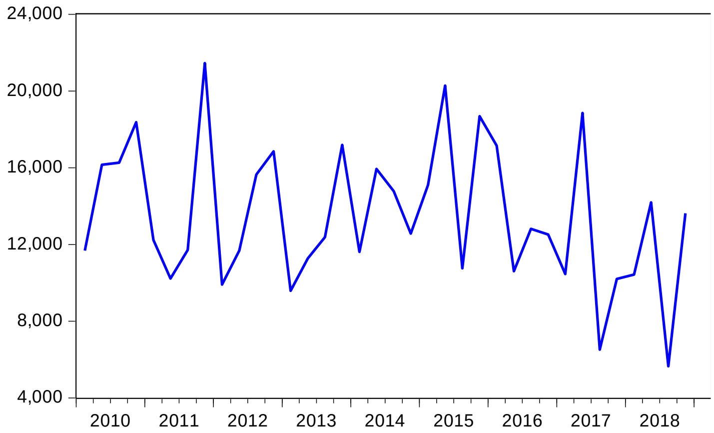
Source: LFS, PSA

Figure 32. Number of Chemists, 2010-2018



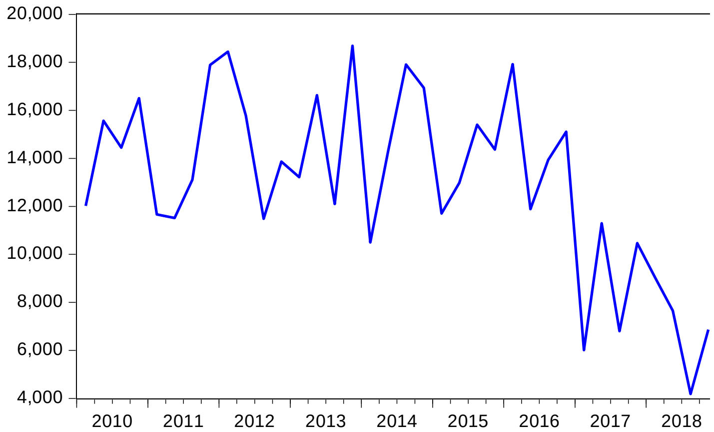
Source: LFS, PSA

Figure 33. Number of Electronics Engineers, 2010-2018



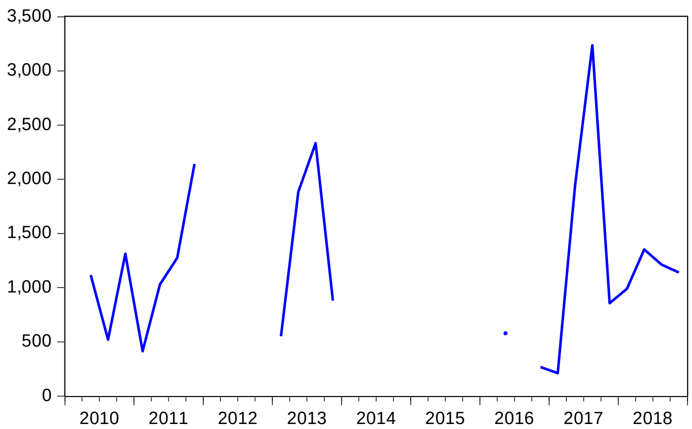
Source: LFS, PSA

Figure 34. Number of Farming, Forestry, and Fisheries Advisers, 2010-2018



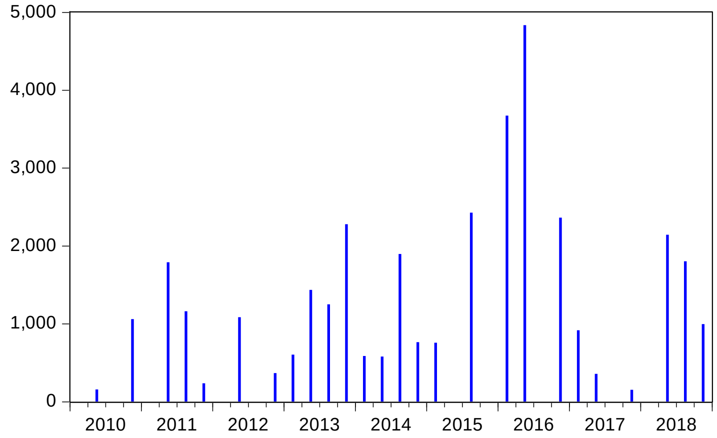
Source: LFS, PSA

Figure 35. Number of Mining Engineers, Metallurgists, and Related Professionals, 2010-2018



Source: LFS, PSA

Figure 36. Number of Biologists, Botanists, Zoologists, and Related Scientists, 2010-2018



Source: LFS, PSA

Chemical engineering was flagged as one of the top 10 paying jobs (for those with one to four years' experience) in the Philippines in 2018 (Business Diary, 2018). In addition, the country's investment priorities plan encourages investments in chemical manufacturing, research and development and the production of oleochemicals, petrochemicals and derivatives, and chlor-alkali products as priority areas (Bellen, 2017). This is also being confirmed by industry associations. Thus positive growth in employment is possible if the industry can address some of the challenges it faces, among them shortage of experts.

For mining engineers, a decline in employment is indicated by the 2018 values of the series. Growth in the value of the country's mineral output is projected to decline by one percentage point annually from 6% in 2018 to 2% in 2022 due to environmental regulation and increase in excise taxes (Business World, 2018). Production is actually declining; some growth in value is still realized on account of generally high world prices of minerals. But *mining engineers* is among the cross-cutting occupations in 2017-2022 identified by the JobsFit report.

The projected levels of employment for the different S&T occupations covered in the LFS are shown in **Annex Table A-2**. The levels are projected for three growth scenarios – low, medium and high growth. The more likely outcome is a combination of these growth rates from year to year rather than a sustained low, a sustained medium or a sustained high growth rate. But the levels are indicative of possible developments.

4.5. Emerging S&T Fields

Hereunder is a list of emerging fields based on current course offerings (as degree program, specialization or internship program) and research thrusts in some of the country's higher education institutions (HEIs) that offer quality S&T programs, as obtained from interviews with officials of these HEIs:

1. Mechatronics and robotics engineering
2. Alternative energy engineering
3. Bioinformatics
4. Nanotechnology
5. Pervasive computing

Meanwhile, the following list enumerates emerging computer-science-related jobs in the country which have not yet been classified in the PSOC and are thus not found in available microdata of the LFS:

1. Information security analyst
2. Back end developer (i.e. develops programming that powers a website)
3. Full stack engineer (i.e. versed in both front end and back end of software and application development)

5. Outlook on S&T Human Resource Requirements

In this section, we look specifically at the academic sector and the government sector. The former provides the supply of S&T human resources, while the latter provides some, albeit a small portion of the demand for S&T human resources. The rationale for looking at the latter is that the residual from the total demand as projected is absorbed by the private sector.

5.1. Academe Sector

The academe sector produces the graduates who form part of the supply of workers in the labor market. This section on the academe sector provides insights from secondary data obtained from the Commission on Higher Education (CHED) and other studies on graduates of S&T degree programs. Most of the S&T degree programs belong to the STEM discipline groups, namely, Engineering and Technology, IT-Related Disciplines, Mathematics, Medical and Allied Fields, and Natural Science, and the available data are usually aggregated by these five discipline groups. It is therefore a limitation in this section that many results could not be presented by degree program.

5.1.1. Enrollment

Table 12 shows the combined national enrollment data for the STEM undergraduate and graduate degree programs from academic year 2005-2006 to 2018-2019 per STEM discipline group. From academic year 2005-2006 to 2009-2010 Medical and Allied Disciplines had the highest enrollment levels among all discipline groups. From 2010-2011 to 2011-2012 and in 2013-2014, IT-related disciplines had the most enrollment. In 2012-2013 and from 2014-2015 to 2018-2019, Engineering and Technology had the highest enrollment levels. Mathematics had consistently the lowest enrollment levels among all discipline groups within the covered academic years.

Table 12. National Enrollment Data in the Combined Undergraduate and Graduate STEM Degree Programs by Discipline Group, 2005-2006 to 2018-2019

Academic Year	Enrollment					Total
	Engineering and Technology	IT-Related Disciplines	Mathematics	Medical and Allied Disciplines	Natural Science	
2005-2006	298964	239548	10994	544513	26204	1120223
2006-2007	306664	247337	13382	602474	24757	1194614
2007-2008	305848	279826	11688	560296	24389	1182047
2008-2009	315453	302057	12115	520026	23580	1173231

2009-2010	339045	346427	12310	440160	24242	1162184
2010-2011	354321	377438	12792	365715	25758	1136024
2011-2012	367620	393913	13595	284598	27442	1087168
2012-2013	406831	404813	13992	243285	30394	1099315
2013-2014	424143	425416	16195	228484	38219	1132457
2014-2015	463221	433712	17544	224897	41454	1180828
2015-2016	517010	460862	18247	228537	45069	1269725
2016-2017	448550	398765	14109	203561	34923	1099908
2017-2018	370710	315694	11814	176532	29307	904057
2018-2019	424269	314414	12315	215234	31188	997420

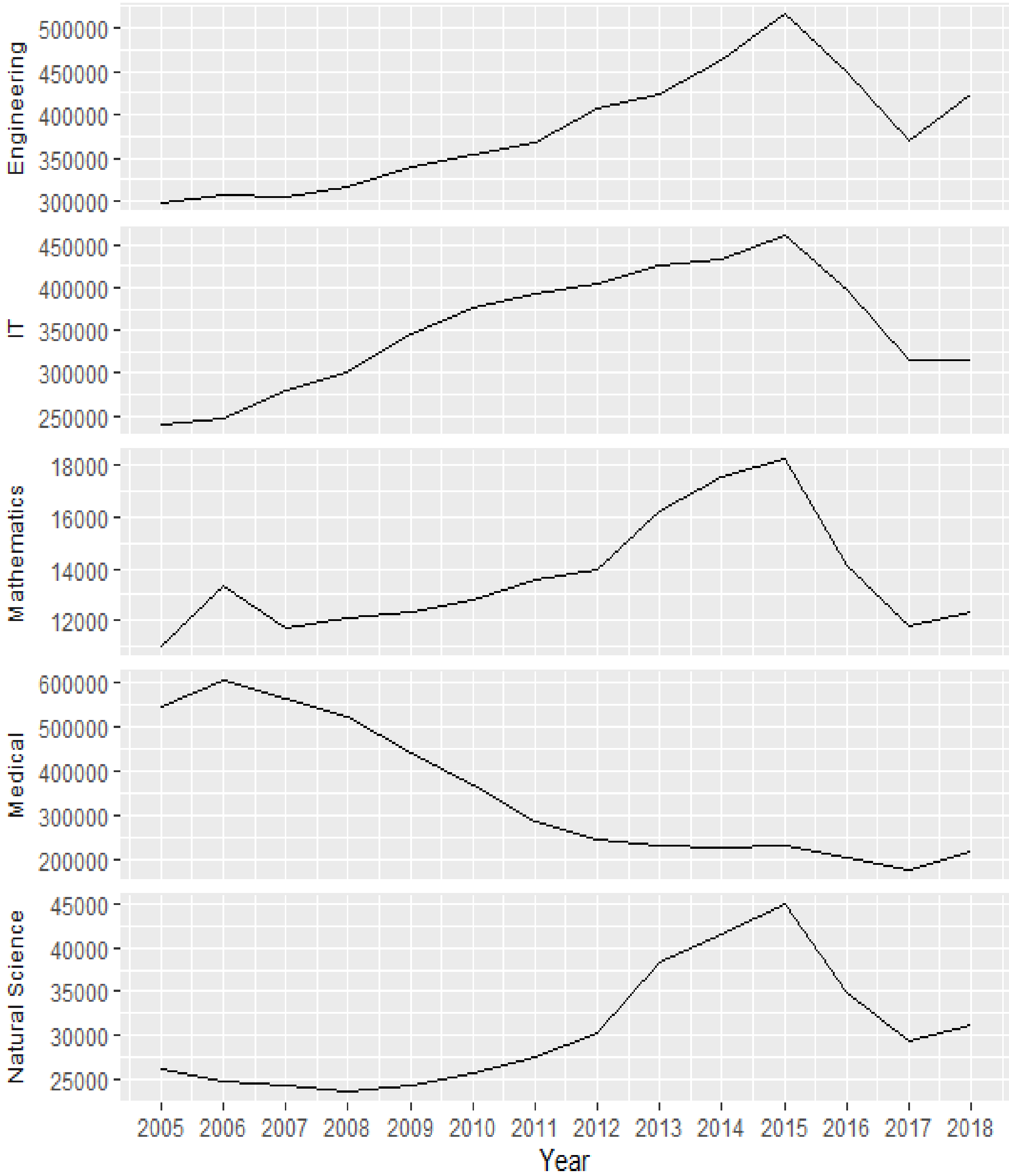
Source: CHED

From the table, Engineering and Technology degree programs as well as IT-Related degree programs have been the choices of most STEM enrollees since academic year 2011-2012. At least 33.81% of the enrollees in academic year 2011-2012 were in Engineering and Technology and 36.23% of the enrollees in that year were in IT-Related Disciplines. Together, the two discipline groups comprised at least 69.04% of the total STEM enrollment in 2011-2012. By academic year 2015-2016, at least 77.02% of total STEM enrollment were in these two discipline groups with Engineering and Technology having more enrollments (40.72%) than IT-Related Disciplines (36.30%). The dominance of these two discipline groups in terms of enrollment is expected to currently continue given the demand for graduates of these fields.

All discipline groups show reduced enrollments in the years 2016-2017 and 2017-2018 because these were the academic years when no high school graduates enrolled at the tertiary level due to the implementation of the K-12 program. If data for these academic years are excluded, the remaining numbers in the table show generally increasing enrollment trends in all discipline groups except in the Medical and Allied Disciplines group. The patterns per discipline group can be seen in **Figure 37**. The continuous general decline of enrollment in the Medical and Allied Disciplines group may have been fueled by the decline in Nursing enrollment after 2006.

It may be expected that tertiary enrollment levels in academic year 2018-2019, the year when the first batch of senior high schools have graduated, would return to similar levels in 2015-2016. But this has not happened as can be seen from **Table 12**. An explanation for this is the likelihood that some senior high school graduates have decided to forego college enrollment in favor of finding work.

Figure 37. Trends in the Combined Enrollment in the Undergraduate and Graduate Degree Programs by STEM Discipline Group, 2005-2006 to 2018-2019



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Enrollment forecasts are useful in determining the quantity of qualified teachers as well as in making decisions on the allocation of resources. Enrollment data is also useful in forecasting the number of graduates. Forecasting of enrollment may be done by using growth rates or by using sophisticated time series models. The method using growth rates is used in forecasting enrollment per discipline group in this section.

The year-to-year growth rates for the enrollment data are presented in **Table 13**. Within the period covered by data, growth in enrollment began in academic year 2008-2009 in Engineering and Technology, in 2005-2006 in IT-Related Disciplines, in 2008-2009 in Mathematics, and in 2009-2010 in Natural Science. There was negative enrollment growth in Medical and Allied Disciplines since 2006-2007 but slightly bounced in 2015-2016.

Table 13. Growth Rates in Percent of the Combined Enrollment in the Undergraduate and Graduate Degree Programs by STEM Discipline Group, 2005-2006 to 2015-2016.

Academic Year	Enrollment Growth Rate in Percent				
	Engineering and Technology	IT-Related Disciplines	Mathematics	Medical and Allied Disciplines	Natural Science
2006-2007	2.58	3.25	21.72	10.64	-5.52
2007-2008	-0.27	13.14	-12.66	-7.00	-1.49
2008-2009	3.14	7.94	3.65	-7.19	-3.32
2009-2010	7.48	14.69	1.61	-15.36	2.81
2010-2011	4.51	8.95	3.92	-16.91	6.25
2011-2012	3.75	4.36	6.28	-22.18	6.54
2012-2013	10.67	2.77	2.92	-14.52	10.76
2013-2014	4.26	5.09	15.74	-6.08	25.75
2014-2015	9.21	1.95	8.33	-1.57	8.46
2015-2016	11.61	6.26	4.01	1.62	8.72
2016-2017	-13.24	-13.47	-22.68	-10.93	-22.51
2017-2018	-17.35	-20.83	-16.27	-13.28	-16.08
2018-2019	14.45	-0.41	4.24	21.92	6.42

There are years when the growth rate shifts to a much higher or lower level than in the previous year. Identifying the breakpoints or years when the unusual shifts in growth occurred may help suggest which growth rates should be considered when forecasting using growth rates. The estimated breakpoints per discipline group are listed in **Table 14**. An asterisk indicates that all growth rates for the following years except the K-12 affected years 2016-2017 and 2017-2018 are to be average to make a forecast. The average growth rare is then taken to be the estimated growth rate of enrollment in 2019-2020. The growth rates for years following 2019-2020 are computed analogous to the moving average method.

Table 14. Estimated Breakpoints in the Trend Plots of the Combined Enrollment in the Undergraduate and Graduate Degree Programs by STEM Discipline Group, 2005-2006 to 2018-2019

Discipline Group	Enrollment Breakpoints
Engineering and Technology	2008-2009, 2011-2012, 2013-2014*, 2016-2017
IT-Related Disciplines	2006-2007, 2008-2009, 2011-2012*, 2016-2017
Mathematics	2012-2013*, 2015-2016
Medical and Allied Disciplines	2008-2009, 2010-2011*
Natural Science	2010-2011. 2012-2013*, 2015-2016

The enrollment forecasts in S&T disciplines groups are presented in **Table 15**. As in the previous section, the projections provided in this report should be used with caution as they are computed from merely an average of recent growth rates and these enrolment projections ignore various factors that can affect enrollment.

Table 15. 2019-2020 Estimated Growth Rates in Percent and Forecasts of Combined Enrollment in the Undergraduate and Graduate Degree Programs by STEM Discipline Group for Academic Years 2019-2020 to 2025-2026

Discipline Group	Academic Year	Estimated Enrollment Growth Rate (in %)	Enrollment Forecast
Engineering and Technology	2019-2020	11.76	474153
	2020-2021	12.61	533924
	2021-2022	12.94	602998
	2022-2023	12.43	677972
	2023-2024	12.66	763794
	2024-2025	12.68	860616
	2025-2026	12.59	968964
IT-Related Disciplines	2019-2020	3.13	324262
	2020-2021	3.21	334656
	2021-2022	2.83	344121
	2022-2023	3.00	354459
	2023-2024	2.35	362799
	2024-2025	2.90	373337
	2025-2026	2.86	384010
Mathematics	2019-2020	8.08	13310
	2020-2021	6.16	14131
	2021-2022	5.62	14925
	2022-2023	6.03	15825
	2023-2024	6.47	16849
	2024-2025	6.07	17872
	2025-2026	6.05	18954
Medical and Allied Disciplines	2019-2020	-3.47	207770
	2020-2021	-0.35	207044
	2021-2022	2.01	211209
	2022-2023	3.36	218308
	2023-2024	4.18	227440
	2024-2025	4.61	237925
	2025-2026	1.72	242029
Natural Science	2019-2020	12.34	35036
	2020-2021	8.99	38184
	2021-2022	9.12	41664
	2022-2023	9.21	45503
	2023-2024	9.91	50014
	2024-2025	9.31	54668
	2025-2026	9.39	59800

On increasing the S&T enrollment and producing more S&T graduates, we have the following questions or issues. First, how effective is the K-12 curriculum in providing students with S&T knowledge and skills? And, second, how effective are science sections and science schools in producing S&T students? Are there enough science sections and science schools in the country?

The K-12 curriculum, science schools, and science sections are all means of exposing students to S&T (thereby developing their interest in S&T) and of providing them with capability in

S&T. If these three avenues are effective in developing the child's interest and capability in S&T, plus the influence of environment including perceived income from S&T jobs, then the chance of the child enrolling in an S&T degree program is higher.

5.1.2. Graduates

Table 16 shows the combined number of graduates for the STEM undergraduate and graduate degree programs from academic year 2004-2005 to 2017-2018 per STEM discipline group. From academic year 2004-2005 to 2011-2012, Medical and Allied Disciplines had the most graduates, dominated by Nursing, among all discipline groups. From 2012-2013 to 2015-2016, IT-Related Disciplines had the most graduates. In 2016-2017 and 2017-2018, Engineering and Technology had the most graduates. The effect of the implementation of the K-12 program on the number of graduates is expected to be felt in academic years 2019-2020 and 2020-2021 for four-year degree programs, and 2020-2021 and 2021-2022 for five-year degree programs. On the other hand, Mathematics had consistently the fewest graduates among all discipline groups within the covered academic years.

Table 16. National Data on Graduates in the Combined Undergraduate and Graduate STEM Degree Programs by Discipline Group, 2004-2005 to 2018-2019

Academic Year	Graduates					Total
	Engineering and Technology	IT-Related Disciplines	Mathematics	Medical and Allied Fields	Natural Science	
2004-2005	47273	37511	2043	60655	4890	152372
2005-2006	48643	36572	2170	88372	4068	179826
2006-2007	46104	35692	1773	111288	3832	198690
2007-2008	47866	38334	1748	121702	3730	213380
2008-2009	47468	44516	2100	128402	4155	226642
2009-2010	49393	49786	2022	116380	3958	221538
2010-2011	57456	54225	1908	100925	3911	218424
2011-2012	56707	66735	2074	76201	4330	206047
2012-2013	59432	72308	3004	57466	5597	197808
2013-2014	63787	73325	2428	50711	6128	196378
2014-2015	70750	74592	2698	44753	6998	199792
2015-2016	74786	77312	2736	41880	6828	203540
2016-2017	82794	73646	3034	43012	7160	209646
2017-2018	86860	77747	3446	42425	8693	219171

Source: CHED

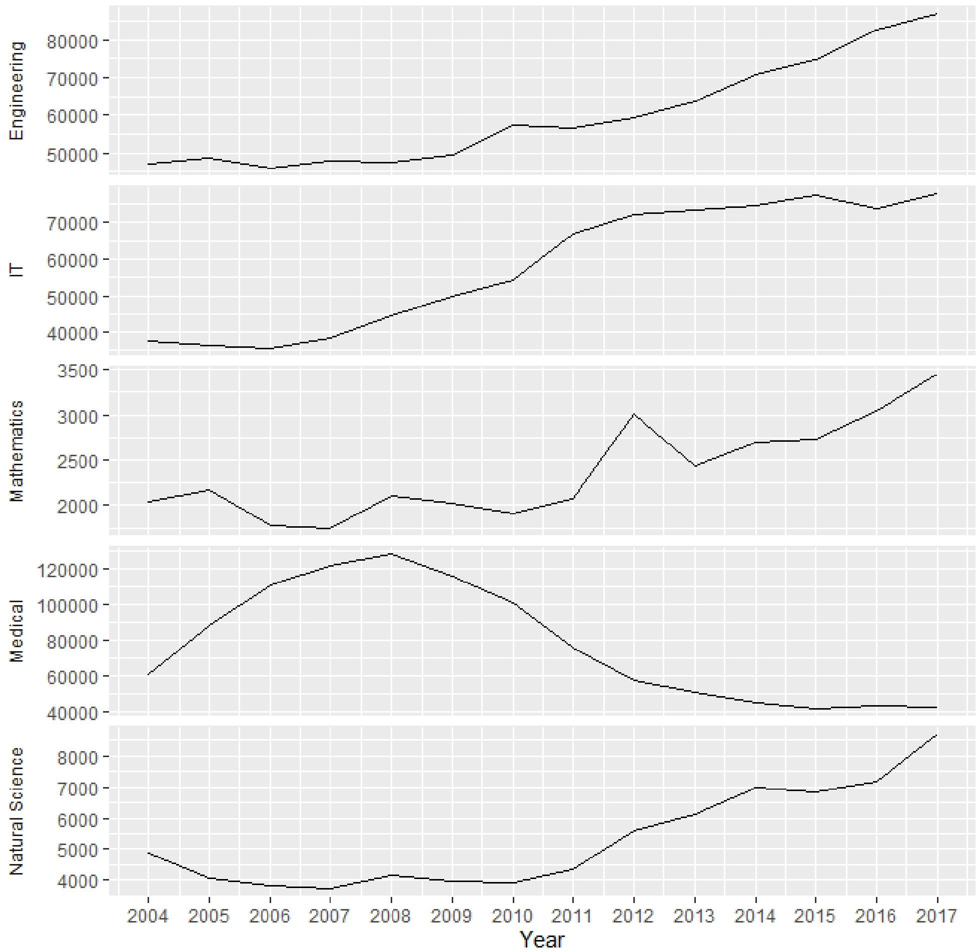
More than a quarter (26.30%) of graduates in academic year 2010-2011 were in Engineering and Technology and another quarter (24.83%) of graduates in that year were in IT-Related Disciplines. Together, the two discipline groups comprised more than half (51.13%) of the total STEM graduates in 2010-2011. By academic year 2017-2018, three quarters (75.10%) of the total STEM graduates were in these two discipline groups with Engineering and Technology having about two-fifths (39.63%) of the total graduates, compared to IT-Related Disciplines (35.47%). The dominance of these two discipline groups in terms of graduates is expected to currently continue given the demand for graduates of these fields (see previous sections).

Growth rates and trends in number of graduates per academic year per discipline group are shown in **Table 17** and **Figure 38**, respectively. Year-to-year growth in number of graduates has been positive for Engineering and Technology since academic year 2012-2013 and positive since academic year 2014-2015 for Mathematics. There is a generally downward trend in the number of graduates in Medical and Allied Disciplines since academic year 2009-2010, although the decrease has recently slowed down. Growth in the number of graduates in IT-Related Disciplines is not as much as in Engineering and Technology in recent years, while in Natural Science, growth in number of graduates has been a mix of ups and downs but has followed a generally upward trend.

Table 17. Growth Rates (in %) of the Combined Number of Graduates in the Undergraduate and Graduate Degree Programs by STEM Discipline Group, 2004-2005 to 2017-2018

Academic Year	Engineering and Technology	IT-Related Disciplines	Mathematics	Medical and Allied Disciplines	Natural Science
2005-2006	2.90	-2.50	6.24	45.70	-16.80
2006-2007	-5.22	-2.41	-18.31	25.93	-5.80
2007-2008	3.82	7.40	-1.41	9.36	-2.67
2008-2009	-0.83	16.13	20.14	5.51	11.39
2009-2010	4.05	11.84	-3.74	-9.36	-4.75
2010-2011	16.32	8.92	-5.64	-13.28	-1.17
2011-2012	-1.30	23.07	8.73	-24.50	10.71
2012-2013	4.81	8.35	44.86	-24.59	29.26
2013-2014	7.33	1.41	-19.19	-11.75	9.48
2014-2015	10.92	1.73	11.12	-11.75	14.21
2015-2016	5.70	3.65	1.41	-6.42	-2.44
2016-2017	10.71	-4.74	10.89	2.70	4.86
2017-2018	4.91	5.57	13.58	-1.36	21.41

Figure 38. Trends in the Combined Graduates in the Undergraduate and Graduate Degree Programs by STEM Discipline Group, 2004-2005 to 2017-2018



The number of enrollees who graduate on time may be affected by various factors. **Table 18** shows the estimated percentage of enrollees who graduate on time per discipline group from academic year 2005-2006 to 2014-2015.

Table 18. Enrollment and Estimated Percentage of Graduates Per Discipline Groups, 2005-2006 to 2014-2015

Discipline Group	Academic Year	Enrollment	Graduated 4 or 5 Years Later	Estimated Percent Graduated (%)
Engineering and Technology*	2005-2006	298964	49393	16.52
	2006-2007	306664	57456	18.74
	2007-2008	305848	56707	18.54
	2008-2009	315453	59432	18.84
	2009-2010	339045	63787	18.81
	2010-2011	354321	70750	19.97
	2011-2012	367620	74786	20.34
	2012-2013	406831	82794	20.35
	2013-2014	424143	86860	20.48
	2014-2015	463221		
	2005-2006	239548	44516	18.58

Discipline Group	Academic Year	Enrollment	Graduated 4 or 5 Years Later	Estimated Percent Graduated (%)
IT-Related Disciplines	2006-2007	247337	49786	20.13
	2007-2008	279826	54225	19.38
	2008-2009	302057	66735	22.09
	2009-2010	346427	72308	20.87
	2010-2011	377438	73325	19.43
	2011-2012	393913	74592	18.94
	2012-2013	404813	77312	19.10
	2013-2014	425416	73646	17.31
	2014-2015	433712	77747	17.93
Mathematics	2005-2006	10994	2100	19.10
	2006-2007	13382	2022	15.11
	2007-2008	11688	1908	16.32
	2008-2009	12115	2074	17.12
	2009-2010	12310	3004	24.40
	2010-2011	12792	2428	18.98
	2011-2012	13595	2698	19.85
	2012-2013	13992	2736	19.55
	2013-2014	16195	3034	18.73
	2014-2015	17544	3446	19.64
Medical and Allied Disciplines	2005-2006	544513	128402	23.58
	2006-2007	602474	116380	19.32
	2007-2008	560296	100925	18.01
	2008-2009	520026	76201	14.65
	2009-2010	440160	57466	13.06
	2010-2011	365715	50711	13.87
	2011-2012	284598	44753	15.72
	2012-2013	243285	41880	17.21
	2013-2014	228484	43012	18.82
	2014-2015	224897	42425	18.86
Natural Science	2005-2006	26204	4155	15.86
	2006-2007	24757	3958	15.99
	2007-2008	24389	3911	16.04
	2008-2009	23580	4330	18.36
	2009-2010	24242	5597	23.09
	2010-2011	25758	6128	23.79
	2011-2012	27442	6998	25.50
	2012-2013	30394	6828	22.46
	2013-2014	38219	7160	18.73
	2014-2015	41454	8693	20.97

Note: Data on number of graduates assumes five-year degree programs in Engineering and Technology and four-year degree programs in the other STEM discipline groups
Source: CHED (enrollment data)

The computations in the previous table were done assuming four-year courses in each academic group except in Engineering and Technology which was assumed to have five-year courses.

The table shows that all discipline groups have percentages of enrollees who graduate on time lower than 25%.

It is difficult to forecast the number of graduates given the data because the last data on graduates is for academic year 2017-2018 and the effect of the K-12 program on the number of graduates is expected to be felt in academic years 2019-2020 and 2020-2021. Thus, the increasing trends shown in Figure 38, except in Medical and Allied Disciplines, may not continue throughout academic years 2019-2020 and 2020-2021, unless the K-12 program has no effect on the number of graduates. It is possible though to estimate the number of graduates as a percentage of enrollment using the estimated percentages graduated in **Table 18**. The percentage graduated in the forecast year is taken to be a moving average of the percentages graduated in the past three years. The results of this procedure are presented in **Table 19**. As in previous forecasts in his subsection, the forecasted values should be used with caution as they are computed from recent percentages graduated, which may be inaccurately measured.

While graduates in S&T are projected in this study to be generally increasing in the next five years, there are factors that have impact on attainment of this projected trend. Increasing the enrollment and number of graduates in S&T requires the development of student interest and capability in S&T, and the reduction in the number of S&T students failing to graduate on time.

Also, producing more graduates would not be enough to meet the projected undersupply of manpower in most S&T disciplines. We also need to consider the quality of education. Ensuring the quality of S&T education means working for improvements in teaching quality and school facilities and ensuring sufficient qualified faculty and relevant courses and degree programs.

How effective are the following in reducing percentage of S&T students who do not graduate on time: entrance and IQ exams; scholarships and financial assistance; and counselling and healthcare for students? What methods are used to match students with degree programs and how effective are they in reducing the percentage of students who fail to graduate on time? Answers to these questions are important because the number of students earning their S&T degree on time directly affects the number of new graduates entering the S&T workforce.

Table 19. Forecast of Graduates as a Percentage of Enrollment by Discipline Group Up to Academic Year 2025-2026

Discipline Group	Enrolled in Academic Year	Enrollment	Graduated in Academic Year	Average of Last Three Percentages Graduated	Forecast of Number of Graduates
Engineering and Technology	2014-2015	463221	2018-2019	20.39	94451
	2015-2016	517010	2019-2020	20.41	105522
	2016-2017	448550	2020-2021	20.43	91639
	2017-2018	370710	2021-2022	20.41	75662
	2018-2019	424269	2022-2023	20.42	86636
	2019-2020	474153*	2023-2024	20.42	96822
	2020-2021	533924*	2024-2025	20.42	109027
	2021-2022	602998*	2025-2026	20.42	123132
IT-Related Disciplines	2015-2016	460862	2018-2019	18.11	83462
	2016-2017	398765	2019-2020	17.78	70900
	2017-2018	315694	2020-2021	17.94	56636

Discipline Group	Enrolled in Academic Year	Enrollment	Graduated in Academic Year	Average of Last Three Percentages Graduated	Forecast of Number of Graduates
	2018-2019	314414	2021-2022	17.94	56406
	2019-2020	324262*	2022-2023	17.89	58011
	2020-2021	334656*	2023-2024	17.92	59970
	2021-2022	344121*	2024-2025	17.92	61666
	2022-2023	354459*	2025-2026	17.91	63484
Mathematics	2015-2016	18247	2018-2019	19.31	3523
	2016-2017	14109	2019-2020	19.23	2713
	2017-2018	11814	2020-2021	19.39	2291
	2018-2019	12315	2021-2022	19.31	2378
	2019-2020	13310*	2022-2023	19.31	2570
	2020-2021	14131*	2023-2024	19.34	2733
	2021-2022	14925*	2024-2025	19.32	2884
	2022-2023	15825*	2025-2026	19.32	3057
Medical and Allied Disciplines	2015-2016	228537	2018-2019	18.30	41822
	2016-2017	203561	2019-2020	18.66	37984
	2017-2018	176532	2020-2021	18.61	32853
	2018-2019	215234	2021-2022	18.52	39861
	2019-2020	207770*	2022-2023	18.60	38645
	2020-2021	207044*	2023-2024	18.58	38469
	2021-2022	211209*	2024-2025	18.57	39222
	2022-2023	218308*	2025-2026	18.58	40562
Natural Science	2015-2016	45069	2018-2019	20.72	9338
	2016-2017	34923	2019-2020	20.14	7033
	2017-2018	29307	2020-2021	20.61	6040
	2018-2019	31188	2021-2022	20.49	6390
	2019-2020	35036*	2022-2023	20.41	7151
	2020-2021	38184*	2023-2024	20.50	7828
	2021-2022	41664*	2024-2025	20.47	8529
	2022-2023	45503*	2025-2026	20.46	9310

Note: Forecasted values were based on estimates of graduates from Table 16.

5.1.3. DOST scholarships for S&T degree programs

One factor that affects choice of and enrollment in a degree program is the financial means of a household. The DOST provides various scholarships to qualified students in S&T degree programs. **Annex Table A-2** summarizes the S&T undergraduate and graduate disciplines currently available for scholarship slots.

A rationale for the DOST scholarship programs is to provide opportunities for enrolling and graduating in S&T disciplines. In theory at least, more DOST scholarships mean more enrollees and, consequently, more graduates in S&T disciplines. However, the number of scholarship slots is capped depending on the available funds and the need or demand for the degree programs. **Table 20** below provides data on the number of DOST scholar-graduates for academic years 2006-2007 to 2017-2018. The data shows that the number of scholar-graduates has been increasing in the recent academic years 2015-2016 to 2017-2018 but the percentage of scholar-graduates among S&T graduates has remained below 3%.

Table 20. Number, Ratio, and Percentage of Undergraduate and Graduate DOST Scholar-Graduates Among Graduates of S&T Degree Programs, 2006-2007 to 2017-2018

Year	Graduates	Number of Scholar-Graduates			Ratio of Scholar-Graduates to Graduates	Percentage of Scholar-Graduates Among Graduates (%)
		Under-graduate Programs	Graduate Programs	Total		
2006-2007	198690	1667	15	1682	1:118	0.85
2007-2008	213380	1482	85	1567	1:136	0.73
2008-2009	226642	1274	165	1439	1:157	0.63
2009-2010	221538	1215	232	1447	1:153	0.65
2010-2011	218424	1482	308	1790	1:122	0.82
2011-2012	206047	1852	390	2242	1:92	1.09
2012-2013	197808	1766	365	2131	1:93	1.08
2013-2014	196378	1256	334	1590	1:124	0.81
2014-2015	199792	782	727	1509	1:132	0.76
2015-2016	203540	1815	777	2592	1:79	1.27
2016-2017	209646	2978	819	3797	1:55	1.81
2017-2018	219171	3655	898	4553	1:48	2.08

Source: DOST

The success of a scholarship program may be indicated by the proportion of scholars who graduate on time. **Table 21** gives the estimated percentage of DOST undergraduate scholars who graduated on time during academic years 2006-2007 to 2014-2015.

Table 21. Estimated Percentage of DOST Undergraduate S&T Scholars in Academic Years 2006-2007 to 2014-2015 Who Graduated on Time

Academic Year	Number of Undergraduate Scholars	Graduated Four Years Later		Graduated Five Years Later	
		Number	Percent (%)	Number	Percent (%)
2007-2008	9798	1482	15.13	1852	18.90
2008-2009	10284	1852	18.01	1766	17.17
2009-2010	11246	1766	15.70	1256	11.17
2010-2011	10142	1256	12.38	782	7.71
2011-2012	9099	782	8.59	1815	19.95
2012-2013	9565	1815	18.98	2978	31.13
2013-2014	10031	2978	29.69	3655	36.44
2014-2015	12117	3655	30.16		

Source: DOST (number of scholars)

Because the data on undergraduate scholars consists of students enrolled in four-year and five year-degree programs and it is not possible to isolate scholars in four-year programs and scholars in five-year programs because of the data aggregation, the table has to incorporate columns on estimated counts and percentages of scholar-graduates four years later and five years later. The estimated percentages are lower than 50% indicating that approximately less than half of the DOST undergraduate scholars in S&T graduated on time during the period. Dropping out of the scholarship program, leave of absence, and shifting to another degree program may have been the possible reasons, among others, for not graduating on time during the period.

5.1.4. Passing rate in PRC examinations

In the five-year period 2012 to 2016, six S&T degree program were in the top 10 of degree programs with highest mean number of Professional Regulation Commission (PRC) board examinees. The S&T degree program with the highest mean number of takers during the period was Nursing with an average of 60515 examinees per year. Other degree programs included in the top 10 are listed in **Table 22**.

Table 22. Top 10 Ranking of S&T Degree Programs with Highest Mean Number of PRC Examinees During the period 2012 to 2016.

Top 10 Rank	Degree Program	Mean Number of PRC Examinees Per Year
3	Nursing	60515
6	Civil Engineering	12448
7	Electronics Engineering	7463
8	Electrical Engineering	5267
9	Midwifery	5131
10	Medical Technology	5088

Source: PRC

Table 23 presents the mean number of PRC examinees in 2012 to 2016 per degree program in each S&T discipline group. The degree program which had the highest mean number of PRC examinees during the period was B.S. Civil Engineering (12448) in the Engineering and Technology discipline group, B.S. Nursing (60515) in the Medical and Allied Disciplines group, and B.S. Chemistry (740) in the Natural Science discipline group.

Table 23. Mean Number of PRC Examinees Per Year and Degree Program in Each S&T Discipline Group During the Period 2012 to 2016

Discipline Group	Degree Program	Mean Number of PRC Examinees Per Year
Engineering and Technology	Civil Engineering	12448
	Electronics Engineering	7463
	Electrical Engineering	5267
	Mechanical Engineering	4974
	Chemical Engineering	1267
	Marine Engineering	984
	Agricultural Engineering	717
	Geodetic Engineering	455
	Aeronautical Engineering	257
	Mining Engineering	165
	Sanitary Engineering	152
	Naval Architecture & Marine Engineering	90
	Metallurgical Engineering	66
IT-Related Disciplines	Library Science	812
Medicine and Allied Disciplines	Nursing	60515
	Midwifery	5131

Discipline Group	Degree Program	Mean Number of PRC Examinees Per Year
	Medical Technology	5088
	Pharmacy	4375
	Medicine	3604
	Radiologic Technology	2661
	Physical Therapy	1624
	Nutrition and Dietetics	980
	Veterinary Medicine	694
	Dental Medicine	629
	Respiratory Therapy	407
	Occupational Therapy	247
	Optometry	161
Natural Science	Chemistry	740
	Geology	246

The passing rates in the PRC exams provides information on the quality of education in S&T degree programs. **Table 24** lists the S&T degree programs that are in the top ten degree programs with the highest mean percent passing during the period 2012 to 2016.

Table 24. S&T Degree Programs Belonging to the Top 10 Degree Programs With Highest Mean Percent Passing in PRC Examinations During the Period 2012 to 2016

Top 10 Rank	Degree Program	Mean Percent Passing (%)
1	Dental Medicine	97.14
2	Optometry	85.83
3	Mining Engineering	82.92
4	Medical Technology	79.35
5	Medicine	74.15
6	Metallurgical Engineering	69.00
7	Mechanical Engineering	65.33
8	Nutrition and Dietetics	64.94

Table 25 shows the mean passing rates of the PRC examinations for the years 2012 to 2016 per degree program in each S&T discipline group. In Engineering and Technology, B.S. Mining Engineering had the highest mean passing rate during the period, while B.S. Marine Engineering, B.S. Agricultural Engineering, B.S. Civil Engineering, B.S. Electronics Engineering, and B.S. Geodetic Engineering had mean passing rates during the period lower than 50%. In Medical and Allied Disciplines, B.S. Dental Medicine had the highest mean passing rate, while B.S. Occupational Therapy, B.S. Radiologic Technology, B.S. Midwifery, B.S. Nursing, B.S. Respiratory Therapy, B.S. Veterinary Medicine had mean passing rates lower than 50%. Other S&T degree programs with mean passing rates lower than 50% during the period was B.S. Library Science and B.S. Geology.

An indicator of the quality of education is the passing rate in the PRC examination. Schools need to meet standards on its facilities: libraries, laboratories, project working areas, and classrooms. It is important that these facilities are complete, match the needs of the degree programs, updated, well-equipped, and are used by students. Since Engineering and Technology is already projected to have an undersupply of manpower in 2025, the poor performance of some Engineering and Technology degree programs will aggravate this condition in the future.

Table 25. Mean Passing Rates in PRC Examinations For the Period 2012 to 2016 Per Degree Program in S&T Discipline Groups

Discipline Group	Degree Program	Mean Percent Passing (%)
Engineering and Technology	Mining Engineering	82.92
	Metallurgical Engineering	69.00
	Mechanical Engineering	65.33
	Sanitary Engineering	58.36
	Chemical Engineering	57.45
	Electrical Engineering	54.08
	Aeronautical Engineering	51.48
	Naval Architecture and Marine Engineering	50.93
	Marine Engineering	45.39
	Agricultural Engineering	43.61
	Civil Engineering	42.80
	Electronics Engineering	39.61
	Geodetic Engineering	37.39
IT-Related Disciplines	Library Science	46.46
Medical and Allied Disciplines	Dental Medicine	97.14
	Optometry	85.83
	Medical Technology	79.35
	Medicine	74.15
	Nutrition and Dietetics	64.94
	Pharmacy	56.75
	Physical Therapy	56.20
	Occupational Therapy	49.38
	Radiologic Technology	48.40
	Midwifery	47.94
	Nursing	44.59
	Respiratory Therapy	40.22
	Veterinary Medicine	37.85
Natural Science	Chemistry	54.03
	Geology	43.38

Source: PRC

5.1.5. 2014 CHED-PIDS Tracer Study

The 2014 CHED-PIDS Graduates Tracer Study was a national study conducted in part to identify the jobs of graduates from academic years 2009-2010 and 2010-2011. This was meant to provide an idea of any jobs mismatch. Here, we discuss data pertaining only to S&T graduates in the said tracer study. The most common baccalaureate degree earned by the 5253 sample graduates of S&T degree programs traced in the study was Nursing. It was estimated that almost half (47.19%) of the graduates of S&T degree programs during the covered period was in Nursing. Although enrollment (consequently, graduates) in Nursing significantly declined in academic years 2009-2010 and 2010-2011, there was still a large population of

Nursing enrollees relative to other S&T degree programs. **Annex Table A-3** lists the S&T degree programs sorted by their percentage of graduates during the covered period.

The table also shows that after B.S. Nursing, B.S. Information Technology (11.96%) and B.S. Computer Science (8.15%) dominated the number of graduates during the reference period. This reflects the higher demand for these courses during the reference period over engineering degrees like Industrial Technology (5.20%) which is ranked fourth, B.S. Civil Engineering (2.70%) which is ranked fifth, and B.S. Electronics and Electrical Engineering (1.73%) which is ranked seventh. Over time, these percentages may change or even flip with Engineering degrees possibly having the higher percentages because of increased demand and financial means of the households.

The percentage of graduates with a given degree in S&T are shown in **Annex Table A-4**. In Engineering and Technology, the degree program with the highest percentage of graduates during the reference period is B.S. Industrial Technology (28.83%); in IT-Related Disciplines, it is B.S. Information Technology (56.27%); in Mathematics, it is (75.68%); in Medical and Allied Disciplines, it is B.S. Nursing (96.57%); and in Natural Science, it is B.S. Biology (81.48%).

The study also determined the jobs of the S&T graduates. Of the 5253 graduates in 2008-2010 and 2010-2011 who were in the sample, 3885 or 73.96% were employed as of 2014 (**Annex Table A-5**). The various jobs per degree program are listed in Table 18. The data shows that although most of the S&T graduates in the sample were working as professionals in their field or in related fields, there were those who were working in jobs unrelated to their field of expertise or unrelated to their technical skills. For example, 45.45% of the chemical engineers in the sample were working in their field as professionals, but 18.18% were working as clerks and 9.09% were working as health professionals.

5.1.6. 2019 TIP Tracer Study

HEIs have been encouraged by CHED to conduct tracer studies on their respective graduates. The Technological Institute of the Philippines (TIP) conducted this year its first tracer study. **Table 26** shows the percentage of TIP S&T graduates who are directly using their expertise in their jobs, based on this study.

Table 26. Percentage of TIP S&T Graduates Working in Jobs Directly Related to Their Education as of 2019

Degree Program Graduated in	Directly Using Their Expertise (%)	Not Directly Using Their Expertise (%)
B.S. Civil Engineering	76.61	23.39
B.S. Computer Engineering	85.42	14.58
B.S. Electrical Engineering	80.50	19.50
B.S. Electronics Engineering	82.91	17.09
B.S. Environmental and Sanitary Engineering	77.42	22.58
B.S. Industrial Engineering	67.65	32.35
B.S. Mechanical Engineering	81.36	18.64
B.S. Marine Engineering	98.96	1.04
Bachelor of Secondary Education Major in Math	71.88	28.12
Bachelor of Secondary Education Major in Science	52.63	47.37
B.S. Computer Science	68.25	31.75

B.S. Information Technology	66.22	33.78
B.S. Information Systems	33.00	67.00

Source: TIP

Data shows that all Engineering degree programs of TIP have more than 60% of their graduates working in jobs directly related to their expertise. Among the Engineering graduates, those who finished B.S. Industrial Engineering have the highest percentage (32.35%) who are not directly using their expertise in their jobs. Further, nearly half (47.37%) of Bachelor of Secondary Education Major in Science graduates of TIP are working in jobs that are not directly related to their expertise. Among IT-Related degree programs in TIP, B.S. Information Systems has about two-thirds (67.00%) of its graduates working in jobs not directly related to their expertise. These results suggest either the lack of demand or an oversupply of graduates in certain fields, or the unemployability of certain degrees because of perceived issues on the quality of education in these degrees.

Aside from conducting tracer studies to determine the relevance of S&T degree programs, there should be a regular assessment of the relevance of existing S&T degree programs so that any deficiency could be corrected making the country better prepared in coping with the disruptions brought by FIRe (Quismorio *et al*, 2019).

5.1.7. New programs offered in DLSU

The academe has a variety of functions. It must be able to produce knowledge through research. It must also be able to develop talents and innate capabilities of the students. When capabilities of students are lacking or insufficient, the academe must be able to provide, develop, or enhance such capabilities. It must be responsive in meeting the manpower and know-how requirements of industry, government, and the population. Because of these, college and university curricula are regularly reviewed and revised, and old degree programs are abolished and new ones developed. Research agendas of academic institutions are also reviewed and revised.

Development or revision of a degree programs may signify that the HEI has knowledge of future manpower needs or is attuned to developments in doing things. One such academic institution is e De La Salle University (DLSU), which has been revising and instituting new courses to meet the changing manpower requirements. Since 2010, it has instituted 23 new degree programs. **Table 27** lists these new degree programs and the number of graduates.

Table 27. New Degree Programs in De La Salle University Since 2010 and Their Number of Graduates as of Academic Year 2018-2019

Year	New Degree Program	S&T Discipline Group	Number of Graduates as of 2018-2019
2010	Doctor of Philosophy in Chemistry	Natural Science	1
2011	Bachelor of Science in Information Systems	IT-Related Disciplines	110
	Bachelor of Science in Service Engineering and Management	Engineering and Technology	135
	Bachelor of Science in Technical Communication	IT-Related Disciplines	40
	Doctor of Philosophy in Electronic Engineering	Engineering and Technology	2

Year	New Degree Program	S&T Discipline Group	Number of Graduates as of 2018-2019
	Doctor of Philosophy in Materials Science and Engineering	Engineering and Technology	1
2012	Doctor of Philosophy in Chemical Engineering	Engineering and Technology	2
2013	Bachelor of Arts in Digital Cinema	non-STEM	50
	Master of Science in Biological Engineering	Engineering and Technology	11
	Master of Science in Industrial Engineering	Engineering and Technology	6
	Master of Science in ME	Engineering and Technology	11
	Master of Arts in Multimedia Arts	non-STEM	6
2015	Bachelor of Science in Education Technology	IT-Related Disciplines	8
	Master of Arts in Psychology	Natural Science	4
2016	Bachelor of Physical Education	non-STEM	0
	Bachelor of Science in Entertainment and Multimedia Computing	IT-Related Disciplines	0
	Bachelor of Science in Physics	Natural Science	3
	Master in Information Technology	IT-Related Disciplines	1
2017	Doctor of Philosophy in Computer Science	IT-Related Disciplines	0
2018	Bachelor of Arts in Digital Film	non-STEM	0
	Master in Business Analytics	IT-Related Disciplines	0
2019	Bachelor of Arts in Broadcast Media	non-STEM	0
	Bachelor of Science in Statistics	Mathematics	0

Source: DLSU

The table shows that out of the (23) degree programs instituted by DLSU since 2010, the bulk (17, equivalent to 73.91% of the programs) are in STEM. Among these STEM degree programs, seven are in Engineering and Technology, seven are in IT-Related Disciplines, two are in Natural Sciences, and one in Mathematics. There are five doctoral degree programs, five master's degree programs, and seven bachelor's degree programs among these. The doctoral and master's degrees are mostly in Engineering and Technology while the bachelor's degrees are mostly in IT-Related Disciplines. Also, in the last five years (that is, 22015 to 2019), five out 11 instituted degree programs are in IT-Related Disciplines, one in Mathematics, one in Natural Science, and four in non-STEM disciplines.

5.1.8. Faculty in the Academe Sector

Table 28. Number and Growth Rates of Faculty Nationwide in Private Higher Education Institutions and State Universities and Colleges, 2013-2014 to 2018-2019

Academic Year	Faculty*	Growth Rate
2013-2014	142673	
2014-2015	146432	0.0263
2015-2016	152688	0.0427
2016-2017	151252	-0.0094
2017-2018	143024	-0.0544
2018-2019	128601	-0.1008

Source: CHED

Recent data in **Table 28** suggests a decreasing trend in number of faculty within the academic years 2015-2016 to 2018-2019. Meanwhile, **Table 29** shows projections of faculty population in the country's academe should this trend continue. The projected counts are computed by multiplying the estimated count in the previous year by the moving average of previous five growth rates.

Table 29. Estimated Growth Rates and Projected Number of Faculty Nationwide in Private Higher Education Institutions and State Universities and Colleges, 2019-2020 to 2025-2026

Academic Year	Average of Previous Five Growth Rates	Projected Faculty
2019-2020	-0.0191	126143
2020-2021	-0.0282	122584
2021-2022	-0.0424	117388
2022-2023	-0.0490	111637
2023-2024	-0.0479	106288
2024-2025	-0.0373	102321
2025-2026	-0.0410	98129

Predicting the current and future number of S&T faculty by discipline group based on data in the past 10 years is difficult because of insufficient data. There is available data within academic years 2001-2002 to 2004-2005 and it may be used to compute percentages of faculty teaching in the discipline groups. Assuming there is not much deviation from these percentages over the years, current and future number of S&T faculty per discipline group may be predicted using these percentages. **Table 30** presents the number of faculty teaching in higher education institutions and their percentages within academic years 2001-2002 to 2004-2005 by discipline group. The data comes from two sources: (i) the DOST-SEI study titled Scientific and Technological Teaching Manpower Requirements in 2000 to 2010 conducted by Ana Maria L. Tabunda in 2007 using data from the 2001-2002 CHED Survey on Faculty, and (ii) CHED's Higher Education Statistical Bulletin for Academic Years 2003-2004 and 2004-2005.

Table 30. Number of Faculty Nationwide in Private Higher Education Institutions and State Universities and Colleges by Discipline Group, 2001-2002 to 2004-2005

Discipline	2001-2002 Faculty		2002-2003 Faculty		2003-2004 Faculty		2004-2005 Faculty	
	Count*	Percent	Count*	Percent	Count*	Percent	Count**	Percent
Agriculture, Forestry, Fisheries, and Veterinary Medicine	1869	1.89	3516	3.20	3322	2.90	3203	2.88
Engineering and Technology	5442	5.50	8333	7.58	9237	8.06	9105	8.19
Mathematics and Computer Science	5053	5.11	1637	1.49	7365	6.42	1869	1.68
Medical and Allied Disciplines	4903	4.96	9593	8.73	11302	9.86	12482	11.22
Natural Science	5139	5.19	2866	2.61	3072	2.68	3263	2.93
IT-Related Disciplines	4058	4.10	5216	4.75	5591	4.88	4239	3.81
Maritime	501	0.51	1257	1.14	1049	0.91	1060	0.95
Other Disciplines	71978	72.75	77474	70.50	73717	64.29	76004	68.33

Total	98943	100.00	109892	100.00	114655	100.00	111225	100.00
S&T Subtotal	26965	27.25	32418	29.50	40938	35.71	35221	31.67

(*) Source: Tabunda (2007).

(**) Source: CHED Higher Education Statistical Bulletin AY 2003-2004 and 2004-2005

Table 31 shows the projected count of faculty per discipline group in the years 2013-2014 to 2018-2019 assuming the percentages shown in Table 30 do not deviate much from the corresponding true percentages in these academic years. Within these years, data on the total number of faculty in the academe is available from CHED. The counts per academic year are computed by multiplying the total number of faculty in that academic year by the moving averages of the available three previous percentages of faculty in the discipline groups.

Table 31. Estimated Percentages and Predicted Number of Faculty Nationwide in Private Higher Education Institutions and State Universities and Colleges by Discipline Group, 2013-2014 to 2018-2019

Discipline Group	2013-2014 Faculty		2014-2015 Faculty		2015-2016 Faculty		2016-2017 Faculty		2017-2018 Faculty		2018-2019 Faculty	
	Average of Three Previous Available Percentages	Predicted Count	Average of Three Previous Available Percentages	Predicted Count	Average of Three Previous Available Percentages	Predicted Count	Average of Three Previous Available Percentages	Predicted Count	Average of Three Previous Available Percentages	Predicted Count	Average of Three Previous Available Percentages	Predicted Count
Agriculture, Forestry, Fisheries, and Veterinary Medicine	3.0	4269	2.9	4280	2.9	4476	3.0	4460	2.9	4197	2.9	3779
Engineering and Technology	7.9	11331	8.1	11804	8.1	12311	8.0	12134	8.1	11512	8.0	10346
Mathematics and Computer Science	3.2	4563	3.8	5517	2.9	4400	3.3	4965	3.3	4735	3.2	4062
Medical and Allied Disciplines	9.9	14177	10.3	15139	10.5	16031	10.3	15516	10.4	14825	10.4	13341
Natural Science	2.7	3910	2.8	4077	2.8	4305	2.8	4207	2.8	3998	2.8	3599
IT-Related Disciplines	4.5	6389	4.4	6426	4.2	6452	4.4	6601	4.3	6187	4.3	5537
Maritime	1.0	1432	1.0	1402	1.0	1483	1.0	1479	1.0	1386	1.0	1251
Other Disciplines	67.7	96603	66.8	97786	67.6	103228	67.4	101891	67.3	96185	67.4	86687
Total	100.0	142673	100.0	146432	100.0	152688	100.0	151252	100.0	143024	100.0	128601
S&T Subtotal	32.3	46070	33.2	48646	32.4	49460	32.6	49361	32.8	46839	32.6	41914

There is lack of data on the total number of faculty in the years 2019-2020 to 2025-2026. For the purpose of computing projections of faculty per discipline group in these years, the counts in Table 29 are used. The computation procedure used is the same as the one used in Table 31. The output of these computations is presented in **Table 32**.

Table 32. Estimated Percentages and Projected Number of Faculty Nationwide in Private Higher Education Institutions and State Universities and Colleges by Discipline Group, 2019-2020 to 2025-2026

Discipline Group	2019-2020 Faculty		2020-2021 Faculty		2021-2022 Faculty		2022-2023 Faculty		2013-2024 Faculty		2024-2025 Faculty	
	Average of Three Previous Available Percentages	Predicted Count	Average of Three Previous Available Percentages	Predicted Count	Average of Three Previous Available Percentages	Predicted Count	Average of Three Previous Available Percentages	Predicted Count	Average of Three Previous Available Percentages	Predicted Count	Average of Three Previous Available Percentages	Predicted Count
Agriculture, Forestry, Fisheries, and Veterinary Medicine	2.9	3709	2.9	3601	2.9	3450	2.9	3281	2.9	3123	2.9	3007
Engineering and Technology	8.0	10140	8.0	9861	8.0	9441	8.0	8977	8.0	8548	8.0	8229
Mathematics and Computer Science	3.3	4100	3.2	3971	3.2	3775	3.2	3612	3.2	3434	3.2	3302
Medical and Allied Disciplines	10.3	13034	10.4	12696	10.4	12155	10.4	11552	10.4	11004	10.4	10592
Natural Science	2.8	3522	2.8	3426	2.8	3281	2.8	3119	2.8	2971	2.8	2860
IT-Related Disciplines	4.3	5464	4.3	5297	4.3	5071	4.3	4827	4.3	4593	4.3	4422
Maritime	1.0	1227	1.0	1191	1.0	1141	1.0	1085	1.0	1033	1.0	995
Other Disciplines	67.3	84946	67.3	82540	67.4	79073	67.4	75182	67.4	71581	67.4	68914
Total	100.0	126143	100.0	122584	100.0	117388	100.0	111637	100.0	106288	100.0	102321
S&T Subtotal	32.7	41196	32.7	40044	32.6	38314	32.7	36455	32.7	34707	32.7	33407

Meanwhile, average teaching load measured in terms of average number of classes per teacher is an indicator of an oversupply or undersupply of teachers. To compute this measure, the number of classes must first be determined. Assuming a class has 35 students and students enroll in six S&T courses in an academic year, then the number classes can be estimated in a simple way by dividing the number of students by 35 and multiplying the result by 6. The increasing projected enrollment in the years 2019-2020 to 2025-2026 and the decreasing projected number of faculty in those years results in an increasing average number of classes per teacher. **Table 33** shows that if the usual number of course taught by a teacher in an academic year is eight, and if the decreasing trend in number of faculty continues, then there will be a demand for more S&T teachers from 2022 onwards.

The country needs more S&T faculty in order to produce more graduates. However, if the recent decreasing trend in the overall number of faculty as shown by CHED data continues, then this study forecasts a lack of S&T teachers by 2022-23. An examination of the impact of faculty development through Ph.D. scholarships and increased pay, benefits, and incentives on faculty retention is also highly recommended.

Table 33. Average Number of S&T Classes Per Teacher, 2019-2020 to 2025-2026

Academic Year	Projected S&T Enrollment	Estimated Number of Classes	Projected Number of S&T Faculty*	Average Number of Classes Per Teacher
2019-2020	1054531	241036	36260	7
2020-2021	1127939	257815	35253	7
2021-2022	1214917	277695	33723	8
2022-2023	1312067	299901	32088	9
2023-2024	1420896	324776	30550	11
2024-2025	1544418	353010	29405	12
2025-2026	1673757	382573	28204	14

Note: This computation excludes faculty in the Agriculture, Forestry, Fisheries, and Veterinary Medicine Discipline Group and faculty in the Maritime Discipline Group.

5.2. Government Sector

The government is the single largest employer of S&T graduates in the country. From the total 1,435,676 government plantilla personnel, about 7.8% are S&T workers. In particular, the following departments and its attached agencies have the most number of technical personnel in its plantilla in 2018: Department of Health (DOH), State Universities and Colleges (SUCs), Department of Agriculture, Department of Public Works and Highways (DPWH), Department of Environment and Natural Resources (DENR), and DOST (**Table 34**).

Table 34. Total Number of Positions and Total Number of S&T Personnel, selected government agencies

Department	Total Positions	Total S&T Plantilla Categories	Total S&T Personnel*	Median SG
DOH	65,956	132	55,231	SG15 (Nurse II)
SUCs	46,531	42	20,470**	SG15 (Asst Prof. I)
DA/DAR	27,040	42	12,732	SG14 (Sr. Agrarian Reform Technologist)
DPWH	15,226	19	12,220	SG16 (Engineer II)
DENR	13,374	96	6,849	SG15 (Forester II)
DOST	5,865	32	4,765	SG16 (Science Research Specialist II)
Various (IT/ICT)	4,947	24	4,236	SG16 (Information Systems Analyst II)
Various/PSA (Statisticians)	3,546	15	2,279	SG16 (Statistical Specialist II)
Total	173,992	363	112,167	

Note: (*) Included are SG10 and above and does not include administrative, finance and management positions; (**) Estimated percentage of personnel in Agriculture, Science and Engineering Colleges.

Source: Department of Budget and Management

If all medical and allied fields workers are considered S&T workers, they will represent the majority in government. The total full-time and part-time medical field positions in the DOH with rank of Salary Grade (SG) 10 and above is 65,956. An overwhelming number of these are nurses (22,913) and medical doctors (19,045) with part-time and full-time posts in government hospitals.

A separate count is likewise done of S&T personnel teaching in the SUCs working as instructors and professors in Science and Engineering departments. There are a total of 46,531 teaching positions in the SUCs, however, there is no definitive count of the number or proportion of faculty in S&T. Using the profile of a representative SUC from Southern Luzon, the number of S&T faculty in this SUC (excluding Medicine/Nursing faculty) accounts for 44% (123) of the total 278 faculty members. The largest colleges are those of Engineering and IT followed by Forestry and Agriculture. The largest non-S&T colleges are those of Education and Nursing. Using the percentage of S&T faculty in this SUC, there are roughly 20,470 S&T graduates employed in all SUCs.

The Department of Agriculture (DA) and the Department of Agrarian Reform (DAR) have fairly spread out plantilla categories. It is unclear if Agrarian Reform Officers need to have a degree in Agriculture to qualify. However, assuming all agriculture, agrarian reform technologists and aquaculture positions require related degrees, there are a total of 12,732 personnel in these two departments. The positions, Agriculturist II (1,208) and Agrarian Reform Technologist I (3,033) have the greatest number of plantilla positions, respectively.

In the DPWH, majority of the positions are Engineer II (7,562) that mostly reside in the District Offices of the DPWH. In fact, counting Engineer III (2,885, SG19) and Engineer IV (785, SG22) positions, this class of S&T personnel dominate the Department's plantilla posts and make up a large majority of the total 12,220 personnel in this Department. Moreover, in 2019 there are a total of 46,944 DPWH personnel under the Cost of Service category or project-based personnel. Project-based personnel, majority of which are likewise engineers (70% based on a 2019 DPWH Administrative Order), outnumber regular personnel by 3 to 1. If project-based personnel are considered, DPWH exceeds the DOH in terms of the highest number of S&T personnel employed.

The DENR has a total of 6,849 S&T personnel. There are 96 categories in DENR's plantilla positions with Foresters (1,249 personnel) being the majority Science field in the Department. This is comprised of Forester I positions (587), Forester II (443), Forester III (215), and Forester IV (4). There are also quite a number of specialists under the positions Ecosystem Management and Environmental Management specialists in the DENR comprising 2,250 personnel. However, it is unclear whether these positions require a degree in environmental science, biology or related fields.

Majority of the positions in the DOST agencies fall under the various levels of the Science Research Specialist positions (4,116 personnel). These positions do not prescribe a certain science or engineering degree to qualify but is left to the discretion of the agency. The largest agency employing S&T workers is DOST-PAGASA with 594 weather and weather facilities specialists. A detailed breakdown of S&T positions for representative DOST agencies is provided below (See **Table 35**).

Table 35. Manpower Complement by selected agencies under DOST

Agency	Total positions	Total Admin	Total Technical					BS/BA	MS/MA	PhD
			Science and Math Grads	Eng'g Grads	IT and ICT	Tech. Mg't	Others			
RDI A	83	25	5	34	6	5	8	55	20	1
RDI B	80	35	13	10	5	5	12	37	28	1
RDI C	174	59	42	18	3	12	40	82	44	11
Average	112.3	39.7	20.0	20.7	4.7	7.3	20.0	58.0	30.7	4.3
%Total		35.3	17.8	18.4	4.2	6.5	17.8	51.6	27.3	3.9
Management A	63	23	35	0	0	0	5	32	27	0
Management B	36	19	2	1	0	2	12	15	11	3
Management C	54	18	7	1	3	4	21	31	17	2
Average	51.0	20.0	14.7	0.7	1.0	2.0	12.7	26.0	18.3	1.7
%Total		39.2	28.8	1.3	2.0	3.9	24.8	51.0	35.9	3.3
Regional Office A	28	9	4	5	1	2	7	20	5	2
Regional Office B	34	9	3	8	2	2	10	22	10	0

Regional Office C	53	8	11	6	2	7	19	38	8	2
Regional Office D	41	12	6	9	2	6	6	28	10	0
Regional Office E	42	9	7	4	0	15	7	20	14	6
Regional Office F	34	9	5	9	1	3	7	25	6	1
Regional Office G	37	6	5	4	2	5	15	22	10	1
Average	38.4	8.9	5.9	6.4	1.4	5.7	10.1	25.0	9.0	1.7
%total	100	23.0	15.2	16.7	3.7	14.9	26.4	65.1	23.4	4.5

Source: DOST

Personnel in the category of Information Technology (IT and ICT) under the government's Planning Services which is distributed across the Bureaucracy total to 4,236. On the other hand, statisticians total to 2,279 and are presumed to be mostly working in the PSA. This number does not include the 1,129 Assistant Statistician posts (SG9) which may or may not require a relevant degree (i.e. BS Statistics) to qualify for this post.

Box 1. Restructuring Research and Development Institutes to enhance innovation

DOST R&D Institutes (RDIs) are a special type of government agency engaged in basic and applied research. While all RDIs also provide some form of service to the general public, its core function remains to be similar to SUCs engaged in research than an R&D management or service agency in DOST. In fact, its deliverables are more analogous to the research outputs of SUCs which includes publications, patents, and trainings. It is in making this comparison that the structure of RDIs must be more similar to SUCs rather than the other DOST agencies. This shift in structure is thought to result in a more productive environment and an increase in interest from S&T graduates to join RDIs.

Flatter bureaucracy. In SUCs, the various position levels (e.g. Instructors, Assistant, Associate and Full Professors) are not arranged in a hierarchy. Lower level positions are not expected to serve as support staff to higher level positions. This is not the case in RDIs where the various levels of Science Research Specialists (SRS) are arranged in such a way that they are grouped with a Supervising or Chief SRS serving as head of the research group or division. This inhibits independent R&D efforts from lower scientist levels. It should be mentioned that there are examples within DOST where lower level SRS are independently conducting research and that these should be commended.

Promotion based on performance. Mobility in terms of promotion should not be hinged on any vacancy in the higher positions but instead dependent solely on the performance of the individual. This is the case in SUCs wherein the plantilla position being occupied by an individual can progress in step and rank until the highest rank possible. Such structure eliminates the need to have a vacancy in higher posts for someone to get promoted. The Scientific Career System partly offers a solution for highly productive senior research specialists.

Tenure for productivity. In the UP system, faculty members are not only working on an increase in their rank but also to gain tenure. In each step, there is a prescribed set of deliverables within a specified time period that a faculty member should accomplish to merit an increase in rank and tenure at the professor level. This also encourages RDI personnel to pursue higher degrees in order for them to get to the next level. It should be mentioned here that a similar tenure and promotion system in SUCs is used in the military service. Adopting this ensures productivity at every level in RDIs and provide a clear path towards progress in one’s career.

Term-limited management positions. In DOST, promotion to higher level SRS positions meant doing more administrative work. In fact, going beyond the SRS level (Deputy Director and Director) meant a permanent administrative post for scientists. In SUCs, administrative posts such as Directors, Associate Deans and Deans are term-limited. These are posts in addition to their work as faculty members and are not a permanent promotional step. After their administrative term, a faculty simply resumes his/her rank and workload as faculty. Adopting this in RDIs will also mean a natural cycle of administration changes which is commonplace in the executive and legislative branches of government.

5.2.1. Preferred S&T fields in the government

Majority of S&T plantilla positions in government are silent in the specific field of specialization that is being required and is commonly left to the discretion of each agency. However, the Engineer and Dredging Operation positions for example in the DPWH are predominantly Civil Engineers followed by Electrical and Mechanical Engineers. Similar with the DPWH, DOST's SRS positions are dependent on the nature or field of the agency. Lumped together in Information Technology positions (4,236), these can be occupied by graduates of ECE, IT, Computer Science, Computer Engineering and other related courses. Even in the DENR where many positions are field-specific, majority are also generic titles such as Land and Ecosystems Managers which can be occupied by personnel with degrees in forestry, agriculture or biological and environmental sciences.

Majority of specified positions in government include Agriculturists (3,336) in DA/DAR, Statisticians (2,279) in PSA, Foresters (1,440) in DENR, and Meteorologists (594) in DOST-PAGASA.

5.2.2. Distribution of S&T workers in DOST

DOST agencies that have participated in a survey for this study provided valuable information regarding their manpower complement. DOST agencies are anonymized and categorized as follows: Research and Development Institutes (RDIs), Research Management (grant-giving agencies), and Regional Offices which mainly does local S&T Services. Overall, 36 to 51% of positions are occupied by S&T personnel in each agency. As expected, a greater percentage of S&T personnel are found in RDIs and those providing S&T services compared to science management agencies which will tend to have bigger administrative and accounting divisions as dictated by the nature of their work. However, more personnel with advanced degrees (Masters and Doctorate) are found in R&D management agencies (39%) compared to RDIs (31%) and Regional Offices (28%). The mix of S&T personnel in each agency is largely dictated by the plantilla positions available. The lesser number of higher science research specialist positions effectively limit the recruitment of people with higher degrees.

5.2.3. Foreseen trends in government hiring

Requests for additional S&T personnel have been approved for DOH medical doctors and nurses, and for statisticians for the PSA. The passing of RA 11055 in 2017 or the Act of establishing the Philippine ID System and its Implementing Rules and Regulations in 2018 shall result in an increase in demand (of about 1,000 additional personnel) for statisticians, computer programmers and IT personnel in the PSA. The expansion of government-run hospitals, the DOH announced in February 2019 that the DBM has approved its 26,000 additional plantilla positions for nurses in government hospitals. However, majority of these positions will be filled by currently contractual nurses and therefore the increase in demand will not be as huge as this number. Furthermore, all other NGAs and SUCs with requests for additional workforce temporarily augment this with contractual staff. It will be difficult to determine the total requirement of S&T personnel of each agency since many of the positions are for short term projects. In addition, with the large total number of vacant positions in the bureaucracy, it is unlikely that DBM will approve any requests for additional personnel.

5.2.4. Recruitment trends: analysis of filled vs. unfilled positions

A comparison of filled vs. unfilled positions in the bureaucracy between the period 2015 and 2018 may provide insights on the current supply and demand status for expertise. This data may also indirectly be related to which fields are currently in demand in the private sector (with potentially higher salaries) resulting in unfilled positions in government. The positions with the largest vacancies since 2015 are Medical Officers II and IV, Nurses I and II, and SUC Instructors. These positions have more than one thousand vacancies that have extended since 2015. These are followed by Agrarian reform Specialists, Medical Specialists (II and II) and Assistant/Associate Professors (Positions with more than 200 to 800 vacancies in each position). In SUCs, more than 5,000 teaching positions are left unfilled. In terms of increasing vacant positions (unfilled positions in 2015 and 2018), IT positions (Data entry and Computer Operators) and Engineering V positions have increased vacancies since 2015.

5.2.5. Requirement for the number of MS and PhDs in government (SUCs, S&T agencies)

Advanced degrees (MS and PhD) for positions in government institutions are, in most cases, no longer a mandatory qualification but instead made just as a preference in hiring for higher positions. This is true for most government agencies except in SUCs wherein an MS degree is still required beyond the Instructor position (>SG 14) and for an employee to proceed to Professorial positions (Assistant, Associate and Full Professor). Furthermore, it is noteworthy that some academic institutions still impose more stringent qualifications such as the UP Diliman College of Science subscribing to international standards wherein a PhD degree is a requirement to enter the Professorial positions. For DOST RDIs, about 30% of the employees have MS degrees which translates to Senior SRS (SG 19) and higher posts having advanced degrees. Note that only a handful of DOST personnel in RDIs have PhD degrees.

Taking the statistics provided above, it seems that the demand for S&T personnel in government with advanced degrees is adjusted by the agencies based on the applications they receive as well as for their existing personnel to qualify for higher positions. A policy change in recruitment specifically affecting S&T agencies engaged in teaching and research is warranted. Below are recommended policies:

1. A Masters degree shall be required for all S&T personnel to be promoted to Assistant Professor and beyond;
2. A PhD degree shall be required for all S&T personnel teaching at the graduate level (Masteral and PhD). A PhD will likewise be a requirement for a teaching staff to be promoted to a Professor 1 position (SG 15) and beyond;
3. A Masters degree shall be required for all S&T personnel in RDIs to be promoted to SRS II or equivalent rank (SG 16) and beyond;
4. A PhD degree shall be required for all S&T personnel in RDIs to be promoted to Chief SRS (SG 24) and beyond;
5. A dedicated scholarship program for existing RDI personnel to finish their advanced degrees is warranted.

Meanwhile, S&T personnel in RDIs are expected primarily to conduct research even if part of their time may be devoted to providing training and laboratory services. As such, hiring must be in line with the RDIs' research programs and therefore a plan to recruit staff with advanced degrees and experience in research must be done. **Table 36** lists government-funded RDIs.

Table 36. List of Government Research and Development Institutions

Agency	Department
Philippine Carabao Center (PCC)	DA
Philippine Rice Research Institute (PhilRice)	DA
Philippine Center for Post-Harvest Development and Mechanization (PHILMEC)	DA
Philippine Rubber Research Institute (PRRI)	DA
National Fisheries Research and Development Institute (NFRDI)	DA
Advanced Science and Technology Institute (ASTI)	DOST
Food and Nutrition Research Institute (FNRI)	DOST
Forest Products Research and Development Institute (FPRDI)	DOST
Philippine Textile Research Institute (PTRI)	DOST
Philippine Nuclear Research Institute (PNRI)	DOST
Metal Industry Research and Development Center (MIRDC)	DOST
Industrial Technology Development Institute (ITDI)	DOST
Research Institute for Tropical Medicine (RITM)	DOH
Philippine Eye Research Institute	DOH
Ecosystems Research and Development Bureau (ERDB)	DENR

Box 2. Rethinking Models on Outward-bound S&T human resources

The United States has a total of 1.09 million foreign students in 2018, making it the largest destination for international students in the world. While a decline in enrolment has been recorded since 2016, the US still admitted 271,738 new students last year. 40% of students are in undergraduate programs, 35% are taking their Masters and Ph.D. degrees, and 25% are enrolled in English classes, short courses or trainings. A staggering 77% of foreign students in Colleges and Universities are in STEM programs. Topping the list of country of origin entering the US in 2018 are: China (46,256), India (12,652) and South Korea (7,265). China overwhelmingly dominates the foreign students sector accounting for 34.3% of total foreign students.

Southeast Asia as a region is becoming an important market with a total 296,109 ASEAN students abroad. Topping the list is Vietnam which now has 24,325 students in the US. However, the main destination for Vietnamese students is changing due to the US administration's stricter foreign policies and now ranks Japan, US, Australia, China and the UK as the preferred destination of more than 96 thousand Vietnamese students studying abroad. Indonesia is likewise sending more and more students to study abroad with Australia and New Zealand as their preferred destinations. Like Vietnam, majority of their overseas students are in undergraduate programs. Finally, Thailand is also starting to send more of its students abroad particularly to the US, topping the list of ASEAN countries in the last two years with more than 700 students entering the US every year. It is noteworthy that majority of the students from these countries are self-funding their education.

Unlike Vietnam, Indonesia and Thailand, the Philippines has continued to lag behind in terms of sending students despite the increase in recorded overseas Filipino students in Australia and the UK (ICEF Monitor, 2014). What do all these data mean? Perhaps Filipinos are still confident with the quality of Tertiary and post-graduate education in the country. However, as our ASEAN neighbors send their undergrads abroad, the likelihood that many of them will continue with graduate degrees abroad become higher. The predicament that our ASEAN neighbors will have more foreign-trained experts within the next decade would tip the balance in the region towards these countries. It may be high time for the Philippines to re-examine whether current models on sending S&T scholars overseas need rethinking in the wake of the successes of our neighbors in improving their innovation ecosystems through strategic investments in S&T human capital.

Country	Estimated Total Student Population overseas in 2017	Total Student Population in the US in 2018	#Students admitted annually in the US	
			2017	2018
Vietnam	94,662	24,325	462	467
Indonesia	45,206	8,650	222	225
Malaysia	63,253	8,271	322	344
Thailand	32,119	6,636	722	729
Singapore	23,715	4,575	326	337
Philippines	17,197	3,225	340	363
Myanmar	8,965	1,569	65	42
Cambodia	5,928	659	24	23
Laos	5,064	104	5	3
Total	296,109	58,014	2,488	2,533

Data Sources:

Institute for International Education (2018). Opendoors Report on International Student Exchange. www.iie.org/opendoors. (Accessed 15 September 2019).

ICEF (2014). Outbound mobility gathering steam in the Philippines. 17 October 2014. ICEF Monitor. https://monitor.icef.com/2014/10/outbound-mobility-gathering-steam-philippines/ (Accessed 17 September 2019).

UNESCO Student Mobility Number. http://data.uis.unesco.org (Accessed 15 September 2019).

6. Summary and Policy Implications

While the diverse S&T occupations differ in growth potential in terms of employment, and therefore some occupations appear more crucial than others, the fact that the total S&T workforce constitutes only a small portion of the country's workforce underscores the need for government support of most of S&T disciplines. Disciplines that are marketable in and of themselves, industrial engineering for example, need not be supported to the extent that other fields are. Disciplines that have declining employment levels, but are extremely needed to improve productivity in some sector or industry, such as those that have to do with agriculture, biology, chemistry and possibly even chemical engineering should be provided with more government support. There is also a need to determine, if it is possible, which sub-specializations under broad disciplines such as civil engineering and mechanical engineering should be promoted to address mismatches in the labor market.

Overall, the results shown in this study supports the idea that S&T workers are essential in supporting a country's economic growth. Although the estimates might be overly reliant on growth forecast given the assumptions used in the study, these nevertheless, serve as basis in eliciting useful lessons and policy recommendations.

Firstly, the great need of our economy for S&T workers to support its projected growth would require a massive boost in support for current and future S&T workers. This cannot be attained by the government alone, but should be a joint undertaking involving the private sector, as well as the academic institutions.

Secondly, there is a need to encourage our young population to go into the S&T fields. Providing financial assistance or scholarships can be helpful, however, this may not be enough to produce the needed numbers. Aggressive media campaigns supporting S&T for instance, especially through social media platforms, could be used to reach the young population as well as their parents. Facebook, Instagram, YouTube and other social media can be utilized for disseminating information on S&T careers and opportunities. It may be important to make use of social media influencers, especially as "poster boys" and "poster girls" for advocating S&T careers. DOST together with DepEd may want to consider implementing an annual survey among students regarding their "dream jobs" similar to the survey implemented by Korea's Ministry of Education and Korea Research Institute for Vocational Education and Training on "annual poll on school-age dream job". Knowing these statistics can help DOST be more strategic in its advocacy campaigns, not only with the young but with their parents.

The academe has a variety of functions. It must be able to produce knowledge through research. It must also be able to develop talents and innate capabilities of the students. When capabilities of students are lacking or insufficient, the academe must be able to provide, develop, or enhance such capabilities. It must be responsive in meeting the manpower and know-how requirements of industry, government, and the population. Because of these, college and university curricula are regularly reviewed and revised, and old degree programs are abolished and new ones developed. Research agendas of academic institutions are also reviewed and revised.

Development or revision of a degree programs means that the academic institution has knowledge of future manpower needs or is attuned to developments in doing things. DLSU, one of the country's premier HEIs, has been revising and instituting new degree programs to meet the changing manpower requirement of various stakeholders. Since 2010, it has instituted 23 new degree programs. Out of 23 degree programs, 17 or 73.91% are in STEM. Among these

STEM degree programs, seven are in Engineering and Technology, seven are in IT-Related Disciplines, two are in Natural Science, and one in Mathematics. There are five doctoral degree programs, five master's degree programs, and seven bachelor's degree programs among these. The doctoral and master's degrees are mostly in Engineering and Technology while the bachelor's degrees are mostly in IT-Related Disciplines. Also, in the last five years (that is, 2015 to 2019), five out 11 instituted degree programs are in IT-Related Disciplines, one in Mathematics, one in Natural Science, and four in non-STEM disciplines.

Third, the need for financial assistance or scholarships is recognized; however, it is equally important to understand other factors that affect the supply of S&T workers. For example, why fewer female S&T graduates are joining the labor force as compared with males? Or why some S&T graduates (ex. Mathematics and Statistics) exit the labor force much earlier than other S&T graduates? Such things should be looked into in more detail in order to obtain behavioral insights and craft necessary policies to incentivize these individuals to participate in the economy.

Fourthly, as indicated by the illustration of the S&T *production rate*, the timing of scholarships is very important. It must be noted that generally, the highest propensity to join the S&T fields is around the onset of the tertiary level; thus, financial support should be concentrated at this point. The future appears favorable for Engineers given our current level of productivity, technology, and projected growth. In contrast, our economy may not be able to accommodate the increasing supply of workers with Computing/IT background. As such, we may need to substantially invest in S&T human resources, and provide supporting mechanisms to make our innovation ecosystem flourish.

Forecasts of enrollment and graduates for the academic years 2020-2021 to 2025-2026 based on growth rates show increasing trend in number of graduates in all S&T discipline groups. Engineering and Technology will be the dominant discipline group in these years in terms of graduates followed by IT-Related Disciplines. It is recommended that an evaluation of skills taught to Engineering and Technology students as well as to students in IT-Related Disciplines be undertaken to identify any mismatches between skills currently taught and skills required in the future. There may be scope to improve not only technical but also soft skills of our learners. A result of these studies would be adjustments in the curricula and research agendas of HEIs resulting in the production of graduates better prepared for jobs in the future. DepEd, CHED, DOST, and PIDS should collaborate and lead in the conduct of studies on policy issues posed on S&T education. Partnership among these agencies should be formalized through memorandum of agreement or similar instruments that would provide for sharing of resources and data, among others, as they collect data that are useful in the studies to be conducted. The agencies must always ensure that the data they collect are correct, complete, and correctly encoded. Quality data is necessary in crafting policies and developing programs.

In a talk during the 41st Annual Scientific Meeting of the National Academy of Science and Technology held last July 11, 2019, Dr. William G. Padolina highlighted the possibility of mismatches between the skills of the country's S&T graduates and the skills demanded by jobs. The country may soon be affected by developments in technology or the so-called "new disruptors"- biotechnology, nanotechnology, sensorization, 3d printing, and the internet of things, big data, AI, renewable energy, and autonomous systems. There is therefore a need to assess degree programs and research agendas of HEIs on their ability and capacity to cope with technological developments.

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Annex Table A-1. Projected number of professionals / practitioners under three growth scenarios by occupation, 2019-2025

OCCUPATION	PROJECTED GROWTH RATE			2018	PROJECTED NUMBER OF PROFESSIONALS / PRACTITIONERS																				
					LOW GROWTH ASSUMPTION							MEDIUM GROWTH ASSUMPTION							HIGH GROWTH ASSUMPTION						
	LOW	MEDIUM	HIGH		2019	2020	2021	2022	2023	2024	2025	2019	2020	2021	2022	2023	2024	2025	2019	2020	2021	2022	2023	2024	2025
Information and Computer Technology Professionals																									
Applications programmer	6.6	13.1	22.5	18,370	19,582	20,874	22,252	23,721	25,287	26,956	28,735	20,776	23,498	26,576	30,057	33,994	38,447	43,484	22,503	27,566	33,768	41,366	50,673	62,074	76,041
Computer network programmers	3.1	8.9	10.0	34,407	35,474	36,574	37,708	38,877	40,082	41,325	42,606	37,469	40,804	44,436	48,391	52,698	57,388	62,496	37,848	41,633	45,796	50,376	55,414	60,955	67,051
Database designers and administrators	-21.9	-8.6	11.8	8,572	6,695	5,229	4,084	3,190	2,491	1,945	1,519	7,835	7,161	6,545	5,982	5,468	4,998	4,568	9,583	10,714	11,978	13,391	14,971	16,738	18,713
Software developers	-4.6	1.6	5.6	12,266	11,702	11,164	10,650	10,160	9,693	9,247	8,822	12,462	12,661	12,864	13,070	13,279	13,491	13,707	12,953	13,678	14,444	15,253	16,107	17,009	17,962
Systems administrators	9.7	18.5	29.0	8,083	8,867	9,727	10,671	11,706	12,841	14,087	15,453	9,578	11,350	13,450	15,938	18,887	22,381	26,521	10,427	13,451	17,352	22,384	28,875	37,249	48,051
Systems analysts	-5.3	0.7	27.8	15,817	14,979	14,185	13,433	12,721	12,047	11,409	10,804	15,928	16,039	16,151	16,264	16,378	16,493	16,608	20,214	25,833	33,015	42,193	53,923	68,914	88,072
Web and multimedia developers	9.8	17.7	27.9	13,799	15,151	16,636	18,266	20,056	22,021	24,179	26,549	16,241	19,116	22,500	26,483	31,170	36,687	43,181	17,649	22,573	28,871	36,926	47,228	60,405	77,258
Architects, planners, surveyors and designers																									
Building architects	2.1	5.9	11.4	23,433	23,925	24,427	24,940	25,464	25,999	26,545	27,102	24,816	26,280	27,831	29,473	31,212	33,054	35,004	26,104	29,080	32,395	36,088	40,202	44,785	49,890
Cartographers and surveyors	-4.8	-1.2	3.8	6,934	6,601	6,284	5,982	5,695	5,422	5,162	4,914	6,851	6,769	6,688	6,608	6,529	6,451	6,374	7,197	7,470	7,754	8,049	8,355	8,672	9,002

OCCUPATION	PROJECTED GROWTH RATE			2018	PROJECTED NUMBER OF PROFESSIONALS / PRACTITIONERS																				
					LOW GROWTH ASSUMPTION							MEDIUM GROWTH ASSUMPTION							HIGH GROWTH ASSUMPTION						
	LOW	MEDIUM	HIGH		2019	2020	2021	2022	2023	2024	2025	2019	2020	2021	2022	2023	2024	2025	2019	2020	2021	2022	2023	2024	2025
Graphic and multimedia	-0.8	2.1	9.1	16,974	16,838	16,703	16,569	16,436	16,305	16,175	16,046	17,330	17,694	18,066	18,445	18,832	19,227	19,631	18,519	20,204	22,043	24,049	26,237	28,625	31,230
Landscape architects	-6.0	0.5	6.0	1,243	1,168	1,098	1,032	970	912	857	806	1,249	1,255	1,261	1,267	1,273	1,279	1,285	1,318	1,397	1,481	1,570	1,664	1,764	1,870
Town and traffic planners	-0.9	12.3	16.1	1,565	1,551	1,537	1,523	1,509	1,495	1,482	1,469	1,757	1,973	2,216	2,489	2,795	3,139	3,525	1,817	2,110	2,450	2,844	3,302	3,834	4,451
Engineering professionals																									
Chemical engineers	-2.4	3.7	12.5	3,542	3,457	3,374	3,293	3,214	3,137	3,062	2,989	3,673	3,809	3,950	4,096	4,248	4,405	4,568	3,985	4,483	5,043	5,673	6,382	7,180	8,078
Civil engineers	2.4	12.5	14.3	85,395	87,444	89,543	91,692	93,893	96,146	98,454	100,817	96,069	108,078	121,588	136,787	153,885	173,121	194,761	97,606	111,564	127,518	145,753	166,596	190,419	217,649
					2,049	2,099	2,149	2,201	2,253	2,308	2,363	10,674	12,009	13,510	15,199	17,098	19,236	21,640	12,211	13,958	15,954	18,235	20,843	23,823	27,230
PRC additional qualifiers				11,752	16,183	22,286	30,689	42,262	58,199	80,145	110,366														
																		80.2041							
Electrical engineers	4.1	9.4	11.5	31,557	32,851	34,198	35,600	37,060	38,579	40,161	41,808	34,523	37,768	41,318	45,202	49,451	54,099	59,184	35,186	39,232	43,744	48,775	54,384	60,638	67,611
Electronics engineers	-8.5	12.3	26.5	10,973	10,040	9,187	8,406	7,691	7,037	6,439	5,892	12,323	13,839	15,541	17,453	19,600	22,011	24,718	13,881	17,559	22,212	28,098	35,544	44,963	56,878
Environmental engineers	-0.4	7.3	29.0	1,077	1,073	1,069	1,065	1,061	1,057	1,053	1,049	1,156	1,240	1,331	1,428	1,532	1,644	1,764	1,389	1,792	2,312	2,982	3,847	4,963	6,402
Industrial engineers	-2.8	-0.4	25.8	17,411	16,923	16,449	15,988	15,540	15,105	14,682	14,271	17,341	17,272	17,203	17,134	17,065	16,997	16,929	21,903	27,554	34,663	43,606	54,856	69,009	86,813
Mechanical engineers	-5.9	1.1	5.5	24,144	22,720	21,380	20,119	18,932	17,815	16,764	15,775	24,410	24,679	24,950	25,224	25,501	25,782	26,066	25,472	26,873	28,351	29,910	31,555	33,291	35,122
Mining engineers, metallurgists	-16.6	1.1	32.9	1,174	979	816	681	568	474	395	329	1,187	1,200	1,213	1,226	1,239	1,253	1,267	1,560	2,073	2,755	3,661	4,865	6,466	8,593

OCCUPATION	PROJECTED GROWTH RATE				PROJECTED NUMBER OF PROFESSIONALS / PRACTITIONERS																					
					LOW GROWTH ASSUMPTION							MEDIUM GROWTH ASSUMPTION							HIGH GROWTH ASSUMPTION						
	LOW	MEDIUM	HIGH	2018	2019	2020	2021	2022	2023	2024	2025	2019	2020	2021	2022	2023	2024	2025	2019	2020	2021	2022	2023	2024	2025
Telecommunications engineers	3.5	**13.7**	18.1	8,048	8,330	8,622	8,924	9,236	9,559	9,894	10,240	9,151	10,405	11,830	13,451	15,294	17,389	19,771	9,505	11,225	13,257	15,657	18,491	21,838	25,791
Life Scientists																									
Biologists, botanists, zoologists and related scientists	**-23.9**	-19.0	28.3	1,650	1,256	956	728	554	422	321	244	1,337	1,083	877	710	575	466	377	2,117	2,716	3,485	4,471	5,736	7,359	9,442
Farming, forestry and fisheries advisers	-13.7	-6.7	**1.0**	6,937	5,987	5,167	4,459	3,848	3,321	2,866	2,473	6,472	6,038	5,633	5,256	4,904	4,575	4,268	7,006	7,076	7,147	7,218	7,290	7,363	7,437
Environmental Protection	-21.0	**11.3**	44.5	4,718	3,727	2,944	2,326	1,838	1,452	1,147	906	5,251	5,844	6,504	7,239	8,057	8,967	9,980	6,818	9,852	14,236	20,571	29,725	42,953	62,067
Physical Scientists																									
Chemists	**-8.0**	14.0	25.4	3,140	2,889	2,658	2,445	2,249	2,069	1,903	1,751	3,580	4,081	4,652	5,303	6,045	6,891	7,856	3,938	4,938	6,192	7,765	9,737	12,210	15,311
Geologists and geophysicists	-16.3	**8.9**	25.1	1,196	1,001	838	701	587	491	491	411	1,302	1,418	1,544	1,681	1,831	1,994	2,171	1,496	1,871	2,341	2,929	3,664	4,584	5,735
Meteorologists	-0.02	**4.4**	24.6	471	471	471	471	471	471	471	471	492	514	537	561	586	612	639	587	731	911	1,135	1,414	1,762	2,195
Physicists and astronomers*				125																					
Mathematical Occupations																									
Mathematicians and actuaries	-3.8	-3.6	28.6	425	409	393	378	364	350	337	324	410	395	381	367	354	341	329	547	703	904	1,163	1,496	1,924	2,474

OCCUPATION	PROJECTED GROWTH RATE			2018	PROJECTED NUMBER OF PROFESSIONALS / PRACTITIONERS																				
					LOW GROWTH ASSUMPTION							MEDIUM GROWTH ASSUMPTION							HIGH GROWTH ASSUMPTION						
	LOW	MEDIUM	HIGH		2019	2020	2021	2022	2023	2024	2025	2019	2020	2021	2022	2023	2024	2025	2019	2020	2021	2022	2023	2024	2025
Statisticians	-7.2	6.2	15.9	2,074	1,925	1,786	1,657	1,538	1,427	1,324	1,229	2,203	2,340	2,485	2,639	2,803	2,977	3,162	2,404	2,786	3,229	3,742	4,337	5,027	5,826

* has only four observations over 36 quarters

Annex Table A-2. Undergraduate and Graduate S&T Disciplines Currently Prioritized in the DOST Scholarship Programs

Undergraduate	Graduate
Aeronautical Engineering	Agriculture (Agronomy, Animal Science, Entomology, Horticulture, Plant Breeding, Plant Pathology, Soil Science, Taxonomy, Veterinary Medicine, Veterinary Entomology), Forestry and Natural Resources
Aerospace Engineering	Analytical Chemistry
Agribusiness Management	Artificial Intelligence
Agricultural and Biosystems Engineering	Atmospheric Science
Agricultural Biotechnology	Bioethics and Data Privacy
Agricultural Chemistry	Biological Sciences
Agricultural Economics	Biomedical Engineering
Agricultural Engineering	Biotechnology
Agricultural Technology	Chemical Biology
Agriculture	Chemical Sciences
Animal Science	Combinatorial Chemistry
Applied Mathematics	Data Science
Applied Mathematics Major in Mathematical Finance	Earth, Atmospheric and Space Sciences
Applied Physics	Environmental Sciences
Applied Physics with Applied Computer System	Ethnomedicine
Applied Physics with Materials Science and Engineering	Ethnopharmacology
Applied Statistics	Fisheries and Marine Science
Astronomy Technology	Genetic Epidemiology
Bachelor of Library and Information Science	Health and Pharmaceutical Sciences
Bachelor of Secondary Education Major in Science	Health Financing
Biochemistry	Immersive Technology
Biology	Information and Communication Technology
Ceramics Engineering	Marine Science
Chemical Engineering	Materials Science and Nanotechnology
Chemistry	Medical Entomology
Chemistry with Applied Computer Systems	Medical Physics
Chemistry with Materials Science and Engineering	Medicinal Chemistry
Civil Engineering	Meteorology
Community Nutrition	Metrology
Computer Engineering	Molecular Biology and Biotechnology
Computer Science	Natural Products Chemistry
Doctor of Veterinary Medicine	Nuclear Science and Engineering

Electrical Engineering	Organic Chemistry
Electronics and Communications Engineering/ Electronics Engineering	Public Health Entomology
Environmental Science	Pure and Applied Mathematics
Fisheries	Pure and Applied Physics
Food Technology	Rehabilitation Medicine
Forestry	Robotics
Geodetic Engineering	Space Technology and Application/Aerospace Engineering
Geography	Statistics
Geology	Virology
Geothermal Engineering	
Health Science	
Human Biology	
Industrial Design	
Industrial Engineering	
Industrial Management Engineering-Information Technology	
Industrial Pharmacy	
Information and Communications Technology	
Information System	
Information Technology	
Information Technology Systems	
Instrumentation and Control Engineering	
Life Sciences	
Management Information Systems	
Manufacturing Engineering	
Manufacturing Engineering-Management-Biomedical Engineering	
Manufacturing Engineering-Management-Mechatronics and Robotics	
Marine Biology	
Marine Science	
Materials Engineering	
Mathematics	
Mathematics and Science Teaching	
Mathematics Teaching	
Mechanical Engineering	
Mechatronics Engineering	
Medical Laboratory Science/Medical Technology	
Metallurgical Engineering	
Meteorology	
Microbiology	
Mining Engineering	

Molecular Biology & Biotechnology	
Nutrition	
Nutrition and Dietetics	
Packaging Engineering	
Petroleum Engineering	
Pharmaceutical Sciences	
Pharmacy (4-year program)	
Pharmacy major in Clinical Pharmacy (5-year program)	
Physics	
Psychology	
Public Health	
Science Teaching (Biology, Chemistry, Physics, Physical Science, Biology and Chemistry)	
Statistics	

Annex Table A-3. Percentage of S&T Graduates With the Given Degree in Academic Years 2009-2010 and 2010-2011

Baccalaureate Degree Program	Percent of Graduates
Bachelor of Science in Nursing	47.19
Bachelor of Science in Information Technology	11.96
Bachelor of Science in Computer Science	8.15
Bachelor of Science in Industrial Technology	5.20
Bachelor of Science in Civil Engineering	2.70
Bachelor of Science in Agriculture	2.42
Bachelor of Science in Electronics and Electrical Engineering	1.73
Bachelor of Science in Biology	1.68
Bachelor of Science in Marine Transport	1.66
Bachelor of Science in Computer Engineering	1.45
Bachelor of Science in Electrical Engineering	1.37
Bachelor of Science in Mechanical Engineering	1.26
Bachelor of Arts in Agricultural Technology	1.09
Bachelor of Science in Architecture	0.95
Bachelor of Science in Food Technology	0.76
Bachelor of Science in Marine Engineering	0.74
Bachelor of Science in Industrial Engineering	0.70
Bachelor of Science in Information Systems	0.57
Bachelor of Science in Pharmacy	0.57
Bachelor of Science in Mathematics	0.53
Bachelor of Arts in Technology	0.48
Bachelor of Science in Medical Technology	0.46
Bachelor of Science in Computer Technology	0.42
Bachelor of Science in Forestry	0.42
Bachelor of Science in Electronics Engineering	0.40
Bachelor of Science in Radiologic Technology	0.36
Bachelor of Science in Automotive Technology	0.30
Bachelor of Science in Fisheries	0.29
Bachelor of Science in Environmental Development	0.29
Bachelor of Science in Chemical Engineering	0.27
Bachelor of Science in Agricultural Engineering	0.25
Bachelor of Science in Agro-Forestry	0.25
Bachelor of Science in Electronics Technology	0.21
Bachelor of Science in Electrical Technology	0.19
Bachelor of Science in Mechanical Technology	0.17
Bachelor of Science in Physical Therapy	0.15
Bachelor of Science in Nutrition and Dietetics	0.15
Bachelor of Science in Chemistry	0.13
Bachelor of Arts in Information Technology	0.11
Bachelor of Science in Marine Biology	0.10
Bachelor of Science in Industrial and Management Engineering	0.10
Bachelor of Science in Management Engineering	0.10

Bachelor of Arts - Bachelor of Secondary Education	0.10
Bachelor of Science in Mathematics for Teachers	0.08
Bachelor of Science in Fishing Technology	0.08
Bachelor of Science in Community/Public Health	0.08
Bachelor of Arts - Bachelor of Secondary Education	0.08
Bachelor of Science in Statistics	0.06
Bachelor of Science in Management Information	0.06
Bachelor of Science in Computer Data Privacy	0.06
Bachelor of Science in Geodetic Engineering	0.06
Bachelor of Science in Electrical Engineering	0.06
Bachelor of Science in Animal Husbandry	0.06
Bachelor of Secondary Education Major in	0.06
Bachelor of Science - Bachelor of Secondary Education	0.06
Bachelor of Science in Applied Physics	0.04
Bachelor of Science in Physics	0.04
Bachelor of Science in Applied Mathematics	0.04
Bachelor of Science in Ceramics Engineering	0.04
Bachelor of Science in Communications Engineering	0.04
Bachelor of Science in Forest Products	0.04
Bachelor of Science in Electronics and	0.04
Bachelor of Science in Animal Science	0.04
Bachelor of Science in Veterinary Technology	0.04
Bachelor of Secondary Education Major in	0.04
Bachelor of Arts - Bachelor of Secondary Education	0.04
Bachelor of Science - Bachelor of Secondary Education	0.04
Bachelor of Science in Chemistry for Teachers	0.02
Bachelor of Science in Bio-Chemistry	0.02
Bachelor of Science in Biological Science	0.02
Bachelor of Science in Micro-Biology	0.02
Bachelor of Science in Physiology	0.02
Bachelor of Science in Computer Data Privacy	0.02
Bachelor of Science in Computer Studies	0.02
Bachelor of Science in Aircraft Maintenance	0.02
Bachelor of Science in Aviation	0.02
Bachelor of Science in Sanitary Engineering	0.02
Bachelor of Science in Food Engineering	0.02
Bachelor of Science in Horticulture	0.02
Bachelor of Science in Aquaculture	0.02
Bachelor of Science in Speech Pathology	0.02
Doctor of Dental Medicine	0.02
Bachelor of Science in Industrial Pharmacy	0.02
Bachelor of Science in Rural Medicine	0.02
Bachelor of Science in Nautical Science	0.02
Bachelor of Arts in Technology in Environment	0.02
Bachelor of Science in Environmental Management	0.02
Bachelor of Secondary Education Major in	0.02

Bachelor of Secondary Education Major in	0.02
Bachelor of Arts - Bachelor of Secondary Education	0.02

Data Source: 2014 PIDS-CHED Graduates Tracer Study

Annex Table A-4. Percentage of Graduates With a Given Degree Per S&T Discipline Group in Academic Years 2009-2010 and 2010-2011.

Discipline Group	Baccalaureate Degree Program	Percent of Graduates	
		Within Discipline Group	Among All S&T Graduates
Agriculture, Fisheries and Related Disciplines	Bachelor of Science in Agriculture	56.95	2.42
	Bachelor of Arts in Agricultural Technology	25.56	1.09
	Bachelor of Science in Fisheries	6.73	0.29
	Bachelor of Science in Agro-Forestry	5.83	0.25
	Bachelor of Science in Fishing Technology	1.79	0.08
	Bachelor of Science in Animal Husbandry	1.35	0.06
	Bachelor of Science in Animal Science	0.90	0.04
	Bachelor of Science in Horticulture	0.45	0.02
	Bachelor of Science in Aquaculture	0.45	0.02
Architecture	Bachelor of Science in Architecture	100.00	0.95
Engineering and Technology	Bachelor of Science in Industrial Technology	28.83	5.20
	Bachelor of Science in Civil Engineering	14.99	2.70
	Bachelor of Science in Electronics and Electrical Engineering	9.61	1.73
	Bachelor of Science in Computer Engineering	8.03	1.45
	Bachelor of Science in Electrical Engineering	7.60	1.37
	Bachelor of Science in Mechanical Engineering	6.97	1.26
	Bachelor of Science in Marine Engineering	4.12	0.74
	Bachelor of Science in Industrial Engineering	3.91	0.70
	Bachelor of Arts in Technology	2.64	0.48
	Bachelor of Science in Electronics Engineering	2.22	0.40
	Bachelor of Science in Automotive Technology	1.69	0.30
	Bachelor of Science in Chemical Engineering	1.48	0.27
	Bachelor of Science in Agricultural Engineering	1.37	0.25
	Bachelor of Science in Electronics Technology	1.16	0.21
	Bachelor of Science in Electrical Technology	1.06	0.19
	Bachelor of Science in Mechanical Technology	0.95	0.17
	Bachelor of Arts in Information Technology	0.63	0.11
	Bachelor of Science in Industrial and Management Engineering	0.53	0.10
	Bachelor of Science in Management Engineering	0.53	0.10
	Bachelor of Science in Geodetic Engineering	0.32	0.06
	Bachelor of Science in Electrical Engineering	0.32	0.06
	Bachelor of Science in Ceramics Engineering	0.21	0.04
	Bachelor of Science in Communications Engineering	0.21	0.04
	Bachelor of Science in Electronics and	0.21	0.04
	Bachelor of Science in Aircraft Maintenance	0.11	0.02
	Bachelor of Science in Aviation	0.11	0.02

	Bachelor of Science in Sanitary Engineering	0.11	0.02
	Bachelor of Science in Food Engineering	0.11	0.02
Environment and Forestry	Bachelor of Science in Forestry	53.66	0.42
	Bachelor of Science in Environmental De	36.59	0.29
	Bachelor of Science in Forest Products	4.88	0.04
	Bachelor of Arts in Technology in Environment	2.44	0.02
	Bachelor of Science in Environmental Management	2.44	0.02
Food Science	Bachelor of Science in Food Technology	83.33	0.76
	Bachelor of Science in Nutrition and Dietetics	16.67	0.15
IT-Related Disciplines	Bachelor of Science in Information Technology	56.27	11.96
	Bachelor of Science in Computer Science	38.35	8.15
	Bachelor of Science in Information Systems	2.69	0.57
	Bachelor of Science in Computer Technology	1.97	0.42
	Bachelor of Science in Management Informatics	0.27	0.06
	Bachelor of Science in Computer Data Privacy	0.27	0.06
	Bachelor of Science in Computer Studies	0.09	0.02
Nautical Science and Related Disciplines	Bachelor of Science in Marine Transport	98.86	1.66
	Bachelor of Science in Nautical Science	1.14	0.02
Mathematics	Bachelor of Science in Mathematics	75.68	0.53
	Bachelor of Science in Mathematics for Teachers	10.81	0.08
	Bachelor of Science in Statistics	8.11	0.06
	Bachelor of Science in Applied Mathematics	5.41	0.04
Medical and Allied Disciplines	Bachelor of Science in Nursing	96.57	47.19
	Bachelor of Science in Pharmacy	1.17	0.57
	Bachelor of Science in Medical Technology	0.93	0.46
	Bachelor of Science in Radiologic Technology	0.74	0.36
	Bachelor of Science in Physical Therapy	0.31	0.15
	Bachelor of Science in Veterinary Technology	0.08	0.04
	Bachelor of Science in Physiology	0.04	0.02
	Bachelor of Science in Speech Pathology	0.04	0.02
	Doctor of Dental Medicine	0.04	0.02
	Bachelor of Science in Industrial Pharmacy	0.04	0.02
	Bachelor of Science in Rural Medicine	0.04	0.02
Natural Science	Bachelor of Science in Biology	81.48	1.68
	Bachelor of Science in Chemistry	6.48	0.13
	Bachelor of Science in Marine Biology	4.63	0.10
	Bachelor of Science in Applied Physics	1.85	0.04
	Bachelor of Science in Physics	1.85	0.04
	Bachelor of Science in Chemistry for Teachers	0.93	0.02
	Bachelor of Science in Bio-Chemistry	0.93	0.02
	Bachelor of Science in Biological Science	0.93	0.02
	Bachelor of Science in Micro-Biology	0.93	0.02
Unclassified	Bachelor of Arts - Bachelor of Secondar	17.86	0.10

	Bachelor of Science in Community/ Public	14.29	0.08
	Bachelor of Arts - Bachelor of Secondar	14.29	0.08
	Bachelor of Secondary Education Major	10.71	0.06
	Bachelor of Science - Bachelor of Secon	10.71	0.06
	Bachelor of Secondary Education Major	7.14	0.04
	Bachelor of Arts - Bachelor of Secondar	7.14	0.04
	Bachelor of Science - Bachelor of Secon	7.14	0.04
	Bachelor of Secondary Education Major	3.57	0.02
	Bachelor of Secondary Education Major	3.57	0.02
	Bachelor of Arts - Bachelor of Secondar	3.57	0.02

Annex Table A-5. Percentage of Those Who Graduated With S&T Degree in 2009-2010 and 2010-2011 With the Given Job

Degree Program	Job	Percent of Graduates in the Degree Program With the Given Job
Bachelor of Science in Aircraft Maintenance Technology	Science and engineering associate professionals	100.00
Bachelor of Science in Aviation	Numerical and material recording clerks	100.00
Bachelor of Science in Ceramics Engineering	Science and engineering professionals	100.00
Bachelor of Science in Chemical Engineering	Science and engineering associate professionals	27.27
Bachelor of Science in Chemical Engineering	Science and engineering professionals	18.18
Bachelor of Science in Chemical Engineering	Teaching professionals	18.18
Bachelor of Science in Chemical Engineering	Customer service clerks	18.18
Bachelor of Science in Chemical Engineering	Health professionals	9.09
Bachelor of Science in Chemical Engineering	General and keyboard clerks	9.09
Bachelor of Science in Civil Engineering	Science and engineering professionals	49.57
Bachelor of Science in Civil Engineering	Science and engineering associate professionals	12.82
Bachelor of Science in Civil Engineering	General and keyboard clerks	5.98
Bachelor of Science in Civil Engineering	Production and specialized services managers	5.13
Bachelor of Science in Civil Engineering	Business and administration associate professional	5.13
Bachelor of Science in Civil Engineering	Teaching professionals	3.42
Bachelor of Science in Civil Engineering	Administrative and commercial managers	2.56
Bachelor of Science in Civil Engineering	Information and communications technician	2.56
Bachelor of Science in Civil Engineering	Chief executives, senior officials and legislators	1.71
Bachelor of Science in Civil Engineering	Hospitality, retail and other services managers	1.71

Bachelor of Science in Civil Engineering	Sales workers	1.71
Bachelor of Science in Civil Engineering	Protective services workers	1.71
Bachelor of Science in Civil Engineering	Laborers in mining, construction, manufacturing an	1.71
Bachelor of Science in Civil Engineering	Business and administration professionals	0.85
Bachelor of Science in Civil Engineering	Information and communication technology professionals	0.85
Bachelor of Science in Civil Engineering	Legal, social and cultural professionals	0.85
Bachelor of Science in Civil Engineering	Numerical and material recording clerks	0.85
Bachelor of Science in Civil Engineering	Building and related trades workers, excluding ele	0.85
Bachelor of Science in Geodetic Engineering	Science and engineering professionals	66.67
Bachelor of Science in Geodetic Engineering	Chief executives, senior officials and legislators	33.33
Bachelor of Science in Communications Engineering	Science and engineering professionals	50.00
Bachelor of Science in Communications Engineering	Numerical and material recording clerks	50.00
Bachelor of Science in Computer Engineering	Teaching professionals	12.07
Bachelor of Science in Computer Engineering	General and keyboard clerks	12.07
Bachelor of Science in Computer Engineering	Science and engineering associate professionals	10.34
Bachelor of Science in Computer Engineering	Customer service clerks	10.34
Bachelor of Science in Computer Engineering	Science and engineering professionals	8.62
Bachelor of Science in Computer Engineering	Information and communication technology professio	8.62
Bachelor of Science in Computer Engineering	Business and administration associate professional	5.17
Bachelor of Science in Computer Engineering	Sales workers	5.17
Bachelor of Science in Computer Engineering	Hospitality, retail and other services managers	3.45
Bachelor of Science in Computer Engineering	Information and communications technician	3.45
Bachelor of Science in Computer Engineering	Numerical and material recording clerks	3.45

Bachelor of Science in Computer Engineering	Other clerical support workers	3.45
Bachelor of Science in Computer Engineering	Administrative and commercial managers	1.72
Bachelor of Science in Computer Engineering	Production and specialized services managers	1.72
Bachelor of Science in Computer Engineering	Business and administration professionals	1.72
Bachelor of Science in Computer Engineering	Legal, social and cultural professionals	1.72
Bachelor of Science in Computer Engineering	Legal, social, cultural and related professionals	1.72
Bachelor of Science in Computer Engineering	Protective services workers	1.72
Bachelor of Science in Computer Engineering	Stationary plant and machine operators	1.72
Bachelor of Science in Computer Engineering	Drivers and mobile plant operators	1.72
Bachelor of Science in Computer Technology	Business and administration associate professional	16.67
Bachelor of Science in Computer Technology	Information and communications technician	16.67
Bachelor of Science in Computer Technology	General and keyboard clerks	16.67
Bachelor of Science in Computer Technology	Other clerical support workers	11.11
Bachelor of Science in Computer Technology	Administrative and commercial managers	5.56
Bachelor of Science in Computer Technology	Teaching professionals	5.56
Bachelor of Science in Computer Technology	Customer service clerks	5.56
Bachelor of Science in Computer Technology	Personal service workers	5.56
Bachelor of Science in Computer Technology	Sales workers	5.56
Bachelor of Science in Computer Technology	Market-oriented skilled agricultural workers	5.56
Bachelor of Science in Computer Technology	Handicraft and printing workers	5.56
Bachelor of Science in Electrical Engineering	Science and engineering professionals	32.76
Bachelor of Science in Electrical Engineering	Science and engineering associate professionals	20.69
Bachelor of Science in Electrical Engineering	Electrical and electronics trades workers	18.97

Bachelor of Science in Electrical Engineering	Business and administration associate professional	5.17
Bachelor of Science in Electrical Engineering	Teaching professionals	3.45
Bachelor of Science in Electrical Engineering	Business and administration professionals	3.45
Bachelor of Science in Electrical Engineering	Chief executives, senior officials and legislators	1.72
Bachelor of Science in Electrical Engineering	Administrative and commercial managers	1.72
Bachelor of Science in Electrical Engineering	Production and specialized services managers	1.72
Bachelor of Science in Electrical Engineering	Health associate professionals	1.72
Bachelor of Science in Electrical Engineering	General and keyboard clerks	1.72
Bachelor of Science in Electrical Engineering	Numerical and material recording clerks	1.72
Bachelor of Science in Electrical Engineering	Sales workers	1.72
Bachelor of Science in Electrical Engineering	Building and related trades workers, excluding ele	1.72
Bachelor of Science in Electrical Engineering	Drivers and mobile plant operators	1.72
Bachelor of Science in Electrical Engineering Technology	Business and administration professionals	33.33
Bachelor of Science in Electrical Engineering Technology	Science and engineering associate professionals	33.33
Bachelor of Science in Electrical Engineering Technology	Electrical and electronics trades workers	33.33
Bachelor of Science in Electrical Technology	Metal, machinery and related trades workers	22.22
Bachelor of Science in Electrical Technology	Electrical and electronics trades workers	22.22
Bachelor of Science in Electrical Technology	Stationary plant and machine operators	22.22
Bachelor of Science in Electrical Technology	Health associate professionals	11.11
Bachelor of Science in Electrical Technology	Business and administration associate professional	11.11
Bachelor of Science in Electrical Technology	Refuse workers and other elementary workers	11.11
Bachelor of Science in Electronics and Communications Engine	Science and engineering professionals	23.53
Bachelor of Science in Electronics and Communications Engine	Science and engineering associate professionals	17.65

Bachelor of Science in Electronics and Communications Engine	Information and communication technology professio	11.76
Bachelor of Science in Electronics and Communications Engine	Customer service clerks	10.29
Bachelor of Science in Electronics and Communications Engine	Business and administration associate professional	7.35
Bachelor of Science in Electronics and Communications Engine	Teaching professionals	5.88
Bachelor of Science in Electronics and Communications Engine	Administrative and commercial managers	4.41
Bachelor of Science in Electronics and Communications Engine	Health associate professionals	2.94
Bachelor of Science in Electronics and Communications Engine	Information and communications technician	2.94
Bachelor of Science in Electronics and Communications Engine	Production and specialized services managers	1.47
Bachelor of Science in Electronics and Communications Engine	Business and administration professionals	1.47
Bachelor of Science in Electronics and Communications Engine	General and keyboard clerks	1.47
Bachelor of Science in Electronics and Communications Engine	Numerical and material recording clerks	1.47
Bachelor of Science in Electronics and Communications Engine	Sales workers	1.47
Bachelor of Science in Electronics and Communications Engine	Handicraft and printing workers	1.47
Bachelor of Science in Electronics and Communications Engine	Electrical and electronics trades workers	1.47
Bachelor of Science in Electronics and Communications Engine	Stationary plant and machine operators	1.47
Bachelor of Science in Electronics and Communications Engine	Agricultural, forestry and fishery laborers	1.47
Bachelor of Science in Electronics Engineering	Science and engineering professionals	81.25
Bachelor of Science in Electronics Engineering	Business and administration professionals	6.25
Bachelor of Science in Electronics Engineering	Customer service clerks	6.25
Bachelor of Science in Electronics Engineering	Protective services workers	6.25
Bachelor of Science in Electronics Technology	Science and engineering associate professionals	22.22
Bachelor of Science in Electronics Technology	Sales workers	22.22
Bachelor of Science in Electronics Technology	Electrical and electronics trades workers	22.22

Bachelor of Science in Electronics Technology	Stationary plant and machine operators	22.22
Bachelor of Science in Electronics Technology	Science and engineering professionals	11.11
Bachelor of Science in Industrial and Management Engineering	Armed forces occupations, other ranks	20,00
Bachelor of Science in Industrial and Management Engineering	Production and specialized services managers	20.00
Bachelor of Science in Industrial and Management Engineering	Science and engineering professionals	20.00
Bachelor of Science in Industrial and Management Engineering	Science and engineering associate professionals	20.00
Bachelor of Science in Industrial and Management Engineering	Sales workers	20.00
Bachelor of Science in Industrial Engineering	Science and engineering professionals	16.67
Bachelor of Science in Industrial Engineering	Science and engineering associate professionals	13.33
Bachelor of Science in Industrial Engineering	Production and specialized services managers	10.00
Bachelor of Science in Industrial Engineering	Information and communication technology professio	10.00
Bachelor of Science in Industrial Engineering	Electrical and electronics trades workers	10.00
Bachelor of Science in Industrial Engineering	Business and administration professionals	6.67
Bachelor of Science in Industrial Engineering	Sales workers	6.67
Bachelor of Science in Industrial Engineering	Stationary plant and machine operators	6.67
Bachelor of Science in Industrial Engineering	Hospitality, retail and other services managers	3.33
Bachelor of Science in Industrial Engineering	Business and administration associate professional	3.33
Bachelor of Science in Industrial Engineering	General and keyboard clerks	3.33
Bachelor of Science in Industrial Engineering	Personal service workers	3.33
Bachelor of Science in Industrial Engineering	Metal, machinery and related trades workers	3.33
Bachelor of Science in Industrial Engineering	Laborers in mining, construction, manufacturing an	3.33
Bachelor of Science in Industrial Technology	Science and engineering associate professionals	12.5
Bachelor of Science in Industrial Technology	General and keyboard clerks	11.46

Bachelor of Science in Industrial Technology	Sales workers	10.42
Bachelor of Science in Industrial Technology	Business and administration associate professional	7.29
Bachelor of Science in Industrial Technology	Hospitality, retail and other services managers	6.25
Bachelor of Science in Industrial Technology	Metal, machinery and related trades workers	5.73
Bachelor of Science in Industrial Technology	Laborers in mining, construction, manufacturing an	5.73
Bachelor of Science in Industrial Technology	Customer service clerks	5.21
Bachelor of Science in Industrial Technology	Electrical and electronics trades workers	5.21
Bachelor of Science in Industrial Technology	Teaching professionals	3.65
Bachelor of Science in Industrial Technology	Information and communications technician	3.13
Bachelor of Science in Industrial Technology	Personal service workers	2.08
Bachelor of Science in Industrial Technology	Stationary plant and machine operators	2.08
Bachelor of Science in Industrial Technology	Science and engineering professionals	1.56
Bachelor of Science in Industrial Technology	Business and administration professionals	1.56
Bachelor of Science in Industrial Technology	Information and communication technology professio	1.56
Bachelor of Science in Industrial Technology	Legal, social, cultural and related professionals	1.56
Bachelor of Science in Industrial Technology	Numerical and material recording clerks	1.56
Bachelor of Science in Industrial Technology	Protective services workers	1.56
Bachelor of Science in Industrial Technology	Production and specialized services managers	1.04
Bachelor of Science in Industrial Technology	Other clerical support workers	1.04
Bachelor of Science in Industrial Technology	Building and related trades workers, excluding ele	1.04
Bachelor of Science in Industrial Technology	Assemblers	1.04
Bachelor of Science in Industrial Technology	Cleaners and helpers	1.04
Bachelor of Science in Industrial Technology	Refuse workers and other elementary workers	1.04

Bachelor of Science in Industrial Technology	Commissioned armed forces officers	0.52
Bachelor of Science in Industrial Technology	Chief executives, senior officials and legislators	0.52
Bachelor of Science in Industrial Technology	Health professionals	0.52
Bachelor of Science in Industrial Technology	Health associate professionals	0.52
Bachelor of Science in Industrial Technology	Market-oriented skilled forestry, fishery and hunt	0.52
Bachelor of Science in Industrial Technology	Drivers and mobile plant operators	0.52
Bachelor of Science in Industrial Technology	Food preparation assistants	0.52
Bachelor of Science in Management Engineering	Administrative and commercial managers	25.00
Bachelor of Science in Management Engineering	Production and specialized services managers	25.00
Bachelor of Science in Management Engineering	Teaching professionals	25.00
Bachelor of Science in Management Engineering	General and keyboard clerks	25.00
Bachelor of Science in Automotive Technology	Science and engineering associate professionals	16.67
Bachelor of Science in Automotive Technology	Sales workers	16.67
Bachelor of Science in Automotive Technology	Drivers and mobile plant operators	16.67
Bachelor of Science in Automotive Technology	Hospitality, retail and other services managers	8.33
Bachelor of Science in Automotive Technology	Protective services workers	8.33
Bachelor of Science in Automotive Technology	Metal, machinery and related trades workers	8.33
Bachelor of Science in Automotive Technology	Stationary plant and machine operators	8.33
Bachelor of Science in Automotive Technology	Laborers in mining, construction, manufacturing an	8.33
Bachelor of Science in Automotive Technology	Refuse workers and other elementary workers	8.33
Bachelor of Science in Mechanical Engineering	Science and engineering professionals	39.62
Bachelor of Science in Mechanical Engineering	Science and engineering associate professionals	15.09
Bachelor of Science in Mechanical Engineering	Teaching professionals	9.43

Bachelor of Science in Mechanical Engineering	Hospitality, retail and other services managers	5.66
Bachelor of Science in Mechanical Engineering	Stationary plant and machine operators	5.66
Bachelor of Science in Mechanical Engineering	Business and administration associate professional	3.77
Bachelor of Science in Mechanical Engineering	General and keyboard clerks	3.77
Bachelor of Science in Mechanical Engineering	Armed forces occupations, other ranks	1.89
Bachelor of Science in Mechanical Engineering	Administrative and commercial managers	1.89
Bachelor of Science in Mechanical Engineering	Production and specialized services managers	1.89
Bachelor of Science in Mechanical Engineering	Health professionals	1.89
Bachelor of Science in Mechanical Engineering	Business and administration professionals	1.89
Bachelor of Science in Mechanical Engineering	Information and communications technician	1.89
Bachelor of Science in Mechanical Engineering	Numerical and material recording clerks	1.89
Bachelor of Science in Mechanical Engineering	Personal service workers	1.89
Bachelor of Science in Mechanical Engineering	Drivers and mobile plant operators	1.89
Bachelor of Science in Mechanical Technology	Science and engineering associate professionals	25.00
Bachelor of Science in Mechanical Technology	Administrative and commercial managers	12.5
Bachelor of Science in Mechanical Technology	Teaching professionals	12.5
Bachelor of Science in Mechanical Technology	Business and administration associate professional	12.5
Bachelor of Science in Mechanical Technology	Metal, machinery and related trades workers	12.5
Bachelor of Science in Mechanical Technology	Stationary plant and machine operators	12.5
Bachelor of Science in Mechanical Technology	Laborers in mining, construction, manufacturing an	12.5
Bachelor of Science in Sanitary Engineering	Health professionals	100.00
Bachelor of Science in Agricultural Engineering	General and keyboard clerks	30.00
Bachelor of Science in Agricultural Engineering	Science and engineering professionals	20.00

Bachelor of Science in Agricultural Engineering	Chief executives, senior officials and legislators	10.00
Bachelor of Science in Agricultural Engineering	Teaching professionals	10.00
Bachelor of Science in Agricultural Engineering	Science and engineering associate professionals	10.00
Bachelor of Science in Agricultural Engineering	Health associate professionals	10.00
Bachelor of Science in Agricultural Engineering	Sales workers	10.00
Bachelor of Science in Forest Products Engineering	Science and engineering professionals	100.00
Bachelor of Science in Marine Engineering	Science and engineering professionals	25.93
Bachelor of Science in Marine Engineering	Drivers and mobile plant operators	25.93
Bachelor of Science in Marine Engineering	Business and administration associate professional	11.11
Bachelor of Science in Marine Engineering	Science and engineering associate professionals	7.41
Bachelor of Science in Marine Engineering	Metal, machinery and related trades workers	7.41
Bachelor of Science in Marine Engineering	Business and administration professionals	3.7
Bachelor of Science in Marine Engineering	General and keyboard clerks	3.7
Bachelor of Science in Marine Engineering	Numerical and material recording clerks	3.7
Bachelor of Science in Marine Engineering	Sales workers	3.7
Bachelor of Science in Marine Engineering	Stationary plant and machine operators	3.7
Bachelor of Science in Marine Engineering	Cleaners and helpers	3.7
Bachelor of Arts in Technology/Bachelor of Technology	Laborers in mining, construction, manufacturing an	21.05
Bachelor of Arts in Technology/Bachelor of Technology	Metal, machinery and related trades workers	15.79
Bachelor of Arts in Technology/Bachelor of Technology	Customer service clerks	10.53
Bachelor of Arts in Technology/Bachelor of Technology	Market-oriented skilled agricultural workers	10.53
Bachelor of Arts in Technology/Bachelor of Technology	Teaching professionals	5.26
Bachelor of Arts in Technology/Bachelor of Technology	Science and engineering associate professionals	5.26

Bachelor of Arts in Technology/Bachelor of Technology	Legal, social, cultural and related professionals	5.26
Bachelor of Arts in Technology/Bachelor of Technology	General and keyboard clerks	5.26
Bachelor of Arts in Technology/Bachelor of Technology	Market-oriented skilled forestry, fishery and hunt	5.26
Bachelor of Arts in Technology/Bachelor of Technology	Food processing, wood working, garment and other c	5.26
Bachelor of Arts in Technology/Bachelor of Technology	Food preparation assistants	5.26
Bachelor of Arts in Technology/Bachelor of Technology	Refuse workers and other elementary workers	5.26
Bachelor of Science in Electronics and Computer Technology	Commissioned armed forces officers	50.00
Bachelor of Science in Electronics and Computer Technology	Electrical and electronics trades workers	50.00
Bachelor of Science in Food Engineering	Numerical and material recording clerks	100.00
Bachelor of Arts in Information Technology/Bachelor in Infor	Teaching professionals	16.67
Bachelor of Arts in Information Technology/Bachelor in Infor	Information and communication technology professio	16.67
Bachelor of Arts in Information Technology/Bachelor in Infor	Science and engineering associate professionals	16.67
Bachelor of Arts in Information Technology/Bachelor in Infor	Information and communications technician	16.67
Bachelor of Arts in Information Technology/Bachelor in Infor	Customer service clerks	16.67
Bachelor of Arts in Information Technology/Bachelor in Infor	Numerical and material recording clerks	16.67
Bachelor of Science in Computer Science	General and keyboard clerks	24.61
Bachelor of Science in Computer Science	Customer service clerks	11.67
Bachelor of Science in Computer Science	Information and communication technology professio	10.41
Bachelor of Science in Computer Science	Sales workers	9.46
Bachelor of Science in Computer Science	Business and administration associate professional	8.83
Bachelor of Science in Computer Science	Information and communications technician	4.42
Bachelor of Science in Computer Science	Hospitality, retail and other services managers	3.47

Bachelor of Science in Computer Science	Teaching professionals	3.47
Bachelor of Science in Computer Science	Numerical and material recording clerks	3.15
Bachelor of Science in Computer Science	Administrative and commercial managers	2.84
Bachelor of Science in Computer Science	Production and specialized services managers	1.89
Bachelor of Science in Computer Science	Business and administration professionals	1.89
Bachelor of Science in Computer Science	Legal, social, cultural and related professionals	1.58
Bachelor of Science in Computer Science	Protective services workers	1.58
Bachelor of Science in Computer Science	Chief executives, senior officials and legislators	0.95
Bachelor of Science in Computer Science	Legal, social and cultural professionals	0.95
Bachelor of Science in Computer Science	Science and engineering associate professionals	0.95
Bachelor of Science in Computer Science	Health associate professionals	0.95
Bachelor of Science in Computer Science	Personal service workers	0.95
Bachelor of Science in Computer Science	Laborers in mining, construction, manufacturing an	0.95
Bachelor of Science in Computer Science	Other clerical support workers	0.63
Bachelor of Science in Computer Science	Market-oriented skilled agricultural workers	0.63
Bachelor of Science in Computer Science	Electrical and electronics trades workers	0.63
Bachelor of Science in Computer Science	Food processing, wood working, garment and other c	0.63
Bachelor of Science in Computer Science	Drivers and mobile plant operators	0.63
Bachelor of Science in Computer Science	Refuse workers and other elementary workers	0.63
Bachelor of Science in Computer Science	4	0.32
Bachelor of Science in Computer Science	Science and engineering professionals	0.32
Bachelor of Science in Computer Science	Stationary plant and machine operators	0.32
Bachelor of Science in Computer Science	Assemblers	0.32

Bachelor of Science in Computer Studies	Personal service workers	100.00
Bachelor of Science in Information System/Management	Business and administration associate professional	22.73
Bachelor of Science in Information System/Management	General and keyboard clerks	18.18
Bachelor of Science in Information System/Management	Customer service clerks	13.64
Bachelor of Science in Information System/Management	Numerical and material recording clerks	13.64
Bachelor of Science in Information System/Management	Chief executives, senior officials and legislators	4.55
Bachelor of Science in Information System/Management	Hospitality, retail and other services managers	4.55
Bachelor of Science in Information System/Management	Business and administration professionals	4.55
Bachelor of Science in Information System/Management	Information and communications technician	4.55
Bachelor of Science in Information System/Management	Other clerical support workers	4.55
Bachelor of Science in Information System/Management	Personal service workers	4.55
Bachelor of Science in Information System/Management	Cleaners and helpers	4.55
Bachelor of Science in Information Technology	General and keyboard clerks	19.92
Bachelor of Science in Information Technology	Information and communication technology professio	12.27
Bachelor of Science in Information Technology	Sales workers	9.26
Bachelor of Science in Information Technology	Customer service clerks	9.05
Bachelor of Science in Information Technology	Business and administration associate professional	8.85
Bachelor of Science in Information Technology	Hospitality, retail and other services managers	5.43
Bachelor of Science in Information Technology	Information and communications technician	4.23
Bachelor of Science in Information Technology	Teaching professionals	4.02
Bachelor of Science in Information Technology	Science and engineering associate professionals	3.82
Bachelor of Science in Information Technology	Numerical and material recording clerks	3.82
Bachelor of Science in Information Technology	Administrative and commercial managers	2.21

Bachelor of Science in Information Technology	Production and specialized services managers	2.01
Bachelor of Science in Information Technology	Business and administration professionals	2.01
Bachelor of Science in Information Technology	Other clerical support workers	2.01
Bachelor of Science in Information Technology	Science and engineering professionals	1.21
Bachelor of Science in Information Technology	Health associate professionals	1.21
Bachelor of Science in Information Technology	Stationary plant and machine operators	1.21
Bachelor of Science in Information Technology	Protective services workers	1.01
Bachelor of Science in Information Technology	Legal, social, cultural and related professionals	0.80
Bachelor of Science in Information Technology	Personal service workers	0.80
Bachelor of Science in Information Technology	Electrical and electronics trades workers	0.60
Bachelor of Science in Information Technology	Cleaners and helpers	0.60
Bachelor of Science in Information Technology	Commissioned armed forces officers	0.40
Bachelor of Science in Information Technology	Assemblers	0.40
Bachelor of Science in Information Technology	Agricultural, forestry and fishery laborers	0.40
Bachelor of Science in Information Technology	Laborers in mining, construction, manufacturing an	0.40
Bachelor of Science in Information Technology	Armed forces occupations, other ranks	0.20
Bachelor of Science in Information Technology	Chief executives, senior officials and legislators	0.20
Bachelor of Science in Information Technology	Legal, social and cultural professionals	0.20
Bachelor of Science in Information Technology	Personal care workers	0.20
Bachelor of Science in Information Technology	Market-oriented skilled agricultural workers	0.20
Bachelor of Science in Information Technology	Handicraft and printing workers	0.20
Bachelor of Science in Information Technology	Food processing, wood working, garment and other c	0.20
Bachelor of Science in Information Technology	Drivers and mobile plant operators	0.20

Bachelor of Science in Information Technology	84	0.20
Bachelor of Science in Information Technology	Refuse workers and other elementary workers	0.20
Bachelor of Science in Management Information System	Information and communication technology professio	33.33
Bachelor of Science in Management Information System	Business and administration associate professional	33.33
Bachelor of Science in Management Information System	Protective services workers	33.33
Bachelor of Science in Computer Data Processing and Informat	Production and specialized services managers	50.00
Bachelor of Science in Computer Data Processing and Informat	Business and administration associate professional	50.00
Bachelor of Science in Mathematics	Teaching professionals	50.00
Bachelor of Science in Mathematics	General and keyboard clerks	16.67
Bachelor of Science in Mathematics	Customer service clerks	8.33
Bachelor of Science in Mathematics	Business and administration professionals	4.17
Bachelor of Science in Mathematics	Business and administration associate professional	4.17
Bachelor of Science in Mathematics	Legal, social, cultural and related professionals	4.17
Bachelor of Science in Mathematics	Sales workers	4.17
Bachelor of Science in Mathematics	Protective services workers	4.17
Bachelor of Science in Mathematics	Assemblers	4.17
Bachelor of Science in Mathematics for Teachers	Teaching professionals	75.00
Bachelor of Science in Mathematics for Teachers	Protective services workers	25.00
Bachelor of Science in Applied Mathematics	Teaching professionals	100
Bachelor of Science in Statistics	Teaching professionals	66.67
Bachelor of Science in Statistics	Customer service clerks	33.33
Bachelor of Science in Community/Public Health	Hospitality, retail and other services managers	25.00
Bachelor of Science in Community/Public Health	Health professionals	25.00
Bachelor of Science in Community/Public Health	Health associate professionals	25.00
Bachelor of Science in Community/Public Health	General and keyboard clerks	25.00
Bachelor of Science in Physical Therapy	Health professionals	33.33
Bachelor of Science in Physical Therapy	Hospitality, retail and other services managers	16.67

Bachelor of Science in Physical Therapy	Legal, social, cultural and related professionals	16.67
Bachelor of Science in Physical Therapy	Customer service clerks	16.67
Bachelor of Science in Physical Therapy	Personal care workers	16.67
Bachelor of Science in Speech Pathology	Health professionals	100.00
Bachelor of Science in Nursing	Health professionals	53.36
Bachelor of Science in Nursing	Customer service clerks	6.78
Bachelor of Science in Nursing	Hospitality, retail and other services managers	5.28
Bachelor of Science in Nursing	Sales workers	4.31
Bachelor of Science in Nursing	General and keyboard clerks	4.25
Bachelor of Science in Nursing	Business and administration associate professional	3.73
Bachelor of Science in Nursing	Health associate professionals	3.56
Bachelor of Science in Nursing	Teaching professionals	2.70
Bachelor of Science in Nursing	Personal care workers	2.30
Bachelor of Science in Nursing	Protective services workers	2.30
Bachelor of Science in Nursing	Administrative and commercial managers	1.84
Bachelor of Science in Nursing	Business and administration professionals	1.72
Bachelor of Science in Nursing	Legal, social, cultural and related professionals	1.03
Bachelor of Science in Nursing	Numerical and material recording clerks	0.92
Bachelor of Science in Nursing	Legal, social and cultural professionals	0.75
Bachelor of Science in Nursing	Other clerical support workers	0.57
Bachelor of Science in Nursing	Science and engineering associate professionals	0.52
Bachelor of Science in Nursing	Chief executives, senior officials and legislators	0.46
Bachelor of Science in Nursing	Production and specialized services managers	0.40
Bachelor of Science in Nursing	Information and communications technician	0.40
Bachelor of Science in Nursing	Personal service workers	0.40
Bachelor of Science in Nursing	Drivers and mobile plant operators	0.40
Bachelor of Science in Nursing	Food processing, wood working, garment and other c	0.29
Bachelor of Science in Nursing	Armed forces occupations, other ranks	0.23

Bachelor of Science in Nursing	Science and engineering professionals	0.23
Bachelor of Science in Nursing	Information and communication technology professio	0.23
Bachelor of Science in Nursing	Commissioned armed forces officers	0.11
Bachelor of Science in Nursing	Market-oriented skilled agricultural workers	0.11
Bachelor of Science in Nursing	Stationary plant and machine operators	0.11
Bachelor of Science in Nursing	Cleaners and helpers	0.11
Bachelor of Science in Nursing	Agricultural, forestry and fishery laborers	0.11
Bachelor of Science in Nursing	Laborers in mining, construction, manufacturing an	0.11
Bachelor of Science in Nursing	Non-commissioned armed forces officers	0.06
Bachelor of Science in Nursing	28	0.06
Bachelor of Science in Nursing	Market-oriented skilled forestry, fishery and hunt	0.06
Bachelor of Science in Nursing	Handicraft and printing workers	0.06
Bachelor of Science in Nursing	Electrical and electronics trades workers	0.06
Bachelor of Science in Nursing	Assemblers	0.06
Bachelor of Science in Radiologic Technology	Health associate professionals	54.55
Bachelor of Science in Radiologic Technology	Health professionals	27.27
Bachelor of Science in Radiologic Technology	Teaching professionals	9.09
Bachelor of Science in Radiologic Technology	General and keyboard clerks	9.09
Bachelor of Science in Medical Technology	Health associate professionals	94.12
Bachelor of Science in Medical Technology	Production and specialized services managers	5.88
Doctor of Dental Medicine	Health professionals	100.00
Bachelor of Science in Industrial Pharmacy	Teaching professionals	100.00
Bachelor of Science in Pharmacy	Health professionals	68.00
Bachelor of Science in Pharmacy	Sales workers	8.00
Bachelor of Science in Pharmacy	Hospitality, retail and other services managers	4.00
Bachelor of Science in Pharmacy	Teaching professionals	4.00
Bachelor of Science in Pharmacy	Health associate professionals	4.00
Bachelor of Science in Pharmacy	General and keyboard clerks	4.00
Bachelor of Science in Pharmacy	Customer service clerks	4.00

Bachelor of Science in Pharmacy	Personal care workers	4.00
Bachelor of Science in Nutrition and Dietetics	Health professionals	80.00
Bachelor of Science in Nutrition and Dietetics	Hospitality, retail and other services managers	20.00
Bachelor of Science in Rural Medicine	Health professionals	100.00
Bachelor of Science in Physiology	Teaching professionals	100.00
Bachelor of Science in Biology	Teaching professionals	23.64
Bachelor of Science in Biology	Sales workers	12.73
Bachelor of Science in Biology	Business and administration associate professional	10.91
Bachelor of Science in Biology	Administrative and commercial managers	7.27
Bachelor of Science in Biology	Hospitality, retail and other services managers	7.27
Bachelor of Science in Biology	General and keyboard clerks	7.27
Bachelor of Science in Biology	Health professionals	5.45
Bachelor of Science in Biology	Customer service clerks	5.45
Bachelor of Science in Biology	Business and administration professionals	3.64
Bachelor of Science in Biology	Production and specialized services managers	1.82
Bachelor of Science in Biology	Science and engineering professionals	1.82
Bachelor of Science in Biology	Legal, social and cultural professionals	1.82
Bachelor of Science in Biology	Health associate professionals	1.82
Bachelor of Science in Biology	Numerical and material recording clerks	1.82
Bachelor of Science in Biology	Other clerical support workers	1.82
Bachelor of Science in Biology	Personal service workers	1.82
Bachelor of Science in Biology	Personal care workers	1.82
Bachelor of Science in Biology	Market-oriented skilled forestry, fishery and hunt	1.82
Bachelor of Science in Marine Biology	Sales workers	50.00
Bachelor of Science in Marine Biology	General and keyboard clerks	25.00
Bachelor of Science in Marine Biology	Protective services workers	25.00
Bachelor of Science in Bio-Chemistry	Teaching professionals	100.00
Bachelor of Science in Chemistry for Teachers	Teaching professionals	100.00
Bachelor of Science in Chemistry	Administrative and commercial managers	20.00
Bachelor of Science in Chemistry	Teaching professionals	20.00
Bachelor of Science in Chemistry	Science and engineering associate professionals	20.00
Bachelor of Science in Chemistry	General and keyboard clerks	20.00

Bachelor of Science in Chemistry	Laborers in mining, construction, manufacturing an	20.00
Bachelor of Science in Applied Physics	Science and engineering professionals	100.00
Bachelor of Science in Physics	Teaching professionals	50.00
Bachelor of Science in Physics	Customer service clerks	50.00

Data Source: 2014 PIDS-CHED Graduates Tracer Study